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PACKAGING OF MATERIEL

PACKING

(VOLUME II)

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(VOLUME II)

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INTRODUCTION

1. Purpose and Scope

a. Purpose. This publication contains information on the fundamental principles and approved methods and techniques used in the protection of military supplies and equipment against deterioration and damage during shipment and storage. It is published as an official document for use in operations and in the training of military and civilian personnel from all segments of the Department of Defense and supporting agencies, as well as for interested industrial personnel. It contains information based on specifications, standards, and other pertinent documents, current as of the date of preparation and coordination of the publication.

NOTE

For Air Force use, this publication is nondirective in nature.

b. Scope. This manual complements Volume I, Packaging of Materiel, to emphasize the importance of packing of military supplies and equipment. It contains detailed information concerning the requirements to accomplish packing operations. The requirements include use of exterior shipping containers; the assembling of items or packs into the container; anchoring, blocking, bracing, and cushioning of items or packages within the container; weatherproofing; strapping of containers; the testing of exterior packs; palletized and unitized loads; parcel post; and related subject matter. General exterior marking in accordance with MIL-STD-129 is discussed. Carloading is not included to avoid unnecessary duplication of the Association of American Railroad publications.

2. Changes and Revisions

a. Changes or revisions to this manual, due to major changes in packing concepts, policies and doctrine, and revision of specifications and other official publications, will be made on a continuing basis, as required. Information contained herein is current as of June 1984.

b. Users are encouraged to submit recommended changes or comments to improve this manual. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028 (Recommended Changes to Publications and Blank Forms) or appropriate service form and forwarded direct to Director, Joint Military Packaging Training Center, Aberdeen Proving Ground, MD 21005.

3. Objectives of Military Packing

The objectives for achieving uniform packing of items of military supply are to—

a. Insure optimum life, utility and performance of materiel through prevention or deterioration or damage.

b. Support the materiel readiness posture of DOD.

c. Provide for efficient receipt, storage, inventory, transfer and issue of materiel.

d. Assure that marking requirements are kept at the minimum necessary for effective identification, handling, shipment and storage.

e. Effect economies by requiring the use of packs which yield lowest overall cost to the total DOD distribution system consistent with known or anticipated shipment, handling and storage conditions. Considerations will include—

(1) Standardization to minimum variety of materials, methods of preservation, and documentation.

(2) Accomplishment with optimum amount of automated operations.

(3) Minimum weight and cube.

(4) Use of modular containers.

(5) Handling by unitized load configuration.

(6) Use of containerization.

(7) Exploitation of new materials, methods, and techniques.

(8) Disposability of packaging materials.

4. Hazards Encountered in Transportation, Handling, and Storage

Military supplies and equipment must be protected against pilferage and damage due to force and exposure, not only until they reach their ultimate destination, but until the items are placed into actual use or service. Force and exposure will reduce the useful lifespan of the item or cause the

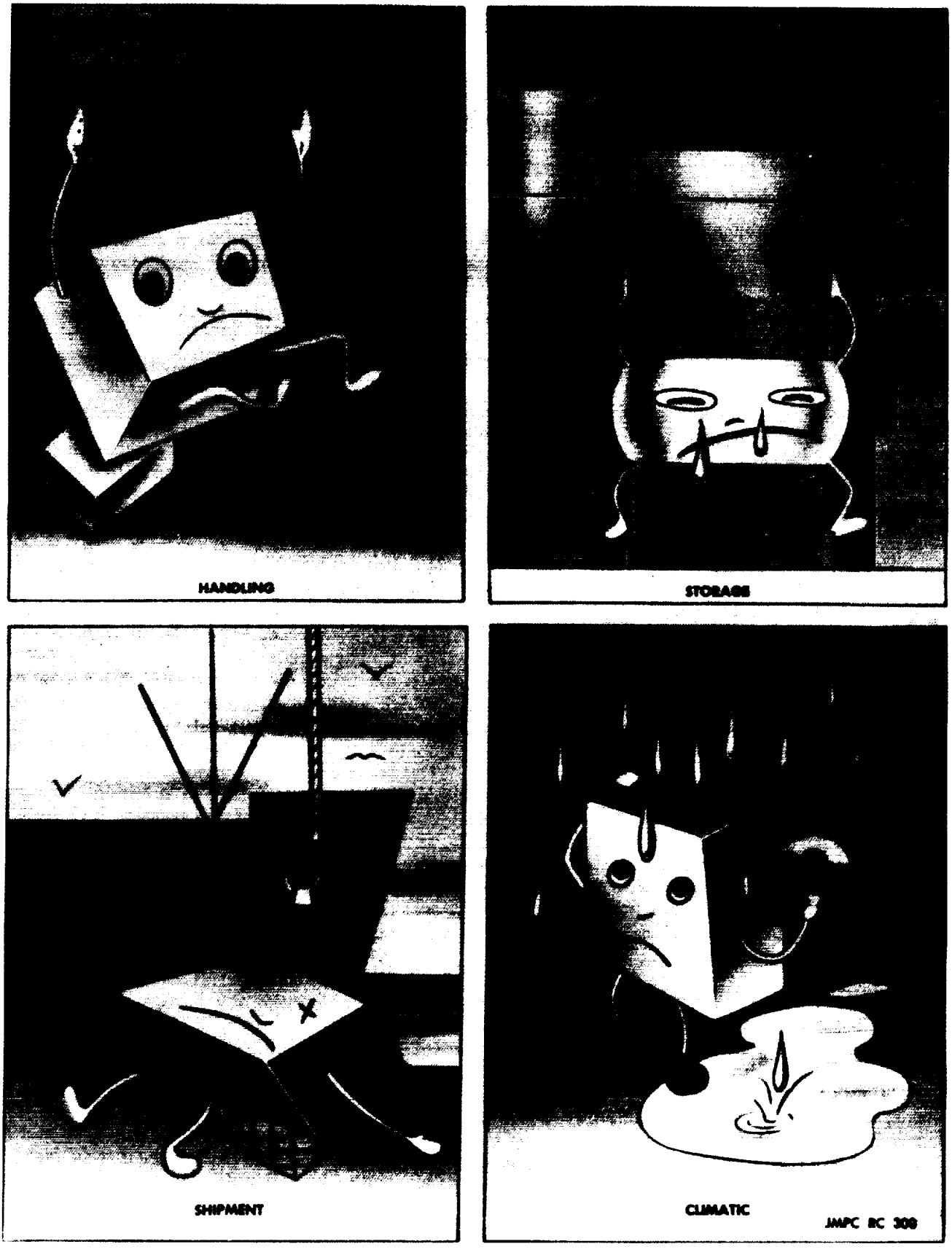


Figure 1. Hazards encountered by military packs.

item to be damaged beyond repair. The objective of packing is to extend the lifespan of the item so that depreciation starts, not when it leaves the manufacturing plant, but when it is placed into service.

a. Force. Damage may result from hazardous forces encountered in transportation, handling, and storage (fig. 1).

(1) Transportation hazards involve forces encountered through rail, truck, boat, or air shipments.

(a) Damage can result from abrupt starts and stops.

(b) Damage can be caused by vibration and jolting.

(2) Handling forces involve those damaging forces received through loading, unloading, and handling during storage operations. Examples of handling where damage often occurs are—

(a) Manual handling—dropping and puncture.

(b) Forklift truck handling—dropping and puncture.

(c) Cargo nets—dropping, crushing, and wracking.

(d) Grab hooks—crushing and puncture.

(e) Slings—crushing, dropping, and wracking.

(f) Conveyors—jarring, smashing, and dropping.

(3) Storage forces involve those forces resulting from the crushing effect of superimposed loads through stacking.

b. Exposure. Exposure to the different climatic conditions and weather hazards, such as high humidity, rain, salt spray, extreme cold, dry intense heat, and the cycling of these weather conditions, will tend to accelerate the breakdown or deterioration of unprotected items.

c. Pilferage. Theft of military supplies and equipment while in transit or storage is a significant problem for the military. Small items of high value are especially vulnerable to pilferage and should be protected as much as possible through packing techniques. If equipment or supplies are especially susceptible to pilferage see section IV, FM 19-30.

d. Counteraction of Packs of Hazards. Items which are packed properly will resist the damaging effects of force and exposure.

(1) Force is counteracted by—

(a) Using rigid shipping containers.

(b) Immobilizing the item within the container through anchoring, blocking, and bracing.

(c) Damping forces through the use of cushioning materials and devices.

(d) Reinforcing shipping containers with metal and nonmetallic strapping.

(2) Exposure is counteracted by the use of—

(a) Weather-resistant shipping containers.

(b) Waterproof barrier materials in various applications.

5. Necessity for a Packing Policy

To attain economy, efficiency, and uniformity in packing, and to provide a uniform procedure in connection with procurement, the departments and agencies of the Department of Defense must have a common packing policy. This is provided by the Department of Defense in Department of Defense Instruction 4100.14, "Packaging of Materiel."

6. Military Regulations

Department of Defense Instruction 4100.14 is implemented by a joint regulation developed by the Department of the Army in coordination with the Defense Logistics Agency, the Department of the Navy, the Department of the Air Force, and the Marine Corps (AR700-15/NAVSUPINST 4030.28A/AFR 71-6/MCO 4030.33A/DLAR 4145.7). This document provides guidance for the development of service preservation, packing and marking requirements to be included in specifications and procurement documents. It is not referenced in contracts, specifications or other instruments for negotiation with industry.

7. Military Packaging Levels of Protection and Industrial/Commercial Packaging

a. Concept of Military Levels of Protection. In regard to requirements for packing, the military services for many years relied heavily on the terms "domestic" and "overseas." Experience proved that for military purposes, these words were vague generalities with no clear-cut meaning to them. Suppliers were often perplexed when confronted with oversea requirements for items destined for domestic installations. It was not apparent to them that the domestic destinations were merely initial receiving points for projected oversea shipments, or that storage and handling conditions were severe enough to justify an oversea type of packing regardless of destination. To permit the military services to state their requirements more objectively, the concept of levels of protection was adopted. The level selected shall be adequate, but not in excess, to assure delivery of supplies to their user in satisfactory condition (fig 2). The following levels of protection apply equally to preservation and packing:

(1) *Level A (maximum protection).* Level A packing provides protection for material under the most severe worldwide shipment, handling, and storage conditions. Packing will be designed to

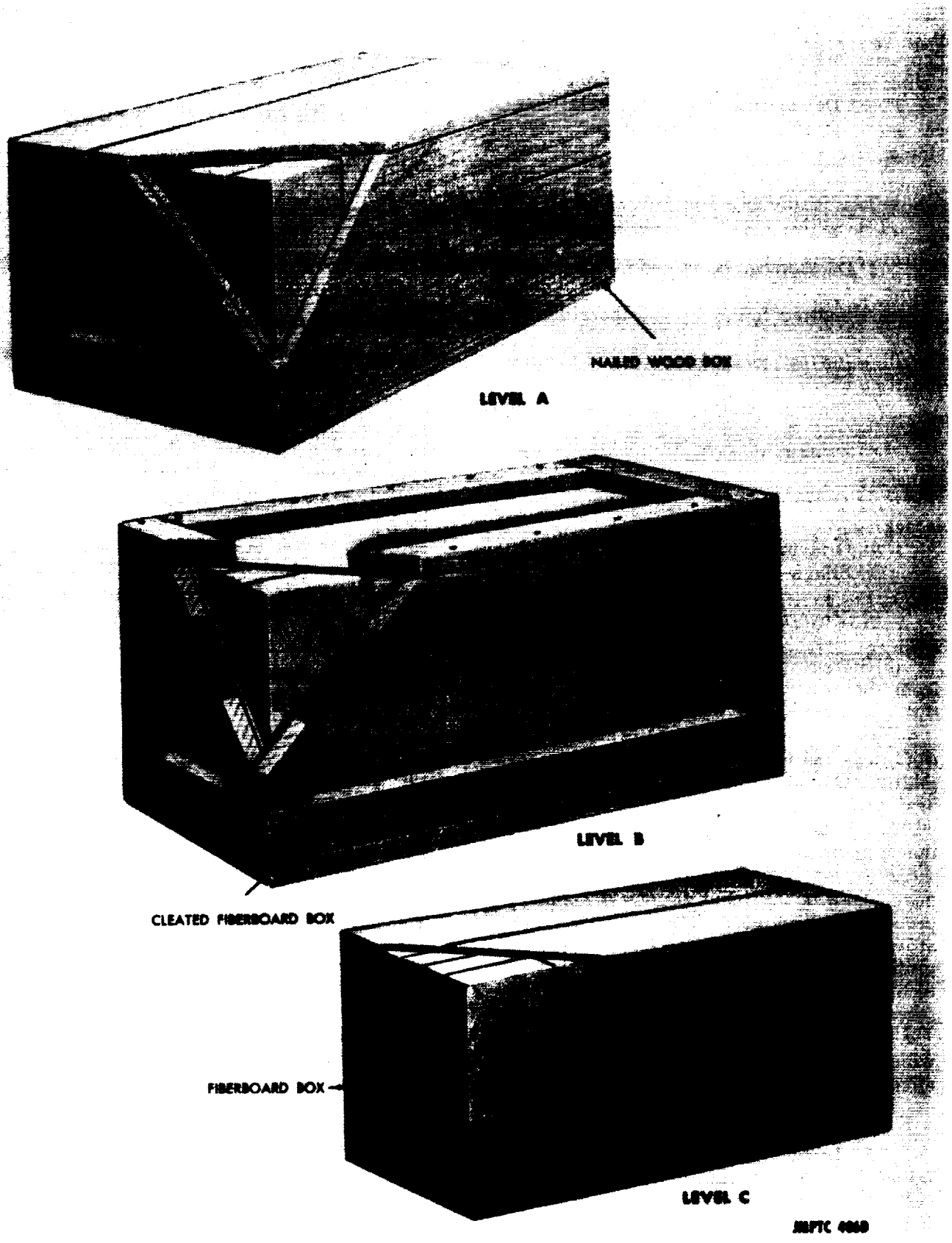


Figure 2. Examples of levels of protection.

protect materiel against direct exposure to extremes of climate, terrain, and operational and transportation environments, without protection other than that provided by the pack.

(2) *Level B (intermediate protection).* Level B packing provides protection for materiel under anticipated favorable conditions of worldwide shipment, handling, and storage.

(3) *Level C (minimum protection).* Level C packing provides protection for materiel under known favorable conditions.

b. Guidelines. For the judicious establishment of requirements for level A, B, or C packaging to be included in specifications, invitations for bids, contracts, orders, etc., the military services have agreed upon the following guidelines:

(1) *Level A.*

(a) Multiple handling during transportation and intransit storage from point of origin to ultimate user.

(b) Shock, vibration and static loading during shipment.

(c) Loading on shipdeck, transfer at sea, helicopter delivery, and offshore or over-the-beach discharge to ultimate user.

(d) Environmental exposure during shipment or during intransit operations where port and warehouse facilities are limited or non-existent.

(e) Outdoor storage in all climatic conditions for a minimum of 1 year.

(f) Static loads imposed by stacking.

(2) *Level B.*

(a) Multiple handling during transportation and intransit storage.

(b) Stock, vibration and static loading of shipment worldwide by truck, rail, aircraft, or ocean transport.

(c) Favorable warehouse environment for a minimum of 18 months.

(d) Environmental exposure during shipment and intransit transfers, excluding deckloading and offshore cargo discharge.

(e) Stacking and supporting superimposed loads during shipment and extended storage.

(3) *Level C.*

(a) Use or consumption of the item at the first destination.

(b) Shock, vibration, and static loading during the limited transportation cycle.

(c) Favorable warehouse environment for a maximum of 18 months.

(d) Effects of environmental exposure during shipment and intransit delays.

(e) Stacking and supporting superimposed loads during shipment and temporary storage.

c. Industrial/Commercial Packaging. Industrial/commercial packaging is defined as the materials and methods used by the supplier to meet the requirements of the distribution systems serving both DOD and industrial consumers.

(1) Industrial packaging will be acceptable for any level of protection when the technical design of the package meets all conditions of the level of protection specified.

(2) It must provide the same level of protection against physical and environmental damage as the military package.

(3) It will be marked to the level it meets.

(4) Use of industrial packaging is contingent upon no increase in packaging charges, size, weight, or delay in delivery.

(5) Bulk practices used in interplant and intraplant movements or shipments to jobbers are not acceptable unless they are the usual trade practices for individual commodities such as coal, textiles, petroleum, and subsistance.

(6) The packaging details will be incorporated into standardization and acquisition documents when applicable.

(7) ASTM D 3951, Standard Practice for Commercial Packaging may be used when appropriate.

8. Has been deleted.

9. Standard Definitions

The definitions for the key packing terms used in this volume will be found in ASTM D 996, Standard Definitions of Terms Relating to Packaging and Distribution Environments, and MIL-STD-2073-1, DOD Materiel Procedures for Development and Application of Packaging Requirements. Technical progress and understanding among interested Government agencies, industrial concerns, and individuals are greatly facilitated when use is made of basic terms which have been standardized.

10. Other Definitions

a. Bolting Down. It is the securing of an item to the base of a shipping container by means of bolts applied through regular mounting holes in the item. Bolting down is one of several forms of anchoring.

b. Containerization. The use of transport containers (container express (CONEX), military-

owned demountable container (MILVAN), commercial or Government-owned (or leased) shipping container (SEAVAN), and roll on/roll off (RORO) trailer) to unitize cargo for transportation, supply, and storage. Containerization aids carriage of goods by one or more modes of transportation without the need for intermediate handling of the contents. Containerization incorporates supply, security, packaging, storage, and transportation into the distribution system from source to user

c. End Grain. Either of the two surfaces exposed when a piece of lumber is cut crosswise (across the grain).

e. Exterior pack. A container, bundle, or assembly which is sufficient by design and construction to protect unit and intermediate packs and contents during shipment and storage. This can be a unit pack or a container with any combination of unit or intermediate packs.

f. Fragility. The inherent physical properties of an item that limit its ability to withstand shock or vibration without damage.

g. Holddown. The securing of an item to the base of a shipping container by applying lumber or metal over all or part of the item, and then tensioning, or otherwise locking down the lumber or metal in a manner that prevents movement of the item within the container. Holddown is one of the means of anchoring often used synonymously with tie down.

h. Humping. Deleted.

i. Intermediate Pack. A wrap, box, or bundle which contains two or more unit packs of identical items.

j. Marking. Application of numbers, letters, labels, tags, symbols, or colors for handling of identification during shipment and storage.

k. Mechanical Damage. Damage resulting from any direct or indirect force which may impair the mechanical or operating function of the item. Some of the causes of physical and mechanical damage are illustrated in figure 1.

l. Military Packaging. The materials and methods prescribed in Federal or military specifications, standards, drawings, or other authorized documents which are designed to provide the packaging necessary for the prescribed level of protection.

m. Packaging. The processes and procedures used to protect materiel from deterioration and/or damage. It includes cleaning, drying, preserving, packing, marking, and unitization.

n. Packing. Assembling of items into a unit, intermediate, or exterior pack with necessary blocking, bracing, cushioning, weatherproofing, reinforcement, and marking (see fig 3).

o. Physical Damage. Damage from internal or external forces which results in breakage, denting, marring, distortion, displacement, or abrasion.

p. Preservation. Application of protective measures, including cleaning, drying, preservative materials, barrier materials, cushioning, and containers when necessary.

q. Specification. A clear and accurate description of the technical requirements for a material, a product, or a service, including the procedure by which it can be determined that the requirements have been met. Specifications are often referenced in purchase orders, invitations for bids, supply manuals, and other procurement documents when the Government buys from industry.

r. Standard. A document that establishes engineering and technical limitations and applications for items, materials, processes, methods, designs and engineering practices.

s. Tiedown. The securing of an item to the base of a shipping container by attaching tensioning devices, such as strapping or wire, to or over the item. This is a form of anchoring.

t. Type of Load. The term "type of load" refers to the physical characteristics of the item, including the nature of the item as it contributes to the support of, or damage to, the container. The same kind of container can be designed to provide adequate protection to various items by adjusting the constructional requirements. This may result in a light-, medium-, or heavy-duty container, as necessary. The design of the shipping container to be used is influenced by the type of load. There are three types of loads: Type 1, Type 2 and Type 3. The types of loads will be mentioned under the various shipping containers and in section I (fig 4).

(1) Type 1—easy load. The load is a single item or single interior container which provides complete and uniform support to all faces of the shipping container. The contents are of moderate density and relatively sturdy. Some examples are wood or metal chests, tool kits, and canned and boxed items packed in a fiberboard box which completely fills the shipping container.

(2) Type 2—average load. The load is composed of more than one item or interior container which give some support to all faces of the shipping container. The contents are of moderate density and relatively sturdy. Some examples are goods in metal cans which are not packed in an interior

container, bottles individually cushioned, hardware in cartons, etc.

(3) Type 3—difficult load. The load gives little or no support to the shipping container. The contents can be extremely heavy, very fragile, very irregular in shape, bulk materials which are free to shift and flow, or a combination of several of these factors. Some examples are rivets, bolts and nuts, delicate instruments, machined parts and assemblies, etc.

u. Unit Pack. 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, which constitutes a complete or

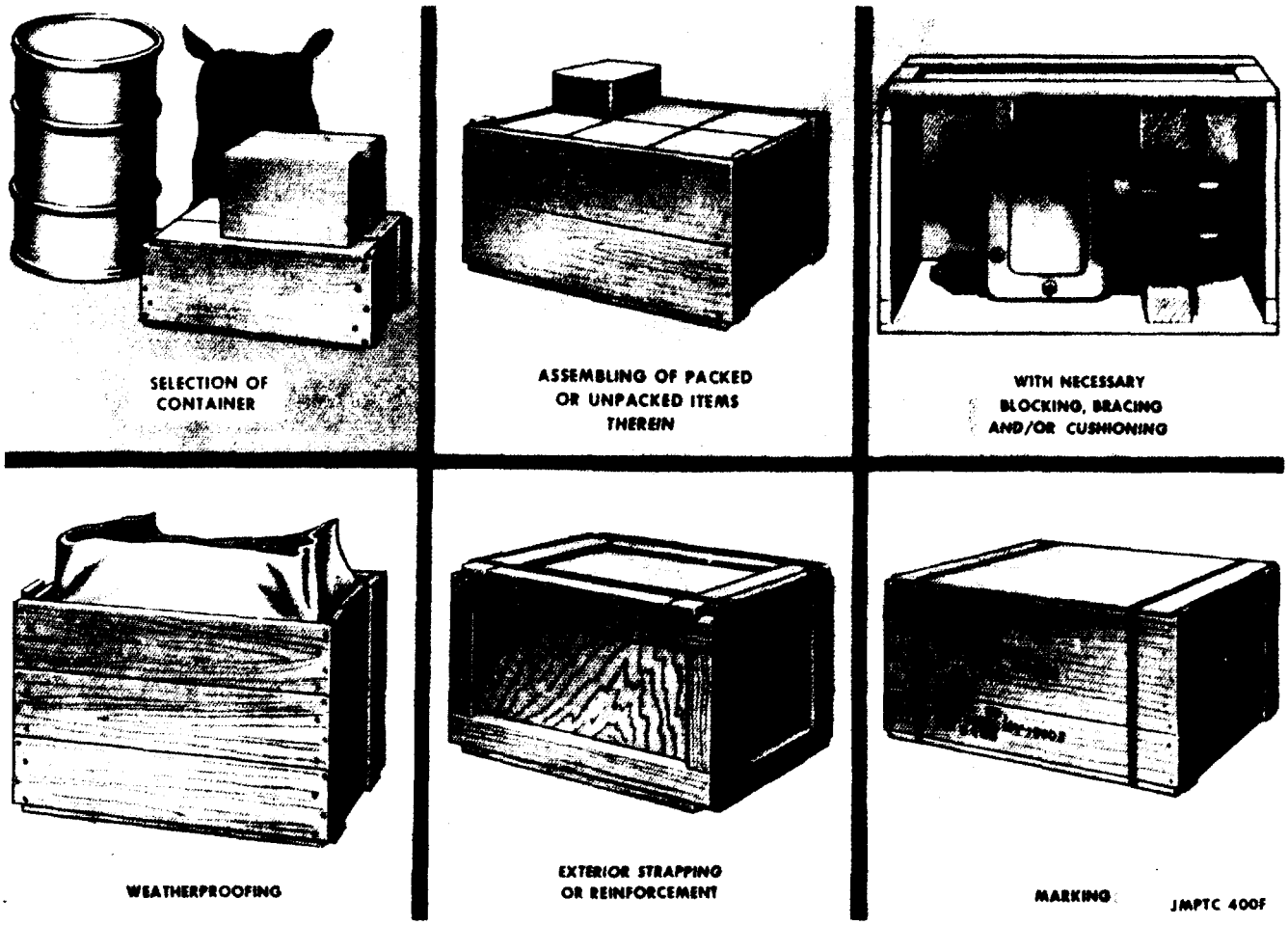


Figure 8. Operations involved in military packing.

identifiable package.

v. Unitization. Assembly of packs of one or more line items of supply into a single load in such a manner that the load can be single load in such a manner that the load can be handled as a unit through the distribution system. Unitization (unitized loads/unit loads) encompasses consolidation in a container, placement on a pallet or load base, or securely binding together.

11. Economy in Packing

The military concept of economy in packing 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 or package should be of prime concern to individuals engaged in the establishment of packing requirements, and to personnel in charge of, or performing packing operations. Figure 5 illustrates the significant savings that were accomplished by reducing the tare weight, cubage, and packing cost of a commodity through proper reengineering of the unit and exterior containers, use of newly developed materials, and employment of alternate methods and techniques.

12. References

Throughout this manual, packing materials, equipment, processes, methods, etc., are referred to by their common names together with the appropriate specification, standard, or other publication symbols. Copies of specifications and other documents required by activities of the Defense Logistics Agency, the Department of the Army, Navy, and Air Force, and the Marine Corps are obtained from supply sources through established channels. Copies of specifications, standards, and drawings required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer. Military and Federal Specifications and Standards are available from: Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, PA 19120. Information pamphlet titled "A Guide for the Private Industry" provides more detailed information and is available upon request.

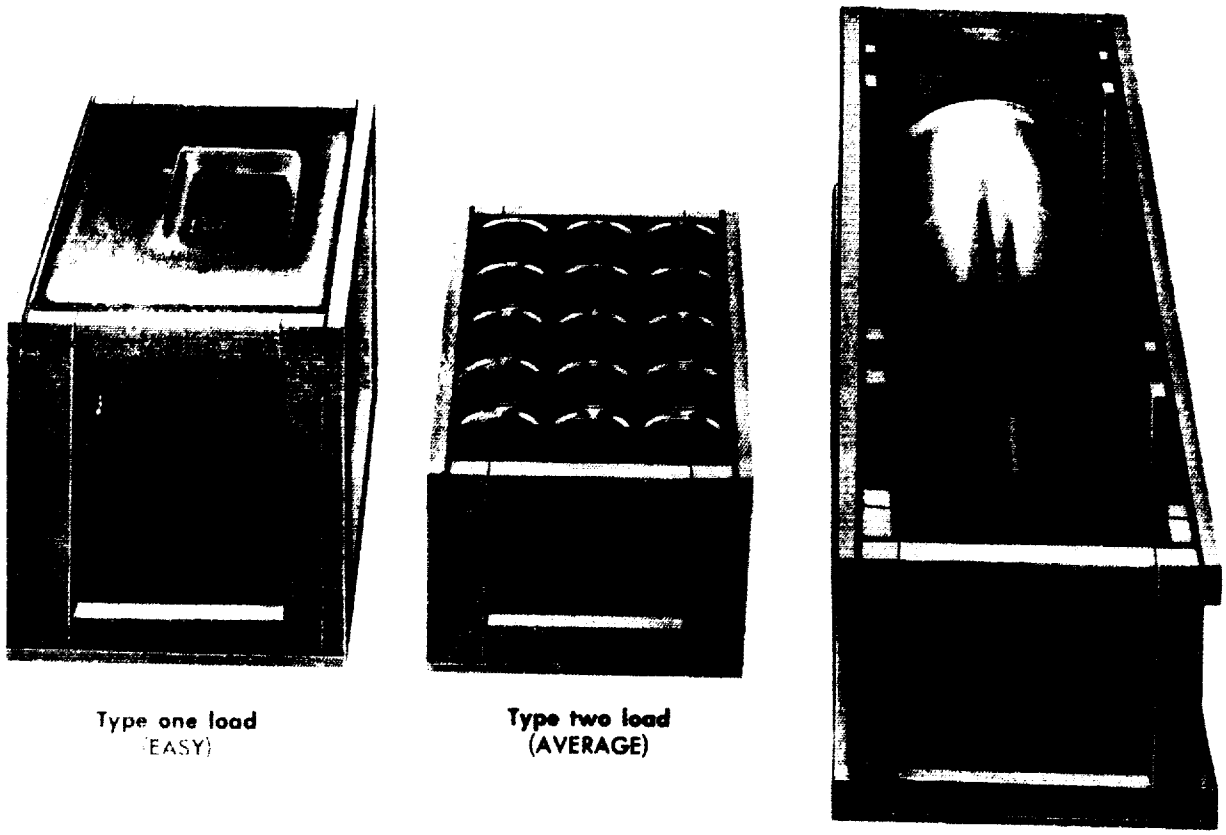


Figure 4. Types of loads

13. National Stock Numbers

General information concerning National stock numbers and their use in the Military Logistics System is found in the appendix.

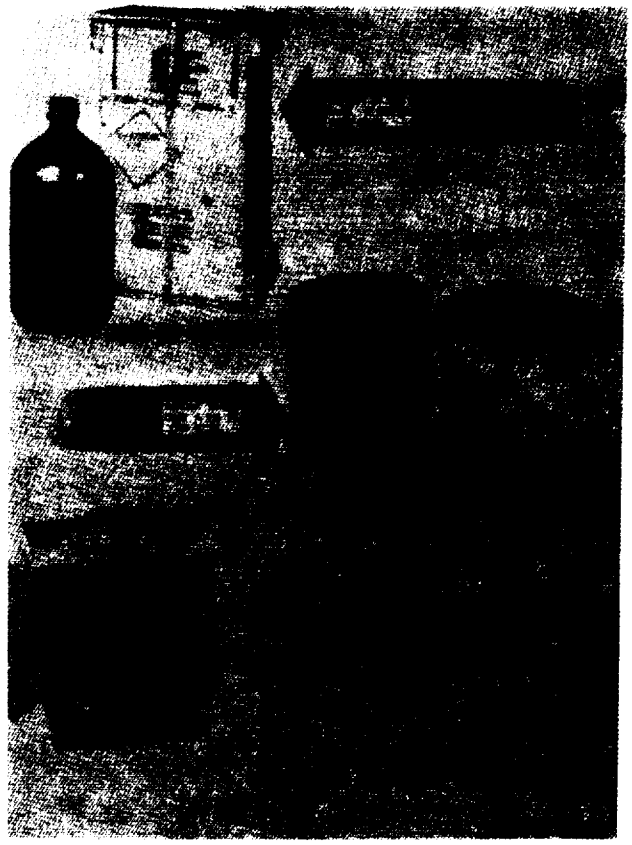


Figure 5. Savings through redesign of packs.

CHAPTER 1
PACKING

1-1. General

a. Packing of General Supplies. Some commodity items require preservation by procedures and materials described in TM 38-230, Volume I, which provide unit containers suitable for shipment without further packing. Other items may require further packing in containers suitable for shipment. This chapter relates to the packing of commodity items directly in shipping containers with whatever protection is required to prevent damage in shipment, handling and storage. The container alone cannot always provide full protection for military items. Items must be properly anchored, braced, blocked, or cushioned in the container to provide adequate protection. A container is often blamed for damage to its contents when the cushioning, blocking, or bracing are at fault (fig 1-1). Every packing operation, including the final closure, strapping, and marking of the container, must be carefully planned and executed to ensure that the contents will arrive at destination in a usable condition.

b. Packing of Hazardous Articles. Commodities classified as hazardous materials come within the scope of the Code of Federal Regulations, which incorporates Department of Transportation Regulations for the Transportation of Explosives and Other Hazardous Articles by Land and Water in Rail Freight Service and by Motor Vehicle (Highway) and Water; the Federal Aviation Administration regulations relative to the transportation of dangerous articles and magnetized materials; and the United States Coast Guard hazardous cargo regulations. In addition, hazardous materials which are to be shipped via military aircraft must be packed in accordance with the joint services manual AFR 71-4, TM 38-250, NAVSUP Pub 505, MCOP-4030.19, DLAM 4145.3.

1-2. Sequence of Packing Operations

The general sequence of military packing is divided into a series of basic operations which may include some or all of the following steps, not necessarily in the order given below:

a. Determine the Packing Requirements. Study the item characteristics (para 1-4) to determine the protection required and the best way to provide it through the use of an adequate container, suitable blocks, braces, and cushions, and appropriate barrier materials. This study will include consideration of the characteristics of the item, its size, shape, fragility, etc.; the types of loads (easy, average or difficult); the mode of transportation (rail, ship, truck, or aircraft); the storage facilities (covered or uncovered); the destination (domestic or overseas in the arctic, temperate, or tropic zones); and the levels of protection required (See Introduction para 7).

b. Select the Container. Select and use an exterior container that will comply with the requirements outlined in applicable chapters of this manual. This selection should consider all factors pertinent to giving adequate protection at a minimum cost such as the characteristics and limitations of the container; its initial cost and upkeep expenses; its weight and cube; its availability or obtainability in appropriate quantities; and its reusability.

c. Prepare Protective Barriers. Prepare an appropriate barrier to give weatherproofing protection not obtainable from the container alone.

d. Insert and Secure the Item to the Container. Insert the item and secure it to the container to control or prevent movement by means of adequate cushioning, blocking, and bracing. The distinction between cushioning and blocking and bracing is that cushioning and blocking and bracing is that cushioning permits controlled movement of the item within the container, while blocking and bracing usually is designed to prevent movement of the item within the container.

e. Seal the Barrier, if Used. Seal the barrier material by means of adhesives, heat seals, pressure seals, or sealing tape to provide weather-proofness of the seams, joints, and closures equal to that of the barrier material itself.

f. Close the Container. Close the container following the detailed requirements outlined in the section of this manual which describes the container selected.

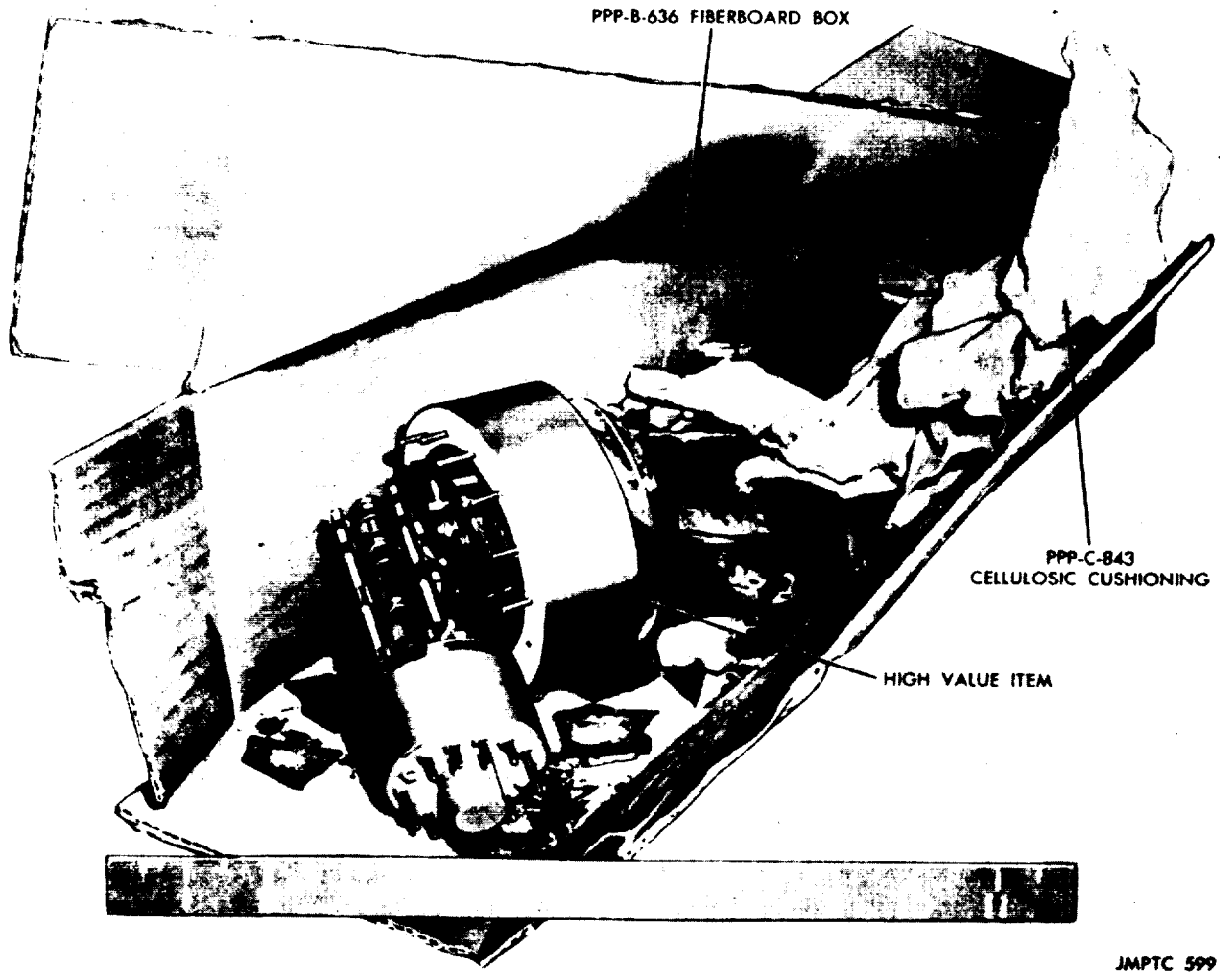


Figure 1-1. Damaged items as a result of improper/inadequate packing.

g. Reinforce the Container. Reinforce the container with metal or plastic strapping or reinforced tape as appropriate and as required for the container selected.

h. Mark the Shipping Container. Mark the container as appropriate to identify the contents and to ensure movement to its destination.

1-3. Determination of Packing Requirements

The different types of items procured by the Department of Defense require a wide variety of packing operations. Items vary from strong, rugged ones that fit the container well and require no cushioning or blocking, to others that are irregular in shape, delicate, or fragile, and require special cushioning and blocking.

a. Basic Factors. To determine packing requirements, several basic factors must be considered, namely, the item characteristics, the load characteristics, the mode of transportation, the storage and handling facilities, and the destination and field conditions.

b. Basic Reference. The basic reference for blocking, bracing, and cushioning is Military Standard 1186, Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; with Appropriate Test Methods. This standard, approved by the Department of Defense and mandatory for use by the Armed Forces, provides general requirements and procedures concerning the arrangement of the contents within the shipping container for the prevention of physical damage.

c. Scope of MIL-STD-1186. The standard covers common packing requirements which may be

omitted from detail specifications for items or categories of items when this standard is referenced in the detail specification. It does not contain requirements for shipping containers themselves or for unit packing both of which also provide physical protection. Tests for determining the adequacy of the protective measures to prevent damage to the package contents or package materials (barriers) are described in paragraph 1-24.

1-4. Item Characteristics

The first step in any packing operation is a careful study of the item to be packed. It is necessary to consider the shape, size, weight, strength, and degree of fragility of the item in all directions. The availability of mounting provisions, the degree of disassembly permissible for shipment, corrosion prevention requirements, and special use requirements which affect the packing operations must be considered.

a. Shape. The shape of the item to be packed is an important factor to consider in designing blocking and bracing. A regular-shaped item with rectangular surfaces requires a minimum of blocking, while an irregular-shaped item with uneven surfaces, including projections, often requires an elaborate blocking system. Curved surfaces require carefully fitted blocking to prevent damage caused by concentrated stresses at contact points, and to distribute internal forces over a greater area of the faces of the container (fig 1-2). Long, slender items, particularly if heavy, exert a tremendous concentrated force on the ends of the container during handling. This force may be counteracted by securely blocking the item to the sides, top, or bottom of the container, and by increasing the thickness of the ends of the container (fig 1-3). Relatively heavy, irregular-shaped small items present a particularly difficult problem when they must be cushioned as well as blocked. Generally, in solving this problem, it is desirable to even out the surfaces by means of pads and blocking to increase the bearing area. This in turn decreases the load per unit area of bearing on the cushion (fig 1-4).

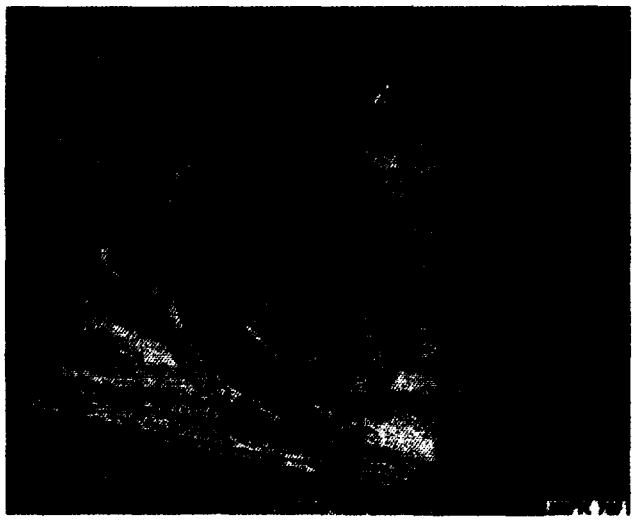


Figure 1-2. Interior blocking for an irregular-shaped item.

Figure 1-3. Interior blocking to protect container against end thrust.

b. Size and Weight. A large item may require more extensive blocking and larger amounts of cushioning than a smaller one. The blocking may be necessary to bridge the relatively wide spans of the container faces, or it may be required to distribute the cushioning over larger areas of the item. Since the impact force developed by the abrupt stopping of a moving object is directly proportional to its weight, the weight of an item is very important in considering the blocking and cushioning. In studying the item, consider the distribution of the weight with respect to the size and bearing areas. Where the weight is concentrated, it may be necessary to distribute it over a larger area. This may be done by transferring some of it from one container face to the edges or corners of the container by the use of end blocks.

c. Strength and Fragility. Some items are rugged enough to withstand greater stacking loads and handling forces than their containers. Various components of vehicles and tanks, in particular, require little protection against shipping hazards, but are placed in containers for ease of handling, stowage, and storage. On the other hand, there are numerous items that require the

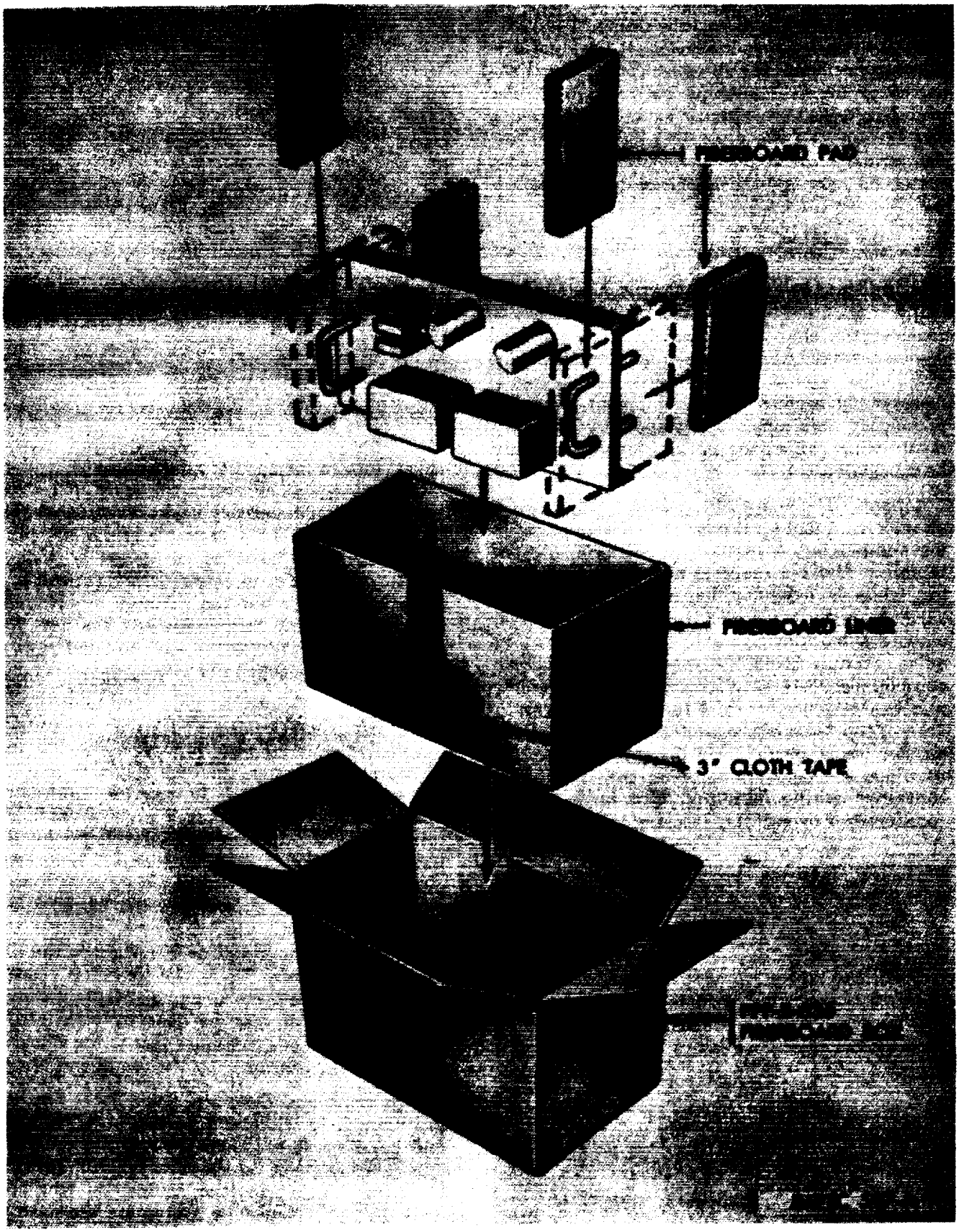


Figure 1-4. Use of corrugated fiberboard pads and liner.

maximum protection afforded by packing materials. Equipment is considered rugged or highly resistant to shock when bracing and blocking within the container is all that is needed for protection. Items that require cushioning for protection are considered to be fragile. The degree of fragility of an item determines the amount of cushioning required to protect it from damage during handling and shipment. Some items are inherently strong and rugged except for one or more fragile components. When the fragile components cannot be removed for separate packing (fig 1–5) then the entire item must be treated as fragile, even though this may result in an unavoidably large, cumbersome pack.

d. Availability of Mounting Provisions. An important factor to consider in packing is the availability of brackets and holddowns on the item that can be used to mount it within the container. Frequently, it is possible to mount an item within the container by using the same brackets and holddowns that are used for positioning and securing it in place when it is permanently installed. Mounting facilities should be examined to determine if they are adequate, especially if the container is likely to be tipped on end (fig 1–6). Compressors, engines, engine components, generators, starters, magnetos, and carburetors are often secured in this manner.

e. Disassembly. Disassembling of an item to reduce the size of the container and to simplify preservation and packing of the various components should be thoroughly investigated (fig 1–7). Before disassembling any equipment, however, competent advice should be obtained as to the feasibility of reassembly and calibration, if necessary, in the field.

CAUTION

Proper authorization must be obtained before disassembling any portion of an item that would require technical skills or special tools to reassemble, realign or recalibrate. Disassembly of simple-to-remove components such as handles, wheels, etc., requiring standard tools, does not need authorization.

f. Special Packing Requirements. Reusable and other special purpose containers usually require special consideration of the packing of the contents in the container. For instance, in reusable containers, the blocking and cushioning must be arranged so that it may be easily removed, and when replaced, it will adequately protect the contents. However, reusable and special purpose containers should be considered for use, especially if their use

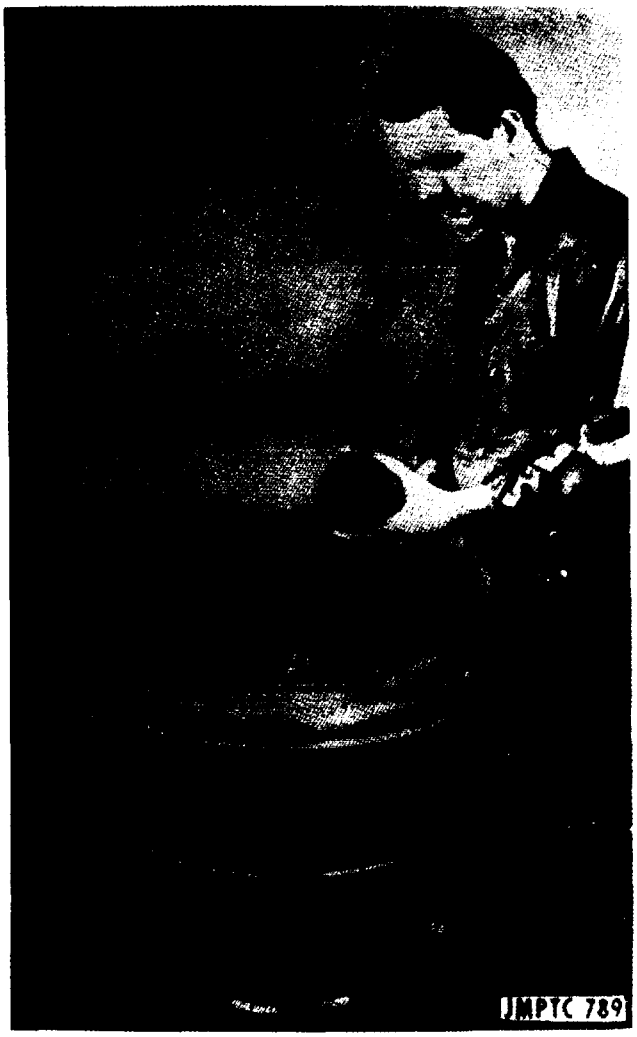


Figure 1–5. Removing a fragile component for separate packing from an otherwise strong and rugged item.

results in reduced tare, cube, or cost. For example, the reusable container for a missile nose cone, shown in figure 1–8, while expensive to procure, may more than pay for itself through its reusability and its designed protection features.

1–5. Load Characteristics

The proper selection of the shipping container for a given load is of the utmost importance. The kind of container must be determined by the weight, size, shape, and fragility of the load. To aid in this selection, the various loads have been classified as Type 1—Easy Load, Type 2—Average Load, and Type 3—Difficult Load. (See Introduction, para 10*c* and fig 4.)

1–6. Modes of Transportation

The mode of transportation is an important factor in determining the packing requirements. The

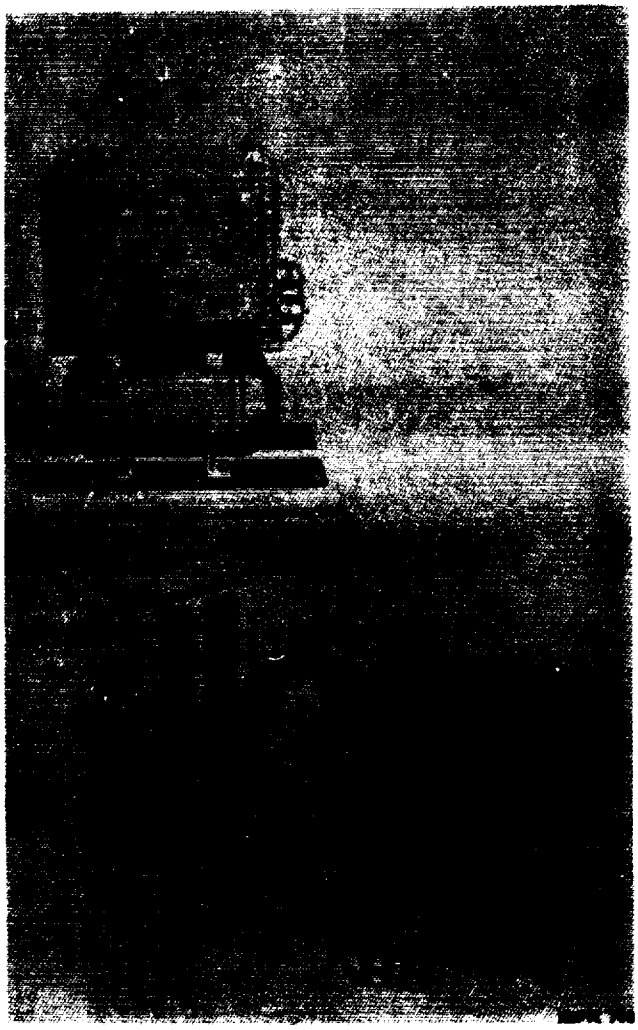


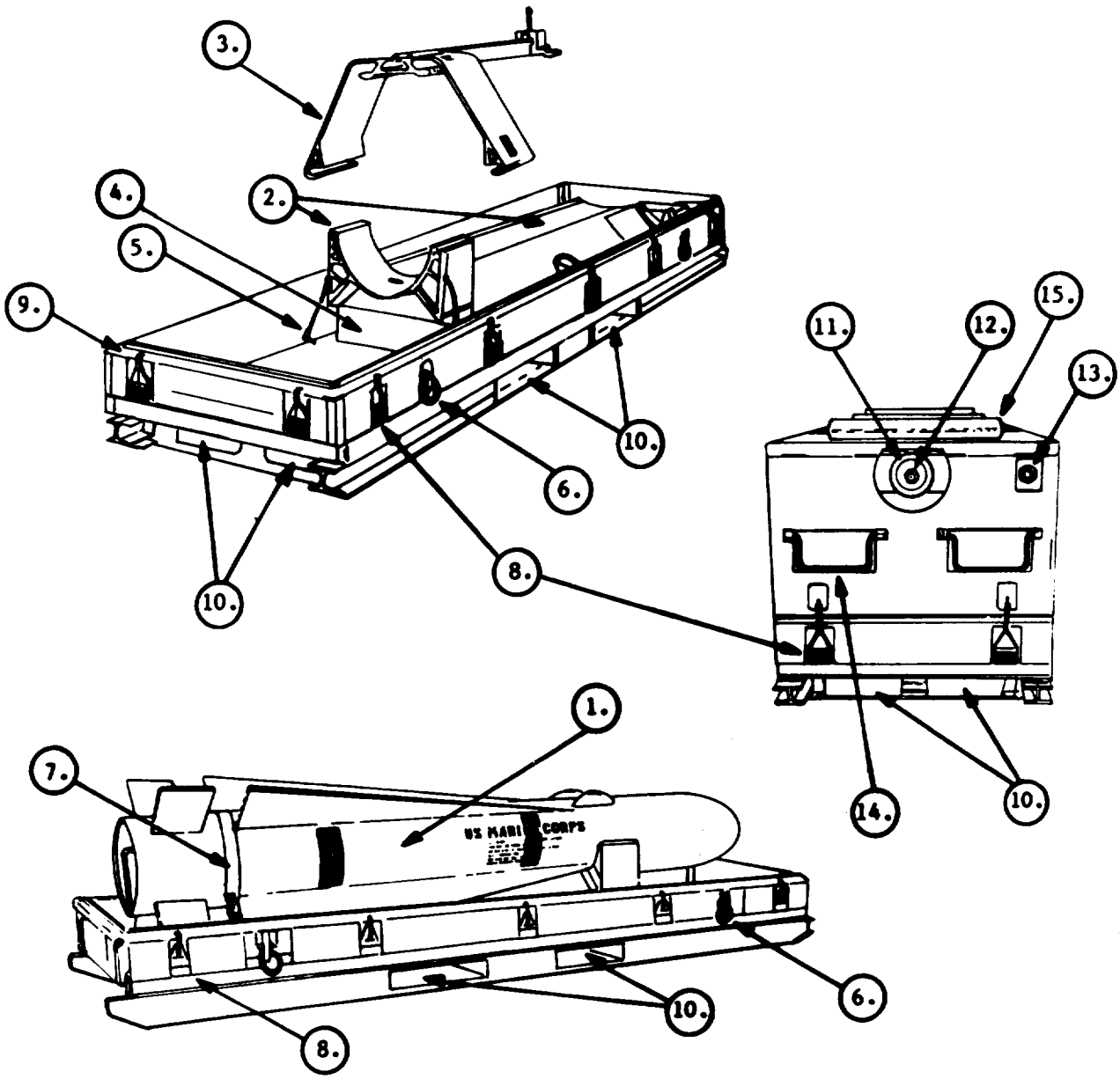
Figure 1-6. Mounting facilities of item must be adequate.

hazards of handling and shipping vary greatly between motor, rail, ship, or aircraft. As an example, there could be considerable difference in the amount of handling that an item being transshipped from truck to rail to ship would receive, and the amount of handling an item delivered by air freight would receive. Likewise, an item to be delivered by airdrop would require much more protection than one to be delivered by truck.

1-7. Storage Considerations

To assure serviceability of the contents after prolonged exposure to deteriorating elements, not only the supplies, but the packing materials which enclose them must be protected. There may be a considerable period from the time the material leaves the manufacturer until it is used. It may be stored outdoors in domestic depots, then shipped to staging areas or ports of embarkation to await

Figure 1-7. Disassembly can reduce cube.



1. MISSLE	6. HOISTING/TIEDOWN/TOWING RINGS	11. DESICCANT PORT
2. CRADLE	7. RESTRAINT STRAP	12. PRESSURE RELIEF VALVE
3. UPPER RESTRAINT	8. LATCH	13. HUMIDITY INDICATOR
4. FOAM CUSHIONING	9. GASKET	14. COVER LIFT HANDLE
5. QUICK-PIN WITH CABLE	10. FORKLIFT POCKETS	15. STACKING INTERFACE

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Figure 1-8. Protection features of a reusable missile container.

transportation overseas. Finally arriving, it may again be stored in depots or supply dumps which could be improvised shacks, native huts, tents, caves, or even in the open. At oversea supply points, the packs are often broken open and smaller intermediate packs distributed to forward areas.

On the other hand, items may be shipped directly from the supplier to the user with a minimum of delay. In this instance, the protection provided by

the pack could be considerably reduced from the amount required for the oversea pack.

1-8. Destination and Field Conditions

The ultimate destination of items is generally unknown when they leave a packing facility. Some items may be used domestically while the rest will eventually go overseas. They may be shipped to the arctic regions, the islands of the seas, or the tropical jungles. They may be subjected to the cold, heat, humidity, aridity, or the extreme temperature changes of the various regions, all of which must be considered in planning the pack to assure adequate protection through the time of delivery and after arrival at destination when they may be subjected to unfavorable field conditions.

1-9. Functions and Selection of Shipping Containers

a. *Functions.* A shipping container is any exterior box, crate, drum, etc., which is required to enclose one or more items during transit or storage. Where only one item is packed, the shipping container is also considered the unit container. The basic functions of a shipping container are to

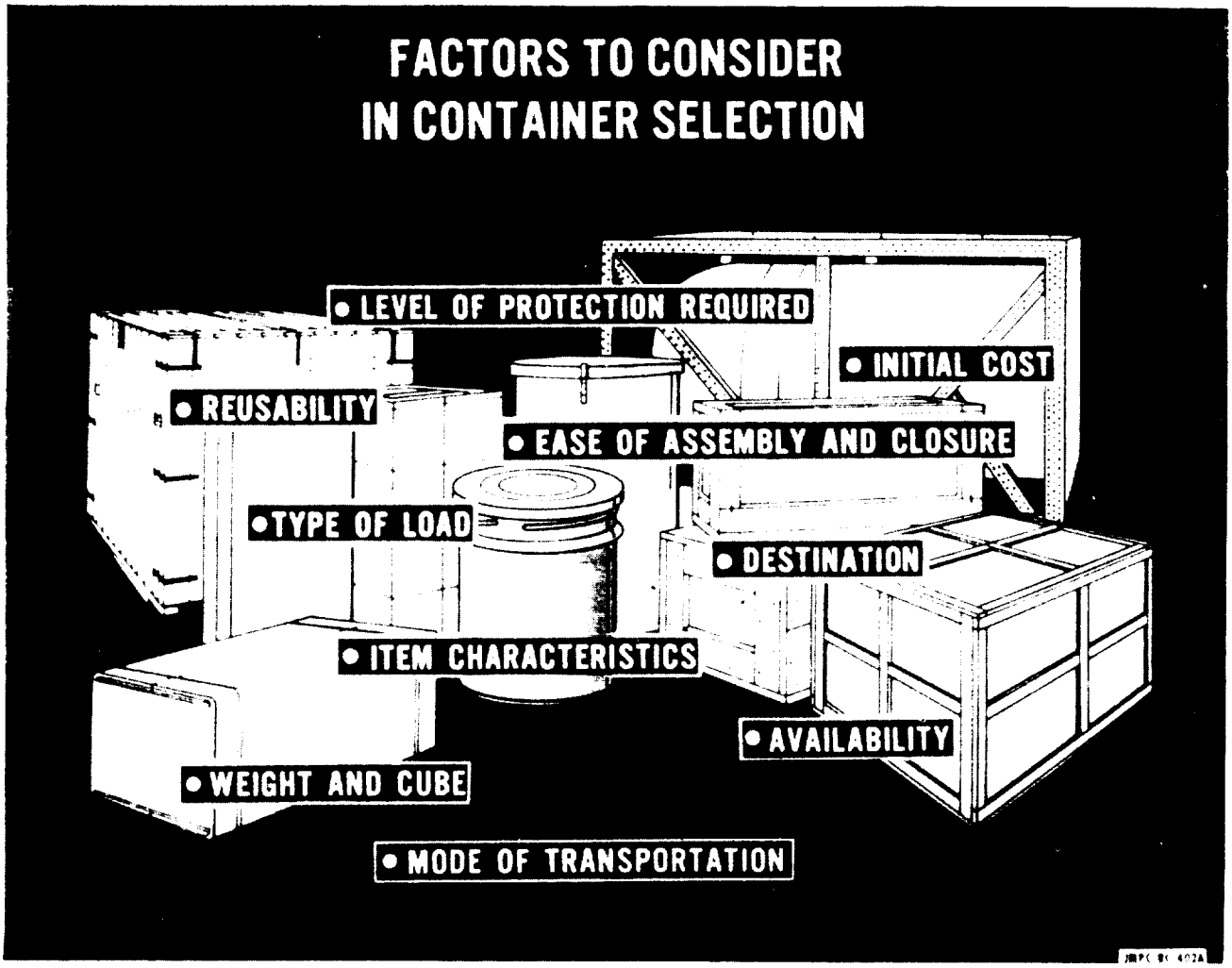

Figure 1-9. Container selection factors.

protect the contents and to provide for ease of handling. Shipping containers assist in the handling of a number of items by consolidation, and of a single item which is difficult to handle. The degree of protection derived from the shipping container depends upon its type, the materials used in its fabrication, its construction features, its final destination, the nature of the contents, and the anticipated hazards. Chapters 2 through 7 of this manual contain information on approved containers for military shipments and should be consulted when making selection of the appropriate containers.

b. Selection. The shipping container is usually established by specifications, directives, technical orders, or other authorized publications. Where a group of containers is authorized, or when the proper container is not specified, the packing supervisor is responsible for the selection of the appropriate container. He must base his selection upon the physical characteristics of the item, its destination, whether domestic or overseas; the level of protection required; the type of load, the initial cost of the container; the weight and cube of the container; the simplicity, economy and ease of assembly and closure; the availability; and the need for reusability of the container (fig 1-9). Nailed wood boxes or similar heavy wooden containers will not be used unless fully justified by past experience or environmental, geographical, or security considerations.

1-10. Arrangement of Contents

The contents of a pack should be arranged within the shipping container so as to provide maximum protection to the interior packing, to the container, and to its contents. Where applicable, the arrangement should permit a container fabricated of materials that will result in low tare weight, smallest practical cube, convenient handling, and suitability for palletization. Contents should completely fill the container or be secured therein with suitable clearance. Packs of like items should contain like quantities and should be uniform in size, shape, and weight.

a. Dissassembled Parts. When practicable, items should be disassembled to afford protection of components, attachments, and accessories against damage and pilferage and to reduce cubage. Disassembled parts should be wrapped, packaged, anchored, braced, blocked, or cushioned within the shipping container so that parts or protective devices within the shipping container cannot be damaged by mutual contact. Disassembled parts should be clearly and legibly marked as to identity and proper location on the assembled item. All fasteners removed during disassembly should be secured in one of the mating parts. A part should not be removed from an assembly unless it can be reassembled readily in the field without special tools.

b. Movable Parts and Projecting Parts. Articles with moving external parts or projecting parts that might become damaged by shock or vibration encountered in shipment should have these parts made secure against movement by means of blocking, bracing, tiedown, or other adequate provisions; or should be disassembled, if practicable.

c. Segregation of Packed Contents. So far as practicable, contents of shipping containers should be segregated in the following order: (a) the order on the packing list; (b) items of the same contract; (c) items of the same National Stock Numbers; and (d) items of the same Federal Supply Class.

d. Conversion of Type 3 Loads. Where practicable, type 3 loads should be converted to type 1 or type 2 loads. (See Introduction, para 10*t*.)

1-11. Blocking and Bracing

a. Blocking and Bracing Defined. Blocking and bracing is the process of providing physical and mechanical protection to an item by means of materials, other than cushioning materials, intended to prevent any free movement of the item within the container, and distribute or transfer concentrated loads of the item to larger areas or other faces of the container.

b. Functions of Blocking and Bracing. Items which do not completely fill the shipping container should be blocked, braced, anchored, or otherwise immobilized within the container. Blocking and bracing should be used to secure items or components so that they will not shift within a container; to make irregular shaped items fit a regular container; to distribute the weight of irregular items over all edges and faces of the container; to protect projections from injury; to prevent projections from damaging the barrier or container; to provide space for spare parts or make room for desiccant; and to reinforce weak portions or mountings. Blocking and bracing modifies the original shape of an item so that it is protected adequately and so that it fits the container. The materials used for this purpose differ from cushioning in that they are not intended to absorb shocks. Items having legs or other projecting portions which may become loose or broken, or which might puncture the container, must be

supported by adequate blocking and bracing. The blocks and braces should be applied against portions of the container that are strong enough to resist forces tending to distort them. Likewise, the bracing should be arranged to distribute forces to several reinforced sections of the surface of the item (fig 1-10). Items or movable parts of items mounted on springs or other flexible supports should be braced securely to prevent movement, except where such mounting is part of the package cushioning or is designed to protect against shock and vibration during shipment.

c. Abrasion Protection. Protection should be provided when the surface of the item in contact with the blocking and bracing can be damaged by relative motion between the contacting surfaces or could become corroded as a result of such continuous contact. Protection against abrasion should be provided for highly finished or easily marred surfaces by wrapping or covering with cushioning material. Surfaces that might be damaged by contact with cushioning material should be separated by a covering of noncorrosive paper conforming to MIL-P-130 or greaseproof barrier material conforming to MIL-B-121, grade A. For specialty items requiring protection beyond the above, kraft paper with a cohesive coating should be applied.

1-12. Application of Blocking and Bracing Materials

The materials selected for all blocking and bracing and the design and application of the blocking and bracing should be compatible with the load to be supported and the size, shape, and strength of bearing areas of the item. The heavier the load needing support, the stiffer and stronger the materials for blocks and braces must be. Hence, the choice of materials depends upon the size and shape of the areas against which the blocking and bracing will be placed, as well as the size and weight of the item being secured. Since a shipping container may be dropped on any of its faces or corners, blocks and braces must be designed to withstand the thrust and impact applied on any direction. The choice of materials used for blocking and bracing vary widely. The chief materials used are corrugated fiberboard in cells, trays, pleated pads, and flat pads, for relatively lightweight items or for supplementary primary blocking of heavy items. Wood, plywood, rigid plastic foams, and metal are used as the primary blocking materials for large and heavy items.

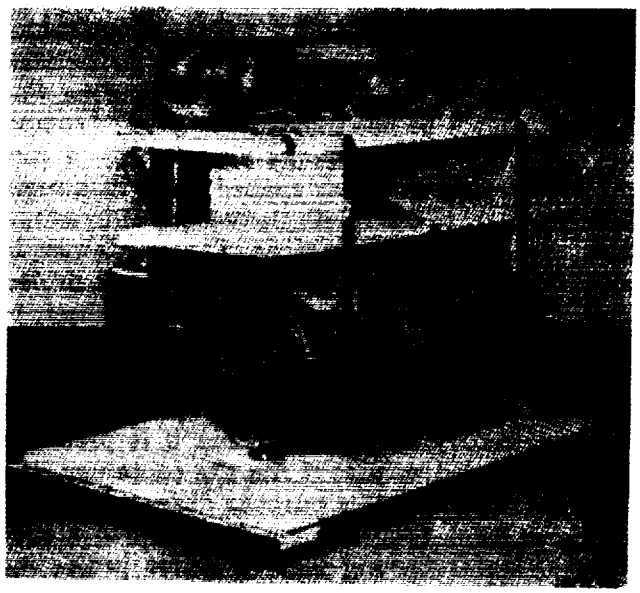

Figure 1-10. Blocking and bracing to prevent movement.

a. Fiberboard.

(1) *Open-end cells and trays of corrugated fiberboard.* When used as blocking, corrugated fiberboard must be designed to fit the bearing area of the item to support and evenly distribute the load. Common forms of corrugated fiberboard blocking are die-cuts, open end cells, trays, pleated pads, and flat pads (fig 1-11 and 1-31). Frequently, various combinations of these forms are employed. They can be used to provide spaces for, and restrain the movement of, disassembled parts, as well as provide openings for bags of desiccant. Generally, cells and trays should be held in shape with tape or staples. 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. No bracing support allowances should be made for the other surfaces. To utilize all of the strength of these bracing supports, they should bear directly on the item. The weight of the item must be exerted in the same direction as the corrugations. If not, the item is inadequately supported and damage may result (fig 1-12). Open-end cells and trays should be used for blocking and bracing deep recesses; bridging long projections; providing spaces for disassembled parts, accessories, and desiccants; and providing clearance between item and container. Bracing supports should bear directly on the article. Allowable loads for bracing supports of open-end cells loaded in the flute direction should be in accordance with table 1-1. If flute direction is at right angles to the direction of the load, the allowable loads should be 50 percent of the values of table 1-1. Trays should be scored

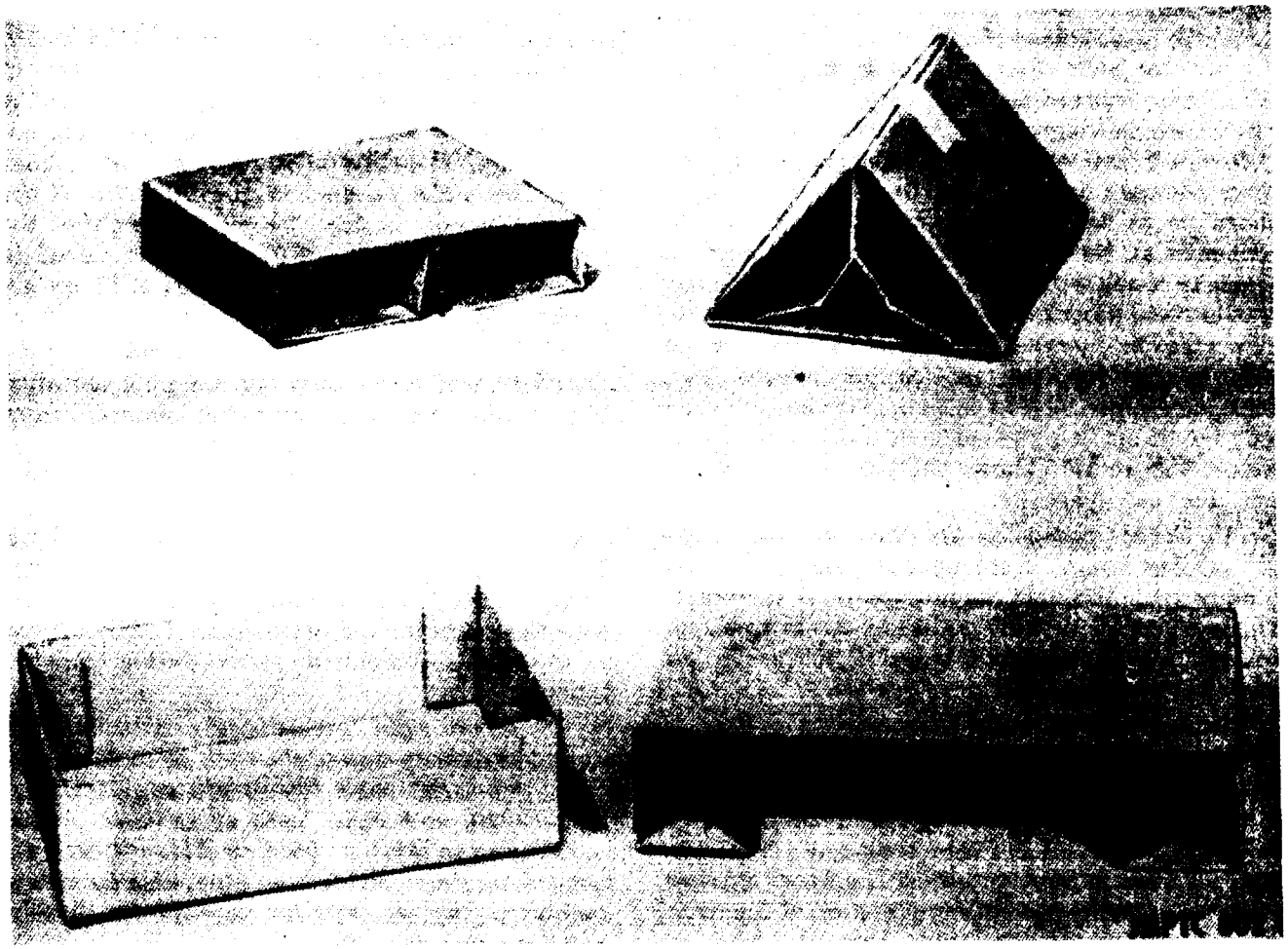

Figure 1-11. Cells and trays made of corrugated fiberboard.

and folded parallel to the flute direction and should not exceed 4 inches in height.

(2) *Corrugated fiberboard forms.* Corrugated fiberboard used for blocking and bracing should conform to Specification PPP-F-320. Blocking and bracing forms should be loaded in the direction parallel to the flutes wherever possible. The cutting, slotting, scoring, and folding of fiberboard blanks to make blocking and bracing supports or forms shall be such as to assure proper fitting and distribution.

(3) *Folded pads.* Folded pads of corrugated fiberboard may be used for blocking greater loads than are feasible to support with cells and trays. The pads should be designed to fit against a flat surface (flat pads) or along an edge (corner pads). Connecting webs between flat pads should always contact the container and not the item. All scores and folds should be made at right angles to the flute direction. Flat pads should be a minimum of 2 inches wide. Portions of folded pads in direct contact with the item are bearing areas. The maximum loads for these bearing areas should be in accordance with table 1-2. Accordion folded pads have greater resistance to breakdown than open end cells because the load is spread over a large area rather than on bracing supports. Accordion folded pads with tight folds distribute the load more evenly to the container. The connecting web between the folded pleats should be placed in contact with the container rather than the item. Creases for accordion folded pads should be made across the corrugations, and the pleat should be at least 2 inches in width. If necessary, a pleat 1½ inches wide may be made, but extreme care must be exercised when folding the pad to prevent crushing the corrugations. Tape should be used to keep accordion folded pads in shape. The load bearing capacity of a pad is based on the initial compressibility of the corrugated material. Increasing the number of pleats does not increase the safe load limit; numerous pleats increase the cushioning value only. Wide or long items are better supported by several accordion folded pads,

placed side by side, than by one pad having extremely wide folded pleats.

(4) *Flat pads.* Flat pads of corrugated fiberboard may be used to block very shallow projections, such as hinges or slight offsets on surfaces; to level off projecting screw heads; to fill in the space between ends of inner flaps of slotted fiberboard boxes to provide additional protection to contents at top and bottom of boxes; and to separate items within a container. Allowing loads should be in accordance with table 1-2. Maximum allowable loads per square inch of bearing area on a flat pad are the same as those for a pleated pad. Flat pads can be slotted to form partitions, or they may be die-cut or punched to fit items of irregular shape. Figure 1-13 shows the assembling of slotted fiberboard partitions.

(5) *Corner pads.* The use of corner pads made of multiple layers of corrugated fiberboard shall comply with the load requirements of table 1-2. The pads shall provide required clearances and support for rectangular shaped items or for an inner box in which items are packed.

(6) *Tubes.* Fiberboard tubes should be used as blocking when items mounted on an auxiliary base are packed on fiberboard boxes. The bottom of the tube shall contact the top of the auxiliary base and the top of the tube shall contact the top inside surface of the container. The flutes shall be oriented in the top-to-bottom direction of the tube. The weight of the item plus auxiliary base, in pounds, divided by the perimeter of the tube, in inches, shall not exceed the appropriate values given in table 1-2 for column heights over 4 inches.

(7) *Corrugated fiberboard liners.* A liner is a continuous pad, bent to fully contact two or more inner faces of a container. Liners are used to reinforce a container against crushing by forces imposed during stacking, or to take the place of two or more flat pads. A liner may also be used as a holddown for base mounted items weighing not more than 20 pounds. The creases in a liner should be made parallel to the direction of the corrugations of the fiberboard, in order that the resistance to forces ordinarily encountered in stacking be the greatest. Examples of liners are shown in figure 2-11.

(8) *Corner posts.* Fiberboard corner posts should be used to reinforce the shipping container and provide blocking for platform-mounted equipment. The flutes should be oriented in the top-to-bottom direction. The bottom end of the corner post shall bear uniformly on the platform, and the top end of the corner post shall bear on the inner flap of the container or top member of a crate. Corner posts, when installed, must so interlock with the contents and other inner padding pieces in order not to become displaced during transportation.

(9) *Other rigid, low-density materials.* Other rigid, low-density materials, such as molded wood pulp, industrial cane fiberboard conforming to PPP-F-320, and rigid foam or cellular plastics conforming to MIL-P-19644, or MIL-P-21929, cut, foamed in place, molded, or otherwise formed as required, may be used for appropriate blocking and bracing applications.

b. Wood or Plywood. Wood or plywood may be used alone or in combination for blocking and bracing. Wood or plywood blocking and bracing members should bear against only those parts of the packed item capable of withstanding the applied dynamic forces or should bear against blocking pads or pressure strips that adequately distribute these forces. Wood or plywood blocking and bracing should be designed to permit easy removal without damage to the item. Both wood and plywood are used for blocking and bracing

Table 1-1. Allowable Loads for Corrugated Fiberboard Columns Loaded in the Flute Direction

Material	Allowable loads per lineal inch of bracing support or column	
	Height up to 4 inches	Height over 4 inches
	Pounds	Pounds
Double-faced fiberboard:		
200-pound bursting strength	2	1
275-pound bursting strength	2.5	1.5
350-pound bursting strength	3	2
Double-wall fiberboard:		
275-pound bursting strength	2.5	1.5
350-pound bursting strength	3	2
500-pound bursting strength	4	2.5
Triple-wall fiberboard:		
1,100-pound bursting strength	5	4

Note. When a greater load is imposed than that permitted by the table, use wood blocking and bracing.

Table 1-2. Allowable Loads for Folded Corner and Flat Pads of Corrugated Fiberboard

Flute design	Maximum allowable load for bearing areas
	Pounds per square inch
A-flute (36 ± 3 corrugations per foot)	2.0
B-flute (50 ± 3 corrugations per foot)	3.0
C-flute (42 ± 3 corrugations per foot)	2.5

Note. The flat crush resistance of the corrugations shall determine the load that may be carried in flat loading of corrugated fiberboard. This shall not be construed to mean the bursting strength of the material.

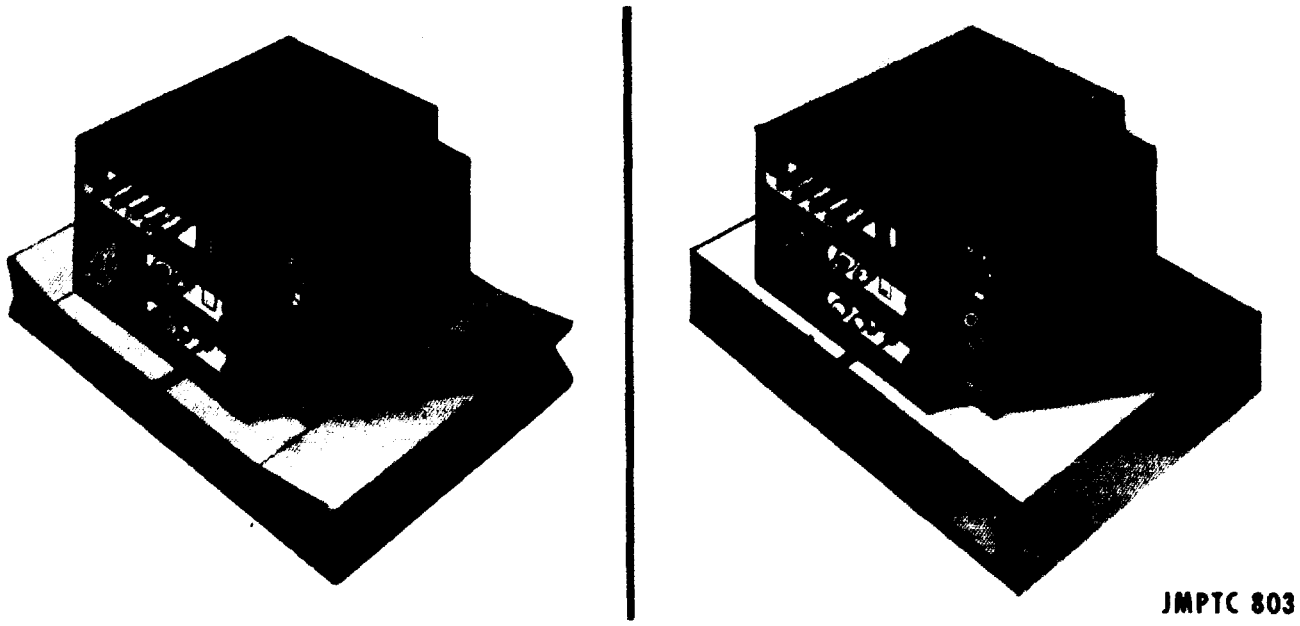

Figure 1-12. Incorrect and correct direction of corrugations.

because of their high strength-weight ratio, general availability, and ease of cutting and fastening. Lumber has certain weaknesses, such as low splitting resistance parallel with the grain, and a tendency to shrink or swell with each change in moisture content. Conversely, plywood has high resistance to splitting and high dimensional stability with changes in moisture content. Because they are more resistant to splitting than solid wood, plywood panels are more often used in thinner dimensions than lumber, and are readily nailed or fastened with screws near the edges. Plywood is more apt to have a lower moisture content than lumber because of the manner in which it is manufactured and stored. Plywood, being constructed of alternate plies at right angles to each other, possess more uniformly distributed strength properties than lumber. When considering lumber and plywood of comparable sizes and quality, it is generally true that the strength properties of lumber parallel to the grain are greater than the respective strength properties of plywood parallel to the grain of the face ply. It is also true that the strength properties of lumber perpendicular to the grain are generally less than the respective strength properties of plywood perpendicular to the grain of the face ply.

(1) *Wood.* Wood used for blocking and bracing should conform to MIL-STD-731. One wood member of each size and type used in the blocking and bracing should be tested for moisture content. Structural members (those subject to critical bending stresses) shall conform to class 1. All other blocking and bracing members shall conform to class 3. Whenever possible, wood blocks or braces shall be placed so that the load is applied against the end grain of the member. Ends of braces shall be socketed or fitted and secured into appropriate notches in load-bearing members.

Figure 1-13. Assembling of slotted fiberboard partitions.

(2) *Plywood.* Plywood used for blocking and bracing should conform to Specification NN-P-530,

group A, (grade 3-4, Type II) or group B, (CD, interior with exterior glue).

c. Wood Blocking and Bracing. The species of woods differ greatly in strength and related properties and, accordingly, have been separated into four groups (para 3-1). Certain species, such as those of Group IV, excel in toughness and shock resistance, but care must be exercised in nailing them to avoid splitting. Other species, such as southern yellow pine and Douglas fir of Group II, are high in bending strength and stiffness; and nailing is a lesser problem. The characteristics of the groups of wood may be used to advantage in various forms of blocking and bracing. Thin pieces of lumber split more easily than thick pieces; hence, thin pieces for blocking should be avoided if possible. If the dimensional limits of the item require that the blocking be thin, it is preferable to use plywood.

(1) *Moisture content.* In accordance with MIL-STD-731, the moisture content of lumber employed as blocking and bracing material should not exceed 19 percent nor be less than 12 percent of its oven dry weight at the time of fabrication. Shrinkage is objectionable because it allows movement of the item and the item may actually break loose. Moisture in lumber is objectionable because it is apt to evaporate into the pack, thus raising the humidity of the pack and causing corrosion of metals or decay of organic materials (para 3-1).

CAUTION

Lumber, plywood, or other hygroscopic materials should never be placed in direct contact with critical metal surfaces since such materials tend to absorb and retain moisture next to the surfaces, finally causing corrosion. Provide always a water-vaporproof barrier between any critical metal surfaces and hygroscopic packing materials, and a waterproof or moisture-resistant barrier between all metal surfaces and hygroscopic materials.

(2) *Defects in blocks and braces.* Wooden members used for blocking and bracing are often subjected to great stress and careful consideration must be given to any weakening defects. If the member functions as a beam or column, defects such as divergence of grain, knots, splits and decay should be avoided (para 3-1 and fig 3-2). This is especially important if the defect is located near the center of the piece, because of the great reduction in shock resistance. If a piece with a knot is used, the load is placed so that the knot is in compression as shown in (2), figure 1-14. Lumber having knots of a diameter exceeding one-fourth the width of the piece should not be used ① fig 1-14). The slope of grain in each piece should not exceed 1 inch in 10 inches of length, or splitting is likely to occur. Decayed wood is avoided under all circumstances because there is no way of determining how much the decay may have weakened the wood.

(3) *Size of wood braces or holddowns.* Braces or holddowns must be of sufficient size to withstand the shocks encountered. The size of a brace varies with the weight of the item, the length of the brace, and the type of loading. Table 1-3 used with figure 1-15, gives the recommended allowable load in pounds for the various sizes of braces and the various types of loading. For example, assume that the weight of the item is 60 pounds, the length of the brace is 24 inches, and the type of loading is the third type illustrated in figure 1-15 (loading in the center 4/5 to 1/3 of the unsupported length of the brace). For this type of loading, multiply the weight of the item by the facter ¾, as shown in figure 1-15. Three-fourths times 60 equals 45. In the column headed "Length of brace in inches," of table 1-3, find 24 inches and read to the right until a value near 45 is found. The heading for this column shows that the proper size of memebr and direction of loading is a 1 x 2-inch member used on edge, or a 1 x 4-inch member used flatwise.

(4) *Positioning loads on blocks and braces.* When wood blocking and bracing is used to secure heavy items, place the block so that the load rests on the end grain of the piece, whenever possible. If this cannot be done, the load should bear on the edge grain. When so placed, the maximum strength of the brace is used (fig. 1-16). Since wood is relatively stable in dimension along the grain, there is little effect from shrinkage or swelling with a change in moisture content. The brace should, if possible, have its narrow face against the item so that its maximum stiffness is utlized. If a larger bearing area is required, and it becomes necessary to have the flat face of the brace against the item, the size of the brace must be increased (table 1-3). Lumber which is relatively wide for its thickness must be reinforced through-out its length to prevent twisting or buckling.

(5) *Using lumber as a mounting base.* If an item is to be secured to a base, and plywood is not available, use dimensional lumber. Bases of dimensional lumber should be constructed with sufficient cleats at right angles to the grain of the baseboards, and fastened with clinched nails to prevent the boards from splitting at the bolt holes. Strength of the bases must be adequate to withstand any rough handling the pack may be likely to receive.

(6) *Securing lumber blocking.* Securing lumber blocking properly is the most essential factor in

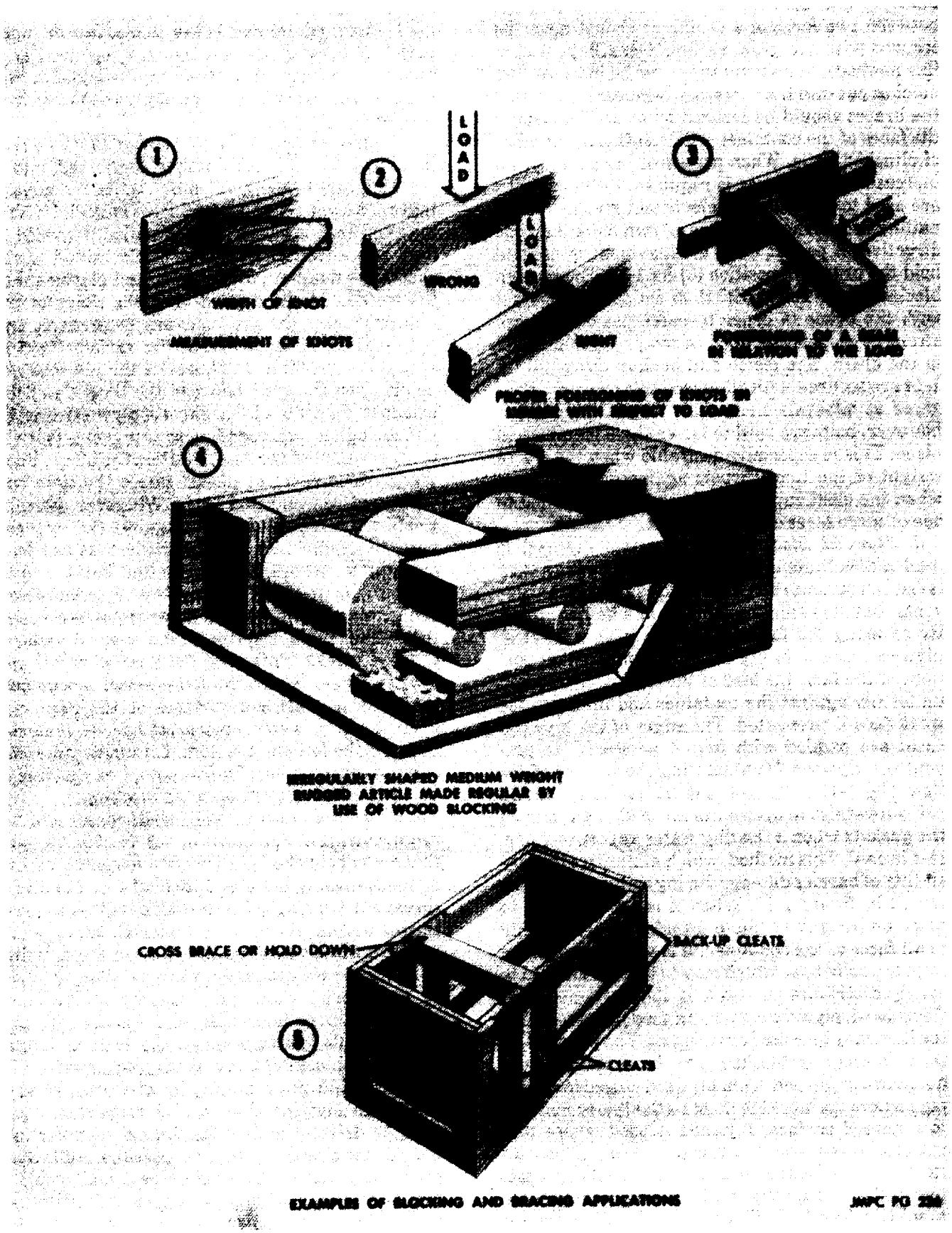

Figure 1-14. Application of wooden blocks and braces.

blocking and bracing. Wooden braces positioned between two faces of a container should never be secured with end grain nailing, toenailing, or similar methods, nor should they ever be inserted into notches cut into the container faceboards. Instead, the braces should be secured by cleats fastened to the faces of the container with a sufficient number of clinched nails. When pressures are great, or an increased nailing area is required, backup blocks are used to reinforce the cleats and give increased nailing area. When pressure is from more than one direction, a pocket cleat arrangement is used to hold the braces in position (3) fig 1-14. The backup blocks are positioned with their end grain in contact with the brace in order to make use of the high strength property of wood in compression parallel to the grain. The cleats and backup cleats (5) fig 1-14 are secured with clinched nails properly staggered at intervals along their length. Sometimes, however, bolts are used to fasten these members in place. This is especially desirable when the entire weight of the item thrusts against the block, or when the cleat supports a framework attached to one or more faces of the container.

d. Plywood Blocking and Bracing. Plywood is used to distribute the load when the face of an item is flat but structurally weak and the weakness prevents that face from being used as a bearing area. By covering the face of the item with a sheet of plywood, so that the plywood bears on stronger portions of the face, the load of the item is distributed uniformly against the container and injury to the weak face is prevented. The edges of the plywood sheet are padded with felt, if necessary, to prevent the plywood from marring the surface of the item (fig 1-17). Plywood can be used for making pressure strips to distribute the load of an item on the gaskets when a floating water-vaporproof barrier is used. This method, which minimizes the possibility of barrier damage during shipment, is illustrated in figure 1-17. When it is not practical to block an irregular item to transfer the load evenly to all faces of the container, it is wise to secure the item to a solid base which may in turn be blocked to evenly distribute the load. If the container is of fiberboard, plywood serves as a good pallet to which the item may be bolted or strapped. The plywood, in turn, is securely blocked into the container by a holddown or top pad. Thin plywood is used to advantage where the blocking must be flexible to conform to a curved surface. Plywood is used where thin material is required as a brace in tension. When an item is to be bolted to a base or auxiliary base, plywood is used for the base because of its resistance to splitting (fig 1-18). Since plywood is obtainable in wide panels, it is especially useful in base construction. For light items, ½- or ¾-inch plywood should be used. For medium and heavy items, two or more pieces of plywood can be fastened together, or a series of strengthening cleats can be added to the panel. The cleats also may be of plywood to reduce the possibility of splitting.

e. Combined Plywood and Lumber Blocking and Bracing. Plywood and lumber, combined into a blocking and bracing assembly, unite the advantages of a strong, lightweight sheet material with a material that is easily cut and nailed. Plywood is used as a sheet with wooden blocks nailed to the sheet. The number , dimensions, and placement of the wooden blocks depend upon the shape of the item, its depth, the positon of any projections, and the loads to be supported at the various bearing areas. The required thickness of the plywood depends upon the span between the blocks and the load to be distributed. The sheet of plywood must be stiff enough to resist bending so as to evenly distribute the weight of the item. Position the blocks upon the plywood sheet at places where the item can withstand concentrated loads. Wherever possible, locate the blocks and braces against the stronger portions of the item. Choose nails that are long enought to permit clinching after being driven through the wooden blocks and the plywood sheets. If clinching is impractical, drive the nails through the thinner piece first (fig 1-19). Cover all surfaces of wood blocks contacting the item with felt and glue in place. Where the felt-covered blocks normally contact critical surfaces of the item, use greaseproof or water-vaporproof barrier material between the felt and the item. Eliminate time consuming construction of a framework at the time of packing by using prefabricated blocking.

f. Nails and Nailing. Nails shall conform to the requirements of Specification FF-N-105. All nails that are not clinched shall be cement coated, etched or mechanically deformed (helically or annularly threaded). Unclinched nails shall be as long as practicable without splitting the material, but not shorter than three times the thickness of the member holding the nailhead for tenpenny nails and smaller, or not shorter than the thickness of the same member plus 1½ inches for twelvepenny nails and larger. Nails loaded transversely to their length (lateral) in blocking and bracing joints need not be clinched. End grain nailing in solid wood or edge nailing in plywood shall not be permitted. Nails shall be driven through the thinner member into the thicker member wherever possible. Nails shall not be subject to withdrawal stresses. Nails shall be driven not closer to the end of a piece of lumber than the thickness of the piece and not closer to its side than one-half its thickness. There shall be at least

Table 1-8. Brace Selection - Allowable Load in Pounds.

THE ALLOWABLE LOAD IN POUNDS IS FOR GROUP I WOODS

NOMINAL SIZE OF BRACE IN INCHES	1 x 1		1 x 2		1 x 3		1 x 4		1 x 6		1 x 8		2 x 2		2 x 3		2 x 4		2 x 6		2 x 8		3 x 3		3 x 4		3 x 6		3 x 8		4 x 4		4 x 6		4 x 8	
12	21	25	47	94	78	225	109	315	172	495	237	653	187	187	313	450	438	630	688	990	906	1305	750	750	1050	1050	1650	1650	2175	2175	2470	2470	2310	2310	3045	3045
18	14	16	31	63	52	174	73	315	115	495	191	653	125	125	208	347	292	630	458	990	604	1305	579	579	810	1050	1273	1650	1678	2175	2470	2470	2310	2310	3045	3045
24	12	12	23	47	39	130	55	235	86	495	113	653	94	94	156	260	219	510	344	990	453	1305	434	434	608	831	955	1650	1259	2175	2191	2191	2078	2310	2687	3045
30	10	10	19	37	31	104	43	204	69	495	91	653	75	75	125	208	175	408	275	990	362	1305	347	347	486	681	764	1650	1007	2175	953	953	1497	2310	1974	3045
36	8	8	16	31	26	87	36	170	57	420	76	653	62	62	104	174	146	340	229	840	302	1305	289	289	405	567	637	1400	839	2175	794	794	1248	1961	1645	3045
42	7	7	13	27	22	74	31	146	49	360	65	626	54	54	89	149	125	292	196	720	259	1251	248	248	347	486	546	1200	719	2086	680	680	1069	1681	1409	2920
48	6	6	12	23	20	65	27	128	43	315	57	548	47	47	78	130	109	255	172	630	227	1095	217	217	304	425	477	1050	629	1825	595	595	936	1470	1234	2555
54	5	5	10	21	17	58	24	113	38	280	50	487	42	42	69	116	97	227	153	560	201	973	193	193	270	378	424	934	559	1622	529	529	832	1307	1099	2271
60	5	5	9	19	15	52	22	102	34	252	45	438	37	37	63	104	88	204	138	504	181	876	174	174	243	340	382	840	503	1460	476	476	749	1176	987	2044
66	4	4	8	17	14	47	20	93	31	229	41	398	34	34	57	95	80	186	125	458	165	796	158	158	221	309	347	764	458	1327	433	433	681	1069	897	1858
72	4	4	8	15	13	43	18	85	29	210	38	365	31	31	52	87	73	170	115	420	151	730	145	145	203	284	318	700	420	1217	397	397	624	980	822	1703
78	4	4	7	14	12	40	17	78	26	194	35	337	29	29	48	80	67	157	106	388	139	674	134	134	187	262	294	646	387	1123	366	366	576	905	759	1572
84	3	3	6	13	11	37	16	73	25	180	32	313	27	27	45	74	62	146	98	360	129	626	124	124	174	243	273	600	360	1043	340	340	535	840	705	1460
90	3	3	6	13	10	35	15	68	23	168	30	292	25	25	42	69	58	136	92	336	121	584	116	116	162	227	255	560	336	973	318	318	499	784	658	1362
96	3	3	6	12	10	33	14	64	22	158	28	274	23	23	39	65	55	128	86	315	113	548	109	109	152	213	239	525	315	913	298	298	468	735	616	1278
102	3	3	6	11	9	31	13	60	20	148	27	258	22	22	37	61	51	120	81	297	107	515	102	102	143	200	225	494	296	859	280	280	440	692	580	1202
108	3	3	5	10	9	29	12	57	19	140	25	243	21	21	35	58	49	113	76	280	101	487	96	96	135	189	212	467	280	813	265	265	416	654	548	1136
114	2	2	5	10	8	27	12	54	18	133	24	231	20	20	33	55	46	107	72	265	95	461	91	91	128	179	201	442	265	768	251	251	394	619	519	1075
120	2	2	5	9	8	26	11	51	17	126	23	219	19	19	31	52	44	102	69	252	91	438	87	87	122	170	191	420	252	730	238	238	374	588	493	1022

LUMBER CROSS SECTION SIZES AS SHOWN IN TABLE ARE NOMINAL. THE ALLOWABLE LOAD IN POUNDS AS SHOWN ARE FOR ACTUAL OR DRESSED SIZES - EXAMPLE 1½ x 3½ = 2 x 4 WC.

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two nails in each joint. Lateral loading of nails for blocking and bracing shall be in accordance with table 1-4. Ends of blocks and braces shall not be fastened to a wood container by end-grain nailing, toe nailing, or similar methods but shall be fastened to a sturdy part of the container or held in place by parallel cleats or other side-grain nailing methods. Blocking and bracing shall be applied against areas of item(s) that are of sufficient strength and rigidity to resist damage. A description of the various types of nails and general requirements for their use are given in chapter 3 and illustrated in figure 3-4. Standard sinker and cooler nails are particularly well suited for use in blocking and bracing. Clout nails with large heads similar in shape to roofing nails, are recommended where plywood of one-half of an inch or less is used. Nails used in blocking and bracing should be coated or chemically etched (para 3-1*b*), especially if the nails cannot be clinched. If nails fail when subjected to forces of direct withdrawal, they usually fail suddenly. Whenever possible, apply nails so that they are subjected to forces of lateral displacement rather than direct withdrawal, that is, the direction of the nails is perpendicular to the direction of the load, rather than in line with the direction of the load.

g. Bolts and Bolting. Carriage or step bolts conforming to Specification FF-B-584, Type I, Class 1, Style a or c, shall be used as fastenings for wood or plywood blocking and bracing where necessary to facilitate disassembly for removal of container contents. Bolts shall also be used for fastening blocking and bracing members that are too thick for proper fastening with nails. Bolt holes in wood or plywood shall be of the same diameter as the bolts. Bolts commonly used for blocking and bracing are machine bolts, carriage bolts, and step bolts (para 6-2*e*). Step bolts are preferred for this use because of their larger head diameter. J- or U-bolts are used for special conditions where regular bolts cannot be applied (fig 1-20). Tie rods and J-bolts are actually extended bolts, applied in pairs either vertically (fig 1-21) or diagonally (fig 1-22), and are used where standard length bolts would not apply. See table 1-5 for the suggested allowable load for the various sizes of bolts. The following precautions should be observed in the use of bolts:

(1) Items such as machines or subassemblies having bolt holes in parts which are sturdy enough to resist breakage when rough handled should, if practical, be bolted to one face of the container.

(2) If nonprecision bolt holes are involved, the diameter of the bolt should be the nearest standard size consistent with the diameter of the hole.

(3) If precision bolt holes are involved, precautions should be taken to insure that precision fitting bolts of the proper fit and characteristics are used to prevent marring or elongation.

(4) Lag bolts should not be used for blocking and bracing.

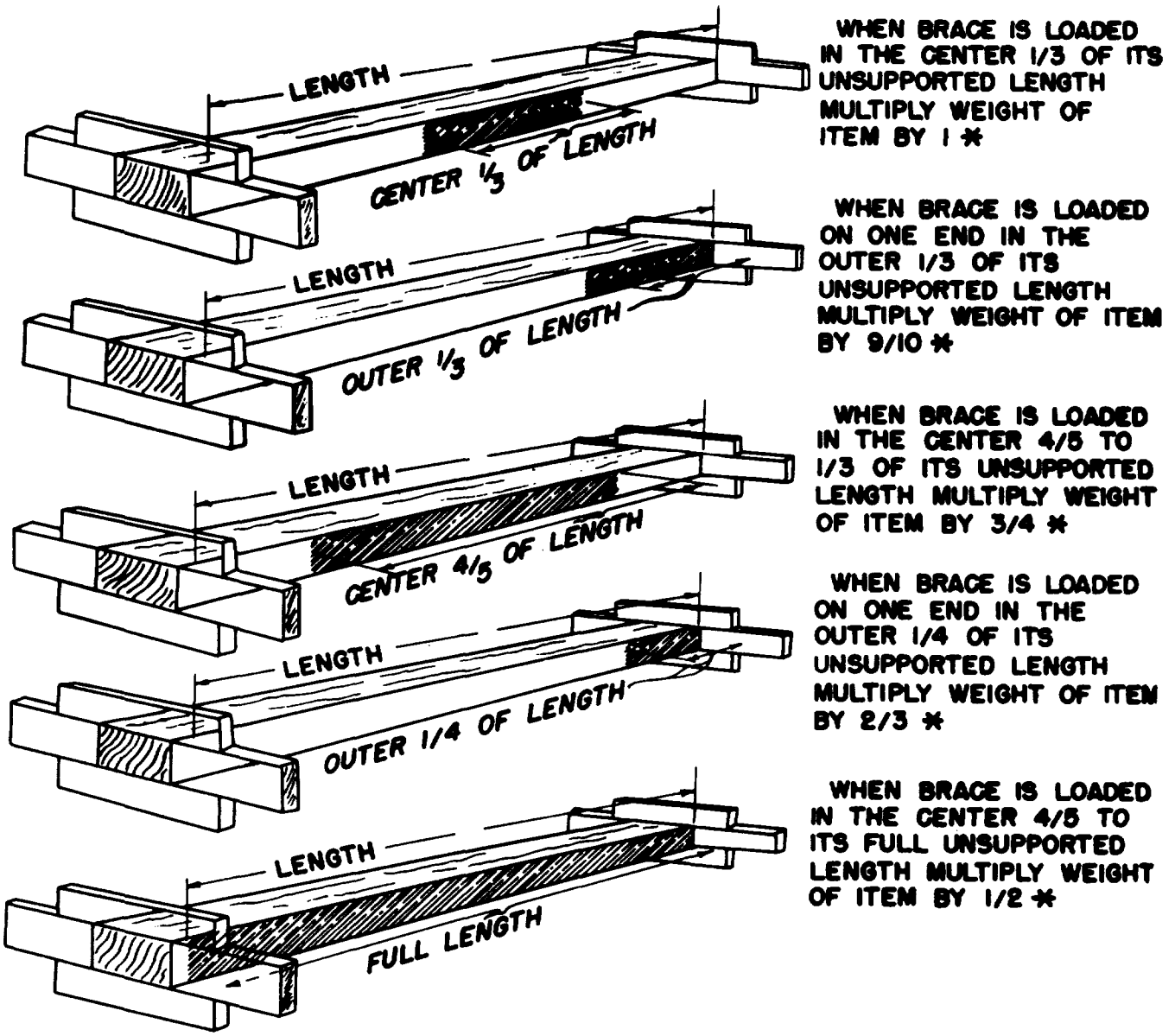

Figure 1-15. Types of loading (four use with table 1-3)

(5) Holes bored through containers or mounting bases must be the same size as the diameter of the bolts to be used.

(6) When mounting items to container bases equipped with skids, extend the bolts through the skids, whenever practical, and in such instances countersink the bolt in the outer surface of the rubbing strip.

(7) Use standard cut washers under the nuts to decrease the possibility of the bolt pulling through the wood.

(8) Make sure that the nuts do not come loose intransit by turning the nut securely on the bolt, and either upsetting or nicking the threads of the bolt beyond the nut; applying asphaltum, paint, lacquer, or P-1 of MIL-P-116 on the threads; using

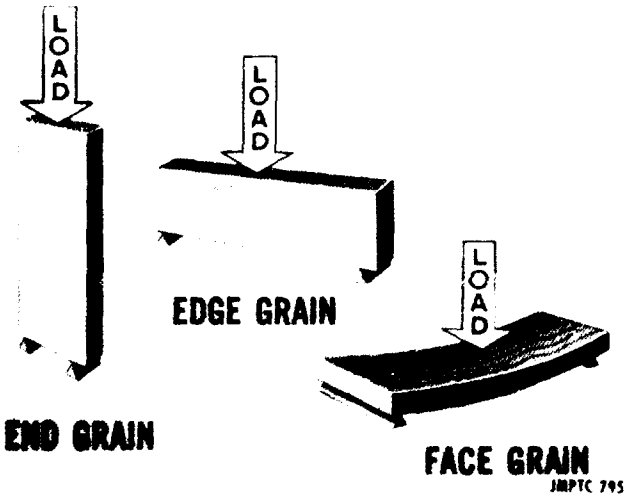

Figure 1-16. Positioning load according to grain of wood.

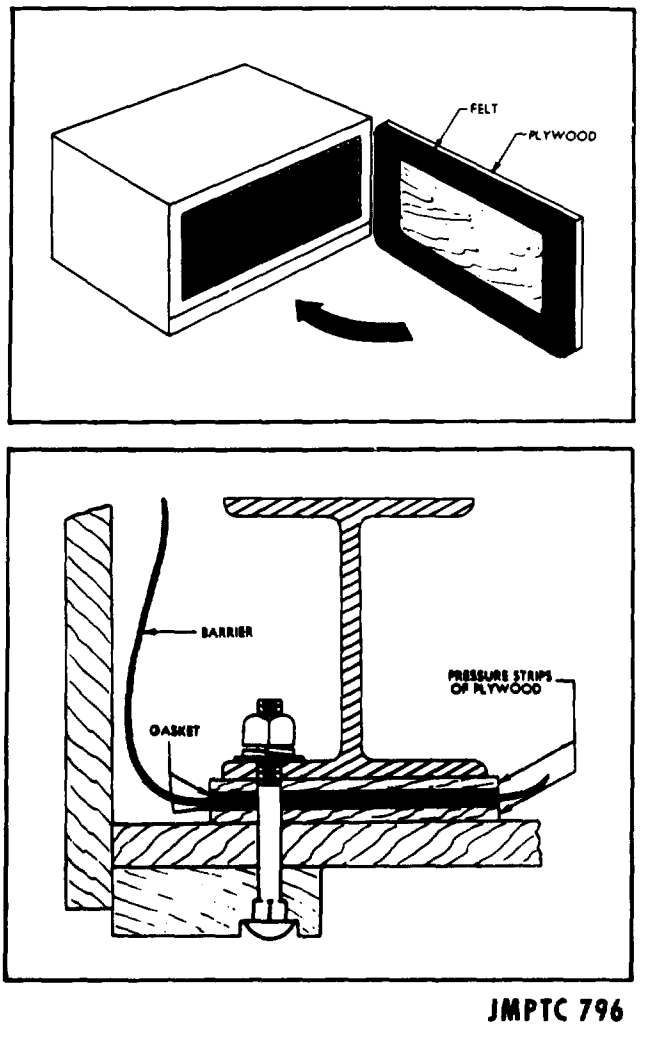

Figure 1-17. Protection for barrier and item surface.

lock nuts; or using cotter pins with the nuts; or lock washers. Metal plates or flat washers are used between lock washers and wood to prevent direct contact.

(9) Bolts and nuts that are not corrosion-resistant must be completely covered with P-1 or P-19 corrosion preventive compounds. The compound must be thoroughly set before the bolts are used.

(10) Where the item has strong frame members fairly close to the face of the container, consider using U- or J-bolts. Whenever feasible, the nut end of the U- or J-bolt should be on the outside of the container. In such cases, it is especially important to upset the threads or otherwise prevent the nuts from loosening.

(11) Use tie rods as extended bolts to secure items when J- or U-bolts are unsuitable. Place tie rods in pairs, either diagonally or vertically as may be necessary. Attach the tie rods to a reinforced point of the container and use them with washers bearing against the wood. Be sure the tie rods pass through the base at an angle which will not cause bending or kinking of the rod. Any kinking will weaken the rods and increase the possibility of failure.

Table 1-4. Allowable Lateral Loads for Unclinched Cement-Coated or Etched Common Wire Nails When Used for Blocking or Bracing.

Species of wood	Load, pounds per nail								
	4d	6d	8d	10d	12d	16d	20d	30d	40d
White pine, ponderosa pine, spruce, and other group I woods	14	17	21	25	26	29	38	42	48
Southern yellow pine, Douglas fir, western larch, and other group II woods	21	26	32	39	40	45	58	65	73
Oak, maple, birch, beech, ash, and other group III and IV woods	26	32	40	48	49	55	71	80	90

Group classification of species not specifically named shall be in accordance with Standard MIL-STD-731.

Table 1-5. Suggested Allowable Lateral Loads for Bolts—Impact Loading

Diameter of bolt (inch)	Allowable load (pounds)
3/8	35
1/2	90
5/8	150
3/4	200

(12) When anchoring heavy castings, tighten the nuts down equally so that there is no undue strain on any portion of the casting. After nuts have been tightened securely, it is advisable to back off the nuts one-fourth to one-half turn to relieve any internal stress on the casting.

1-13. Anchoring

Anchoring of heavy items should be accomplished by securing the item to a base by tension devices, either by bolts through mounting bolt holes on the item (bolting down); or by metal strapping, cables, tie rods, chains, wire, or other tension devices attached to, or applied over, the item (tiedown or holddown); or by both. The same washer requirement as specified for bolts of equal diameter should apply to tie rods (*a* below).

a. Anchor Bolts. Carriage or step bolts conforming to Specification FF-B-584, type I, class 1, style a or c, should be used. Articles having mounting holes in areas that can withstand rough handling without breakage shall be bolted to either the base of the container or an auxiliary base. The bolt heads of anchor bolts (those holding the item to the container base or the auxiliary base) should be on the outside of the container when an item is bolted to the base of the container, otherwise on the underside of the auxiliary base. The heads of all anchor bolts shall bear against a wide washer conforming to Specification FF-W-92, type A or B, grade I, class A, medium size, except that the minimum diameter or minimum size of square bolts shall be as specified in table 1-6 when the member adjacent to the bolt head is wood. Bolts through mounting bolt holes shall form a snug fit, except that precision holes shall be bushed to prevent damage by anchor bolts. In a crate where the item is bolted to a skid-type base, the anchor bolts shall pass through the skids or through loadbearing members that are bolted to the skids. Bolt holes in wood should be of the same diameter as the bolts. The maximum allowable load for anchor bolts required and the minimum size of wood-bearing washers should be as specified in table 1-6. When the weight of the item exceeds that shown which can be anchored adequately using allowable loads in table 1-6 and all of the available mounting bolt holes on the item, the excess weight shall be taken care of by tiedown provisions specified herein. After the nuts have been tightened, the exposed bolt thread should be painted with asphalt or P-1 of MIL-P-116 unless locknuts or cotter pins are used. The required size and quantity of bolts used as tie rods or for anchoring the ends of the tiedown tension members should be in accordance with table 1-6. Lag bolts should not be used in lieu of carriage or step bolts.

b. Metal Brackets or Frames. Many items have attachment points which provide facilities for bolting, but often these points are not located on the base, so that brackets must be used to fasten the item to the container. In those situations where tie rods or U- or J-bolts cannot be used, specially constructed brackets, sleeves, or frames made entirely of metal, wood, or a combination of these, are used to act as intermediate connections between the item and the container. These frames or brackets must be designed with sufficient strength and fastening facilities to hold the item to the container securely. Select sleeves that will fit the interior of the container snugly and will have sufficient structural strength to support the load (fig 1-23).

c. Metal Strapping. Metal strapping used to tie down an item to the base or other face of the container

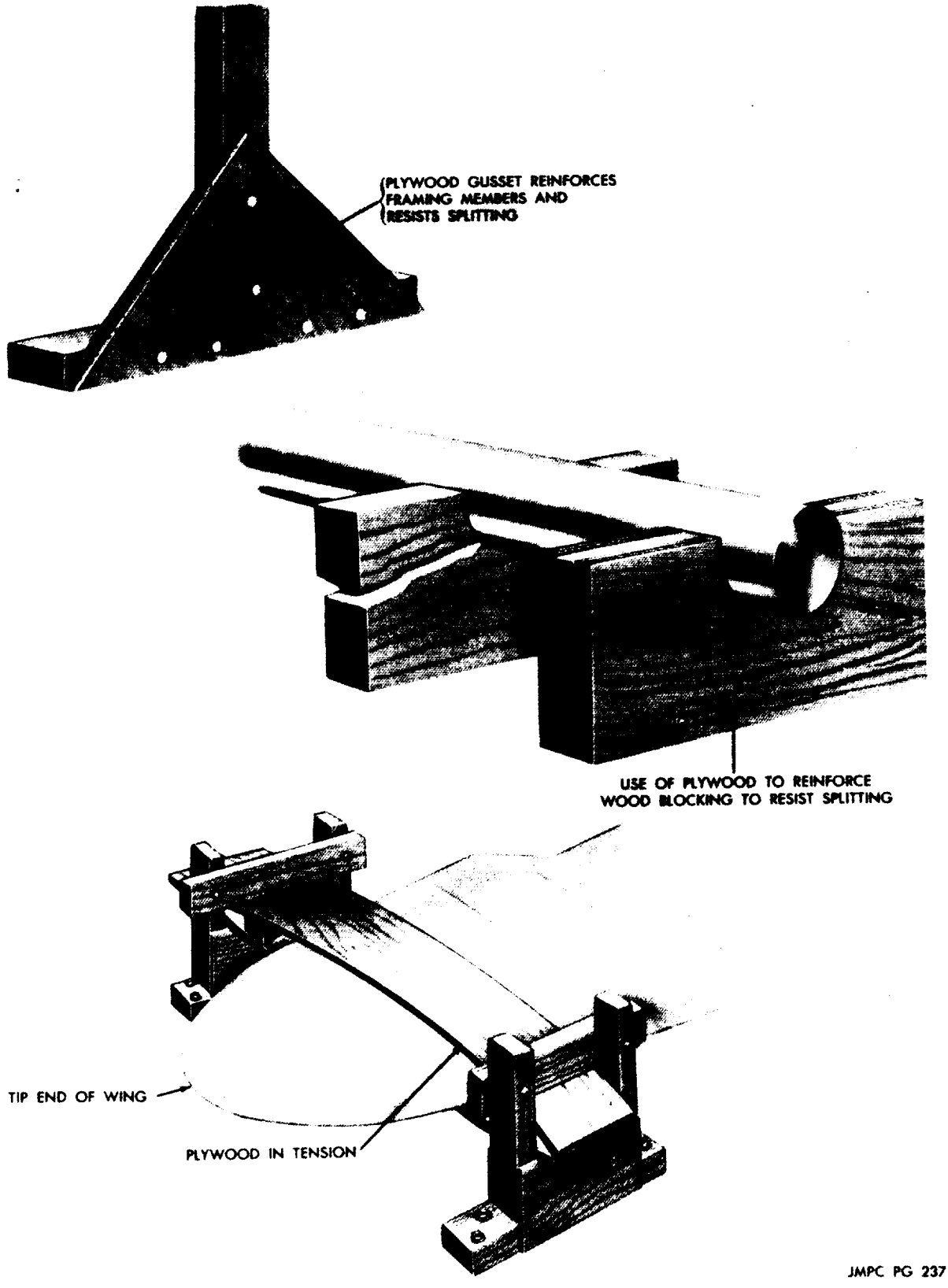

Figure 1-18. Uses of plywood for blocking and bracing.

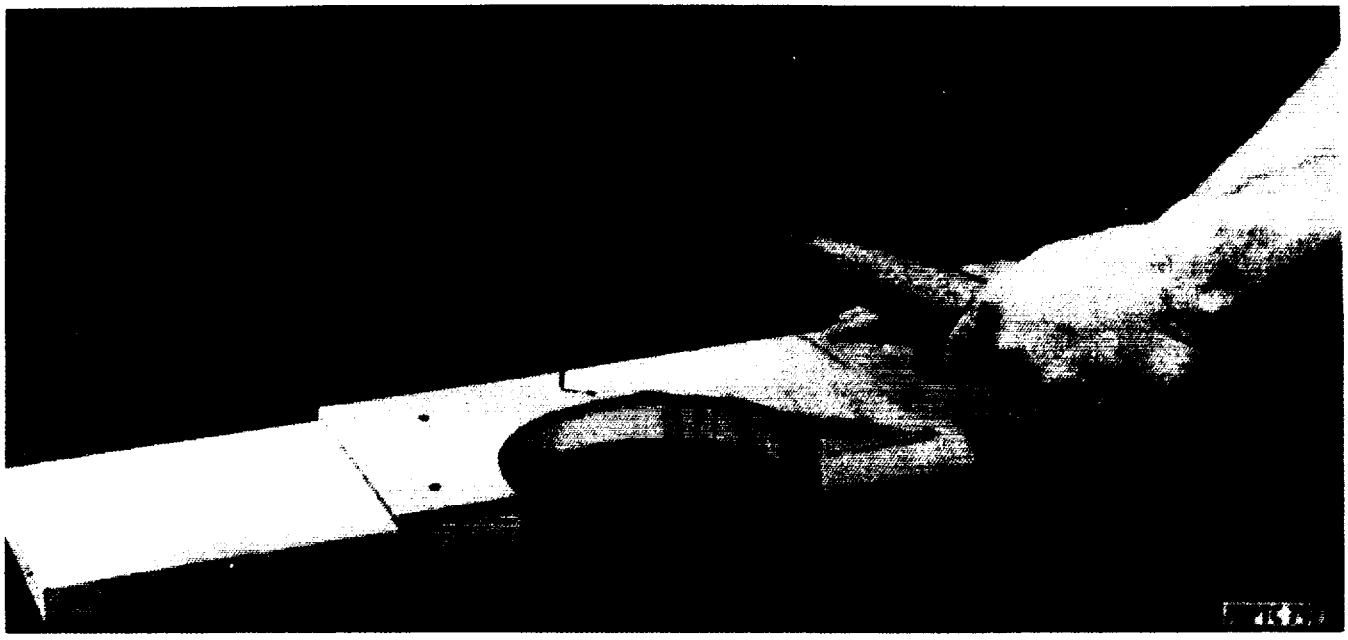

Figure 1-19. Plywood nailed to wood for reinforcement.

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Figure 1-20. Bolts for blocking and bracing.

or to an auxiliary base should be either flat or round wire steel strapping conforming to Specification QQ-S-781. Tiedown strapping shall be securely attached to or looped over the item. It shall be anchored to the container or auxiliary base either by looping around a load bearing member or by utilizing steel slotted anchor plates for flat strapping or drivescrews and staples for round strapping secured to the container or auxiliary base. Padding material or suitable edge protectors, as applicable, shall be used under the straps to prevent damage to the item. Whenever possible, all strands holding down an item shall be of approximately the same length. Maximum allowable loads for each strand of tiedown strapping shall be

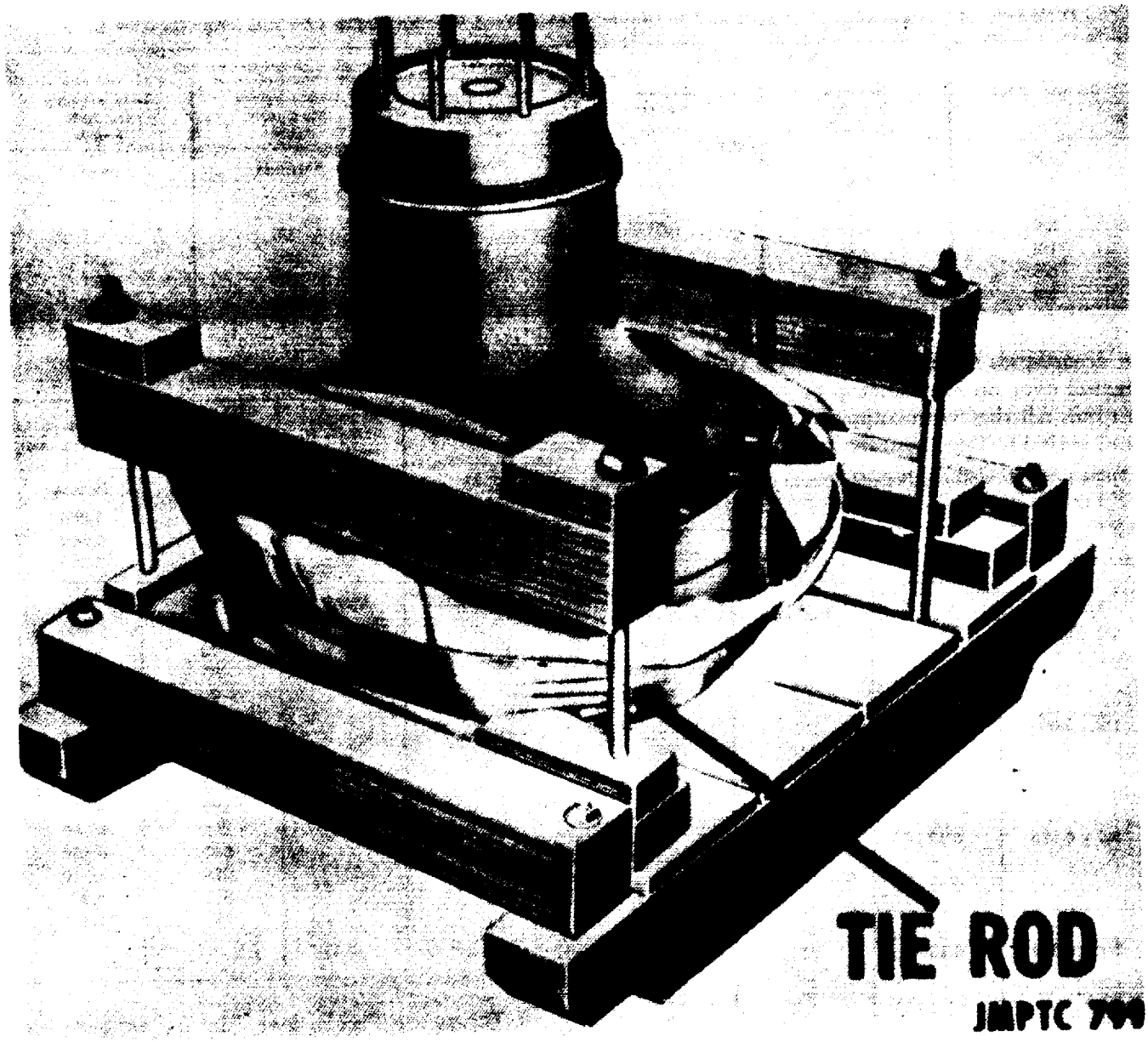


Figure 1-21. Vertical use of tie rods.

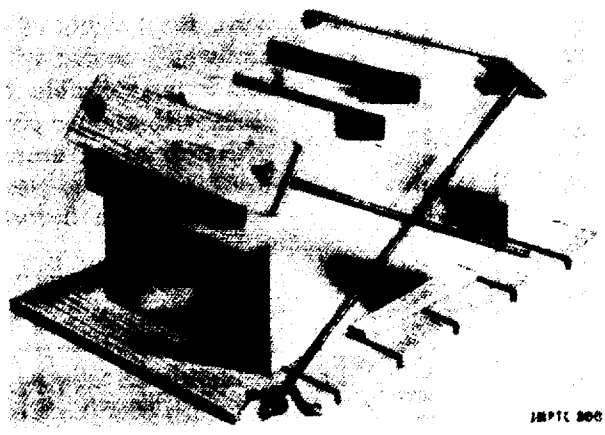


Figure 1-22. Diagonal use of tie rods.

Table 1-6. Maximum Allowable Loads and Minimum Sizes of Wood-Bearing Washers for Anchor or Tiedown Bolts

Diameter of bolt	Wood-bearing washers		Maximum allowable load per bolt		
	Minimum diameter of round	Minimum size of square	Items weighing 200 pounds and less	Items weighing 200 to 3,000 pounds	Items weighing over 3,000 pounds
Inch	*Inch*	*Inch*	*Pounds*	*Pounds*	*Pounds*
1/4	1.35	1.00	10	--------	--------
5/16	1.75	1.25	30	--------	--------
3/8	2.10	1.50	50	75	--------
1/2	2.85	2.10	100	150	300
5/8	3.60	2.65	150	225	450
3/4	4.70	3.25	--------	375	750

in accordance with table 1-7. Each tiedown strap passed over an item should be considered as one strand. All tiedown strappings shall be tensioned and sealed or tied securely.

Table 1-7. Maximum Allowable Loads for Each Strand of Strapping

Size of flat strap	Minimum diameter of round strap	Minimum length of hold down straps	Maximum allowable load
Inch	*Inch*	*Inches*	*Pounds*
3/8 x 0.020	0.10	10	22
		20	44
		30	66
		40	88
1/2 x 0.020	0.12	10	30
		20	60
		30	90
		40	120
		50	150
5/8 x 0.020	0.13	10	37
		20	75
		30	112
		40	150
		50	187
3/4 x 0.020	0.135	10	43
		20	86
		30	129
		40	172
		50	215
		60	258
		70	300
3/4 x 0.023	0.148	10	50
		20	100
		30	150
		40	200
		50	250
		60	300
		70	350
		80	400
		90	450
		100	500
3/4 x 0.035	0.183	30	225
		40	300
		50	375
		60	450
		70	525
		80	600
		90	675
		100	750
		120	900

Table 1-7—Continued.

Size of flat strap	Minimum diameter of round strap	Minimum length of hold down straps	Maximum allowable load
Inch	*Inch*	*Inches*	*Pounds*
		140	1,050
		160	1,200
		180	1,350
		200	1,500
1-1/2 x 0.035	0.258	50	750
		60	900
		70	1,050
		80	1,200
		90	1,350
		100	1,500
		120	1,800
		140	2,100
		160	2,400
		180	2,700
		200	3,000
		240	3,600
		280	4,200
		320	4,800
		360	5,400

d. Strapping Precautions. Metal strapping may be the only convenient way in which an item or container can be secured or reinforced (fig 1-24). Metal strapping may be either flat steel or round wire. Both kinds of strapping are tensioned and preferably sealed with specially designed tools. If this is not possible, flat strapping can be held in place with anchor plates and round wire strapping with special drivescrews and staples. General precautions on the use of metal strapping which apply to both flat steel and round wire are as follows:

(1) Where possible, the item and its support must be completely encircled. When it is impossible to do this, anchor the two ends of the metal strapping as follows:

(*a*) For flat strapping, anchor the two ends of the strap to the container base with anchor plates, or if the strap is designed for nailing, nail

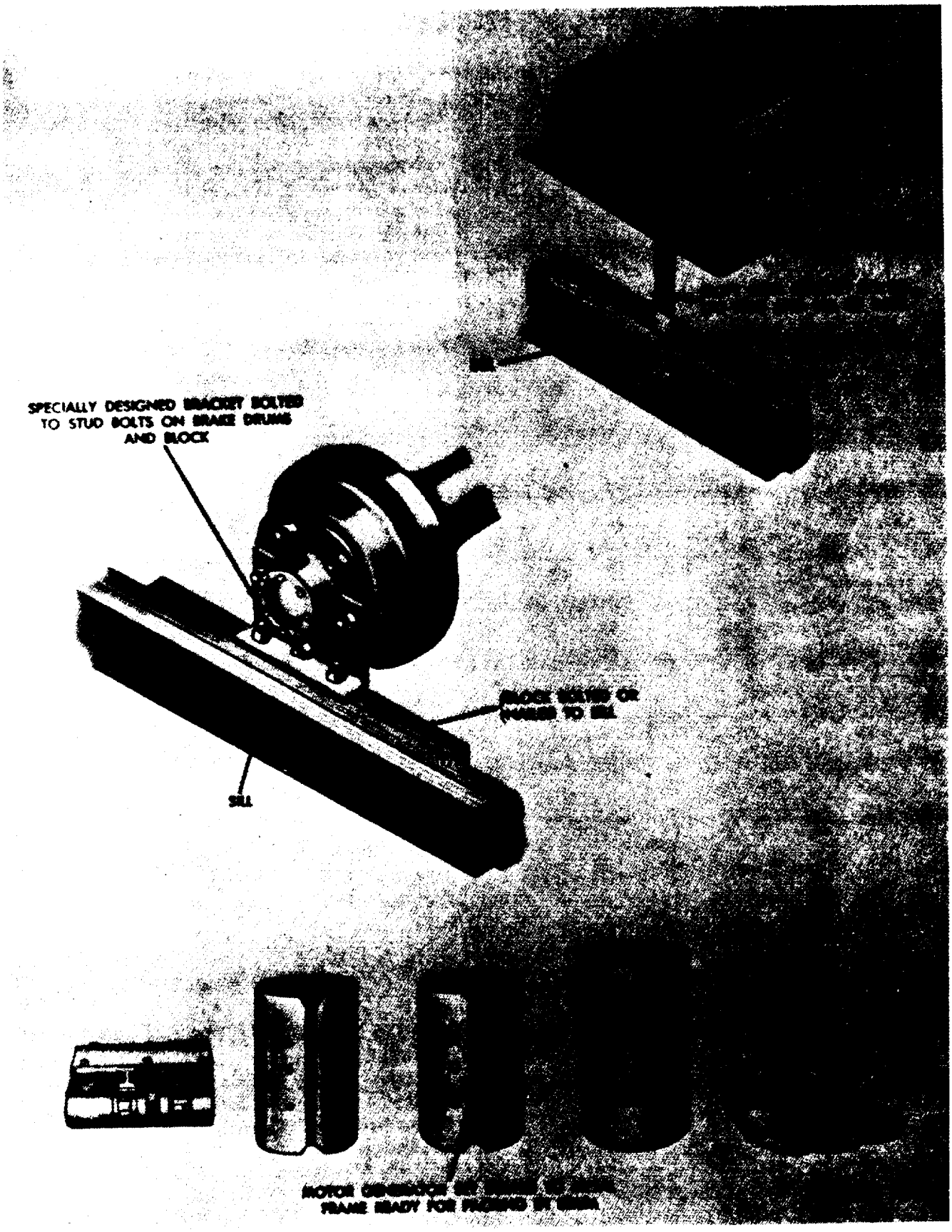


Figure 1-23. Use of metal brackets, frames, and sleeves.

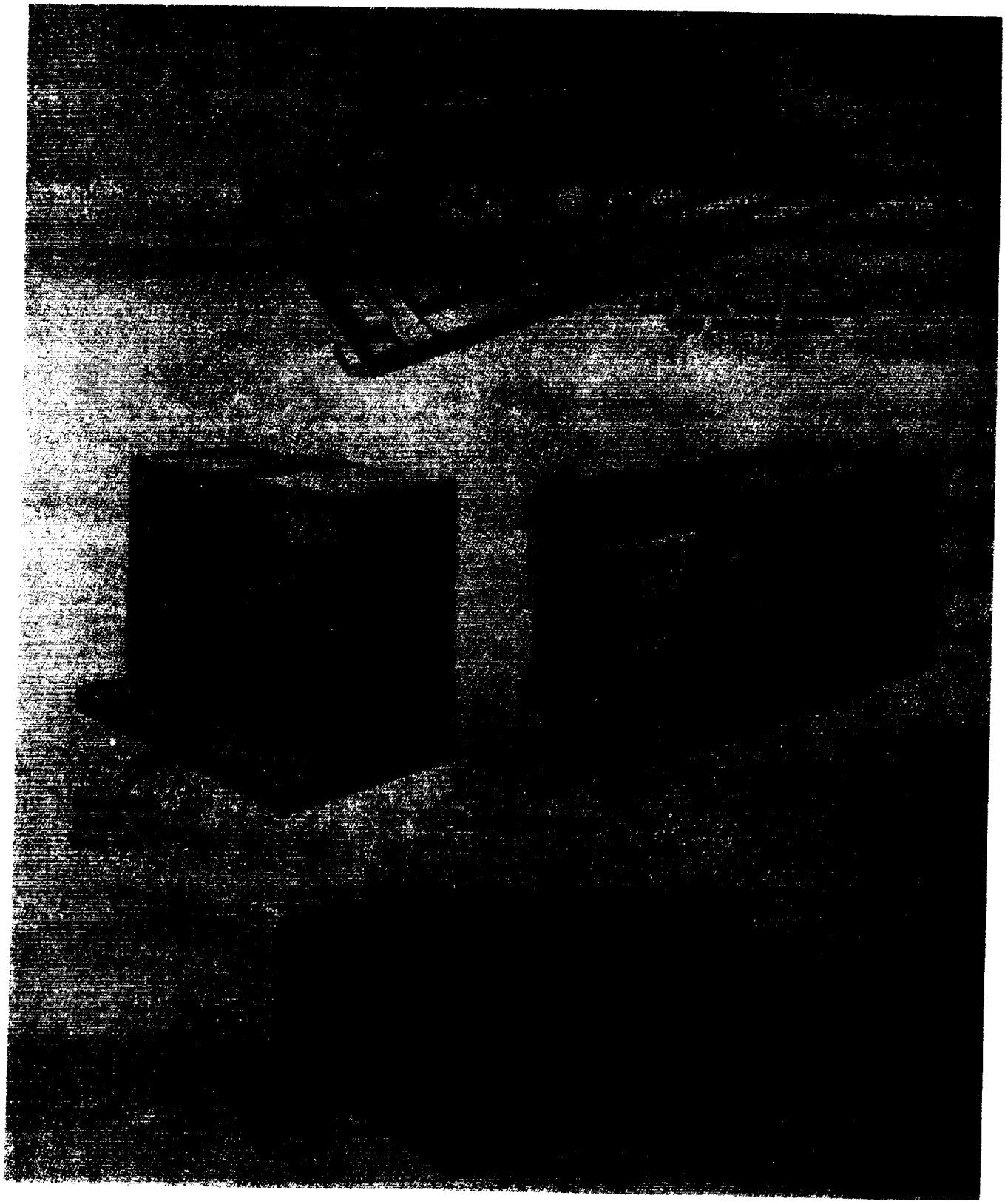


Figure 1-24. Use of metal strapping for bracing and anchoring.

the ends of the strap to the container base. Place the nails so that the straps exert a pull at right angles to the nail axis.

(b) For round wire, anchor the two ends of the round wire to the container with drivescrews and staples. Loop the wire around the shank of the drivescrew and further anchor the wire by means of staples. Be sure the wood is thick enough to hold the entire length of the drivescrew and that the drivescrew is of adequate gauge to carry the load. When drivescrews are used, place them so that the wire exerts a pull at right angles to the drivescrew axis.

(2) Apply tension to the strap with a tension tool and seal the strap in the customary manner. Use a one-piece strap wherever possible.

(3) Straps should be placed only on those strong portions of the item which can withstand the impact load and weight of the item.

(4) Where strapping passes over a sharp edge of the item, use corner protectors, if necessary, to prevent the strapping from becoming fractured.

(5) Protective materials should be used between the item and the strap if the strap is likely to scratch or otherwise injure the item.

(6) Arrange strapping on the container, where possible, to further reinforce blocking and bracing or anchoring of the item within the container.

(7) Use annealed strapping only for lighter items, since it stretches more readily than the more highly tempered tension strapping.

e. Minimum Lengths of Straps. The minimum total length of straps shown in table 1-7 does not include that portion of material used to make a secure fastening at the ends of each strand but is the sum of, and does include, all lengths of material between such fastenings. Overall lengths of each strand shall be adequate to permit fastening as specified in *d* above.

f. Maximum Allowable Loads. The maximum allowable loads shown in table 1-7 are based on available energy of 8,640 inch-pounds per cubic inch of strap in tension and an assumed drop height of 30 inches, as established by QQ-S-781. If greater loads than those shown in table 1-7 are to be tied down or if other sizes of strap are used, additional strapping shall be applied on the basis of 300 pounds of load per cubic inch of strap in tension.

1-14. Strapping Reinforcement for Containers

In addition to the use of metal strapping as reinforcement for blocking or bracing, its widest use is for reinforcement of exterior wooden containers. Only tempered, high tensile strength, flat steel or round wire strapping should be used as wood container reinforcement, except in limited instances such as reinforcing of a crate corner where annealed nail-on-type flat steel strapping is employed. For export shipments, bare metal strapping should not be used due to its lack of corrosion resistance. Each military container specification has a section or an appendix devoted to closure and strapping. It is important that the instructions contained in these publications be observed. Summaries of these instructions are to be found in chapters 2, 3, and 6 of this manual under specific containers.

a. Web Strapping. The use of web strapping to tie down an item to a base, to other faces of the containers, or to a built-up frame, is *NOT* considered a good practice. Web strapping has a tendency to shrink or stretch with change in moisture content, thereby losing its ability to hold the item firmly in place. It is hygroscopic, and may cause corrosion to contacting metal surfaces, and it is often difficult to anchor properly.

b. Reinforced Tapes for Packing. Various kinds of tapes have been developed with longitudinal filament reinforcing strands to provide high tensile strength. When such tapes are properly applied to containers or bundled items, significant increases in resistance to rough handling are attained. These tapes consist of either a paper or plastic backing, which has been coated on one side with an insoluble pressure-sensitive adhesive, or a gummed adhesive that is activated by a solvent. The high tensile strength of the tape is produced by filaments of rayon, glass, or other fibers that have been lineally aligned and embedded in the backing material. When the tape is applied to the container so that the direction of the rough handling stresses are parallel to the embedded filaments of the tape, considerable container strengthening results. Longitudinal tensile strength of these tapes may be over 500 pounds per inch of width. Some of the advantages claimed for their use are that sufficient tensile strength and elastic properties are present to enable a package or pack to be highly resistant to shock loads. The adhesive holds the tape to the area of application and thus prevents slippage during handling. These tapes do not easily snag and do not interfere with stacking and handling of containers. No special equipment is needed for their application. They provide a means of reducing pilferage.

(1) *Reinforced paper, gummed tape (PPP-T—45).* There are three types and two classes available. Type I (reinforced, asphaltic laminated) and Type II (reinforced, nonasphaltic laminated) are intended for use in so called single strip closure under the Uniform Freight Classification Rule 41, section 7. Types I and II are used for closure of fiberboard boxes for domestic shipment and storage and for securing wrappers of packages. Type II shall be used where the presence of asphalt would have a deleterious effect on the con-

tents, such as food products. Type III is intended for use in general sealing of cartons, fiberboard boxes, and wrappers and for banding paper and paper products. Class 1 (strippable) is used when ease of opening and removal of the tape is desired. Class 2 (nonstrippable) is used when removal of the tape from boxes is not necessary for reuse.

(2) *Filament reinforced, pressure tape (PPP-T—97).* These tapes are supplied in four types based on tensile strength. Type I (low tensile strength) has a minimum tensile strength of 160 pounds per inch of width. Type II (medium tensile strength) has a minimum tensile strength of 240 pounds per inch of width for Class A, and 300 pounds per inch of width for Class B. Type III (high tensile strength) has a minimum tensile strength of 425 pounds per inch of width. Type IV (high tensile strength, weather-resistant) has a minimum tensile strength of 400 pounds per inch of width. Only Type II has two classes, based on the transparency of the tape. Class A is opaque or nontransparent, and Class B is transparent enough to allow reading of printed matter through one layer of the tape. These tapes are intended for use in securing packages and reinforcing bundles and containers.

c. Reinforced Tape Application Guidelines. Individual container specifications, and appropriate standards should be checked for the proper use of reinforced tapes. Some basic rules that may be helpful are as follows:

(1) Do not use a wide tape if a narrower tape is strong enough to accomplish the intended purpose.

(2) If it is anticipated that high humidity conditions or excessive moisture will be encountered in shipment or storage, use tapes with waterinsoluble adhesives.

(3) The adhesion of tapes to the surface of a container will depend upon the condition of the surface. Hence, in strip applications, the strips should be long enough to provide sufficient adhesion to take advantage of the full potential strength of the tape. This should require at least 6 or more inches of good contact between the tape and the container surface. The tape length should be equally divided over a seam, scoreline, or other point of application.

(4) In using reinforced paper gummed tape (PPP-T—45) for sealing containers shipped under the jurisdiction of the Interstate Commerce Commission, only the center seam of a container needs to be sealed. This is accomplished by using a strip at least 3 inches wide which must extend no less than 2½ inches over each end of the container.

(5) In using filament reinforced, pressure-sensitive tape (PPP-T—97), the following information will serve as a guide in its use. It should be recognized that special conditions will necessitate occa-

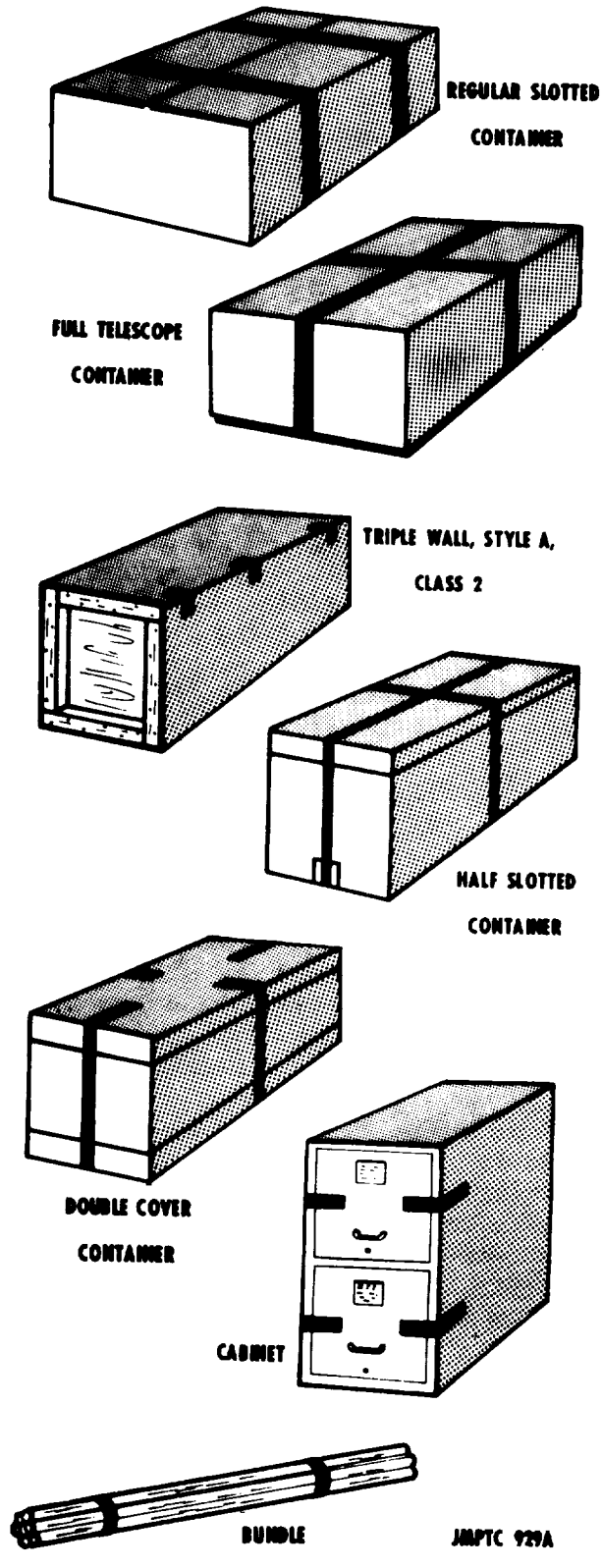


Figure 1-25. Use of filament reinforced tape.

Table 1-8. Tape Strips Used in Handling Rigid Materials [1]

Gross weight of bundle	Type III tape band width in inches (minimum)									
	Number of encirclements (Example: Three encirclements could refer to either three separately located single wrapped bands or to one band which completely overlaps itself three times.)									
Pounds	1	2	3	4	5	6	7	8	9	10
Up to 20 incl	¾	½	½	½	½	½	½	½	½	½
Over 20 to 40 incl	1	¾	½	½	½	½	½	½	½	½
Over 40 to 60 incl	1¼	1	¾	½	½	½	½	½	½	½
Over 60 to 80 incl	1½	1¼	1	¾	¾	½	½	½	½	½
Over 80 to 100 incl		1½	1¼	1	¾	¾	¾	¾	¾	¾
Over 100 to 150 incl			1½	1¼	1	¾	¾	¾	¾	¾
Over 150 to 200 incl				1½	1¼	1	¾	¾	¾	¾
Over 200 to 300 incl					1½	1¼	1	¾	¾	¾
Over 300 to 400 incl						1½	1¼	1	1	1
Over 400 to 500 incl								1½	1¼	1

[1] If material to be bonded is somewhat flexible, tape widths may be reduced by 25 to 50 percent. In no case should less than ½ inch tape be used.

sional deviations from these recommendations in the interest of economy or good practice. The filament reinforced, pressure-sensitive tapes are intended for use in reinforcing fiberboard or fiberboard surfaced containers, strapping, bundling, and other miscellaneous applications. Type I, characterized by high elongation and low tensile strength, is best suited for strip reinforcement of containers and anchoring moving parts. Type II with lower elongation but high tensile strength, is also suited for closures. Type III, with higher tensile strength and low elongation, is most effectively used in complete wraparounds such as bundling and other forms of circumferential binding. Type IV should be used where weather resistance is required and should be used in the same lengths as the type it replaces. These tapes should be applied in continuous strips. Typical applications are shown in Figure 1-25. Tape should be smoothly and firmly adhered to surfaces which are relatively smooth and nominally free from dust, dirt, grease, and moisture. Care should be taken to avoid excessive handling of tape adhesive surfaces, particularly at the ends of the strips. Such excessive handling might contaminate the surface of the adhesive and reduce its ability to bond firmly.

(6) The high tensile strength tapes are also used for bundling of rods, shafts, or tubular objects for easier handling. Table 1-8 shows the correct amounts of Type III (PPP-T—97) tape for use in bundling. The tape should be applied with sufficient hand tension to "snug" the bundle and secure maximum contact between the tape and the bundled items.

1-15. Cushioning

a. Cushioning Defined. Cushioning is the protection given to items against physical and mechanical damage by means of appropriate materials which absorb the energy of shocks and vibrations through a gradual but increasing resistance to the movement of the item. The energy from shocks and impacts is absorbed when the cushioning material is compressed, which in turn increases the pressure upon the entrapped air within the cushioning material, resulting in a damping or minimizing of the force to the item.

b. Cushioning Versus Blocking and Bracing. The distinction between cushioning and blocking and bracing is that cushioning permits controlled movement of the item within the container, while blocking and bracing usually is designed to prevent movement of the item within the container.

c. Cushioning and Corrosion. Where applicable cushioning should be used in one or more of the following ways to provide necessary physical protection. Cushioning materials shall be separated from surfaces which might be corroded at points of contact by either noncorrosive wrapping paper conforming to Specification MIL-P—130 or greaseproof barrier material conforming to Specification MIL-P—121, Grade A. If a noncorrosive cushioning material is used, the wrap is not required. Cushioning materials containing asphalt shall not be permitted to come in direct contact with highly finished, varnished, or lacquered surfaces.

d. Flotation or Suspension. Delicate or fragile items should be protected against shock and vibration by flotation or suspension within the shipping container by suitable cushioning materials. These materials may be in sheet form applied to give

support at top, bottom, sides, and ends of the item. For items in sturdy cabinets, cases, consoles, or packed in an inner box, the cushioning material may be in the form of prefabricated corner pads. Materials shall be bound fiber conforming to PPP-C—1120; fiberboard conforming to MIL-F—26862; wood excelsior conforming to PPP-E—911; fibrous glass conforming to MIL-C—17435; cellulosic material conforming to PPP-C—843; expanded polystyrene conforming to PPP-C—850; prefoamed polyurethane conforming to MIL-P-26514; foam-in-place materials complying with MIL-F—83671; or such other materials as specified in the procurement documents.

e. Abrasion Protection. Protection against abrasion should be provided for highly finished or easily marred surfaces by wrapping or covering with cushioning material. Surfaces that might be damaged by contact with cushioning material should be separated therefrom by a covering of noncorrosive paper conforming to MIL-P—130 or MIL-P—17667 or greaseproof barrier material conforming to MIL-B—121, Grade A.

f. Coatings and Barriers. Protection should be provided for strippable compound coatings and for greaseproof, waterproof, or water vaporproof barriers at points of contact with blocking, bracing or projecting members of containers. Cushioning materials should be applied to reduce the statis pressure at points of contact of 30 pounds or less per square inch.

g. Moisture Resistance. Unless otherwise specified in the product specification, cushioning mate-

rial conforming to Specification PPP-C-843 should be of the water resistant type.

h. Dusting. Cushioning materials that are not dust producing should be used for packing items that are adversely affected by dust, unless a dustproof barrier is used to prevent dust from reaching the item.

i. Factors Influence Cushioning Selection and Use. Shock resulting from rough handling or dropping of shipping container is the usual cause of mechanical damage to the contents. The purpose of package or item cushioning is to reduce the intensity of the shock reaching the packed item to a level which the item can withstand. Factors influencing cushion design are the fragility and weight of the item, the load-bearing area of the cushion, the dynamic, force-deformation characteristics of the cushioning material, and the equivalent height of drop (usually 30 inches) for which protection is desired. Among these, the fragility and weight of the item are fixed values for any particular item. The load—bearing area of the cushion can be altered by suitable blocking or by packing the item in an inner container, if desired.

1-16. Application of Cushioning Materials

a. 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. Details on "Package Cushioning Design" may be obtained in MIL-HDBK-304.

b. Functions of Cushioning. In order to utilize properly the many cushioning materials available in the military supply system, it is necessary to understand the functions of cushioning. Among these functions (fig 1-26) the more important are—

(1) *Controls movement and prevents damage caused by vibration.* Cushioning, when properly applied, controls the movement of the item within the barrier or container and dampens vibration.

(2) *Protect fragile or delicate components.* When fragile or delicate components form a part of an otherwise rugged item, they may be disassembled and packaged separately. If disassembly is not permitted and they must be left in place, cushioning is applied to give them protection.

(3) *Prevent rupture of barriers and containers.* Many items have sharp corners or projections which could puncture the barriers or containers in which they are packaged, resulting in the entry of moisture or water. Cushioning is applied to these projections or corners to insure that waterproof or water-vaporproof barriers are not rendered useless by such damage.

(4) *Distribute forces.* Cushioning materials reduce the shock to an item by distributing forces over a large area, thus lowering the stress concentration at any one point on the surface of the item.

(5) *Prevent abrasion.* Items with highly finished surfaces which may be marred by blocking, strapping, contact with container surfaces, or contact with other items in the container, must be protected against abrasion by cushioning. Usually, lesser amounts and thickness of cushioning materials are employed to accomplish this cushioning function.

(6) *Absorb shocks.* Perhaps the most frequent and important use of cushioning is to absorb the energy resulting when an impact shock strikes a container. This shock energy is absorbed as the cushioning material is compressed by the impact.

(7) *Multipurpose cushioning.* The foregoing functions of cushioning should not be considered separately because cushioning is often used for more than one purpose in the same package. Material selected to protect an item against shock may at the same time minimize movement, prevent abrasion, protect barriers, and cover sharp projections. Many cushioning materials also act as good insulation to protect items against drastic temperature changes. Cushioning may be required to absorb liquids and consequently must have liquid-absorbing qualities to prevent liquid flow in case of breakage of the containers.

c. Requirements for the Use of Cushioning Materials. In addition to the requirements established in cushioning specifications in regard to material quality, construction, and performance, other important requirements must be met when cushioning materials are used within waterproof or water-vaporproof barriers. Sound packaging design practices dictate placing only the minimal required amount of cushioning material within water-vaporproof barriers, thereby minimizing the barrier area and the desiccant requirements. In addition, Specification MIL-P-116 requires that—

(1) Cushioning be as dry as practicable.

(2) Cushioning in contact with bare metal surfaces shall be capable of meeting Test Method 3005 of Federal Test Method Standard 101.

(3) If the item is coated with a preservative, the preserved item must first be wrapped in a

Figure 1-26. Functions of cushioning.

barrier conforming to MIL-B-121, Grade A, QQ-A-1876, or MIL-B-22191, Type I or II, before applying the cushioning material.

d. 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 packages, and the means of transportation must all be taken into consideration before an item can be properly cushioned.

(1) *Nature of the item.* 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 (fig 1-27).

(*a*) *Shock resistance or fragility.* Fragility may be observed, but cannot be measured accurately by eye. The tendency is to overcushion seemingly fragile items and to undercushion seemingly sturdy items. Fragility—the greatest amount of dynamic force 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 measuring the peak acceleration (deceleration) an item will withstand during impact and dividing this acceleration value by the acceleration due to gravity (32.16ft/sec/sec). This is expressed as—

$$\text{G-factor} = \frac{\textit{Acceleration of the Item}}{\textit{Acceleration due to Gravity}}$$

The G-factor values of many military items are being determined. In the absence of known G-factor values, the selection of cushioning must be based on experience with previous shipments and testing of similar items, or by assuming a G-factor for drop test purposes.

(*b*) *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.

(*c*) *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.

(*d*) *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 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 will have to be employed to adequately protect such items.

(*e*) *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 surfaces may be corroded and pitted by chemical action due to the presence of moisture and acidic or basic elements in the cushioning material.

(*f*) *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.

(2) *Characteristics of cushioning materials.* The chemical and physical properties of cushioning materials are many and may 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. For instance, high moisture absorbency is required for packaging liquids, but is not desirable when packaging corrodible metal items.

(*a*) Compression set (fig 1-28) is the difference between the original thickness of a cushioning material and the thickness of the same material after having been released from compression under a standard load for a given period of time. This is important in determining whether a cushioned item can remain in storage for an extended period of time without causing the cushioning to lose its resiliency. Permanent compression set is undesirable when it creates free-moving space in the container.

(*b*) Resilience (fig 1-28) 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 climatic conditions.

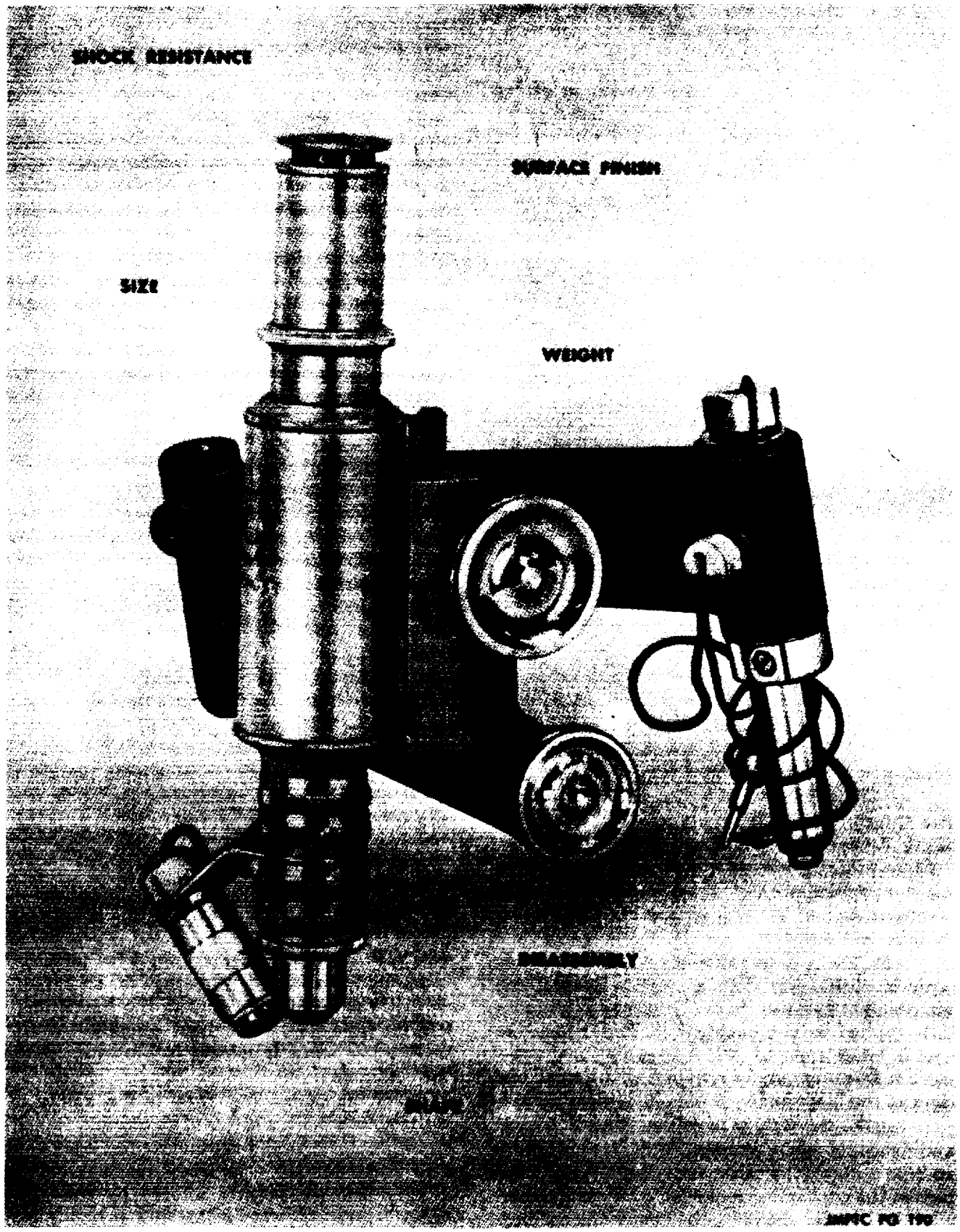
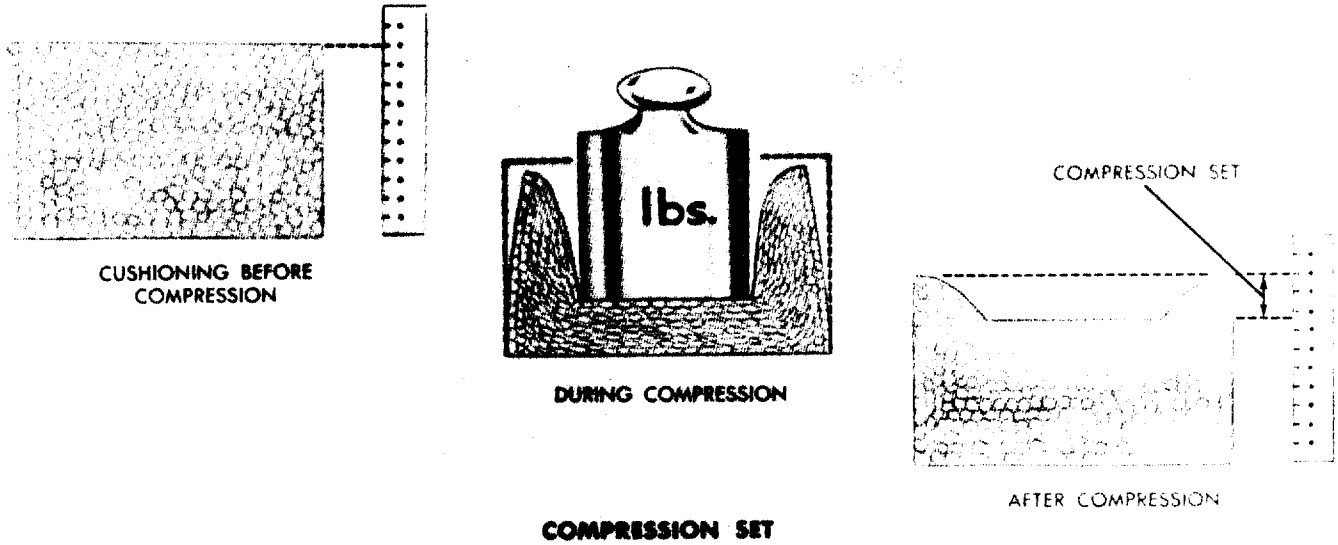
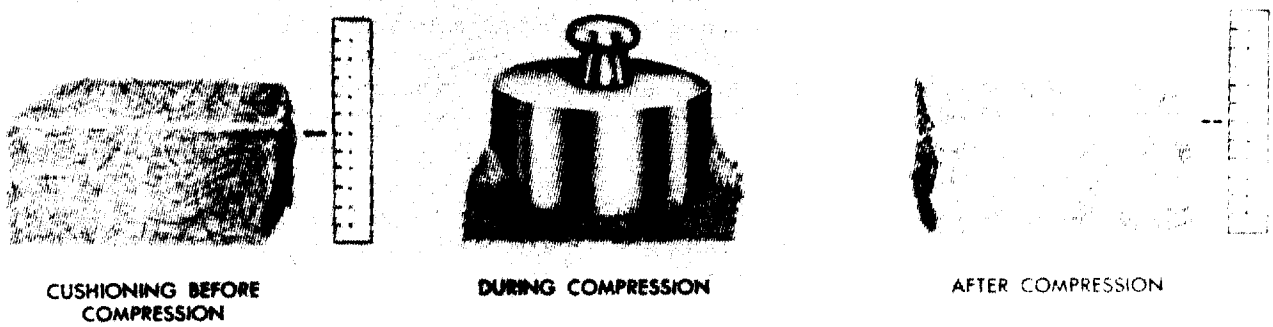


Figure 1-27. Item characteristics which determine the selection of cushioning materials.





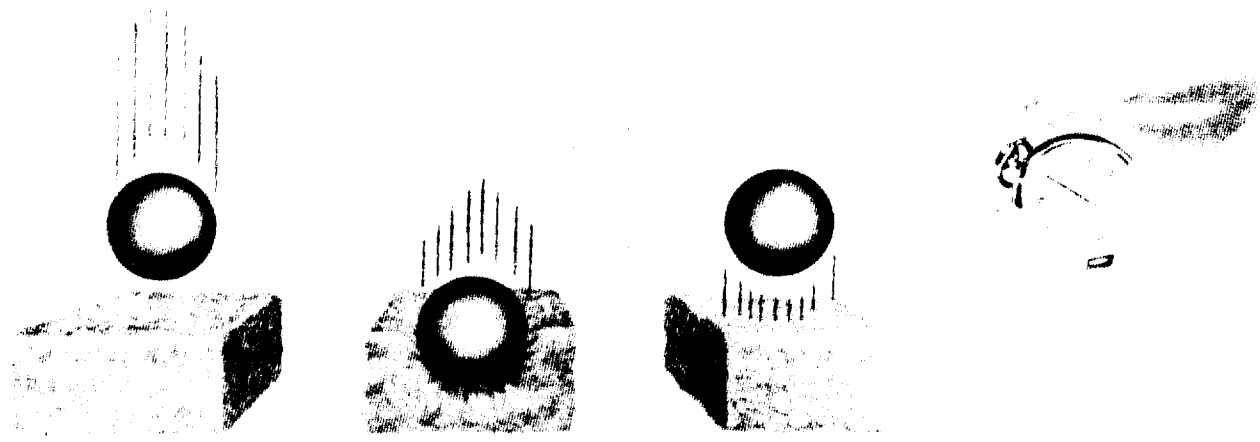


Figure 1-28. Characteristics of cushioning materials—compression set, resilience and rate of recovery.

(c) Rate of recovery (fig 1-28), or the time it takes for a cushioning material to return to its original shape after compression, is also important as some materials have too rapid a rate of recovery and "spring back" so quickly that damage to the item may result.

(d) Dusting, which results from the 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 (fig 1-29).

(e) The corrosive effect of some cushioning materials is undesirable when packaging 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 basic content must not be enclosed within waterproof or water-vaporproof barriers (fig 1-29). When cushioning material contains natural hair, it shall be treated with insecticide to prevent carpet beetle infestation.

(f) Fungus resistance of some materials is low and allows for 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 (fig 1-29).

(g) 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 (fig 1-30).

(h) 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 (fig 1-30).

(i) Other characteristics which should not be neglected in choosing cushioning materials are fire resistance or flammability (fig 1-30), and the possibility of the material causing skin irritation to personnel who come in contact with it.

(3) *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 as to make them 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.

(4) *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 that an item being transhipped from truck, to rail, to ship would get and one that is 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.

e. Representative Cushioning Materials.

(1) *Cushioning material, uncompressed bound fiber (PPP-C—1120).* This material 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 examples. It is furnished in five types and two classes and three grades. Type I is soft, Type II is medium soft, Type III is medium firm, Type IV is firm, and Type V is extra firm. When specified, each type shall be identified with a color matching as closely as possible colors shown in Federal Standard 595, as follows: Type I, brown; Type II, yellow; Type III, orange; Type IV, red; and Type V, black. Class A is water-resistant and Class B, a commercial class, is not necessarily water-resistant. Grade 1 is a flame-resistant material; Grade 2 provides low temperature characteristics; and Grade 3 is a standard material. This material may be supplied as uncompressed sheets and rolls and in molded shapes 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 good at low temperature. They are intended to protect items against vibrational and impact shocks where resilient and water-resistant cushions are required.

(2) *Cellulosic cushioning material (PPP-C—843).* This material may be made of any kind of cellulosic matter which will result in a product meeting specification requirements. The cellulosic matter used may be cotton, bonded fibers, natural fibers, or creped wadding. The material is furnished in two types—Type I, water absorbent, and Type II, water-resistant. It is available in three classes—Class A, low tensile strength, Class B, high tensile strength, and Class C, very high tensile strength.

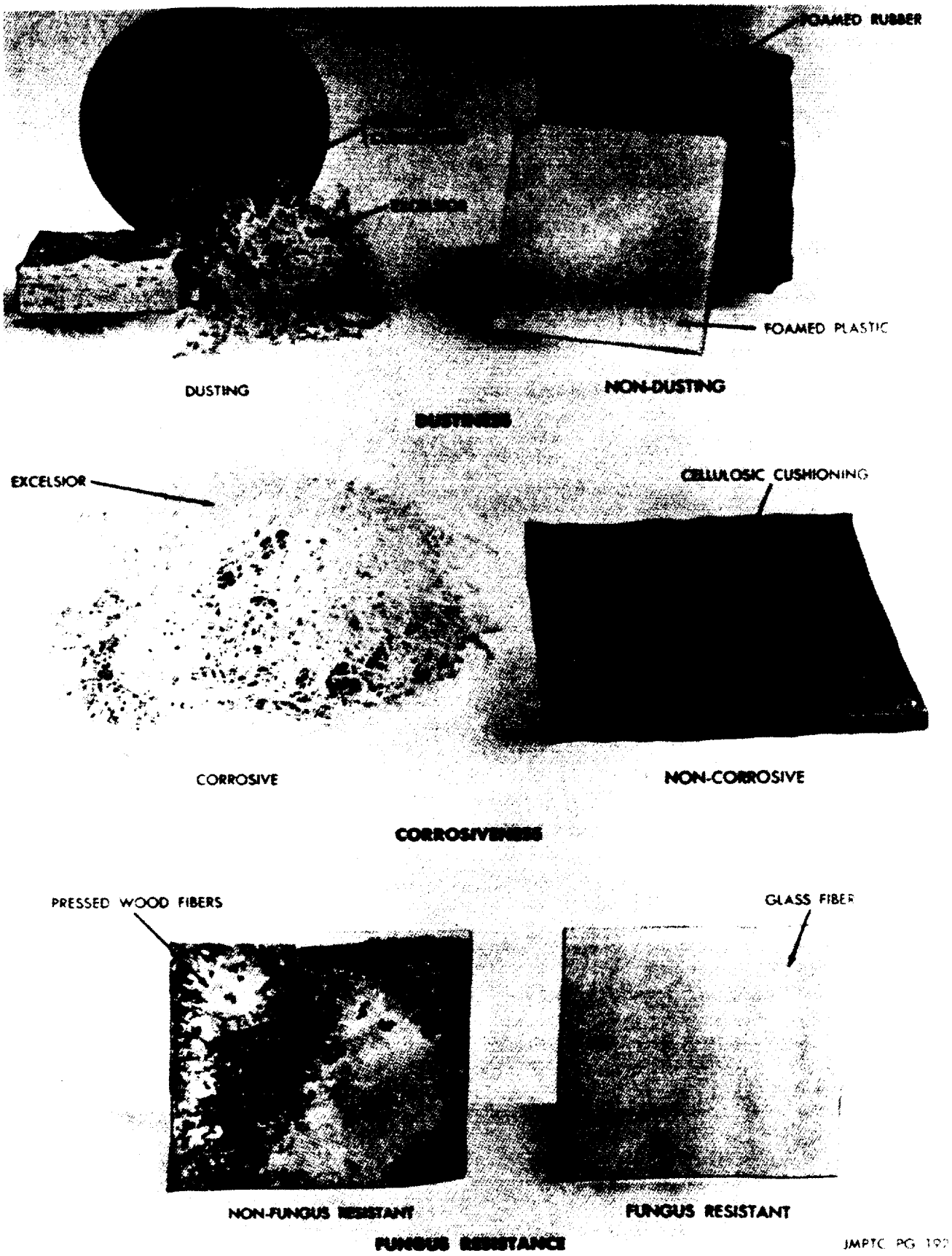


Figure 1-29. Characteristics of cushioning materials—dustiness, corrosiveness and fungus resistance.

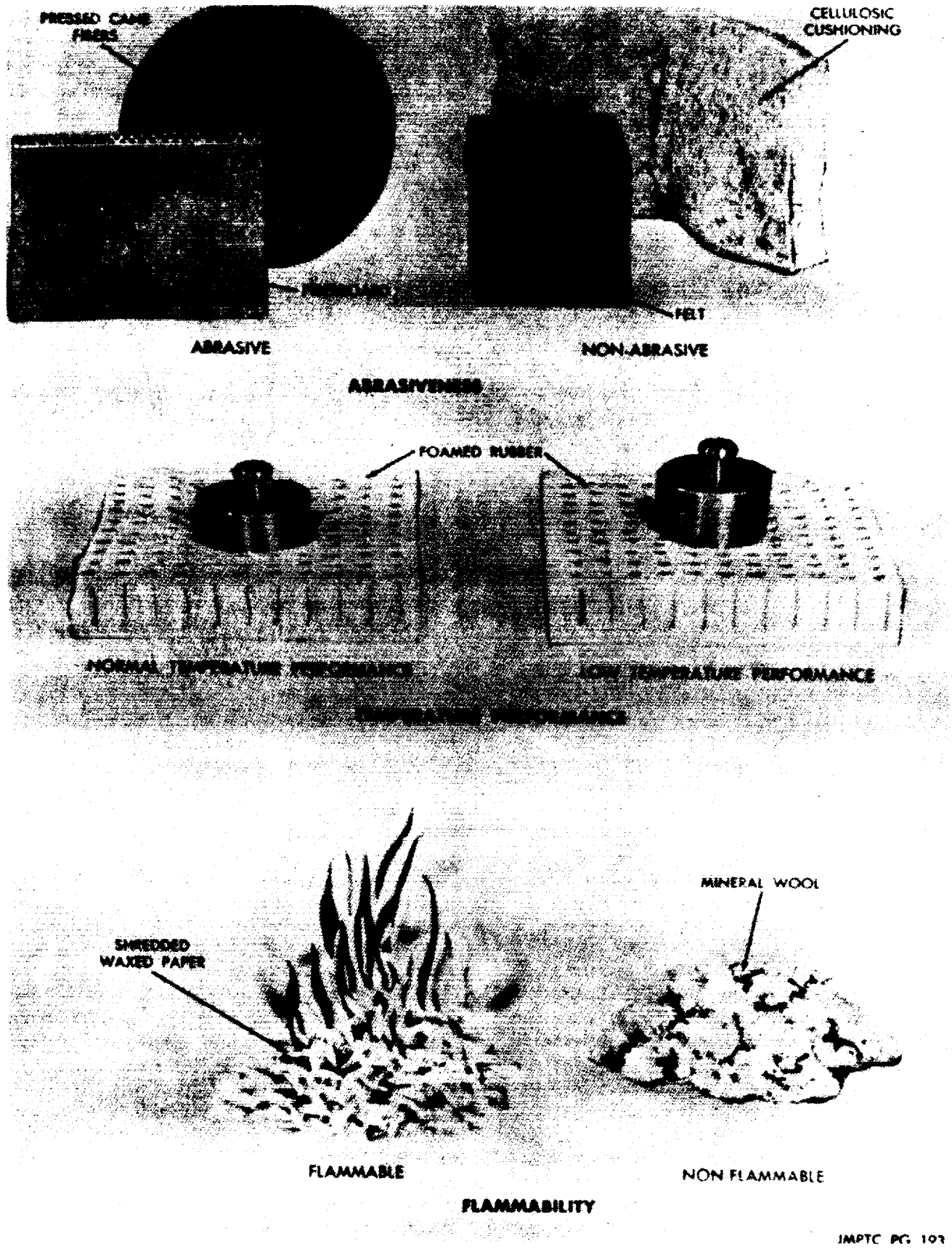


Figure 1-30. Characteristics of cushioning materials—abrasiveness, temperature performance and flammability.

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 packaging lightweight, fragile items; as a protection against abrasion; and Type I, specifically, for absorbing liquids from containers broken in transit.

(3) *Firbous glass cushioning material (MIL-C—17435).* This material consists of glass fibers matted, bonded, or otherwise treated to meet specification requirements. The surface of Type II material is coated with an elastomeric material to prevent dusting. This material can be supplied in various classes of density ranging from a very soft material with a load range from 0.5 to 3.0 pounds per square inch to a very firm material with a load range from 50 to 120 pounds per square inch. The resilience of the material is high, its compression set low, its damping fair, and its dusting slight, especially in the Type II material. It is highly flame-resistant and water-resistant. The material is neutral and will produce no corrosive effects. Moisture content and moisture absorbency qualities are low. The material is fungus resistant and performs well at low temperatures. Fibrous glass cushioning is intended for use in protecting packaged or installed equipment against shock and vibration. A temporary skin irritation may occur as a result of handling the uncoated type (Type I). Minute fibers sticking to the skin are readily removed by ordinary washing. Suitable precautions and adequate ventilation should be used when there is any possibility of particles getting into the eyes or of accumulation of glass dust in the air.

(4) *Paper honeycomb cushioning material (MIL-H—9884).* This material consists of unbleached kraft fibers constructed into slice increments by lamination of sheets of paper board with a weatherproof adhesve. This material is primarily used an an energy dissipating medium for landing shock to which air dropped objects are subjected. It may also be used for special packaging requirements. The material is not recoverable because it is crushed upon impact.

(5) *Hair felt (C-F—202).* Hair felt consists predominately of washed cattle hair, although some other animal hair may be used. It is finished in four types based on the fabrication process. It is available in rolls four feet wide and seven standard sizes of sheets. It is also available in a variety of thicknesses and densities. It has an average degree of resilience, low compression set, poor damping, and some amount of dusting. It will withstand repeated compression and abrasion without disintegrating. The felt must be free from acids. It will retain moisture and is subject to fungus attacks unless treated. It is used mainly as cushioning and padding of cradles for large articles. It should be glued in place and kept dry. When felt is to be used in direct contact with materials that might be affected by acid, specify that it must be free from organic and mineral acidity.

(6) *Solid and corrugated fiberboard (MIL-B—3106 and PPP-F—320).* 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 (fig 1-31). 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 or irregular shape. Application of fiberboard cells, trays, and pads is illustrated in figure 1-32.

(7) *Unicellular polypropylene foam (PPP-C—1797).* This material is a low density, resilient, unicellular (closed cell) polypropylene foam material for use in cushioning and packing applications in the form of rolls or flat sheets. Type I is used for general cushioning applications. Type II is used when protection from electrostatic discharge is required. It is useful throughout a temperature range from -65°F to 160°F. It is intended for use as a cushioning wrap for low density items. The foam can be laminated to a wide range of products including paper, paperboard, and may be used for the protection of surfaces from abrasion. Typical packaging application/s is surface protection for optical lenses, equipment with critical surfaces, electrical and electronic equipment, glassware, ceramics, and magnetic tape rolls. When stored in closed containers it produces no trapped volatiles which could cause fire or explosions. Polypropylene, by its nature, is unaffected by most exposures to grease water and most acids, bases and solvents. It contains no plasticizers, solvents, or lubricants.

(8) *Expanded polystyrene (PPP-C—850).* This

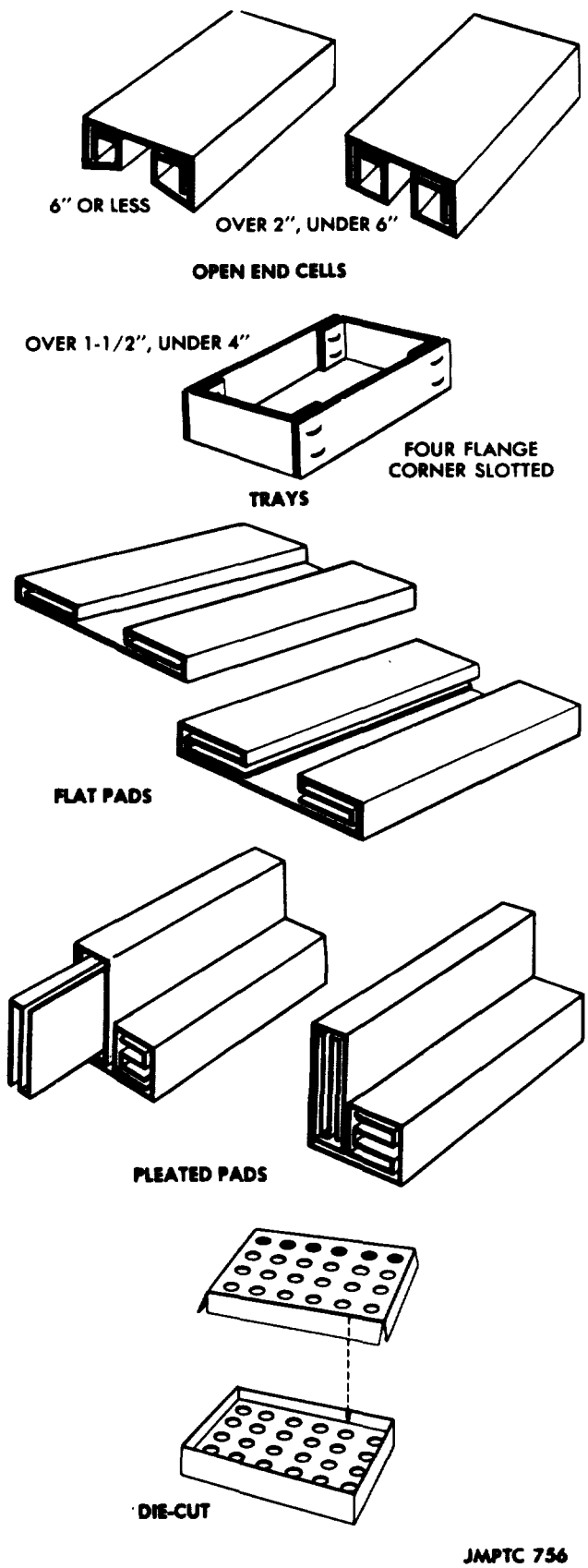


Figure 1-31. Examples of fiberboard die-cuts, open end cells, trays and pads.

resilent cushioning material consists of expanded polymers or copolymers of styrene for use in packaging applications. It is furnished in two types. Type I is in sheet form and Type II is in roll form. Both types come in four classes and two grades. Class 1 is soft, Class 2—medium, class 3—firm, class 4—extra firm. Grade SE is self-extinguishing. This cushioning material is used within packages to protect items from damge due to shock, vibration, abrasion, and concentrated forces during handling and shipment. It is especially suited where a high degree of energy absorption is required in a minimum space and with a minimum weight of cushioning. It can also be used to provide temperature insulation or when cushioning material must perform at extremely low temperature.

(9) *Cushioning, wrapping paperboard (PPP-P—291).* This is a paperboard composed of a corrugated sheet or a solid molded pulp sheet firmly cemented to a backing flat sheet of ubleached sulfate fiber paper. The paperboard is furnished in two types—light and heavy-duty, and in two styles. Style 1 material must have a backing sheet. The backing sheet is optional for Style 2. It is furnished in sheets or rolls, as desired. Both styles are flexible in all dirctions. 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 grease-proof barrier.

(10) *Rigid or flexible polyurethane foam (MIL-P—26514).* This material consists of both rigid and elastic types of foamed products obtained through the proper blending of complex synthetic chemical compounds. By proper combinations, reaction mixtures can be poured or pumped into various shaped cavities. Volatization of the blowing agent causes rapidly stiffening resin to expand, completely filling the space. The material then sets rapidly to a lightweight, cellular structure that has excellent cushioning properties. The material is furnished in a form suitable for foaming-in-place application or it may be preformed and supplied in rolls, sheets, or molded shapes. Strong rigid foams, tough elastic foams, soft flexible foams, and spongy water-absorbent foams can be obtained by the choice of ingredients. Foams with densities as low as .5 pounds per cubic foot may be obtained. These foams can be adjusted to give a high or low compression set, excellent or poor damping, and high or low resilience. In other words, the material can be tailor-made to meet the requirements of any type of cushioning required. There is no

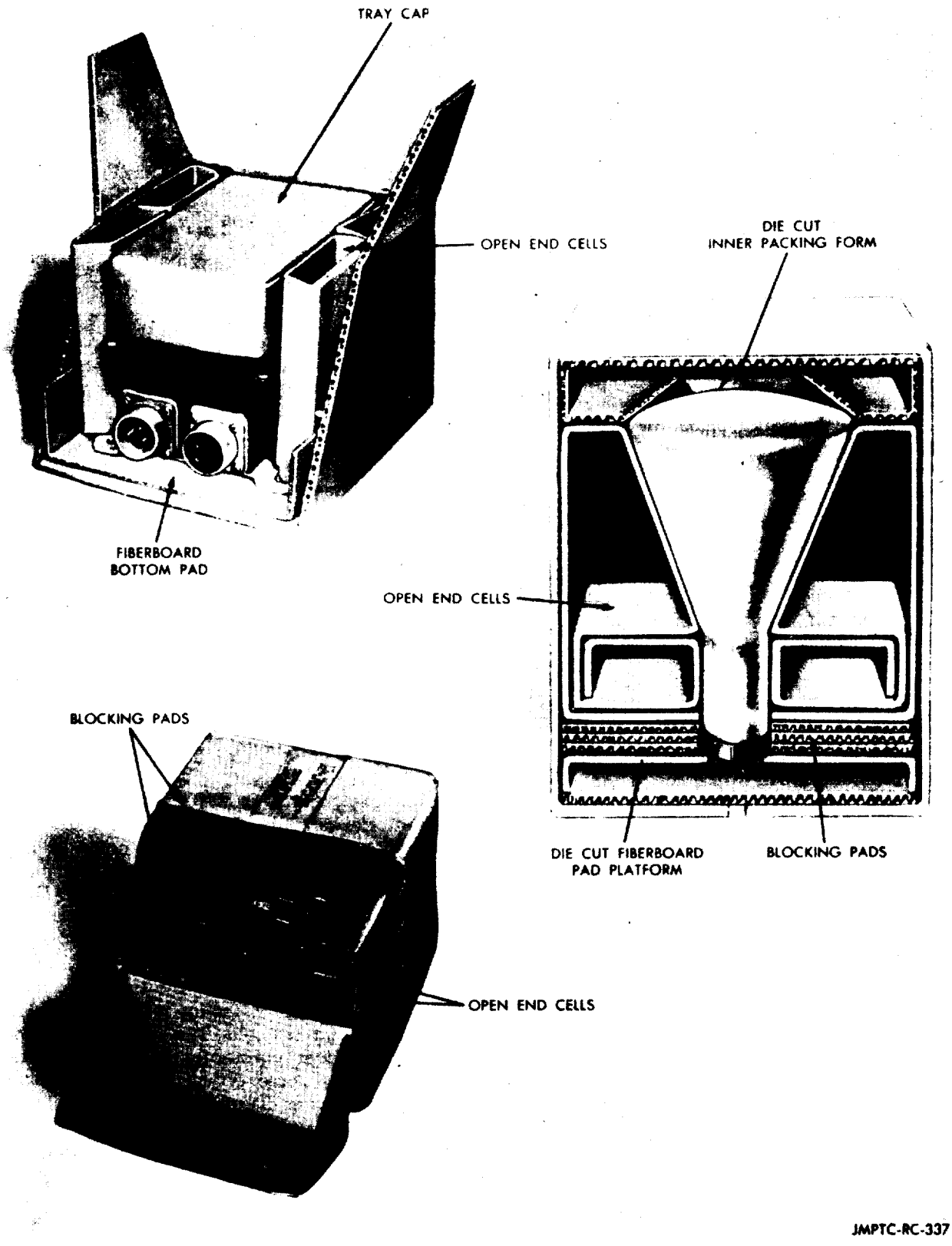


Figure 1-32. Application of fiberboard die-cuts, open end cells, trays and pads.

dusting problem; moisture content is negligible. The material is flame- and fungus-resistant, and it performs well in cold climates. For further details regarding procedures and equipment used with polyurethane foam, see MIL-P—45216 and MIL-F—87075 respectively.

(11) *Latex foam sponge rubbers.* These materials are made by incorporating into the rubber an inflating agent such as baking soda, that gives off a gas which expands the mass during the vulcanization process. The rubber is made from slab rubber into sheets, strips, molded or special shapes. These materials may be supplied in cored or uncored types; soft, medium, firm, and extra firm classes; and in flame-resistant and nonflame-resistant grades. The materials have a very high resilience, low compression set, fair damping properties, high moisture content, and high moisture absorption. They produce some dusting. If kept dry, the corrosive effects are slight. Their low temperature performance is poor. The materials have a high density and are expensive to use. The molded forms are often used in conjunction with reusable containers and the initial cost is reduced by the amount of reuse obtained.

(12) *Chemically blown cellular rubber (MIL-R—6130).* Type I, open cell, is made by incorporating into the rubber compound a blowing agent, such as sodium bicarbonate, that gives off a gas which expands the rubber during vulcanization to provide a mass having open and interconnecting cells. Type II, closed cell, is made by subjecting a rubber compound to a gas, such as nitrogen, under high pressure. It may also be made by incorporating gas-forming materials in the compound. When the pressure is lowered during vulcanization, the mass expands, and Type II becomes a myriad of individual, nonconnected, gas-tight cells. These materials may be obtained in soft, medium, and firm classes; oil- and flame-resistant, nonoil-resistant, and low temperature nonoil-resistant grades. These materials are furnished in sheets or specially molded shapes, as required. The materials have high resilience, low compression set, fair damping, little dusting, slight corrosive effect, and a limited range of temperature performance. The major differences in properties of types I and II are that, because of its closed cell construction, type II will absorb less water than type I and will expand at the low pressures encountered at high altitudes.

(13) *Plastic film, heat sealable, flexible, cellular, (PPP-C—795).* This material is constructed of a composite of two or more sheets of plastic film, one face having uniformly distributed closed cells (bubbles), the other a flat surface. It is available in three classes: class 1—regular; class 2—antistatic, tinted; and class 3—fire retardant. All are used as cushioning for packaging applications. Material is furnished with various cell sizes (air bubbles). It is intended for use within packages to protect items from damage due to shock, vibration, concentrated forces, corrosion, contamination, and abrasion during handling and shipment and is especially suitable for use as inserts within transparent bags. The use of class 1 material, due to its transparency, permits inspection of the contents without opening the pack. The flexibility of the material permits it to be used as pads, bags, wraps, dunnage, or as a filler. Class 2 material protects sensitive electronic devices from electrostatic discharge damage. When fire-retardancy is required, class 3 material is selected.

Note: Many of the materials made under this specification are laminates of chlorinated plactic and polyethylene. Chlorinated organic materials give off vapors of hydrogen chloride which can combine with water to form highly corrosive hydrochloric acid.

(14) *Unicellular polyethane flexible foam, (PPP-C—1752).* This specification covers six types and four classes of cushioning material. Type refers to the density range of the material. For example, type VII has a density of .9 to 2.0 pounds per cubic foot while type V has a density range of 6.0 to 10.0 per cubic foot. The class generally describes the form the material takes and may be solid or laminated planks, sheets, cut shapes, rounds, or molded shapes. In addition, type VII, class 4, materials are antistatic. Temperature performance has a useful range of minus 65° to plus 165° F. Compression set is low and the materials are noncorrosive, nonabrasive, and virtually dust free.

(15) *Open cell plastic cushioning (PPP-C-1842).* This material is made of one sheet of plastic film or a composite of two or more sheets of film, formed into a network of uniformly distributed open cells. The cells may be a hexagonal or fluted shape, depending upon whether a facing or reinforcing top film laminate is required. The hexagonal form is used when a reinforcing top laminate is applied to the open face of the cells. The fluted form is used when a facing is applied to the crowns of the formed cells. The resulting material is lightweight, transparent, flexible, and heat sealable. There are three types; Type I, hexagonal; Type II, fluted; and Type III, hexagonal, electrostatic free. The two styles describe whether or not the material has a top laminate or facing. All three types are available with or without a top laminate or facing and are furnished in rolls or sheets. The material is noncorrosive, nonabrasive, has low compression set, and performs well at low temperatures. The cushioning is intended for use within packages as inserts within transparent bags, wraps, dunnage, and filler.

(16) *Expanded polystyrene loose-fill bulk cushioning material, PPP-C—1683.* This material is used as cushioning and dunnage when a bulk, loose-fill, lightweight material is required. Two types and two classes are available. Type I, medium peak acceleration, is based on peak acceleration values that will not exceed the 60G level when tested in accordance with the specification. Type II, high peak acceleration, is based on peak acceleration values that do not exceed the 90G level. Class 1 materials are called flowable, with a flow rate of not less than 6 cubic feet per minute. Class 2, non-flowable, has a flow rate of less than 6 cubic feet per minute. The materials may take any shape as long as the specification dimensions are followed. Although compression set is relatively small, the container should be filled to the top, vibrated slightly so that the material settles, and the container then overfilled so that it requires fairly heavy pressure to make the final closure. This will help avoid the problem of voids developing during transportation from vibration and provide maximum cushioning protection.

(17) *Combustion retardant foam, MIL-F—87090(SA).* This specification was developed by Navy to meet a continuing need to eliminate or substantially reduce the number of flammable and toxic fume producing materials aboard ships. The specification covers combustion retardant flexible foams with low emission of smoke and toxic products. The foam is available in two classes—Class 1, sheet-stock, and Class 2 die cut. The dynamic cushioning requirements are the same as for Class 2, MIL-P—83671 materials. The foam is flexible from minus 110°F to plus 527°F and the cushioning properties must not vary more than 10 percent at either extreme.

f. Methods of Cushioning. Cushioning is generally accomplished by one of the following methods:

(1) *Floated item.* The item is floated in cushion material and placed within a unit container (fig 1-33). This is perhaps the method most commonly used for cushioning small, lightweight, fragile items against shock, vibration, and abrasion. It is in this case that the requirements of MIL-P—116 concerning dryness and noncorrosiveness of cush-

ioning materials are most important since both the item and the cushioning material will be inclosed in the unit container. Cushioning materials in direct contact with metal surfaces shall meet the requiremets of MIL-P-116. The accepted practice today, when the requirements of MIL-P-116 have been met, is to make the cushioning the first wrap. Greaseproof barriers are required if the item is preserved. 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.

(2) *Foated pack.* The item is packed in an interior container which in turn is floated in cushioning materials (fig 1–33). This method is generally used in connection with semifragile 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:

(*a*) When both the interior and exterior containers are water-resistant, the cushioning material may be simply placed between the two containers.

(*b*) When either container is nonwater-resistant, the cushioning material must be placed in the form of pads wrapped in a water-resistant barrier material.

(*c*) An alternative for the second case ((*b*) above) is to 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.

(3) *Shock mounts.* The item is cushioned by means of shock mounts (fig 1–33). 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 elastomeric springs or rubber blocks. This method of cushioning may be accomplished in four main ways.

(*a*) The item may be suspended directly by means of elastomeric springs.

(*b*) The item may be blocked in a cradle and the cradle suspended by means of elastomeric springs.

(*c*) The item may be boxed in an intermediate container and the intermediate container suspended by means of elastomeric springs.

(*d*) The item may be boxed in an intermediate container and the intermediate suspended by means of rubber shock mounts.

1–17. Packing Problems

The basic reason for packing any item is to provide enough protection against the hazards it is likely to encounter during shipment. This minimizes the chances that damage will occur during the interval between the time the pack leaves the shipper and when the item is placed in use by the receiving activity. It is, of course, an impossibility to evaluate all the hazards that might be encountered in transit, as there are too many variables which can affect the condition in which an item may be found upon arrival at its destination. The guidelines to packing presented herein have indicated the principles and practices that have been found satisfactory in giving protection under average handling and storage conditions. If the solution of a specific packing problem is not located in this section, the following procedures are recommended for shipment from depots:

a. Domestic Shipments. If an item is being shipped domestically, pack the item in a manner which closely duplicates the pack in which the item was received in good condition.

b. Oversea Shipments. If shipment overseas is involved, and no previous history of a container in

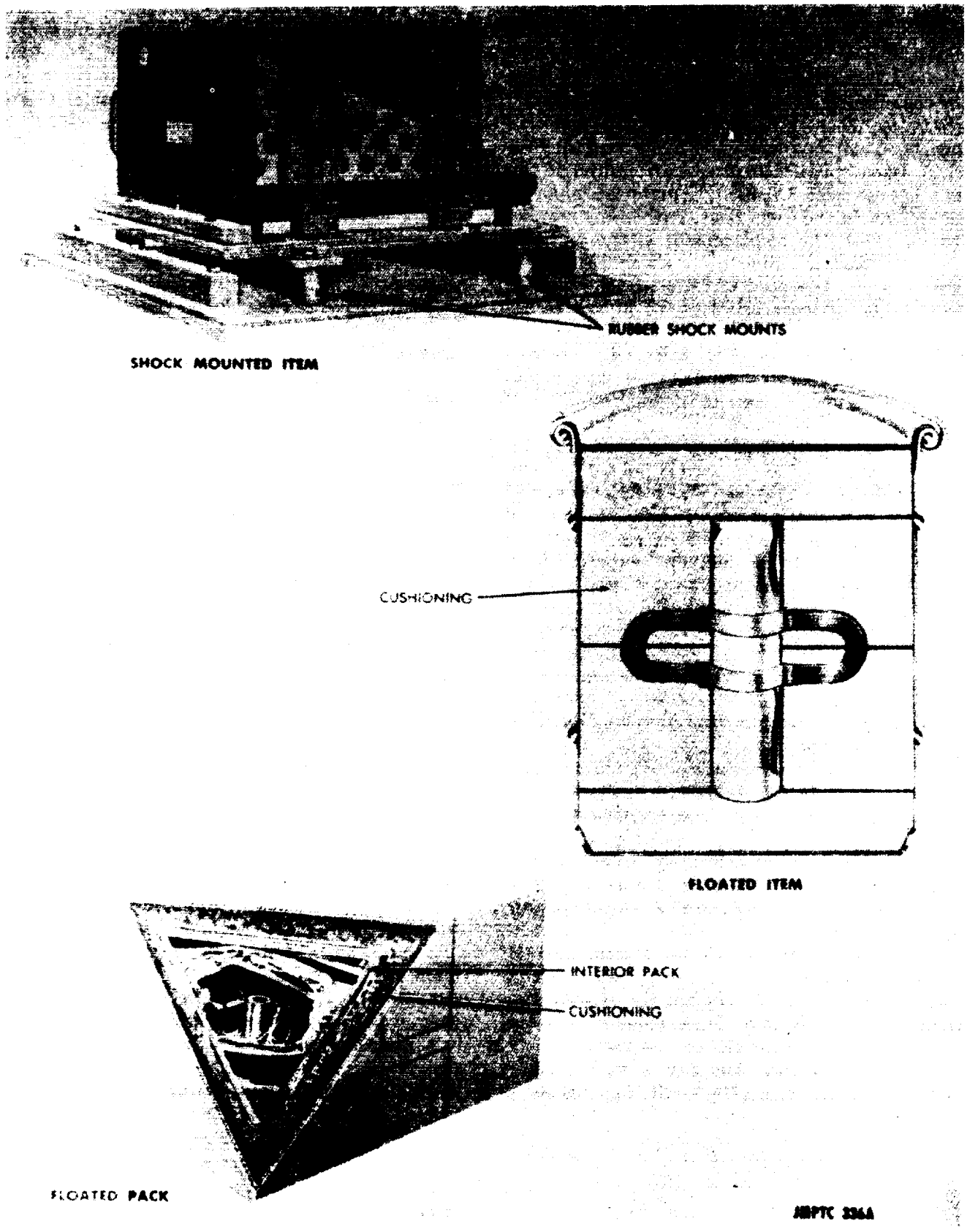


Figure 1–33. Methods of cushioning.

which the item had been shipped to a similar destination is available, construct a pack embodying as many as possible of the principles outlined in this section. This pack should be prepared exactly as it would be shipped including complete preservation and interior packing. It is then tested by subjecting it to the applicable performance tests described in paragraph 1-24. The tests are based upon the size as well as the gross weight of the container since both influence the amount of rough handling the container will receive. Small, light packages are easier to move than the larger and heavier packs and, consequently, they can be expected to receive a greater amount of handling. Performance tests are required for the primary purpose of determining the adequacy of all the operations entering into preparation of a pack. At the conclusion of the tests, performance is based on the condition of the container, its contents, the blocking and bracing, cushioning, preservation, and other packing materials. The pack should be examined for any damage, noting in particular any obviously weak points which might need to be strengthened. Usually the container, if constructed according to specifications, will withstand the rough handling. If, however, the container is damaged, a study should be made of the causes. Deficiencies in the blocking and bracing may result in damage to the container, in which case these deficiencies should be corrected. Other times the nature or shape of the item may cause the container to fail. Then, the container should be reinforced. In any event, when deficiencies become obvious, either in the containers, the contents, the blocking and bracing, cushioning, preservation, etc., the pack should be appropriately modified and the test repeated until no damage occurs which affects the utility of the pack.

1-18. Packing Small, Lightweight Items

As previously pointed out, cushioning materials are frequently employed to block lightweight items. Various methods to accomplish blocking with cushioning are described in paragraph 1-12. In some instances, however, cushioning materials such as fiberboard are primarily used for blocking. The effectiveness of fiberboard as blocking and bracing depends upon its strength and its resistance to moisture when not protected by suitable moisture barriers. The domestic class of fiberboards will rapidly absorb moisture with a resulting loss of strength. The weather-resistant class on the other hand, retains a greater proportion of its strength in the presence of moisture. Fiberboard is most frequently employed as blocking in fiberboard containers because the items packed in them are usually small and lightweight and do not require heavier types of blocking. Also, the container manufacturers can provide and fabricate pads, cells, trays, or partitions of the same material at a low cost. Both solid and corrugated fiberboard are employed as blocking material, but the corrugated is used more frequently because it has greater cushioning value and because if its lower cost. Occasionally, a pack will contain a comparatively large void which will necessitate blocking to prevent shifting of the item. In such cases, a fiberboard carton may be used for blocking the item in place. The carton used for blocking should be closed and sealed, and must be strong enough to provide adequate strength in all directions.

1-19. Packing Large Items

Large items require special attention to adequately secure them within the container. Such items are anchored to the base of the container and blocked and braced into a secured position on the base. A clearance of at least 1 inch is provided between the end, side, and top panels and the item is seldom blocked and braced to these panels. Thus, the container must have a rigid base and the rest of it must be free to distort without placing stresses directly on the contents.

a. Anchoring to Base of Containers. Crates for large and heavy items should have sturdy bases to which the items can be adequately secured. Many ingenious methods have been developed to hold items to crate bases (para 6-1c(5)). For sill and skid type crates, it is essential that the load be carried primarily by the outside skids or sills. This means that loads that cannot be secured to the side sills or bases must be provided with load bearing members that transmit the load to them.

b. Blocking and Bracing a Large Item. After the item has been anchored to the base of the container to prevent its movement in a vertical direction, it is blocked and braced to prevent its movement in a horizontal direction. An item should be anchored only to the base, hence all bracing and blocking should be so secured.

1-20. Clearance Between Item and Container

When an item is blocked, braced, anchored, or tied down to the inside of one face of a container or to an auxiliary base which, in turn, is so secured, a clearance of not less than 1 inch should be provided between the item and all members of the

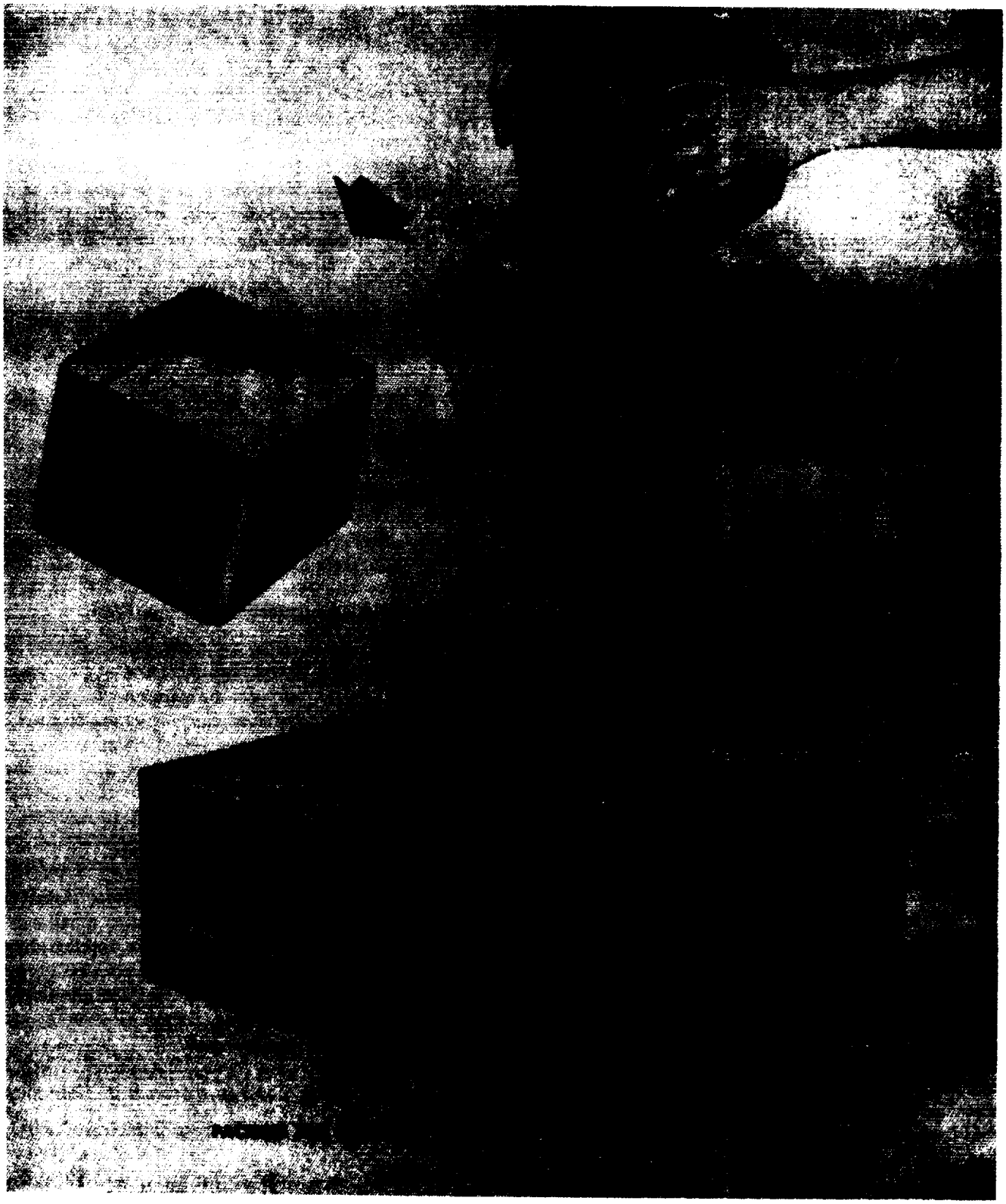


Figure 1-34. Waterproofing of individual packages.

remaining faces of the container. A minimum clearance of 2 inches should be provided around fragile parts of the item that might be damaged due to slight distortion of the container. A minimum 2-inch clearance should be provided between items within floating bag barriers and adjacent members of the container.

1-21. Weatherproofing the Pack

At this point in the sequence of packing operations, it is assumed that a careful study has been made of the item to be packed; a suitable container has been selected; blocking, bracing, and cushioning has been designed; and the contents are ready to be placed into the container. The next step is to provide, when necessary, a protective barrier in the form of a case liner, crate liner, shroud, wrap, or tarpaulin fabricated from one of several materials. The barriers are intended to prevent deterioration of the item, and the preservation and packing materials used to protect it, by excluding the entry of liquid water, by limiting the entrance of water vapor, or by diverting water from the materials which are subject to water damage. In addition, barriers will afford protection from dust, dirt, and other foreign matter. Barriers designed to prevent the entry of liquid water (waterproof barriers) will not be used when the interior packs have been individually waterproofed as shown in figure 1-34, nor when the asphaltum in the barrier materials or sealants may prove injurious to the inclosed items. The water-vaporproof protection afforded by caseliners differs from that afforded by a Method II package in that water absorbing desiccant is not used with caseliners.

1-22. Weatherproofing (Case Liners, Wraps, and Shrouds)

Except as provided herein, weatherproof liners, wraps, shrouds or other suitable means shall be provided in shipping containers as necessary to shield the contents from the effects of water, water vapor, dust, dirt, and other harmful matter. When a completely inclosed barrier is provided as in the case of liners and wraps, all seams should be completely and continuously sealed to offer protection equal to the barrier material itself. Barrier materials and sealants constructed with asphaltum shall not be used in the presence of mothproofing chemicals such as paradichlorobenzene and naphthalene. Barrier materials and sealants constructed of asphaltum shall not be used to protect items subject to stain or other damage caused by asphalt unless such items are initially protected to exclude asphalt.

a. Types of Weatherproofing Barriers. The particular type of barrier to be used depends on the type of exterior container or the intended use of the barrier (table 1-9). In selecting the type of barrier to be used, consideration should be given to the following.

(1) Sealed case liners and sealed wraps are used to resist the passage of water and water-vapor. Fabrication of case liners is covered in *b* below.

(2) Sealed case liners will not be used in the packing of materiel unless specifically authorized.

(3) Crate liners and shrouds are used to shed water from the top and sides of the item, allowing free circulation of air. The application of crate liners is described in chapter 6 (fig 6-19). Shrouds are fabricated from waterproof barrier material conforming to Specification PPP-B—1055, Class E or heavier. The seams are sealed with water-resistant adhesive conforming to Specification MMM-A—260. Shrouds also may be made of material conforming to Specification L-P—378.

(4) It is important that shrouds be secured to prevent damage or loosening by storms. They should be weighted if necessary and arranged to avoid formation of water pockets. Shrouds should never extend entirely to the base of a crate or to the ground since the free circulation of air around the enclosed equipment is thereby prevented.

b. Case Liners, Overwraps, and Plastic Bags. Flexible waterproof or watervaporproof case liners, overwrap sheets, and plastic bag liners should be fabricated and closed in accordance with Specification MIL-L—10547.

(1) They shall be furnished in the following types: Type I, high-top case liner (fig 1-35); Type II, double-top pad liner (fig 1-36); Type III, overwrap sheet, and Type IV, plastic bag. Type II liners may be used when a level, rigid surface exists or when the depth of the case liner exceeds 36 inches. Type III overwrap sheets are barriers used around intermediate boxes. Type IV plastic bag liners are used in the same manner as Type I and II case liners.

(2) They are available also in six grades as follows: Grade A, watervaporproof; Grade B, waterproof, all temperatures; Grade C, waterproof, asphalt-laminated kraft; Grade D, waterproof and greaseproof; Grade E, waterproof, greaseproof, transparent, all temperatures, and Grade F, waterproof, transparent, all temperatures.

Table 1-9. Application of Weatherproof Barrier Materials for Packing

Use	Barrier Materials				
	L—P—378	PPP—B—1055	MIL—B—121	MIL—B—131	MIL—B—22191
Case Liner	.....	Classes H-2, H-3(a), H-4, H-5, L-2(b), and M-1 Waterproof	Types I and II, Grade A, Class 1 Waterproof	Classes 1 and 2 Watervaporproof	
Sealed Wraps and Plastic Bags	Type I Waterproof	Classes B-1, B-2, B-3, C-1, C-2(a), E-1, and E-2 Waterproof	.....	Classes 1, 2 and 3 Watervaporproof	Types II or III Waterproof
Crate Liner	.....	Classes C-2(a), E-1, E-2, H-5, L-2(b), and M-1 Watershed			
Shroud	Types I and II Watershed	Classes E-2, H-5, and M-1 Watershed			
Baling	.....	Classes B-1, B-2, B-3, and E-2 Watershed	.....	.....	
Temporary Tarpaulin	Type I Watershed	Class L-4 Watershed			
Ammunition Containers	.....	Class P-1			

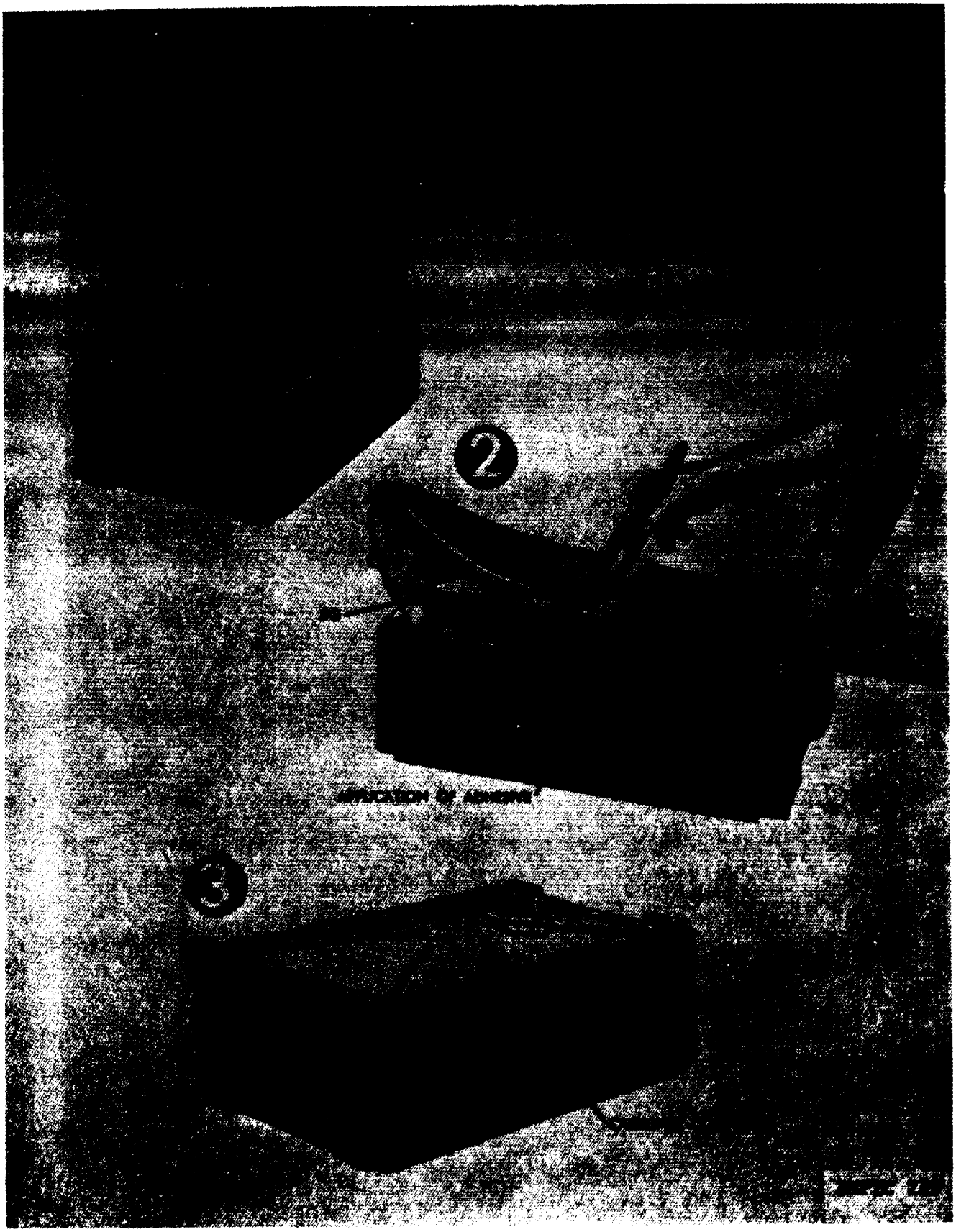


Figure 1-35. Using and closing a high top caseliner.

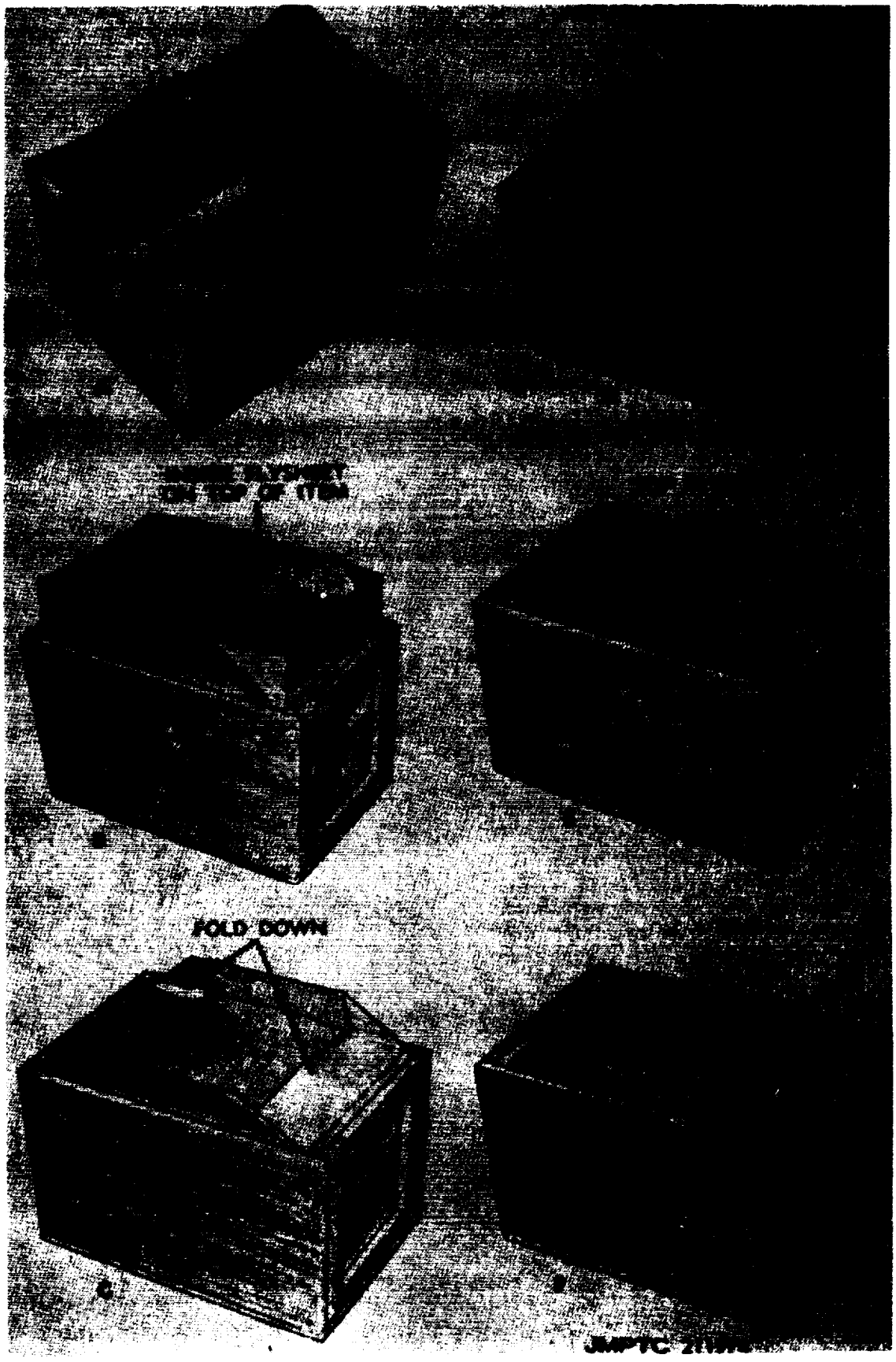


Figure 1-36. Double-pad closure caseliner.

Table 1-10. Barrier Materials for Case Liners, Overwraps, and Plastic Bag Liners

Use	Liners, overwraps, and bag liner		Specification	Barrier materials
	Grade	Types		Classification
Subsistence item	C	I, II, III	PP-B-1055	Classes H-2 thru H-5, M-1
	F	IV	L-P-378	Type I
Nonsubsistence item	A	I, III	MIL-B-131	Classes 1, 2 and 3
	C	I, II, III	PPP-B-1055	Classes E-1, E-2, H-1 thru H-5, L-2, M-1
	D	I, II	MIL-B-121	Types I and II, grade A, class 1
	E	IV	MIL-B-22191	Type II

(3) Table 1-10 shows the barrier material to use depending on the type and grade of case liner, overwrap, or bage liner required and whether they are to be used for subsistence or nonsubsistence items.

(4) Case liners should be made large enough so that the weight of the load will be borne entirely by the container, not by the liner. There should be no tension in the walls or joints of the liner after it has been closed around the contents.

(5) Experience has shown that under some conditions, especially when the contents do not fill the case liner completely, waterproof case liners do more harm than good by trapping and holding water rather than preventing its entry. It is not essential that there be openings in the sealed liner for this to happen. If the liner material has low resistance to watervapor transfer (a common occurrence) water can enter in the form of vapor and condense on items within the liner. That this can be largely a one-way process has been proven when, at the end of an extended outdoor exposure period, sealed case liners have been opened and found partially filled with liquid water. When packed items need protection against water, it is preferable to incorporate the protection in the individual unit packages in lieu of using case liners.

c. Linings for Drums, Kegs, Barrels, and Bags. Linings should be provided for drums, kegs, barrels, or bags when their contents require protection not otherwise provided by the containers against sifting, contamination, or free water. The lining material should conform to Specification PPP-B—1055 or MIL-B—22191. Fabrication and closure seams should be heat sealed or sealed with adhesive conforming to MMM-A—260, as applicable.

d. Waterproof and Watervaporproof Wraps. Waterproof and watervaporproof wraps shall be fabricated and sealed in accordance with MIL-L—10547.

e. Unsealed Waterproof Wraps. Unsealed waterproof wraps should be applied to shed water while permitting breathing and circulation of air.

1-23. Testing of Packs

a. Purpose of Testing. The purpose of testing is to prove the adequacy of packaging design and the workmanship of fabrication. Testing may be performed in the research and development phase or by tests at the operational level. Since containers in the storage and shipment cycle are subjected to various and constantly changing storage and shipping hazards, it is difficult to develop complete data for their design by merely observing the containers in service. Examinations of failures will reveal the weaknesses and suggest the specific principles of design to overcome such failures. Since service tests are not performed under controlled conditions, laboratory tests are necessary to simulate field hazards. Each test is designed to reproduce one or more of the stresses encountered in the field. During the test cycles the sequence of failures can be observed, classified, and the weaknesses from which the failures result determined. By means of such tests any number of containers can, in turn, be subjected to exactly the same actions, thus providing the data necessary to produce balanced construction and workmanship. On the following pages are described a number of methods that have been devised for subjecting containers to hazards similar to those encountered in the field. Both laboratory and field testing are necessary since there are certain conditions inherent in each method of testing that cannot be duplicated in the other.

b. Types of Tests. Development and testing of packs and containers should be started as soon as possible after initiation of item development. Some of the tests most commonly used in proving design adequacy include the vibration, rough handling, and cyclic exposure tests (fig 1-37). One or more of these tests are usually applicable to the design of military packs. In many cases the technical activity having design responsibility, has intervals tests and procedures that are applicable to a specific design problem. The documents most generally used for test guidance are Specification MIL-P—116, Mil-

itary STD—1186, and Federal Test Method Standard 101.

c. Testing (MIL-P—116). After an item has been packed in accordance with one of the MIL-P—116 methods, tests are conducted to determine the effectiveness of the pack. The types of tests conducted will depend on the particular method used, and are also specified in MIL-P—116. The tests called for in MIL-P—116 are not all-inclusive, however, and additional or different tests are sometimes required. The types of tests specified in MIL-P—116 for proving the adequacy of unit protection are the leakage test, rough handling tests, cyclic exposure tests, and the heat-seal seam tests. See volume I for details.

d. Testing (MIL-STD—1186). When packs prepared for shipment in accordance with the detailed requirements of MIL-STD—1186 are tested for any rough handling required, there should be no settlement or shifting of contents. Further, the testing should cause no damage to the contents and should not loosen, break, or displace the anchoring, blocking, or bracing. The testing should not render the interior containers, wraps, liners, barriers, or cushioning ineffectual in providing continued and adequate protection to the contents.

e. Types of Rough Handling Tests. The various types of rough handling tests include: free-fall drop test; cornerwise drop test; pendulum-impact test; incline-impact test; edgewise drop test; vibration test; and others. The particular tests employed usually depend upon the size and shape of the package. Completed packages as prepared for shipment are given a rough handling test when specified. When a rough handling test is required, it precedes applicable tests specified to detect leaks and inadequate seals or closures and preservative retention. Inspection and tests for leaks in barrier materials, seals and closures, and preservative retention, when required, are performed on the contained unit packs(s) following the rough handling test to determine existence or extent of detrimental effects. Unless a particular test is specified, selection of the applicable rough handling test should be in accordance with (1) or (2), below, as applicable. The drop heights shall be as indicated by MIL-P—116 (see table 1-11) or as specified by Fed Test Method STD 101.

(1) *Small containers.* Only free-fall drop tests and vibration tests shall apply to small containers; both or either vibration test shall be conducted at the option of the contractor. Small containers are those having no one edge or diameter over 60 inches and a gross weight of 150 pounds or less. Any container with skids is tested as a large container. Any container holding an item that has a net weight of more than 100 pounds and which is fastened to a base within or to the base of the container will be tested as a large container.

(2) *Large containers.* All rough handling tests, except for free-fall tests, shall apply to large ocntainers; both or either vibration test shall be conducted at the option of the contractor. However, tipover tests will apply only when additionally 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

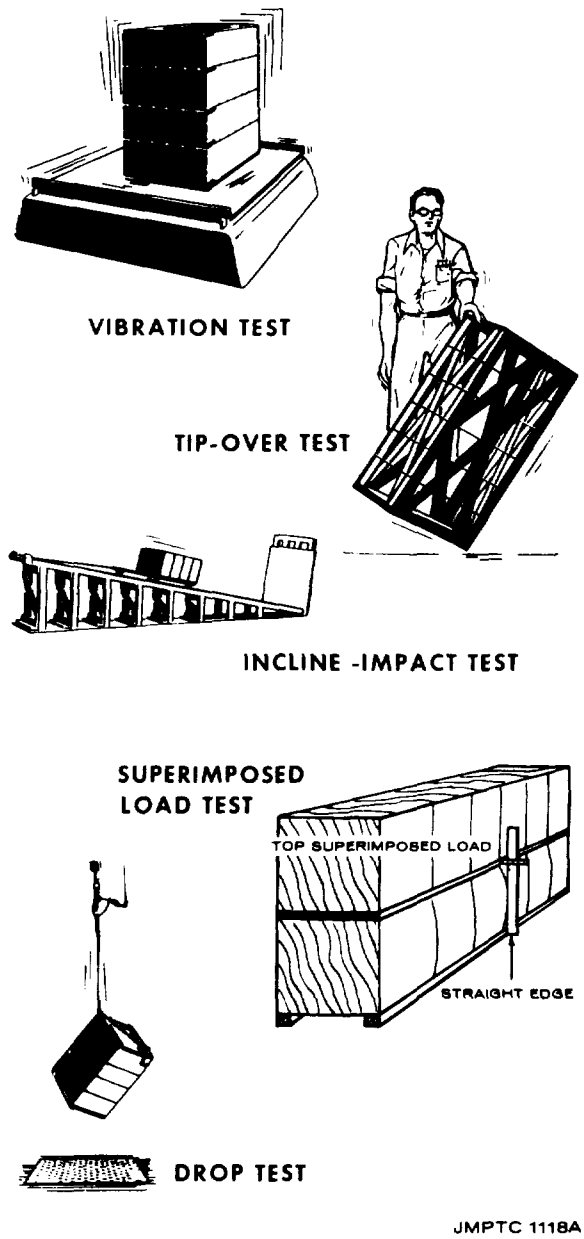


Figure 1-37. Examples of container tests.

gross weights in excess of 150 pounds or those which have skids.

(3) *Free-fall drop test (fig 1-38).* The pack may be tested in accordance with test method 5007 of Federal Test Method Standard 101.

(a) A drop tester is any suitable apparatus which will allow an absolutely free, unobstructed fall of the container at the orientation and the direction required. A lifting device that will not damage the container will be used and a level steel or cement surface to absorb all shock without displacement will be provided.

(b) The height from which the specimen should be dropped is dependent upon the weight, size, kind of container, and level of pack.

(c) This test is meant to simulate the fall of an item dropped by a man from a height he would normally use to lift and carry an item of that size.

(d) The container should be dropped from the designated height onto a steel, concrete, or stone surface of sufficient mass to absorb the shock without deflection in such a manner that the designated surface of the container absorbs the full force of the fall (fig 1-38). This test should be repeated until the designated number of drops have been made. (The height of refers to the distance from the steel, concrete, or stone surface to the nearest surface of the container when suspended prior to the fall.) The fall shall be a free-fall, in that no ropes or other suspending media are attached to the container during the fall. If the container is of the drum type, the top and bottom of the drum should be marked so that the circle of the top and bottom is quartered, and the test should be applied to each quartered section.

(4) *Tipover test (fig 1-37).* The container may be tested in accordance with test method 5018 of Federal Test Method 101. The loaded container is placed on its bottom and slowly tipped until it falls freely (by its own weight) on its side to a smooth, level, concrete slab or similarly unyielding surface. Structural damage to the exterior shipping container which would result in either spilling of contents or failure of the container in subsequent handling is cause for rejection. This test is meant to simulate the impacts of accidentally tipping over a container. It is intended that the tipover test be used only on containers that are susceptible to accidental tipovers.

(5) *Edgewise drop test (fig 1-39).* The pack may be tested in accordance with test method 5008 of Federal Test Method Standard 101. The loaded container should be supported at one end of its base on a sill or block 6 inches in height and at right angles to the skids. The opposite end of the container should be allowed to fall freely from the specified height onto a steel, concrete, or stone surface of sufficient mass to absorb the shock without deflection (fig 1-39). The test should be applied twice to each end of the container. If the size of the container and the location of the center of gravity are such that the drop tests cannot be made from the prescribed height, the height of the sill will be increased.

(6) *Cornerwise-drop test (fig 1-40).* The pack may be tested in accordance with test method 5005 of Federal Test Method Standard 101. The container should be supported at one corner of its base on a block 6 inches in height. A 12-inch block should be placed under the other corner of the same end of the container. The lowest point of the opposite end of the container should then be raised to the specified height for the weight and allowed to fall freely onto a steel, stone, or concrete surface of sufficient mass to absorb the shock without deflection.

(7) *Impact tests.* Packs having a gross weight exceeding 150 pounds or any dimension exceeding 60 inches, closed for shipment, may be subjected to one of the following guided impact tests. A single impact should be applied to each of two opposite ends. The tests are performed to simulate railroad humping or other accidental impacts, evaluating the adequacy of the blocking, bracing and tie-downs used to secure a load on or in a rail car.

(a) Pendulum-impact test (fig 1-41). The pack

Table 1-11. Graduated Drop and Impact Test Heights (MIL-P—116)

Gross weight of container and contents	Edgewise-drop test (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) use either test	
Pounds	Height of drop (inches)	Height of drop (inches)	Pendulum impact (inches)	Incline impact (feet)
150-250	30	30	14	7.0
Over 250 through 500	24	24	11	5.5
Over 500 through 1,000	18	18	8	4.0
Over 1,000	12	12	5	2.5

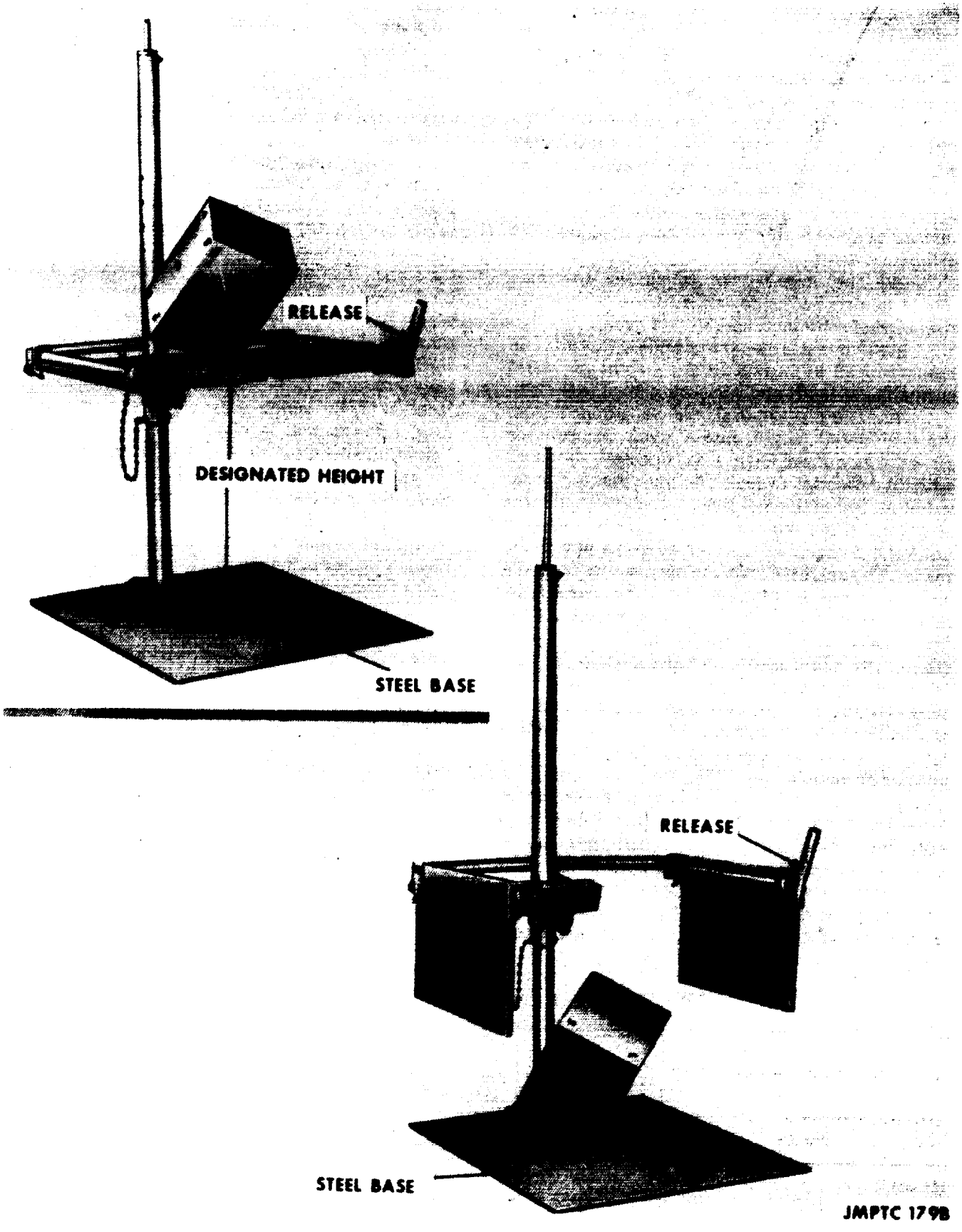


Figure 1-38. Free-fall drop test.

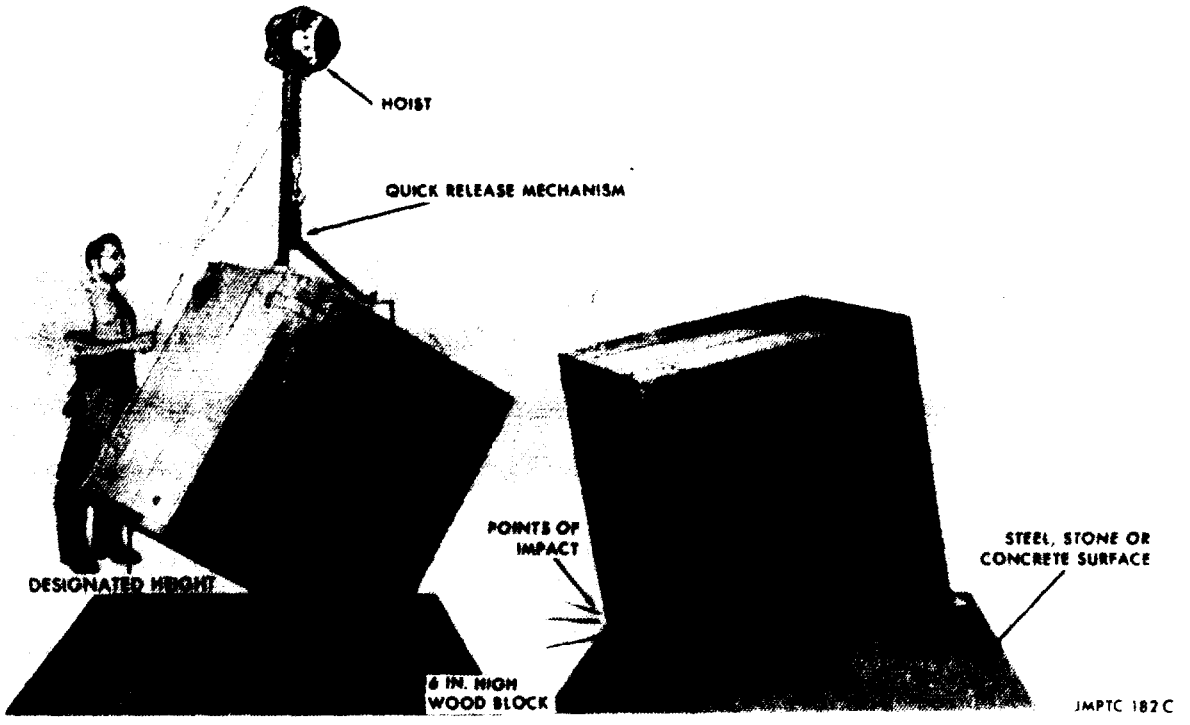


Figure 1-39. Edgewise-drop test.

may be tested in accordance with test method 5012 of Federal Test Method Standard 101. A pendulum-impact tester which consists of a platform suspended from a height at least 16 feet above the floor by four or more ropes, chains, or cables; and a bumper consisting of a flat, rigid concrete, or masonry wall, or other equally unyielding flat barrier. The bumper shall be 18 inches high, wide enough to make full contact with the container end, and shall have sufficient mass to resist the impacts without displacement. The impact surface shall be oriented perpendicular to the line of swing of the platform. The platform shall be large enough to support the container or pack, and when hanging free, shall have its top surface approximately 9 inches above the floor, and its leading edge at least 3 inches from surface of the bumper. The suspension chains shall be vertical and parallel so that when the platform is pulled straight back it will raise unformly but remain at all times horizontal and parallel to the floor. The specimen shall be placed on the platform with the surface which is to be impacted projecting beyond the front end of the platform so that the specimen just touches the vertical surface of the bumper.

(b) Incline-impact test (fig 1-37). The pack may be tested in accordance with test method 5023 of Federal Test Method Standard 101.

1. This test simulates the abuses encountered by packs in freight cars or trucks when the vehicles are subjected to sudden starts and stops.

2. The pack, mounted on a movable platform dolly which rides on a plane inclined 10 degrees from the horizontal, is released from a known distance up the incline and permitted to strike against a fixed backstop at the bottom of the plane. The magnitude of impact shock is varied by using different release points.

(8) *Superimposed-load test (fig 1-37).*

(a) The shipping container may be tested in accordance with test method 5016, stackability, with dunnage, or test method 5017, uniformly ditributed without dunnage of Federal Test Method Standard 101.

(b) The procedure (test method 5016) is applicable for determining the ability of shipping containers to resist loads such as imposed on the bottom container of a stack of similar containers in storage, or on a container supporting top dunnage and superimposed lading. Test method 5017 is applicable for determining the ability of shipping containers to resist loads superimposed on their tops as imposed

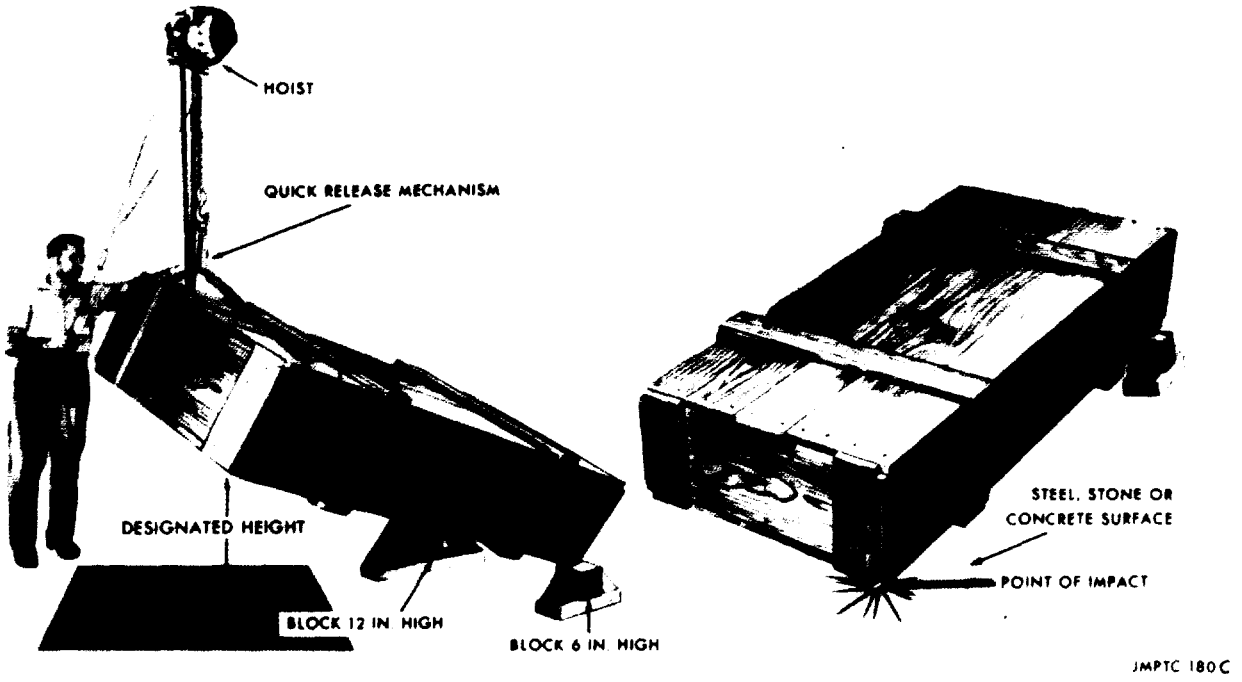


Figure 1-40. Cornerwise-drop test.

by piling without top dunnage many small, heavy packs on a container.

(c) Stackability, with dunnage tests are conducted by placing a prescribed load on the top of the container in a manner simulating the effect of similar containers being stacked on top, and the load shall be allowed to remain in place for 1 hour. A check shall be made of any changes or breaks in the container, such as apparent buckling or failure of members in the sides or ends. Observations should be made to determine if the distortions are enough to damage or dislodge the interior packing or contents.

(d) the uniformly distributed, without dunnage superimposed load test is conducted by placing weights not greater than 10 x 10 inches in outside length and width, on top of the container in a symmetrical pattern approximating uniform load and allowed to remain in place for 1 hour. Measurements of distortions shall be made immediately before the load is removed. Checks should be made of any changes or breaks in the container, such as apparent buckling or failure of members in the top, sides or ends.

(9) *Vibration test (fig 1-37).* The pack may be vibration tested in accordance with Test Method 5019 or 5020 of Federal Test Method Standard 101, as specified. The duration of the vibration test should be as specified.

(a) Vibration (Repetitive Shock) Test. Test Method 5019 of Federal Test Method Standard 101 is used to indicate whether or not a package and its contents will withstand transportation shocks and vibrations without damage when the shipment is not securely tied down to the floor of the vehicle. The package is placed on, but not fastened to, a platform supported on a mechanism that will maintain the surface essentially horizontal as it vibrates the platform. The amplitude of the vibration will be 1 inch total. The frequency will be variable within an approximate range from 3 to 5 Hz. Fences, barricades, or blocking can be attached to the platform to keep the package in position without unnecessarily restricting the vertical or rotational movements of the package. Unless failure occurs, total time of vibration will be 2 hours if the package is tested in one position; 3 hours if tested in more than one position.

(b) Vibration (Sinusnodial Motion) Test. Test Method 5020 of Federal Test Method Standard 101 is used to determine the adequacy of packages that contain items susceptible to damage from vibration encountered during shipping and are tied down to the floor of the carrier. The package is attached securely to a platform supported on a mechanism that will maintain the surface essentially horizontal as it vibrates the platform vertically. Controls are provided to vary the frequency from 2 to 500 Hz as specified. If the package might be shipped in more than

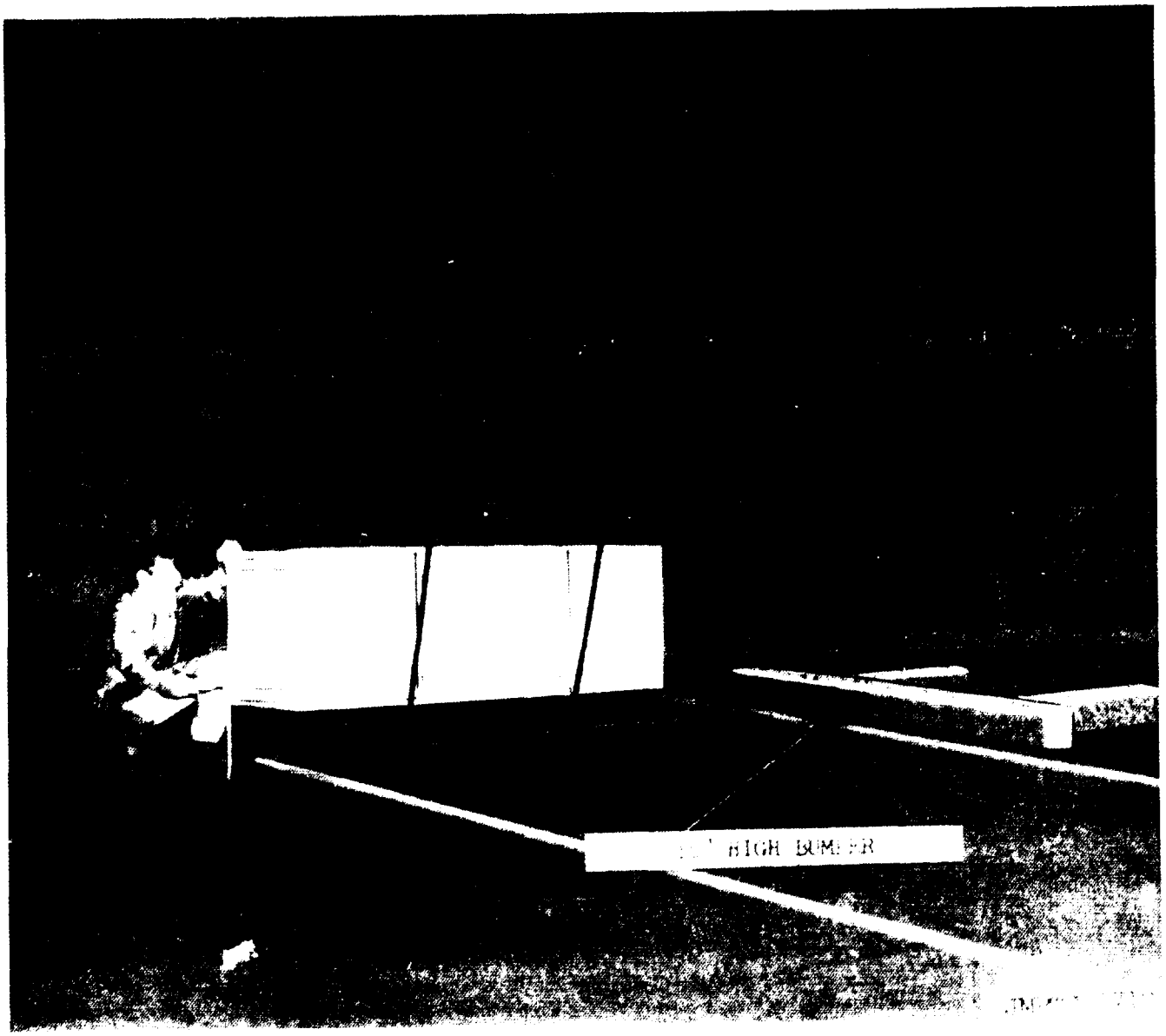


Figure 1-41. Pendulum-impact test.

one position, the package will be tested in each position.

(c) Vibration frequently produces deterioration or partial crushing of the unit or interior packing which reduces resistance to other shocks, such as impact from dropping, jolting, or bumping. This test can disclose weakness in assembly of the packed item.

(d) Vibration tests simulate the forces and motions typical of railroad cars, motor trucks, air transportation, etc.

(10) *Simulated contents.* Simulated contents of the same dimensions, weight, center of gravity, and physical properties as the actual contents may be substituted in the tests described above. A shock-recording instrument of an acceptable type should be appropriately installed within the shipping containers. This provision is intended to avoid unnecessary damage or complete destruction of valuable commodities and to avoid hazards to personnel conducting the tests.

(11) *Interpretation of results.* All materials and components comprising the method of preservation shall be free from damage or evidence of displacement which affects the utility of the method of preservation. The material used in the method of preservation should show no visible signs of damage. When specified, functional tests should be conducted on the preserved items or equipment to determine freedom from operational malfunction.

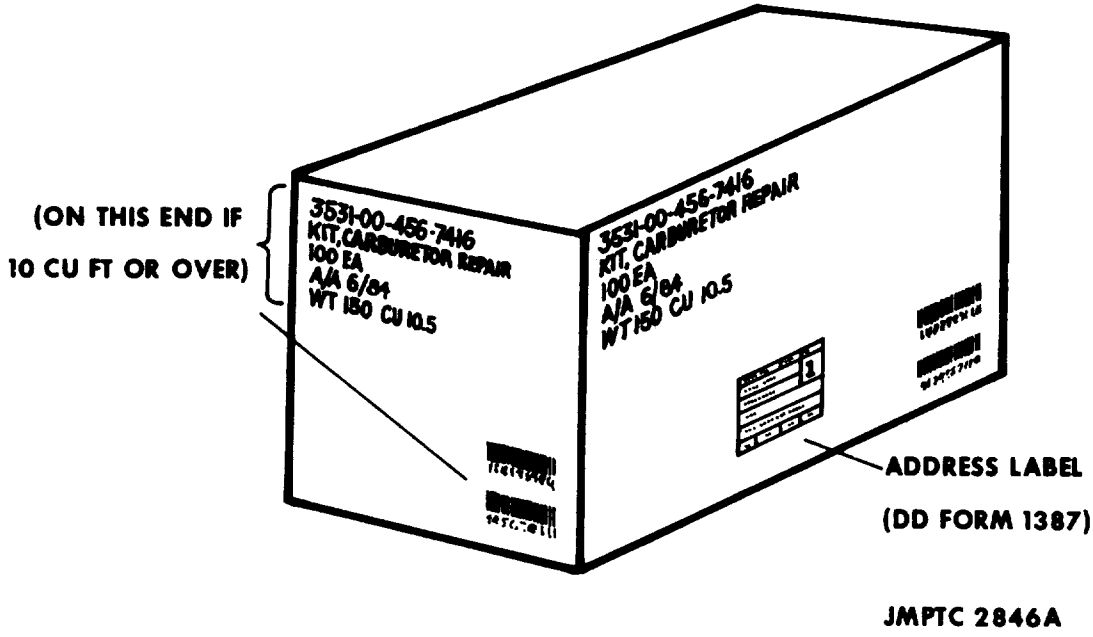


Figure 1-42. Identification and Address Markings.

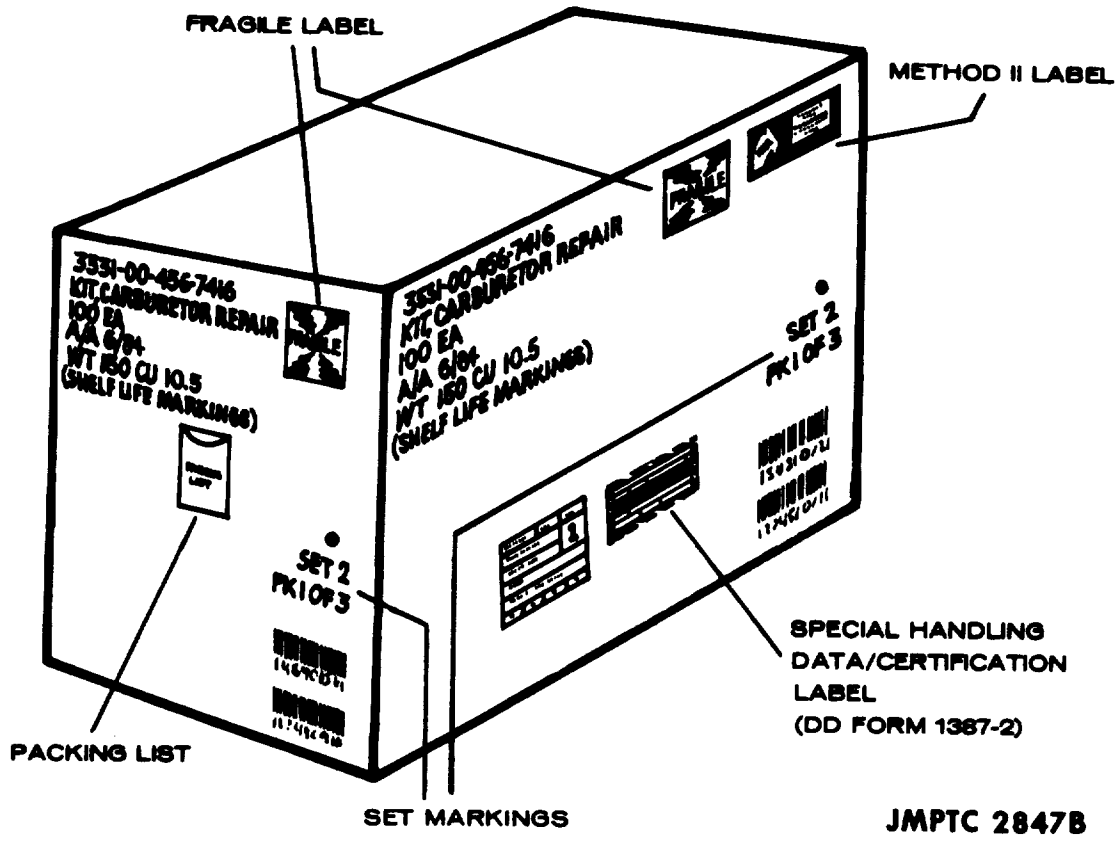


Figure 1-43. Special Markings.

1-24. Marking of Packs

a. Purpose. The purpose of marking is to permit ready identification of contents, consignor and consignee addresses so that shipments can be moved without confusion or delay. No matter how well an item is made or packed, it is valueless if it cannot be identified upon reaching its destination. The Department of Defense procures so many types and makes of equipment, ammunition, materials, and repair parts, particularly during an emergency, that there is insufficient time to trace the origin of a shipment to determine its destination or to open containers to identify their contents.

b. Marking of Packs. The publication for marking of military supplies is Military Standard 129, Marking for Shipment and Storage. This publication has been approved by the DOD for the marking of military supplies. It is mandatory for use by the military services and DOD supply agencies. This standard provides the requirements for the uniform marking of military supplies and equipment for shipment and storage. It accommodates the requirements for coded and in the clear data and the forms required by Military Standards Requisitioning and Issue Procedures (MILSTRIP) and Military Standard Transportation and Movement Procedures (MILSTAMP) for movement processing.

c. MIL-STD—129. Basic exterior container marking must include the identification, contract data, and address markings. Unless specifically exempted in the contract or order, bar code markings shall also be applied. When containers of unrelated items are consolidated into a shipping container, the word "MULTIPACK" shall be applied to the shipping container in lieu of the identification marking. The weight and cube will be included on the exterior containers and will be located just below the "MULTIPACK" identification. Additional special markings may be required depending upon the item and container being shipped (see fig 1-43). For further details refer to MIL-STD—129.

1-25. Economy in Packing

a. Standardization. Economy in packing is the responsibility of everyone concerned with military supply. The Secretary of Defense has established policies on packaging that must be followed. These policies emphasize that the military services standardize their preservation, packaging, and packing. For example, the services, by using packaging standards, assure the same requirements for the same type of items, thus reducing the number of materials, methods, and procedures—whether these requirments are performed by the contractor or by a depot.

b. False Economy. Defense material must be protected against all hazards at the lowest possible cost, with the tare weight and cube kept to a minimum. Any attempt, however, to relax standards to anything less than adequate, is false economy. To associate the size and price of an item with the cost of packing is also false economy. Items of small size or low monetary value are often essential to the proper function of a million dollar assembly. To use more material or more expensive material than is essential is also false economy.

c. Reducing Tare Weight and Cube. One important way to reduce overpacking is through the use of pilot packs carefully engineered and tested for a particular item. The redesigning of established packs and the use of standardized processing forms may result in substantial savings. Wherever the selection of the container is optional study the comparative initial cost, the labor handling and storage costs, and any possible reduction in tare weight and cube. Probably no area is more fruitful in realizing savings than in the reduction of tare weight and cube.

d. Potential Areas for Economy. There are two areas of great saving potential. One is repair parts and general stores items which account for the greatest shipping volume through high turnover. The other is items of large cubic volume on which shipping charges are high, such as pontoons, fuel tanks, electronic equipment, and machine tools. Figure 1-44 shows an example where savings in weight and cube, together with reduction in top heaviness, were achieved by remounting the item on its side. The length of the crate framing members and diagonals was reduced, and the basic strength of the crate was increased by having the angles of the diagonals nearer to the ideal 45 degree.

e. Economy Procedures. Worthwhile reductions in cost can be realized by following some or all of these procedures:

(1) Disassemble equipment, whenever permissible, into smaller units to minimize storage and shipping space (fig 1-7).

(2) Make vigorous efforts to maintain the moisture content of lumber used for containers, crates, and blocking and bracing within the allowable limits.

(3) Order resawn lumber to reduce weight and cube. By resawing lumber, more board footage per dollar can be obtained. For only 25 percent extra, board footage more than double the amount of surface area can be realized. (Military Handbook MIL-HDBK—7, "Lumber and Allied Products.")

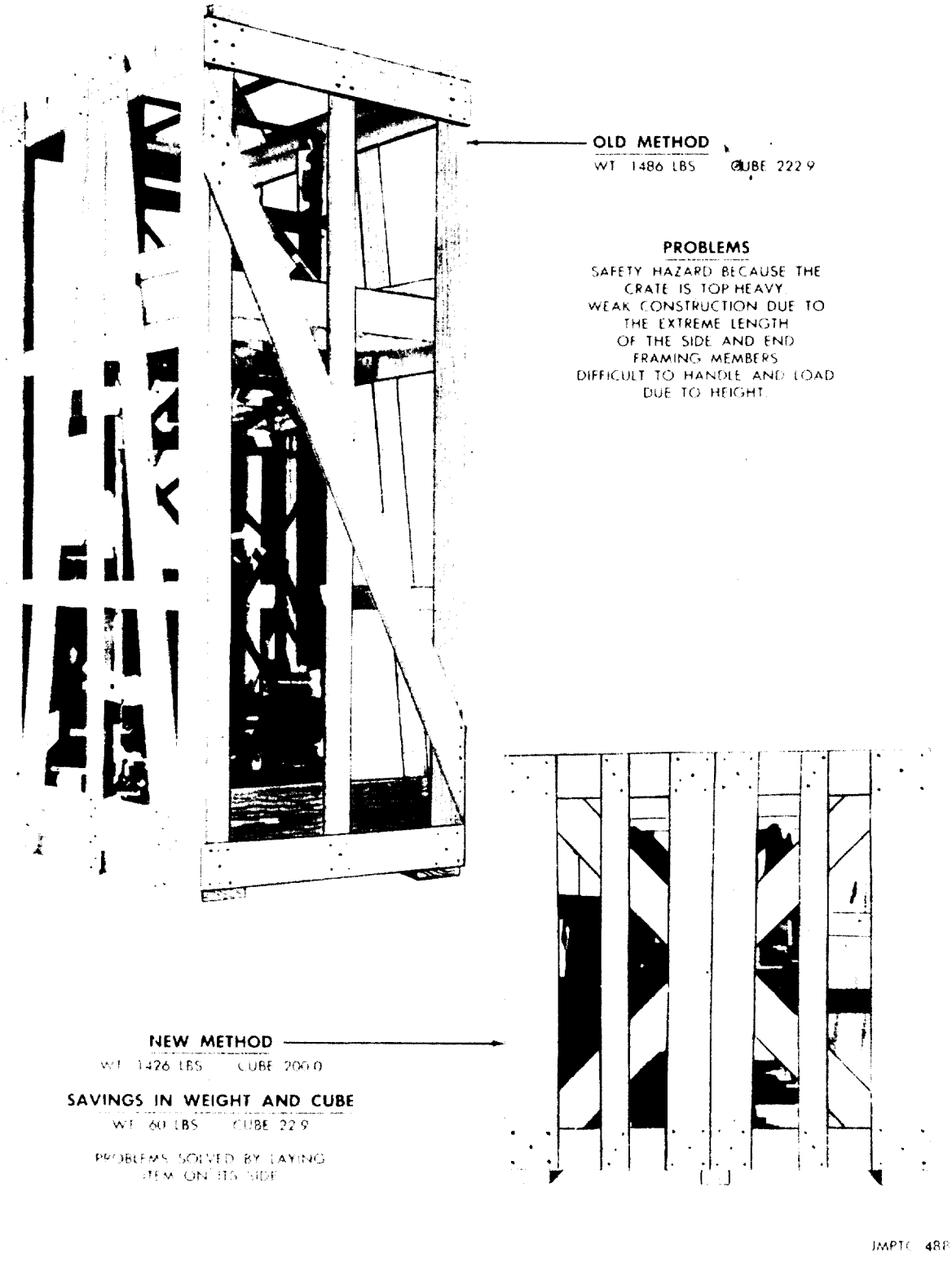


Figure 1-44. Savings achieved through remounting of an item.

use a wooden box when a lighter container is adequate for the pack.

(5) Develop an active training program for packing supervisors and personnel to alert them to the constant need for the reduction of weight and cube. Figure 1-45 shows how saving in weight, cube, and materials resulted from a imple redesign of the pack.

(6) Make available a greater selection of light weight containers on the packing lines. Operators will not be as likely to use heavier containers when fiberboard or other lightweight ocntainers are available and can do just as well.

(7) Consolidate multipack shipments into low cost containers to eliminate the shipping weight of smaller individual containers. The wood, wirebound, and triple-wall fiberboard pallet boxes are all light in weight, are economical and suitable for consolidating materials for domestic and air shipments.

f. Other Economy Areas. There are several other areas in which economies can be achieved.

(1) *Manpower.* Any reduction in manpower cost will have a definite bearing on the economy of packing. One way to reduce manpower cost is to recognize that the well-trained packer is the economical packer. This means using the right man on the right job.

(2) *Mechanization.* Savings of considerable importance can be derived from the proper use of mechanization. Powerized conveyor belts, mechanized handling systems, and automatic packing machinery, all help to reduce handling and speed up operations.

(3) *Reuse of materials.* Another field in which savings can be effected is through the salvage and reuse of materials. Lumber, cushioning, blocking and bracing materials, containers, and metal fasteners can be reused with a little careful planning (fig 1-46).

(4) *Parcel post.* One other area for achieving savings is the more efficient use of parcel post. Frequently, parcel post reduces the need for documentation, allows a lowering of the level of protection, cuts down on marking requirements, and permits faster delivery. Remember, to obtain the maximum value for each Defense dollar, one must be awake to every new idea that may lead to the reduction in packing costs.

1-27. Parcel Post Requirements

a. General Supplies. Military requirements for parcel post shipments must conform to the Postal Service Manual and the various Armed Service regulations.

b. Nonmailable matter. Nonmailable matter includes all matter which is by law, regulation, or treaty stipulation, prohibited from being sent in the mail or which cannot be forwarded to its destination because of illegible, incorrect, or insufficient address.

(1) *Harmful matter.* With certain exceptions, any articles, compositions, or materials, which may kill or injure another or injure the mail or other property, are nonmailable. This includes but is not limited to—

(a) All kinds of poisons, including controlled substances.

(b) All poisonous animals, except scorpions, all poisonous insects, all poisonous reptiles, and all kinds of snakes, turtles and spiders.

(c) All disease germs and scabs.

(d) All explosives, flammable material, infernal machines, and mechanical, chemical, or other device or compositions which may ignite or explode.

(2) *General examples of harmful matter.* Harmful matter includes, among others, that which is likely to destroy, deface, or otherwise damage the contents of the mailbags or harm the person of anyone engaged in the Postal Service, such as caustic poisons (acids and alkalies), oxidizing materials, or highly flammable solids; or which are likely under conditions incident to transportation to cause fires through friction, through absorbtion of moisture, through spontaneous chemical changes or as a result of retained heat from manufacturing or processing; explosives or containers previously used for shipping high explosives having a liquid ingredient (such as dynamite), ammunition; fireworks; highly flammable liquids or substances; radioactive materials; matches; or articles emitting a bad odor.

c. Harmful Matter Requirements. Harmful items should not be shipped parcel post without prior approval of the Postal Service. Whenever there is doubt about the mailability of a particular item, a request for a ruling should be made to the local postmaster. Mailability rulings may also be obtained from a nearby mail classification center or from the Office of Mail Classification, US Postal Service, Washington, DC 20260.

d. Types of Shipping Containers.

(1) *General.* Postal regulations require containers strong enough to retain and protect their contents from the weight of other mail.

(2) *Common containers used.* The following containers, with applicable specifications, are most commonly used, depending on size, weight, and nature of the article(s): Cotton Mailing Bags (PPP-B—20); Burlap Cotton and Waterproof Laminated Textile Shipping Bags (PPP-B—35); Folding Boxes (PPP-B—566); Fiberboard Boxes (PPP-B—636);

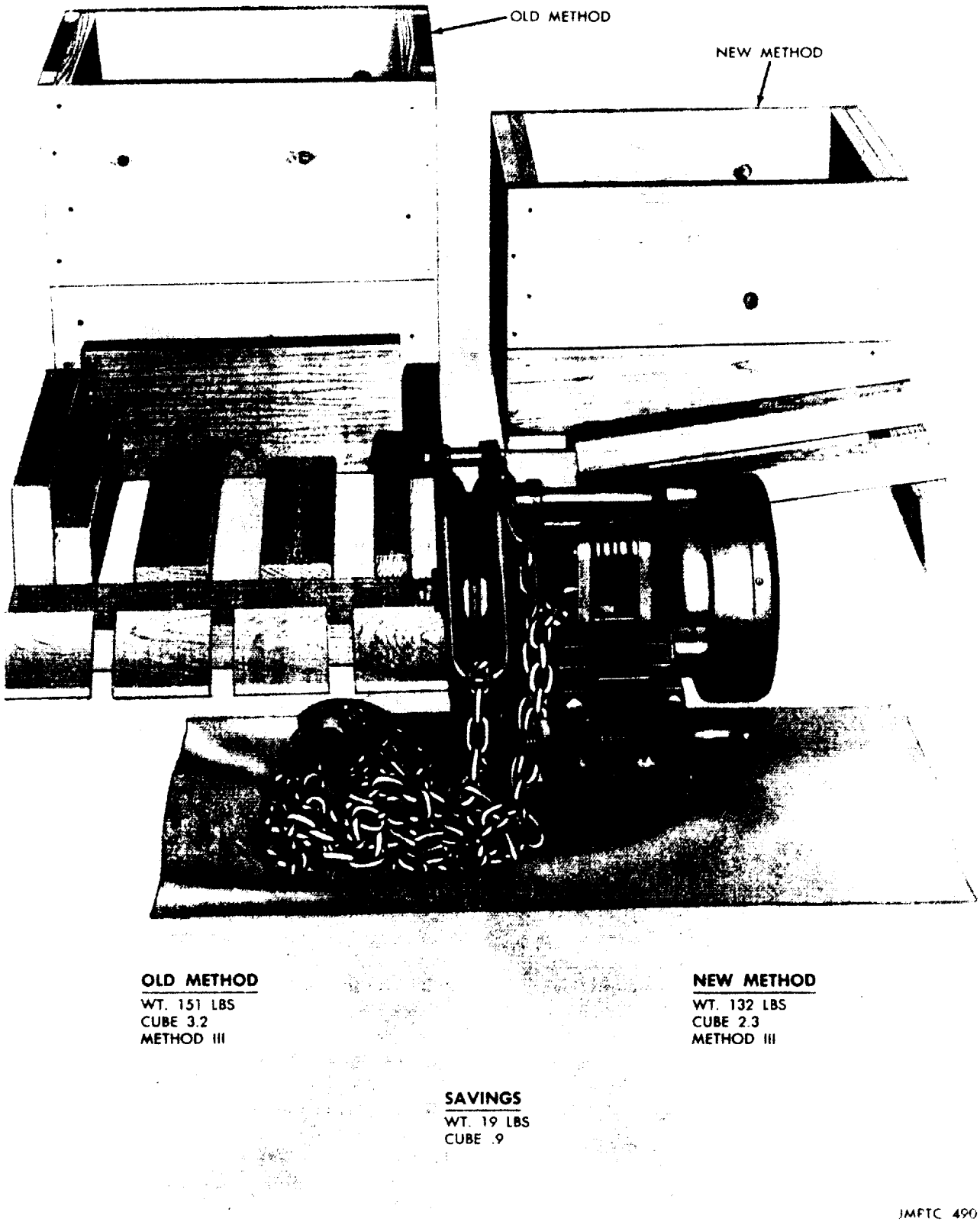


Figure 1-45. Savings achieved by redesigning a pack

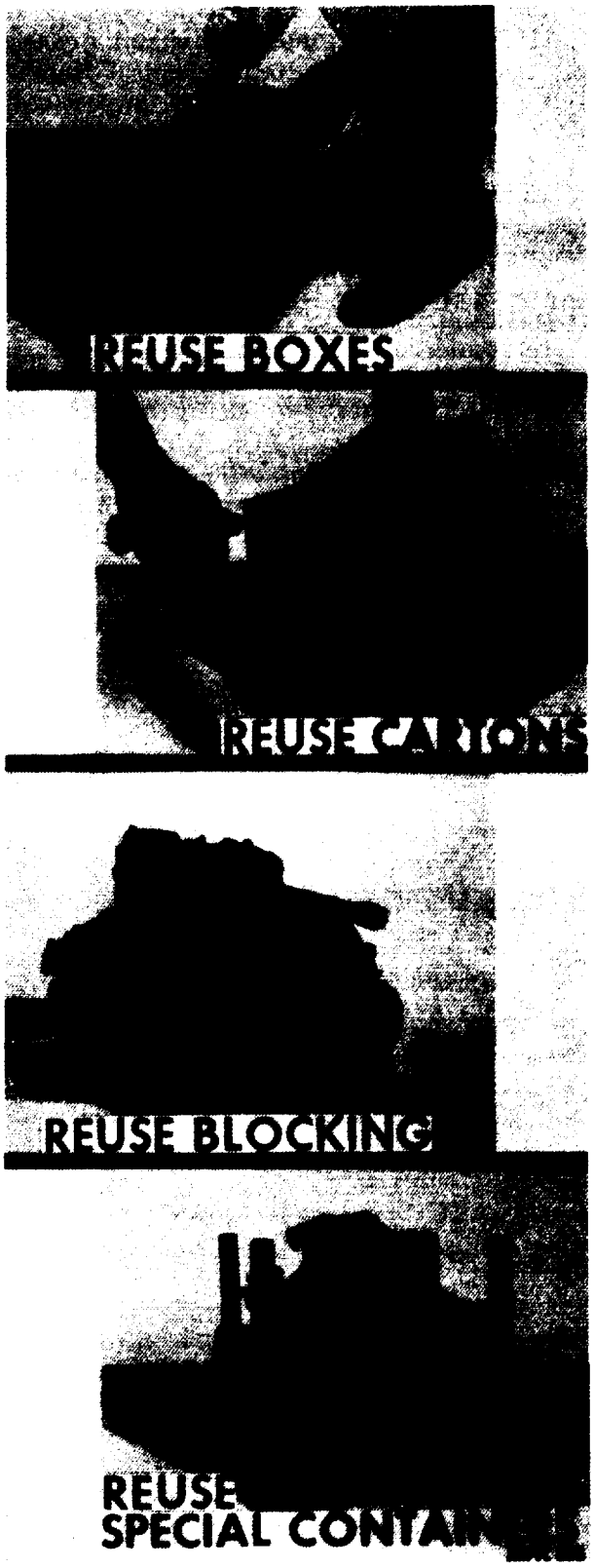


Figure 1-46. Reusing packing materials means economy.

Sacks, Shipping, Paper, Cushioned (PPP-S—30); and Cans, Fiber, Spirally-wound (MIL-C—3955).

(3) *Mailbags.* Mailbags may be used as containers for consolidated shipments of unbreakable or nonfragile items going to the same location, provided projections are cushioned to prevent rupture of the bag during shipment. Use of one of the three available sizes of mailbag should be based on volume of material going to individual customers.

(4) *Used containers.* Used containers in good rigid condition with all flaps intact are acceptable. If a container of desired size cannot be found, a large one may be cut down to meet the needs.

e. Size and Weight of Container. The shipping containers must be of the proper size to accommodate the item(s) being shipped. Sufficient space for cushioning material should be allowed at the time of container selection, avoiding both the underpacking and overpacking of the item and remaining within the weight limitations.

(1) The size and weight of packages mailed at most post offices is limited to 108 inches, length and girth combined, and 70 pounds.

(2) Some military post offices overseas have more restrictive size and weight requirements.

(3) The weight of an addressed piece of parcel post must be 16 ounces or more.

f. Reusable Containers. The use of reusable containers may be determined by considering the following factors:

(1) When the military characteristics of the item are such that a reusable type container is necessary.

(2) When the container can serve a dual purpose of shipping container and case while the item is in use.

(3) When the item is designated as recoverable-repairable item.

(4) The cost of reusable containers is offset by multiple use as compared to the cost of single shipment, disposable containers.

(5) When the cost of the item and/or its critical characteristics, or the need for periodic inspection or exercising justifies the use of a reusable container.

(6) Reusable drums with protruding closure devices, such as locking rings, shall be cushioned to prevent injury to postal employees, equipment or other mail.

g. Outside Wrapping and Closure.

(1) When a box itself is an adequate shipping container, paper wraps should be omitted. If a paper wrap is used as an outside cover for boxes, the paper should have at least a 60 pound basis weight. Closure and reinforcement should be made by the use of tape.

(2) Closure and reinforcement is accomplished by using gummed and pressure-sensitive tapes, adhesives, strapping, and staples for boxes and bags. Various friction closures, screw caps and locking devices for cans and similar containers.

(a) General purpose transparent mending tape and masking tape shall not be used for closure or reinforcement, but may be used to augment adhesive closures on envelopes or to cover staples on bags.

*(b)*Pressure sensitive filament reinforced tape or reinforced paper tape is recommended for closure and reinforcement.

(c) Except for pressure sensitive filament tape, tapes used for closure and reinforcement shall be not less than 2 inches wide.

(d) When strapping is used for closure and reinforcement, it should encircle the length and girth of the package at least once. Twine and cord should not be used.

(e) Loose strapping is not acceptable because it presents a hazard to employees and equipment and does not reinforce the container.

h. Marking of Parcels and US Mailbags.

(1) Parcels shall be marked to show the consignor; consignee; Transportation Control Number (TCN); and required delivery date, project code, and mark for, when specified.

(2) Marking of US mailbags shipped both domestically and overseas should be tagged in the space located on the locking device to prevent possible opening in transit. Suggested wording of the tag is "OFFICIAL MAIL FOR ORGANIZATION OF ADDRESS. DO NOT OPEN IN TRANSIT."

(3) In addition to the postage tag located on the locking device of the mailing bag, an additional tag will be attached. The tag will notify the local postal authorities that the bag is to be delivered intact to its destination and will contain the complete address to which the bag is destined and the return address.

CHAPTER 2

FIBERBOARD AND PAPERBOARD CONTAINERS

2-1. Fiberboard Boxes (PPP-B-636)

a. Description of Fiberboard Boxes. A fiberboard box is a container made of one or more pieces of corrugated or solid fiberboard. The pieces are creased, slotted, joined, and folded according to standard styles described in PPP-B-636 and illustrated in figures 2-6, 2-7, and 2-8.

b. Use of Fiberboard Boxes. The quantity of fiberboard boxes used in military shipments is increasing steadily and rapidly. A fiberboard box weighs considerably less than a wooden box of the same capacity. This difference in weight is a factor when large shipments are involved, as any saving of weight is reflected in lower shipping cost and easier handling. The main requirements for a shipping container are light weight, low cost, ability to withstand rough handling, and ability to protect the contents against loss or damage. New facilities, such as motor trucks, airplanes, container cards, skid platforms, lift trucks, platform slings, and palletized loads have been important factors in reducing transportation and handling hazards, thus expanding the use of lightweight fiberboard boxes.

c. Advantages in the Use of Fiberboard Boxes. Fiberboard boxes are adaptable to a great variety of packaging and packing conditions. They offer the following advantages:

(1) They are made of materials of exactly the specified strength and water resistance.

(2) They are prefabricated.

(3) They are made in several styles to suit different shapes and sizes of items.

(4) They are shipped and stored in the flat, and hence save shipping and storage space.

(5) They are easy to assemble and handle.

(6) They are light in weight and relatively strong.

(7) They are neat in appearance and easy to mark.

(8) When packed, they occupy less space than most other containers of the same inside dimensions.

d. Classification of Fiberboard Boxes. Fiberboard boxes, for domestic and oversea shipments, have been consolidated under PPP-B-636. Fiberboard material must conform to PPP-F-320. Boxes may be procured or fabricated in the following types and classes:

(1) *Types (see fig 2-1).*

(*a*) *Type CF boxes.* Type CF boxes are fabricated from corrugated fiberboard (CF) stock (*h* below). Corrugated fiberboard is of two varieties.

1. SW variety is single-wall construction.

2. DW variety is double-wall construction.

(*b*) *Type SF boxes.* Type SF boxes are fabricated from solid fiberboard (SF stock *h* below).

(2) *Classes.*

(*a*) *Class domestic and domestic/fire-retardant.* Domestic class boxes are made to meet either normal or special requirements. Under normal requirements, the boxes are used as single-trip containers and no multiple shipments are involved. Under special requirements, the boxes are used where more hazardous storage and shipping conditions are expected (see fig 2-1).

(*b*) *Class weather-resistant.* Weather-resistant boxes are made to meet either normal or special requirements (see fig 2-1).

(*c*) *Class waterproof and water vapor resistant (WWVR).* WWVR boxes are made to meet either normal or special requirements the same as class weather-resistant boxes (see fig 2-1).

(*d*) *Fire-retardant boxes.* Interim amendment -4 (SA), developed by the Navy for procurement in an effort to reduce combustible packaging materials aboard Navy ships, adds class weather-resistant/fire-retardant to type CF of PPP-B-636. Under type SF, the interim amendment also adds class domestic/fire-retardant and class weather-resistant/fire-retardant.

(3) *Grades of fiberboard.* Different strengths of fiberboard are indicated as grades.

(*a*) Grades of fiberboard of class domestic, types CF and SF; and class domestic/fire-retardant, type CF are differentiated by psi (pounds per square inch) of bursting strength (table 2-1).

(*b*) Weather-resistant grades of fiberboard are differentiated by a letter-number combination such as V2, V3, W5, and W6 which represent different bursting strengths. The numeral in each combination represents the grade of material and the letter in each combination represents a kind of fiberboard (V- or W-board). V-board is a heavy-duty, highly weather-resistant board, and W-board is a lower strength, highly weather-resistant board.

1. Type CF (corrugated fiberboard) can be obtained in grades 3, 5, 6, 11, 13, and 15 with compliance symbols of V3c, W5c, W6c, V11c, V13c and V15c. The small c indicates corrugated fiberboard.

2. Type SF (solid fiberboard) can be obtained in grades 2, 3, 4, 5, and 6 with compliance symbols of V2s, V3s, V4s, W5s, and W6s. The small s indicates solid fiberboard.

(c) Waterproof and water vapor resistant (WWVR) grades of fiberboard are differentiated by a letter-number combination followed by the letters "WWVR." Waterproof and water vapor resistant boxes are fabricated from type CF (corrugated fiberboard) and can be obtained in grades V3c, WWVR and W5c, WWVR in the single wall variety and grades V11, WWVR and V13, WWVR in the double-wall variety.

e. Capabilities of Fiberboard Boxes. The three principal factors affecting the carrying capacity of corrugated and solid fiberboard boxes are resistance to compression, strength at the score lines, and resistance to puncture. A fourth factor that should be taken into consideration is the ability of fiberboard to resist the weakening effect of moisture. The importance of the first three factors varies according to the commodity for which a particular box is designed, and the type of interior packing employed. Resistance to compression, for example, is a relatively minor factor when the contents support the walls of the container or when the interior packing furnishes the necessary support. When these factors are not present, the shipper must make certain that the container has sufficient resistance to compression to prevent it from caving in when it is placed in the bottom tier of a pile of similar boxes. Corrugated and solid fiberboard boxes may be used to ship articles that are not readily susceptible to damage resulting from ordinary distortion of the container. The manner in which a commodity is packed governs to a great extent its condition on arrival at destination. Therefore, the selection of the proper style, class, and grade of fiberboard box should be carefully considered to ensure the commodity against the hazards of storage, shipment, and handling. The items normally packed in fiberboard boxes are type 1 or type 2 loads. Type 3 loads should be converted to type 1 or 2 loads by proper interior packing.

f. Uses and Limitations of Class Domestic and Domestic/Fire-retardant Fiberboard Boxes. The uses of fiberboard boxes are essentially as indicated in *d*(2) above. Many variations of special die-cut inserts, scored pads, and partitions (see figures 1-31 and 1-32) can be fabricated to five additional protection to the item. Table 2-1, is used to determine the application requirements when class domestic and domestic/fire-retardant fiberboard boxes are needed. The normal requirements column is used for single-trip containers; the special requirements column applies to multiple or hazardous shipments (see figure 2-1). The columns for corrugated and solid fiberboard (CF and SF) show the minimum bursting strength of the fiberboard in pounds per square inch which determines the grades. Class domestic/fire-retardant boxes are to be used for stowage of items aboard Navy ships to reduce risks and hazards of fire.

g. Uses and Limitations of Class Weather-resistant and WWVR Fiberboard Boxes. V-board was developed primarily for the fabrication of exterior containers for oversea shipment. W-board was developed primarily for the fabrication of interior containers which are packed in exterior containers for oversea shipment. At oversea points, the exterior pack is sometimes removed and the W-board boxes become the exterior containers. When W-board boxes are used as exterior containers, their weight and dimensional limitations should not be exceeded. Although both V- and W-boards 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 Specification PPP-B-1055 or MIL-B-13239 (fig 1-34); by the use of case liners conforming to Specification MIL-L-10547 (fig 1-35 and 1-36); or by the use of waterproof, pressure-sensitive tape conforming to Specification PPP-T-60, or PPP-T-76, applied as shown in figure 2-2 after proper closure of the box in accordance with *n*(2) and (3) below. Table II of Specification PPP-B-636, herein reproduced as table

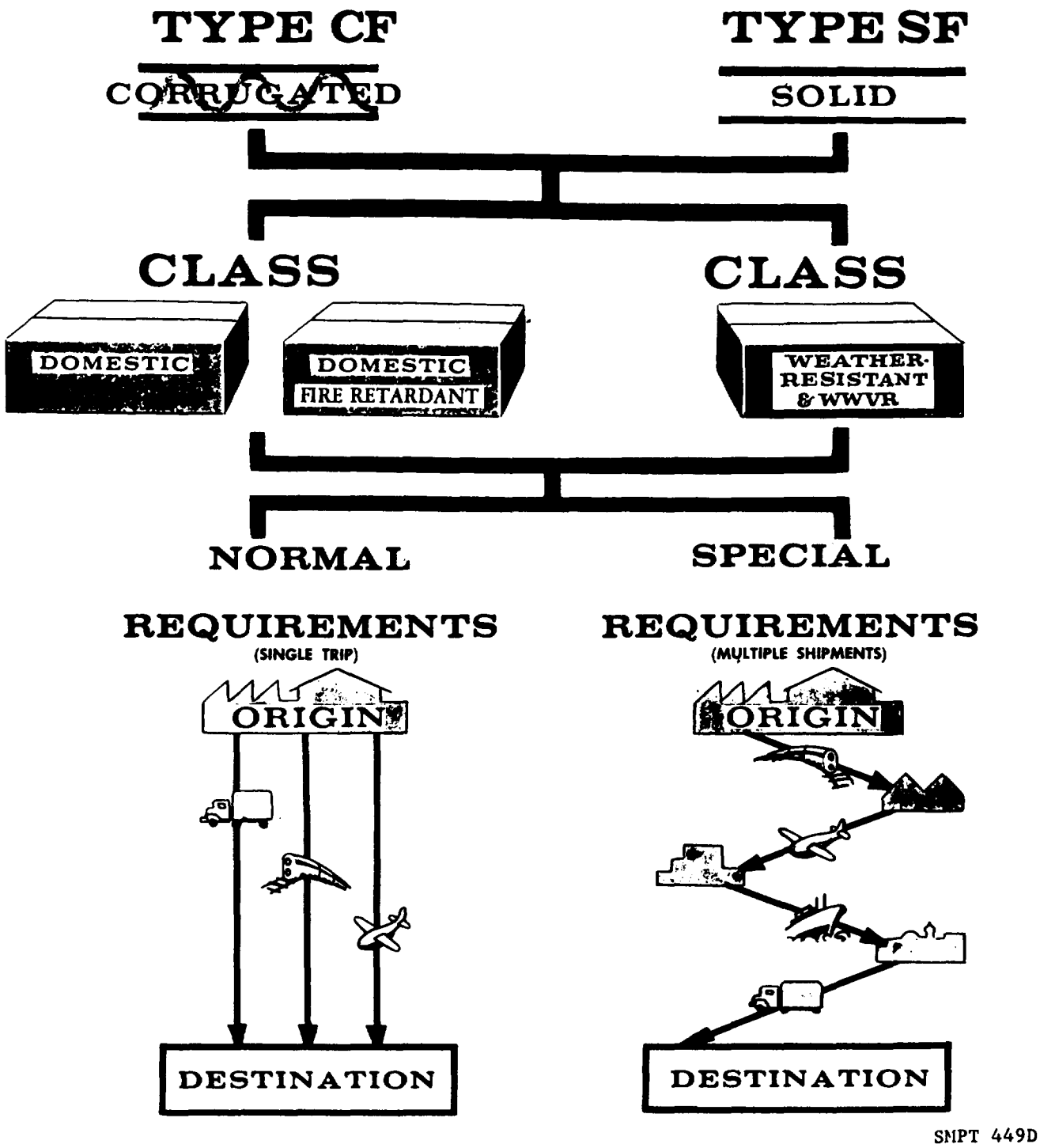


Figure 2-1. Classification of fiberboard boxes.

2-2 is used to determine the weight and size limitation when class weather-resistant fiberboard boxes are required. Compliance symbols are given in the first column, V2, etc. The remainder of the table is divided into "Normal requirements" and "Special requirements". The normal requirements

column is used for single-trip containers, the special requirements column applies to multiple shipments (fig 2-1). Maximum weight of box and contents are listed for type 1 and type 2 loads under both normal and special requirements. Maximum total inside dimensions are also given for type 1 and 2 loads under both normal and special requirements.

Table 2-1. Requirements for Class Domestic and Domestic/Fire Retardant Fiberboard Boxes

Type CF		Type SF	Normal requirements		Special requirements	
Variety			Max. wt. of box and contents (lbs)	Max. inside dimensions L+W+D (inches)	Max. wt. of box and contents (lbs)	Max. inside dimensions L+W+D (inches)
SW Grade	DW Grade					
125	.....	125	20	40		
175	.....	175	40	60	20	60
200	200	200	65	75	45	75
275	275	275	90	90	65	90
350	350	350	120	100	90	100
	500	500	140	110	120	110
	600	600	160	120	140	120

Table 2-2. Size and Weight Limitations for Class Weather-Resistant and WWVR Fiberboard Boxes Used as Exterior Containers

Grade (compliance symbol)	Normal requirements		Special requirements		
	Maximum weight of box and contents	Maximum inside dimensions of box (length, width, depth added)	Maximum weight of box and contents		Maximum inside dimensions of box (length, width, depth added)
	Type 1 and 2 loads *Pounds*	*Type 1 and 2 loads* *Inches*	*Type 1 load* *Pounds*	*Type 2 load* *Pounds*	*Type 1 and 2 loads* *Inches*
V2s	120	100	80	65	80
V3s, V4s and V3c	90	90	75	45	75
W5s and W5c	65	75	55	40	55
W6s and W6c	30	30	25	25	30
V11c	160 [1]	120	160	160	120
V13c	120	100	120	120	100
V15c	90	90	90	90	90

[1] Maximum weight may be increased to 225 pounds provided the manufacturer's body joint is fastened with flat metal staples not less than 0.103 inch wide by 0.023 inch thick when made of flat wire, or not less than 0.103 inch wide by 0.020 inch thick when made of accurate wire, spaced not more than 1 inch apart.

h. Materials.

(1) *Corrugated fiberboard, type of.* Corrugated fiberboard is fabricated of flat sheets of paperboard (called facings) glued to the crowns of a corrugated sheet of the same material. Strength requirements are obtained by varying caliper, number, and quality of the component facings and the corrugated medium. Corrugated fiberboard has low resistance to puncture but affords a high degree of resilience and cushioning. Single-wall (SW, also called double-faced), corrugated fiberboard consists of two outer paperboard facings laminated to a corrugated sheet between them (see fig 2-3). Double-wall (DW) corrugated fiberboard consists of three flat facings and two corrugated sheets, a center facing, a corrugated sheet, and a facing (see fig 2-3). It is this combination of flat and corrugated sheets that gives corrugated fiberboard its qualities of strength and resilience. Corrugated fiberboard is constructed with different kinds and arrangements of flutes. A flute, with 36 plus or minus 3 flutes per linear foot, is generally used where cushioning of contents is desired. B flute, with 50 plus or minus 3 flutes per linear foot, is used where the contents that support the box are of low fragility. C flute, with 42 plus or minus 3 flutes per linear foot, can be made to serve either purpose (see fig 2-4). A flute is the largest of the three and its strength is realized in stacking applications. Its ability to withstand impact as well as its resistance to flat crushing is the lowest of the three flute sizes due to the lesser number of flutes per linear span. The smallest standard flute size, B, is the weakest in terms of stacking strength, but it performs very well under puncture and flat crush stress. C, which is the

middle size flute, will perform moderately well in all three areas—stacking, puncture, and flat crush. It is used where maximum strength in any one area is not required, but where weakness in no area can be tolerated.

(a) *Domestic and Domestic/Fire-retardant Fiberboard Boxes.* Variety SW fiberboard used to fabricate type CF boxes will be A, B, or C flute at the option of the supplier. Variety DW fiberboard used to fabricate type CF boxes will be any combination of A, B, or C flutes, except BB. Type CF boxes, fabricated from vari-

Figure 2-2. Waterproofing of fiberboard boxes with tape.

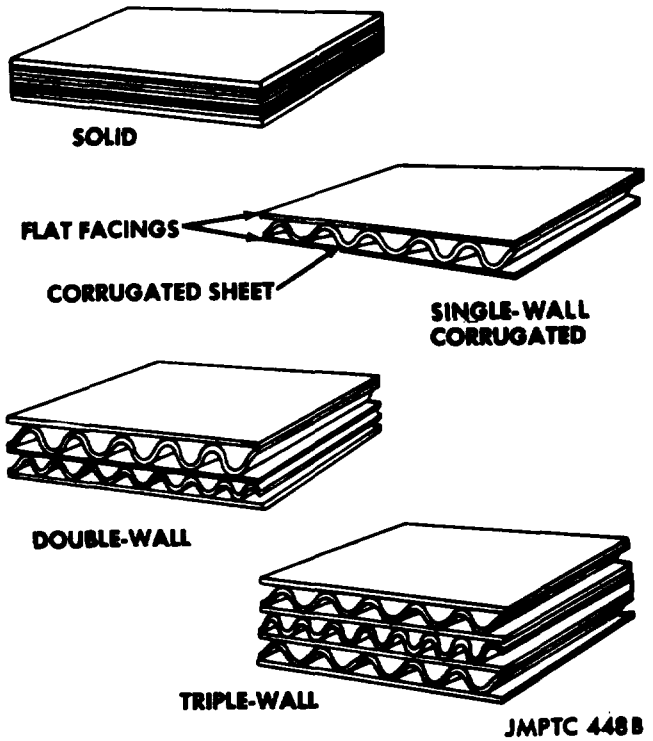


Figure 2-3. Types and varieties of fiberboard.

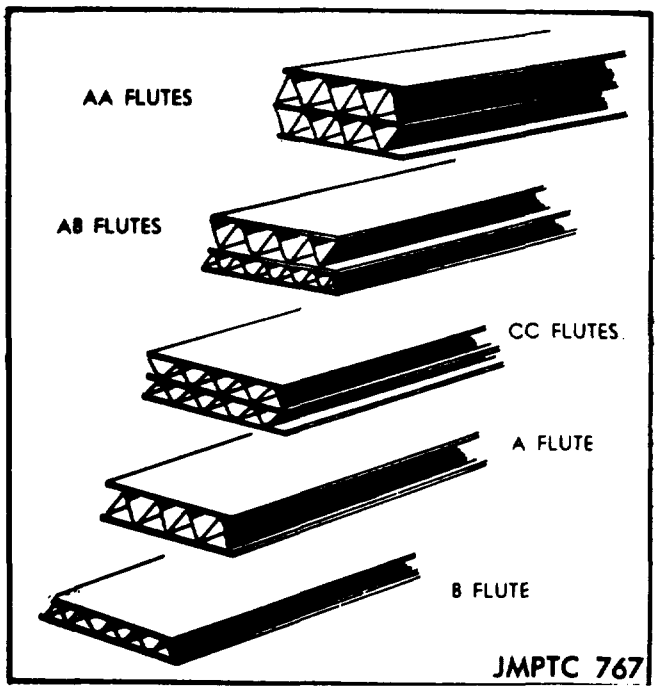


Figure 2-4. Corrugated fiberboard flutes.

ety SW or DW fiberboard shall have the flutes running perpendicular to the scores of the box openings. When specified, the flutes for variety SW or DW fiberboard will run horizontal to the scores of the box openings for boxes of a size that the top and bottom openings are on the smallest panels.

(*b*) *Weather-resistant and WWVR fiberboard boxes.* SW fiberboard used to fabricate type CF boxes will be B or C flute unless otherwise specified, conventional slotted type CF boxes shall have the flutes run perpendicular to the scores of the box openings. When specified, the flutes for these boxes shall run horizontal to the scores of the box openings for boxes of a size and style that the top and bottom openings are on the smallest panel. For Styles DBLCC and IC boxes (fig 2-8), they shall have the flutes run the depth of the box perpendicular to the opening.

(2) *Solid fiberboard, Type SF.* Solid fiberboard consists of several sheets or plies of paperboard laminated together with an adhesive applied over the entire area of contact between the sheets (fig 2-3). The paperboard may be sheets of chipboard between two outer sheets of kraft or jute, or all sheets may be of jute and kraft. The combined material is solid, hard, and rigid, and boxes fabricated from it resist puncture to a high degree but offer little cushioning to their contents. They do, however, offer greater resistance to rough handling and wear, and are better adapted for use in shipping heavier and less fragile items than those shipped in corrugated fiberboard boxes. If the weight of the box and contents does not exceed 40 pounds, the fiberboard will be not less than two-ply. If the weight exceeds 40 pounds, the fiberboard will be not less than three ply.

(3) *Tapes.* Among the tapes most commonly used for closing and sealing fiberboard boxes are—

(*a*) PPP-T-76, a pressure-sensitive water-resistant, paper-backed tape, normally used to close interior containers.

(*b*) PPP-T-60, a pressure-sensitive waterproof tape, used to close and waterproof interior and exterior fiberboard boxes.

(*c*) PPP-T-45, a reinforced, paper-gummed tape, used for sealing fiberboard containers for domestic shipment and storage.

(4) *Adhesive.* Adhesive used for closing fiberboard boxes will conform to Specification MMM-A-250.

(5) *Metal fastenings.* Metal fastening for securing the manufacturer's joint and closing class weather-resistant and WWVR fiberboard boxes, will be commercially preformed staples or staples from commercial steel stitching wire. The staples will be treated with a commercially applied coating of zinc or copper wash to resist corrosion.

Staples may be flat or arcuate (arced) and may be of various sizes. PPP-B-636 specifies the sizes of staples to use.

(6) *Reinforcing materials.* Steel strapping, QQ-S-781; nonmetallic strapping, PPP-S-760; or pressure-sensitive, filament-reinforced taped, PPP-T-97 are used to reinforce packed and closed fiberboard boxes. Other documents to use for reinforcing materials include ASTM D 3950, Standard Specification for Strapping, Plastic (and Seals); and ASTM D 4675, Standard Guide for Selection and Use of Flat Strapping Materials.

i. Fabrication of the Boxes.

(1) *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.

(2) *Body joint (manufacture's joint).*

(a) Domestic and domestic/fire-retardant boxes, types CF and SF. The body joint (manufacturer's joint) of domestic and domestic/fire-retardant, corrugated fiberboard boxes will be either lapped, butted, or spliced, as specified (see fig 2-5). Only on domestic solid fiberboard boxes are lap joints permitted.

1. Lapped joint. The lap may be either on the inside or outside of the box and not less than 1¼ inches overlap. On a type CF box it may be secured by staples, stitching wire, or adhesive, and on a type SF box it may be secured by staples or stitching wire only.

2. Butted joint (type CF only). The butted joint will be secured with gummed tape not less than 2 inches wide for gross weights up to 65 pounds, inclusive, and not less than 3 inches wide for gross weights in excess of 65 pounds. The tape shall be centered on the joint, extend its full length or within three-eighth: of an inch of full length, and adhere over at least 90 percent of the entire area of contact with the fiberboard.

3. Spliced joint. This joint is permitted only on double-wall corrugated fiberboard. The spliced joint is effected by removing the corrugated media and center liner and splicing inner and outer facings over the end of the abutting corrugated fiberboard. The overlap will extend not less than 1 inch. Both facings must be securely glued over the entire area of contact between the facings.

(b) Weather-resistant and WWVR boxes, type CF and SF. Only the lap joint may be used on, weather-resistant and WWVR grade boxes (see fig. 2-5).

1. The lap joint will overlap either inside or outside the box not less than 1½ inches, and will be secured with steel staple or steel stitching wire. The staples or stitches will be spaces not more than 2 inches apart, and the distance between the outer stitches and the end of the joint will not exceed 1 inch. An additional tie-stitch will be used about one-half inch from the outer stitches at each end of the joint.

2. In lieu of a tie-stitch joint, boxes may be stapled or stitched with the same number of fasteners (including tie-stitches) equally spaced in a single row.

3. When specified, the body joints of grades W5c, W6c and V3c fiberboard boxes may be secured by the use of adhesive conforming to MMM-A-250.

j. Styles of Fiberboard Boxes. The styles covered in figures 2-6, 2-7, and 2-8 are the basic styles of domestic and domestic/fire-retardant, weather-resistant, and WWVR fiberboard boxes.

(1) *RSC, regular slotted box.* In this design, all the flaps (inner and outer) are of equal length. The outer flaps meet in the center when closed. This style is the most commonly used.

(2) *CSSC, center special slotted box.* This box is designed so that the inner and outer flaps meet in the center giving a double thickness for top and bottom.

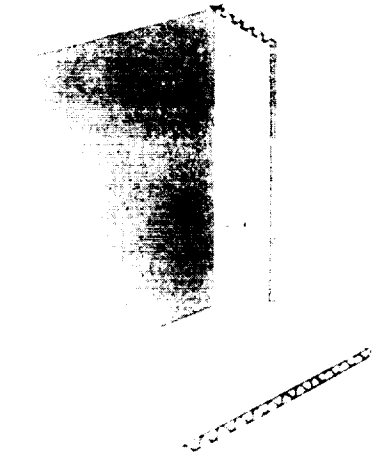
(3) *CSOSC, center special overlap slotted box.* This box is designed the same as the CSSC except the outer flaps are the same length as the inner flaps and may overlap. No flap cutting is required.

(4) *FTC, full telescope box.* The box consists of a body and a snug fitting cover. The flaps of both may be positioned in one of 3 possible combinations. This style of box, when closed, has a triple thickness of fiberboard on all four corners, affording good stacking strength.

(5) *SFF, special full flap slotted box.* In this design the inner flaps meet in the center of the box. A one-fourth inch gap is permitted.

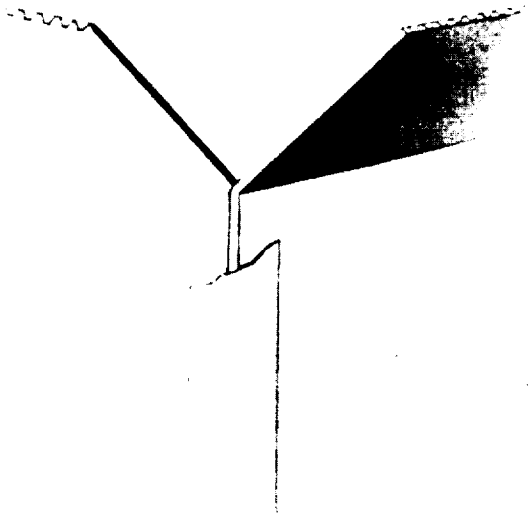
(6) *FOL, full overlap slotted box.* In this design, the length of the outer flaps shall be not less than the inside width of the box minus 1 inch. This design results in a container with at least two thicknesses of fiberboard covering the entire top and bottom surfaces.

(7) *OSC, overlap slotted box.* In this box, when closed, the inner flaps must not overlap, and the outer flaps will overlap the distance specified in the order or invitation for bids. The inner flaps will be of the same length as the outer flaps, except when the relation of width to length would

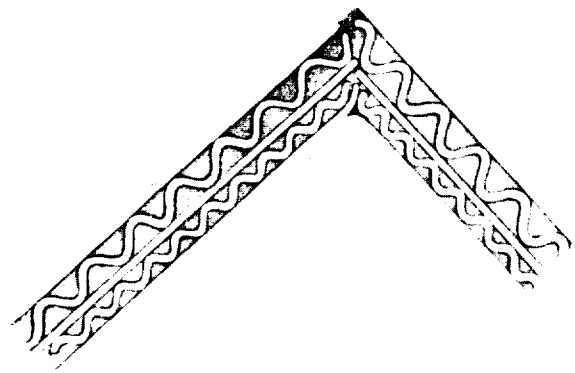


LAPPED AND STITCHED JOINT

LAPPED AND GLUED JOINT



BUTTED AND TAPED JOINT



SPLICED JOINT
FOR DOUBLE WALL

Figure 2-5. Body joints for fiberboard boxes.

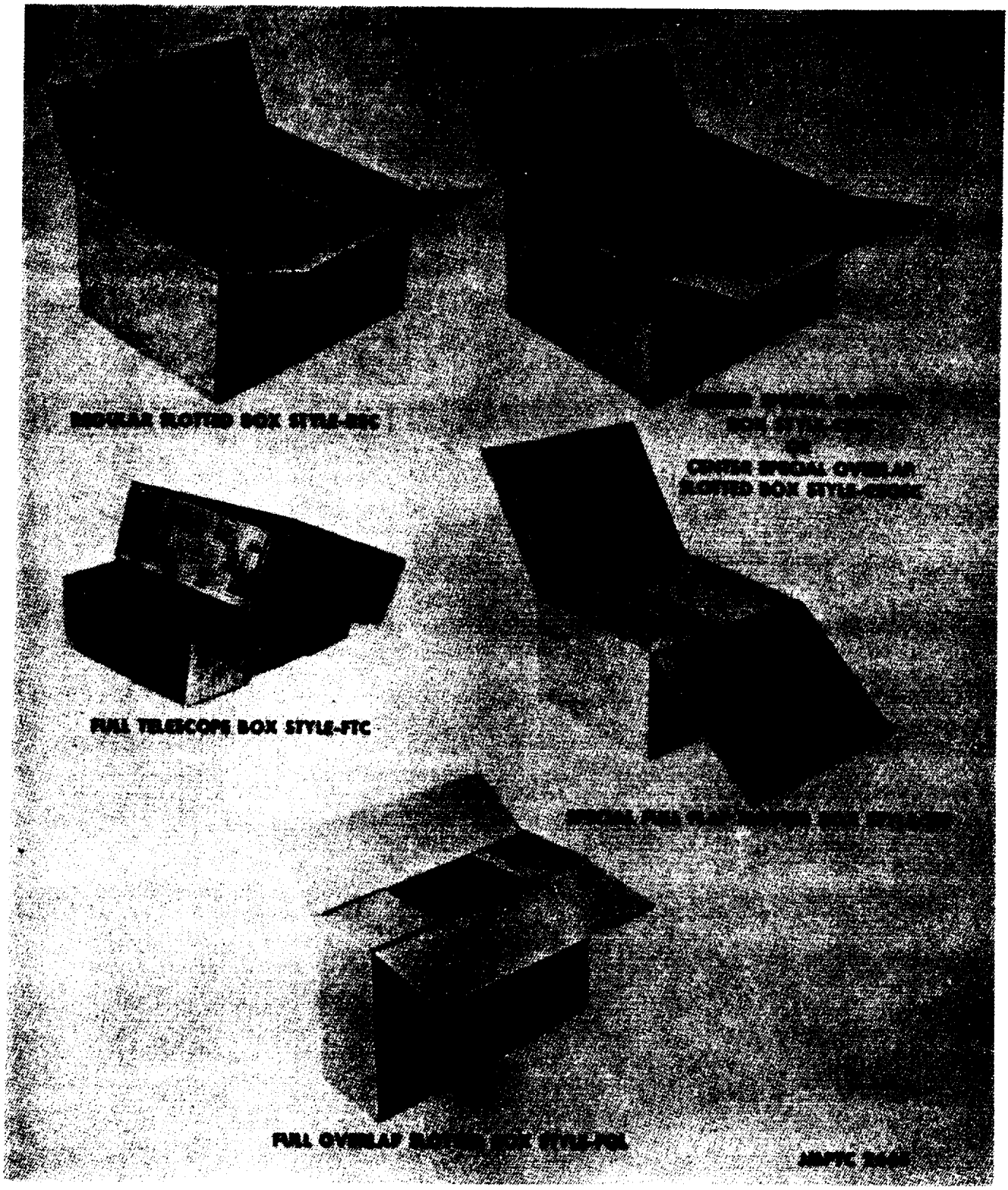


Figure 2-6. Styles of fiberboard boxes.

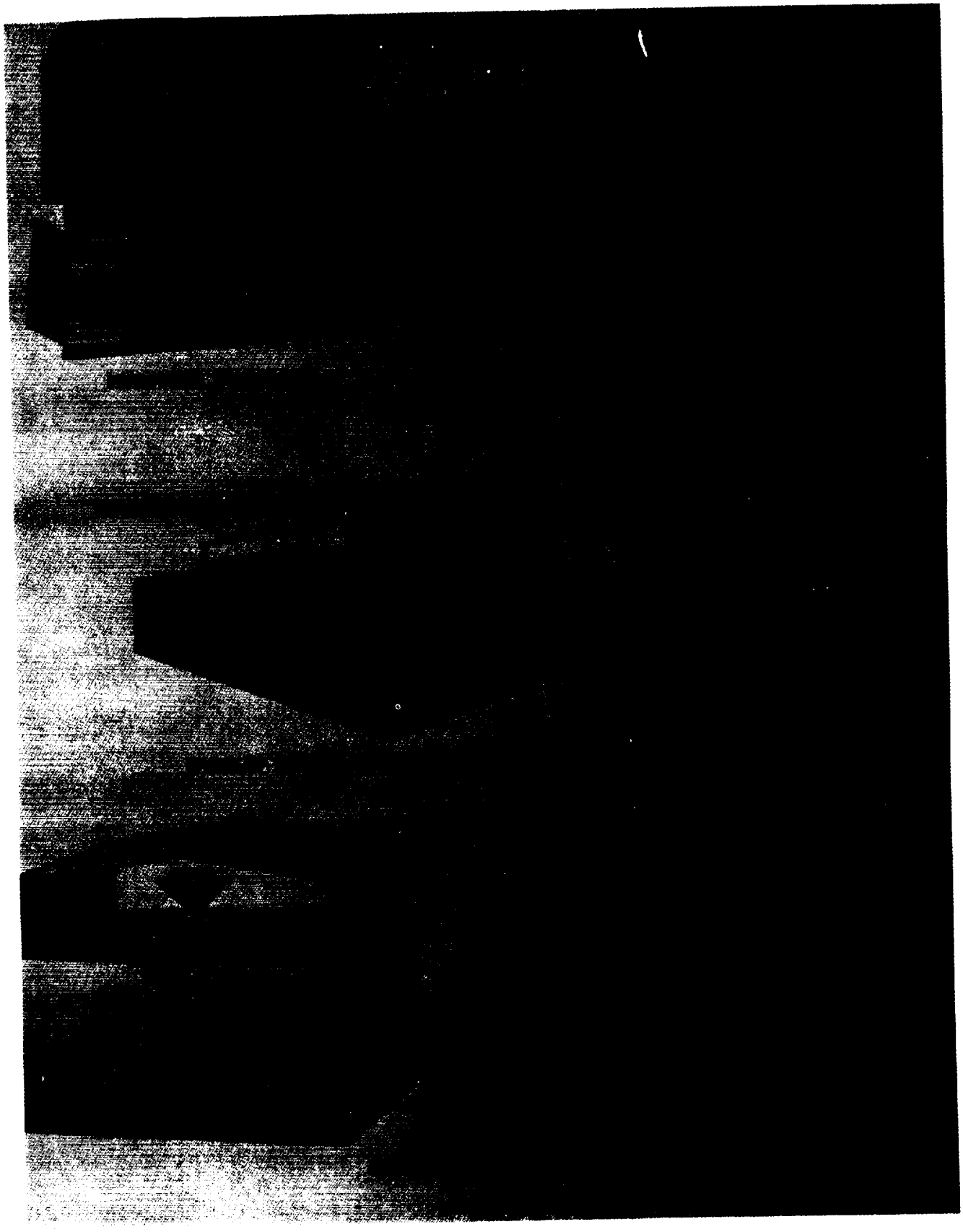


Figure 2-7. Styles of fiberboard boxes.

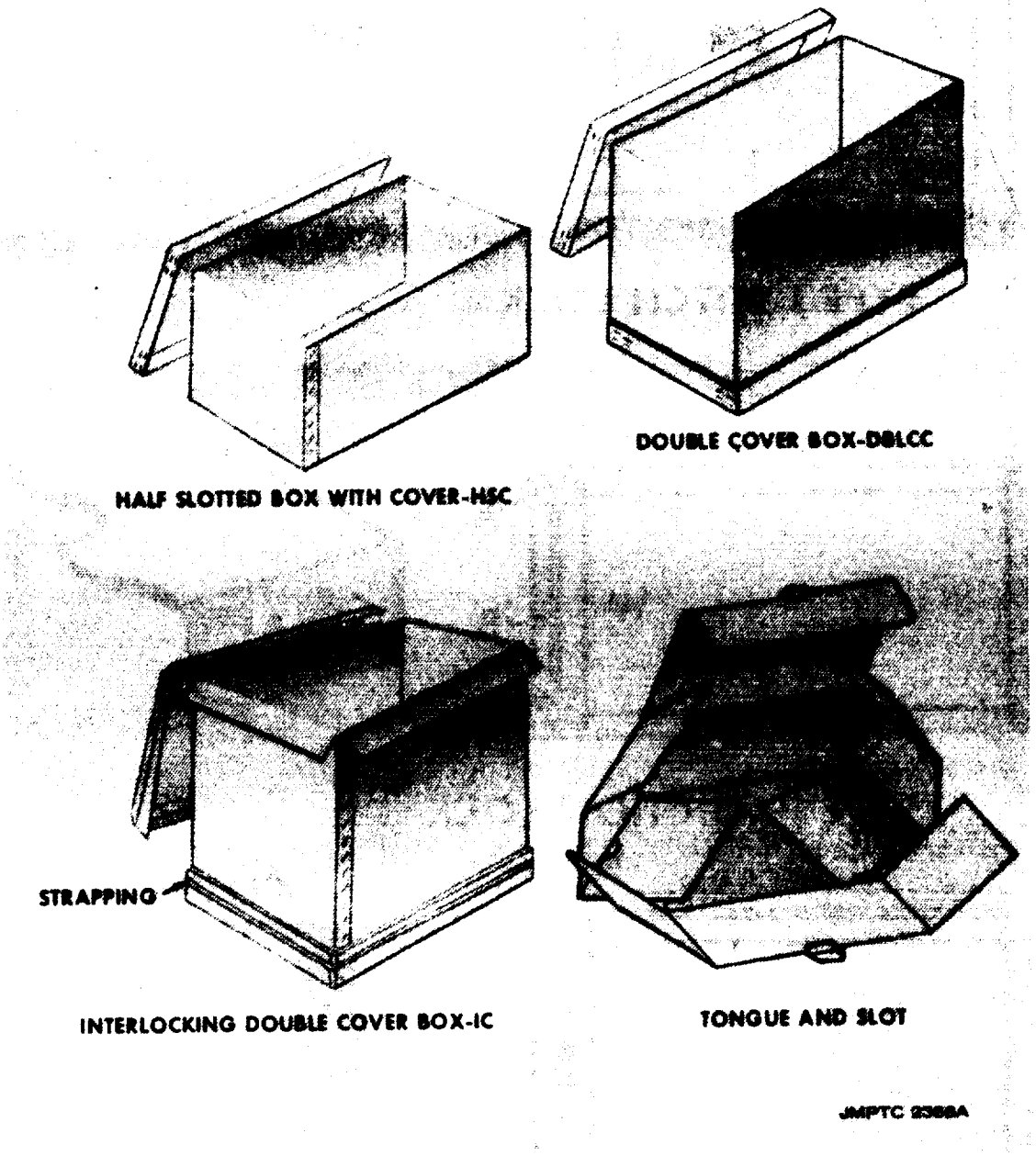
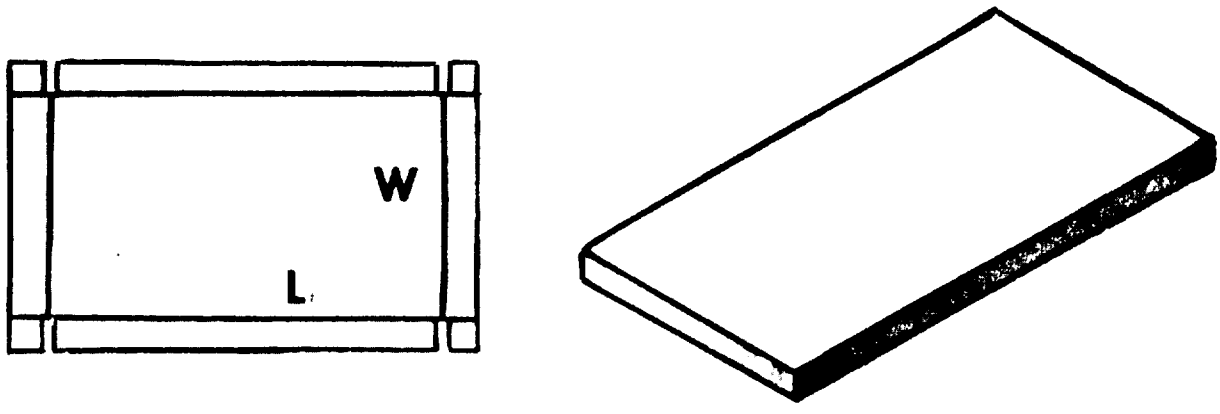


Figure 2-8. Styles of fiberboard boxes.

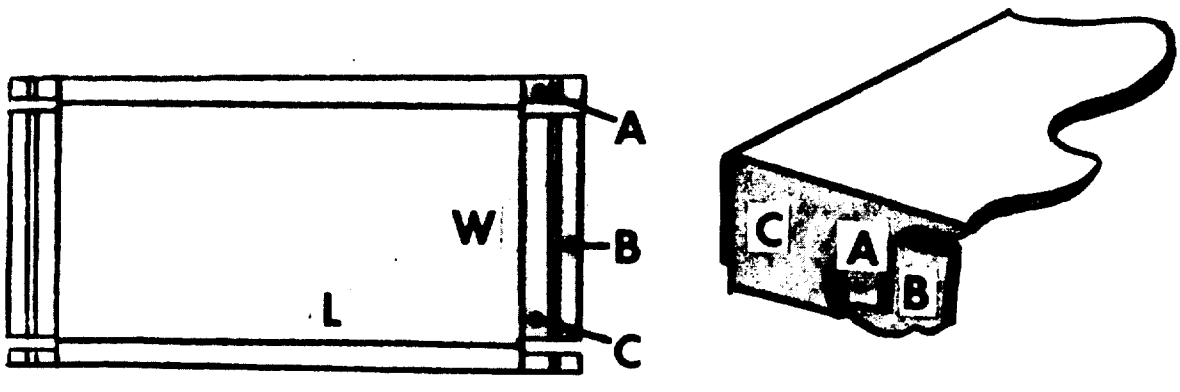
cause the inner flaps to overlap. In such a case, the inner flaps will be cut to meet in the center of the box.

(8) *OPF, one-piece folder.* When this box is closed, the outer flaps must meet. Unless otherwise specified, the inner flaps will 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. This style is also known as a book wrapper.

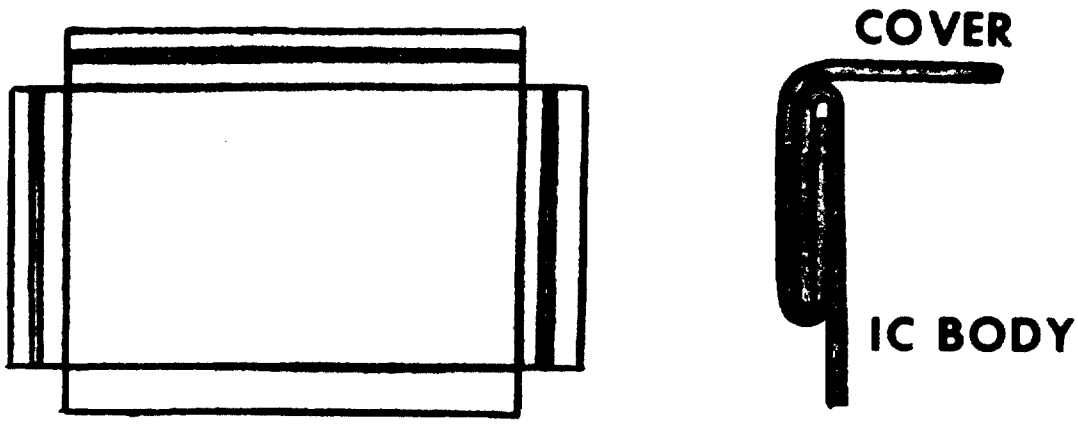
(9) *TS, triple-slide box.* This design, made from corrugated fiberboard only, is identified by the arrangement of corrugations in which all corrugations run at right angles to the score lines in all parts of the box. It consists of three slides, each of one piece of corrugated fiberboard, scored so as to cover



TYPE I STITCH LOCK



TYPE II FRICTION LOCK



TYPE III FLANGE INTERLOCK

JMPTC 2372

Figure 2-9. Cover assemblies.

completely four faces of the box. The joint of the inner slide will be left open. The middle slide will be taped at the body joint and will be a sliding fit on the assembled inner and outer slides. The outer slide will be taped at the body joint and will be a sliding fit on the assembled inner and middle slides.

(10) *FPF, five-panel folder.* This design consists of a single scored slotted sheet. When set up the outer end flaps will fully overlap. This box is used to an advantage in the packing of stacked or nested items which can be arranged on the flat scored sheet and when in position, the box is folded over the contents.

(11) *HSC, half slotted container with cover.* This box consists of a box body and a cover. The body is formed from fiberboard, scored, slotted, and stitched to form a tube having four flaps of equal length, approximately half the width of the box, on the bottom only. Unless otherwise specified the cover shall be a Type I (fig 2-9). When specified the cover shall be Type II. The depth of the cover is three inches unless otherwise specified.

(12) *DBLCC, double cover container.* This box consists of a body tube and two covers. Unless otherwise specified Type I covers, three inches deep, are to be used.

(13) *IC, interlocking double cover container.* This box consists of a body tube with top and bottom flanges and two interlocking covers. The body shall be SW or DW fiberboard, scored, slotted, and stitched to form a tube having double scored short flanges which form a lock with the flanges of the cover (fig 2-9). The top and bottom covers shall be secured with horizontal straps. Unless otherwise specified the flanges shall be three inches wide for boxes made with single-wall fiberboard and four inches wide for boxes made with double-wall fiberboard.

(14) *TSC, tongue and slot closure.* This box is constructed of one piece fiberboard, scored and slotted as shown in figure 2-8.

k. Sleeves. A sleeve may be specified for use with any of the box styles to provide added strength. Sleeves will be made from class weather-resistant fiberboard of the same type and grade as the box. A sleeve will closely fit the box over which it is placed and will cover the top bottom, and both ends. The length of the sleeve (length of the stapled joint) will be the same as the inside width of the box. Unless otherwise specified, the corrugations will be at right angles to the score lines (fig 2-10).

l. Liners (fig 2-11). Liners are made from one piece of fiberboard. They are scored to cover the end and side panels of the boxes. The height of the liners shall be the full inside depth of the boxes for which they are intended and the ends of the liners shall

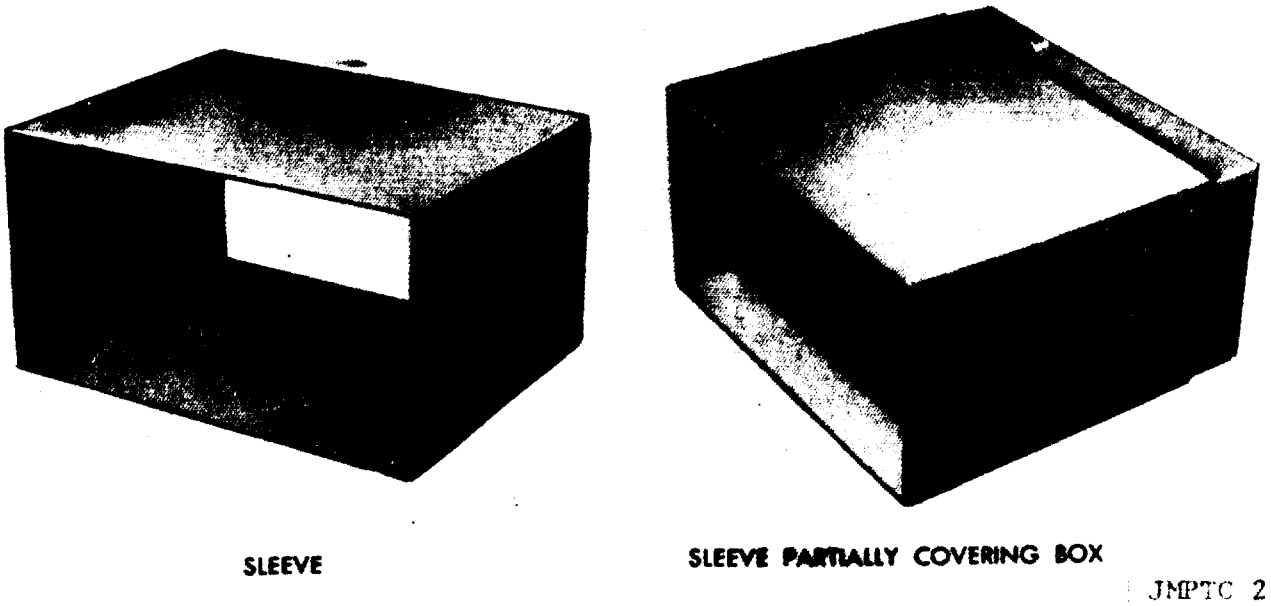


Figure 2-10. Use of a fiberboard sleeve.

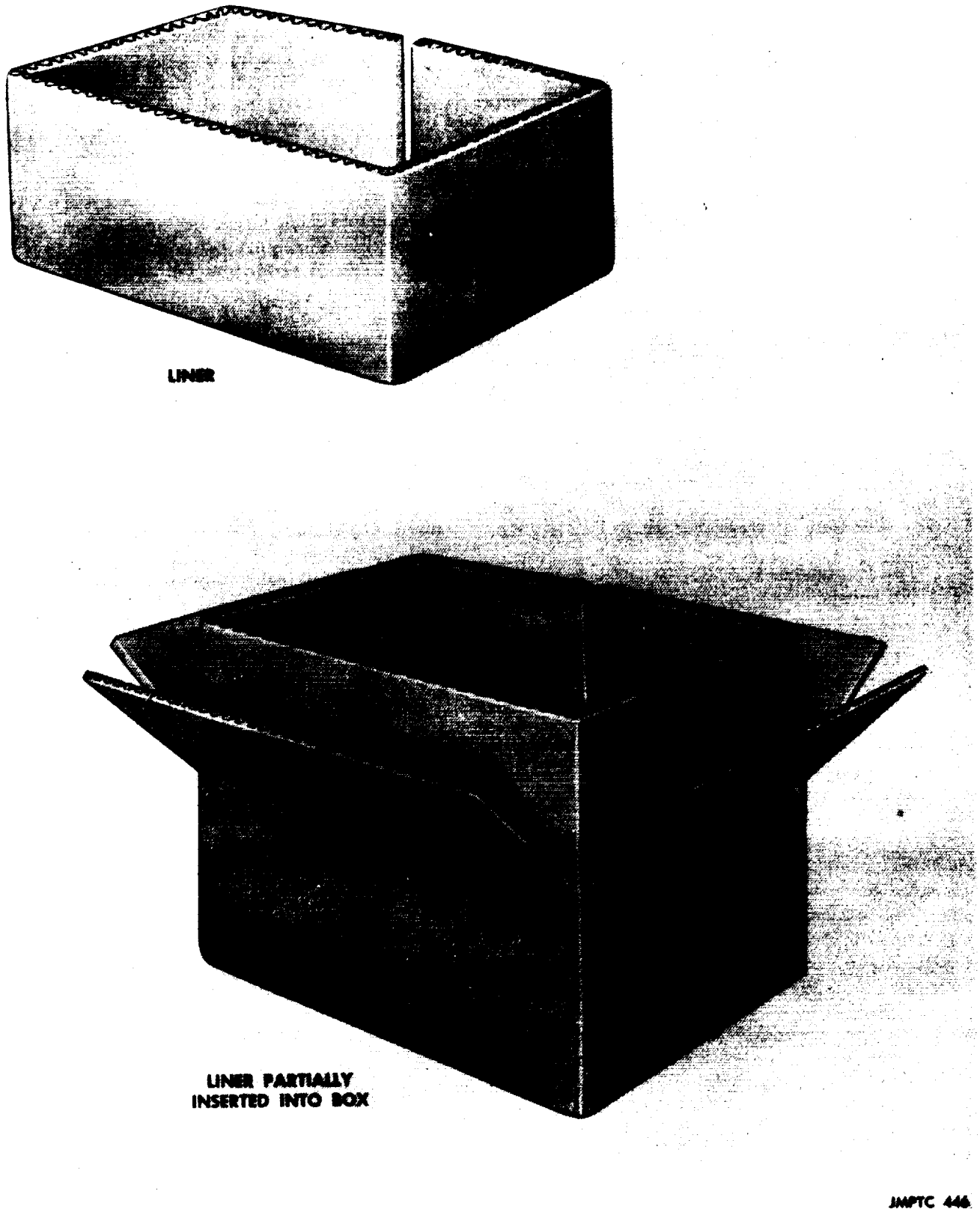


Figure 2-11. Use of a fiberboard liner.

about in the center of the side panels of the boxes.

(1) Unless otherwise specified, liners for class domestic and domestic/fire-retardant boxes shall be constructed for double-wall fiberboard, grade 275. The joints shall be secured with minimum 2-inch wide tape conforming to PPP-T-45, type III. Liners shall be constructed from the same class of material as the boxes themselves.

(2) Unless otherwise specified liners for class weather-resistant boxes shall be constructed of V15c fiberboard. When specified grade W5c, W6c, V3c, or V13c shall be used. Liners fabricated from single-wall fiberboard shall be A or C flute and liners fabricated from double-wall fiberboard shall be any combination of A, B, or C flutes, except BB flutes shall not be used. The flutes shall be perpendicular to the box openings (as shown in fig 2-11). The joints shall be secured with minimum 2-inch wide tape running not less than three quarters the length of the joint.

m. Box Maker's Certificate (see fig 2-12). Each fiberboard box will be plainly marked with the box maker's certificate, signifying compliance with the requirements of the applicable freight classification rules. Type CF and type SF, class domestic and domestic/fire-retardant boxes are not required to be marked as being in compliance with PPP-B-636. However, the words "FIRE RETARDANT" are placed below the box maker's certificate on class domestic/fire-retardant boxes. There is no objection to marking boxes that are manufactured in compliance with the specification. Types CF and SF, class weather-resistant boxes, in addition to the box maker's name, will be marked with the date of manufacture expressed in month and year, such as 7-89; the identification symbol, such as V3s; and the specification compliance data and the minimum average bursting strength guaranteed in excess of . . . PSI. The figure to be inserted should be that corresponding to the dry mullen requirements in PPP-F-320 for the particular grade of fiberboard used.

n. Closure Requirements. All boxes should be securely closed. Inner and outer flaps of slotted style boxes should be drawn together as closely as possible to insure proper closure. The lengthwise flaps should meet (RSC, CSSC, DSC) or overlap (OSC, CSOSC, FOL, SFF), as specified. The flaps should not project over the side or end edges, and the application of adhesive or metal stitches should be such as to prevent lifting of free edges and corners of outer flaps on assembled boxes.

(1) *Class domestic and domestic/fire-retardant boxes.* Unless otherwise specified, these boxes will be securely closed by method I or method II, below. When specified, only method II closure should be utilized. Method II closure is usually only utilized when specified because the containers reusability is affected when boxes are glued.

(*a*) *Method I.* Domestic and domestic/fire-retardant fiberboard boxes should, as a minimum, be closed in conformance with the requirements of Rule 41 of the Uniform Freight Classification and item 222 of the National Motor Freight Classification. When specified, method I closure may be used for boxes to be palletized or unitized for shipment where storage and redistribution is expected through the depot supply system.

(b) Method II. Domestic and domestic/fire-retardant fiberboard boxes are set up by glue or hot melt adhesive in accordance with Rule 41 of the Uniform Freight Classification and item 222 of the National Motor Freight Classification; by stitching or stapling; or by taping in accordance with method 121 of Federal Standard Number 224. The final closure will be accomplished with glue, hot-melt adhesive, or tape.

(2) *Class weather-resistant and WWVR boxes (styles RSC, OSC, FOL, SFF, CSSC, and CSOSC).* All weather-resistant and WWVR (see fig 2-6, 2-7, and 2-8) fiberboard boxes should be closed by one of the follwing methods:

(a) Method III. The top and bottom flaps of slotted boxes should be firmly glued together over not less than 75 percent of the surface area of contact between the flaps (see fig 2-13). The adhesive used should conform with the requirements of MMM-A-250. The bottom flaps may be fastened with metal stitches or staples in lieu of gluing. The number of stitches to be used is based upon the table 2-3. 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 (see fig 2-13). After packing, the other set of flaps (top of the box) is sealed with MMM-A-250 adhesive in the same manner described for this method above.

(b) Method IV, Taping (styles RSC and CSSC) interior containers. These styles, which are to be overpacked for shipment, may, unless otherwise specified, have the top and bottom flaps closed with 2-inch wide tape conforming to Specification PPP—T—76, or PPP-T—60, Type III or IV.

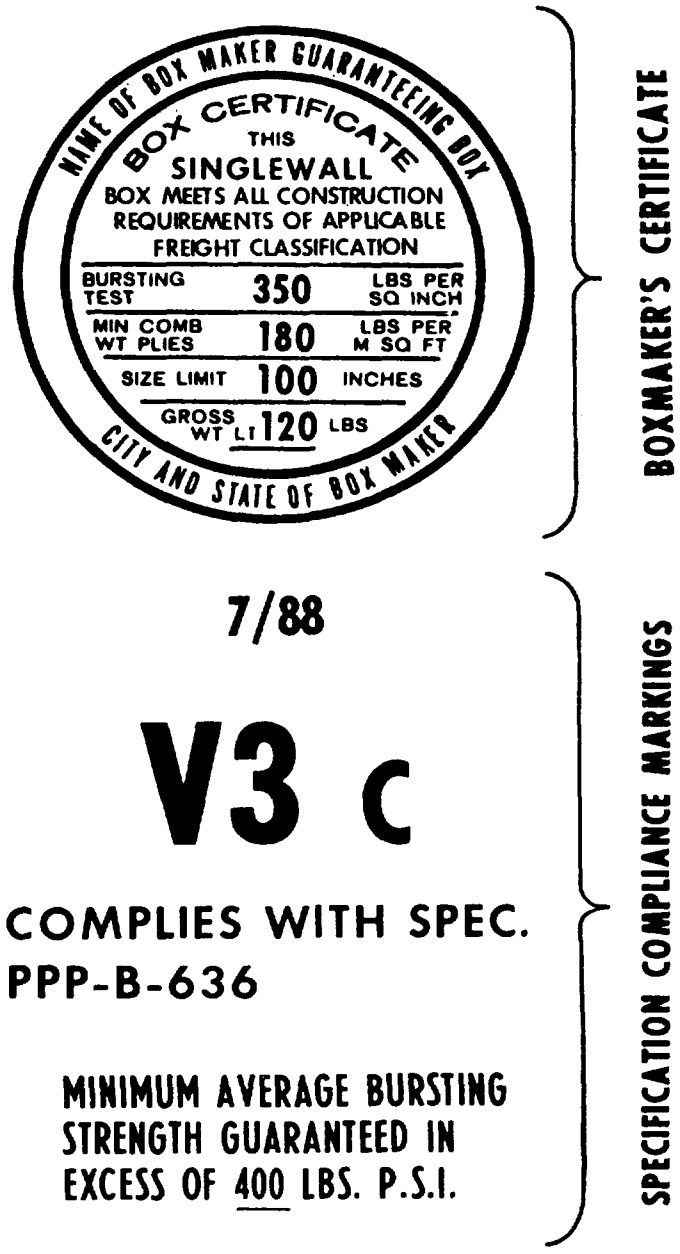


Figure 2-12. Sample of box maker's certificate (circular).

(c) Method V, Taping (styles RSC, CSSC, and CSOSC) as exterior containers. When specified, flaps of these styles of boxes shall be closed with tape applied over all seams, corners, and manufacturer's joint with minimum 2-inch wide tape conforming to Specification PPP—T—76 or PPP-T—60, Type III or IV. The tape shall be centered over the seams and joints and should extend over 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 closing 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 need only cover the joint and need not to be extended over the corners of the box onto the adjacent panels.

(d) Method VI, Hot melt. When specified the flaps shall be closed in accordance with Method II for hot melt (thermoplastic).

Table 2-3. Basic Number of Stitches or Staples for Closing Weather-Resistant Slotted Fiberboard Boxes

Inside width of the box in inches		Basic number of stitches or staples 1-¼ [1]	Basic number of stitches or staples ⅜ thru 1-¼ inches[2]
Up to and including	8	8	12
	10	10	16
	12	12	20
	14	16	24
	16	18	28
	18	20	32
	20	22	36
	22	24	40
	24	28	44
	26	30	48

[1] Staples or stitches hardened to not less than equivalent of Rockwell B90.
[2] Not hardened to equivalent Rockwell B90.

(3) *Class weather-resistant and WWVR boxes (styles FTC, OPF, FPF, TS, and folders).* All exterior full telescope, one-piece, folder, five-panel folder, and triple slide and folding boxes will be closed by taping all seams and joints with a minimum of 2-inch wide tape conforming to Specification PPP-T—60, Type III or IV, or PPP-T—76 (fig 2-14). FTC boxes may be closed by banding as specified in *o*(1) and (2) below.

(4) *Class weather-resistant and WWVR boxes (style IC).* The top and bottom covers of the interlocking flange boxes shall be secured by flat strap-

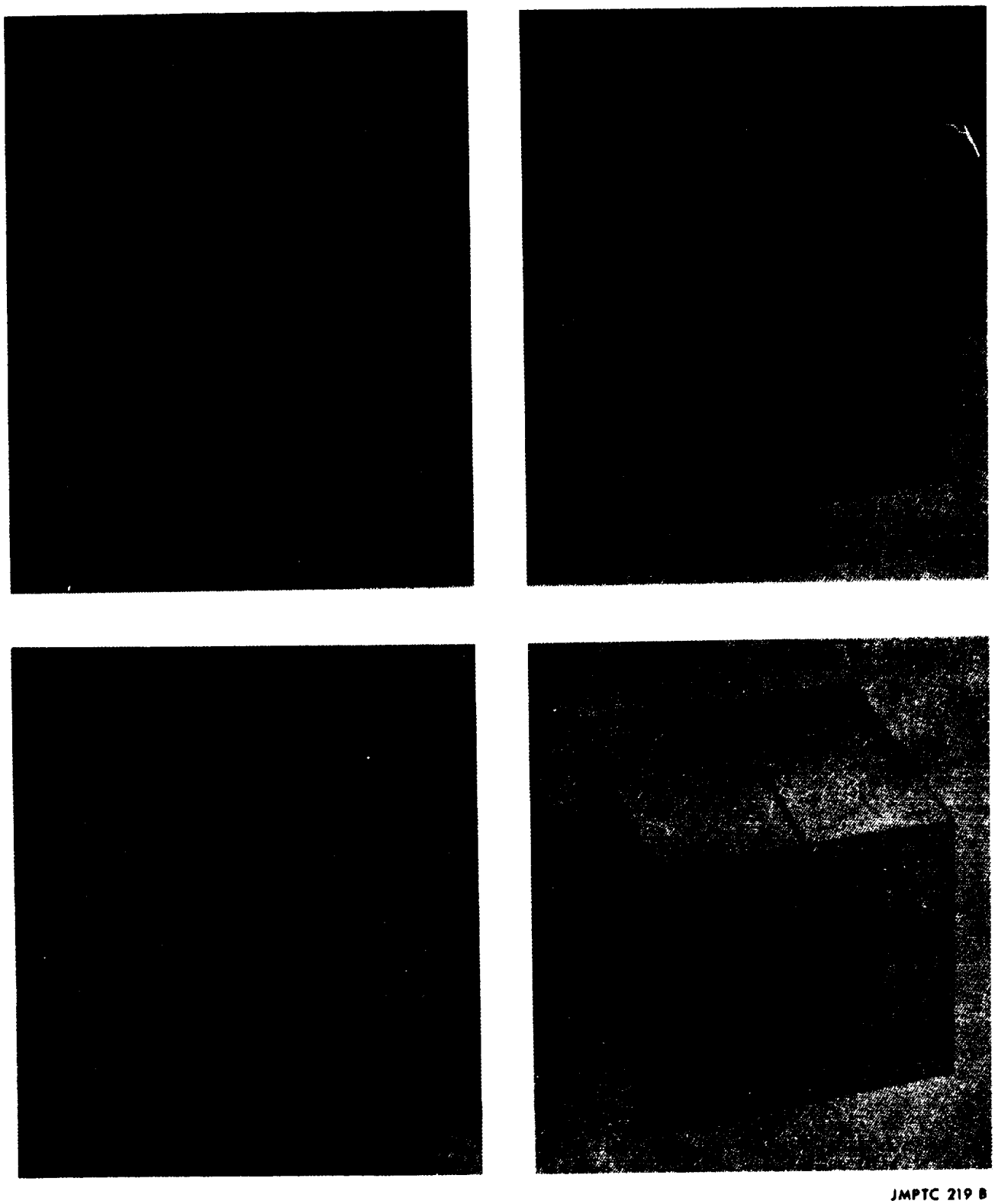


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Figure 2-13. Closure of slotted class weather-resistant fiberboard boxes with adhesive and/or stitches.

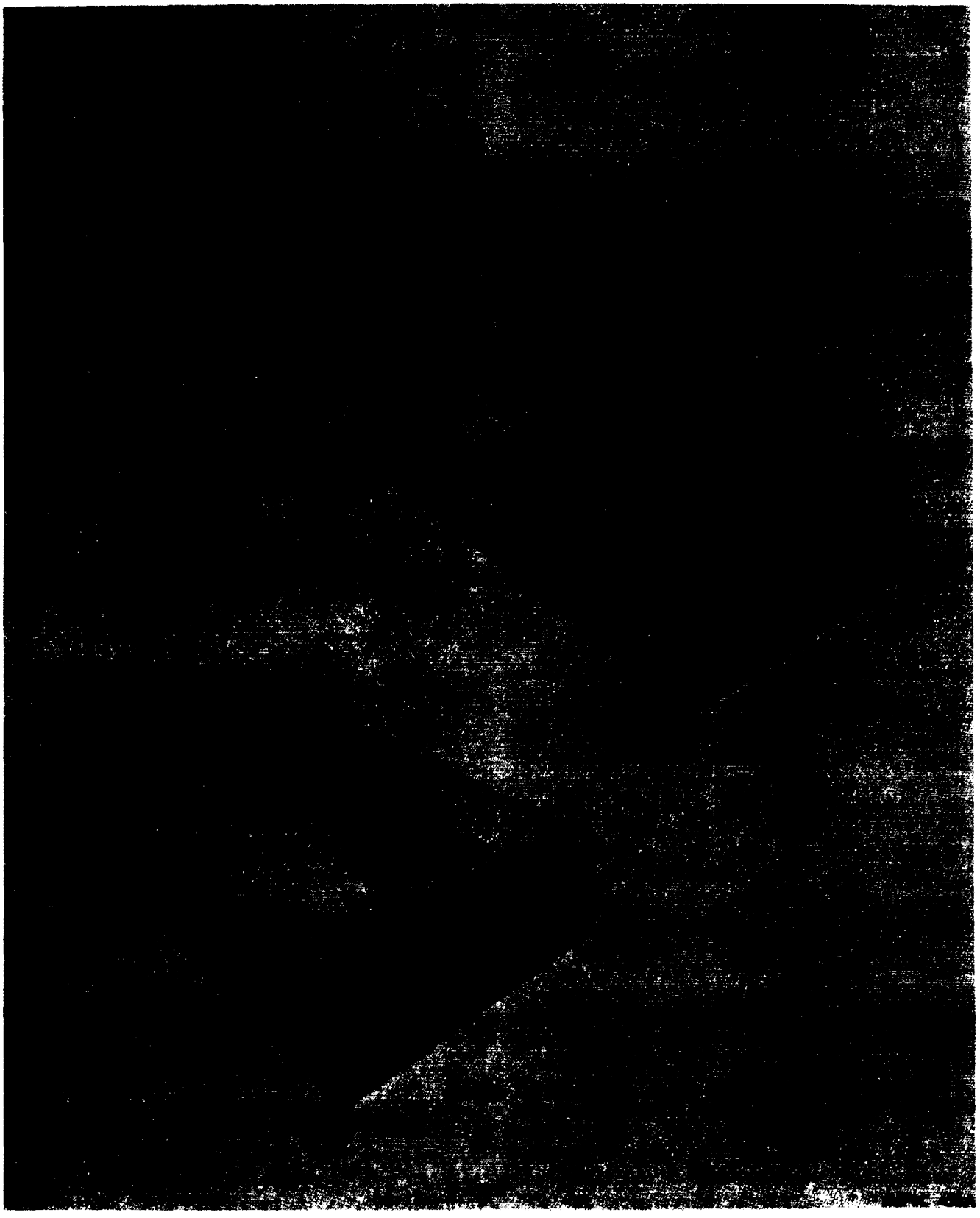


Figure 2-14. Closure of nonslotted class weather-resistant and WWVR fiberboard boxes with tape.

ping shall be not less than three-eighths of an inch by 0.015-inch, class A or B, grade 2, of QQ-S—781 or type II of PPP-S-760. See also ASTM D 3950, ASTM D 3953, and ASTM D 4675 regarding reinforcing materials.

(5) *Class weather-resistant and WWVR boxes (style DBLCC).* The covers may be secured by taping, strapping, or gluing. When adhesive is used, the covers shall be glued firmly to the box bodies. When tape is used, it shall consist of encircling bands of pressure-sensitive adhesive, filament-reinforced tape conforming to type IV if PPP-T—97. The width and number of tape bands to use will conform to the requirements of Federal Standard 224. When metal or nonmetallic banding is used, it shall conform to the requirements of QQ-S—781 to type II or III of PPP-S—760. Three ASTMs have been adopted for use by DOD. They are ASTM C 3950, ASTM D 3953, and ASTM D 4675.

(6) *Class weather-resistant and WWVR boxes (style HSC).* This style shall have the bottoms secured as stated in (3) above. The tops shall be secured by minimum 2-inch wide tape conforming to PPP-T-60, type III or IV or PPP-T—76.

o. Reinforcing (Metal, nonmetallic, or tape banding) of Fiberboard Boxes (see fig. 2-15). It is appropriate to use ASTMs for reinforcing materials whenever QQ-S—781 and PPP-S—760 are listed.

(1) *Class domestic and domestic/fire-retardant boxes.* Unless specifically stated on the order or in the commodity specification, class domestic and domestic/fire-retardant boxes will not be reinforced by the use of banding. When reinforcing is required, metal banding conforming to QQ-S—781, or nonmetallic strapping conforming to type I, II or III of PPP-S—760, or type II, class B, of PPP-T—97 tape may be used. The size and number of strapping required shall be in accordance with the appropriate tables. (See tables 2-4 through 2-8.) Buckles shall not be used with nonmetallic strapping. The width and application of tape shall be in accordance with the requirements of the appropriate table and box style method of Federal Standard No. 224 (see fig 2-16).

(2) *Class weather-resistant and WWVR boxes.* Class weather resistant boxes shall be reinforced by encircling bands of steel strapping conforming to QQ-S—781 nonmetallic strapping conforming to type II or III of PPP-SA—760; or pressure-sensitive adhesive, filament-reinforced tape conforming to type IV of PPP-T—97, except when tape is used for perishable subsistence, type I, II, III or IV of PPP-T—97 may be used. The size of metal and nonmetallic strapping to be used is shown in table 2-4 for type, grade, and class required. The location, number, and application metal and nonmetallic strapping is shown in tables 2-5 and 2-8. Buckles shall not be used on nonmetallic strapping. When tape is used to reinforce the box, it is applied in complete bands and the width shall be in accordance with table 2-9. Banding, including tape, shall not cover or obliterate markings on the shipping container. Unless otherwise specified shipping containers closed as specified in Method V (taping) must be reinforced by banding with tape or nometallic strapping.

(3) *Application of reinforcement.* When only one band is required on a box in given direction, it shall be centered except in the case of lengthwise bands on styles RSC and CSSC boxes. On these styles the lengthwise band shall be offset slightly from the seam formed by the top and bottom flaps in the closed position. When two or more bands are used around the box in the same direction, they shall divide the box into units of equal length. Cross banded boxes shall have the longer band applied first. Boxes carrying loads having restricted points of contact shall be banded, wherever practicable, over these points of contact. Bands shall be applied straight and shall be sufficiently tensioned. Metal bands shall be embedded into the edges of the box, but shall not cut or tear the fiberboard or crush the contents. When a sleeve is specified the bands shall be applied after the sleeve is placed on the box.

NOTE

Reinforcement may be omitted from class weather-resistant boxes containing nonperishable subsistence items and clothing which are to be palletized or containerized. An exception to this is nonperishable subsistence materiel consigned to the Naval Supply Center at Norfolk and Oakland for subsequent transfer at sea.

p. Reuse and Conservation of Fiberboard Boxes. It is important that attention be given to the reuse and conservation of fiberboard boxes. This must be looked upon from an economical standpoint. If care is used in opening incoming fiberboard boxes, some of them may be reused as interior intermediate containers, but never as exterior shipping containers, with the exception of good V-board boxes. The condition of the box is a big factor in its reuse. No box that has been cut, torn, pierced, or damaged by water or moisture should be reused. If used, V-board boxes are included in this category, they may be reused for domestic shipments. Used boxes shall have all old markings pertaining to

previous shipments obliterated before reuse as interior or exterior containers. If the whole boxes cannot be reused, consideration should be given to the use of clean, sound fiberboard as material for one of the following applications:

(1) Fabrication of blocks and braces to prevent

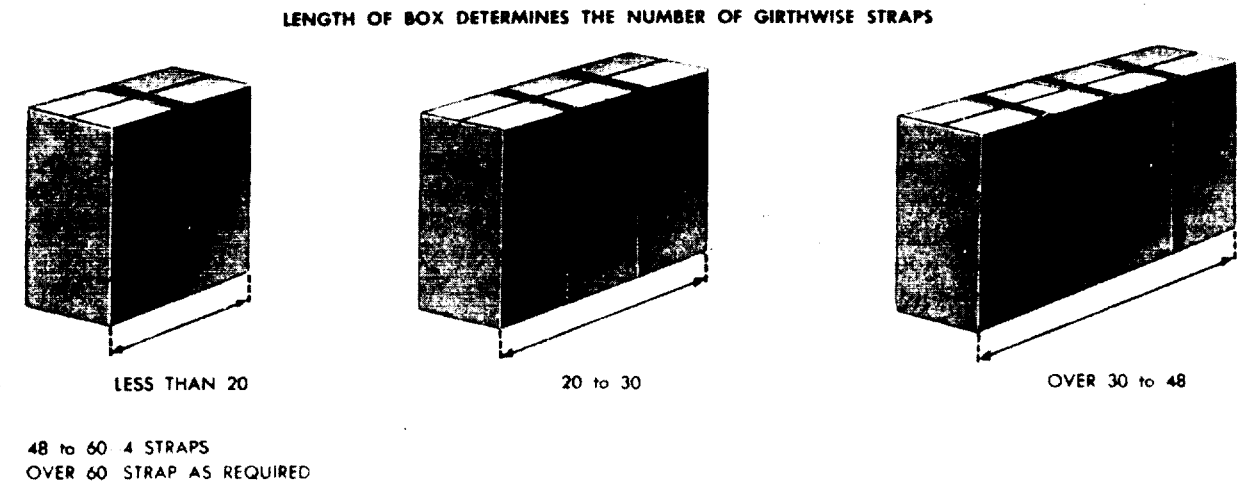


Figure 2-15. Strapping of fiberboard boxes.

MINIMUM NUMBER OF TAPE STRIPS WHICH MUST CROSS A SEAM OR SCORELINE

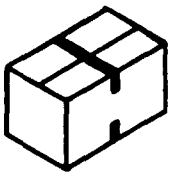
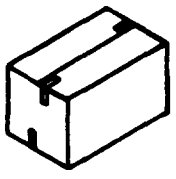
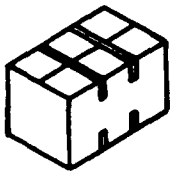
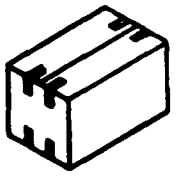
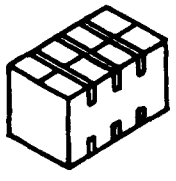
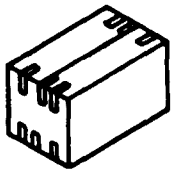
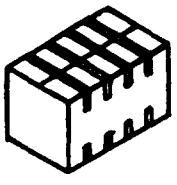
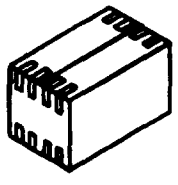
LENGTH OF SEAM OR SCORELINE (INCHES)	NO. OF STRIPS	LENGTH	WIDTH
UP TO 15 INCLUSIVE	1		
OVER 15 TO 30 INCLUSIVE	2		
OVER 30 TO 60 INCLUSIVE	3		
OVER 60	4		

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Figure 2-16. Tape Reinforcing of fiberboard boxes.

Table 2-4. Metallic and Nonmetallic Strapping Requirements

Gross weight of container and contents	QQ-S-781, size of flat-steel strapping			PPP-S-760 size of nonmetallic strap		QQ-S-781 size (gage) of round steel strap	
(Pounds)	Type I	Type III	Type IV	Type II	Type III	Class A	Class B
Up to 35, incl.	¼ x 0.015 5/16 x 0.012 ⅜ x 0.010	0.138 x 0.025 0.063 x 0.024 1/	¼ x 0.015	⅜ x 0.015 ⅜ x 0.018 or ¼ x 0.025 or 0.027	7/16 x 0.017 or ½ x 0.015	16-½	16-½
Over 35 to 70, incl.	⅜ x 0.015 2/	0.138 x 0.025	⅜ x 0.015 2/	⅜ x 0.015 ⅜ x 0.024 or ¼ x 0.025 or 0.027 or 7/16 x 0.025	7/16 x 0.017 or ½ x 0.015	16	15
Over 70 to 110, incl.	⅜ x 0.020 ½ x 0.015		⅜ x 0.020 ½ x 0.015	½ x 0.015 ⅜ x 0.020 7/16 x 0.025 or ½ x 0.022	½ x 0.015 7/16 x 0.017	14	13
Over 110 to 225 incl.	½ x 0.020		½ x 0.020 or ⅝ x 0.015	½ x 0.020 ⅝ x 0.015 or 7/16 x 0.025 or ½ x 0.022	7/16 x 0.023 or ½ x 0.020	13	

1/ 0.063 x 0.024 inch strapping shall be allowed only for V2s sleeve boxes and shall conform to QQ-S-781 except that it shall have a tensile strength of 135,000 psi, a breaking strength of 205 lbs, and a joint strength of not less than 170 lbs.

2/ ¼ x 0.015 inch strapping may be used for type I loads and FTC boxes of frozen foods.

Table 2-5. Required Number of Reinforcing Bands

Direction of bands[1]					
Lengthwise		Girthwise		Horizontal[2]	
Outside width of box	Number of bands (min.)[3]	Outside length of box	Number of bands (min.)[3]	Outside depth of box	Number of bands (min.)[3]
Inches		*Inches*		*Inches*	
Up to 9	None	Up to 20	1	Up to 18	None
Over 9 to 18	1	20 to 30, incl.	2	18 to 30, incl.	1
Over 18 to 30	2	Over 30 to 48	3	Over 30 to 48	2
Over 30 to 48	3	Over 48 to 60	4		
Over 48		Over 60[4]		Over 48[4]	

[1] Lengthwise—Encircling top, bottom, and ends. Girthwise—Encircling top, bottom, and sides. Horizontal—Encircling sides and ends.
Note that the location of the openings determines the designation of the panels, rather than normal storage position.

[2] Horizontal bands are only occasionally required. Where contents exert severe pressure on vertical score lines, they should be used.

[3] Full telescope-style boxes, having corners not otherwise sealed to bodies, will usually require use of one or more additinal bands, both lengthwise and girthwise when dimensions approach the upper range of the size brackets listed in above table. Additional bands, when required, will be specified by the procuring agency.

[4] As directed by the procuring agency.

Table 2-6. Metal Straps Required for DBLCC, IC or HSC Boxes

Box length (inches)	Number of straps		
	Box width		
	0 inches to 18 inches	18 inches to 30 inches[1]	30 inches to 48 inches[2]
0 to 20	2	3	4
Over 20 to 38	3	4	5
Over 38 to 56	4	5	6
Over 56 to 72	5	6	7
Over 72	6	7	8

[1] One centered lengthwise strap required.

[2] Two equally spaced lengthwise straps required.

Table 2-7. Required Number of Reinforcing Bands for Slotted and FTC Boxes

Direction of bands [1]					
Lengthwise	Girthwise			Horizontal [2]	
Outside width of box	Number of bands (min.) [3]	Outside length of box	Number of bands (min.) [3]	Outside depth of box	Number of bands (min.) [3]
Inches		Inches		Inches	
Up to 9	None	Up to 20	1 [3]	Up to 18	None
Over 9 to 18	1 [3]	20 to 30, incl.	2 [3]	18 to 30, incl.	1
Over 18 to 30	2 [3]	Over 30 to 48	3 [3]	Over 30 to 48	2
Over 30 to 48	3	Over 48 to 60	4		
Over 48 [4]		Over 60 [4]		Over 48 [4]	

[1] Lengthwise—Encircling top, bottom, and ends. Girthwise—Encircling top, bottom, and sides. Horizontal—Encircling sides and ends. See figures for designation of top bottom, side, and faces. Note that the location of the openings determines the designation of the panels, rather than normal storage position.
[2] Horizontal bands are only occasionally required. Where contents exert severe pressure on vertical score lines, they should be used.
[3] Full telescope-style boxes, having covers not otherwise sealed to bodies, will usually require use of one or more additional bands, both lengthwise and girthwise when dimensions approach the upper range of the size brackets listed in above table. Additional bands, when required, will be specified by the procuring agency.
[4] As directed by the procuring agency.

Table 2-8. Size of Nonmetallic Banding (Minimum)

Gross weight of box and contents	PPP-S-760, Type I, grade A [1]	
Pounds	Size in inches	Number and position of bands
0 to 70	¼	1 girthwise (centered)
Over 70 to 110	⅜	2 girthwise [2]
Over 110 through 225	½	2 girthwise [2]

[1] Type II or III nonmetallic strapping of PPP-S-760 of equivalent strength may be substituted for the type I, grade A.
[2] Bands shall divide box into units of equal length.

Table 2-9. Tape Banding Requirements for Weather Resistant Boxes

Gross weight of container and contents	Number of bands and sizes in inches							
Pounds	1	2	3	4	5	6	7	8
Up to 35 inclusive	½	½	½	½	½	½	½	½
Over 35 up to 70 inclusive	¾	½	½	½	½	½	½	½
Over 70 up to 100 inclusive	1	¾	¾	½	½	½	½	½
Over 110 up to 140 inclusive	1	1	¾	½	½	½	½	½
Over 140 up to 180 inclusive		1	1	¾	½	½	½	½
Over 180 up to 220 inclusive			1	1	¾	¾	½	½
Over 220				1	1	1	¾	¾

movement of the item within the container, contact of items among themselves (when more than one is packed in a shipping container), or contact of an item with the faces of the container.

(2) Fabrication of die-cuts, cells, trays, pads, etc., for cushioning purposes.

2-2. Triple Wall Corrugated Fiberboard Boxes (PPP-B—640)

a. Description and Characteristics. A triple-wall corrugated fiberboard box is a container made of triple-wall corrugated fiberboard in accordance with Specification PPP-B—640. Triple-wall corrugated fiberboard consists of three corrugated sheets laminated to four flat facings (fig 2-3) resulting in a thick, relatively sturdy structural material. Boxes made of this material have the following characteristics:

(1) They are especially suited for difficult, heavy loads that require exceptionally large containers.

(2) They are extremely resistant to sudden forces such as those encountered when the box is dropped.

(3) They have a high resistance to compression and can sustain heavy loads for long periods of time.

(4) They are lighter in weight and smaller in cube than wooden containers made for the same items.

(5) They have certain inherent cushioning characteristics due to the corrugated stock from which they are made.

(6) The fire-retardant requirements of class 3 boxes are intended to reduce losses due to fire destruction.

b. Classes and Styles. Triple-wall, corrugated fiberboard boxes are furnished in the following classes, styles, and types of ends:

(1) Class 1—Nonweather resistant.

(2) Class 2—Weather resistant.

(3) Class 3—Nonweather resistant/fire-retardant.

(3.1) Interim amendment—6 (SA), developed by the Navy for procurement in an effort to reduce combustible packaging materials aboard Navy ships, adds class 4, weather resistant/fire-retardant, to PPP-B—640.

(4) *Style A*--One-piece fiberboard, five-panel, with one of four types of ends (*c* below), with ends inserted in box body (see fig 2-17).

(5) *Style B*—One-piece fiberboard, five-panel, with one of four types of ends (*c* below), with ends inserted in box body overlapped on the box ends (see fig 2-17).

(6) *Style C*—Two-piece fiberboard, three-panel, with one of four types of ends (*c* below), and with ends inserted in box body overlapped on the box ends (see fig 2-17).

(7) *Style D*—Two-piece fiberboard, three-panel, with one of four types of ends (*c* below), and with ends inserted with outside edges of the box body overlapped on box ends (see fig 2-18).

(8) *Style E*—A regular slotted fiberboard box (para 2-1j), conforming to style RSC of PPP-B—636. The body (manufacturers') joint should be 2 inches wide, crushed, and stapled on a slant not more than 1 inch apart (see fig 2-18). The corrugations of that portion of the side panel in which the body joints overlap shall also be crushed. Style E boxes may also be made with a 1½-inch crushed overlap on the top and bottom panel of the box. This is called an alternate style E box.

(9) *Style F*—A full telescopic fiberboard box (para 2-1j), consisting of a body and a cover each of one-piece slotted and scored triple-wall fiberboard. The inside depth of the cover shall be the overall depth of the body (see fig 2-18).

(10) *Style G*—Half regular sloted box with short top flaps and cover. Style G box is similar to style F, except that all the top flaps are 4 inches long and are crushed-rolled 1½ inches at the edges. A cover, at least 6 inches deep, forms the top of the container. The cover may be constructed so that the end and side flanges form a butt joint at each of the four corners (see fig 2-19), or it may be made with end or side flaps which are stapled to the adjacent flange of the top.

c. Wood Ends. There are four types of wood or wood-cleated panel ends that can be used of styles A, B, C, and D triple-wall, corrugated fiberboard boxes. The wood used to fabricate the ends must conform to wood groups I and II as set forth in PPP-B—621 and MIL-STD—731. The ends are of the following designs (see fig 2-20).

(1) *Number 1 end*—A single piece of nominal 2-inch lumber.

(2) *Number 2 end*—Two thicknesses of nominal 1-inch lumber with the grain direction at right angles, the two thicknesses securely joined by clinched nails, and no piece less than 2½ inches in width.

(3) *Number 3 end*—Nominal 1-inch material with a nominal 1-inch thick cleat minimum width of 2¼ inches, securely joined by clinched nailing.

(4) *Number 4 end*—Cleated panel ends consisting of two sets of overlapped cleats with a panel of triple-wall corrugated fiberboard. The cleats shall be nominal 1 inch thick, 2¼ inches wide, and shall be assembled with clinched nailing. The fiberboard shall be fastened to the inside of the cleats with either nails or staples.

d. Limitations. Maximum weight and size limitations for triple-wall corrugated fiberboard boxes are not given in PPP-B—640. When triple-wall, corrugated fiberboard boxes are to be used for commodities covered in Rule 41 of the Uniform Freight Classification and item 222 of the National Motor Freight Classification, the sum of the inside length, width, and depth shall not exceed 120 inches. Containers exceeding these limitations must be made under a special package permit.

e. Sealing. When sealing against the entry of water or dust is required, all seams and joints of the boxes shall be covered with minimum 2-inch tape conforming to PPP-T—76. Closure of slotted boxes is frequently done prior to sealing.

f. Closure. The kinds of closure for triple-wall, corrugated fliberboard boxes will depend on the style of box to be used, and may be made by means of nails, staples, steep straps, filament-reinforced tape, or a combination of these materials. When nails are used for closure or for fastening blocking and bracing members to the interior

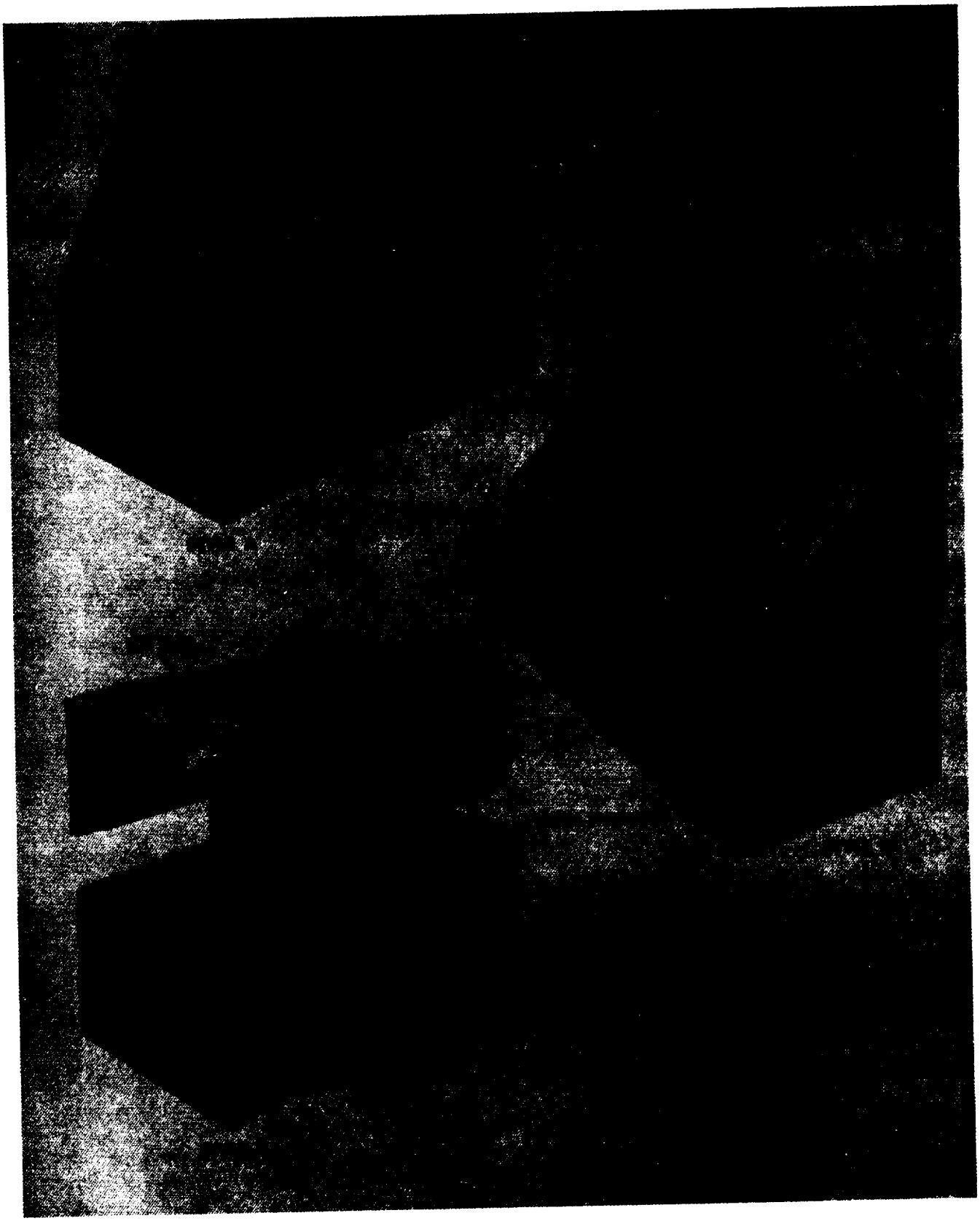


Figure 2-17. Styles A, B, and C, triple-wall corrugated fiberboard boxes.

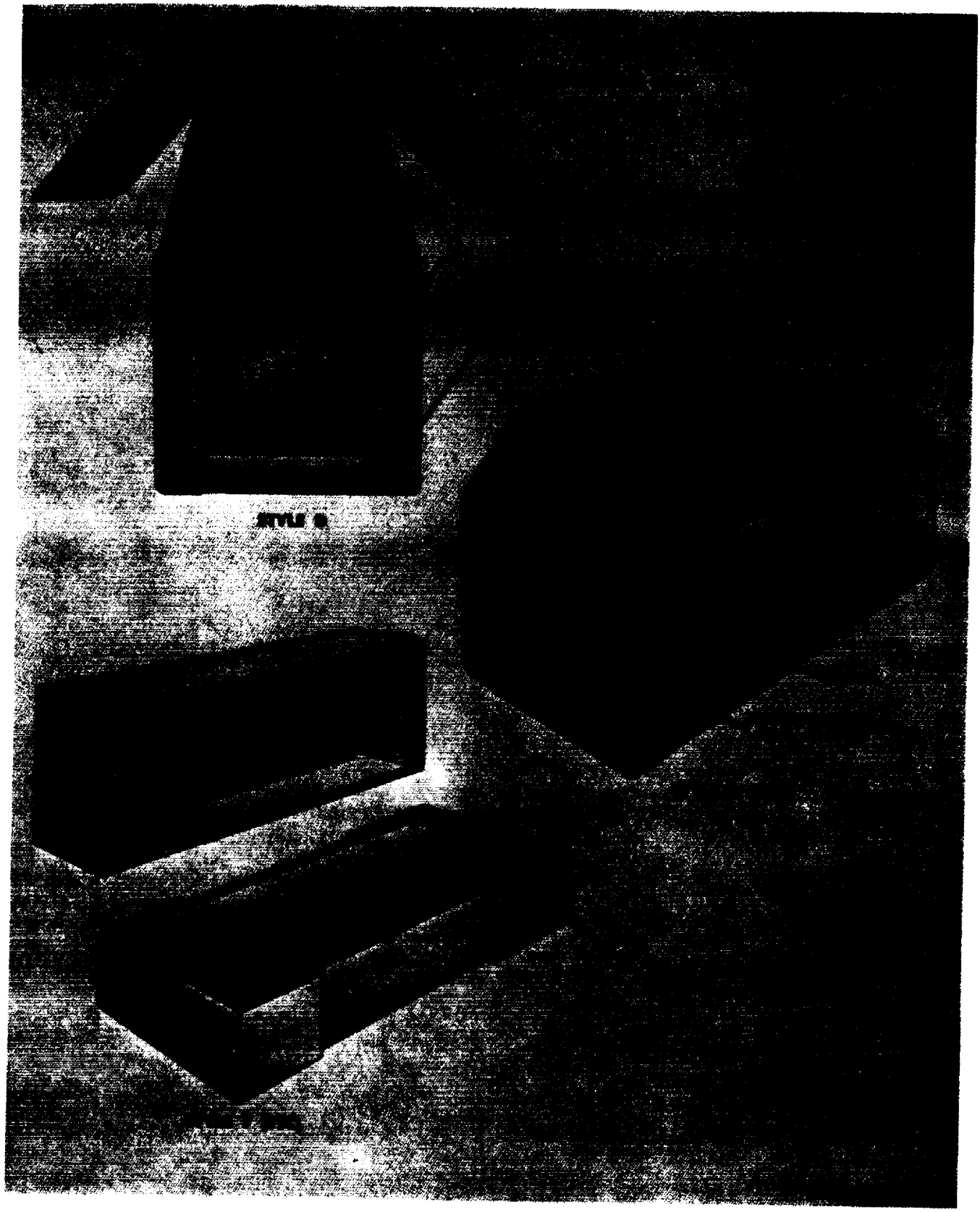


Figure 2-18. Styles D, E, and F, triple-wall corrugated boxes.

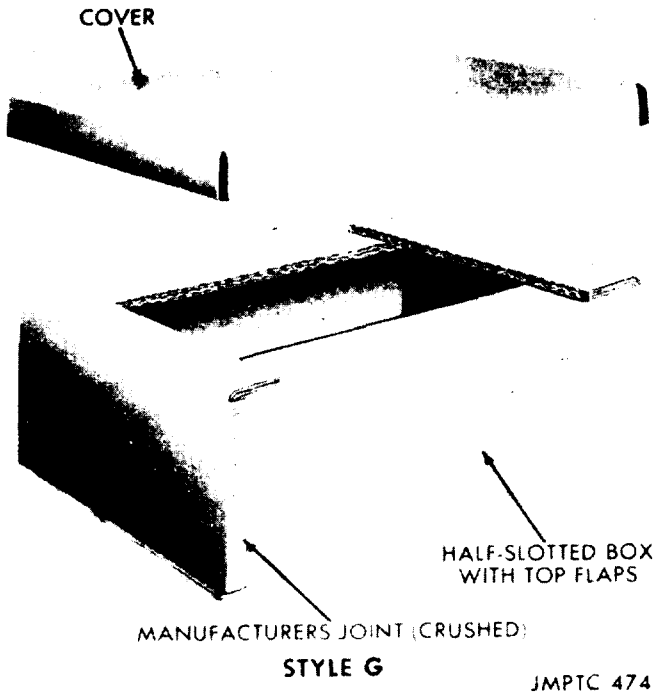


Figure 2-19. Style G, triple-wall corrugated fiberboard box.

of the boxes, it is recommended that each nail should pass through an oversize washer, piece of banding, or clips designed to prevent pulling of the nail heads through the triple-wall material. Whenever QQ-S—781 and PPP-S—760 are specified for reinforcing materials, DOD personnel may use instead ASTM D 3950, ASTM D 3953, or ASTM D 4675.

(1) *Closure of style A boxes.* This style may be closed with zinc-coated, steel roofing nails not less than 1¼ inches long; with power driven, double pointed zinc-coated or copper-washed staples, with divergent points and minimum dimensions of 14-gauge wire, ¾-inch crown, and 1¼-inch legs; with flat, Type I, Class A or B, ⅝-inch wide and 0.018-inch thick steel straps conforming to Specification QQ-S—781; with round strapping conforming to Specification QQ-S—781 or with nonmetal strapping in accordance with Specification PPP-S—760, Type I or II (when Type I is used it shall be Grade B) with a nominal width of ⅝ inch; or with pressure-sensitive, filament-reinforced tape meeting the requirements of Specification PPP-T—97, Type III, ½-inch wide, except for Styles E and F, which shall be 1 inch wide. On weather-resistant boxes, the PPP-T—97 tape shall be Type IV, ¾-inch wide, except for Styles E and F, which shall be 1 inch wide.

(a) Using nails for closure of style A boxes. When nails or staples are used, they shall be spaced not more than 2 inches apart and staggered as permitted by the thickness of the ends of the box. The nails or staples shall extend through each thickness of fiberboard and into the wood ends. If the box is 24 inches long, a strip of filament-reinforced tape shall be placed at the center of the outside top flap so as to extend onto the top flap 5 inches and onto the side panel 5 inches. For length greater than 24 inches, one such strip will be added for each additional 18-inch increment of length greater than 24 inches. The total number of strips will be spaced evenly (fig 2-21).

(b) Using straps for closure of style A boxes. When steel or nonmetal straps are used, one band will be placed at each end of the box to encircle the top, sides, and bottom of the box. The straps will be placed not more than 3 inches in from the ends to bear evenly on the wood ends. If the box is 24 inches long, a strap will be added at the center. Filament-reinforced tape may be used in lieu of this additional strap. For lengths greater than 24 inches, one such strap will be added for each additional 18 inches of length and placed so that they are evenly spaced (fig 2-21).

(c) Using tape for closure of style A boxes. When filament-reinforced tape is used, a 10-inch strip will be placed 2 inches in from each end of the box. For boxes 24 inches long and over, additional strip requirements are the same as for steel strapping. All the tape strips will be applied perpendicular to the joint formed by the top flap and the side wall of the box. They will be centered over

the joint and extend 5 inches onto the top flap and 5 inches on the side wall (fig 2-21).

(2) *Closure of style B boxes.* Style B boxes may be closed with nails or staples in the same manner as Style A boxes; but, in addition, a staggered row of nails or staples, spaced not more than 2 inches apart, must be driven through the overlap portion of the top flap into the face of the wood ends. When using steep straps or filament-reinforced tape for closure, the same requirements as given for Style A boxes also apply to Style B (fig 2-21).

(3) *Closure of style C boxes.* This style of box will be closed along the top and sides by means of nails, staples, or steel straps as specified for Style A boxes, except when using nails or staples they will be spaced nor more than 2 inches apart and staggered and driven through the top one-half of the box into the wooden ends along the two end edges of each side panel and both end edges of the top panel (fig 2-22).

(4) *Closure of style D boxes.* This style of box shall be closed along the top and sides by means of nails, staples, or steel straps as specified for Style A. In addition, a staggered row of nails or staples shall be driven through the overlapping top flaps into the face of the wooden ends. For boxes 24 inches long and longer, strips of tape will be applied as for style A box (fig 2-22).

(5) *Closure of style E boxes.* Style E boxes may be closed by the use of staples, steel or nonmetallic strapping, or with tape.

(a) Closure with staples. Staples will not be used for boxes fabricated with class weather-resistant fiberboard. Staples are placed not more than 1½ inches, or less than 1 inch, from the free edge of the flap. Spacing around the edge of each flap is not more than 5 inches, center-to-center of the staples. Additional staples are so spaced within the boundaries outlined by the edge staples so that no area will have a diameter greater than 4 inches without a staple, with a minimum number of eight staples in each flap. Staples are flat wire, 0.050 inch thick, 0.085 inch wide, with a 1¼-inch crown (fig 2-23).

(b) Closure with metal or nonmetallic strapping. The requirements for closure with strapping is the same as for style A boxes, except that a lengthwise strap may be applied to hold the girthwise strap flat (fig 2-24).

(c) Closure with tape. A 12-inch strip is applied to each end of the two top and bottom flaps so that 6 inches of each strip is attached to the flap and 6 inches of each strip is attached to the end panel. The strips are located adjacent to the inner length edge of the flaps, approximately 2 inches from this edge. The use of additional strips will be as specified for style A boxes.

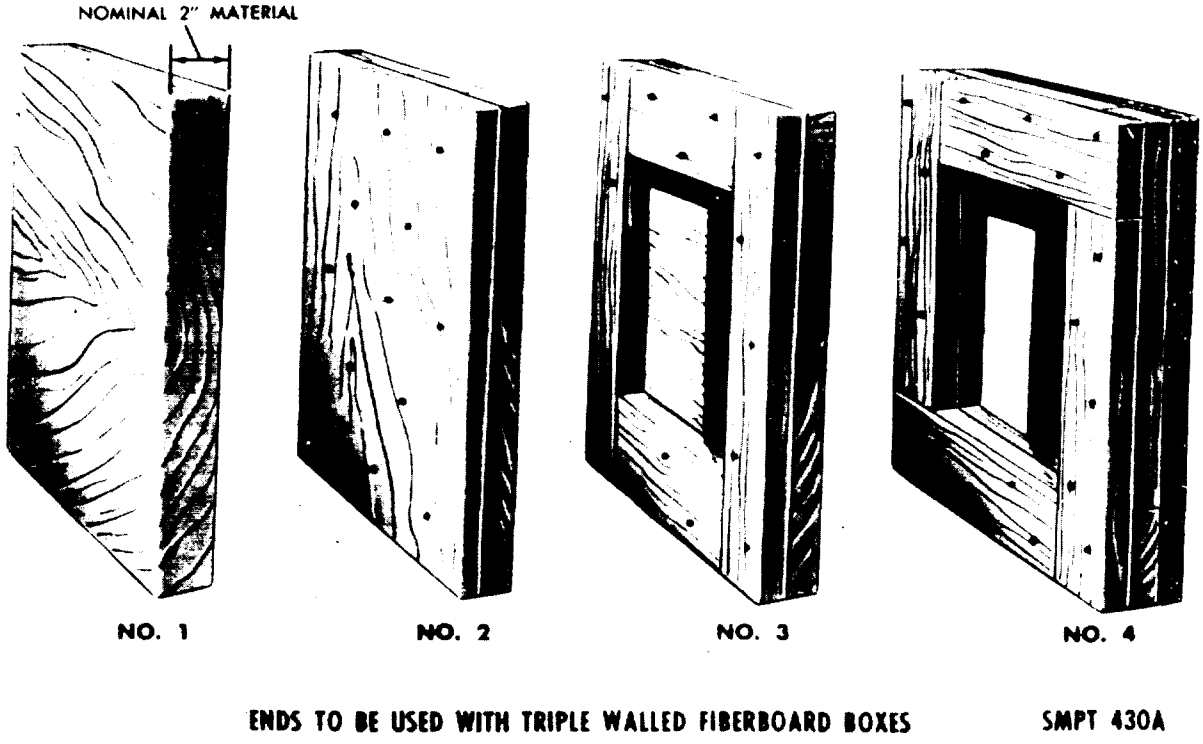


Figure 2-20. Types of ends for styles A through D, triple-wall corrugated fiberboard boxes.

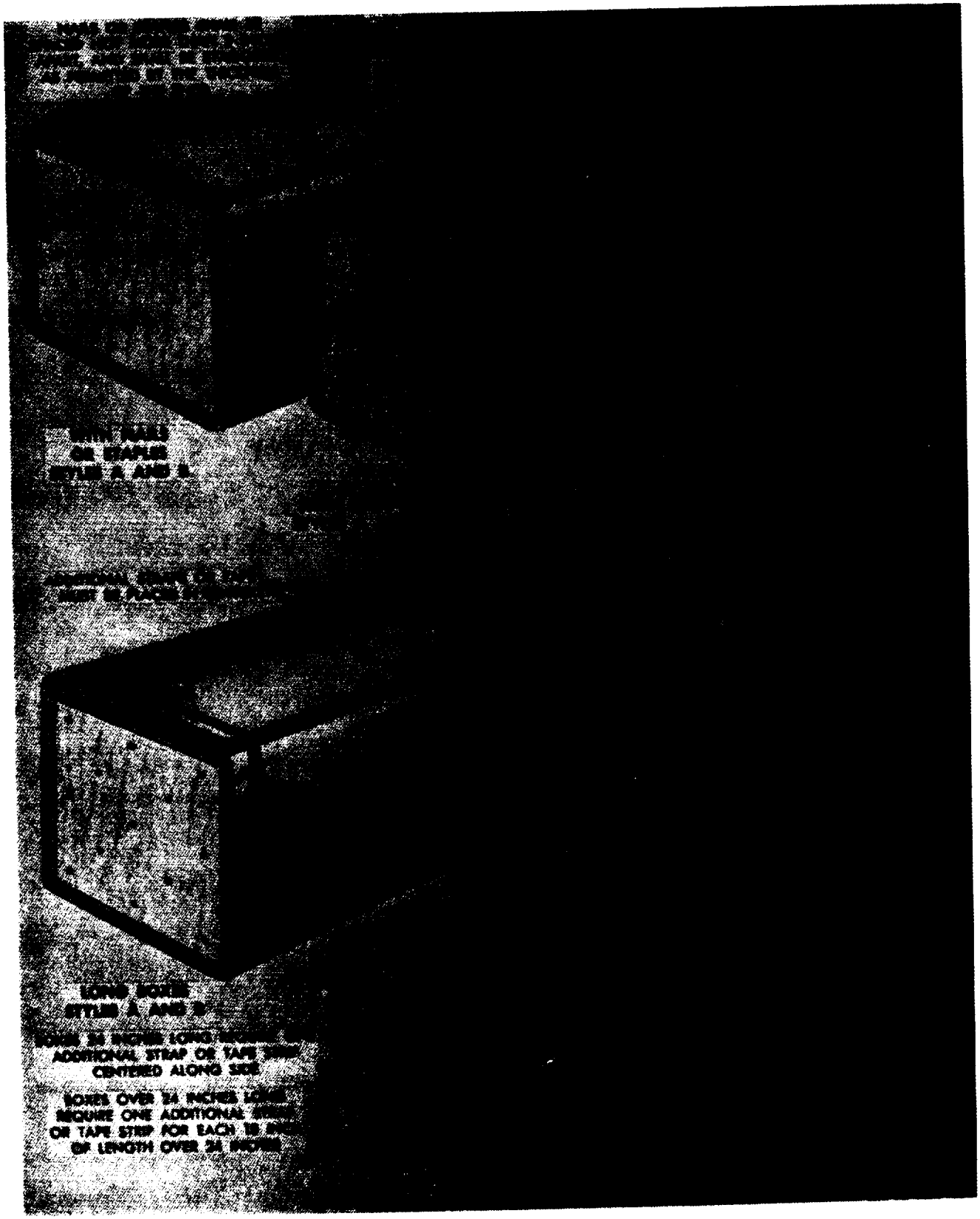


Figure 2-21. Closure of styles A and B, triple-wall corrugated fiberboard boxes.

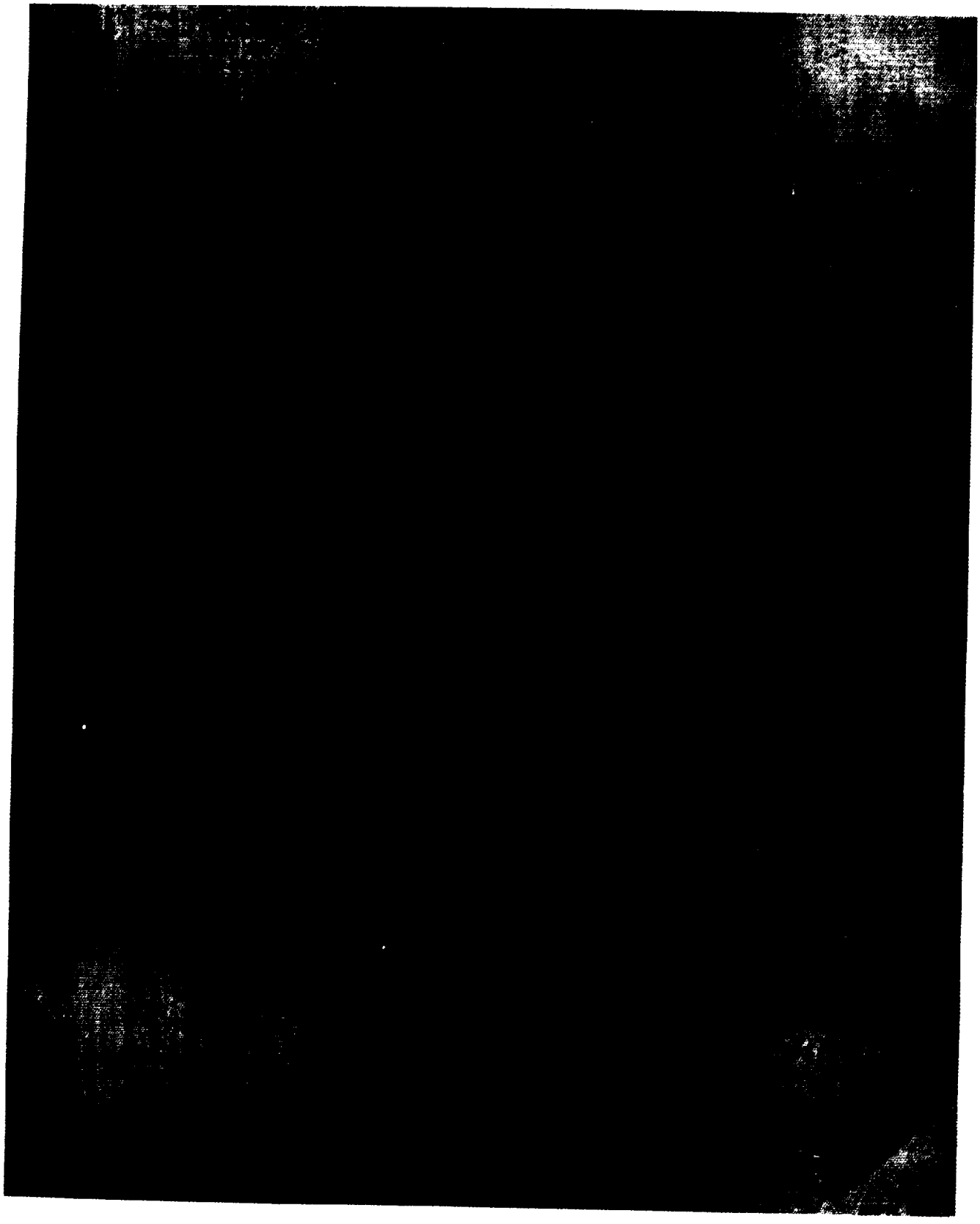


Figure 2-22. Closure of styles C and D, triple-wall corrugated fiberboard boxes.

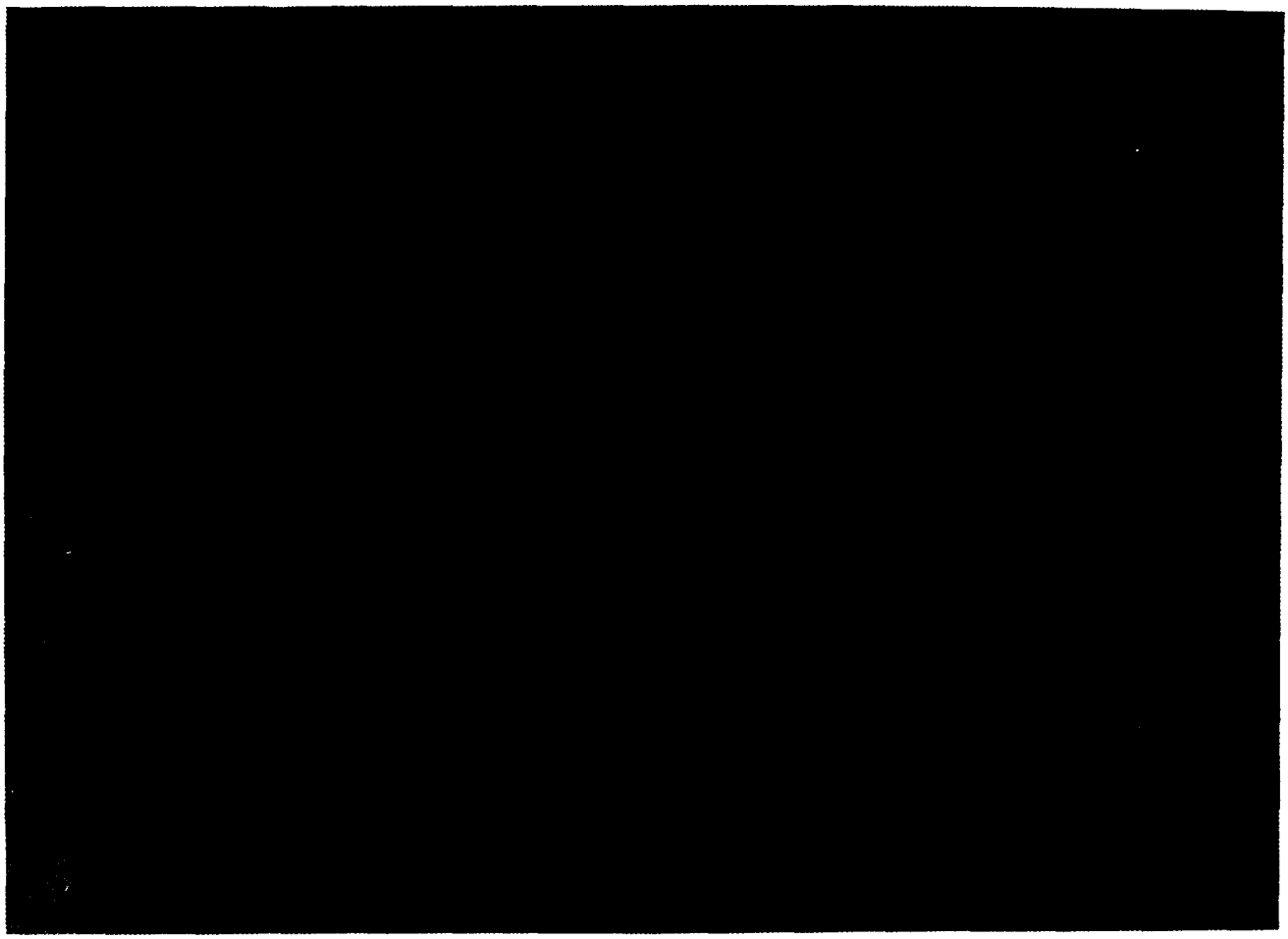


Figure 2-23. Stapling requirements for closure of style E, triple-wall corrugated fiberboard boxes.

(6) *Closure of style F boxes.* This style may be closed with steel or nonmetallic straps or filament-reinforced tape. When straps are used, they will be applied as described for style E boxes. When tape is used, one strip will be used on each side and each end. The strips will be not less than 12 inches long and will be applied at the center of the side and end panels and extend to the bottom of the box. When the length of the box is 24 inches, an additional strip will be added to each side and the two will be evenly spaced. Additional strips will be added for each 18-inch increment of length greater than 24 inches. Similar additional strips as required for length will be added to the ends when the box is 24 inches or greater in width (fig 2-25).

(7) *Closure of style G boxes.* When this box is used in conjunction with a pallet, closure and sealing will be as specified by the procuring activity. Without a pallet, style G boxes will be closed with straps. One strap will be centrally located around the top, ends, and bottom. Two straps will be applied around the top, sides, and bottom, at a distance from the ends equal to three-fourths the length of the inner bottom flaps. If the distance between the straps exceeds 24 inches, additional straps will be spaced not more than 24 inches apart (fig 2-26).

2-3. High Compression Strength, Weather-Resistant, Wax-Resin Impregnated, Corrugated Fiberboard Boxes (PPP-B-1163)

a. Description and Use. These boxes are made of single-wall and double-wall fiberboard which are impregnated with a wax-resin composition to increase their wet strength. They are intended primarily for use where high stacking strength is desirable, when the ultimate handling atmosphere is moisture-laden, when the products are iced or wet packed, and when uncovered storage conditions may be encountered.

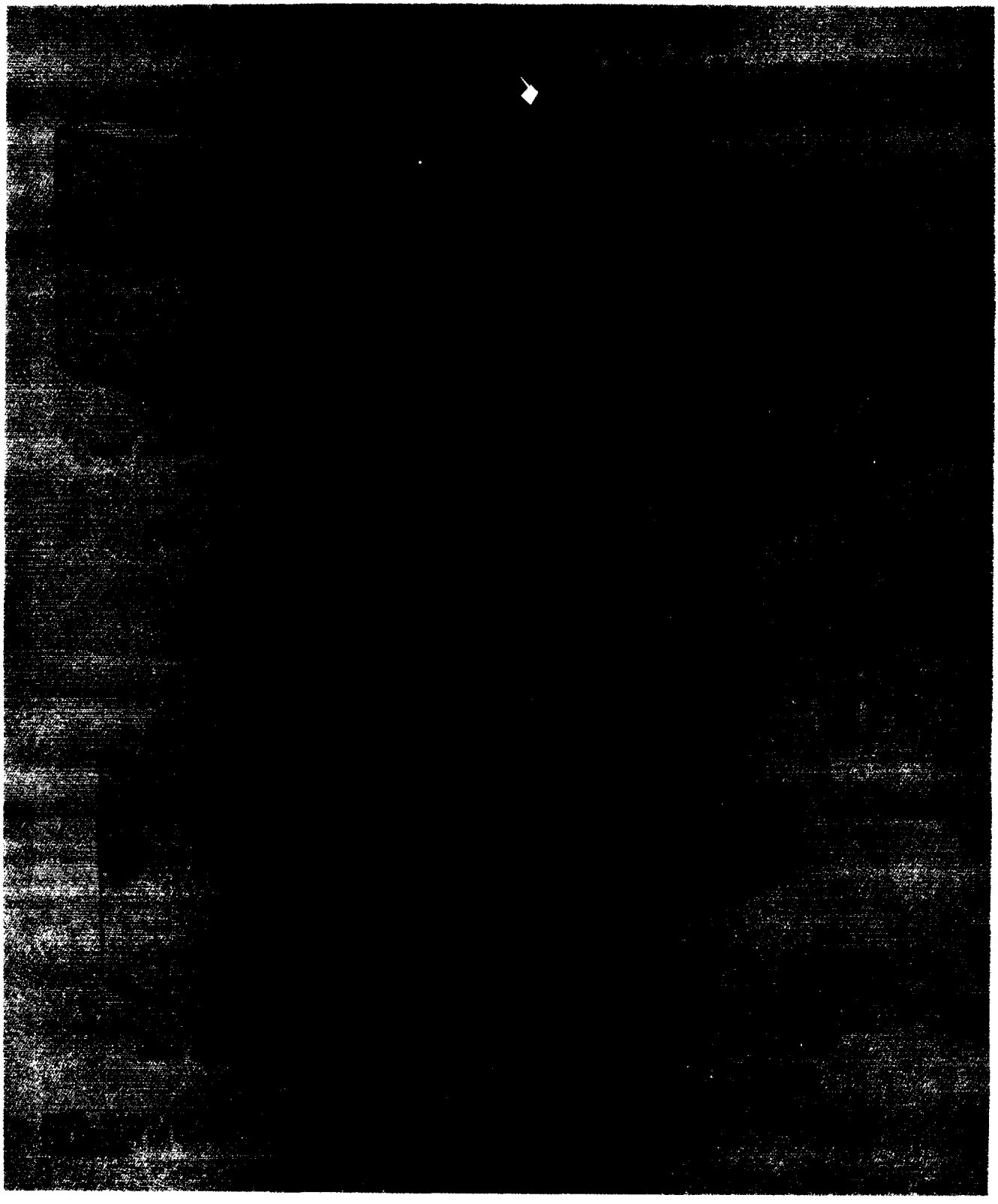


Figure 2-24. Closure of style E, triple-wall corrugated fiberboard box.

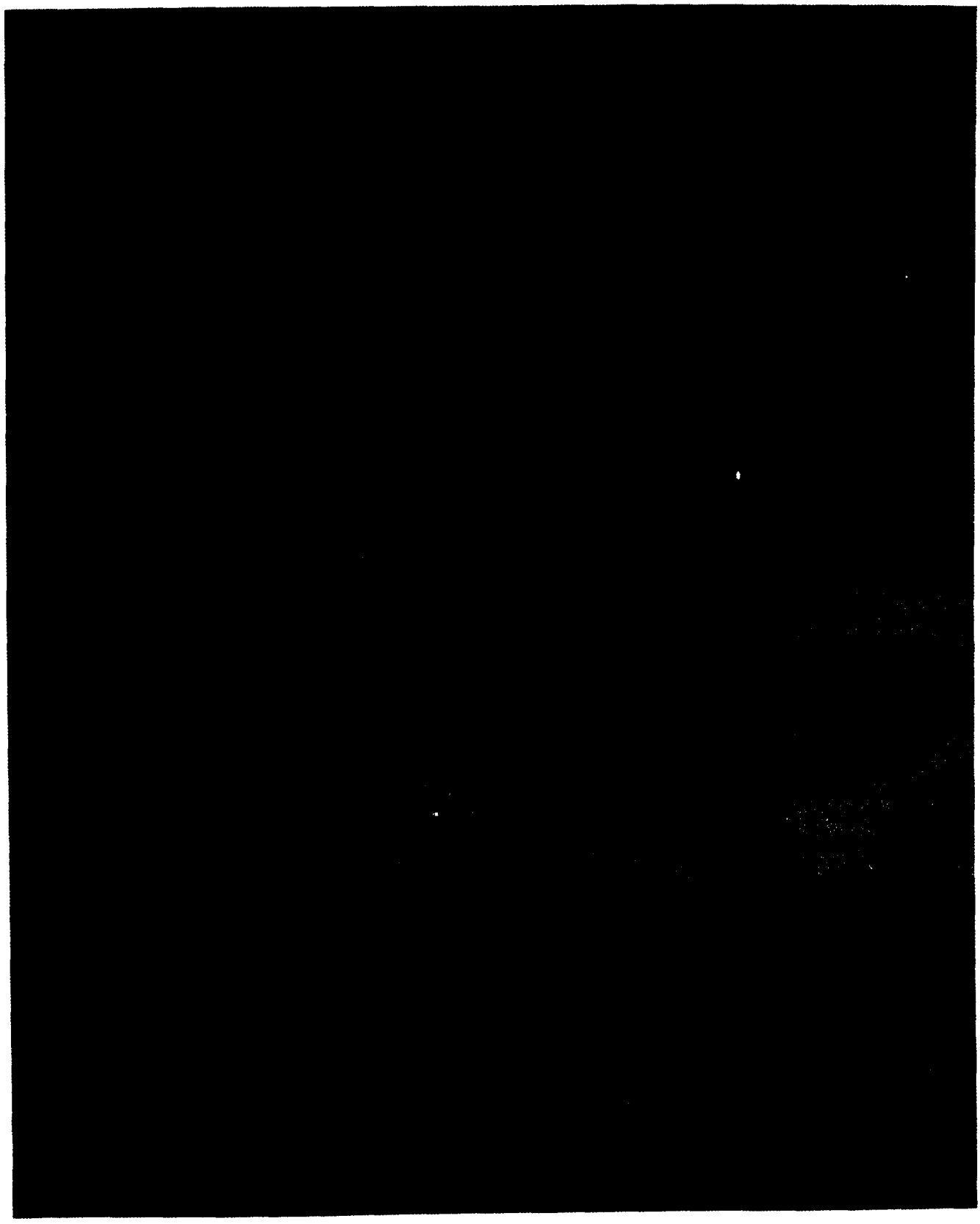


Figure 2-25. Closure of style F, triple-wall corrugated fiberboard box.

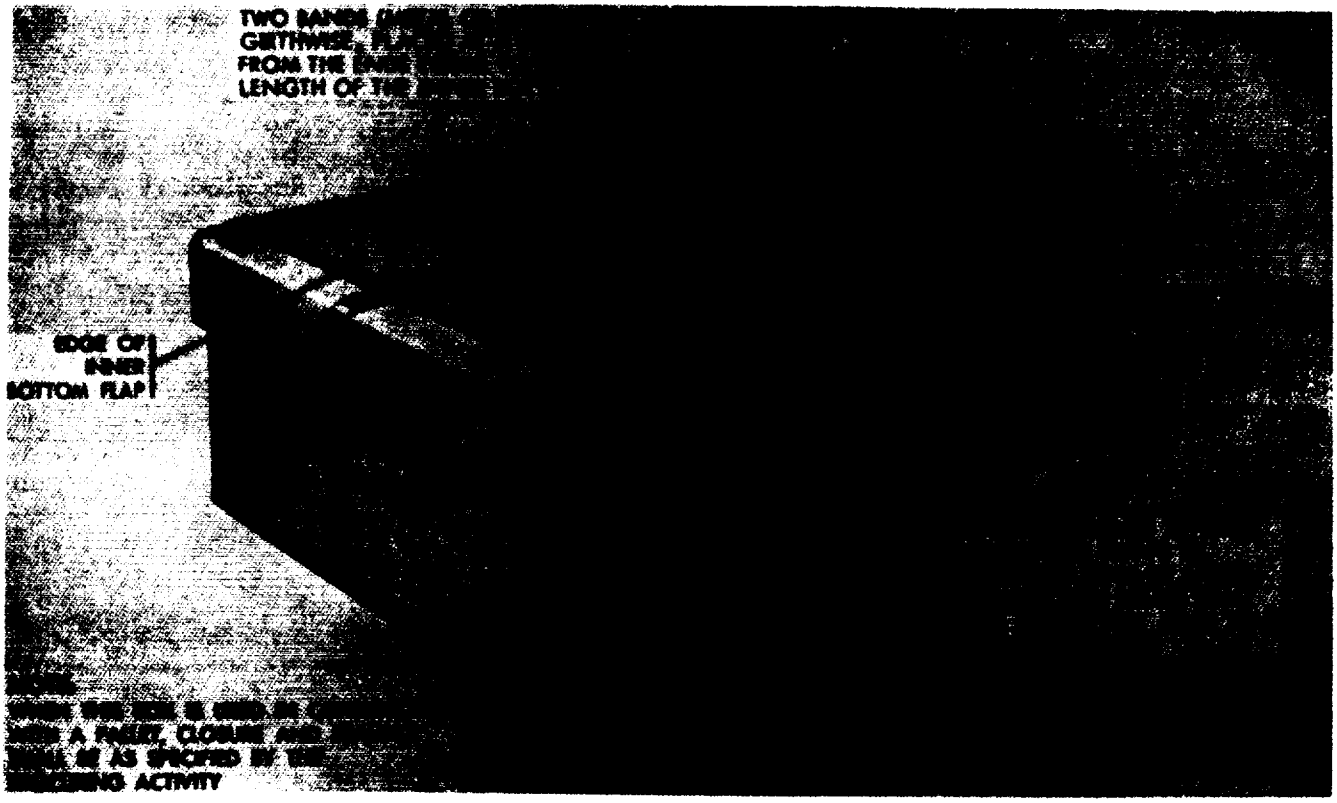


Figure 2-26. Closure of style G, triple-wall corrugated fiberboard box.

b. Classification. These boxes are available in seven styles, two classes, two types, and nine grades.

(1) *Styles.*

(*a*) *RSC, regular slotted box.* Construction features of this box are similar to the RSC style box of Specification PPP-B-636. See paragraph 2-1*j*(1) and figure 2-6 for details.

(*b*) *OSC, overlap slotted box.* Construction features of this box are similar to the OSC style of Specification PPP-B-636. See paragraph 2-1*j*(7) and figure 2-7 for details.

(*c*) *TC, telescope box, full or partial.* Construction features of this box are similar to the FTC style of Specification PPP-B-636, except that the inside depth of the cover shall be either the overall depth of the body, as required for the FTC box, or the depth specified in the invitation for bids. See paragraph 2-1*j*(4) and figure 2-6 for details.

(*d*) *HSC, half-slotted box with cover.* Construction features of this box are similar to the HSC style of Specification PPP-B-636, except that the cover shall not be less than four inches and the overlapping flaps must be secured with at least five staples. See paragraph 2-1*j*(11) and figure 2-8 for details.

(*e*) *HSCS, half-slotted box with flanged tube and cover.* Construction features of this box are similar to the Type III, Style 4, half RSC with telescope sleeve and cap of Specification MIL-B-43666, except for the cap which is similar to the cap used for the HSC box discussed above. Unless otherwise specified, prior to loading, the Style HSCS box shall be placed on a pallet or wood skid which shall be one inch longer and one inch wider than the box. See paragraph 7-11c(2) and figure 7-11, Type III Style 4, for details of half slotted body and the flanged tube (telescoping sleeve). See figure 2-8, HSC style box, for the details of the cover.

(*f*) *DCC, double cover.* Construction features of this box are similar to the DBLCC style box of Specification PPP-B-636. See paragraph 2-1*j*(12) and figure 2-8 for details.

(2) *Classes, types, and grades.* The available classes, types, and grades are shown in table 2-10.

c. Size Limitations. For commodities covered therein, Rule 41 of the Uniform Freight Classification limits the sum of the inside length, width, and depth dimensions to 120 inches. For commodities not covered by Rule 41, there are no size limitations on the boxes.

Table 2-10. Classes, Types, and Grades of Wax-Resin Impregnated Fiberboard Boxes (PPP-B—1163)

Class I—High Compression Strength [1]		Class II—Low Water Absorbing [2]	
Type SWCF [3]	Type DWCFI [4]	Type SWCFI [4]	Type DWCFI [4]
Grade 125 Grade 175 Grade 200 Grade 250 Grade 275 Grade 300 Grade 350	Grade 275 Grade 350 Grade 450 Grade 600	Grade 250 Grade 275 Grade 300 Grade 350	Grade 350 Grade 450 Grade 600

[1] Primarily intended for shipping containers.
[2] Primarily intended for pallet shrouds and sheathing.
[3] Single-wall corrugated fiberborad, impregnated.
[4] Double-wall corrugated fiberboard, impregnated.

d. Closure Requirements.

(1) *Styles RSC, OSC, TC, and HSC.* The requirements for the closure of these styles are the same as the requirements for the corresponding styles of weather-resistant boxes as specified in the appendix of PPP-B—636 with the following exceptions.

(*a*) Slotted style boxes for produce may have stitched closures in accordance with common carrier rules.

(*b*) Tape will conform to PPP-T—60 and be a minimum of 3 inches wide.

(*c*) The glue used does not have to conform to MMM-A—250 as specified in Method III closure due to variations in waxed boxes from different manufacturers. Adhesion should be tested for compatibility with the boxes with which they are to be used.

(2) *Style HSCS.* The closure of this style shall be accomplished by the use of steel straps conforming to type I, class A or B, of QQ-S—781, or nonmetallic strapping conforming to type I, grade B, and type II, and type III of PPP-S-760. Two straps, positioned approximately 10 inches from the edge of the box, shall be placed lengthwise around the box. These straps shall be placed either on top or beneath the pallet or skid. Straps also shall be placed girthwise around the box, within six inches of each end, plus one additional strap for every 24 inches of box length. These straps shall be placed under or through the pallet or skid in such a manner as not to be changed during the handling and shipping. See also ASTM D 3450, ASTM D 3953, and ASTM D 4675 for reinforcing materials.

2-4. Paperboard Boxes

Paperboard boxes are mainly used for interior packing. They are available in various types, styles, and sizes, and must conform to the requirements of PPP-B—566, and PPP-B—676. In many instances, depending upon the item, a paperboard box may be used in packing when utilizing parcel post (para 1-27). For further details on paperboard boxes, see volume I of this manual.

CHAPTER 3

WOODEN CONTAINERS AND PALLETS

3-1. Container Materials

a. Wood as a Container Material. Wood is particularly valuable as a container material because of its high strength-weight ratio which compares favorably with mild steel. Tests and experience have shown that the strength of a wooden container depends largely upon the type of wood used in its construction. The durability of wood and its ability to withstand shock and impact stresses are important properties in the selection of wood for containers. The quality of wood members for containers and pallets is set forth in Military Standard MIL-STD-731, "Quality of Wood Members for Containers and Pallets." Military Handbook MIL-HDBK-7, "Lumber and Allied Products," provides a ready source of information on wood products normally procured in considerable quantity for Department of Defense installations. This handbook is not intended for reference in purchase specifications or other contractual documents. However, it will assist materially with installation requisitioning, receiving, inspection, storage, and handling of container wood materials.

(1) *Wood groups.* All woods fall into two general categories: either softwoods, which come from coniferous or needle-bearing trees; or hardwoods, which come from broad-leafed trees. For purposes of container construction, wood is divided into four groups based on nail holding power, tendency to split, comparative strength as a beam, and shock resisting capacity (fig 3-1). Over 90 percent of all wooden containers are made from Group I and II woods. However, the materials given in Section 3 of the applicable container specification must be used. When a wood group is specified in the contract, any species in that group may be selected.

(*a*) Group I includes the softer woods such as white fir, ponderosa pine, yellow poplar, cottonwood, cedar, and others. These woods are relatively free from splitting when being nailed, have moderate nail-holding power, moderate strength as a beam, and moderate shock resisting capacity.

(*b*) Group II includes the harder soft woods such as Douglas fir, southern pine, hemlock, and larch. They have greater nail-holding power than the Group I woods, as well as greater strength and shock resisting capacity. Group II woods are more inclined to split, the grain often deflects nails and causes them to run out at the side of the piece.

(*c*) Group III includes the medium density hardwoods. Ash, elm, and cherry are examples. These are similar to Group II woods in nail-holding power and strength as a beam, but have less tendency to split and shatter under impact.

(*d*) Group IV includes the true hardwoods such as oak, hard maple, and hickory. These woods have the greatest shock resistance and nail-holding power, are extremely strong, but are very susceptible to splitting. They are the heaviest and hardest domestic woods, and are difficult to work.

(2) *Wood defects.* All boards should be cut to the correct length and be free from all defects that materially weaken them, expose the contents of the box to damage, or interfere with the prescribed fabrication or nailing (fig 3-2).

(*a*) *Knots.* Knots in wood are most weakening when located in the middle third of the length of the board. Across the width of the board, the weakening effect is proportional to the effective diameter (measured as shown in fig 3-3) of the knots. No knot, or series of knots across the face of the board, within a length equal to the width of the board, shall have a diameter or sum of diameters greater than one third the width of the board. No knot will exceed 4 inches when measured across the width of the board.

(*b*) *Slope of grain.* Any board with a slope of grain steeper than a ratio of 1 in 10 of length is not permissible. Figure 3-2 shows the results of excessive slope or cross grain.

(3) *Moisture content.* It is important that the moisture content of lumber required by an applicable container specification be followed. High moisture content in lumber will cause excessive tare weight. Shrinkage, due to the loss of high moisture content in the boards of a nailed wood box will cause gaps between the pieces of lumber.

Figure 3-1. Characteristics for the classification of wood.

Shrinkage will also cause the loss of nail holding-power, splitting of the lumber at the nails, and the loosening of straps. Moisture content is determined by the use of electric moisture meters or by the oven dry method, as outlined in Military Standards MIL-STD-1363 and MIL-STD-731.

(*a*) *Moisture meter method.* The moisture meter method is faster than the oven dry method, but less accurate. A moisture meter consists essentially of an electrical device designed to measure the resistance or the capacitance of the wood between two electrodes in contact with the sample. The values obtained will vary with the water content of the wood. They will also vary as a result of a number of other factors, most important of which are the temperature of the wood, its species, and density. Although correction tables are furnished with each instrument which must be used for even approximations of true values, the readings obtained are still only approximations because the effect of the other variables cannot be determined with scientific accuracy. Instruments of this type cannot be used where an accuracy of plus or minus 1 percent is required. In view of the foregoing, the moisture meter method is primarily usable for screening inspections of large lots of lumber, while the oven dry method is almost always resorted to in the event of disputes. The meter used should be capable of giving instantaneous readings of moisture content within a range of 7 to 20 percent, and should be equipped with correction tables to permit the correction of meter readings for temperature, species, and density. The meter should be adjusted prior to use in accordance with the manufacturer's instructions. When a series of readings are being made, the adjustment should be checked periodically. Batteries should be replaced whenever initial adjustment cannot be accomplished, or whenever it is obvious that inaccurate readings are being obtained because of weak batteries. The following general precautions should be observed:

1. The entire area of plate-type electrodes should be in contact with the wood. Do not use this type of electrode on rough wood.

2. Drive the needle-type electrodes to their full depth and in such a manner that the flow of current will be parallel to the wood grain. When wood splitting occurs, discard the reading obtained. Where the wood is over one inch thick, drive 1¼- to 1½-inch nails, spaced the same distance apart as the electrodes, straight into the wood to a depth equal to approximately one-fifth the thickness of the piece. These nails must not be

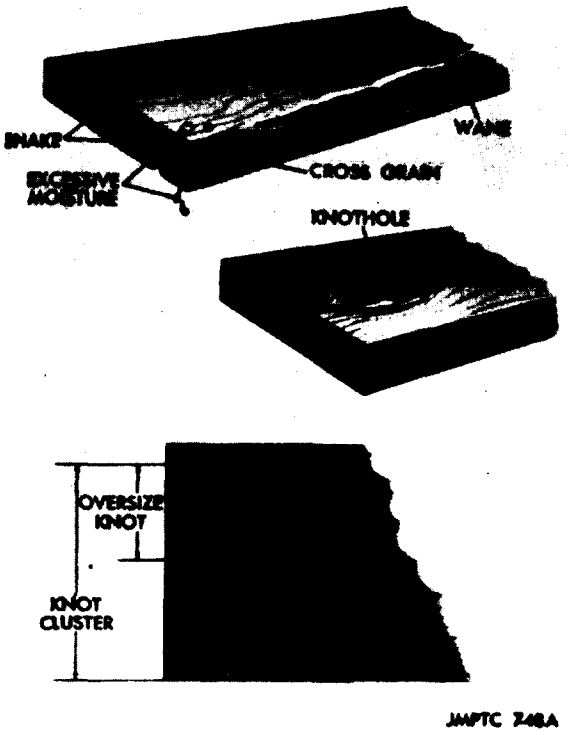


Figure 3-2. Wood defects.

cement coated but may be either bright or chemically etched.

3. Never use the meter on wood whose surface is wet with rain, dew, or fog.

4. Never use the meter on the ends of a piece.

5. Never use the meter on a painted or otherwise finished piece.

6. Never use the meter on composite pieces where the current between the two electrodes will have to pass through a glue joint.

7. Do not use the meter on a piece just removed from the kiln since the temperature correction tables (which are concerned with the temperature of the piece) will not be applicable.

8. On thin pieces, do not support the piece on another piece of lumber, metal, or other material which may give false electrical readings.

(b) Oven dry method. Use a drying oven capable of maintaining a constant temperature of 212° F. to 221° F., and a scale that is accurate to within one-half of 1 percent. To determine the moisture content, use the following procedure:

1. Cut off at least the first 12 inches of the piece in order to avoid the effects of end drying.

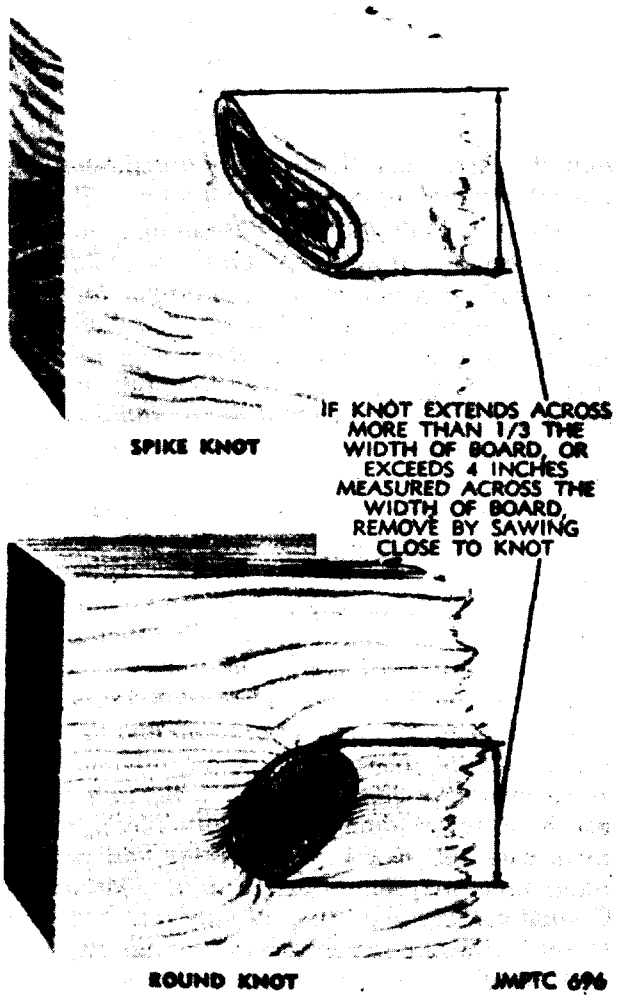


Figure 3-3. Measuring knot diameters.

2. As soon as possible, cut off a piece approximately 1 inch the full thickness by the full width of the piece.

3. Immediately after sawing, remove all loose splinters and determine W, the weight before drying.

4. Place the wood in the hot oven and leave overnight. The next day, weigh the specimen and replace in the oven. Repeat at 2-hour intervals until the weight is the same at the end of two successive 2-hour periods. This will occur after approximately 24 hours. If more than one, specimens must be open-piled in the oven to allow free access of air to all parts of the pieces.

5. The final weight of the piece immediately after removal from the oven is D, the overn dry weight.

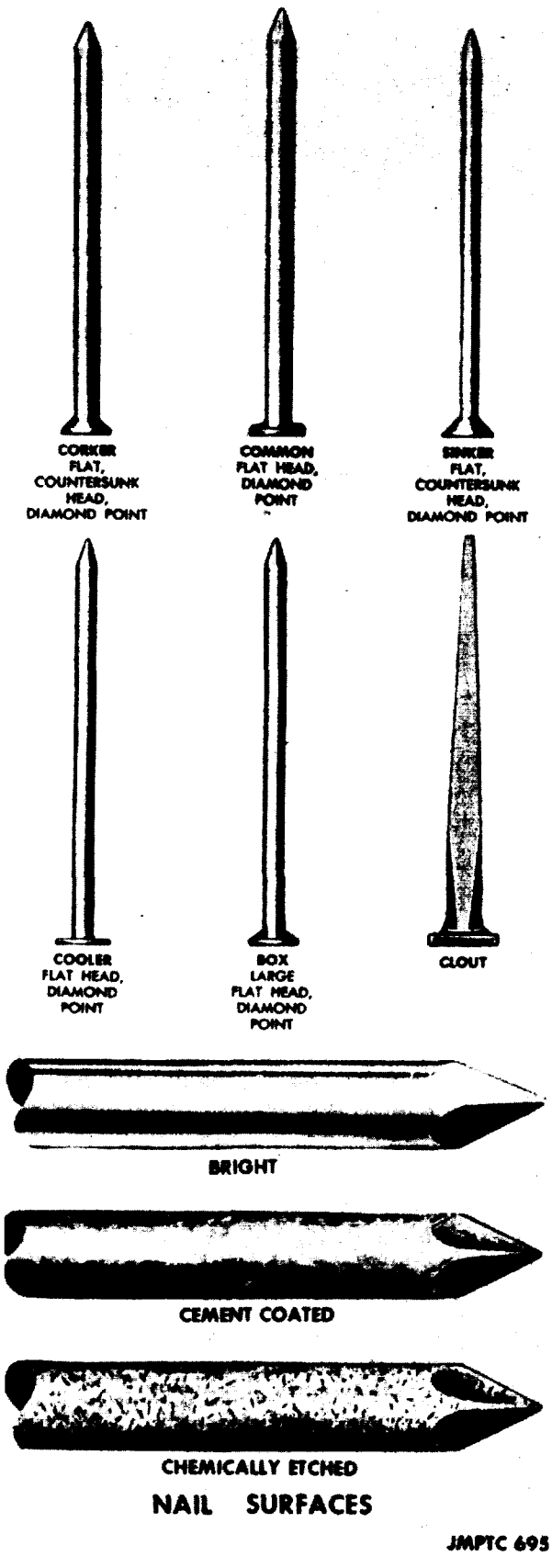
6. Calculate the percentage of moisture content by using the following formula:

$$\frac{(W-D)}{W} \times 100 = \% \text{ Moisture}$$

b. *Other Materials Used in Container Construction.* The following additional materials are used in container construction as applicable.

(1) *Nails (FF-N—105).* These may be box, corker, sinker, cooler, or common nails Sinker and cooler nails are relatively slender, can be driven into denser' woods and withstand shocks well. The heads do not break off or pull through the wood easily (fig 3-4). The resistance of nails to with drawal varies with an number of factors such as the hardness or density of the wood, surface condition of the nails and the shape and form of the nails Dense woods hold nails much better than soft woods. To get the same nail strength with softer woods, more nails or larger nails are required. The use of chemically etched or coated nails is particularly important with soft woods. Resistance of nails to withdrawal also varies with the area of contact of the nail with the wood, increasing directly with the diameter of the nail and the depth of penetration, Nails may be subjected to forces which withdraw them directly, that is, in the direction of their length, or to forces which displace them laterally. Nails offer greater resistance to lateral displacement than to direct withdrawal. Cement coating or etching increases the resistance of nails in direct withdrawal more than in lateral withdrawal, since the nail shank is distorted in lateral withdrawal about the same, whether coated or uncoated. Etched nail surfaces have certain advantages oover cement coated surfaces. The effect of etching in increasing with drawal resistance in relatively permanent, while cement coatings deteriorate a few months after nailing. Etched nails are effected with woods of all densities, while cement coatings tend ot rub off when nails are driven into dense woods. Here is a simple procedure for etching nails Prepare a 10 percent solution (by weight) of commercial monoammonium phosphate in water. Do not use metal container for preparing or storing the solution. Keep the solution near room temperature (about 68° F). Immerse the nails in the solution for about7 hours, stirring occasionally. Five gallons of solution is sufficinet to etch about 100 prounds of nails. At the end of the etching period, remove the nails and rinse with water. Finally, airdry the nails to prevent rusting.

(2) *Screws (FF-S-111).* Sometimes it is particularly desirable to use screws for closing wooden



boxes when the contents are such that they need to be checked, lubricated, or inspected.

(3) *Corrugated fasterners (FF-F—133).* Corrugated fasteners are used in the construction of built-up faceboards in wooden boxes (figure 3-11). When used for this purpose, nailing machine operators do not have to align each board prior to nailing. Corrugated fasteners also help to prevent pilferage of contents during storage or shipment.

(4) *Staple (FF-N—105).* Staples are used to attach cleats to panels on cleated-panel boxes. Staples with crowns not less than one-half inch must be long enough to penetrate the thickness of both the panel material and the cleat with a minimum clinch of one-eighth of an inch.

(5) *Wire fasteners.* Fasteners, other than nails, and staples, may be used to attach cleats to plywood or veneer panels. They must provide lateral displacement equal to that of nails properly spaced and driven. Wire fasteners are formed and driven by machine from a roll of knurled wire.

(6) *Strapping.* Either flat metal or round wire conforming to QQ-S—781 are used to strap wooden containers. ASTM D 3953 may be used.

(7) *Plywood (NN-P—530).* Plywood used for boxes, either for domestic or oversea destinations, shall be as specified in the procurement document or other directive establishing the container requirements. Plywood will be purchased in accordance with NN-P—530.

(8) *Fiberboard (PPP-F—320).* For oversea cleated panel boxes, solid V-board with a minimum dry bursting strength of 400 pounds is the only material authorized. For domestic cleated panel boxes, either solid fiberboard, solid pulp-board, or double-faced corrugated board may be used (para 2-1*h*).

(9) *Paper overlaid veneer (PPP-V—205).* This material, made of thin veneer covered on both faces with heavy kraft paper, is used as panelling material for paper overlaid veneer boxes, conforming to PPP-B—576.

3-2. Nailed and Lock-Corner Wood Boxes (PPP-B—621)

a. Description and Selection. The nailed wood box is constructed of wood, assembled by fastening the top, sides, and bottom to the ends with nails, or by gluing the lock-corners of the sides and ends and fastening them to the top and bottom with nails. The placement of cleats on the ends or the lack of cleats determines the style of box. Nailed wood boxes will not be used if fiberboard or less expensive light-weight boxes will provide adequate protection for shipment and storage.

b. Characteristics. Nailed wood boxes are satisfactory shipping containers for supplies and equipment, especially for items that are susceptible to damage. These containers have the following favorable and unfavorable characteristics:

(1) *Favorable characteristics.*

(*a*) Maximum protection to contents against damage due to puncture, distortion, and breakage.

(*b*) Ability to support loads due to stacking during transit and storage.

(*c*) Ability to contain difficult loads without undue distortion.

(*d*) Adaptability to complex wood blocking and bracing.

(*e*) Adaptability to varying strengths by adjusting the style of box, thickness of materials, and group of wood.

(*f*) Easy workability and simple construction.

(2) *Unfavorable characteristics.*

(*a*) High tare weight and cube.

(*b*) Not watertight.

(*c*) Tendency to wrack.

c. Classes and Grades (fig 3-5). The classes of nailed wood boxes are—

(1) *Class 1, domestic boxes.* These boxes are subject to storage, rehandling, or shipment to domestic destinations in which no sea transportation is involved. Net weight is limited to a maximum of 600 pounds.

(2) *Class 2, oversea boxes.* These boxes are subject to storage, rehandling, or reshipment to offshore and oversea destinations. Net weight is limited to a maximum of 1,000 pounds. Class 2 boxes (all styles) shall be furnished in the following grades, as specified. When no grade is specified in the contract, purchase order, or other procurement document, Grade B shall be supplied.

(*a*) Grade A—With preservative treatment.

(*b*) Grade B—Without preservative treatment.

d. Styles and Limitations. Class 1 and 2 boxes are described simultaneously, as applicable, in the coverage of the box styles. Styles 1, 2, 2½, 4, 4½, 5, 6, and 7 are permitted for Class 1 (domestic) and Styles 2, 2½, 4, 4½, 5, and 7 are permitted for Class 2 (oversea) shipments. Weight limitations for each class, as applicable, are given under the description of each style of box.

(1) *Style 1 box (fig 3-6).*

(*a*) Style 1 box is identified by lack of cleats on the end faceboards and single line nailing of

sides to ends, and of top and bottom to ends and sides.

(*b*) Style 1 box is intended for domestic shipments only. It is restricted to Type 1 and 2 loads.

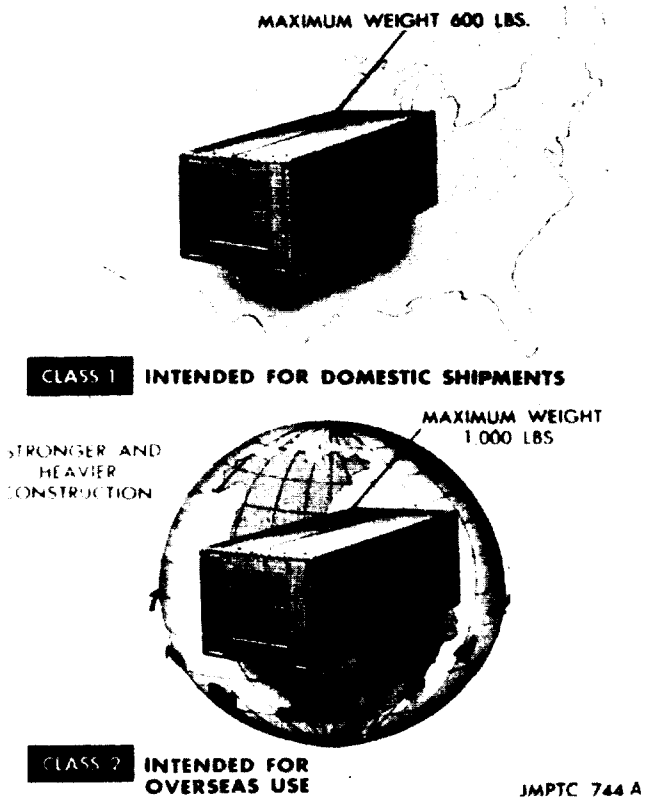


Figure 3-5. Classes of nailed wood boxes.

(*c*) Style 1 box may not exceed a load limit of 50 pounds for two-piece sides and 100 pounds for one-piece sides.

(*d*) Direction of the grain on Style 1 box must run in the direction of the greatest dimension.

(*e*) This box is limited to a height of 10 inches and total dimensions (length, width, and depth) of 50 inches.

(2) *Style 2 box (fig 3-6).*

(*a*) Style 2 box is identified by two vertical and two horizontal cleats on each end.

(*b*) Vertical cleats are positioned at right angles to the grain of the end. They are one-eighth of an inch shorter than the edge of the end at the top and bottom.

(*c*) Horizontal cleats, which are placed parallel to the grain of the end, are butt-joined to the vertical cleats and are flush with the top and bottom edges of the box.

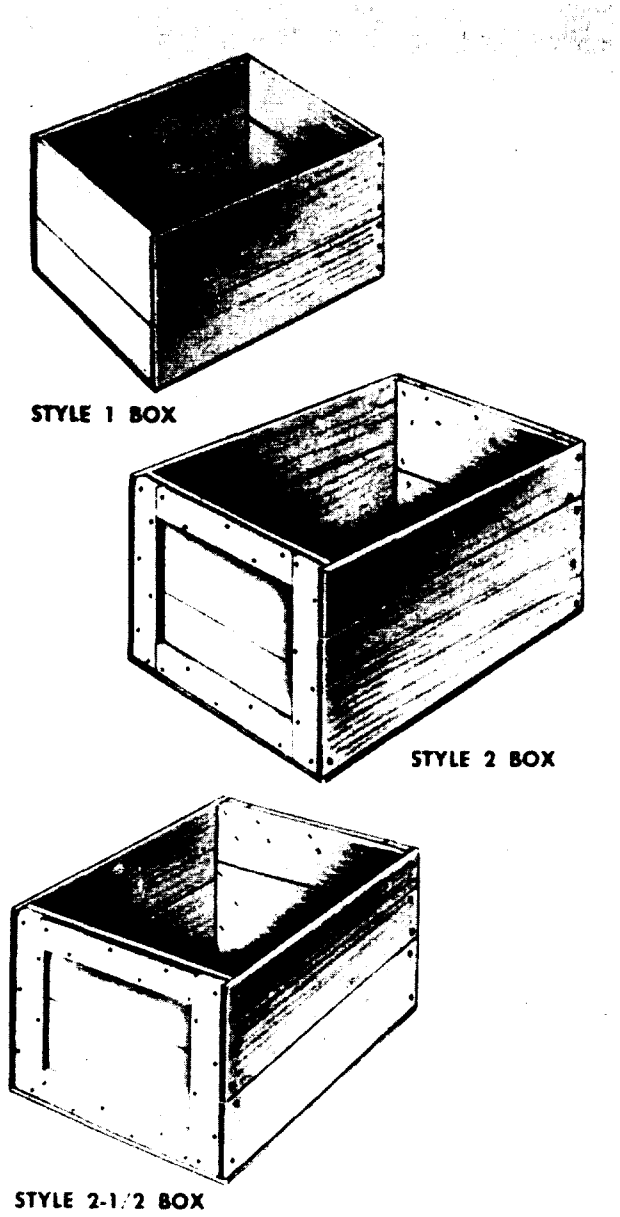


Figure 3-6. Styles of nailed wood boxes (1).

(*d*) The top, bottom, and sides extend over the ends and cleats and are nailed in a staggered pattern. Thus, there is some side-grain nailing on all edges.

(*e*) The cleat pattern provides ease of handling.

(*f*) Weight limitation for a Style 2, Class 1 box (domestic) is 600 pounds.

(*g*) Weight limitation for a Style 2, Class 2 (oversea) box is 1,000 pounds.

(3) *Style 2½ box (fig. 3-6).*

(*a*) Style 2½ box is identified by two vertical notched cleats and two horizontal cleats on each end.

(*b*) It has the same advantages as the Style 2

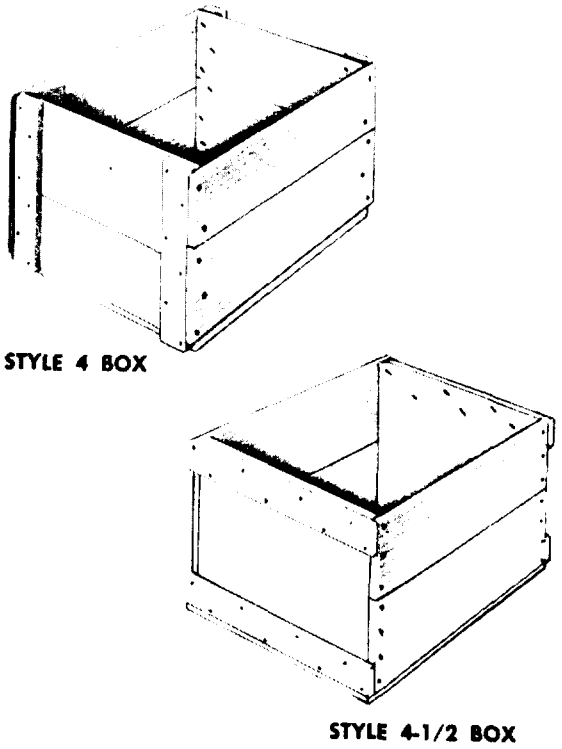


Figure 3-7. Styles of nailed wood boxes (2).

box, but is slightly higher in cost.

(c) Vertical cleats are notched approximately one-fourth to three-eighths inch to support the horizontal cleats. Vertical cleats are positioned one-eighth inch above the bottom edge of the end.

(d) Weight limitation for Style 2½, Class 1 box (domestic) is 600 pounds.

(e) Weight limitation for Style 2½, Class 2 box (overseas) is 1,000 pounds.

(4) *Style 4 box (fig 3-7).*

(a) Style 4 box is identified by two vertical cleats on each end.

(b) Vertical cleats, which are positioned at right angles to the grain of the end, are one-eighth inch shorter than the outside surfaces of the top and bottom of the box.

(c) The top and bottom cover the sides. They fit between the cleats and are attached to the ends by straightline, side-grain nailing. The sides overlap the ends and cleats, providing for a staggered nailing pattern.

(d) Weight limitation for Style 4, Class 1 box (domestic) is 250 pounds.

(e) Weight limitation for Style 4, Class 2 box (overseas) is 400 pounds.

(5) *Style 4½ box (fig 3-7).*

(a) Style 4½ box is identified by two horizontal end cleats.

(b) Horizontal cleats, which are positioned at right angles to the grain of the end, are one-eighth inch shorter than the outside surface of the sides.

(c) The sides extend over the ends, and provide for straight-line, side-grain nailing. The top and bottom extend over the ends and cleats, and provide for both side- and end-grain nailing.

(d) Weight limitations for both classes of boxes are the same as for Style 4 boxes.

(6) *Style 5 box (fig 3-7).*

(a) Style 5 box is identified by interior vertical cleats.

(b) The cleats extend to within one-eighth inch from the top and bottom edges of the end of the box.

(c) Other than the placement of cleats, construction and nailing pattern for this container is the same as for Style 4 box.

(d) The interior cleats may be rectangular or triangular, provided the cross section area of the triangular cleat is not less than that of the required rectangular cleat.

(e) Weight limitation for Style 5, Class 1 box (domestic) is 250 pounds.

(f) weight limitation for Style 5, Class 2 box (overseas) is 400 pounds.

(7) *Style 6 box (fig 3-7).*

(a) Style 6 box is identified by the lockcorner

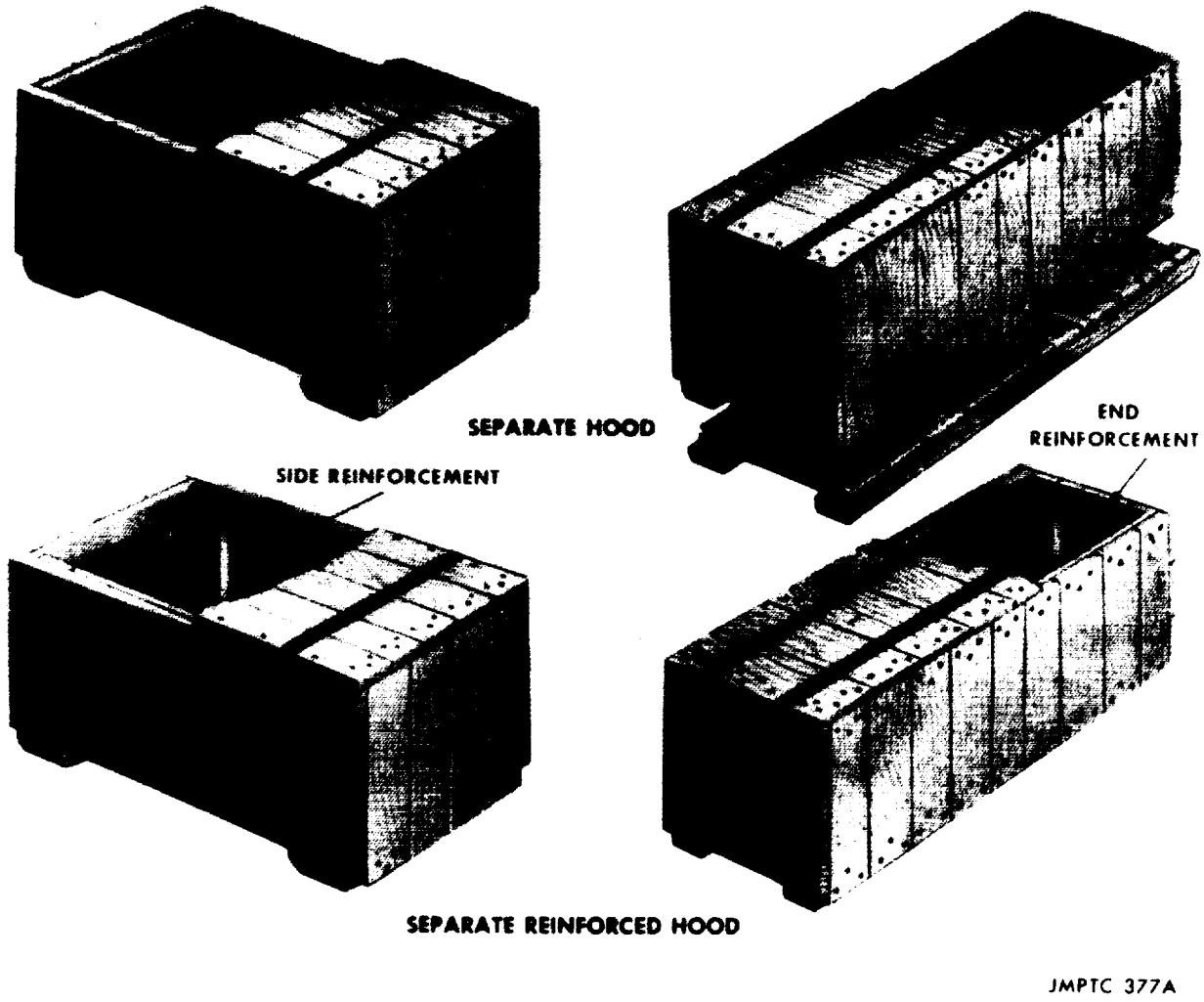


Figure 3-8. Style 7 nailed wood box.

construction which is glued.

(b) This box has about the same advantages and disadvantages as Style 1 box.

(c) Style 6 box is intended for domestic shipments only and Type 1 and 2 loads.

(d) This box has a weight limitation of 50 pounds, but may go to 100 pounds if the box has one-piece sides.

(8) *Style 7 box (fig 3-8)*

(a) Style 7 box is an internally reinforced box consisting of a skidded base with a separate hood assembled from the top, sides and ends.

(b) Style 7 boxes are for contents ranging from 100 to 1,000 pounds. The contents must readily permit attachment to the skids.

(c) The base is assembled to 2 x 4 inch skids to facilitate mounting to a skid base.

(d) The skids are positioned across the extreme ends of the bottom pieces to permit attachment of all end pieces to the skid edges.

(e) Vertical and horizontal framing members and reinforcing members in the form of a rectangle, and cross diagonals, as applicable, are attached to the interior surfaces of the prefabricated box panels. Framing members are required when contents exceeds 250 pounds or when side length is greater than end length.

(f) End panels are identified by vertical sheating which extends within one-eighth of an inch of each skid bottom.

(g) The hood assembly is placed over the item mounted to the base, then nailing and strapping is accomplished.

(h) Style 7 boxes are intended for both Class 1 and Class 2 use.

(9) *Shallow box (fig 3-9).*

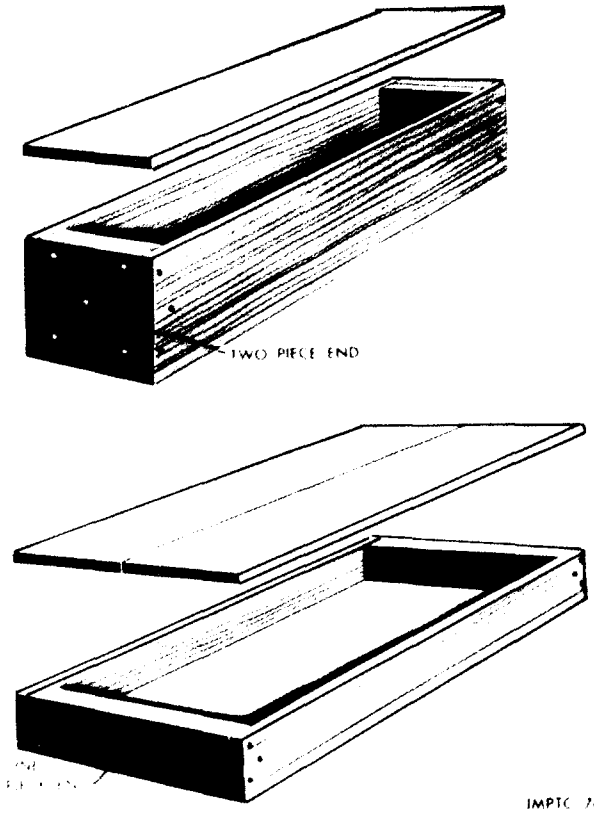


Figure 3-9. Shallow boxes.

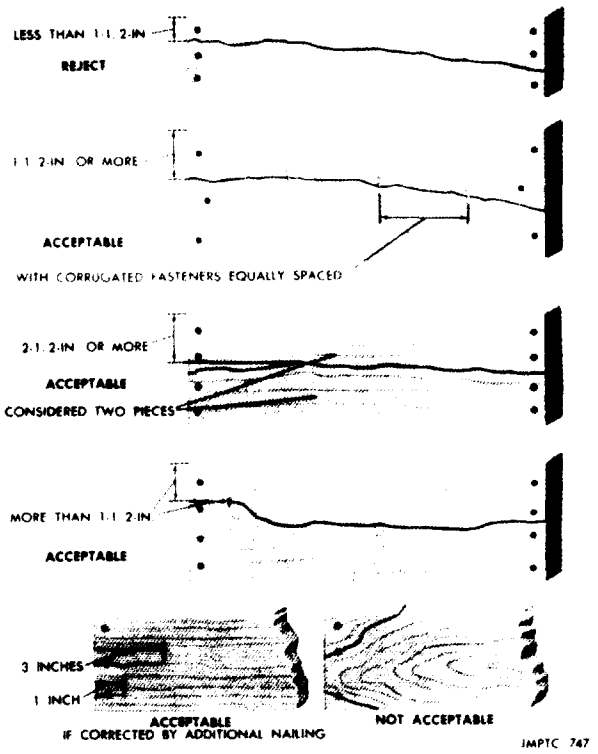


Figure 3-10. Split board rules.

(a) When the inside depth of a box is five inches or less, cleats are not used. If cleats were applied to shallow boxes, they would be so small that in attaching them to the ends they would split.

(b) The end of the box may be made of one piece, or if the end is approximately square, it may be made of two pieces placed so that the grain runs in opposite directions.

(c) For Style 2, 2½, 3, 4, and 4½ boxes, the thickness of the ends shall be not less than the combined thickness of the end and cleat, as specified.

(d) Slides overlap the ends.

(e) Top and bottom overlap the sides and ends.

(f) Top, bottom, and sides are attached to the ends by staggered nailing.

(g) Weight limitation is 1,000 pounds for oversea shipments.

e. Construction Details. When nailed wood boxes are built locally, use the following information for constructing and closing the various styles. If purchased and received in shook form, the sides, top, and bottom will be ready to be attached to the constructed ends. Figure 3-10 shows the amount of acceptable splitting allowed in the component parts.

(1) *Size of lumber.* The size of lumber used in nail wood box construction is found in tables 3-1, 3-2, 3-3, and 3-4. Information necessary to use these tables is: Class of box, type of load, net weight, style of box, and group of wood.

(2) *Construction of built-up faceboard pieces (fig 3-11).* The number of pieces in any side, top, bottom, or end will be chosen so that no single solid piece or built-up piece shall be less than 2½ inches in width measured across the face, and will not exceed the number given in table 3-5. Built-up face-board pieces may be constructed according to the following conditions:

(a) The Linderman joint when glued.

(b) Butt joints glued under pressure.

(c) Tongued and grooved joints glued under pressure.

(d) Tongued and grooved joints glued with two or more corrugated fasteners driven from one side.

(e) Tongued and grooved unglued joints with two or more corrugated fasteners driven from alternate sides.

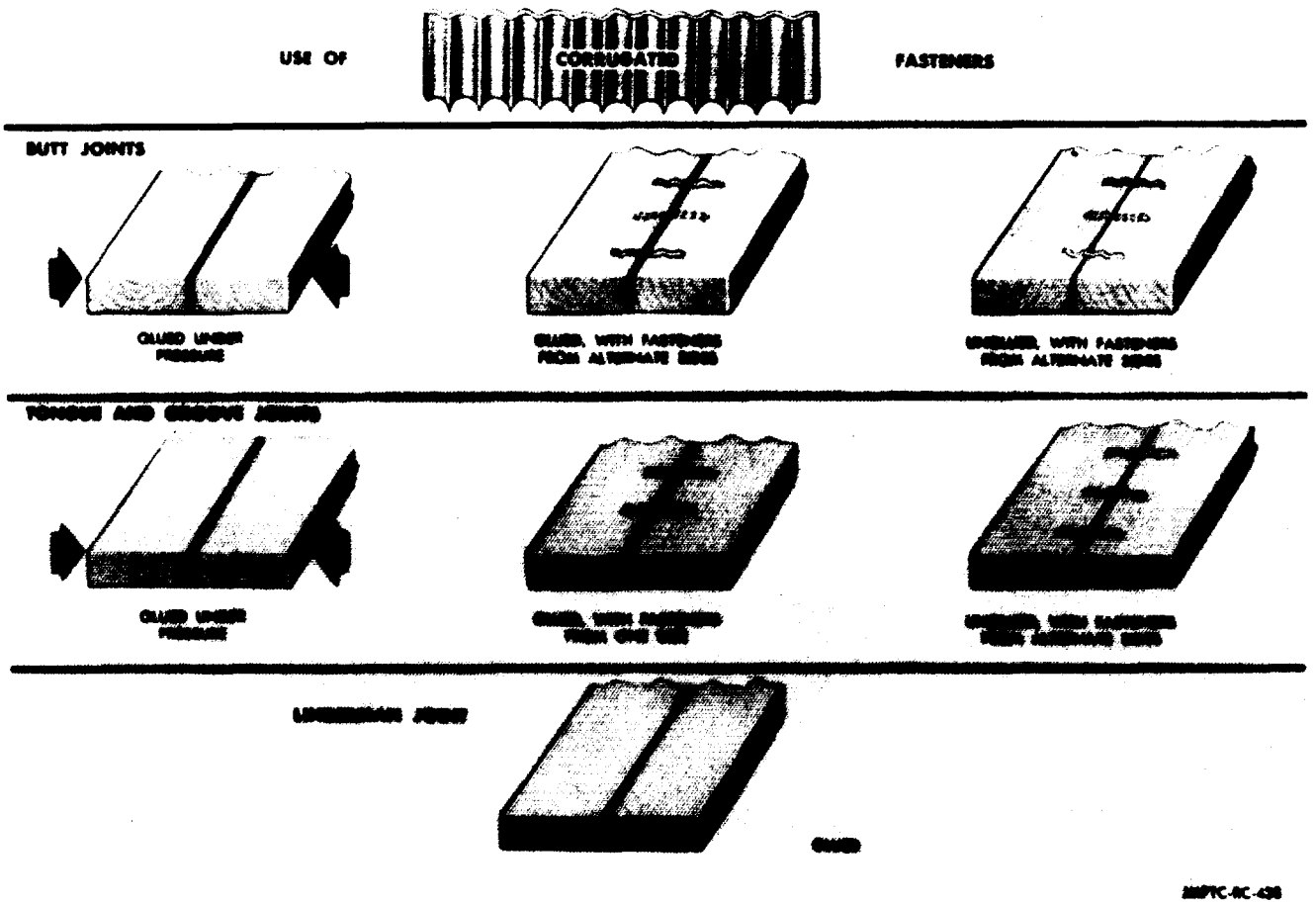


Figure 3-11. Jointed pieces of lumber.

(3) *Additional cleats and battens.* Additional cleats will be made of the same size lumber as the regular cleats. They are placed on the ends of a box when required, according to length of unsupported span (table 3-6). Additional cleats applied to ends to ends run across the grain of the end (right angle to grain direction) and midway between the regular cleats. Battens are made of the same size lumber as regular cleats. Battens are used on the sides, top, and bottom when the limit of unsupported span is exceeded (table 3-6). Wherever possible, and without increasing the size of the container, battens should be placed inside the box. When battens are required to be placed on the outside of a box without skids, not less than two sets shall be attached across the sides, top, and bottom. They shall be applied so that those on the top and bottom extend over the ends of the side battens. They shall be located not less than 2½ inches nor more than one sixth the length of the box with respect to each box end. However, that distance and the interval between sets of battens shall be not more than maximum span specified in table 3-6. Exterior battens shall be applied to boxes with skids in the same manner as required for interior battens except that the bottom battens shall be fabricated from one piece of lumber a minimum of 2½ inches high and 3½ inches wide.

(4) *Diagonals (fig 3-12).* Sometimes diagonal reinforcing members are added to the interior or exterior surfaces of the box. Diagonals used on both the end and side panels are the same width and thickness as required for cleats and are nailed in the same manner.

(a) The presence of intermediate battens or cleats, required by table 3-6, determine the number of single diagonals on each panel.

(b) Single diagonals in each of two adjacent areas of one panel are arranged to peak at the center and bear at the upper end of the intermediate batten.

Table 3-1. Boxes for domestic shipment, type 1 (easy) and type 2 (average) loads; thickness of sides, tops, bottoms, and ends, and thickness and width of cleats

Weight of contents			Groups I and II woods[1]			Groups III and IV woods[2]		
Exceeding	Not exceeding	Style of box[6]	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats[3]
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
—	50	1	3/8	1/2	—	1/4	1/2	—
—	50	4, 4-1/2, 5	3/8	1/2	1/2 by 2	1/4	1/2	1/2 by 1-3/4
—	50	2	3/8	3/8	3/8 by 2	1/4	3/8	3/8 by 1-3/4
—	50	6	3/8	1/2	—	1/4	3/8	—
50	100	1[4]	3/8	1	—	3/8	3/4	—
50	100	4, 4-1/2, 5	3/8	5/8	5/8 by 3	3/8	1/2	1/2 by 1-3/4
50	100	2, 2-1/2,	3/8	1/2	1/2 by 2	3/8	1/2	1/2 by 1-3/4
50	100	6[4]	3/8	1	—	3/8	1/2	—
100	250	4, 4-1/2, 5	1/2	5/8	5/8 by 3	1/2	1/2	1/2 by 2-1/4
100	250	2, 2-1/2, 7	1/2	5/8	5/8 by 3	1/2	1/2	1/2 by 1-3/4
250	400[5]	2, 2-1/2, 7	5/8	1	1 by 3	1/2	3/4	3/4 by 2-1/4

[1] Nominal. The dressed sizes of wood shall equal or exceed the minimum sizes shown in Table I of 20-70. For the purpose of this specification, reference to STD 20-70 shall be limited to the above.

[2] Thickness tolerance shall be ± 1/16 inch for parts 3/8 inch thick and thicker, except as otherwise specified. Thickness tolerance shall be + 1/16, -1/32 inch for pieces less than 3/8 inch thick.

[3] Width tolerance shall be ± 1/16 inch, except as otherwise specified.

[4] Providing the boxes have one-piece solid sides of sawed lumber and contents are packed in interior containers.

[5] When load to be carried by the box exceeds 400 pounds, use Table 3-3; when load exceeds 600 pounds, use Table 3-4.

[6] Styles 2, 2-1/2, 4, 4-1/2 boxes. Unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combined thickness of the end and cleat, as specified. Each side and end shall be made form one piece, except when the end is approximately square, a two-piece end may be used with each end piece of approximately equal thickness, and with the grain of each piece running at right angles to the other. Two-piece ends shall be nailed together with at least two clinched nails.

Table 3-2 Boxes for domestic shipment, type 3 (difficult) loads; thickness of sides, tops, bottoms, and ends, and thickness and width of cleats

Weight of contents			Groups I and II woods[1]			Groups III and IV woods[2]		
Exceeding	Not exceeding	Style of box[5]	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats[3]
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
—	50	4, 4-1/2, 5	3/8	5/8	5/8 by 2	3/8	1/2	1/2 by 1-3/4
50	100	4, 4-1/2, 5	1/2	1	1 by 3	1/2	1/2	1/2 by 1-3/4
50	100	2, 2-1/2	1/2	5/8	5/8 by 2	1/2	1/2	1/2 by 1-3/4
100	250	4, 4-1/2, 5	5/8	1	1 by 3	1/2	3/4	3/4 by 2-1/4
100	250	2, 2-1/2, 7	5/8	1	1 by 3	1/2	1/2	1/2 by 2-1/4
250	400	2, 2-1/2, 7	1	1	1-1/4 by 4	3/4	3/4	3/4 by 2-1/4
400	600[4]	2, 2-1/2, 7	1	1	1-1/4 by 4	3/4	3/4	3/4 by 2-5/8

[1] Nominal. The dressed sizes of the wood shall equal or exceed the minimum sizes shown in Table I of STD 20-70. For the purpose of this specification, reference to STD 20-70 shall be limited to the above.

[2] Thickness tolerance shall be ± 1/16 inch for parts 3/8 inch thick and thicker, unless otherwise specified.

[3] Width tolerance shall be ± 1/16 inch, unless otherwise specified.

[4] When load to be carried by the box exceeds 600 pounds, use Table 3-4.

[5] Styles 2, 2-1/2, 4, 4-1/2 boxes. Unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combined thickness of the end and cleat as specified. Each side and end shall be made from one piece, except when the end is approximately square, a two-piece end may be used with each end piece of approximately equal thickness, and with the grain of each piece running at right angles to the other. Two-piece ends shall be nailed together with at least two clinched nails.

Table 3-3. Boxes for overseas shipment, type 1 (easy) and type 2 (average) load; thickness of sides, tops, bottoms, and ends, and thickness and width of cleats

Weight of contents			Groups I and II woods[2]			Groups III and IV woods[2]		
Exceeding	Not exceeding	Style of box[1]	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats[3]
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
—	50	4, 4-1/2, 5	3/8	5/8	5/8 by 2	3/8	1/2	1/2 by 1-3/4
50	100	4, 4-1/2, 5, 7	1/2	1	1 by 3	3/8	1/2	1/2 by 1-3/4
100	250	4, 4-1/2, 5	5/8	1	1 by 3	1/2	3/4	3/4 by 2-1/4
100	250	2, 2-1/2, 7	5/8	5/8	5/8 by 3	1/2	1/2	1/2 by 2-1/4
250	400	4, 4-1/2, 5	1	1	1 by 3	3/4	3/4	3/4 by 2-1/4
250	400	2, 2-1/2, 7	1	1	1 by 3	3/4	3/4	3/4 by 2-1/4
400	600	2, 2-1/2, 7	1	1	1 by 3	3/4	3/4	3/4 by 2-1/4
600	1000	(See Table 3-4)						

[1] Styles 2, 2-1/2, 4, 4-1/2 boxes. Unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combines thickness of the end and cleat as specified. Each side and end shall be made from one piece, except when the end is approximately square, a two-piece end may be used with each piece of approximately equal thickness, and with the grain of each piece running at right angles to the other. Two-piece ends shall be nailed together with at least two clinched nails.

[2] Nominal. The dressed sizes of the wood shall equal or exceed the minimum sizes shown in Table I of STD 20-70. For the purposes of this specification, reference to STD 20-70 shall be limited to the above.

[3] Thickness tolerance shall be plus or minus 1/16 inch for parts 3/8 inch thick and thicker, unless otherwise specified.

[4] Width tolerance shall be ± 1/16 inch unless otherwise specified.

Table 3-4. Boxes for overseas shipment, type 3 (difficult) load; thickness of sides, tops, bottoms, and ends, and thickness and width of cleats

Weight of contents			Groups I and II woods			Groups III and IV woods[3]		
Exceeding	Not exceeding	Style of box[1]	Thickness of sides, tops, and bottoms[2]	Thickness of ends[2]	Thickness and width of cleats[2]	Thickness of sides, tops, and bottoms	Thickness of ends	Thickness and width of cleats[4]
Pounds	Pounds		Inch	Inch	Inches	Inch	Inch	Inches
—	100	4, 4-1/2, 5	1/2	1	1 by 3	1/2	1/2	1/2 by 1-3/4
—	100	2, 2-1/2, 7	1/2	5/8	5/8 by 3	1/2	1/2	1/2 by 1-3/4
100	250	4, 4-1/2, 5	5/8	1	1 by 3	1/2	3/4	3/4 by 2-1/4
100	250	2, 2-1/2, 7	5/8	5/8	1 by 3	1/2	3/4	1/2 by 2-1/4
250	400	4, 4-1/2, 5	1	1 1/4	1 1/4 by 4	3/4	7/8	7/8 by 2-5/8
250	400	2, 2-1/2, 7	1	1	1 1/4 by 4	3/4	3/4	3/4 by 2-5/8
400	600	2, 2-1/2, 7	1	1	1 1/4 by 4	3/4	7/8	7/8 by 2-5/8
600	800	2, 2-1/2, 7	1	1 1/4	1 1/4 by 4	3/4	7/8	7/8 by 2-5/8
800	1000	2, 2-1/2, 7	1 1/4	1 1/2	1 1/2 by 5	7/8	1 3/8	1 3/8 by 3-1/4

[1] Styles 2, 2-1/2, 4, 4-1/2 boxes. Unless otherwise specified, when the inside depth of a box is 5 inches or less, end cleats shall not be used. Thickness of the ends shall be not less than the combined thickness of the end and cleat as specified. Each side and end shall be made from one piece, except when the end is approximately square, a two-piece end may be used with each end piece of approximately equal thickness, and with the grain of each piece running at right angles to the other. Two-piece ends shall be nailed together with at least two clinched nails.

[2] Nominal. The dressed sizes of the wood shall equal or exceed the minimum sizes shown in Table I of STD 20-70. For the purpose of this specification, reference to STD 20-70 shall be limited to the above.

[3] Thickness tolerance shall be ± 1/16 inch for parts 3/8 inch thick and thicker, unless otherwise specified.

[4] Width tolerance shall be ± 1/16 inch, unless otherwise specified.

(c) Three or more diagonals in adjacent areas of one panel are arranged in a zigzag manner.

(d) When a 24-inch minimum strapping interval is required, the inner surface of the exterior diagonals must be notched slightly to permit the strapping to pass under each diagonal.

(5) *Skids.* Boxes (except style 7) with items packed therein, having a gross weight in excess of 200 pounds, or containers with length and width dimensions of 48 inches by 24 inches or more and weighing more than 100 pounds, shall be provided

Table 3-5. Number of Pieces in Any Box Part

Width of box part		Maximum number of pieces single solid or built-up
Exceeding	Not exceeding	
Inches	*Inches*	
0	2-1/2	1
2-1/2	5	2
5	7-1/2	3
7-1/2	12	4
12		(See note)

Note: The width of pieces in box parts exceeding 12 inches shall not average less than 3 inches. No single solid or built-up piece shall be less than 2-1/2 inches when measured across the face.

with a minimum of two skids. The skids shall be fabricated from one piece of lumber of 2½ inches high and 3½ inches wide. Skids shall replace exterior battens on box bottoms when battens are required in table 3-6. Skids shall be placed parallel to and extend the full width of the box and shall be positioned not closer than 2½ inches nor more than one sixth the length of the box from each end of the box. The distance between skids, measured between the inside edges, shall not exceed the distance between battens, and when battens are not required, shall not exceed 48 inches. Additional skid(s), as required, shall be positioned so as to divide the distance between the end skids into units of equal length. When bolt fastening is provided for the item being packed, additional skids, as needed, shall be located on the box bottom so as to enable the item to be bolted through the skids. The skids shall be notched as applicable to provide clearance for either girthwise or lengthwise strapping. When 4-way fork entry is required, skids shall be a minimum of 3½ inches high and 3½ inches wide, cut out a minimum of 2 inches, in depth and of such width as to accommodate forks and slings for handling, and may be placed lengthwise flush with the box sides. The skids shall be secured to the box by nails. The nails shall be driven from the inside through the bottom into the skids and be clinched not less than ⅛ inch. Alternative to clinching, nails conforming to type II, style 18 of FF-N-105 may be used of such length as to penetrate a minimum of ¾ the thickness of the skids and shall not protrude through the skid. The nails shall be arranged in two rows in a staggered pattern, with space between nails in each row not to exceed 6 inches. Nails shall not be located less than ½ inch from edges of the skid nor less than approximately 1½ inches from ends of the skid. Variation in specified thickness of skids may be plus or minus ⅛ inch and the variation in specified width of skids may be plus or minus ¼ inch. When skids are specified and box requires 2 or more inside battens (table 3-6), the inside bottom battens need not be applied. However, a skid shall be attached to the outside of the box bottom placed in alignment with each side batten.

(6) *Nailing requirements.*

(a) Spacing and sizes. Nail spacing and sizes will conform to tables 3-8 and 3-9.

(b) Nailing of top and bottom. When specified, the top and bottom should be nailed to the box sides.

(c) Nail sizes. Sizes of nails are determined from the following information:

1. Nail sizes for fastening sides, top, and bottom to ends and cleats are determined by the group of wood and thickness of the pieces being fastened together (table 3-7).

2. Nail sizes to secure top and bottom to the sides are determined from the group of wood being used and the thickness of the side (table 3-8).

3. Nails to fasten cleats to the ends will be long enough to penetrate both the cleat and the end and be clinched at least one-eighth of an inch. However, when eightpenny nails or smaller are used, they may be clinched not more than three-eighths inch.

4. If the correct nail size is not available, or splitting is encountered, one size smaller is used, and the spacing will be one-fourth of an inch closer.

(d) Nail spacing. The spacing of nails is determined from the following:

1. Nail spacing for fastening sides, top, and bottom to the ends will depend on the size of nails used, and whether driven into side-grain or end-grain. If nails are driven into both side- and end-grain, the spacing is the same as for end-grain nailing (table 3-9).

Table 3-6. Requirements for Additional Battens or Cleats

Thickness of ends, side, top, or bottom		Length of unsupported span
Groups I and II woods	Groups II and IV woods	
Inches	*Inches*	*Inches*
	1/4	19
3/8		21
	3/8	23
1/2		30
	1/2	34
5/8		38
	5/8	42
	3/4	47
1		50
	13/16	54
1-1/4	7/8	64

2. Nail spacing for fastening the top and bottom to the sides of the box is determined from the thickness of the sides. If the thickness of sides is less than three-fourths of an inch, no nailing is permitted. There is a minimum and maximum spacing (table 3-8).

3. When attaching cleats and battens, the nails are driven in two parallel rows spaced alternately as given in table 3-9, so that the end nails are not less than three-fourths of an inch from the end of the cleat or batten. All nails shall pass through both the cleat and the end (or batten and side, top and bottom) and be clinched. Nails are driven approximately three-eighths of an inch from the edge when the cleat or batten is 2 inches or under in width, and one-half of an inch when it is over 2 inches in width.

(e) Nailing rules. It is imperative that poor nailing practices be avoided and correct nailing procedures be followed. Both are shown in figures 3-13 and 3-14, and stressed in the following rules:

1. Each single solid piece or built-up piece in the sides, top, or bottom will have at least two nails or other acceptable fastener at each end.

2. Each single piece or built-up piece is fastened to each vertical cleat or batten with not less than two nails or other acceptable fastener.

3. Wherever possible, side-grain nailing should be accomplished. In nailing to both the end and the cleats, at least half of the nails are driven into the cleat.

4. Where a cleat is attached to an end, at least one end nail will be adjacent to the inside edge of the cleat.

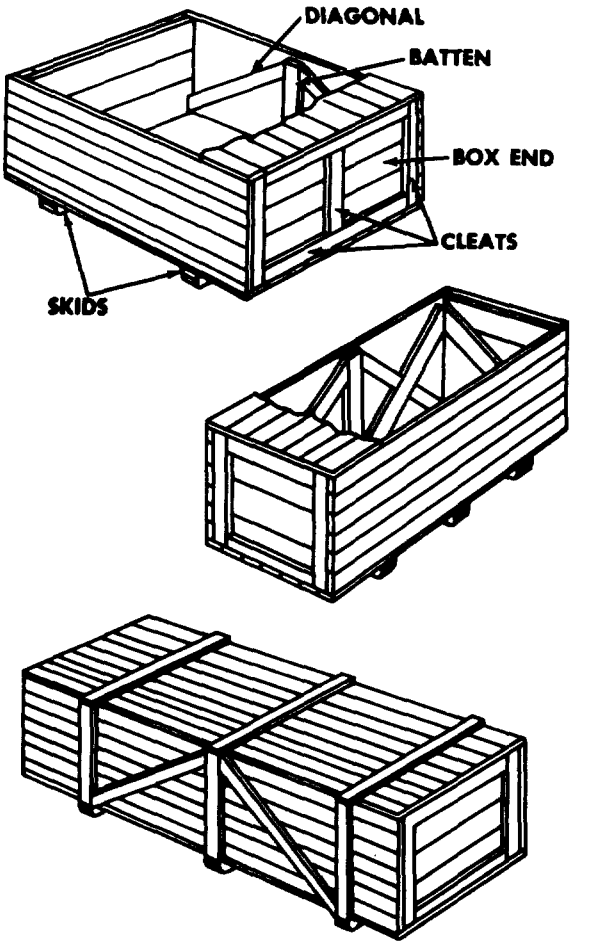


Figure 3-12. Style 2 reinforced wood box.

Table 3-7. Size of Cement-coated or Chemically-etched Cooler, Sinker, and Standard Box Nails for Boxes

Species of wood	Thickness of ends or cleats to which sides, tops and bottoms are nailed										
	Exceeding	.....	7/16	1/2	9/16	5/8	11/16	13/16	5/8	1	1-1/8	1-1/4
	Not exceeding	7/16	1/2	9/16	5/8	11/16	13/16	5/8	1	1-1/8	1-1/4	.....
Group I	Size of nail (penny)	4	5	5	6	7	8	8	9	9	10	12
Group II		4	4	5	5	6	7	7	8	9	9	12
Group III		3	4	4	5	5	6	7	7	8	9	10
Group IV		3	3	4	4	4	5	6	7	8	8	9

Table 3-8. Size of Nails and Spacing for Nailing Tops and Bottoms to Sides of Boxes

Tickness of side (inches)	Group I wood	Group II wood	Groups III and IV wood	Spacing (inches)	
				Minimum	*Maximum*
Under 3/4	No nailing permitted				
3/4 thru 7/8 incl	7d	6d	5d	6	8
15/16 thru 1-1/16 incl	8d	7d	6d	6	8
Over 1-1/16	10d	9d	8d	8	10

Table 3-9. Spacing of Nails

Size of nails	Spacing when driven into side grain	Spacing when driven into end grain
	Inches	*Inches*
Sixpenny or smaller	2	1-3/4
Sevenpenny	2-1/4	2
Eightpenny	2-1/2	2-1/4
Ninepenny	2-3/4	2-1/2
Tenpenny	3	2-3/4
Twelvepenny	3-1/2	3
Sixteenpenny	4	3-1/2
Twentypenny	4-1/2	4

When nails are alternately driven into end-grain of end and side-grain of cleat (such as nailing sides to ends in Styles 2, 2-1/2, 3, 4, 4-1/2, 5 and 7) use spacing based on driving nails into end-grain.

5. Nails are clinched across the grain of the wood, if possible.

6. Nails must be driven so that neither the head nor the point will project above the surface of the wood.

7. Occasionally, overdriven nails are permitted. Nails overdriven more than one-eighth the thickness of the piece are not permitted.

8. Cement-coated or chemically-etched nails have a holding power considerably greater than that of uncoated and consequently 25 percent more nails of the same size are needed when smooth nails are used in place of cement-coated or chemically-etched nails. The comparative holding power of nails is illustrated in figure 3-15. Bright, uncoated nails must be clinched.

f. Setting up of Style 1 and 6 Boxes. The setting up of these styles is accomplished in the following order:

(1) *Select nails and glue.*

(a) Size of coated and etched nails and proper spacing is determined from tables 3-7, 3-8, and 3-9.

(b) Glue for securing sides to ends of Style 6, lock-corner box, is any commercially available water-resistant glue.

(2) *Fasten the sides to the ends.*

(a) Fasten the sides to the ends by straight-line nailing, using cement-coated or chemically-etched nails.

(b) Apply glue to both surfaces of the sides and ends of the lock-corners of Style 6 boxes.

(3) *Nail the top and bottom.*

(a) Use nails and proper spacing determined in (1) above.

(b) Secure the bottom of the box by nailing into the ends.

(c) After the load is inserted, secure the top of the box in the same manner as the bottom.

g. Setting up of Style 2 and 2½ Boxes. The setting up of these styles is accomplished in the following order:

(1) *Select nails and proper spacing.* Select proper size and spacing of coated or etched, and bright, uncoated nails from tables 3-7 and 3-8.

(2) *Fasten the cleats to the ends.*

(a) Nail cleats to end, using a staggered nailing pattern.

(b) Nails for nailing cleats to ends may be bright, uncoated, but must be clinched.

(c) Position the vertical cleats on the end at right angles to the grain of the end.

(3) *Fasten the sides to the ends.*

(a) Lap the sides over the ends and cleats.

(b) Nail the sides to the ends and cleats with coated or etched nails in a staggered pattern.

(4) *Nail the top and bottom.*

(a) Lap the top and bottom over the ends and cleats.

(b) Nail the top and bottom to the ends and cleats with coated or etched nails in a staggered pattern.

h. Setting up of Style 4, 4½, 5, and Shallow Boxes. The setting up of these styles is accomplished in the following order:

(1) *Select nails and proper spacing.* Select the proper size and spacing of coated or etched, and bright, uncoated nails from tables 3-7, 3-8, and 3-9.

(2) *Fasten the cleats to the ends.*

(a) Nail the cleats to the end using a staggered nailing pattern (para 3-2e(6)).

(b) Nails for nailing the cleats to the ends may be bright, uncoated, but must be clinched.

(3) *Fasten the sides to the ends.*

(a) Lap the sides over the ends and cleats on Style 4 and 5 boxes.

(b) Fasten the sides to the ends and cleats in a staggered nailing pattern.

(c) Lap the sides of Style 4½ and shallow box over the ends.

(d) Drive the nails in a straight line for Style 4½ box and in a staggered pattern for shallow boxes.

(4) *Nail the top and bottom.*

(a) Nail the bottom of the box to the ends and sides.

(b) On style 4 and 5, boxes nail the top and bottom to the end with straightline nailing.

(c) On Style 4½ and shallow boxes, nail the top and bottom to the ends with a staggered nailing pattern.

i. *Strapping Requirements.* Strapping used on nailed wood boxes may be either round or flat (para

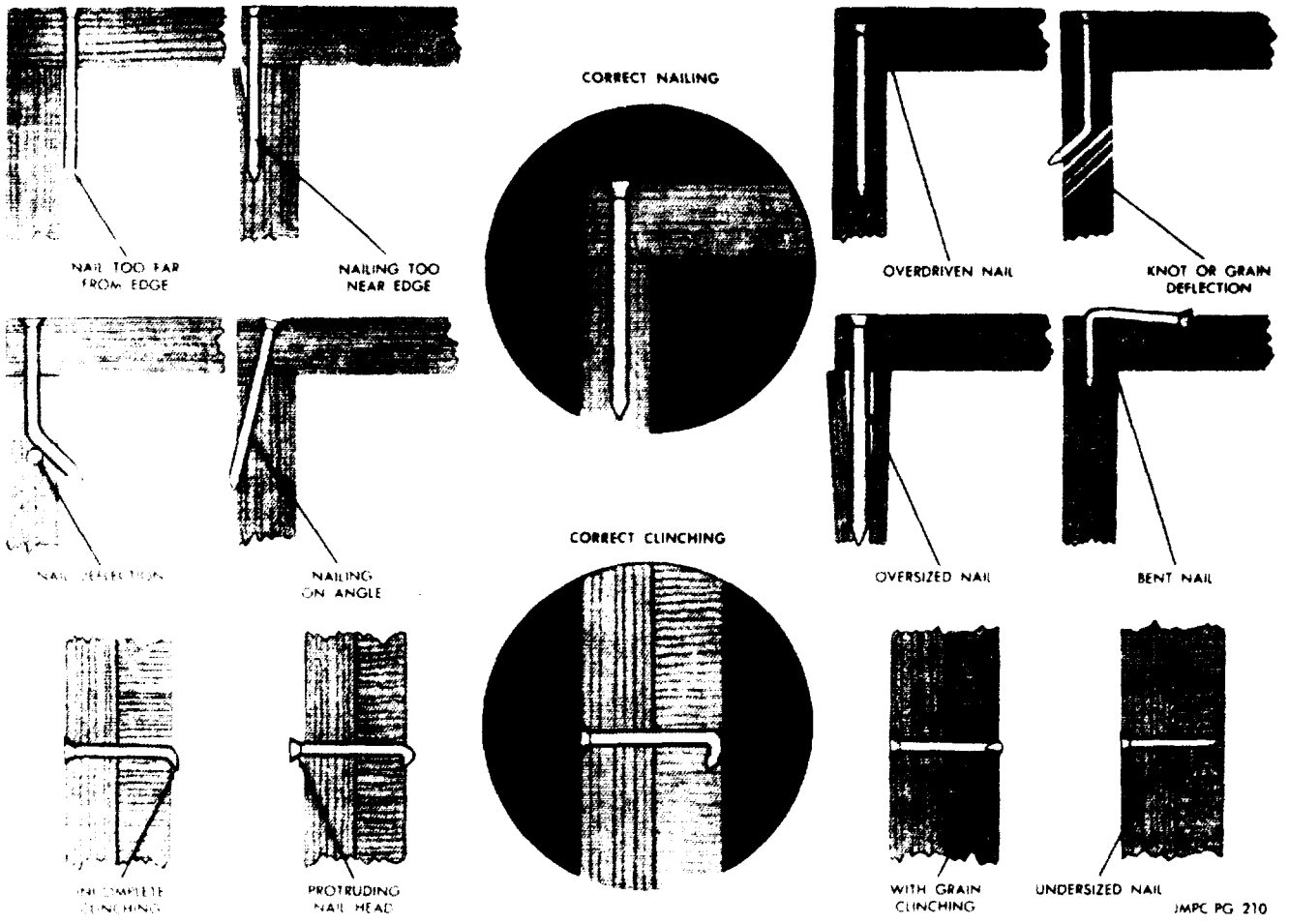


Figure 3-13. Nailing—avoid poor practice.

3-1*b*(6)). Proper size of strapping is determined by the net weight of contents and the number of straps used (tables 3-10 and 3-11). All straps are applied perpendicular to the edges of the box over which they pass and are drawn tight so as to sink into the wood at the edges. Straps shall be applied just prior to shipment where practicable. Strapping requirements are found in the Appendix to Specification PPP-B-621.

(1) *Class 1 (domestic) boxes.* Unless otherwise specified, Style 1 and 6 boxes, regardless of weight, and Style 2, 2½, 4, 4½, 5 and 7 boxes, with weight of contents exceeding 100 pounds, shall be strapped. When specified, Style 2, 2½, 4, 4½, and 5 boxes, with weight of contents less than 100 pounds, shall be strapped.

(2) *Class 2 (oversea) boxes.* All boxes used for a shipment intended for overseas shall be strapped (fig 3-16).

(3) *Placement of straps.*

(a) On most boxes, the first straps are positioned girthwise about one-sixth of the length of the box from each end, not to exceed 9 inches from the ends.

(b) On styles 1 and 6, the first strap is lengthwise, followed by two girthwise straps.

(c) When strapping is required on Style 7 boxes, one strap is applied parallel to, and immediately adjoining the inner edge of each skid. Three or more straps, equally spaced, are required when spacing between straps exceeds 24 inches.

(d) Additional straps are placed girthwise so that the distance between straps does not exceed 24 inches.

(e) Small boxes less than 12 inches long and having less than 35 pounds of contents require only one girthwise strap. The single girthwise

Table 3-10. Minimum Gage of Round Wire for Various Weights of Boxes.

Net weight of contents		Gage of wire when different number of wires are used			
		Two bands		Three or more bands	
Exceeding	Not exceeding	Class B	Class A	Class B	Class A
Pounds	*Pounds*	*Inch*	*Inch*	*Inch*	*Inch*
0	70	0.0720 (15 gage)	0.0625 (16 gage)	0.0720 (15 gage)	0.0625 (16 gage)
70	125	0.0800 (14 gage)	0.0720 (15 gage)	0.0800 (14 gage)	0.0720 (15 gage)
125	175	0.0915 (13 gage)	0.0800 (14 gage)	0.0915 (13 gage)	0.0800 (14 gage)
175	250	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)
250	400	0.1055 (12 gage)	0.0990 (12-1/2 gage)	0.0915 (13 gage)	0.0915 (13 gage)
400	1,000			0.1055 (12 gage)	0.0990 (12-1/2 gage)

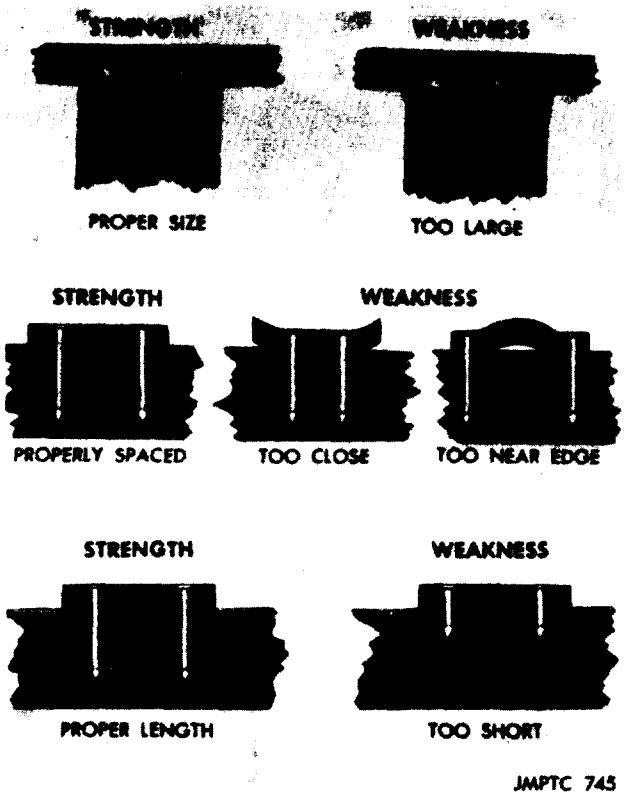


Figure 3-14. Proper and improper nailing.

strap may be 16 gage round wire, or ⅜ × 0.010-inch flat strap.

(f) When the outside length of unreinforced style 2, 2½, 4, 4½, 5, and shallow boxes exceeds 36 inches, three or more straps will be applied girthwise so that the distance between straps is not more than 24 inches.

j. Workmanship. Throughout the fabrication, setting up, nailing, and strapping of nailed wood boxes, good workmanship should be practiced at all times. Figure 3-17 shows some of the defects which must be avoided.

Table 3-11. Minimum Sizes of Flat Metal Bands for Various Weights of Boxes.

Net weight of contents		Dimensions of flat metal bands when different numbers of bands are used	
Exceeding	Not exceeding	Two bands	Three or more bands
	70	3/8 by 0.015	3/8 by 0.015
70	125	3/8 by 0.020	3/8 by 0.020
125	175	1/2 by 0.020	1/2 by 0.020
175	250	5/8 by 0.020	5/8 by 0.020
250	400	3/4 by 0.020	3/4 by 0.020
400	1,000		3/4 by 0.023

k. Preservation. When specified, each PPP-B-621 box or all of the finished wood parts shall be preserved by immersing for a minimum of one minute in one of the following wood preservative solutions: 2 percent copper Maphthenate, 3 percent zinc naphthenate, or 1.8 percent copper-8-quinolinolate. These three chemicals exhibit characteristics which are within safe health criterial levels and are acceptable for DOD-wide use provided handling instructions prescribed by the manufacturer are followed. After the dip treatment, the boxes or wood parts must be air dried (or dried for an appropriate time in a kiln or oven) for a period of 24 hours minimum in a well-ventilated area allowing full air circulation around all surfaces of the individual wood box or wood part. The boxes or parts must be dried prior to shipment. Dryness can be determined by the absence of discoloration of the red oil soluble dye when tested as specified in PPP-B—621.

3-3. Cleated-Panel Boxes (General)

a. Description. Cleated-panel boxes are made by attaching wood cleats to sheets of plywood, fiberboard, or paper-overlaid veneer to form panels that are later fastended together at the cleats to form a container. When plywood is used as panel material, they are called wood-cleated plywood boxes, specification PPP-B—601; when fiberboard

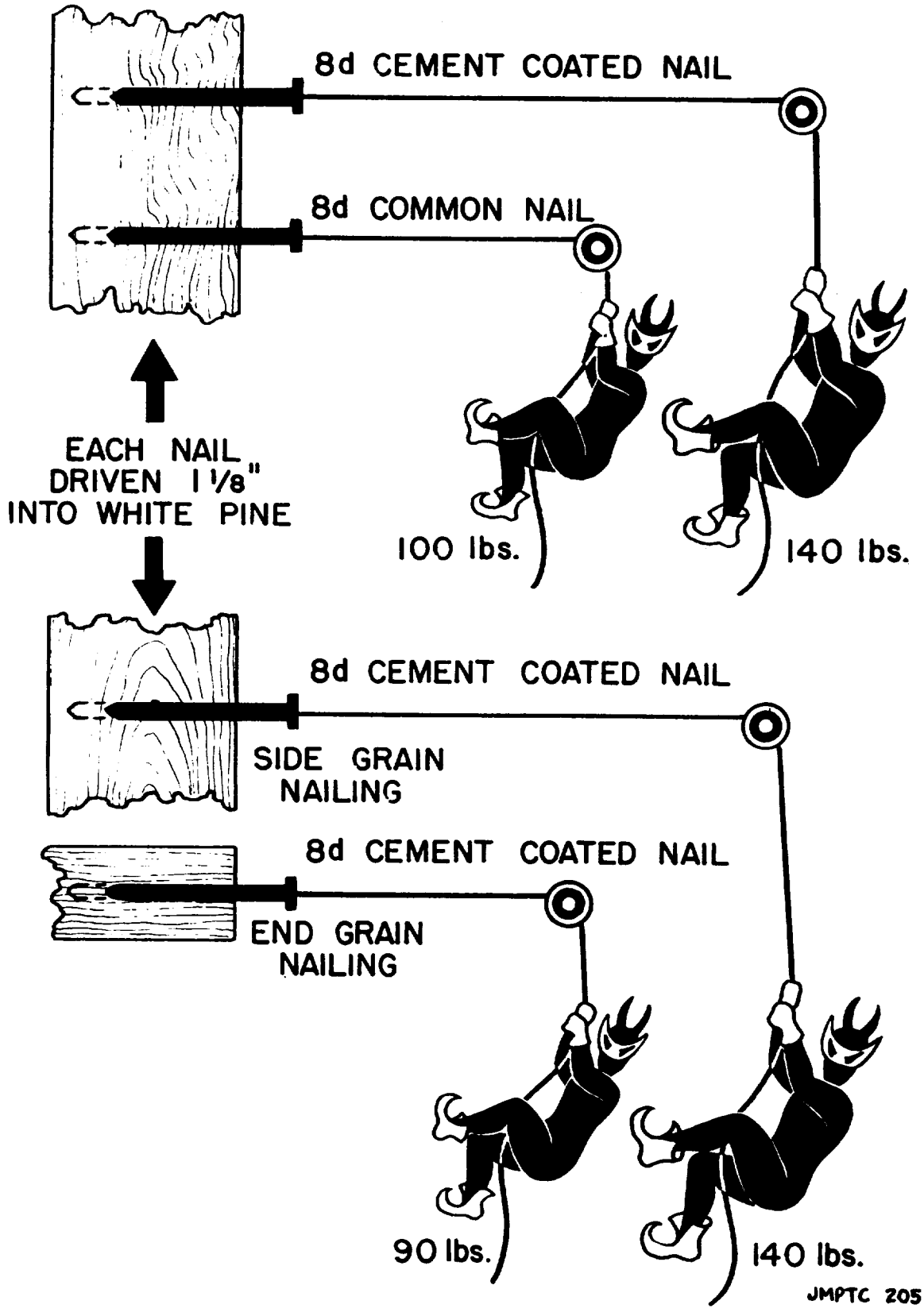


Figure 3-15. Nail holding power.

is used, they are called wood-cleated fiberboard boxes, specification PPP-B—591; and when paper-overlaid veneer is used, they are called wood-cleated, paper-overlaid veneer boxes, specification PPP-B-576. In each type of box, the cleats act to reinforce the edges and to aid in mailing.

b. Characteristics. The chief characteristics of cleated-panel boxes are: lightweight, high resistance to diagonal distortion, resistance to corner damage, and ability to withstand severe tumbling and dropping. They are easy to mark and handle, almost dustproof, and lend themselves to easy fabrication. Panels may be bought in large quantities in the knocked-down form, which can be easily stored in a minimum of space. These boxes afford three choices of cleated panel boxes for use in the shipping of military supplies and equipment. Selection of the panel material for the box is based upon the destination of the shipment, the minimum protection required, the weight of the item, and the container limitations.

c. Intended Uses and Limitations. The styles of boxes permitted for domestic and oversea shipments, with limitations for cleated plywood, cleated fiberboard, and cleated paper overlaid veneer boxes are cited in table 3-12.

(1) *Oversea type boxes.* Styles A and B are the only ones permitted, for cleated fiberboard and veneer. Cleated plywood boxes permit Styles A, B, I, and J. Plywood and paper overlaid boxes will take all three types of loads. Cleated fiberboard boxes will take Type 1 and 2 loads only. Style A lends itself to ease of assembly and opening. Style B has greater strength, but is more difficult to open. The designs of these boxes and their load limit for oversea shipments are given in the respective container specifications.

(2) *Domestic type boxes.* Domestic boxes are intended for normal use when the additional strength of the oversea type is not required (fig 3-19). The selection of the style depends largely on the nature and weight of the item, and how it is to be supported. Styles B, D, E, and G have 3-way corners and are satisfactory if the boxes are not to be opened for inspection and reclosed. If the boxes are to be opened and reclosed, Style A and K are preferred. The full-cleated Styles A and B are the strongest and most suitable for heavy items, if the weight can be applied over the entire area of any face. Styles A and B require only one size of nails for assembling the box, whereas, two sizes of nails are required for Styles C and K, inclusive. Paper overlaid veneer boxes are only available in Styles A and B for domestic shipment. All three types of loads are permitted, except for wood cleated fiberboard boxes, where Type 3 loads must be converted to either Type 1 or 2.

3-4. Cleated Plywood Boxes (PPP-B—601)

a. Construction of Panels. Plywood will conform to the minimum commercial standard grades in table 3-13. Plywood for domestic boxes will conform to HPMA-HP 1983, type III, grade 3-4, and PS-1, standard interior. Plywood for overseas boxes will conform to HPMA-AP 1983, type I, grade 3-4, and PS-1, standard interior with exterior glue (see tables 3-14, 3-15). If it is known that the boxes will not be exposed to the weather during storage and handling to its final overseas destination, plywood as specified for domestic type boxes should be specified. Cleated-plywood boxes are classified as grade A, with preservative treatment, and grade B, without preservative treatment. Plywood and cleats for grade A boxes shall be treated with water-repellant preservative conforming to the following: 2% copper Maphthenate,

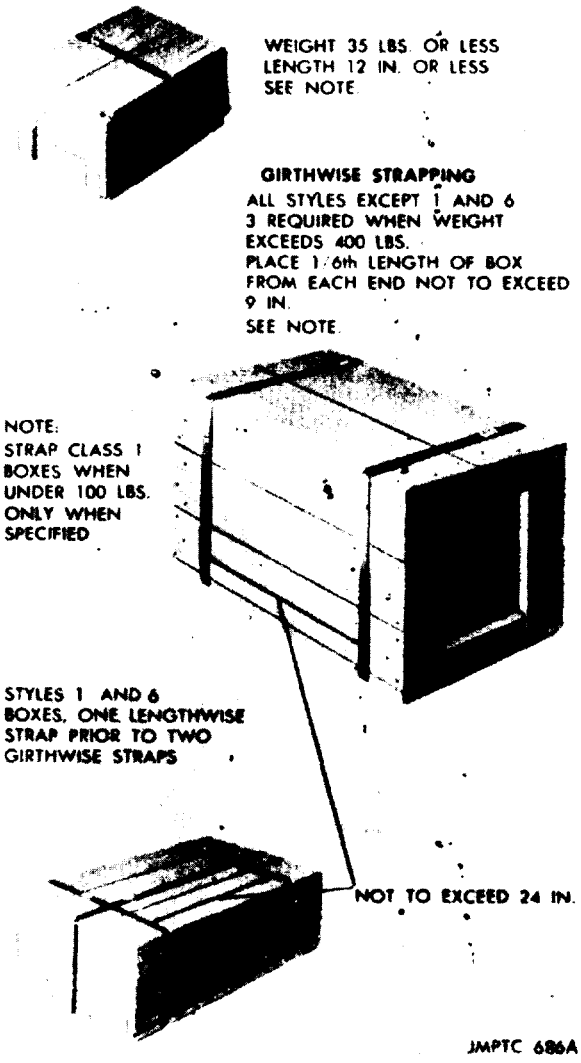
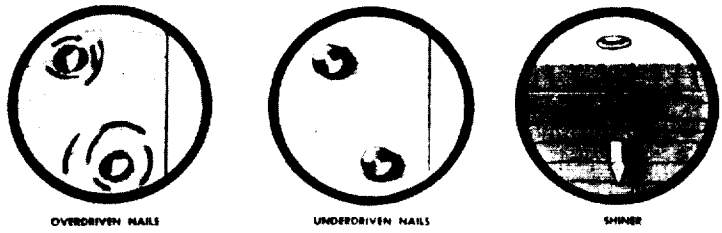


Figure 3-16. Strapping of nailed wood boxes.



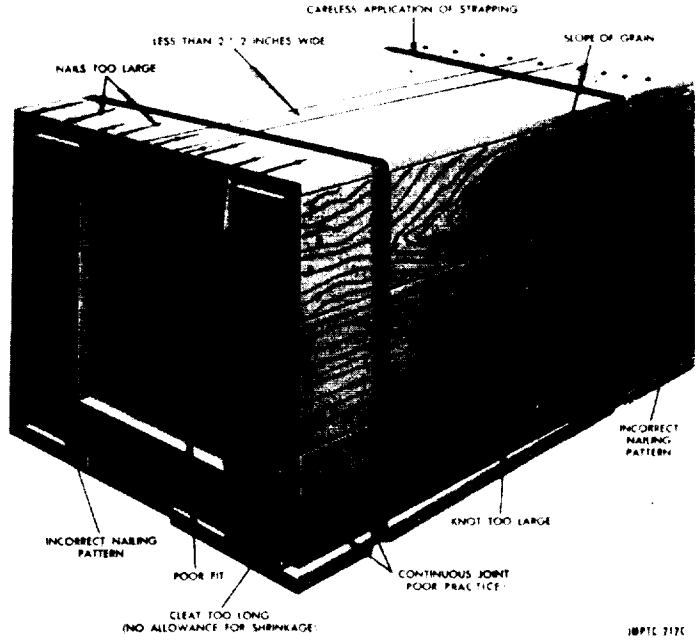


Figure 3-17. Defects of nailed wood boxes.

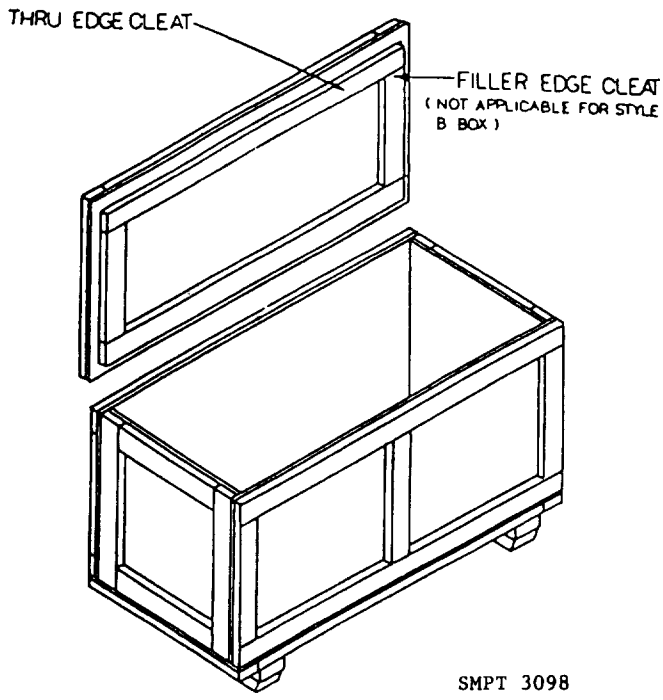


Figure 3-17.1. Top panel modification of unnailed closure, PPP-B-601, style A box.

3% zinc naphthenate, and 1.8% copper-8-quinolate. Treated boxes shall be dried before shipment. Shipments of subsistence and clothing shall not be made in boxes fabricated from toxic treated plywood. If smooth finish for sanded panels are required, appropriate sanded grades should be specified. The minimum thickness of the plywood and size of cleats should be as shown in tables 3-14 or 3-15, as applicable. The plywood is attached to the cleats in the following manner:

(1) *Arrange the cleats.*

(*a*) Each panel for styles A and B will have two through cleats and filler cleats.

(*b*) Position the through cleats opposite each other at the edges of the panel material; then position the filler cleats between the through cleats at the edges.

(*c*) Style A and B boxes may have the top panel modified. When specified, style A shall have edge cleats and filler edge cleats placed on the underside of the top panel (fig. 3-17.1). Style B boxes are modified by providing through edge cleats only on the underside of the panel. These underside cleats shall be of the same width and thickness as the outer cleats.

(*d*) Unless otherwise specified (*e* and *f* below), filler edge cleats shall be either the same length as the distance between the through edge cleats or approximately one-eighth inch shorter.

(*e*) Filler edge cleats on top and bottom panels, except on top only when the box is provided with skids, shall be either the same length as the distance between the through edge cleats or approximately one-fourth inch shorter for overseas type boxes.

(*f*) When the filler cleats are the same length as the distance between through edge cleats, each end shall be either cut at an angle or notched to provide a drainage area between the filler cleat and the plywood of approximately one-fourth inch by one-fourth inch. Drainage areas are not applicable on the underside cleats of the top panels of the unnailed closure style A box.

(*g*) Each cleat shall be a single unjointed piece.

(2) *Fasten the panel material to the cleats (fig 3-20).*

(*a*) Nails, staples, wire stitches, or other fasteners positioned lengthwise of a cleat are staggered in two parallel rows, approximately three-eighths inch from the edge of the cleat.

(*b*) The distance between the nearest edge of a fastener and the edge of a cleat shall not be less than three-eighths of an inch and not closer than three-fourths of an inch nor more than 1 inch from the end of the cleat.

(*c*) Space the nails not more than 6 inches apart lengthwise in each row.

Table 3-12. Comparison of Cleated Panel Boxes

Items of comparison	Cleated plywood (PPP-B-601)	Cleated fiberboard (PPP-B-591)	Paper overlaid veneer (PPP-B-576)
Styles	A, B, I and J	A through K	A and B
Class of use	domestic and overseas	1 and 2	1 and 2
Styles, oversea	A, B, I and J	A and B	A and B
Styles, domestic	A, B, I and J	A through K	A and B
Weight limit vs. styles			
Oversea	A, B, I and J 1,000*	A and B 200*	A and B—350*
Domestic	A, B, I and J 1,000*	A and B—400* C through K—150*	A and B—400*
Types of loads vs. weight	1, 2 and 3	1 and 2	Type 1—2 Domestic 400* Type 3—Domestic 300* Type 1—2 Overseas 350* Type 3—Overseas 250*
Unsupported span for intermediate cleats, maximum.	Type 1 and 2 loads—24" Type 3 load—20"	Overseas—20" Domestic—24"	Type 3 load, Class 2 use—20" All other—24"
Size limit			
Oversea	No size limit	4'×3'×3'	No size limit
Domestic	No size limit	No size limit	No size limit

Table 3-12. Comparison of Cleated Panel Boxes

Items of comparison	Cleated plywood (PPP-B-601)	Cleated fiberboard (PPP-B-591)	Paper overlaid veneer (PPP-B-576)
Strapping			
Styles A and B	2 lengthwise straps, and strap over all intermediate cleats, except cleats located on ends of plywood containers		All class 2 boxes and Class 1 when over 150*
Styles C thru K	Consult Appendix of Specification		
Staples	4" maximum from corners, approximately 6" apart thereafter (except over bands on bottom of box for plywood)		

(*d*) Space staples not more than 7 inches apart in each row.

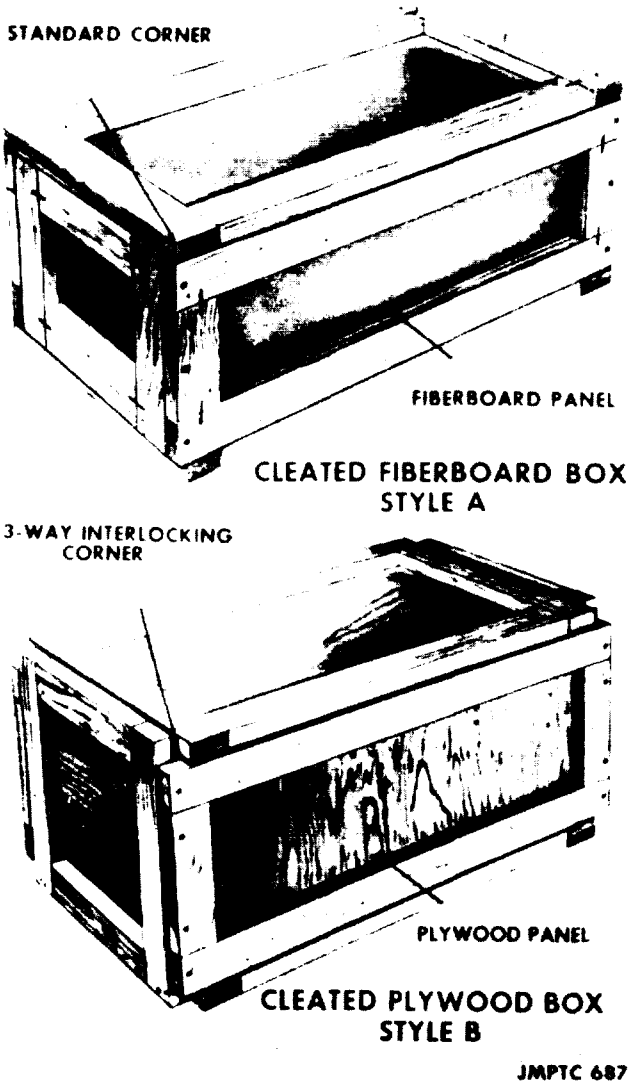


Figure 3-18. Oversea styles of cleated panel boxes.

(*e*) Usually, nail or staple through the plywood and then cleat and clinch. Reversal of this sequence is permitted only for nails.

b. Construction of Plywood Joints. In the construction of large cleated plywood boxes, it frequently becomes necessary to join sheets of panel material. Bottom panels of boxes not exceeding 72 inches in length or 48 inches in width, and top and bottom panels of style I boxes shall consist of a single piece of plywood. All other panels shall consist of one or two pieces of plywood joined by either a lap or butt joint (see fig 3-21) as specified in (1) and (2) below. Each piece of plywood in two-piece panels shall be not less than 24 inches in length or width. Plywood joints in adjacent panels should not be closer than 12 inches of being in line.

(1) *Lap joint.* Overlap two pieces of panel material at least 3 inches. Fasten the sheet together with metal stitches through the overlap and clinch. Use not less than two parallel rows of stitches. Space stitches not less than 2 inches apart. The average spacing of stitches in each row must not exceed 4 inches. The maximum thickness of plywood to be used for this type of joint shall be $\frac{3}{16}$ inch.

(2) *Butt joint.* Butt two pieces of plywood at the midwidth of a joint cleat. Fasten each piece of plywood to the joint cleat. The thickness of a joint cleat will be the same as an edge cleat. The width of a joint cleat for a domestic box will be no less than 2¼ inches. If the edge cleat is more than 2¼ inches wide, the joint cleat will be of the same width. For oversea type boxes, the joint cleat will be not less than 1⅓ times the required width of the edge cleats or never less than 2¼ inches.

c. Determine the requirements. Additional wood cleats, of the same width and thickness as the edge cleat, are applied to an unframed area which exceeds 24 inches in any dimension or 20 inches for oversea type boxes with Type 3 loads. Additional cleats are applied to any face of a box having a load concentration near the center of the unframed area.

(1) *Fasten the cleats.* Apply cleats perpendicular to the greater of the two dimensions between

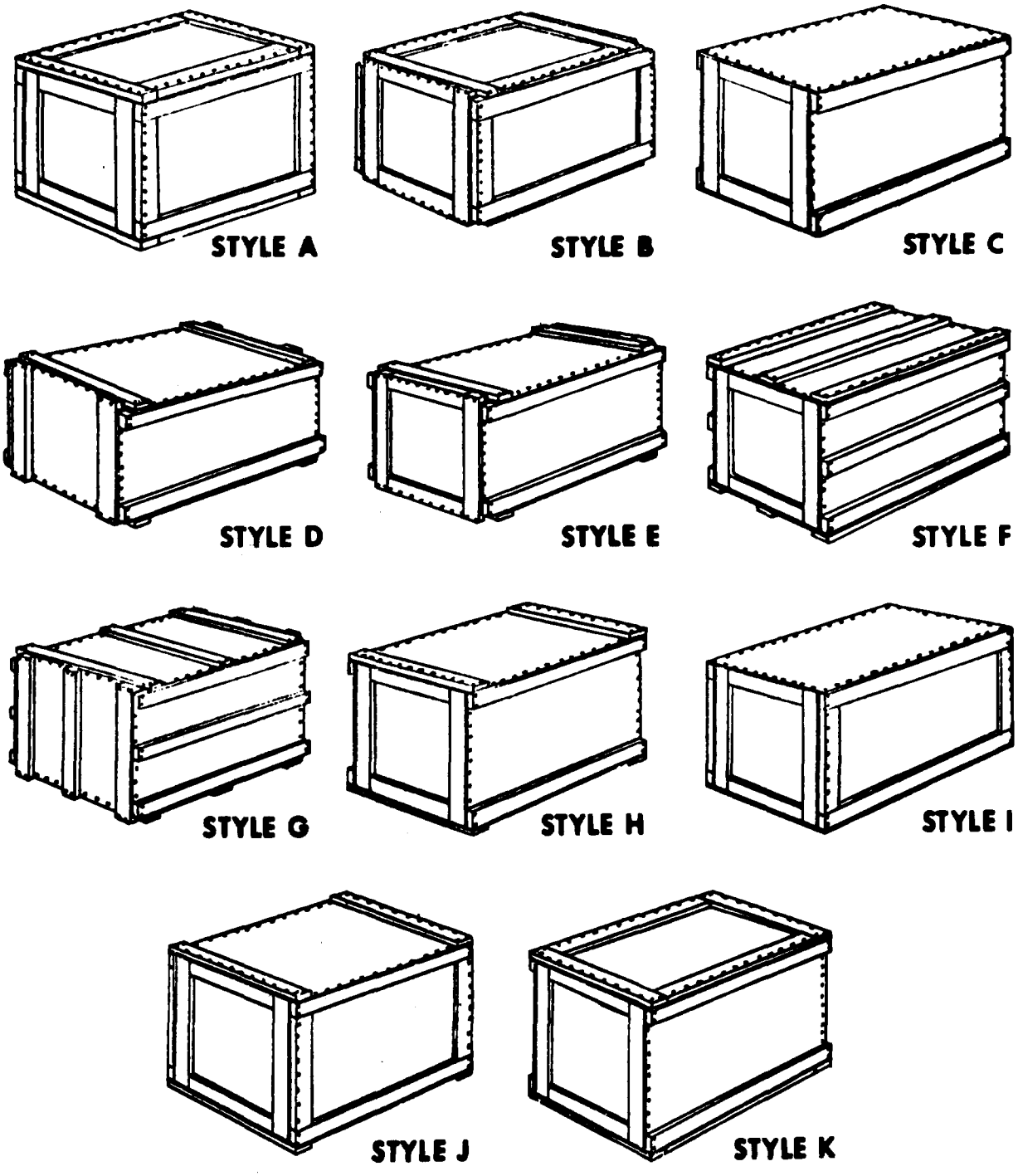


Figure 3-19. Styles of cleated panel boxes.

Table 3-13. Plywood PS-1 and PS-51, Commercial Standards [1], [2]

Box type	PS-51	PS-1
Domestic	Type III, grade 3-4 venters	C-D.
Overseas	Type I, grade 3-4 veneers	C-D, with exterior glue.

[1] Plywood is furnished unsanded. If smooth finish or sanded panels are required, appropriated sanded grades should be specified in the contract or order.
[2] End grain butt joints shall be prohibited for grade 4 veneers.

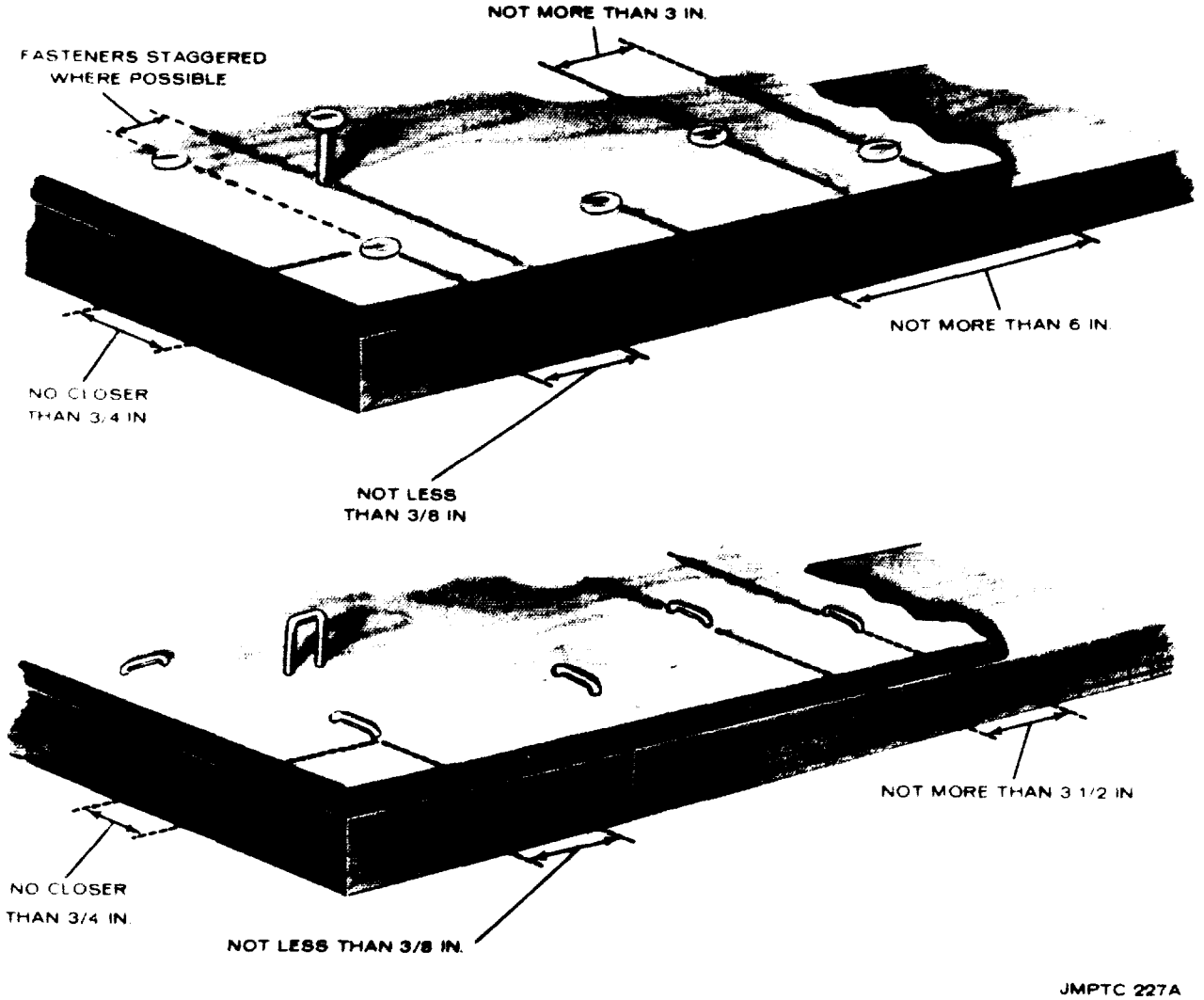


Figure 3-20. Spacing of fasteners.

edge cleats. Space and drive fastenings in the same manner as for edge cleats.

d. Assembly of Boxes.

(1) *Style A (oversea)*

(a) Assembly of the panels. Arrange the panels so that one through cleat and one filler cleat forms each edge of the box. Arrange the cleats to form a standard box corner (fig 3-18). Arrange the top and bottom panels to overlap the sides and ends.

(b) Nailing the panels together. Nail all panels to each other by single line nailing. Use either mechanically deformed, cement-coated or chemically-etched nails. Space the nails in accordance with the type of load and the thickness of cleats (tables 3-16 and 17).

(2) *Style B (oversea).*

(a) Assembly of the panels. Arrange the panels so that one through cleat and one filler cleat forms each edge of the box. Arrange the

Table 3-14. Domestic Type, Requirements for Cleats and Plywood (PPP-B—601)

Style of box	Weight of contents		Minimum thickness of plywood [5]		Size of cleats [1]	
	Exceeding	Not exceeding	PS-1 (see table 3-13) [2]	HPMA-HP 1983 (see table 3-13) [3]	Thickness	Width
					All Wood groups (incl)	All Wood groups (incl)
	Pounds	*Pounds*	*Inch*	*Inch*	*Inch*	*Inches*
A, B, I and J	0	75	5/16 [4 6]	1/8	3/4	1 3/8
A, B, I and J	75	150	5/16 [4 6]	1/8	3/4	1 3/4
A, B, I and J	150	300	5/16 [4 6]	3/16 [4]	3/4	1 3/4
A, B, I and J	300	500	5/16 [6]	3/16	3/4	1 3/4
A, B, I and J	500	800	5/16	1/4	3/4	2 1/4
A, B, I and J	800	1000	3/8	5/16	3/4	2 5/8

[1] At no place shall the actual thickness be less than the required thickness, minus 1/16 inch, nor the actual width be less than the required width, minus 1/4 inch.
[2] Alternatively low density wood plywood conforming to HPMA-HP 1983 (table 3-13) may be used.
[3] Low density wood plywood conforming to HPMA-HP 1983 (table 3-13) shall not be used.
[4] 5/20 minimum inch thick plywood conforming to type III, grade 4 of HPMA-HP 1983 may be used in place of the 5/16 inch (3/20 inch thick plywood is not standard thickness in HPMA-HP 1983).
[5] Except that commercial tolerance shall apply.
[6] At the option of the supplier, 1/4-inch sanded plywood may be furnished.

Table 3-15. Overseas Type, Requirements for Cleats and Plywood (PPP-B-601)

Weight of contents		Minimum thickness of plywood [6]								Sizes of edge cleats for all groups [1]	
		Types 1 and 2 loads				Type 3 load					
		PS-1 (see table 3-13) [2]		HPMA-HP 1983 (see table 3-13) [3]		PS-1 (see table 3-13) [2]		HPMA-HP 1983 (see table 3-13) [3]			
		Style		Style		Style		Style			
Exceeding	Not Exceeding	A&B	I and J [4]	A&B	I and J [4]	A&B	I and J [4 7]	A&B	I and J [4 7]	Thickness	Width
Pounds	*Pounds*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*	*Inch*
0	100	5/16 [8]	3/8	3/16 [5]	5/16	5/16 [8]	3/8	3/16 [5]	5/16	3/4	1 3/4
100	200	5/16 [8]	3/8	3/16 [5]	5/16	5/16 [8]	3/8	3/16	5/16	3/4	1 3/4
200	300	5/16 [8]	1/2	3/16	3/8	5/16	1/2	1/4	3/8	3/4	1 3/4
300	400	5/16 [8]	1/2	3/16	3/8	5/16	1/2	1/4	3/8	3/4	1 3/4
400	500	5/16 [8]	1/2	3/16	3/8	5/16	5/8	1/4	1/2	3/4	2 1/4
500	600	5/16	1/2	1/4	3/8	5/16	5/8	1/4	1/2	3/4	2 5/8
600	800	3/8	5/8	5/16	1/2	3/8	5/8	5/16	5/8	3/4	3 1/4
800	1000	3/8	5/8	5/16	1/2	1/2	5/8	3/8	5/8	3/4	3 1/4

[1] At no place shall the actual thickness be less than the required thickness, minus 1/16 inch, nor the actual width be less than the required width, minus 1/4 inch.
[2] Alternatively low density wood plywood conforming to HPMA-HP 1983 (table 3-13) may be used.
[3] Low density wood plywood conforming to HPMA-HP 1983 (table 3-13) shall not be used.
[4] Top and bottom panels of I and J boxes only, all other panels as specified for styles A and B.
[5] Minimum 3/20 inch thick plywood conforming to type I, grade 4 of HPMA-HP 1983 may be used in place of the 3/16 inch thick plywood. (3/20 inch thick plywood is not a standard thickness in HPMA-HP 1983).
[6] Except that commercial tolerance shall apply.
[7] The maximum weight of contents for Air Force shipments for style I and J shall be 150 lbs.
[8] At the option of the supplier, 1/4 inch sanded plywood may be furnished.

cleats to form a 3-way interlocking corner (see fig 3-18). Arrange the top and bottom to overlap the sides; then arrange the ends to overlap the top and bottom and, finally, arrange the sides to overlap the ends.

(b) Nailing the panels together. Nail each through cleat to two other through cleats at the corner with nails driven at right angles to each other. Nail the panels to each other by single line nailing. Use either mechanically deformed, cement-coated, or chemically-etched nails. Space the nails in accordance with the type of load and the thickness of the cleats (tables 3-16 and 3-17).

(3) *Styles A, B, I and J (domestic).* Four styles are available for domestic use: styles A, B, I

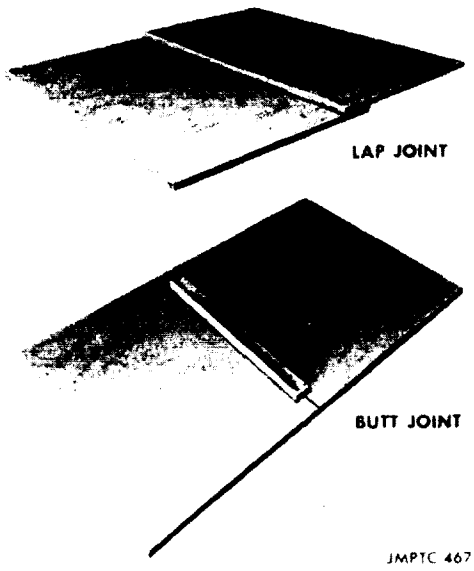


Figure 3-21. Acceptable plywood joints.

and J, depending on the cleat arrangement. A study of figure 3-19 shows the cleat arrangement for each style. For Styles I and J the plywood along each uncleated edge is fastened to the cleat on the adjacent panel by nails passing through the plywood and into the cleat. Nails shall not be less than 1 inch longer than the thickness of the plywood through which they pass for domestic type and 1⅜ inches for overseas types and their spacing shall not exceed 3 inches.

e. Application of Skids. Unless otherwise specified, boxes with items packed therein, having a gross weight in excess of 200 pounds or length and width dimensions of 48 inches by 24 inches or more, and gross weight of 100 pounds or over, shall be provided with a minumum of two skids. The skids shall be a minimum of 2½ inches high and 3½ inches wide. When 4-way fork entry is required, skids shall be nominal 4-by-4-inch, placed lengthwise not less than 1½ inches nor more than 2½ inches from the container sides and cut out a minimum of 2 inches in depth and of such width as to accommodate forks and slings for handling. Each skid shall be notched sufficiently to provide clearance for strapping. The skids shall be placed parallel to, and extend the full width of the box (the shorter of the two horizontal dimensions), and shall be set not less than 2½ inches nor more than ⅛ the box length from each end. The distance between skids, measured between the inside edges, shall not exceed 48 inches. Filler cleats of the same thickness as the end cleats of the bottom panel and not less than the width of the skids shall be provided between each skid and the bottom panel of the shipping container. Additional skid(s), as required, shall be positioned so as to divide the area between the end skids into units of equal lengths. When boltholes are provided in the item, additional skids if needed, shall be located so as to enable the item to be bolted to the skids. The skids shall be secured to the box by nails. The nails shall be driven through the bottom panel, the filler cleats, and the skids, and shall penetrate a minimum of three-fourths the skid, thickness. The nails shall be pallet nails having mechanically deformed shanks conforming to FF-N-105. These nails shall not protrude through the bottom surface of the skid. The nails shall be arranged in two rows in a staggered pattern, with spacing between nails in each row to be not more than 6 inches. Each row of nails shall be approximately one-half inch in from the edge of the skid, and the nailing pattern shall begin and end approximately 1½ inches in from the end of each skid and shall not be nailed through the strap notch.

Table 3-16. Domestic Type, Sizes and Spacing of Nails for Fastening Together Adjacent Cleated Panels

Cleats Thickness	Maximum spacing of nails all wood groups		Size of nails for wood groups [1]			
	Types 1 and 2 loads	Type 3 load	I	II	III	IV
Inch	*Inches*	*Inches*	Penny	Penny	Penny	Penny
¾	5	4	7	7	7	6

[1] If the nail protrudes through the last edge clear or splits cleat, then the next smaller size penny nail shall be used.

f. Closure. The top panel shall be positioned and nailed. The size and spacing of nails shall be shown in tables 3-16 and 3-17. Drive nails straight to prevent them from protruding.

g. Strapping Requirements. Strapping requirements are found in the appendix to PPP-B-601. The sizes of round wire and flat metal straps are found in tables 3-18, 3-19 and 3-20. Styles A or B boxes that have modified tops will be closed with flat steel strapping. Other means are prohibited.

(1) Styles A, B, I and J (overseas).

(a) Strap styles A, B, I and J, unless otherwise specified (see figure 3-23).

(b) On styles A and B, apply two lengthwise straps on the edge cleats over the ends, top, and bottom.

(c) On styles I and J, apply two lengthwise straps on the edge cleats over the ends and sides.

(d) Place a girthwise strap over intermediate

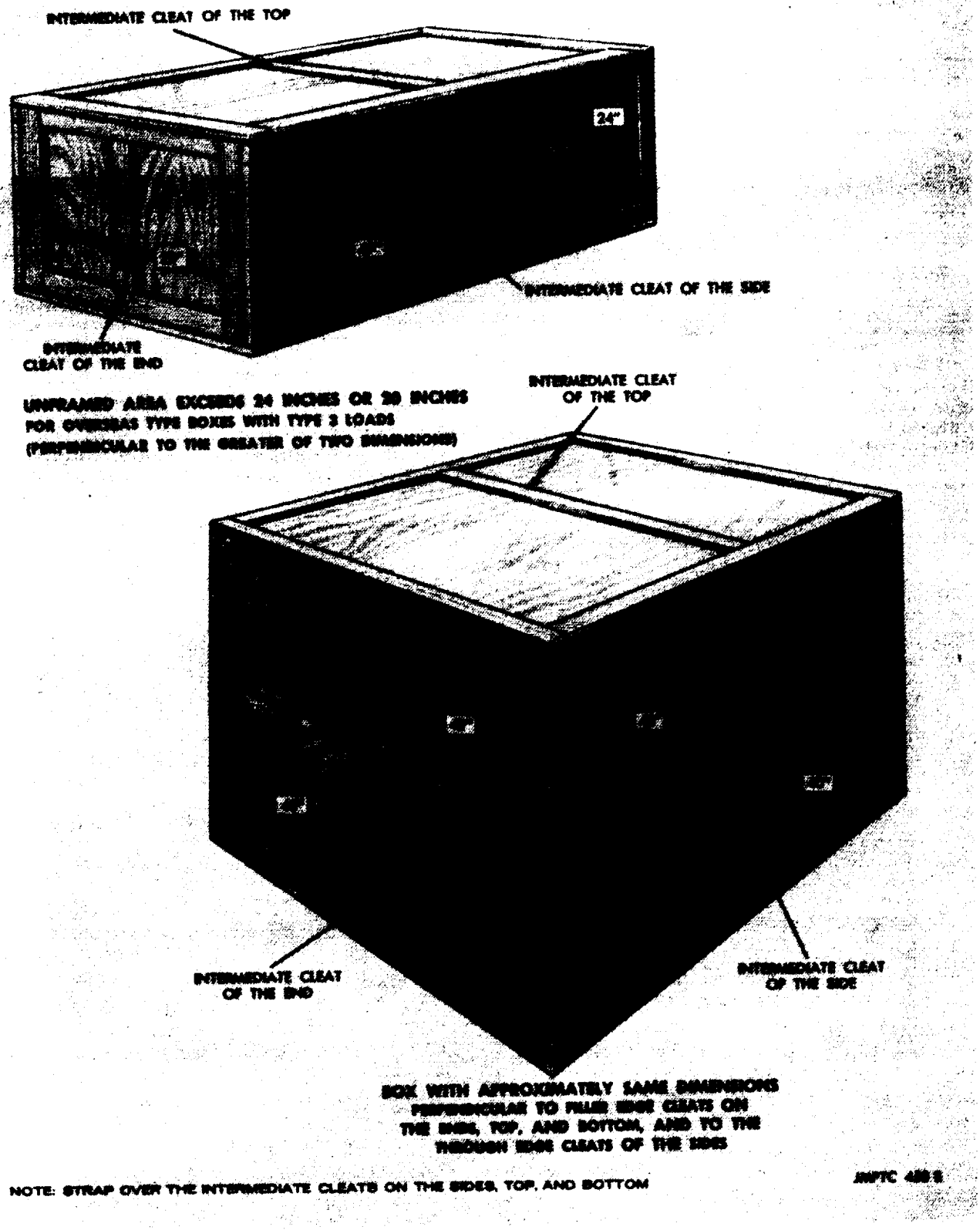


Figure 3-22. Spacing of intermediate cleats.

Table 3-17. Oversea Type, Sizes and Spacing of Nails for Fastening Together Adjacent Cleated Panels

Cleats, thickness (Inch)	Maximum spacing of nails, all wood groups		Size of nails for wood groups[1]			
	Types 1 and 2 loads	Type 3 load	I	II	III	IV
	Inches	*Inches*	*Penny*	*Penny*	*Penny*	*Penny*
3/4	5	4	9	8	7	6

[1] If the nail protrudes through the last edge cleat or if it splits the cleat, then the next smaller size penny nail shall be used.

Table 3-18. Diameter of Round Wire Strapping

Weight of contents	Diameter of wire when different numbers of wire are used			
	2 wires		3 or more wires	
	100,000 pounds per square inch tensile strength	140,000 pounds per square inch tensile strength	100,000 pounds per square inch tensile strength	140,000 pounds per square inch tensile strength
Pounds	*Inch*	*Inch*	*Inch*	*Inch*
Up to 70, incl	0.0720 (15 gage)	0.0720 (15 gage)	0.0720 (15 gage)	0.0720 (15 gage)
71 to 125, incl	0.0800 (14 gage)	0.0720 (15 gage)	0.0800 (14 gage)	0.0720 (15 gage)
126 to 175, incl	0.0915 (13 gage)	0.0800 (14 gage)	0.0915 (13 gage)	0.0800 (14 gage)
176 to 250, incl	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)	0.0915 (13 gage)
251 to 400, incl			0.0915 (13 gage)	0.0915 (13 gage)
401 to 1,000, incl			0.1055 (12 gage)	0.0990 (12-1/2 gage)

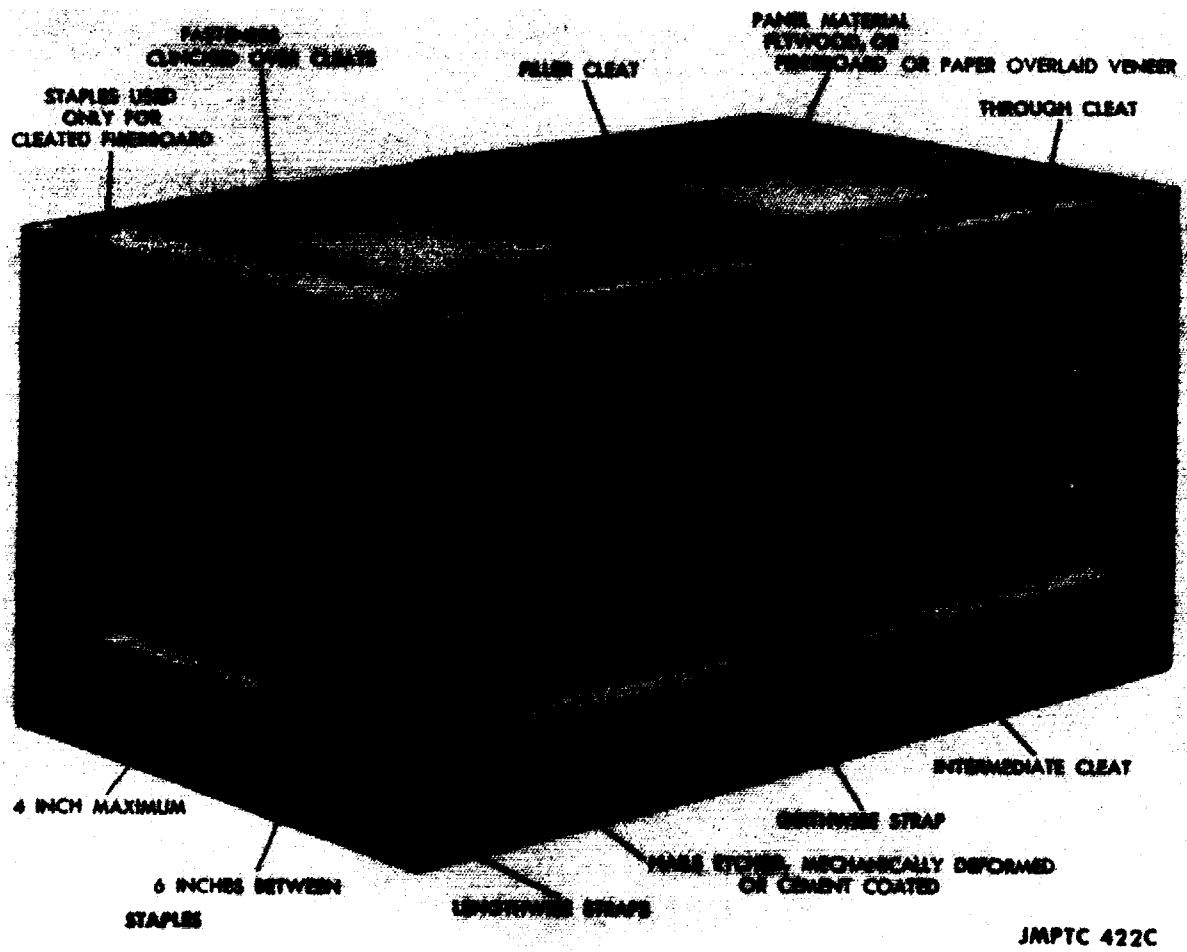


Figure 3-23. Strapping of cleated panel boxes.

cleats, when required, on the sides, top and bottom.

(e) Draw strapping tightly so as to sink into the edges of the cleats.

(f) Fasten strapping to the cleats with staples spaced approximately 6 inches apart, and within 4 inches from the edge of the box over which the strap passes (except over bands on the bottom of the box and bands applied over filler cleats on the top). Staples shall be applied just prior to shipment where practicable. Strapping used for unnailed closure boxes shall not be stapled.

(g) Alternately, each lengthwise and girthwise strap may be replaced by four corner straps each 8 inches long and secured to the box with three staples on each leg pneumatically driven through the strap into the cleat. However, corner straps shall not be used on unnailed closure boxes.

(h) Exercise care in strapping domestic styles so that the straps do not pass over voids between cleats and thus become susceptible to snagging.

(2) *Styles A, B, I and J (domestic).*

(a) Strap domestic styles only where specified.

(b) Strap in accordance to the appendix to PPP-B-601.

Table 3-19. Size of Flat Metal Bands

Weights of contents	Dimension of flat metal bands when different numbers of bands are used	
	2 bands	3 or more bands
Pounds	*Inch*	*Inch*
Up to 70, incl	3/8 by 0.020	3/8 to 0.020
71 to 125, incl	3/8 by .020	3/8 by .202
126 to 175, incl	1/2 by .020	1/2 by .020
176 to 250, incl	5/8 by .020	5/8 by .020
251 to 400, incl		3/4 by .020
401 to 1000, incl		3/4 by .023

Table 3-20. Size of Type III, Twist-Tied Flat Metal Strapping

Weight of contents not exceeding	Dimensions when different numbers of bands are used	
	2 straps	3 or more straps
Pounds	*Inch*	*Inch*
70	0.140 by 0.031	0.138 by 0.025

Table 3-21. Requirements for Fiberboard for Class I Domestic Box (PPP-B-591)

Weight of contents of box		PPP-F-320 material requirements	
Exceeding	Not exceeding	Type CF (double-faced) Class—domestic Grade	Type SF (solid-fiberboard) Class—domestic Grade
Pounds	*Pounds*		
0	75	200	200
75	150	275	275
150	225	300	300
225	300	350	350
300	400	400	375

Table 3-22. Requirements for Fiberboard for Class II Weather-Resistant Box (PPP-B-591)

Weight of contents of box	Style of box	Dimensional limitations maximum			PPP-F-320 material requirements, type SF Grade
Not exceeding		Length	Width	Depth	
Pounds		Feet	Feet	Feet	
200	A or B	4	3	3	V3s or V4s

Table 3-23. Size of Cleats for Class I Domestic Box (PPP-B-591)

Style of box	Weight of contents of box		Minimum size of cleats		
	Exceeding	Not exceeding	Thickness		Width
			Groups I and II woods	Groups III and IV woods	All wood groups, inclusive
	Pounds	*Pounds*	*Inch*	*Inch*	*Inches*
C through K	0	75	11/16	5/8	1-1/2
C through K	75	150	3/4	11/16	1-11/16
A and B	0	75	5/8	9/16	1-1/2
A and B	75	150	11/16	5/8	1-3/4

Table 3-23. Size of Cleats for Class I Domestic Box (PPP-B-591)—Continued

Style of box	Weight of contents of box		Minimum size of cleats		
			Thickness		Width
	Exceeding	Not exceeding	Groups I and II woods	Groups III and IV woods	All wood groups, inclusive
A and B	150	300	3/4	11/16	1-3/4
A and B	300	400	1	13/16	1-3/4
A and Ab					

h. Dimensions. Dimensions shall be given in the sequence of length, width and depth of the inside measurements. The first two dimensions will be the open face of the box. A tolerance of plus or minus ⅛ inch is permitted in the dimensions.

3-5. Cleated-Fiberboard Boxes (PPP-B-591)

These boxes are identical in styles and similar in construction to the cleated plywood boxes with the following exceptions:

a. Fiberboard is used in place of plywood as the panel material (tables 3-21 and 3-22).

b. Cleated fiberboard boxes handle only type 1 and 2 loads. Styles A and B only are authorized for both domestic and overseas shipments. They are limited to a maximum weight of 400 pounds domestic and 200 pounds overseas, with a size limit of 4 feet X 3 feet X 3 feet.

c. Staples or corrugated fasteners are used to fasten the cleats at all butt joints. (See tables 3-23 and 3-24 for size of cleats.)

d. Panels may be glued to cleats on domestic boxes.

e. Panels may be made up of one or two pieces of fiberboard at the option of the contractor. The only acceptable joint is a butt joint. A joint cleat, of the same thickness and twice the width of the edge cleat, shall be placed over each butt joint.

f. Overseas boxes require intermediate cleats when the unsupported span exceeds 20 inches. Domestic boxes require intermediate cleats when the unsupported span exceeds 24 inches.

Table 3-24. Size of Cleats for Class II Weather-Resistant Box (PPP-B-591)

Style of box	Weight of contents of box		Minimum size of cleats, for all wood groups	
	Exceeding	Not exceeding	Thickness	Width
	Pounds	*Pounds*	*Inch*	*Inches*
A or B	0	200	3/4	1-3/4

Table 3-25. Class1 Boxes: Requirements for Paper Oerlaid Veneer Panelboard and Cleats

Weight contents		Size of cleats		Paper overlaid veneer panelboard	
				Types 1 and 2 loads	Type 3 loads
Exceeding	Not exceeding	Minimum width	Minimum thickness	Minimum thickness	Minimum thickness
Pounds	*Pounds*	*Inches*	*Inch*	*Inch*	*Inch*
0	75	1-3/8	5/8	0.070	0.090
75	150	1-3/4	5/8	0.115	0.140
150	225	1-3/4	3/4	0.115	0.140
225	300	1-3/4	3/4	0.170	0.195
300	400	1-3/4	13/16	0.225	—

3-6. Cleated Paper-Overlaid Veneer Boxes (PPP-B—576)

These boxes are identical in styles and similar in construction to the cleated plywood and cleated fiberboard boxes with the following exceptions:

a. Paper-overlaid veneer, conforming to PPP-V—205, is used in place of plywood as panel material.

b. Wood-cleated, water-overlaid veneer boxes take all three types of loads to a maximum weight of 400 pounds for domestic use (class 1 boxes), and 350 pounds for overseas use (class 2 boxes), in accordance with PPP-B—576. Styles A and B only are authorized for both domestic and oversea shipments.

c. Tables 3-25 and 3-26 contain the requirements for the paper-overlaid veneer panelboard and the cleats for class 1 and 2 boxes, respectively, according to the weight of contents.

d. Skids are attached to the bottom of boxes having a gross weight of more than 200 pounds, or when the length and width dimensions are 48 inches by 24 inches or over and the gross weight is 100 pounds or over. The skids shall be a minimum of 2½ inches high and 3½ inches wide and may be fabricated from more than one piece of lumber to make up the required height. The skids shallbe set not less than 2½ nor more than 4 inches in from each end. Filler cleats of the same thicknes as the edge cleats and the same width as the skids should be placed between the skids and the bottom panel of the box.

Table 3-26. Class 2 Boxes: Requirements for Paper Overlaid Veneer Panelboard and Cleats

Weight of contents		Size of cleats		Paper overlaid veneer panelboard	
				Types 1 and 2 loads	Type 3 loads
Exceeding	Not exceeding	Minimum width	Minimum thickness	Minimum thickness	Minimum thickness
Pounds	*Pounds*	*Inches*	*Inch*	*Inch*	*Inch*
0	100	1-¾	⅝	0.070	0.120
100	250	1-¾	¾	1.40	.180
250	350	1-¾	.225	—	

3-7. Wood-cleated, Skidded, Load-Bearing Base Boxes (MIL-B-26195)

These boxes may be used for the shipment of items which can be secured to a load-bearing base. The sides, tops, and ends are of cleated panel construction. Panels may be plywood, fiberboard, or paper-overlaid veneer and comply with the applicable requirements of PPP-B—601, PPP-B—591, and PPP-B—576, respectively. Styles A, B, and C are used for type I, domestic, and type II, oversea shipments. The bases are fabricated as class 1, plywood base, and class 2, lumber base (see fig 3-24).

a. Intended Use. Boxes covered by MIL-B-26195 are intended to be used for items which can be attached to a load-bearing base. It is intended that the entire load be carried on the base. The superstructure (tops, ends, and sides) provides only for superimposed loads and protection against the elements. It is not intended for the box to be lifted or moved other than by the base. The superstructure may be removed when it is not required.

b. Fabrication of Panels. When panels are fabricated locally, they are made according to information contained in paragraph 3-4*a*.

(1) Even filler cleat tolerance and drainage shall be in accordance with PPP-B—601. Cleat arrangement on top panels is illustrated in fig. 3-25.

(2) When joists are required for the superstructure to hold superimposed loads, they are selected in accordance with table 3-27.

(3) Joist supports are required to be placed beneath each joist (see fig. 3-26). The vertical and material supports shall comply with the material requirements for the cleat stock, except that the thickness shall not be less than one inch thick for container loads up to 1,000 pounds. For loads in excess of 1,000 pounds, the supports shall be not less than 2 inches. The vertical joist supports shall be nailed to the side panels with nails long enough to pass through the clinch of one-eighth-inch for group II, III, and IV woods and one-fourth-inch clinch for group I woods.

c. Fabrication of Base Components (see fig 3-24).

(1) *Skids.* Skids will be made of group II, III, or IV lumber. The cross section and length of skids are chosen from table 3-28, based upon weight of contents and load conditions, as illustrated in figure 3-27. For boxes whose outside width exceeds 36 inches, a third skid conforming to table 3-28 is added. The third skid is placed equidistant between the outer skids. At the ends of each skid, the lower half is beveled approximately 45 degrees.

Table 3-27. Selection of Joists for Wood Cleated, Skidded, Load Bearing Base Boxes (Joists spaced 24 inches—center to center)

Nominal joist size (Inches)	Outside width of box (Inches)
None required	24
1×4	25-36
2×4	37-60

(2) *Load bearing members.* Load bearing members will be free of defects which could materially weaken them. They are selected in accordance with table 3-29. The cross section of load bearing members for a particular load is determined either by assuming a total width of such load bearing members and determining the thickness necessary or by assuming a thickness and determining t total width of load bearing members.

(3) *Lumber flooring.* Lumber flooring will be a minimum of 1-inch thick, and not less than 4 inches wide. Lumber is laid at right angles to the skids. The boards are separated one-eighth to one-fourth of an inch to allow for swelling and drainage. The board ends are placed flush with the outer edge of the skids.

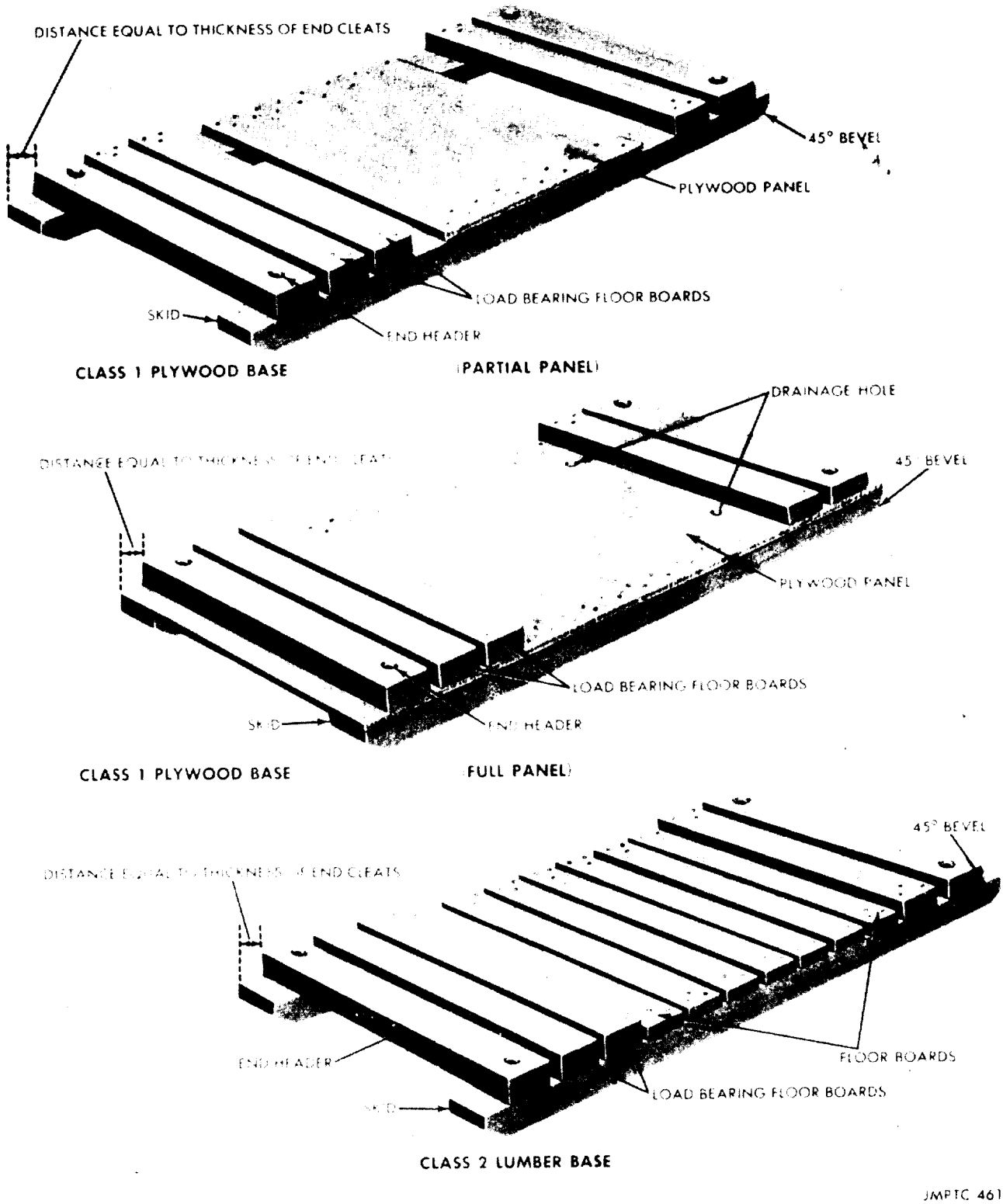


Figure 3-24. Classes 1 and 2 bases for wood-cleated, skidded, load-bearing base boxes, MIL-B-26195.

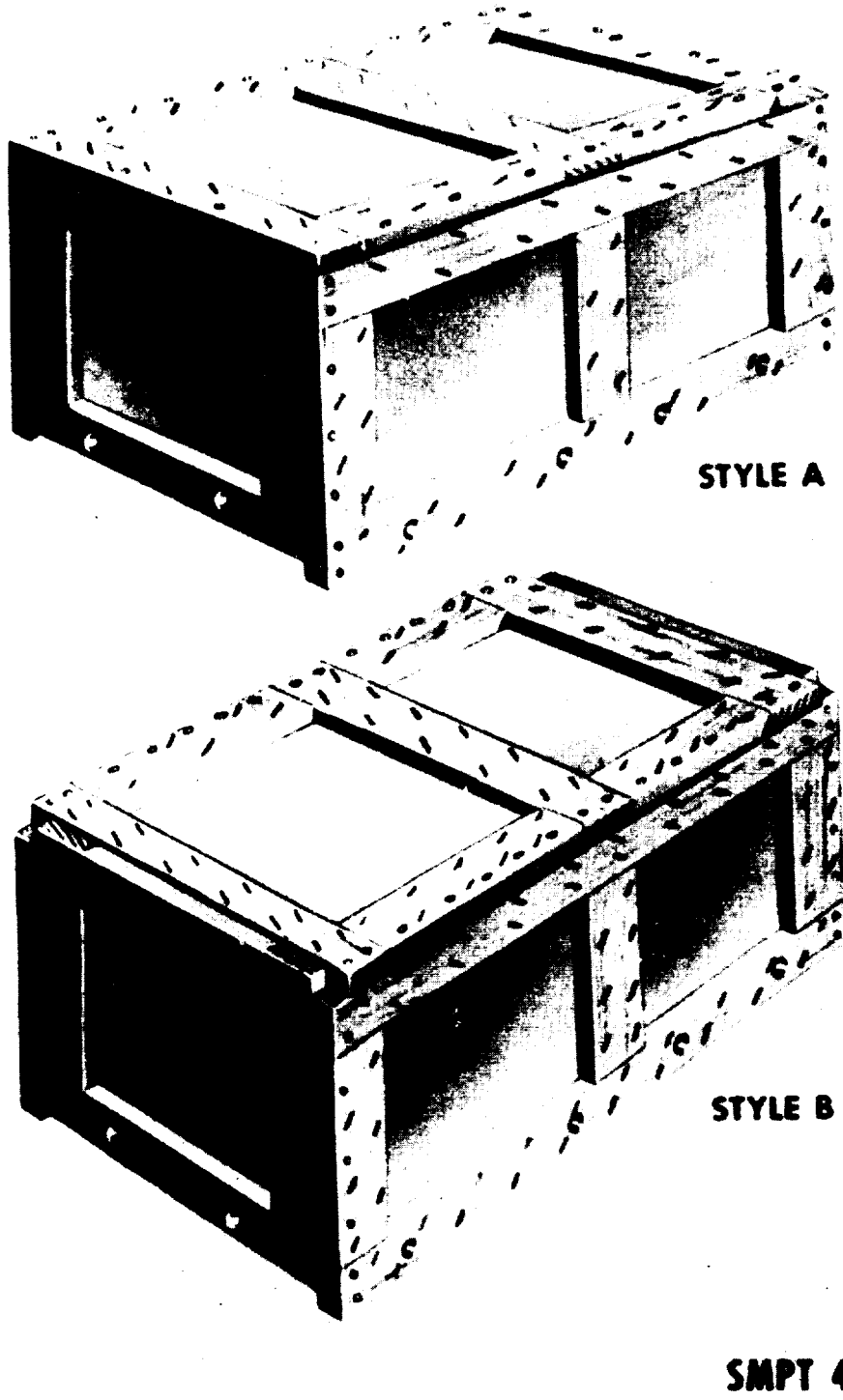


Figure 3-25. Styles A and B cleat arrangement for wood cleated, skidded, load bearing base boxes.

(4) *Plywood flooring.* Unless otherwise specified, plywood used for type I boxes shall conform to HPMA-HP 1983, type II, grade 3-4, PS1, standard interior. The minimum thickness shall be three-eighths of an inch. See table 3-13. It may be the full length and width of the base, or it may be a centrally located square piece with the length equal to the base width. When a full piece of plywood is used, a drainage hole one-half inch in diameter is placed in each corner of the base. Addi-

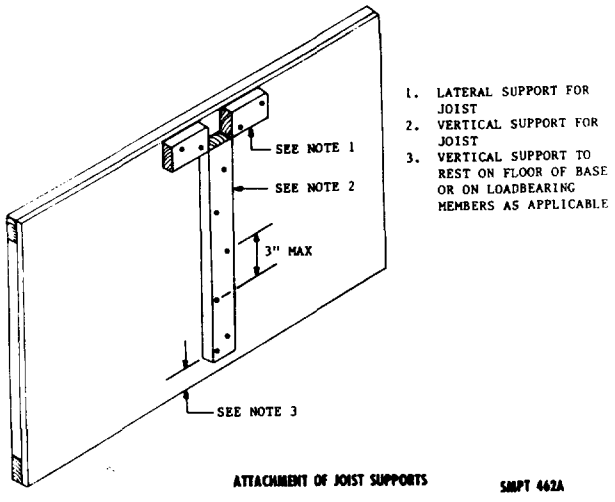


Figure 3-26. Attachment of joist supports for wood cleated, skidded, load bearing base boxes.

tional drainage holes are placed every three feet along the side of the base. When load bearing floorboards are placed over plywood panels, at least one drainage hole is placed on each side of the base between the load bearing floorboards.

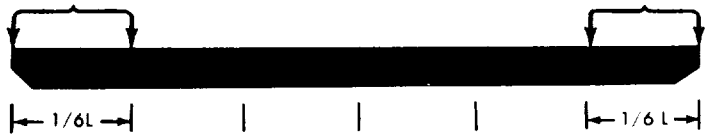
(5) *End headers.* End headers are placed at the ends of the box. Headers are nominal 2 × 4 inches.

(6) *Rubbing strips.* When specified, rubbing strips shall be applied under each skid to facilitate forklift handling. They will provide a nominal 3-inch clearance for forklift entry.

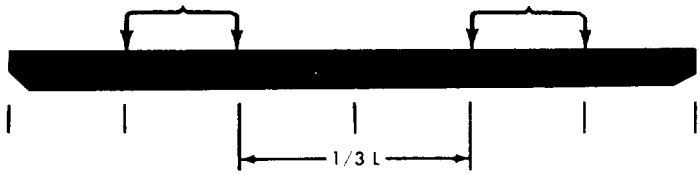
d. Assembly of the Base. Depending upon the weight of the item, load condition, size and length of skids, and whether it is a class 1 or class 2 base, the base parts are cut to size for fabrication.

(1) The nailing of plywood and lumber flooring to the skids is illustrated in figure 3-24.

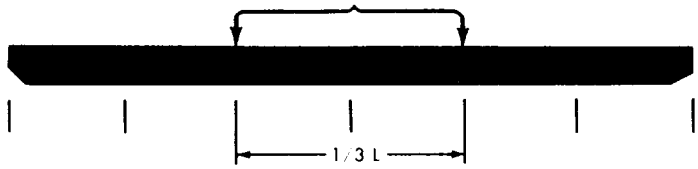
(2) Load bearing floor members over 2 inches thick and up to 4 inches in width are bolted to the skids with one carriage bolt at each end. Two carriage bolts are used at each end of load bearing floor members when they exceed two inches in thickness and 4 inches in width. The load bearing floor members are fastened to skids with ⅜-inch carriage bolts. Load bearing members less than 2 inches in thickness are nailed to the skids. Nails



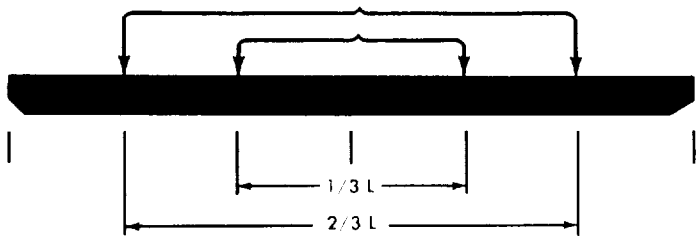
LOAD CONDITION A
LOAD BEARING POINTS ON OUTER ONE-SIXTHS OF SKID LENGTH



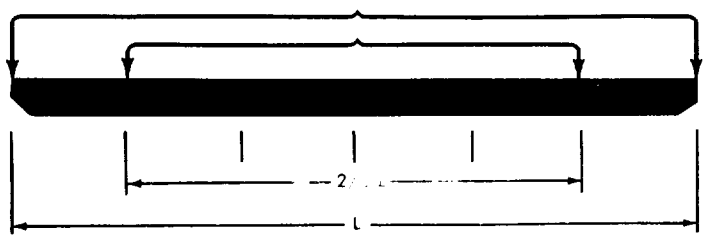
LOAD CONDITION B
LOAD BEARING POINTS OUTSIDE OF CENTRAL ONE-THIRD OF SKID LENGTH BUT NOT IN OUTER ONE-SIXTHS OF SKID LENGTH



LOAD CONDITION C
LOAD BEARING POINTS WITHIN CENTRAL ONE-THIRD OF SKID LENGTH OR LOAD EVENLY DISTRIBUTED WITHIN CENTRAL ONE-THIRD OF SKID LENGTH



LOAD CONDITION D
LOAD EVENLY DISTRIBUTED OVER MORE THAN CENTRAL ONE-THIRD OF SKID LENGTH BUT NOT OVER MORE THAN CENTRAL TWO-THIRDS OF SKID LENGTH



LOAD CONDITION E
LOAD EVENLY DISTRIBUTED OVER MORE THAN CENTRAL TWO-THIRDS OF SKID LENGTH

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Figure 3-27. Load distribution of skids.

Table 3-28. Nominal Sizes and Maximum Lengths of Skids for Wood Cleated, Skidded, Load Bearing Base Boxes

Weight of Contents (Pounds)	Load Condition 1/	Nominal Sizes					
		2 x 4	2 x 6	2 x 8	4 x 4	4 x 6	6 x 6
		Maximum Length of Skid (Feet)					
0 - 100	A	16					
	B	16					
	C	16					
	D	16					
	E	16					
101 - 200	A	16					
	B	16					
	C	16					
	D	16					
	E	16					
201 - 400	A	11	15	16			
	B	13	16				
	C	8	12	16			
	D	10	15	16			
	E	13	16				
401 - 600	A	8	11	14	16		
	B	9	14	16			
	C	5	8	11	16		
	D	7	10	14	16		
	E	9	14	16			
601 - 800	A	7	9	11	16		
	B	7	10	14	16		
	C	4	6	8	16		
	D	5	8	10	16		
	E	7	10	14	16		
801 - 1000	A	6	8	10	16		
	B	5	8	11	16		
	C	3	5	7	16		
	D	4	6	8	16		
	E	5	8	11	16		
1001 - 1200	A	6	7	8	16		
	B	4	7	9	16		
	C	3	4	5	13	16	
	D	3	5	7	16		
	E	4	7	9	16		

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Table 3-28. Nominal Sizes and Maximum Lengths of Skids for Wood Cleated, Skidded, Load Bearing Base Boxes—Continued

Weight of Contents (Pounds)	Load Condition 1/	Nominal Sizes					
		2 x 4	2 x 6	2 x 8	4 x 4	4 x 6	6 x 6
		Maximum Length of Skid (Feet)					
1201 - 1400	A	5	7	8	14	16	—
	B	5	6	8	16	—	—
	C	0	4	5	11	16	—
	D	3	4	6	14	16	—
	E	5	6	8	16	—	—
1401 - 1600	A	5	6	7	13	16	—
	B	3	5	7	16	—	—
	C	0	3	4	18	15	16
	D	3	4	5	12	16	—
	E	3	5	7	16	—	—
1601 - 1800	A	5	6	7	12	16	—
	B	3	5	6	15	16	—
	C	0	3	4	9	14	16
	D	0	3	4	11	16	—
	E	3	5	6	15	16	—
1801 - 2000	A	4	5	6	11	15	16
	B	3	4	5	13	16	—
	C	0	0	3	8	12	16
	D	0	3	4	10	15	16
	E	3	4	5	13	16	—
2001 - 2200	A	4	5	6	10	14	16
	B	0	4	5	12	16	—
	C	0	0	3	7	11	16
	D	0	3	4	9	14	16
	E	0	4	5	12	16	—
2201 - 2400	A	4	5	6	10	13	16
	B	0	3	4	11	16	16
	C	0	0	3	7	10	16
	D	0	0	3	8	13	16
	E	0	3	4	11	16	—
2401 - 2500	A	4	5	6	9	13	16
	B	0	3	4	10	16	—
	C	0	0	3	6	10	16
	D	0	0	3	8	12	16
	E	0	3	4	10	16	—

1/ The load condition is determined by the manner in which the load is applied to the skids (fig. 3-27).

JMPTC 2254A

Table 3-29. Allowable load (pounds) per inch of width of load-bearing floor members.

Length between outside skids (inches)	Nominal 1-inch thick boards (lbs per inch)		Nominal 2-inch thick boards (lbs per inch)		Nominal 3-inch thick boards (lbs per inch)	
	Wood Groups		Wood Groups		Wood Groups	
	I or II	III or IV	I or II	III or IV	I or II	III or IV
12	38	46	176	211	459	551
18	26	31	118	142	306	367
24	19	23	88	106	230	276
30	15	18	70	84	183	220
36	13	16	58	70	154	185
42	11	13	52	62	131	157
48	10	12	44	53	115	138
54	9	11	39	47	102	122
60	7	8	35	42	92	110

shall be as large as practicable without splitting the piece.

(3) The end headers are fastened to the skids with ⅜-inch carriage bolts.

e. Assembly of the Superstructure. The assembly of the cleated plywood, cleated fiberboard, and cleated paper-overlaid veneer panels into the superstructure shall comply with the applicable requirements of the specifications already described. When joists are required, they are placed as explained in b above.

f. Assembly of the Superstructure to the Base. The end and side panels are assembled to the base with lag bolts (sometimes referred to as "lag screws"). One 3-inch lag bolt, three-eighths inch in diameter, is placed through the lower longitudinal cleat of the side panel and into the skid, at a distance not less than 2 inches from the end of the cleat. The distance between additional lag bolts shall not exceed 12 inches. In attaching the end to the header, one lag bolt is placed through the lower filler cleat and into the end header, at a distance not less than 2 inches, nor more than 3 inches from the end of the filler cleat. A minimum of two lag bolts are required through each end filler cleat.

CAUTION

Lag bolts shall not be driven with a hammer except to start them. They shall be turned in their holes the full distance. If the threads become stripped in the wood, the lag bolt is to be removed and inserted in a new hole near the old position. A washer is placed under the head of each lag bolt. Countersinking of lag bolts is not permitted.

3-8. Wirebound Wood Boxes (PPP-B—585)

A wirebound wood box is a resilient engineered structure deriving both strength and economy from the substitution of steel wires for a considerable portion of wood. The sides, top, and bottom of this container are stapled to several binding wires and are fastened to a framework of cleats at each end by staples driven astride the end binding wires. The ends are nailed, stapled, or wired to the cleat framework to form the container.

a. Description of Box Components (fig 3-28).

(1) *Blank.* A blank is the assembled parts of a wirebound wood box. The wood faceboards of the box are held together by wires which are stapled to them. Blanks are "set up" to form a box.

(2) *Cleats.* Cleats form the framework to which the ends of the faceboards or slats are fastened. They are made with mitered or mortised and tenoned ends (tongued-and-grooved). Intermediate rows of cleats may be required to reinforce unsupported spans.

(3) *Faceboards.* Faceboards are the thin boards that form the six faces of the box. They are made of veneer, resawn lumber, plywood, or paperoverlaid veneer. Their chief function is to hold the contents of the box in place.

(4) *Binding wires.* They hold the faces of the box together and carry most of the weight in the box.

(5) *Staples.* They hold the faceboards and cleats to the binding wires.

(6) *Ends.* The ends may be either plain, lined, or battened, according to the type of material used, the weight of contents, and the type of load. Only ends made from plywood are plain.

(a) *Battens.* They are pieces of wood used on the ends of wirebound wood boxes to reinforce the ends, to reinforce the cleats, and to increase the

strength of the box so that it may carry heavy stacking loads.

(b) *Liners.* They are thinner pieces of boards stapled to the ends in order to tie all parts together and to strengthen the fastening section. The grain of the liner is placed at right angles to the grain of the end faceboard. They are stapled to either the outside or inside face of the ends. Liners for Styles 1 and 2 boxes are always vertical; liners for Style 3 boxes are always horizontal.

(7) *Skids.* A wirebound box has two skids added when it carries a gross weight in excess of 200 pounds or when the gross weight exceeds 100 pounds, but the length and width are 48 inches by 24 inches or more. Additional skids are added if the distance between them exceeds 48 inches. They are secured by two rows of nails in a staggered pattern. PPP-B-585 stipulates other requirements concerning the addition of skids.

b. Classes.

(1) *Class 1 domestic.* For domestic shipments not involving sea transportation, but subject to storage, rehandling, or reshipment to domestic destinations. Weight limitation is 500 pounds.

(2) *Class 2 normal oversea.* For off-shore and oversea shipments contemplating projected storage and commercial-type handling. Weight limitation is 400 pounds.

(3) *Class 3 military oversea.* For oversea shipments and handling in military supply systems, subject to repeated rehandling and unprotected storage, and which may also be subjected to extreme climatic conditions. Weight limitation is 300 pounds.

(4) If required, class 2 and 3 boxes are preserved with the same preservative treatment as PPP-B—621 and PPP-B—601 wood boxes.

c. Styles of Boxes. Three styles of wirebound wood boxes are used for domestic and oversea shipments. These styles differ primarily in the manner of closure of the binding wires. Each style can be easily recognized in figure 3-29. Style 1 has a twisted wire closure, Style 2 has a looped wire closure, and Style 3 has a looped wire closure and has the ends reinforced with wire instead of battens. Unless end battens are used, the Style 3 box is not recommended for Type 3 (difficult) loads.

d. Ordering Data. Wirebound wood boxes are engineered and manufactured commercially and are not made locally by military activities. Procurement documents should include the specification number (PPP-B—585); the inside length, width, and depth to the nearest one-sixteenth of an inch; the style of box; the class of box; the type of load; the weight, quantity, and marking of contents. If blocking or bracing is required, it is suggested that a drawing or a sample of the item be furnished to the box manufacturer.

e. Container Manufacturer's Identification. Unless otherwise specified, each box is imprinted with the following information, which is limited to 15 square inches and placed in a lower corner of one side panel:

(1) Federal Specification PPP-B-585.

(2) Box manufacturer's name.

(3) Plant location.

(4) Maximum weight of contents . . . pounds.

(5) Class . . . box. For type . . . load. Style . . . Box.

f. Box Usage. Each box is manufactured to do a specific job. When used for the proper maximum weight of contents, type of load, and class of use, it will afford adequate protection to the item being shipped. It is important that the container manufacturer's identification be utilized prior to packing. The following points must be considered:

(1) In using the boxes, care should be exercised to select the box designed for the type of load to be shipped. A Type 2 load will not be packed in a box designed to carry a Type 1 load,

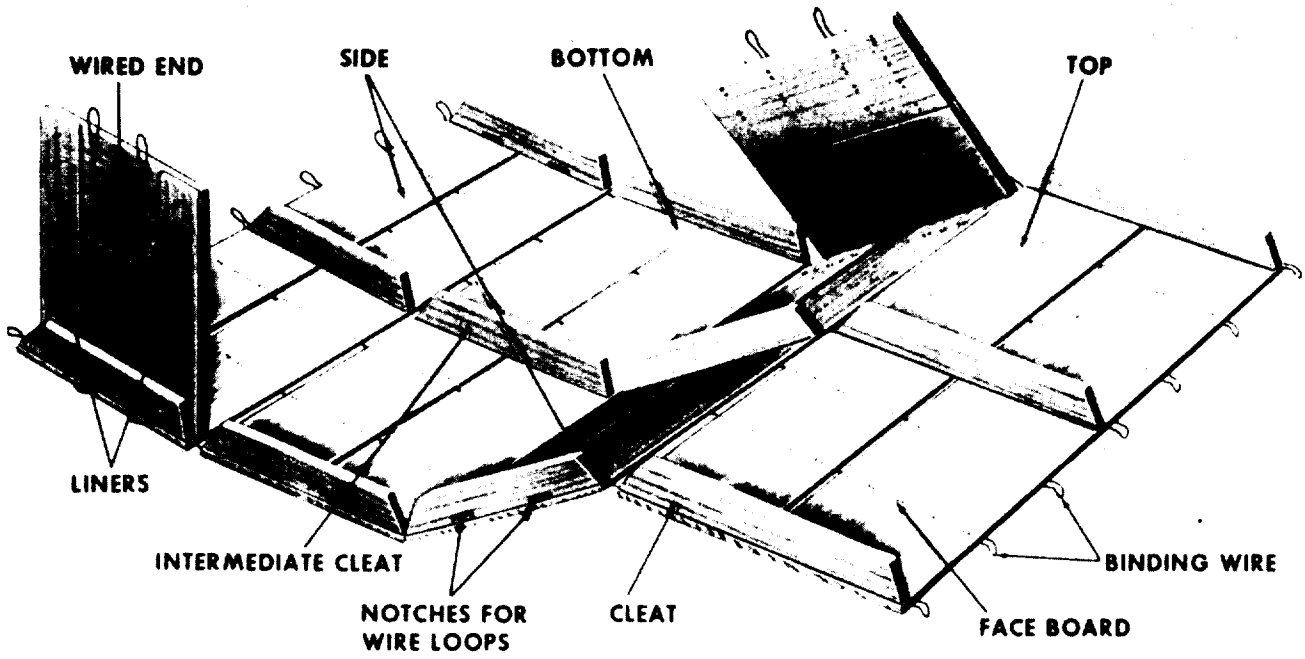

Figure 3-28. Components of wirebound wood boxes.

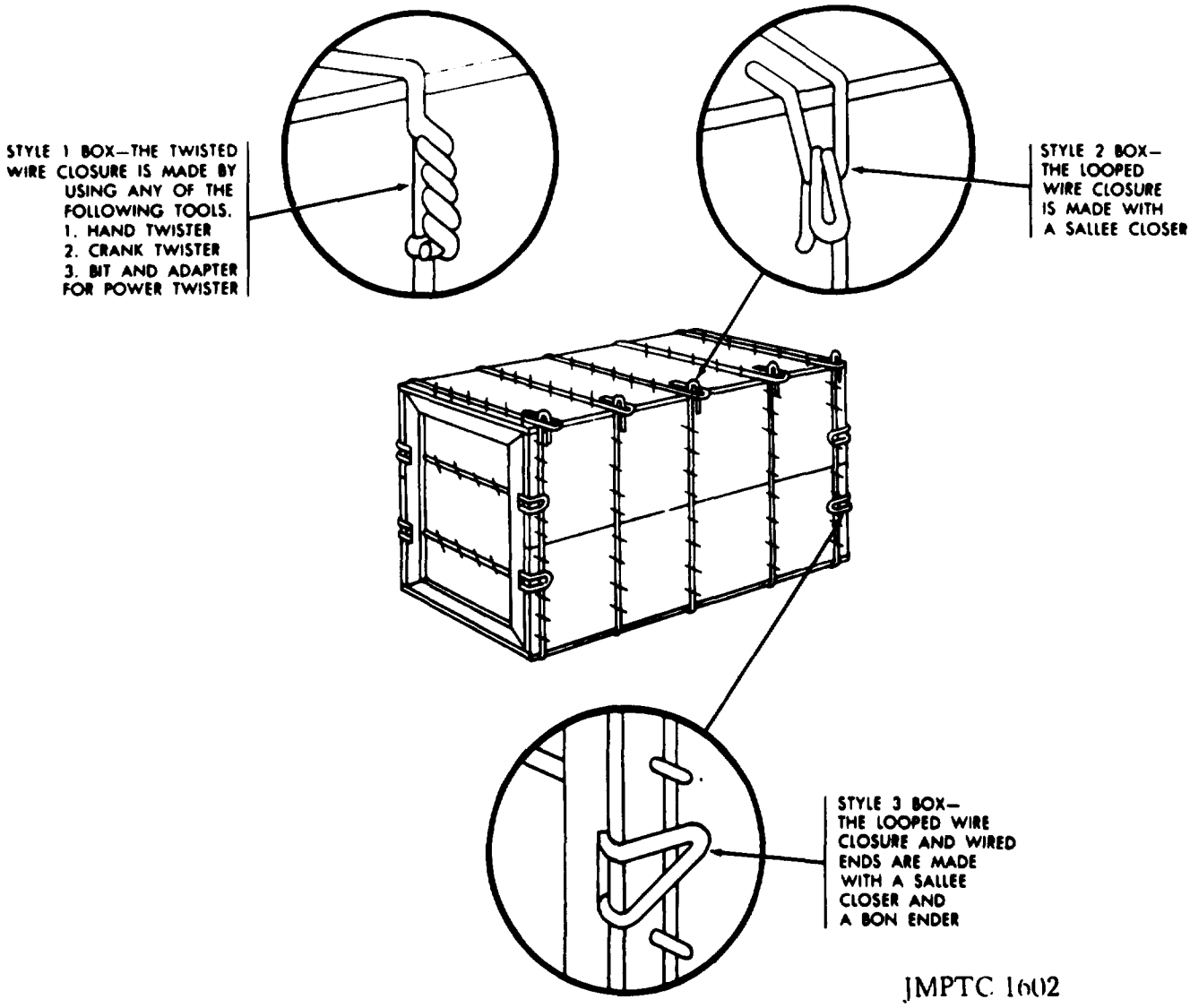

Figure 3-29. Styles of wirebound wood boxes.

and a Type 3 load will not be packed in a box designed to carry either a Type 1 or a Type 2 load.

(2) For Type 1 and 2 loads, the inside dimensions of the box will be sufficiently exact so that the contents fit snugly into the box and give support to all its faces.

(3) For Type 3 loads, other than bulk loads, the contents will be firmly bolted, blocked, braced, or otherwise anchored to the frame of the box in such a manner that shifting of the contents will not occur during handling of the shipment.

g. Economy Factors.

(1) Generally, a wirebound wood box contains approximately one-half as much lumber as a nailed wood box of the same size which carries the same amount of contents. Wirebound wood boxes are usually available at a lower price than many other shipping containers of more rigid construction.

(2) Style 3 boxes are resilient on all six faces. Items requiring this characteristic in the box can use a Style 3.

(3) Style 3 boxes are the most economical of the styles. The original cost of the box is less than that of the other styles. The savings of time in setting up the boxes is advantageous.

(4) Since the amount of lumber in a wirebound wood box is greatly reduced, compared to other types of wood containers, the tare weight is lower. Accordingly, the freight charges on a given size shipment are correspondingly lower.

(5) There is a saving in labor operations due to the simplicity of assembly and the ease of closure.

(6) Styles 2 and 3 boxes can be opened and

reclosed at intermediate stages of distribution much easier than other kinds of containers.

(7) Wirebound boxes may be recoopered.

h. Setting up the Boxes. Boxes arrive from the manufacturer in a knockdown condition and are stored knockdown until the time of use. Each box is then set up prior to loading of shipment. The method of setting up depends upon the style of the box.

(1) *Setting up of Styles 1 and 2 (fig 3-30).*

(*a*) Lift the sides of the blank slightly before folding. Fold the box by raising the sides at right angles to the bottom.

(*b*) Fasten the ends to the side cleats using a steel nailing table or an end stapling machine.

1. Ends are fastened to side cleats by either staples or cement-coated and chemically-etched nails. Unless otherwise specified, staples for Class 3 use boxes are galvanized.

2. The length of each fastening will be not less than the thickness of the end boards plus three-quarters the thickness of the cleats or battens.

3. The points of the fastenings will not protrude from the cleats or battens, but, if driven through, they must be clinched.

4. The average spacing of the fastenings will not exceed 2½ inches.

(*c*) Drive sevenpenny cement-coated or chemically-etched cooler or sinker nails through side cleats into adjacent battens and through bottom cleat into intermediate batten. Boxes having both vertical and horizontal battens adjacent and parallel to cleats should be fastened by nailing through bottom faceboards and cleats into the battens only. The spacing of nails driven into adjacent battens will not exceed 5 inches.

(2) *Setting up of Style 3 (fig 3-31).*

(*a*) Bend up looped end wires of ends using the hollow end of a bon ender.

(*b*) Lift sides of the blank slightly before folding and raise sides at right angles to bottom.

(*c*) Pass the bent end loops through notches in the cleats. Using the tapered end of the bond ender, bend back the looped wire over and around the binding wire of the side.

(*d*) When battens are used on the ends of Staple 3 boxes, the following rules apply:

1. Battens adjacent to batten cleats are nailed by driving sevenpenny cement-coated or chemically-etched cooler or sinker nails through the bottom boards, through the cleat and into the

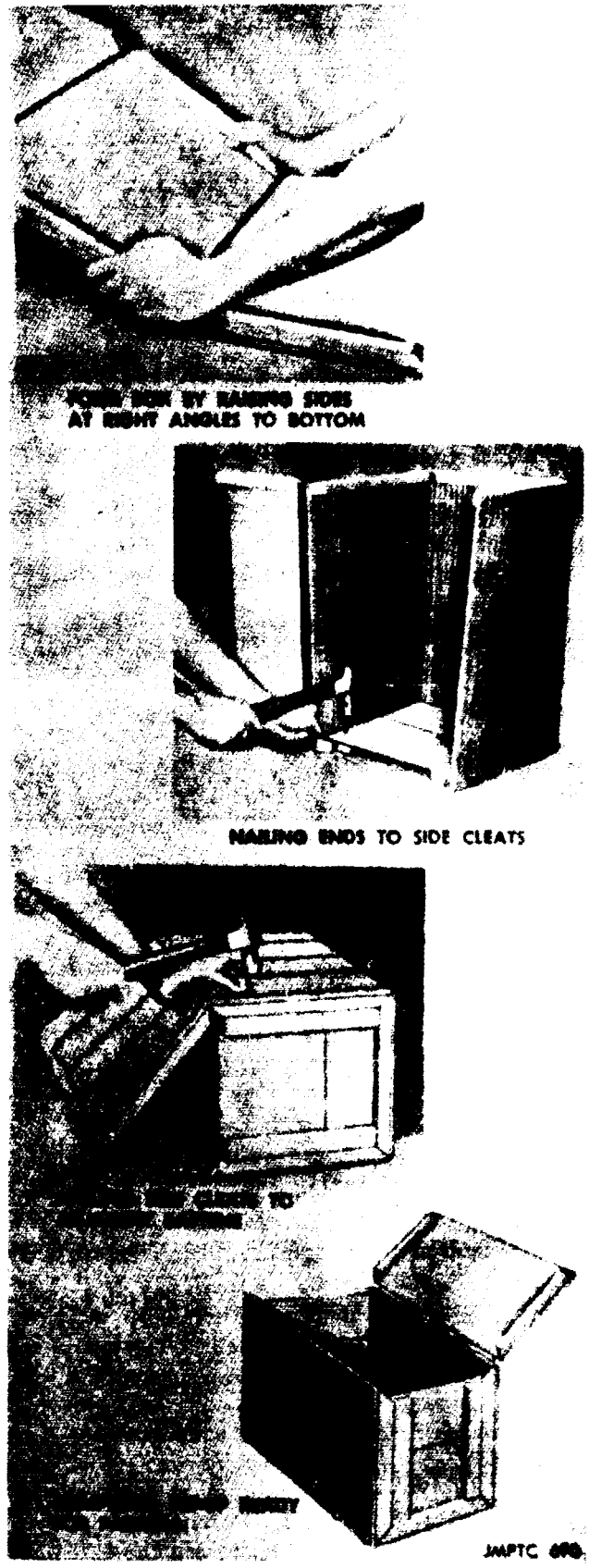

Figure 3-30. Setting up of styles 1 and 2, wirebound wood boxes.

adjacent batten. Spacing of nails will not exceed 5 inches.

2. Intermediate battens are secured by driving one sevenpenny cement-coated or chemically-etched cooler and sinker nail through the board and cleat into the end of the intermediate batten.

i. Strapping Requirements. Where strapping is required, the top cleats shall be brought in contact with the side cleats and the strapping is applied before the wires at the closing edges are twisted or looped. This eliminates occasional slack which may develop when strapping is applied after closure is made. Strapping is placed as indicated in figure 3–32 according to Class 1, Class 2, or Class 3 box, based upon weight of contents. Round wire strapping cannot be smaller than 13-gauge. Flat strapping cannot be less than $^5/_8 \times 0.020$-inch.

j. Closure of the Boxes.

(1) *Closure of Style 1.* Style 1 boxes are closed by using special tools (fig 3–33). When intermediate battens are used on the ends of the box, one sevenpenny cement-coated or chemically-etched sinker or cooler nail is driven through the top board and cleat and into the end of each intermediate batten. This is done prior to making the closures of the binding wires.

(2) *Closure of Styles 2 and 3.* These styles are closed by using a Sallee closer. Perform the steps, as shown in figure 3–34.

(*a*) Insert the Sallee closer through the side loop and catch the top loop in the notch on the end of the tool.

(*b*) Raise the handle of the Sallee closer to slightly beyond a vertical position and push the top loop down against the side of the box.

(*c*) Complete closing by swinging the handle of the Sallee closer down as far as possible.

(*d*) Drive a nail through the top cleat into each intermediate batten. Do not nail into the ends of the battens that are adjacent to the cleats.

Note. The applicable tools for making closures are illustrated in figures 3–33 and 3–34. Correct tools are available from box manufacturer. Do not use screw drivers, pliers, etc., because an adequate closure cannot be made and their use is time-consuming and may be a safety hazard.

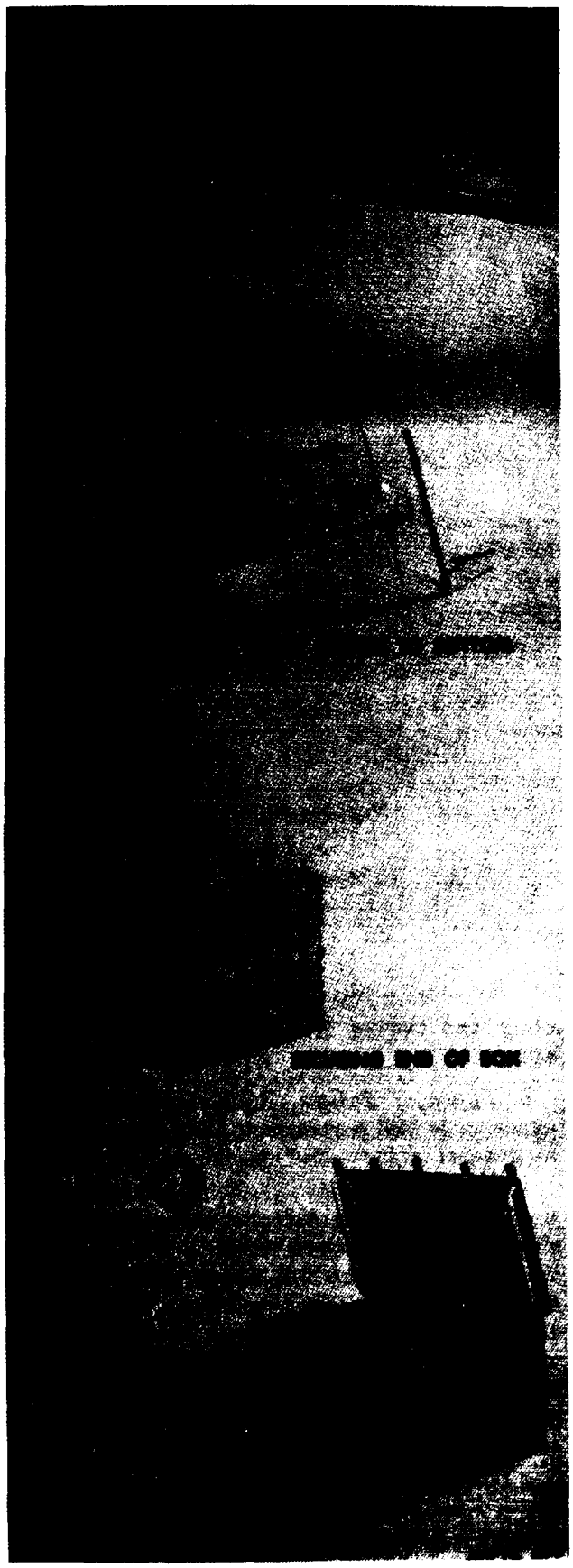

Figure 3–31. Setting up of style 3 wirebound wood box.

3–9. Pallets (General)

a. Description. A pallet is a portable platform on which material is placed to facilitate handling and transportation. This platform is generally a two-deck structure which permits mechanical han-

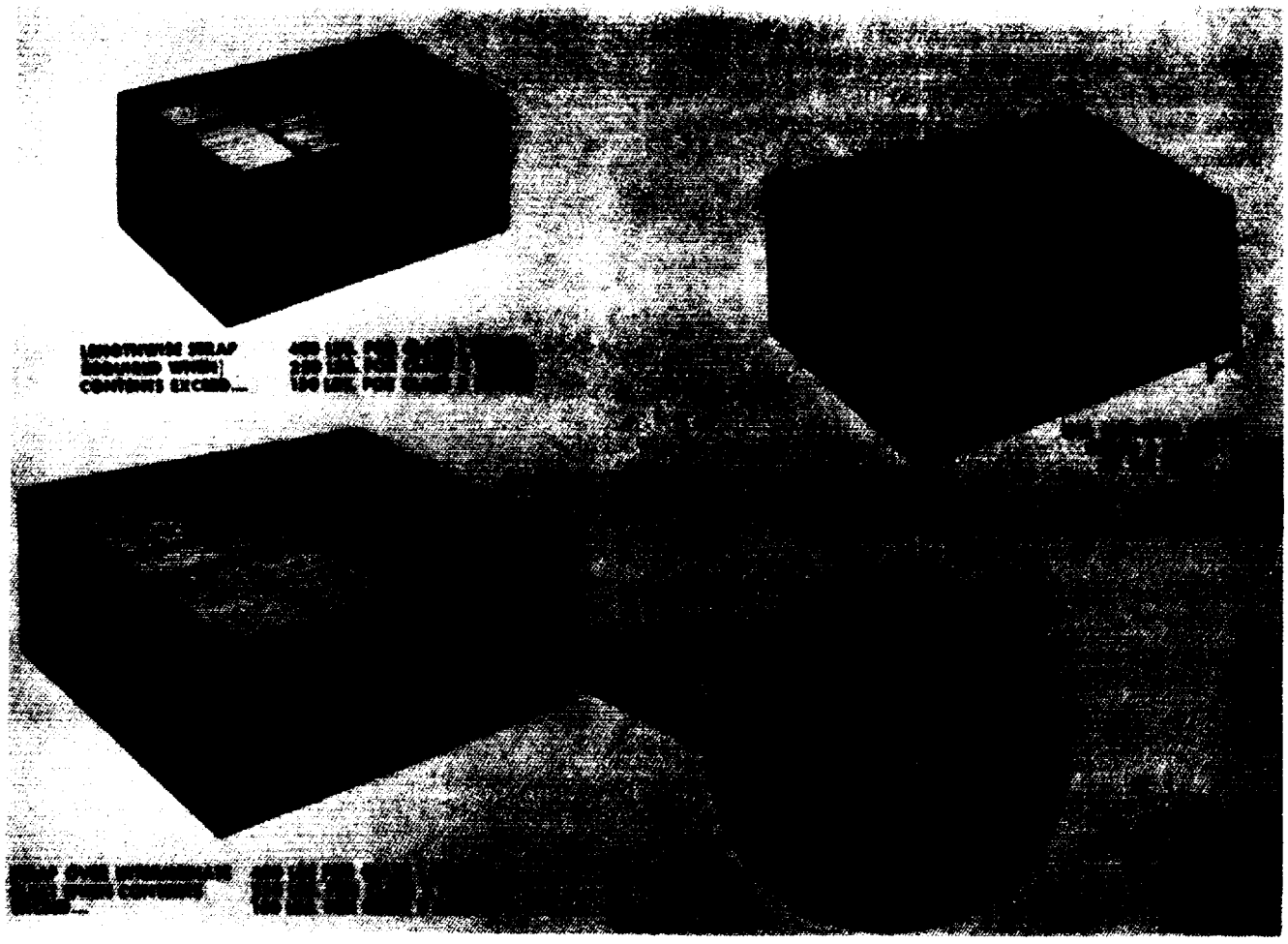

Figure 3-32. Strapping of wirebound wood boxes.

dling and tiering of unit loads of supplies and equipment.

b. Types of Pallets. Pallets are classified as expendable and permanent. They are also classed as general purpose and special purpose.

(1) *Expendable pallets.* Expendable pallets are designed generally for one shipment and then discarded. Their construction is usually of wood, fiberboard, or a combination of the two. In order to be effective as one-trip pallets, they must be lightweight and low in cost. When the cost of using them is equalled or exceeded by the savings realized during a single trip, they are truly expendable pallets. Examples of expendable pallets are illustrated in figure 3-35.

(2) *Permanent pallets.* Permanent pallets are termed as general purpose and special purpose pallets.

(3) *General purpose pallets.* The general purpose pallets are constructed of hard wood and are normally 40 inches by 48 inches in size. They fit economically into railroad cars, motor vehicles, and trailers. Two general purpose pallets are the 4-way entry post pallet and the 4-way (partial) four-stringer pallet. (fig 3-36).

(4) *Special purpose pallets.* Pallets made of metal, which are suitable for certain heavy duty usage, are special purpose pallets. They are more rugged and will stand more abuse than wood pallets. There are no fasteners to work loose and cause damage to flexible containers and their contents. Pallets made of aluminum have been developed that are light in weight. The initial cost of metal pallets is high in comparison to pallets made of wood.

3-10. Four-Way Post Construction Pallets (MIL-P-15011)

These pallets are available in two types: Type I

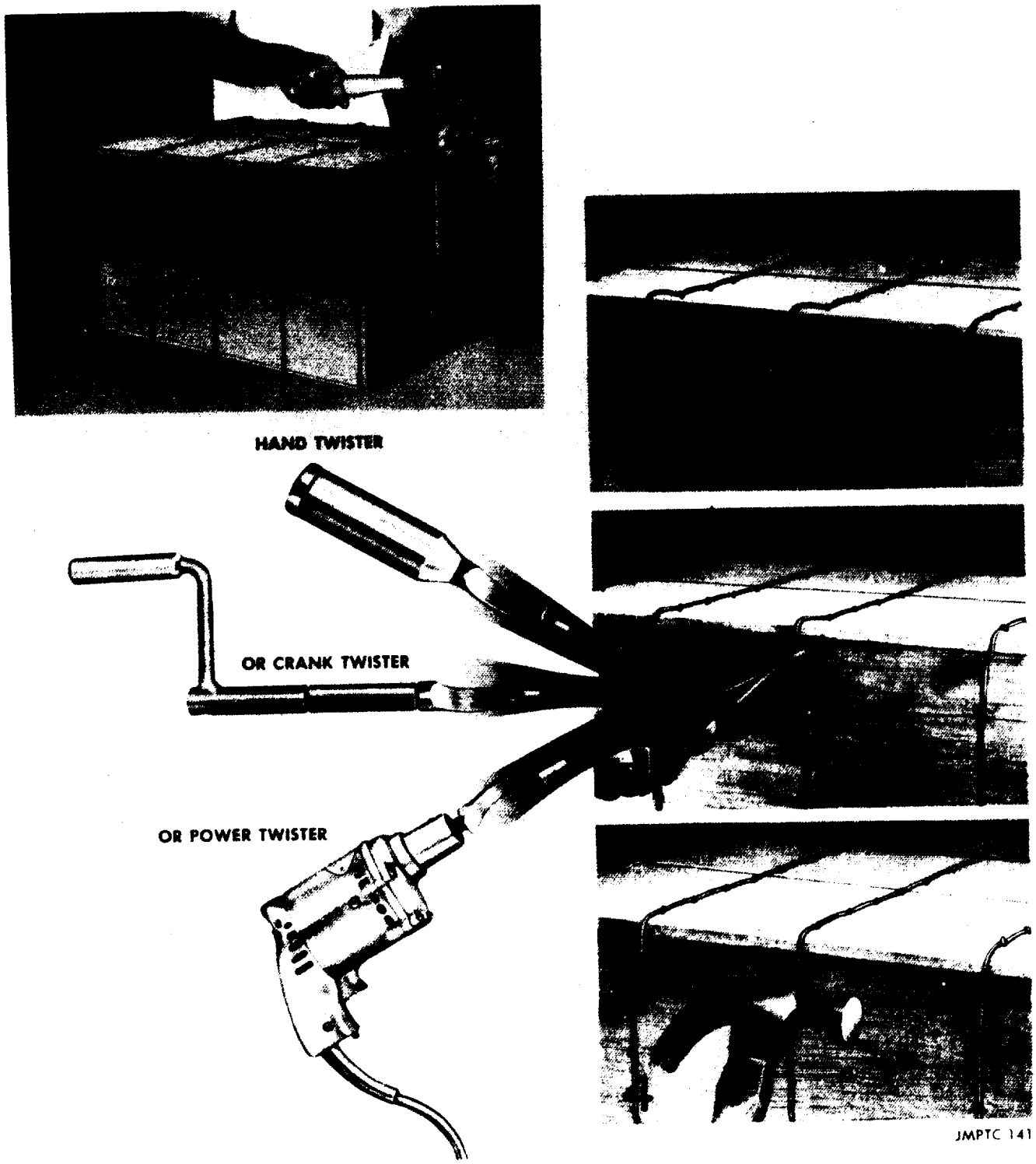

Figure 3-33. Closing of style 1 wirebound wood box.

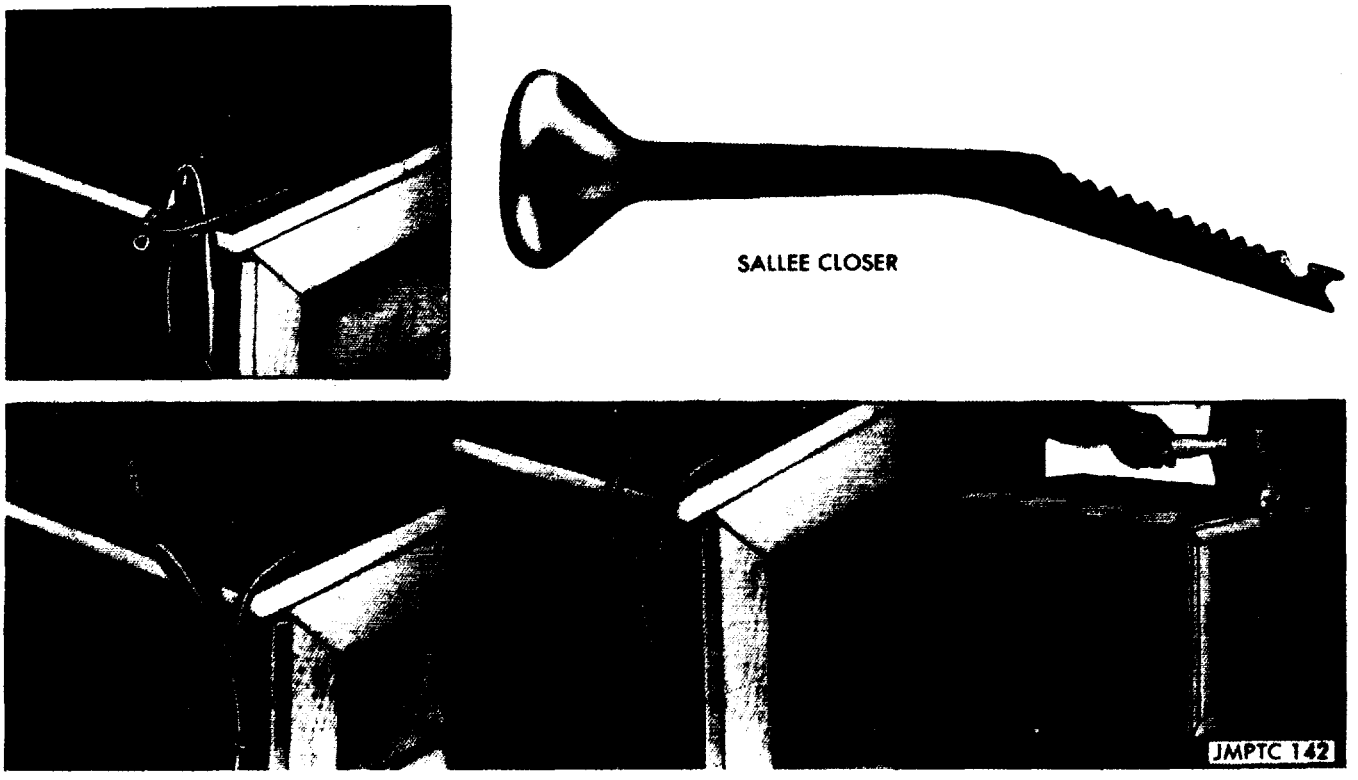

Figure 3-34. Closing of style 2 and 3 wirebound wood boxes.

(assembled) and Type II (unassembled). Each type is available in two classes: Class 1 (seasoned lumber, 22 percent maximum average moisture content); class 2 (unseasoned lumber, unspecified moisture content). There are four styles. Style 1 is the general storage pallet and is of the standard 40 inch by 48 inch size, and unless otherwise specified, is constructed of high density wood. Style 1A pallets are constructed the same as Style 1 pallets except that the size is 35 inches long by 45½ inches wide. The smaller, Style A1 pallets are designed for better utilization in intermodal transporters and the fourth style, Style 2, is a light-weight, air cargo pallet, 40" X 48" in size. It is constructed of the low or medium density woods with thickness less than that for Styles 1 and 1A. These pallets provide full 4-way entry to materials handling equipment. As indicated in figure 3-36 nine post are placed on the bottom boards with drive-screw nails conforming to type II, style 18, of FF-N-105. Stringers extending the length (40 inches, Styles 1 and 2 and 35 inches for Style 1A and 42 inches for Style 1B) of the pallet are fastened to each row of posts. The deck boards are nailed through the stringers and into the posts. Style 1B pallets are constructed the same as Style 1 pallets except that the size is 42 inches long by 53 inches wide.

3-11. Four-Way (partial) Stringer Construction Pallets (NN-P-71)

Two-way and four-way stringer pallets are available in several types and may be assembled or unassembled. Each type is available in various sizes. They are used wherever two-way or partial four-way entry is required by conventional materials handling equipment. As indicated in figure 3-40, four stringers made from 2 X 4-inch lumber are nailed or bolted at right angles to the bottom deck boards. The stringers are cut out to enable fork lift entry. The top deck boards are nailed to the stringers.

3-12. Maintenance of Pallets

Wooden pallets are susceptible to damage and must be kept in constant repair. Broken or split deck boards must be replaced when their holding power is impaired. Fastenings that work loose should be carefully repaired. When nails must be replaced, snip off nail heads and drive into stringer or block. Make sure that new nails do not line up with previously occupied nail holes. It is recommended that a stack of repair parts be available for making all repairs.

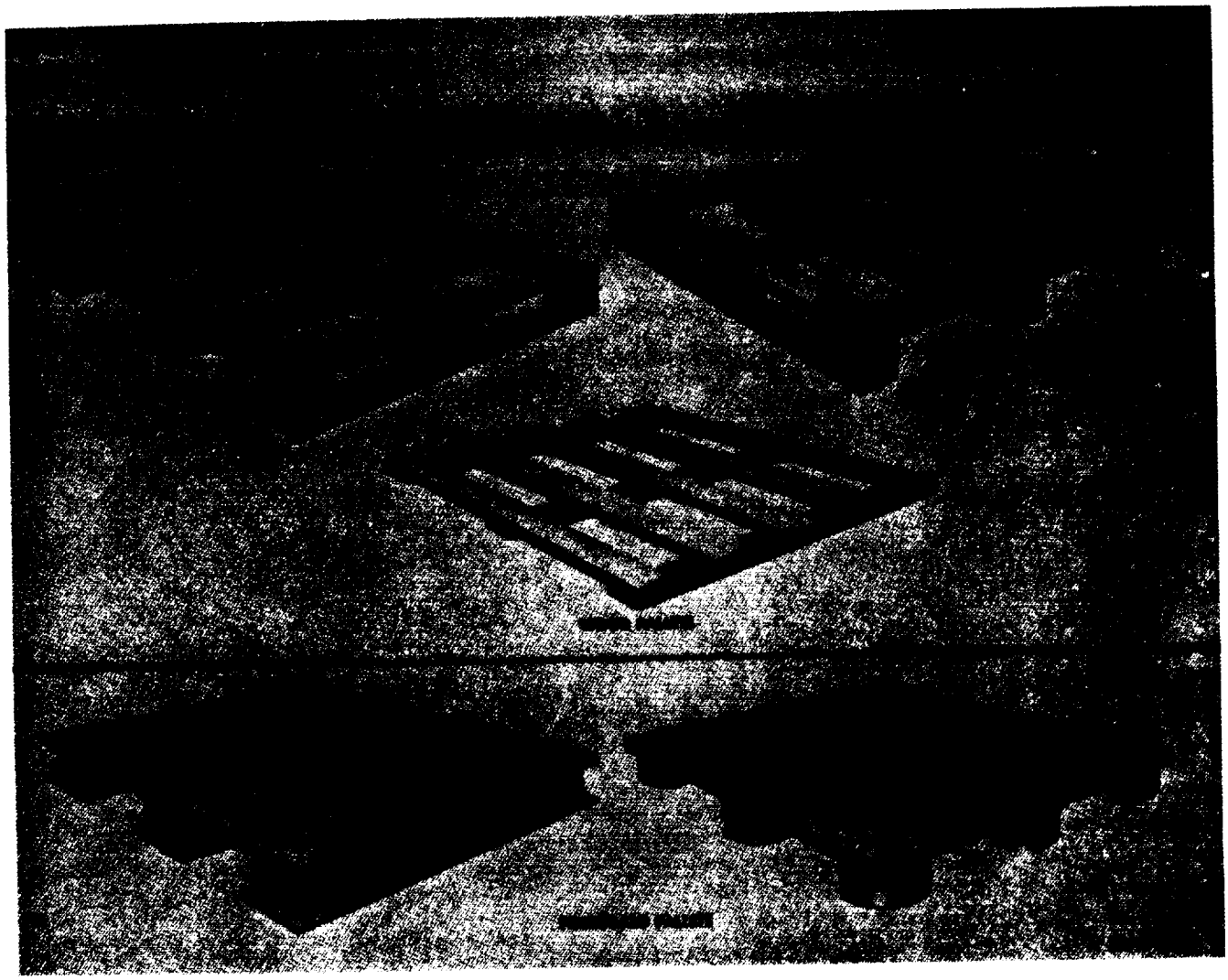

Figure 3-35. Examples of expendable pallets.

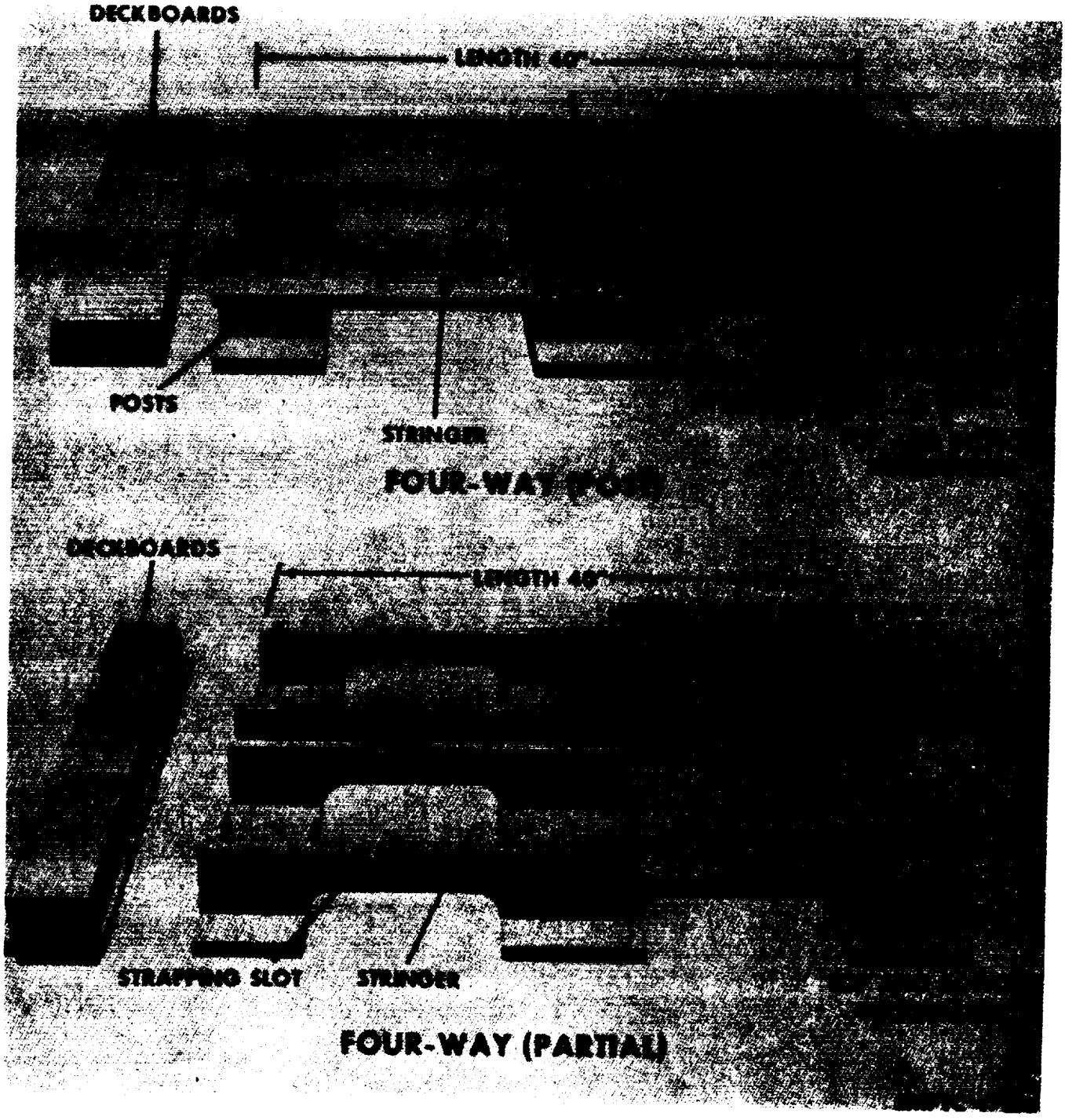

Figure 3-36. Construction of 4-way entry pallets.

CHAPTER 4

BAGS AND SACKS

4-1. Need for Bags and Sacks

While a considerable amount of the materiel furnished to the Military Services is shipped in fiberboard, metal, or wooden containers, there are many supplies which can be most economically shipped in bulk quantities in bags and sacks. Items such as food products, building materials, some chemicals and minerals are effectively shipped in bags and sacks. Bags and sacks possess the inherent advantages of having low tare weight ratio (that is, the ratio of the weight of the container to the weight of the contents); being flexible; providing ease in filling and handling; requiring a minimum storage space; and being constructed of low cost materials.

4-2. Bags Defined

A *bag* is a preformed container made of flexible material, generally closed on all sides except one which forms an opening that may or may not be sealed after filling. It may be made of a single ply or multiple plies of flexible material, or a combination of two or more materials such as paper, metal foil, cellulose, and plastic films and textiles, any of which may be coated, laminated, or treated to provide the properties required for packaging, storing, and distributing the commodity.

4-3. Sacks Defined

A *sack* often used as a synonym for a bag, generally refers to heavier duty or shipping bags. No exact line of separation can be drawn between what is referred to as heavy duty bag and a shipping sack. In this section, both bags and sacks are discussed and may be employed to handle the same weights and kinds of commodities. Usually, a container designed to carry over 50 pounds is considered a shipping sack.

4-4. Military Shipping Bags and Sacks

For shipping military supplies, there are five flexible containers that are approved for use by the Armed Forces. These containers are: cotton mailing bags (PPP-B-20); cushioned paper shipping sacks (PPP-S-30); burlap, cotton, and waterproof textile shipping bags (PPP-B-35); paper shipping sacks (UU-S-48); and (table 4-1).

4-5. Cotton Mailing Bags (PPP-B-20)

Cotton mailing bags (fig 4-1) are intended for packaging and mailing small miscellaneous items. They are of the "end-opening" type with a drawstring closure of 12-ply, hard-finished cotton twine, inserted through a hem in the open end. Alternatively, when specified, the drawstring may be hard-finished (polished) twine of not less than 3-ply construction with a breaking strength of 25-30 pounds. A paper tag, made of white cotton cloth-lined paper stock, with a hard finish, suitable for pen and ink addressing on the face side, is securely sewn into the bottom seam of the bag. Cotton mailing bags are tied and bundled in the sizes and quantities shown in table 4-2.

4-6. Cushioned Paper Shipping Sacks (PPP-S-30)

Cushioned paper shipping sacks are made of two sheets of kraft paper separated by an evenly distributed cushioning medium. They may be used for interior or exterior packing where insulation, water resistance, or light cushioning effect is required for items weighing not more than 10 pounds.

a. Classification. Cushioned paper sacks are supplied in four types: Type I cushioned sacks are made with a 60-pound outer liner and a 40-pound inner liner (24 × 36-500 minimum weight).

b. The cushioning material should be evenly distributed between the exterior and interior sheets of the sack at a thickness of between 1/8 and 3/16 inches. Type II sacks are fabricated from a 70 pound outer liner (24 × 36-500 basis weight) with closed cell plastic fiber cushioning material 3/16 inch thick. Type III and IV sacks are fabricated from a 60 pound outer liner (24 × 36-500 basis weight). Type III incorporates an expanded polystyrene foam bead cushioning material evenly

Table 4-1. Bags and Sacks Used in Military Packing

Specification No.	Title	Type, grade, class, style	Uses
PPP-B-20	Bags, cotton, mailing	The grade known commercially as "first."	For packing and mailing of small miscellaneous items.
PPP-B-35	Bags, textile, shipping, burlap, cotton and waterproof, laminated.	Type I—Standard burlap bag—number B-1 through B-16, based on ply construction. Type II—Standard cotton bag—28 bag construction C-21 to C-71, not listed consecutively. Type III—Laminated textile bags. Class 1—Paper-asphalt-textile. Bag numbers P1 to P9. Class 2—Paper-asphalt-paper-asphalt-textile. Bag numbers P10 to P18. Class 3—Paper-asphalt-textile-asphalt-paper. Bag numbers P20 to P28. Class 4—Paper-asphalt-paper-adhesive-textile. Bag numbers P30 to P38. Class 5—Paper-latex (or other laminant)—textile. Bag numbers P40 to P48. Class 6—Polyethylene-adhesive-paper-adhesive-textile. Bag numbers P50 to P58. Class 7—Other combination as specified by the procuring agency. Grade I—Cotton sheeting. Grade II—Cotton, Osnaburg. Grade III—Jute burlap. Type IV—Textile inner bags.[1] Style A—Sewn side and bottom seams (for Types I, II, or III). Style B—Cemented longitudinal seams sewn and taped bottoms (for Type III only).	For domestic or oversea shipment of supplies of a pulverized, powdered, granulated or crystalline condition, and of a hygroscopic or non-hygroscopic nature. The user will need to consult tables XI and XII of PPP-B-35 to determine the proper bag construction for any particular commodity.
UU-S-48	Sacks, shipping paper	Type I—Pasted bottom, open mouth (POM). Class 1—Sewn closure. Class 2—Pasted pinch style closure. Type II—Sewn bottom, open mouth. (SOM). Type III—Pasted valve. Type IV—Sewn valve. Type V—Sewn open corner (limited copy missing. Type IV—Pinch style, open mouth. Style A—Flat tube paper shipping sacks. Style B—Gusseted tube paper shipping sacks.	For the handling of bulk type granular, pulverized, crystalline, powdered, or solidifying liquid type commodities within the United States or for ocean shipment. The user must consult table XII of UU-S-48 to determine the minimum sack requirements permitted for any particular commodity.

Table 4-1. Bags and Sacks Used in Military Packaging and Packing—Continued

Specification No.	Title	Type, grade, class, style	Uses
PPP-S-30	Sacks, shipping paper (cushioned or reinforced).	(Styles applicable to all types). Type I—Cushioned, Macerated Paper. Type II—Custioned, Closed Cell Polyethylene. Type II—Cushioned, Polystyrene. Type IV—Cushioned, Laminated Foam/Paper.	For use as exterior packaging in the shipment of publications and small items where a light cushioning effect and water resistance are required. Also may be used for interior packaging of fragile items such as bottled liquids, radio tubes, and testing and laboratory equipment.

See Table XIII of PPP-B-35 for minimum bag requirements for specific commodities to be packed in inner bags.

Table 4-2. Requirements for Bundling Cotton Mailing Bags

Size of bag	Quantity per bundle	Number of bundles per shipping container
3 x 4	100	24
3 x 5	100	24
4 x 9	100	20
4-1/2 x 8	100	16
5 x 7	100	16
6 x 9	100	12
5-1/2 x 14	50	18
6-1/2 x 10	50	20
7-1/2 x 18	50	12
8 x 10	50	16

Table 4-3. Sizes and Quantities of Cushioned Paper Shipping Sacks

Size	Type I No. bags per box	Type II No. bags per box	Type II No. bags per box	Type IV No. bags per box
4 x 8	500	500	500	500
5 x 10	250	500	500	500
6 x 10	250	500	500	500
7-1/4 x 12	100	500	200	250
8-1/2 x 12	100	250	200	250
8-1/2 x 14-1/2	100	250	200	250
9-1/2 x 14-1/2	100	250	200	250
10-1/2 x 16	100	250	100	250
12-1/2 x 19	50	100	100	125
14-1/2 x 20	50	100	100	125

distributed between the inner and outer sheets (1/8 to 3/16 inches thick), while Type IV uses a 1/8 inch polyethylene foam as the cushioning agent. In some cases, it may be desirable to add cushioning or reinforcing materials inside the sack to provide additional protection against internal puncture or breakage.

b. Procurement. Cushioned paper sacks are supplied in standard sizes and in the quantities as shown in table 4-3.

4-7. Burlap, Cotton, and Textile Shipping Bags (PPP-B-35)

Textile shipping bags conforming to Specification PPP-B-35 may be made from cotton cloth; burlap cloth; or textile, laminated to paper, polyethylene, or other specified materials. They are used for domestic or oversea shipment of pulverized, powdered, granular, or crystalline supplies of either a hygroscopic or nonhygroscopic nature.

a. Classification of Textile Bags. Textile bags are classified into four types based on the material used in their construction (table 4-1 and fig 4-2). The Type III bags are further classified by classes based on the materials used in the layers of the laminated walls of the bags (table 4-1 and fig 4-3). The textiles used in the construction of Type III laminated textile bags are designated by three grades based on the fabric weight, and texture of weave. Grade I is made from cotton sheeting, grade II is of Osnaburg cotton, and grade III is jute burlap. The bags are made in two styles, A and B, based on the means of closing the seams (table 4-1). Bag numbers are assigned to the various types of bags in a series to designate specific construction features. Each construction within a type is given a bag number, such as B-1, C-21, P8, or P58. These construction numbers, found in Tables I, II, and III of PPP-B-35, must be used to determine minimum requirements for burlap, cotton, and laminated textile bags for domestic and export shipments and for special commodity and storage conditions.

b. Textile Bag Construction Materials. Textile bags conforming to Specification PPP-B-35 are constructed of a single ply or multiple plies of textiles, paper, polyethylene, and suitable laminants.

(1) *Textiles.* The textiles used in laminated bag construction may be cotton sheeting, cotton Osnaburg (a course heavy sack cloth), or jute burlap cloth. The cotton sheeting material varies in weight and texture. Weights of cotton material are expressed in terms of running or linear yardage per pound of a given loomed width. Burlap material is designated by the weight of one yard of goods of a given width.

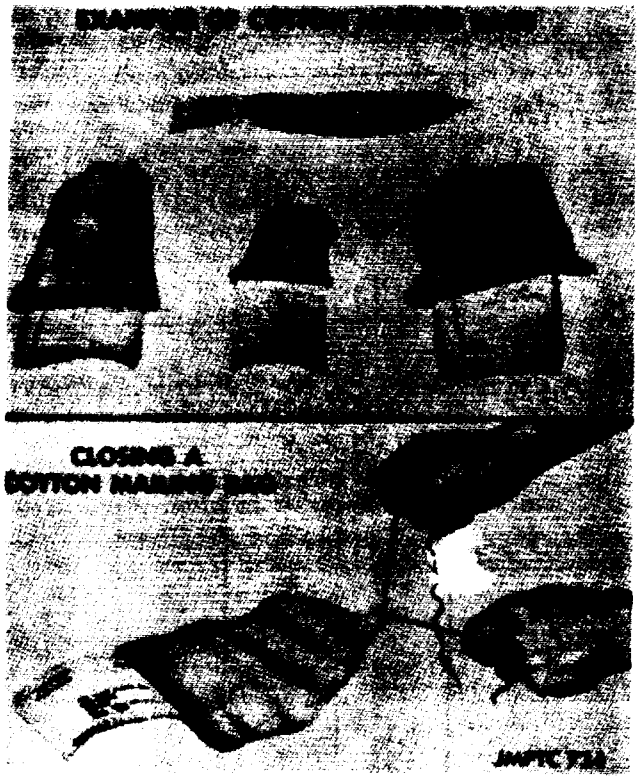

Figure 4-1. Cotton mailing bags.

(2) *Paper.* Laminated shipping bags are fabricated in part from either plain or wet strength kraft paper. Kraft (meaning "strong" in German) paper is a long fibered paper, which is widely used and readily available. It may be plain or creped in one direction of the paper, creped in two directions, or creped in one direction and corrugated or pleated in the other. Plain kraft paper is 100 percent unbleached kraft fiber, resin sized. It has not been treated for special qualities such as resistance to rain, scuffing, molten resins, hot asphalt, grease, and water-vapor. Wet strength kraft paper is 100 percent unbleached kraft fiber, resin sized, and distinctly marked for identification purposes with longitudinal red stripes of a minimum width of one-eighth inch, spaced not less than 2 inches nor more than 10 inches apart across the paper width. No other bag construction is striped in this manner.

(3) *Polyethylene.* The polyethylene that is used for Type III, Class 6, bags must be at least 2 mil (0.002-in.) thick to afford the commodities to be packed the desired protection against moisture, odor, and gases.

(4) *Laminants.* Usually, asphalt is used as the laminant for textile bags because of its low cost and its moisture-resisting qualities. It is used in varying weights per ream of kraft paper as indi-

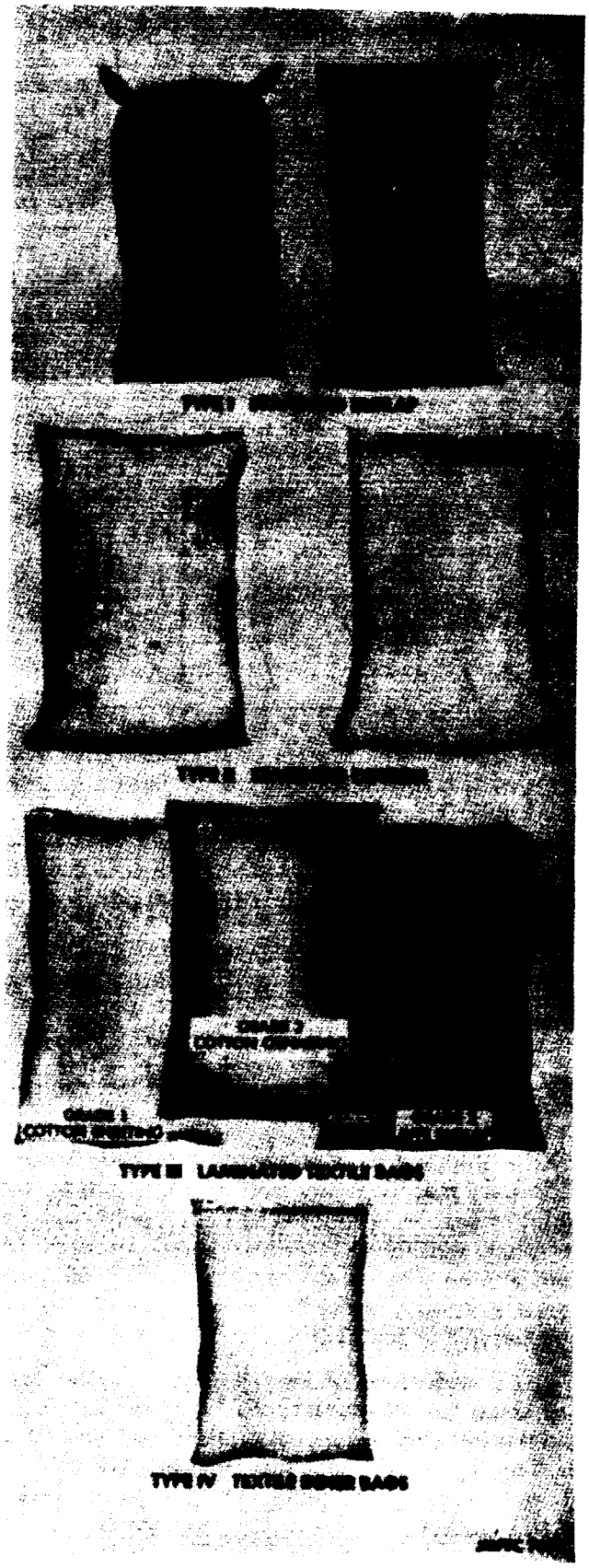

Figure 4-2. Types of textiles shipping bags.

cated for classes 1, 2, 3, and 4 in figure 4-3. Other laminants that may be used include latex, polyvinyl acetate, and vegetable glues.

c. Waterproofing of Textile Bags. The bags may be waterproofed by inserting a waterproof paper liner or a polyethylene liner inside the textile bag, or be laminating textile and paper with asphaltum, latex, or other water-resistant adhesive before manufacturing the bag.

d. Selection of the Correct Bag. Since bag constructions vary widely, it is essential that a copy of Specification PPP-B-35 be available. Use must be made of tables XI, XII, and XIII of PPP-B-35 to determine the minimum requirements for a bag to be used in packing any specific commodity. For example, in shipping sodium chloride (rock salt), table XI shows that a construction number P45A bag may be used for domestic shipments of 50 pounds; but a P6A bag is required for an overseas shipment of 100 pounds to a civilian agency, while either a P12, style B or A, or a P15, style B or A, is required for military shipments. Table XII of PPP-B-35 lists the bag constructions required for sugar, flour, cereals in bulk, etc. If commodities such as flour, salt, beans, peas, rice, or sugar are to be packed in units of 50 pounds or less, table XIII of PPP-B-35 must be used.

e. Requirements for Packing. The commodity may be packed in one of several ways. It may be packed in bulk in either 50- or 100-pound lots in type I, II or IV bags. It may be packed in cotton cloth inner bags in lots of 5 or 10 pounds. These

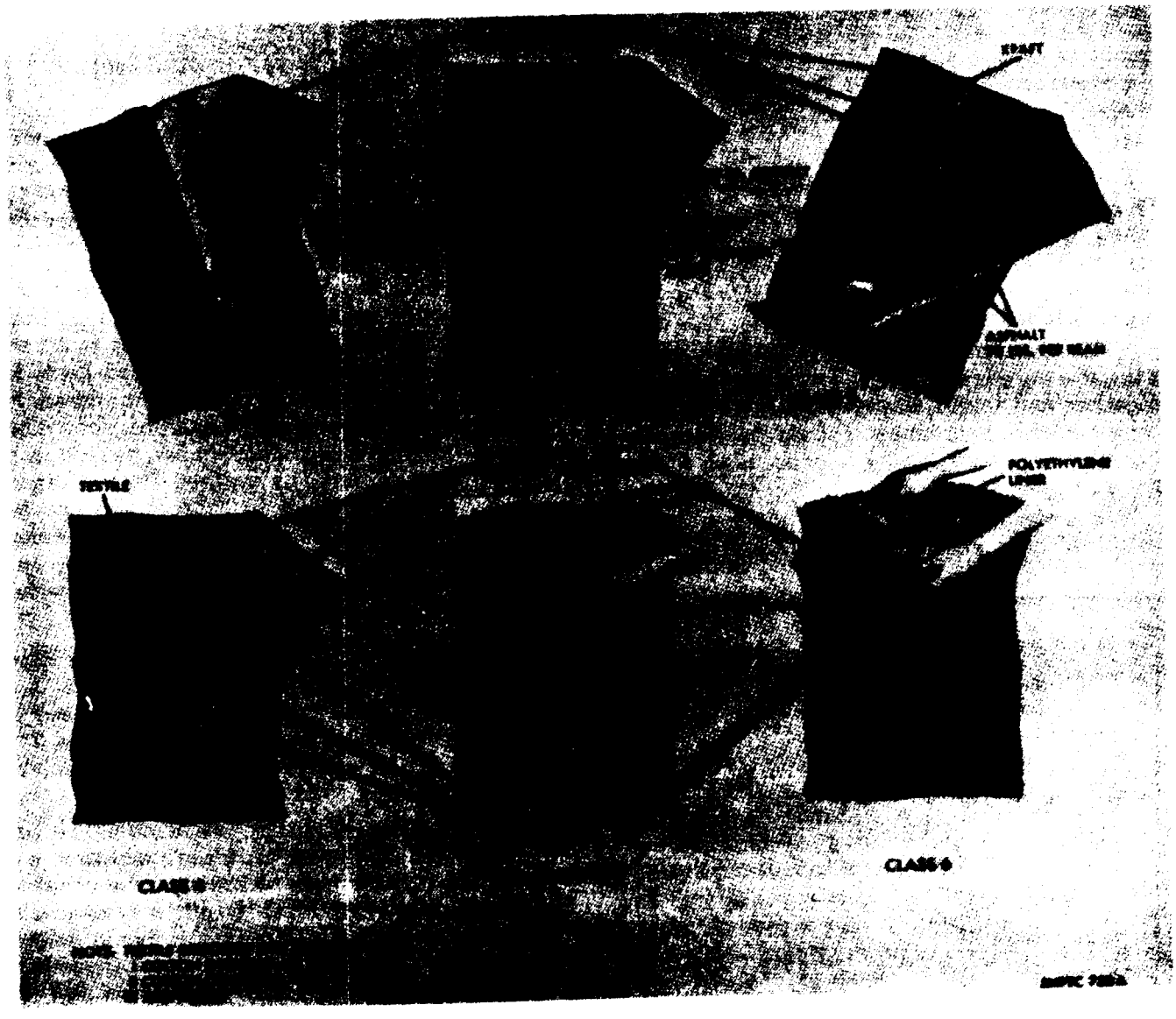

Figure 4-3. Classes of textile shipping bags.

inner cloth bags are in turn packed in type III laminated textile bags as described below.

(1) *Packing 5- or 10-pound bags.* Twelve filled and closed type IV cotton cloth bags of 5 pounds capacity, or six filled and closed 10-pound, type IV, cotton cloth bags are packed into a type III shipping bag. Place one on top the other with the faces of the inner bags down and the ends of the inner bags adjacent to the side edges of the outer shipping bag (fig 4–4). The laminated shipping bag should inclose the contents, leaving no space that will permit shifting of the inclosed inner bags.

(2) *Packing of 50-pound bags.* One filled and closed type IV cotton bag of 50 pounds is packed into a laminated textile shipping bag. Place the factory closed end down and have the side edge adjacent to the side edge of the outer bag. Be sure the outer and inner bags are of proper relative sizes so that after packing with the required quantity of the commodity, there is sufficient space left to allow the inner bag to conform to the shape of the outer bag during handling and stacking.

f. Requirements for Closure of Types I, II, and IV Bags. Types I, II, and IV bags are closed after filling by sewing a line not less than 1 inch from the top of the cloth and parallel to the top. When liners are used with these bags, they are closed (fig 4–5) as follows:

(1) *Paper bag liners.* After filling the combined bags, the top edges of the paper liners are brought together and folded down against the top of the contents with a minimum of three flat folds allowing sufficient slack for the product to shift. Close the outer bag by sewing.

(2) *Polyethylene bag liners.* After filling the combined bags, gather the top of the polyethylene liner together and tie with heavy cord or, if equipment is available, the top may be heat sealed. Close the outer bag by sewing. If types I, II, or IV bags are provided with valves, fold the tuck-in-sleeve down and back into the valve space directly under the sleeve so that it will securely hold against sifting.

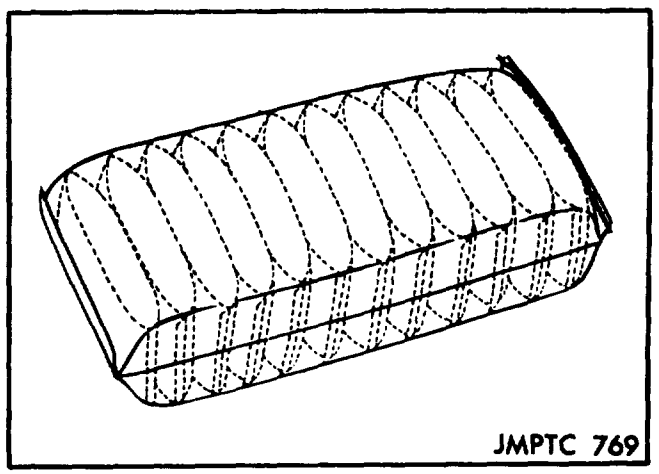

Figure 4–4. Packing inner bags in a laminated textile bag.

g. Requirements for Closure of Type III Bags. After filling, type III bags may be closed by sewing with a flat seam or a single turn-over seam and waterproofed by dipping the sewn seams in microcrystalline wax or a blend of paraffin wax and polyethylene, at least one-fourth of an inch beyond the upper edge of the seam on the bag body. Alternatively, the bag may be sewn with a strip of paper-asphalt-textile material 2½ inches wide, cemented over the sewing with asphalt (fig 4–5).

4–8. Paper Shipping Sacks (UU–S–48)

Paper shipping sacks are made in a great variety of sizes and constructions to meet the needs for the shipment of wide range of bulk materials. These paper sacks can be custom-made to suit the demands of the product, or the filling, packing, shipping, and storage conditions (table 4–1).

a. Advantages of Paper Shipping Sacks. For shipping bulk materials up to 110 pounds, these shipping sacks are ideal. They are easy to fill and empty. They constitute one-man sized loads for handling. They are low in tare weight and occupy a minimum storage space prior to use. The protection required for the commodity can be built in by the bag manufacturer as required. Paper shipping sacks can be designed to protect the product against weather changes, water, insects, rodent excreta, chemical reactions, and foreign substances. The basic material, kraft paper, is widely used and readily available.

b. Classification of Paper Shipping Sacks. Paper shipping sacks conforming to Specification UU–S–48 are classified into types and classes based on bottom construction, filling device, or closure. Two styles applicable to all types are also available (table 4–1).

c. Paper Shipping Sack Construction. The successive walls of a shipping sack are arranged and fabricated in tube form one within the other so that each wall bears its share of the burden. The number of walls vary from two to five in accordance with the shipping sack construction numbers detailed in tables I and II of Specification UU–S–48. It has been found that greater flexibility and strength are obtained by using several walls of

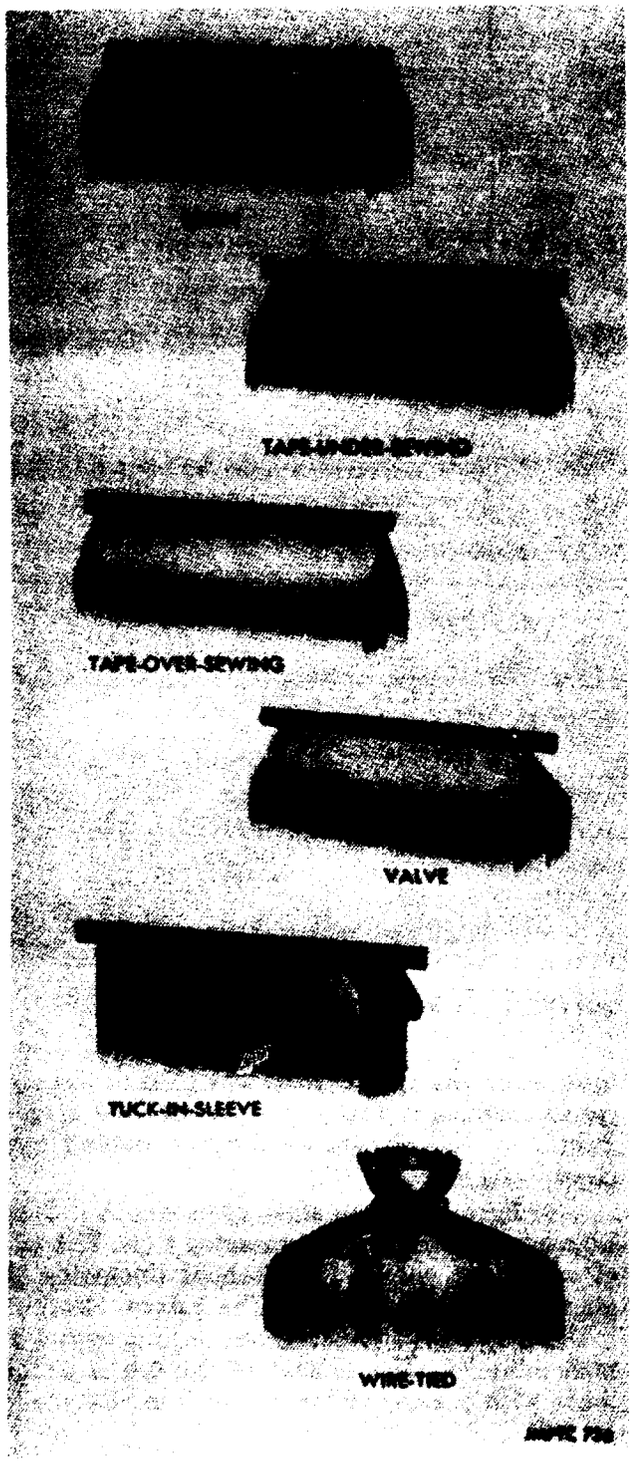

Figure 4–5. Types of closures of sacks.

relatively light-weight, rather than few walls of heavier paper. For this reason, the average heavy-duty multiwall shipping sack is constructed of a number of sheets ranging from 50 to 70 pounds basis weight paper. (Basis weight is the weight of one ream—3000 square feet—of paper.)

d. Construction Materials. Paper shipping sacks may be constructed either wholly or in part from several classes of paper. The paper may be plain heavy-duty shipping sack kraft made from all sulfate pulp, without other fiber which has not been treated by coloring, bleaching, creping, coating, spraying, laminating, or impregnating for special qualities. The paper may also be plain wet strength, asphalt laminated, MB (moisture barrier) coated or lined, in regular or extensible varieties to provide special strength and moisture-proof characteristics to a specific sack according to its construction number. When necessary, an insect repellent treatment may be applied to shipping sacks. Such treatment will be applied to the outside surface of the sack and in accordance with Military Specification MIL–T–21330.

e. Construction Numbers. Since each commodity differs in chemical and physical characteristics, and the factors of availability of packing equipment, value of product shipping conditions, number of transfers, atmospheric conditions, and exposure to the elements must all be taken into consideration before determining the construction of a shipping sack, a great number of combinations of constructions have been developed. These constructions are to be found in tables I and II of Specification UU–S–48. Tables I and II delineate the different constructions permitted, numbering 1 to 18 and 1x to 18x, respectively. Sacks from either table may be selected for packing of commodities for shipment, handling, indeterminate storage and worldwide redistribution (Level A), or for packing of commodities destined for multiple domestic shipments, handling and covered storage, and for ocean shipments and covered storage at destination where the end use of the commodity is to be at the initial overseas receiving activity (Level B). Sacks for Level A must be of wet strength kraft paper.

f. Description of Sack Types. The types of sacks furnished by Specification UU–S–48 have the following features and uses:

(1) *Type I, pasted bottom, open mouth (POM).* This may be either a flat tube nongusseted sack often called an *open mouth satchel bottom sack*, or it may be a gusseted sack with a factory made square, pasted bottom, called the *open mouth automatic sack (type I, fig 4–6).*

(2) *Type II, sewn bottom, open mouth (SOM).* This sack may be either gusseted at the sides or of flat tube construction. The bottoms are formed by sewing through reinforcing tape. The mouth is left open for filling (type II, fig 4–6).

(3) *Type III, pasted valve.* This valve may be

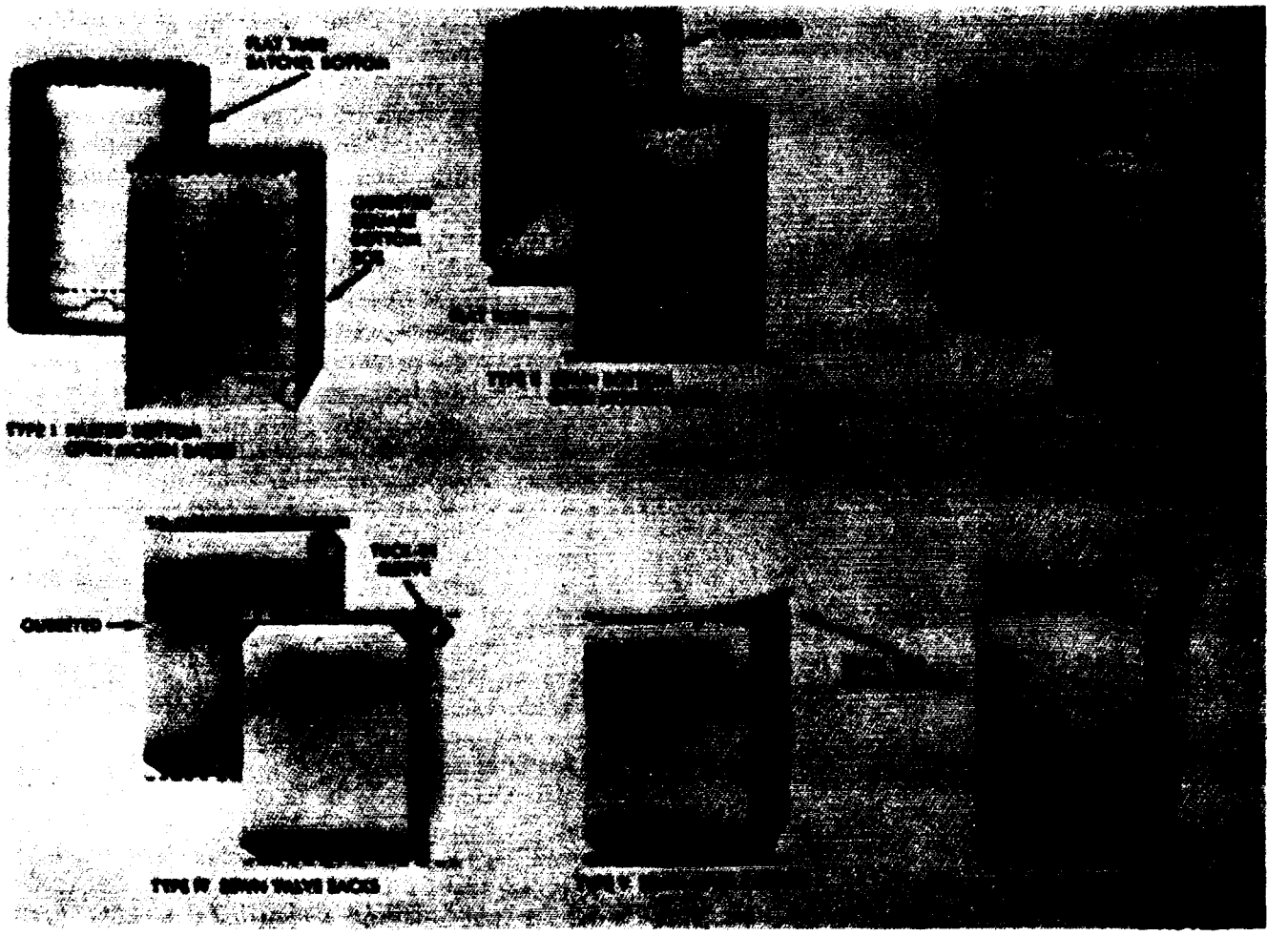

Figure 4-6. Types of paper shipping sacks.

made by forming satchel folds at top and bottom and pasting. A valve opening is left in one corner. Special valve filling equipment is necessary for these sacks. The valve may be of several types depending on the commodity to be packed. Two common types are the plain valve and the tuck-in-sleeve valve. The plain valve is held closed by the commodity. The tuck-in-sleeve must be tucked in manually to provide a good seal (type III, fig 4-6).

(4) *Type IV, sewn valve.* These sacks are closed at top and bottom by sewing with a reinforcing tape. A valve in one corner provides for filling. The valve may be plain or with a tuck-in-sleeve (type IV, fig 4-6).

(5) *Type V, sewn, open corner.* This is a special purpose sack, intermediate between the valve and the open mouth type sack. These sacks are used for commodities which are packed while in a molten state, and which solidify into a block which takes the shape and size of the sack when the material cools. Filling is usually done by a pipe inserted in the open corner. The plies at the open corner are then brought together and stapled down over this closure for further reinforcement (type V, fig 4-6).

(6) *Type VI, pinch style, open mouth (PSOM).* This bag is made from a gusseted tube. The ends of which are shingled or stepped (including the gussets) on opposite sides. The bottom closure is realized by scoring, folding, and sealing with a hot melt adhesive. The closure of the top is usually made with preapplied hot melt adhesive (type VI, fig 4-6).

g. Selection of Appropriate Sacks. To ship any specific commodity in paper shipping sacks conforming to UU-S-48, it is essential to consult table XII of the specification to determine the sack construction numbers for the commodity for each packing level and the shipping weights. The construction for any sack number so given is found in table I and II of the specification. As an illustration, if granular sugar is destined for shipment in

bulk overseas, sack numbers of 4–4x, 10–10x, and 14–14x are indicated in table XII, depending upon weight. Their constructions are found in tables I and II of the specification.

h. Storage of Unfilled Paper Sacks. Paper shipping sacks give their best service during packing and closing operations when the moisture content of the paper is 6 to 8 percent. Storage prior to filling can mean the destruction of a paper shipping sack unless the humidity is kept at that level. If the sack is allowed to dry out, it becomes weak and brittle. Brittleness can be detected by shaking a sack briskly, if it rattles sharply, it is too dry. Sacks that are too dry upon receipt from the manufacturer, should be spread out in a humidified room, or on a covered loading platform during rainy weather to allow the sacks to absorb the moisture needed to regain their flexibility and strength. The problem of dryness is very serious when sacks are filled by automatic equipment. Unlike human operators, the machine makes no allowances for brittle sacks and ruptured sacks and spilled contents are the result.

i. Filling Paper Shipping Sacks. The wrong filling equipment can damage paper shipping sacks. These sacks are filled in three ways: with gravity feed, auger packers, or valve packers.

(1) *Gravity feed equipment.* Gravity feed equipment is used mostly on open mouth sacks into which the feeder drops the product. The product must be free flowing. Such products as sand, grits, beans, and peas are typical for this type filling.

(2) *Auger packer.* The auger packer pushes the product into an open mouth sack. It is used for materials that are not free flowing in themselves, such as flour.

(3) *Valve packers.* There are four types of valve packers: The gravity feed, belt, auger, and impeller. All have a spout which inserts into the valve of sewn or pasted valve sacks. The gravity feed valve packer is used on free flowing materials. With the belt packer, the material is poured into a channel between a rotating pulley and a moving belt which conveys it into the sack. This is used for granular materials. The auger valve packer forces nonfree flowing material into the sack horizontally through the spout. Flour, starch, and similar materials are packed with this equipment. Impeller valve packers have an impeller wheel, mounted either vertical or horozontal to the sack which drives the dense powders (cement, plaster, or lime) into the sack.

j. Closure of Paper Shipping Sacks. The top closure, formed by the packer, varies according to the commodity packed and the sack type. Basically, the closures are made by sewing or pasting. The specification must be consulted for details.

CHAPTER 5
PAILS AND DRUMS

5-1. Description, Classification, and Selection Factors

a. Description:

(1) *Pails.* Pails are cylindrical containers made of metal or plastic, with or without a bail (handle). They have a capacity of 1 to 12 gallons. Metal pails are constructed of 20 gage or heavier metal. The sides and bottoms of the plastic pails are integral units having a minimum thickness of 0.045 inches and designed so they can be easily stacked. Pails may have fixed heads employing pour spouts of various designs or have full removable heads.

(2) *Drums.* Drums are cylindrical, straight-walled containers made of metal, plastic fiber or plywood, or a combination of these materials. Drums may be provided with rolling hoops pressed or expanded from the body of the drum, or I bars welded to the body. Drums have fixed or removable heads.

Note. Cans are lightweight containers made of metal, paperboard, pulpboard, or a combination of metal and paperboard or pulpboard. Since cans usually are associated with unit packaging, information concerning them is found in volume I of this manual.

b. Classification. Pails and drums are classified as to usage, that is, interior or exterior containers, and reusable and nonreusable containers. They are also classified as to composition—metal and nonmetal.

(1) *Interior and exterior containers.*

(a) Interior. Interior containers are covered in volume I of this manual.

(b) Exterior. These containers consist of pails, reusable type metal containers, and drums. Exterior containers are designed to withstand rough usage. They may be palletized for convenience in handling.

(2) *Reusable and nonreusable containers.*

(a) Reusable. Certain 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 pails and drums may, under certain conditions, be refilled and reused for the shipment of liquid, powdered or granular commodities.

(b) Nonreusable. Single-trip containers usually are 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 enclosed product. Other single-trip containers, designed of light gage metal, are discarded after the first trip because of Department of Transportation (DOT) Regulations, or because the general physical condition of the container would not warrant another trip.

(3) *Metal and nonmetal containers.* Pails and drums usually are made from metal, although some may be made from fiberboard. The most common metal used for drums is mild steel. Some drums, however, are made of aluminum, nickel, stainless steel, various alloys, or plastics.

c. Use and Selection Factors.

(1) *Use.* A wide range of items and commodities are adaptable for shipping in pails and drums. Liquids, semiliquids, semisolids, granular, flaked, 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, such as corrosive liquids, flammable solids, flammable liquids, and acids which cannot be shipped in any other type of container may be shipped in approved types of pails and drums.

(2) *Selection.* When selecting a pail or drum, it must be remembered that these containers are structurally rigid in design and are dustproof. They may also be waterproof or water-vaporproof. They are easy to mark and afford excellent physical protection to contents during shipment and storage. Pails and 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; it is also true when selecting the correct container for other items. For example, a square item in a cylindrical container takes about 1½ 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.

5-2. Molded Plastic Polyethylene Drums (MIL-D-40030)

a. Description. These interior drums are made of natural color polyethylene, molded in one piece, are cubical or cylindrical in shape, and have either a one-flange opening or two-flange opening.

b. Classification. Polyethylene drums are classified as Style A, cubical, and Style B, cylindrical. Style A has only one size, size 1, which has a nominal capacity of 5 gallons. Style B has sizes 1, 2A, 2B, 3, and 4 with nominal capacities of 5, 15, 15, 30, and 55 gallons, respectively. Both Styles A and B comply with specifications 2S of the Department of Transportation (DOT) Regulations.

c. Use.

(1) These drums are intended for use as containers for liquids, powders, or pastes. They are not intended for use with strong oxidizing liquids or aromatic or aliphatic hydrocarbons, but are suitable for some organic and inorganic acids, alcohols, and alkalies. In all cases, the chemical should not be packed in a polyethylene drum if the boiling point of the chemical approximates, or is lower than, the anticipated storage temperature. Table II of Specification MIL-D-40030 must be consulted to determine the specific materials that may be shipped or stored in these drums.

(2) After filling, Style A drums are packed in fiberboard lined nailed wood boxes for level A shipments, while Style B drums are packed in type I or II steel drums. The type I steel drum is constructed to leave the closure flange of the polyethylene drum exposed, and the type II steel drum fully incloses the polyethylene drum. Steel drums must conform to specification 5B or 6J of the Department of Transportation (DOT) Regulations.

(3) Packing for level B shipments is the same as for level A, except that Style A polyethylene drums are packed in type CF or type SF, class domestic fiberboard box, conforming to Specification PPP-B-636 (para 2-1).

(4) Polyethylene drums should be protected from exposure to sunlight (ultraviolet rays), since ultraviolet rays accelerate the aging of the polyethylene.

d. Closure. Size 1 drums have a one-flanged opening. Size 2, 3, and 4 drums have a two-flanged opening. The drums are provided with polyethylene plugs for each opening. All plugs are constructed so that they may be tightened with a standard plug wrench and do not interfere with the placement of an outer cap. Outer caps are provided for each opening. The caps are rigid metal or plastic screw-type closures which, when hand-tight, will prevent foreign matter from coming in contact with the polyethylene flanges.

5-3. Reusable Molded Polyethylene Container (DOT 34 and MIL-D-43703)

a. Description. These polyethylene containers range in capacities from 5 gallons to 30 gallons. They are required to have a minimum thickness of 0.045 inches for containers having capacities from 5 gallons through 6½ gallons, 0.075 inch thickness from 15 gallon containers and a thickness of 0.125 inches for 30 gallon drums. These containers are reusable and are designed for use without overpack. Removable heads are not authorized. Ultraviolet light protection is provided by impregnation of polyethylene with carbon black or other equally efficient pigments or inhibitors. These additives must be compatible with lading and must retain their effectiveness for the life of the container. Other materials may be added (such as reinforced metal chimes, tops and bottoms) provided they do not adversely affect the physical properties of the container.

b. Use. These molded polyethylene drums are reusable for holding all types of dry and liquid products, especially acids and other sensitive commodities.

c. Closure. Openings shall not exceed 2.7 inches in diameter for any size DOT 34 container. Closures shall be of material resistant to lading and adequate to prevent leakage under conditions incident to transportation and handling. Vented closures are authorized when specified.

d. Marking. Each container must be permanently marked by embossment in letters and figures at least ½ inch in size with month and year of manufacture and the rated capacity of the container. For example, DOT-34-5-6/74 to indicate a container of 5 gallons capacity made in June 1974. These marks shall be understood to certify that the container complies with all specification requirements.

5-4. Steel Shipping Pails, 1 Through 12 Gallons (PPP-P-704)

a. Description. These pails are cylindrical containers constructed of 20-gage or heavier steel. They usually are furnished with a bail (handle). Pails may have full removable heads or fixed (tight) heads which are provided with spouts of various designs (fig 5-1).

b. Classification. Pails furnished in accordance with Specification PPP-P-704 are classified as Type I, tight head pails; Type II, lug cover pails; and Type III, lug cover nesting pails. (Types I and II are shown in fig 5-1). The classes, metal gage, capacities and applicable DOT specification, or Rule 40 of the Uniform Freight Classification and item 260 of the National Motor Freight Classification are shown in table 5-1. These pails are furnished with straight sides (Types I and II) and tapered sides with one or two beads (Type III).

Figure 5-1. Tight head and lug covered pails.

c. Use.

(1) *Statutary requirements.* Shipping containers conforming to Military and Federal specifications must conform also to Department of Transportation Regulation: Code of Federal Regulations, Title 46; Title 49; Uniform Freight Classifi-

Table 5-1. PPP-P-704 Steel Shipping Pails—1 Through 12 Gallons

Type	Class	Gage	Applicable specification	Capacity available in gallons
I—Tight head	1	28	DOT-37B	1 through 5
	2	26	Rule 40 and 260	1 through 7
	3	24	DOT-17E	1 through 5
	4	24	DOT-17C or DOT-5B	1 through 5
	5	26	DOT-37B	1 through 12
	6	22	DOT-37B	1 through 12
	7	22	DOT-5	1 through 5
	8	22	DOT-17E	10
	9	20	DOT-17C	1 through 10
	10	20	DOT-5	1 through 10
	11	20	Rule 40 and 260	1 through 12
II—Lug Cover	1	26	DOT-37A-60	1 through 5
	2	28	Rule 40 and 260	1 through 4
	3	24	DOT-37A-80	1 through 5
	4	26	Rule 40 and 260	5 through 10
	5	24	DOT-37A	6 through 10
	6	24	Rule 40 and 260	1 through 12
	7	24/20	DOT-17H	1 through 5
	8	28/26	DOT-37C	1 through 5
	9	28	DOT-37A	1 and 2
	10	24	DOT-37A-40	1 through 5
	11	20	DOT-17C	1 through 10
III—Lub cover—nesting pail	1	26	DOT-37A-60	1 through 5
	2	8	Rule 40 and 260	1 through 4
	3	24	DOT-37A-80	1 through 5
	4	26	Rule 40 and 260	5 through 10
	5	28/26	DOT-37C	6 through 10
	6	22	DOT-37A	1 through 5
	7	24	DOT-5B	1 through 5
	8	22	DOT-5B	6 through 10

cation, Rule 40; and the National Motor Freight Classification, Rule 260. The DOT requirements are for the shipment of dangerous materials. These requirements are issued in a tariff by the Bureau of Explosives. This tariff specifies the type of container for the shipment of hazardous materials. These containers are referred by a DOT specification number. For example, a DOT-17E pail covers light steel shipping containers and nonreturnable (single-trip) containers (table 5-1). Nonreturnable containers cannot be reused unless they are retested and approved by the Bureau of Explosives. Rule 40 and Rule 260 apply to containers carrying "non-regulatory" products not classified as dangerous.

(2) *Application.* Liquid products are usually shipped in Type I, tight head pails, which are provided with spouts of various designs for pouring. Solids, such as powdered, granular and flaked materials; semisolids, such as heavy greases; and semiliquids, such as molasses, are shipped in Type II and III, lug cover pails, because the heads can be removed to gain access to the contents (fig 5-1).

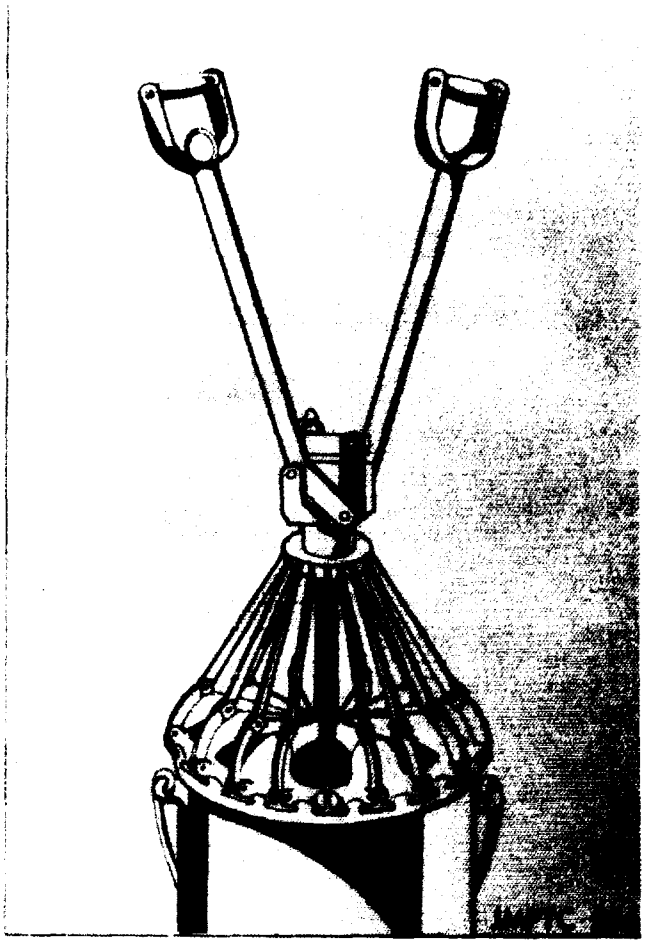

Figure 5-2. Lug cover closing machine.

d. Closure. Type I lids are permanently secured at time of manufacture. The spout closures are accomplished immediately following the filling operation. Careful inspection should be made during handling, shipment, and storage to assure that these spouts have not received damage and are still maintaining an adequate seal. Lug covers may be secured by a tool specifically designed to accomplish closure on this type of container. Figure 5-2 shows a machine which will close all lugs in one operation, while figure 5-3 shows a small handtool which closes two lugs at a time. Hands, pliers, hammers, or other improvised means are not satisfactory and should not be used.

5-5. Metal Containers With Polyethylene Inserts (PPP-C-1337)

a. Description. These containers, ranging in capacity from 5 to 55 gallons are best described as a drum within a drum. the assembled container is a unit comprised of a polyethylene insert and a steel drum over-pack, neither of which is intended to be used separately (fig 5-4). The covers of the outer packs are fully removable. These units are considered single-trip containers.

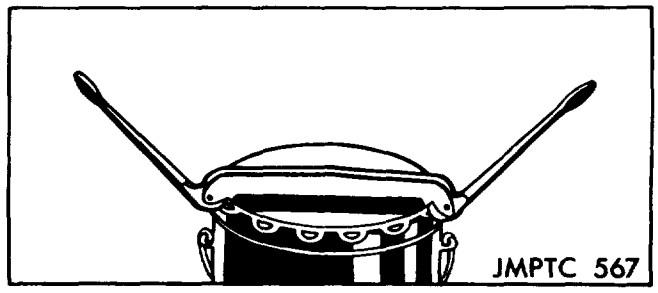

Figure 5-3. Hand closing tool for lug covers.

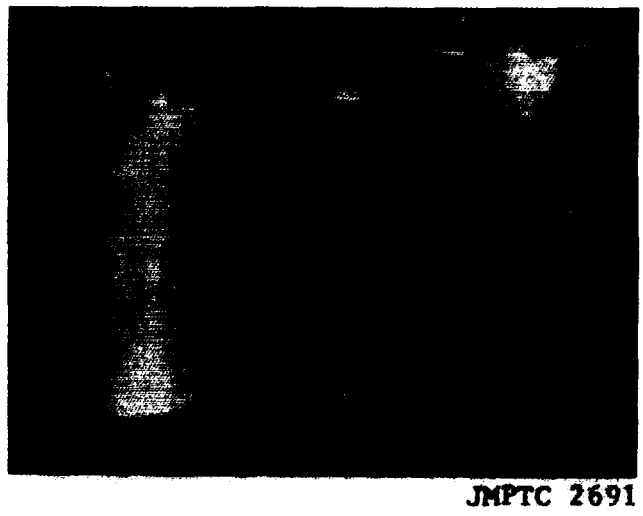

Figure 5-4. Plastic lined composite container.

b. Classification. These containers are furnished as Type I containers for surface shipment only and Type II to be used for both air and surface shipment. Table 5-2 shows the classes available under both types, depending upon the rated capacity of the insert in gallons, together with the corresponding Department of Transportation specification number, and the minimum thickness of the inserts and steel overpacks.

c. Use. These containers are intended for shipment of liquids that do not physically or chemically affect or are not affected by polyethylene. These containers are not intended to be used for the shipment of concentrated hydrochloric acid. Liquids having a vapor pressure of more than 16 pounds per square inch absolute at 115° F. are not to be packed in the composite container. Care must be exercised in assembling the polyethylene insert in the steel overpack and the filling of the assembled container.

d. Closures. For all class 1 and 2 containers the closures neck must provide adequate provision for pouring contents over edge of steel drum or provide flexible pour spouts for each container to accomplish this. Closure necks of the polyethylene inserts for the different types and classes are as described in tables 5-2 and 5-3. All covers shall be secured with locking rings. Type 1, Classes 1 and 2, may be equipped with lug type covers and locking rings.

5-6. Metal Shipping and Storage Drums (MIL-D-6054)

a. Description. These reusable steel shipping and storage drums are fabricated of 18 and 22 gage steel and incorporate a full removable (recessed or dome style) cover. Bolted-ring or lever lock closures are used to seal the cover onto the drum body, (fig 5-5). Gaskets for the covers may be tubular or solid. The covers, gaskets and locking rings are interchangeable within each diameter group. Rolling hoops, which increase the strength, rigidity, and ease of handling, also provide the means of anchoring internal dunnage through the use of split expanding steel rings which fit into the grooves (fig 5-6). When properly sealed, the drums provide a highly effective water-vaporproof container, thus affording a de-

Table 5-2. Closures, PPP-C-1337 Containers

Type	Class 1 5 gallon	Class 2 15 gallon	Class 3 30 gallon	Class 4 55 gallon
I	Crimped on flexible type closure. Closure accessible through steel cover.		2-inch N. P. T. primary closure and 3/4 inch N. P. T. vent closure. May be crimped on threaded type or may be attached to and integral with polyethylene insert.	
II	Closure fully enclosed, attached to or integral with top of polyethylene insert; 38mm (MIN) 70MM (MAX) externally threaded closure neck with screw cap or plug; cap flush with top for shipping and capable of being lifted up to pour over edge of steel pail or drum.		Closure fully enclosed, attached to or integral with top of polyethylene inserts; 2-inch N. P. T. primary closure and 3/4-inch N. P. T. vent closure.	

Table 5-3. Composite Container Requirements (PPP-C-1337)

	Polyethylene Insert Minimum thickness	Department of Transportation specification	Metal container Department of Transportation specification	Minimum Thickness[3]			Rated (marked) capacity Polyethylene insert gallon
				Body	Bottom	Covers	
Type I:							
1	.010	2U	37P	26 GA	26 GA	24 GA	5
2	.015	2U	37P	22 GA	22 GA	19 GA[1]	15
3	.015	2U	6D	19 GA	19 GA	19 GA	30
4	.015	2U	6D	18 GA	18 GA	18 GA	55
Type II:							
1	.015	2U	6D	22 GA	22 GA	20 GA[2]	5
2	.015	2U	6D	20 GA	20 GA	20 GA	15
2A	.030	2SL	6D	20 GA	20 GA	20 GA	15
3	.030	2SL	6D	19 GA	19 GA	19 GA	30
4	.040	2SL	6D	18 GA	18 GA	18 GA	55

[1] Twenty (20) gage authorized.
[2] Heavier gage than 6D.
[3] Design and metal thickness of type II container bodies, heads, and locking rings may be increased if necessary to meet the no leak requirements when tested in accordance with 4.6.10 of PPP-C-1337.

Figure 5-5. Bolted ring and lever actuated type closures.

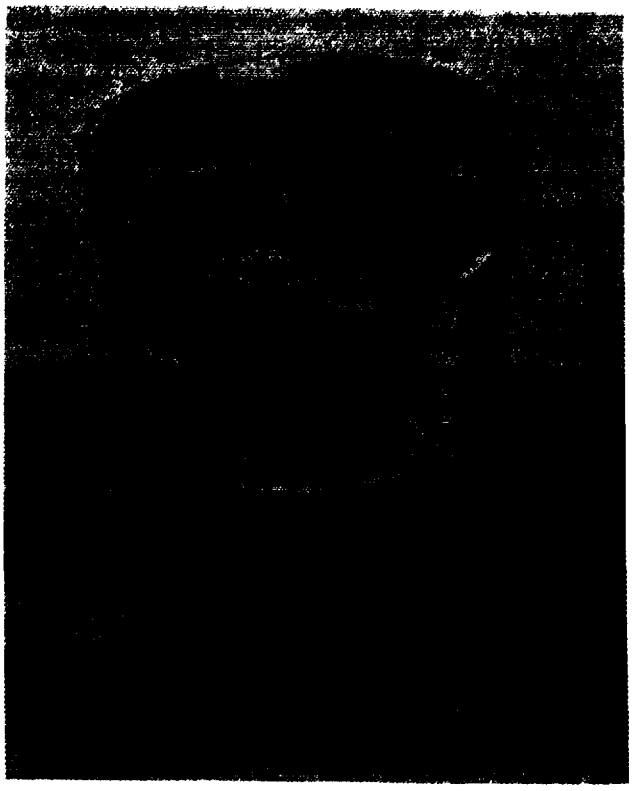

Figure 5-6. Internal locking rings in position.

gree of protection suitable for Method IA and Method II preservation (vol I).

b. Classification. The drums are available in various capacities ranging from 3 to 80 gallons, and from 40 to 250 pounds gross weight. The drums are available with inside diameters ranging from 10.50 inches to 30 inches, and inside usuable heights ranging from 8.08 to 41.12 inches. The capacities and dimensions, which are available in different combinations, are specified in Military Standards MS27683 and MS27684.

c. Use. These metal drums are intended to be used for storage and shipment of military material. Drums are required by test to withstand internal pressure of 15.0 pounds per square inch (psi), which will allow them to be used for packing of hazardous materials for transportation by military aircraft. These diameter drums are also used as overpacks for shipments by air of containers which will not meet 15 psi. All size drums are suitable for all methods of preservation where a rigid container is specified. The use and selection of metal shipping and storage drums are affected by the following factors:

(1) *Size and capacity.* There is no specific rule for the selection of a container for a particular item. It is obvious, however, that a container will

be selected which will be adequate to contain the item and its blocking and cushioning, yet allow sufficient clearance between the item and the container, or between the blocking and the container walls, to prevent damage to the item when the drum is handled roughly. The container must not be too large, as this will involve the use of extra space and weight. This is a disadvantage when a large number of such drums are to be shipped or stored.

(2) *Internal locking rings.* The split steel locking ring is designed to fit snugly within the rolling hoop of a metal container and provide a circular flange support for interior blocking (fig 5-7). Care must be used in the design of the interior blocking or other fittings to prevent displacement of the locking ring when loaded. Without some safety device, the locking ring may be loosened by rough handling of the container due to the load imposed on the ring. Figure 5-7 illustrates a safety ring made of plywood. If the item being packed precludes the use of a safety ring, the same function may be performed by using three blocks equally spaced around the internal locking ring and secured to the dunnage by screws. This permits the removal of the blocks for unpacking.

(3) *Cup-type inserts.* The cup-type metal insert was developed primarily as a mount for generators and starters for metal container packing, but it may be adapted to other items. Figure 5-8 shows the metal cup, with plywood fastened to the two ends to aid in blocking while figure 5-9 shows the cup in position, anchored between the locking ring and container cover. It will be noted that the stepped rim of the insert forms the safety to prevent the ring kicking out of the rolling hoop. The numerous bolt holes through the cup allow it to be bolted to various items as required.

(4) *Crate-type inserts.* The crate-type metal insert is shown in figure 5-10. In use, the item being packed is bolted to two adjacent side mem-

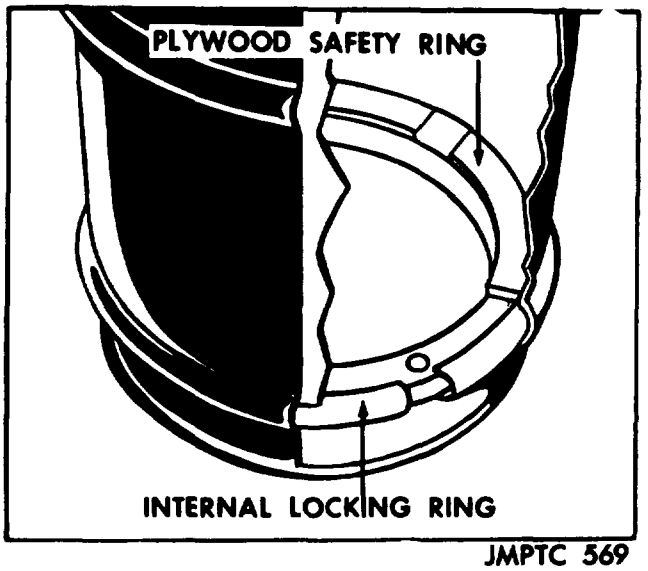

Figure 5-7. Use of internal locking ring.

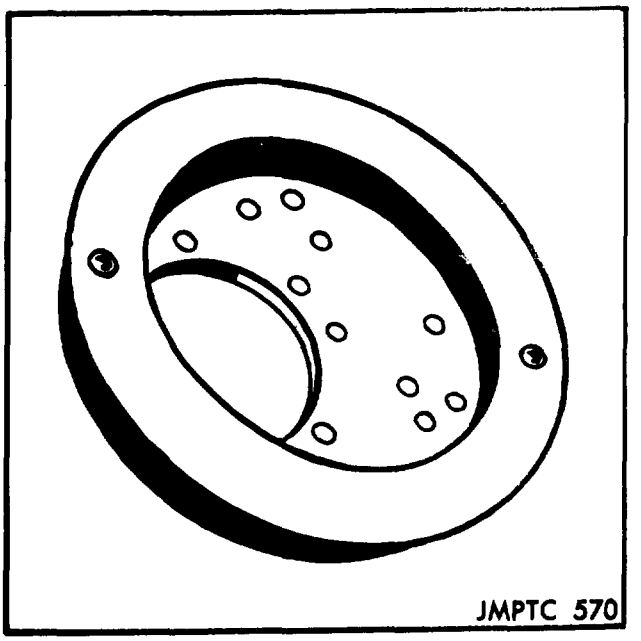

Figure 5-8. Cup-type metal insert.

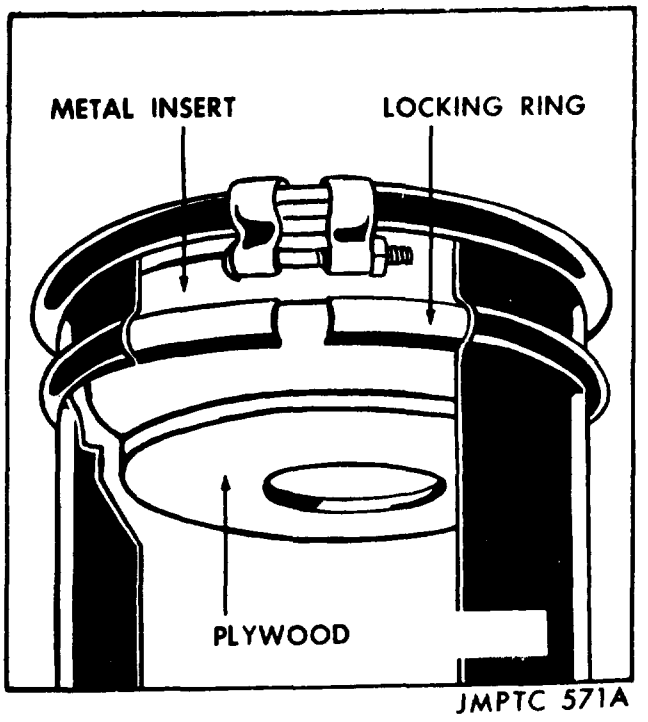

Figure 5-9. Cup-type insert locked in place.

Figure 5-10. Item installed in crate-type insert.

bers. Plywood disks on the ends of the insert provide some cushioning. The base of the item packed will be insulated from the insert with barrier material conforming to Specification MIL-B-121, Grade A to preclude the possibility of corrosion from reaction of two dissimilar metals. The maximum weight of the packed item should not exceed 25 pounds for the 10 1/2-inch diameter insert, or 30 pounds for the 13 13/16-inch insert.

d. Closure. There are two styles of closure for these drums. They are the bolted ring closure, and the lever activated locking closure. Closures are made in one or the other of the following manners:

(1) *Bolted-ring closure.* The closure may be made in two ways. A device may be used which encircles the locking ring and applies pressure uniformly around the circumference of the ring. The closure is effected by tightening the bolt and nut after uniform pressure is applied at all points around the ring. Care should be taken that the gasket is properly seated in the groove of the cover prior to closure. Alternately, closure may be made by tightening the closure bolt (fig 5-11). The locking ring is tapped at various points about the closure ring while the closure bolt is being tightened. The tightening is continued until at least a minimum torque of 6 foot-pounds plus or minus one-half is applied. In lieu of the specified torque indicating device, closure of an exterior metal container having a slotted-head bolt may be accomplished by using a common screwdriver having an overall length of approximately 17 inches. If this procedure is followed, a spot check of torque with a torque indicating device should be made to assure adequate tensioning. Drums used for shipping commodities by Parcel Post will have the bolt end and protruding edges of the closure ring wrapped, taped, cushioned or otherwise securely covered to prevent damage to postal employees, mail bags, and other containers during shipment. Containers shall be overpacked in fiberboard boxes when this extra precaution is considered necessary. When overpacked, containers shall be secured within the fiberboard box with fiberboard or other suitable dunnage.

(2) *Lever actuated locking closure.* When specified in the contract or purchase order a lever actuated type locking ring may be used instead of the nut and bolt type locking ring. Use may be made of a device which encircles the locking ring and applies pressure uniformly about the circumference of the locking ring. The closure is then affected by closing the locking lever and then the wire and lead seal lever which locks the locking lever in position. When the encircling device is not available for use, tension is applied by the locking lever and the ring is tapped repeatedly around the circumference until the ring is seated and the lever is in a locking position. The lever is then locked into place by the wire and lead seal lever lock.

Figure 5-11. Tapping locking ring while tightening bolt to insure an effective seal.

e. Sealing. Sealing of the container is effected by means of a wire and metal seal which is applied after the closure is complete. Drill 3/32-inch diameter holes in each locking ring lug if they are not already predrilled. The sealing wire is inserted through the holes and the loose ends are twisted together tightly, after which the seal is crimped over the twisted ends of the wire.

f. Repair and Reuse. The components of the metal shipping and storage drums are repaired and reused as follows:

(1) *Containers, cover, ring, and gasket.* Due to the welded construction of an exterior type metal container, dents are considered repairable even though a seam or joint is involved. Dents are removed, painted surfaces retouched, and the container reused or returned to stock. If the container is distorted beyond practical repair, or has a dented or otherwise damaged sealing lip, it is unfit for further use and should be handled accordingly. Damage to covers, gaskets, and locking rings is discussed in chapter 5, volume 1.

(2) *Metal inserts and dunnage.* It is not normally considered advisable to repair metal inserts or dunnage, due to the fact that once distorted or deformed, the metal insert would probably be weaker if bent back into the original shape, and thus be incapable of affording the necessary protection. If bent back and reinforced, the spring rate of the material might be greatly changed, thus transmitting any shock directly to the part to be packed and causing damage. However, in an emergency they may be repaired under competent engineering supervision. Immediately upon removal of an item from a metal insert type mount, the interior locking rings and metal inserts must be returned to stock, unless required for immediate reuse. All inserts and interior locking rings are stocked and handled as separate items, and never as component parts of the container assembly.

5-7. Metal Drums (Standard) (Miscellaneous)

a. Description. Metal drums are cylindrical, single-wall shipping containers with a capacity which usually ranges from 12 to 110 gallons, 55 gallons being the most common capacity. Metal drums are equipped with rolling hoops which provide additional strength to the side wall and provide for ease of handling. The rolling hoops may be parallel to each other or be offset to facilitate closer nesting for palletization and carloading. Metal drums may have full removable heads or tight heads (fixed) (fig 5-12). A drum with a tight head is provided with a 2-inch diameter bung and 3/4-inch diameter vent hold for filling and emptying. These openings may be on the drum head or in the drum body. Drums may be unlined or lined with lacquer, varnish, enamel and plastics, rubber, lead, or aluminum.

b. Classification. The Armed Forces use many kinds of drums for the shipment of various materials. When shipping hazardous materials, the Federal or Military specification in each case equals or exceeds the DOT specification requirement for the kind of drum required for that particular material. Listed in table 5-2 are the coordinated Federal and Military drum specifications and titles, and the corresponding DOT specification. Uniform Freight Classification rule 40, or National Motor Freight Classification rule 260. Figure 5-12 shows the types of drums classified in Federal Specification PPP-D-729 and the corresponding DOT-5B. DOT designates the DOT 17E and DOT-37A drums as single trip containers when used to ship specified hazardous materials.

c. Use. The tight (fixed) head drums are primarily used for the shipment of liquids. Emptying may be through either the filler or vent hold, although the filler hole is most commonly utilized. A spout may be affixed to the threaded portion of the hole to facilitate emptying. A pump, either hand or hydraulically operated, may be utilized in the hole. Greases, dry powdered, flaked or granular materials, etc., may be shipped in a full removable head drum. The full removable head drum provides the easiest access to the contents.

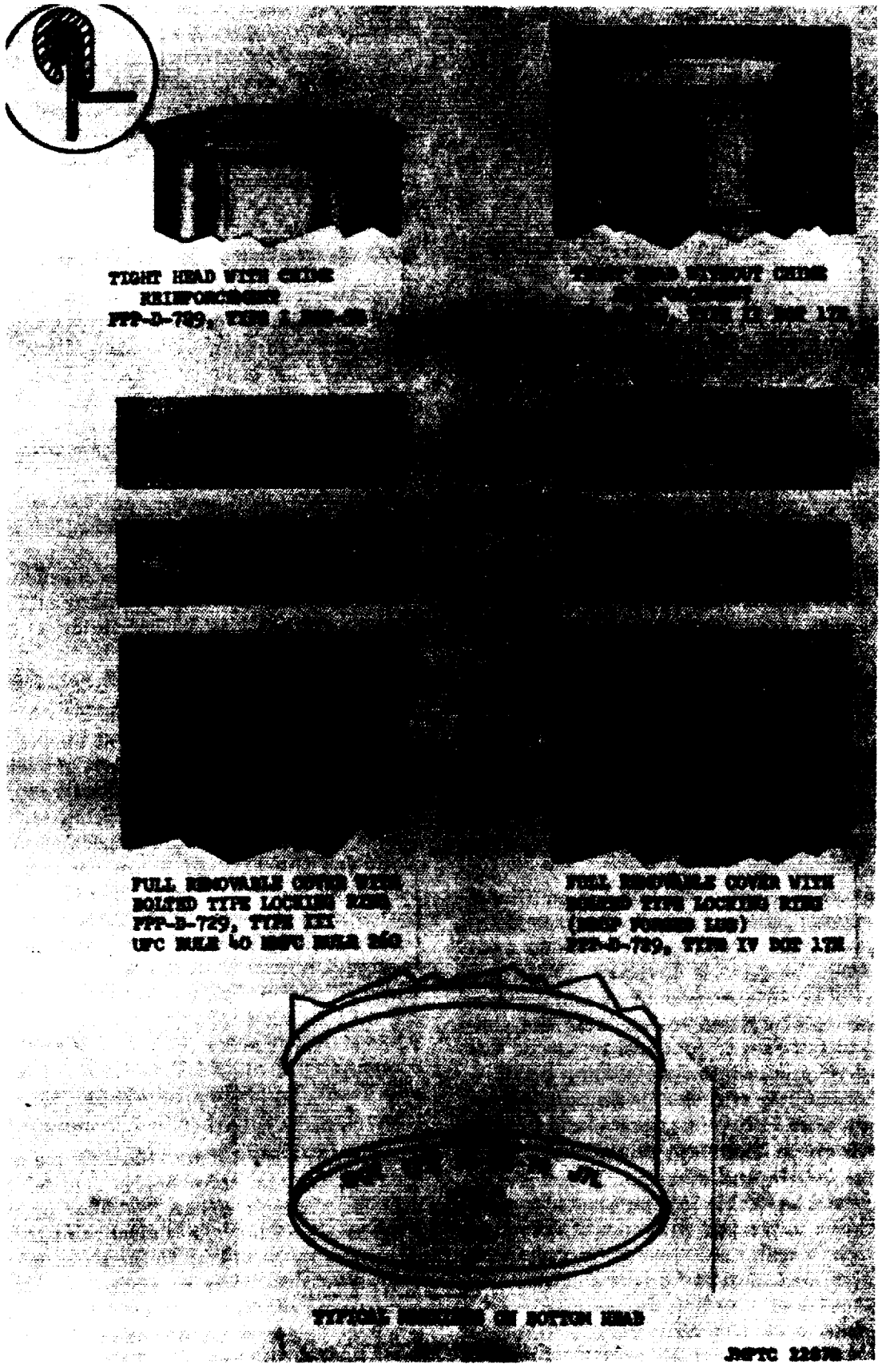

Figure 5-12. Types of drum closures and typical markings (PPP-D-729).

Table 5-4. Specifications and Titles of Metal Drums

Federal or military specification number and title	DOT specification, Uniform Freight Classification rule, or National Motor Freight Classification rule
PPP-D-705 Drums, metal shipping steel (over 16 and under 30 gallon).	
Type I 30 gallon	DOT-17E Steel drums, single trip container, removable head containers not authorized.
Type II, 16 gallon	DOT-17E (Same as above).
Type III, 120 # grease	UFC Rule 40 NMFC Rule 260
Type IV, 30 gallon	UFC Rule 40 NMFC Rule 260
Type V, 30 gallon	DOT-17H Steel drums, single trip container, removable head required.
Type VI 16 gallon	UFC Rule 40 NMFC260
PPP-D-711 Drum, metal shipping steel, lightweight (55 gallon).	Not applicable.
PPP-D-729 Drum, metal, 55 gallon (for shipmnt of noncorrosive materials).	
Type I	DOT-5B Steel barrels or drums. Removable head containers which will pass all required tests are authorized.
Type II	DOT-17E Steel drums, single trip container. Removable head containers not authorized.
Type III	UFC Rule 40 NMFC Rule 260
Type IV	DOT-17H Steel drums, single trip container. Removable head required.
PPP-D-732 Drums, metal, reconditioned 55 gallon (for shipment of noncorrosive materials).	
Type I	DOT-5B Steel barrels or drums. Removable head containers which will pass all required tests are authorized.
Type II	DOT-17E Steel drums, single trip container. Removable head containers not authorized.
Type III	UFC Rule 40 NMFC Rule 260
Type IV	DOT-17H Steel drums, single trip container, removable head required.
PPP-D-736 Drums, steel, shipping, Type 6A and 6B (for phosphorous, white or yellow, dry or in water).	
Type I, 30 gallon	DOT-6A Steel barrels or drums. Removable head containers which will pass all required tests are authorized.
Type II, 30 gallon	DOT-6A (Same as above).
Type III, 30 gallon	DOT-6B Steel barrels or drums. Removable head containers which will pass all required tests are authorized.
Type IV, 30 gallon	DOT-6B (Same as above).
Type V, 30 gallon	DOT-17C 18 gage.
Type VI, 55 gallon	DOT-17C 16 gage.
PPP-D-1152 Drums, steel, 55 gallon (24 and 21 gage) Reinforced.	DOT-37D Steel drums.
MIL-D-195 Drum, steel calcium carbide, 100-pound capacity.	UFC Rule 40 NMFC Rule 260

d. Reuse. Most metal drums are initially filled at the manufacturer's plant and are reusable except for single-trip containers. When empty, the drums may be returned to destination for refilling. If refilling is done by the initial user, care should be taken not to reuse drums which have been used to ship hazardous materials, until such drums are cleaned and tested in accordance DOT regulations. Failure to do so may create a serious health hazard. When filling drums with dangerous materials, only DOT specified type drums may be used for that commodity. The DOT drum specification number, the name, initial, or symbol of the manufacturer; the letters "US" to indicate that the drum is the property of the Government; the letters "STC" if the drum is a single trip container; and a numerical indication of the thinnest gage of metal used in the construction, the capacity of the drum in gallons, and the year of manufacture are embossed on the bottom of the drum (fig 5-12). For example, 18-55-74 means that drum is 18 gage metal, 55-gallon capacity, and was made in 1974. When filling the drums, the contents may not exceed the marked capacity minus 2 percent for outage.

5-8. Fiber Drums (PPP-D-723)

a. Description. Fiber drums are cylindrical shipping containers with bodies made of fiberboard, either lapped or parallel wound (convolutely) in the form of a hollow cylinder. They may be either single unit or telescopic body type. The heads are of metal, wood, plywood, or fiberboard. There are many characteristics of fiber drums which give them advantages over other types of containers. Included among these are cleanliness, durability, low uniform tare weight, retard temperature fluctuation, easy opening and closing, water and moisture resistance, stackability, easy handling, product protection and wide range of diameters and heights. Fiber drums are easily opened and reclosed.

b. Classification. Fiber drums are available in the types, grades, and classes shown in table 5-5.

c. Use. The intended uses are also shown in table 5-5. The other factors covered by this paragraph must also be observed.

(1) *Application.* The size and weight capacities for the three types of drums vary according to specification requirements: therefore, the specification requirements should be consulted for details. Basically, however, the maximum capacity for both Type I and II drums, Grade A, and B, is 550 pounds weight of contents and 75 gallons, except for Type I, Grade A, Class 2, which has a maximum net weight of 200 pounds. For Grade C, the maximum capacity is 55 gallons. Type III, Grade A, is limited to 400 pounds and 75 gallons, while Grade C is limited to 115 pounds and 55 gallons. Although dyestuffs, chemicals, waxes, re-

Table 5-5. PPP-D-723 Fiber Drums

Type	Grade	Class
I-Domestic	A—For dry or solid materials	1—Regular construction 2—Foil laminated construction
	B—For semiliquids	
	C—For hot-plured materials that solidify on cooling	
	D—For rolled or cylindrical items	
	E—For liquids or articles in liquids (non-regulated)	3—Integral plastic lining 4—Semirigid plastic component 5—Molded rigid one-piece plastic component
II-Normal oversea	A—For dry of solid materials	
	B—For semiliquid materials	
	C—For hot-poured materials that solidify on cooling	
	D—For rolled or cylindrical items	
	E—For liquids or articles in liquids (non-regulated)	3—Integral plastic lining 4—Semirigid plastic component 5—Molded rigid one-piece plastic component
III-Military oversea	A—For dry or solid materials	1—Regular construction
	B—For semiliquid materials	2—Foil laminated construction
	E—For liquids or articles in liquids (non-regulated)	3—Integral plastic lining 4—Semirigid plastic component 5—Molded rigid one-piece plastic component

sins, asphalt, etc., can be placed directly into the drums without further consideration, fragile and delicate items, such as electronic equipment, require cushioning with plastic form, foam rubber, bonded fibers, or similar materials. The increased use of fiber drums for the shipment of coiled wire, tubing, and rolled or cylindrical items, is an indication of the trend towards fuller utilization of fiber drums.

(2) *Compliance marking.* In addition and adjacent to the drum manufacturer's markings required by Uniform Freight Classification, National Motor Freight Classification or DOT rules or regulations, each drum is stamped or printed in black capital letters not less than $^{3}/_{16}$-inch in height with information concerning the type, class, grade, specification number, etc. For example, the information for the Type I drum is shown below:

Type I
(DOMESTIC TYPE)
COMPLIES WITH FED. SPEC. PPP-D-723H
FOR DOMESTIC SHIPMENT _____
GRADE ___ CLASS _____
MAX. WT. OF CONTENTS _____ LBS.
MAX. CAPACITY OF CONTENTS ___ GAL.

In addition, Grade D drums shall have stencilled or printed on the cover and side wall in letters not less than ¾-inch in height, the following precautionary markings:

STAND ON END
KEEP COOL AND DRY

Only contents of the type, grade, and class as indicated in the compliance markings are to be placed in these drums. The weight and capacity must also conform to these requirements.

d. Closure. The closure of fiber drums must be such that they may be opened and reclosed by hand or simple tools. These are three types of closures which are commonly used. They are the friction-type or telescopic slip on covers, which are secured with pressure sensitive tape, lever-activated locking bands, and the metal clip or lug closure (fig 5-13).

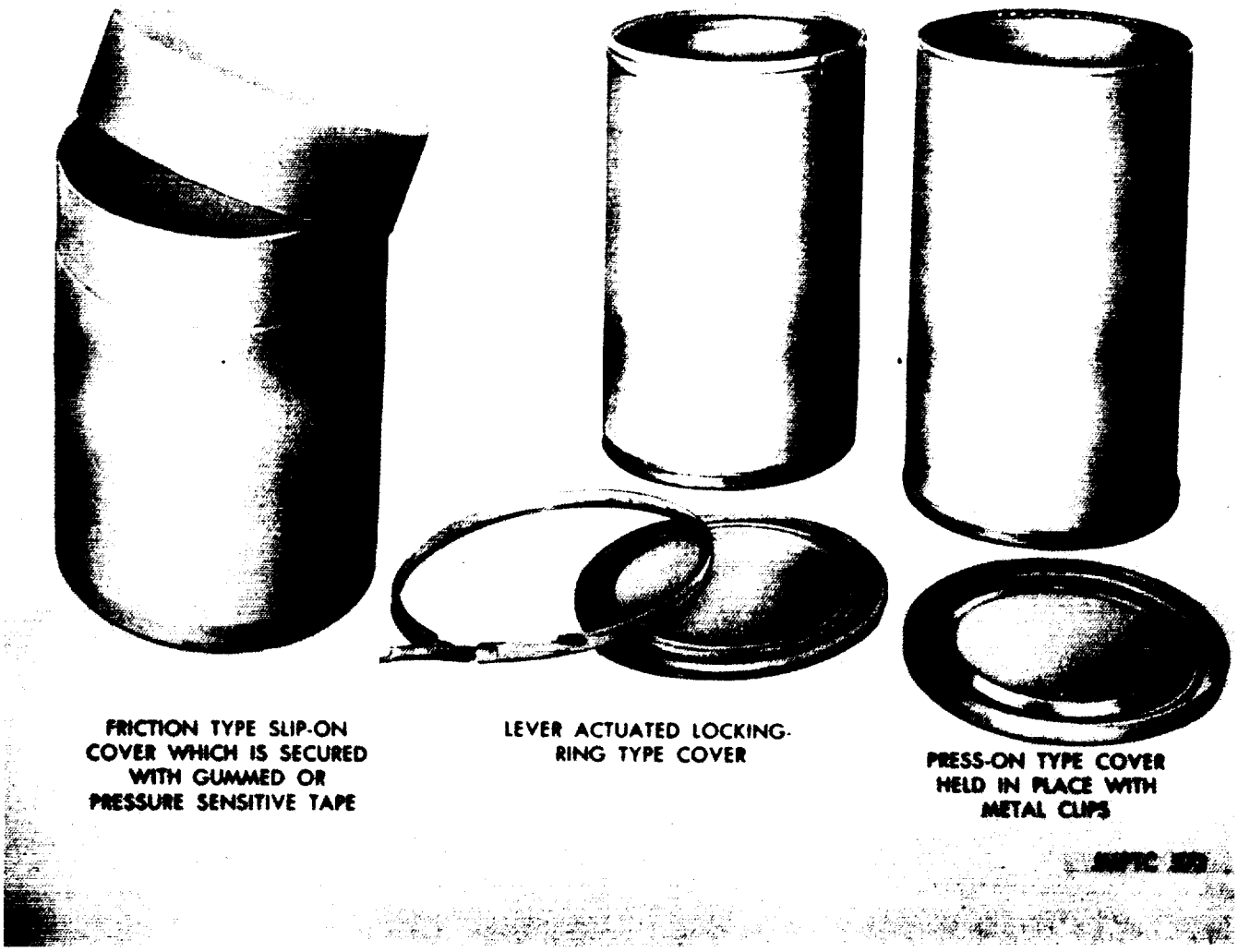

Figure 5-13. Types of fiber drum closures.