

INCH-POUND

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DEPARTMENT OF DEFENSE HANDBOOK

PALLETIZED UNIT LOADS



**This handbook is for guidance only.
Do not cite this document as a requirement.**

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FOREWARD

1. This handbook is approved for use by all Departments and Agencies of the Department of Defense (DoD).
2. This standard establishes the methods, materials, and techniques to be employed in the formation of bonded palletized unit loads of military supplies, which are adaptable to unit loading. The methods prescribed herein are to be utilized with a standard, general purpose, 40- by 48-inch pallet.
3. Comments, suggestions, or questions on this document should be addressed to:
Chief, U.S. Army Materiel Command, Logistics Support Activity, Packaging, Storage, and Containerization Center, ATTN: AMXLS-AT, Tobyhanna, PA 18466-5097. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at www.dodssp.daps.mil.

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1. SCOPE

1.1 Scope. This handbook establishes the methods, materials, and techniques to be employed in the formation of bonded palletized unit loads of military supplies, which are adaptable to unit loading. The methods prescribed herein are to be utilized with standard, general purpose, 40- by 48-inch pallets conforming to the various classes, types, and styles in ASME MH 1, Part 9. However, the various methods of bonding and types of storage aids may be modified for use with other size pallets. This handbook will not be used for the palletization of ammunition, explosives, or semi-perishable subsistence unless specifically prescribed by the cognizant technical activity. (Ammunition unit loads should be in accordance with MIL-STD-1660, while semi-perishable subsistence unit loads will be in accordance with DSCP Form 3507.) **This handbook is for guidance only and cannot be cited as a requirement.**

1.2 Application. As specified within, the contents of this handbook are provided as guidance for the preparation and shipment of bonded palletized unit loads for DoD facilities. It is also applicable for the movement of materiel between or within the military services.

1.2.1 Direction. The guidance herein may be applied independently or collectively. Variations from the load types or in the application and use of bonding methods and storage aids to meet unusual requirements are permitted but are to be coordinated with and approved by the requiring agency or activity prior to implementation. The applicable loading patterns are listed numerically in figure B-1 of appendix B. Determination of the applicable pattern should be accomplished by referring to table B-I of appendix B. Loads will be tied by reversing the pattern for each layer.

1.3 Customary units-metric units conversion. To accommodate the requirements of FED-STD-376 and SD-10, two tables describing customary-metric conversion applicable to this handbook are provided, beginning on page two. For convenience in calculation, metric equivalents are expressed to two decimal places (nearest hundredth), wherever practical.

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TABLE I. Standard customary units-metric units equivalentsVolume:

1 fluid ounce = 29.57 milliliters
 1 pint = 0.47 liter
 1 quart = 0.95 liter
 1 gallon = 3.79 liters
 1 cubic foot = 0.03 cubic meter

NOTE: To change cubic inches to cubic feet, divide by 1728.

Weight:

1 ounce (avoirdupois) = 28.35 grams
 1 pound (avoirdupois) = 453.59 grams, 0.454 kilogram
 2.2 pounds = 1.00 kilogram

Length:

1 inch = 2.54 centimeters, 25.4 millimeters
 1 foot = 30.48 centimeters, 0.305 meter
 39.37 inches = 1.00 meter
 3.28 feet = 1.00 meter
 25.00 feet = 7.625 meters
 50.00 feet = 15.25 meters

NOTE: Centimeters times 10 equals millimeters
 (cm X 10 = mm).

Temperature conversion:

To change degrees Celsius (C) to degrees Fahrenheit (F), multiply temperature by 1.8 and add 32 degrees F.

To change degrees Fahrenheit (F) to degrees Celsius (C), subtract 32 from the temperature and divide by 1.8.

Degrees Fahrenheit = Degrees Celsius

0	-18
32	0
212	100

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TABLE II. MIL-HDBK-774 customary units-metric units conversions

<u>Volume (Liquid):</u>		<u>Inches</u>	=	<u>Centimeters</u>
<u>Gallons</u>	= <u>Liters</u>	0.025		0.06
		0.030		0.08
1	3.79	0.035		0.09
5	18.95	0.042		0.11
30	113.70	0.063 (1/16)		0.16
55	208.45	0.125 (1/8)		0.32
		0.188 (3/16)		0.48
		0.25 (1/4)		0.64
		0.50 (1/2)		1.27
<u>Volume (Solid):</u>		0.625 (5/8)		1.59
		0.75 (3/4)		1.91
<u>Cubic feet</u>	= <u>Cubic meters</u>	0.875 (7/8)		2.22
		1.0		2.54
1.0	0.03	1.25		3.18
20.0	0.60	1.5		3.81
66.6	1.998	2.0		5.08
		2.75		6.99
		3.0		7.62
		4.0		10.16
<u>Pounds</u>	= <u>Kilograms</u>	5.0		12.70
		6.0		15.24
1	0.454	7.0		17.78
10	4.54	8.0		20.32
15	6.81	9.0		22.86
32	14.53	10.0		25.40
45	20.43	14.875		37.79
100	45.40	20.0		50.80
120	54.48	26.875		69.53
250	113.50	30.0		76.20
900	408.6	40.0		101.60
2000	908.0	45.5		115.57
2500	1135.0	48.0		121.92
3000	1362.0	50.0		127.00
6000	2724.0	53.0		134.62
9000	4086.0	60.0		152.40

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2. APPLICABLE DOCUMENTS

2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this handbook.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications and standards form a part of this document to the extent specified herein.

INTERNATIONAL STANDARDIZATION AGREEMENTS

STANAG 2828 - Military Pallets, Packages and Containers

(Copies of Standardization Agreements (STANAGs) are available online at www.dodssp.daps.mil or from the Document Automation and Production Service, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

FEDERAL SPECIFICATIONS

MMM-A-260 - Adhesive, Water-Resistant, (for Sealing Waterproofed Paper)

FEDERAL STANDARDS

FED-STD-376 - Preferred Metric Units for General Use by the Federal Government

COMMERCIAL ITEM DESCRIPTIONS

A-A-203 - Paper, Kraft, Untreated
 A-A-3174 - Plastic Sheet, Polyolefin
 A-A-55057 - Panels, Wood/Wood Based; Construction and Decorative
 A-A-59692 - Adhesive, Water-Resistant (for Closure of Fiberboard Boxes)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-DTL-4 - Tires and Inner Tubes, (Non-Aircraft); Packaging of
 MIL-P-15011 - Pallets, Material Handling, Wood, Post Construction
 4-Way Entry

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DEPARTMENT OF DEFENSE STANDARDS

- MIL-STD-129 - Standard Practice for Military Marking for Shipment and Storage
- MIL-STD-290 - Packaging of Petroleum and Related Products
- MIL-STD-1660 - Design Criteria for Ammunition Unit Loads

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or www.dodssp.daps.mil or from the Document Automation and Production Services, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein.

DEFENSE STANDARDIZATION PROGRAM OFFICE

- SD-10 - Guide for Identification and Development of Metric Standards

(Copies of this document are available online at <http://assist.daps.dla.mil/quicksearch/> or www.dodssp.daps.mil or from the Document Automation and Production Services, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

DEPARTMENT OF COMMERCE

- US Product Standard (PS) PS-1 - Construction and Industrial Plywood

(Copies of PS-1 are available online at <http://ts.nist.gov/ts/htdocs/210/sccg/vps.htm> or from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402-9325.)

DEFENSE SUPPLY CENTER PHILADELPHIA (DSCP)

- DSCP Form 3507 - Loads, Unit: Preparation of Semi-perishable Subsistence Items

(Copies of DSCP Form 3507 are available online at www.dscp.dla.mil/subs/subsbo/specs/procure.htm or from the Defense Supply Center Philadelphia, ATTN: DSCP-HSL, Building 6, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

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INTERNATIONAL PLANT PROTECTION CONVENTION (IPPC)

International Standard for Phytosanitary Measures (ISPM) 15	-	Guidelines for Regulating Wood Packaging Material in International Trade
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(Copies of ISPM standards are available online at www.ippc.int or from the IPPC Secretariat, FAO-AGPP, Viale Delle Terme di Caracalla, 00100 Rome, Italy, telephone (39) 06 5705 4812 or facsimile (39) 06 5705 6347.)

2.3 Non-Government standards and publication. The following documents form a part of this document to the extent specified herein.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME MH1	-	Pallets, Slip Sheets, and Other Bases for Unit Loads
ASME MH1, Part 1	-	Definitions and Terminology Covering Pallets and Related Structures
ASME MH1, Part 3	-	Wood Pallets
ASME MH1, Part 9	-	Wood Pallets for Military Use

(Copies of ASME documents are available online at www.asme.org or from the ASME Information Central Orders/Inquiries, P.O. Box 2300, Fairfield, NJ 07007-2300, telephone 1-800-843-2763.)

ASTM INTERNATIONAL

ASTM D 996	-	Standard Terminology of Packaging and Distribution Environments
ASTM D 3950	-	Standard Specification for Strapping, Plastic (and Seals)
ASTM D 3953	-	Standard Specification for Strapping, Flat Steel (and Seals)
ASTM D 4675	-	Standard Guide for Selection and Use of Flat Strapping Materials
ASTM D 4727/ D 4727M	-	Standard Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes
ASTM D 5486	-	Standard Specification for Pressure-Sensitive Tape for Packaging, Box Closure, and Sealing
ASTM D 6199	-	Standard Practice for Quality of Wood Members of Containers and Pallets
ASTM F 1667	-	Standard Specification for Driven Fasteners: Nails, Spikes and Staples

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(Copies of ASTM International standards are available at www.astm.org or from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, telephone (610) 832-9585, facsimile (610) 832-9555.)

3. DEFINITIONS

General packaging and pallet definitions may be found in ASME MH1, Part 1; ASTM D 996; the DoD Dictionary of Military and Associated Terms at www.dtic.mil/doctrine/jel/doddict/; or in other referenced documents. For purposes of this handbook, the following definitions are to apply:

3.1 Batten. A wooden member used to fill space, protect against damage, provide additional surface for strapping, or help create a stable load.

3.2 Bonding. The securing of units of material on a pallet to form a consolidated and stable load which itself can be handled as a unit.

3.2.1 Bonding methods (previously called "bonding means"). The methods used to secure units on and to a pallet to form a load.

3.3 Cap. A cover, with sides extending perpendicular from its perimeter, which is used to protect against damage or to help create a stable load. Made from canvas, fiberboard, wood, or plywood, a cap may be used over the load, inverted under a load, or used under or over intermediate layers.

3.4 Collar. Fixed, hinged, removable, or collapsible horizontal solid, slatted, or mesh, framing members to tie together vertical elements of pallet superstructure; also, element on top of pallet deck to contain unit load placed on pallet; rail.

3.5 Crossties or intersection seal. A 2-way seal applied to straps intersecting at right angles and crimped to prevent lateral movement of the straps.

3.6 Deck. Top or bottom surface of pallet, consisting of one or more elements, that is, slatted, close-boarded, or solid.

3.7 Edge protector. A right-angle piece placed over the edge of boxes, crates, bundles and gates, or bracing to distribute the pressure from metal bands or ties in order to prevent cutting.

3.8 End of load. The vertical surface of a load along the 40-inch length of the pallet.

3.9 Extra heavy weight units. Units weighing more than 45 pounds per cubic foot.

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3.10 Frame. A wooden structure, consisting of wood or plywood sheathing, which is nailed to stringers and used to protect the load or to help stabilize the load by containing, compacting, compressing, or supporting the units in the load.

3.10.1 Frame supports. Boards laid on the pallet deck under a load to carry the weight of the frame used with the load. A method of structuring corner board supports and stringers to the pallet to provide additional support for stacking pallets upon one another when the load will not support stacking by itself.

3.11 Glue. A water-resistant adhesive compound which will bond units to the pallet and to each other to prevent lateral movement, but which will permit their vertical removal at the point of use without damage to the container or its contents.

3.11.1 Glued load. A load bonded with glue or glued strips.

3.11.2 Glued strip. A piece of chipboard or newsboard, with glue applied to both sides, used to bond units to the pallet and to each other. Newsboard is paperboard made chiefly from repulped newspaper.

3.11.3 Glue stripe. Glue applied manually or mechanically to a pallet or container.

3.12 Heavy weight units. Units weighing over 32 pounds but not more than 45 pounds per cubic foot.

3.13 Interlocking pattern. An arrangement of units in successive layers, by which the units in one layer overlap the inner edges of units in the adjacent layers by 2 inches or more.

3.14 Layer (previously called "course"). A horizontal layer of units in a load.

3.15 Length of pallet. For this handbook, the length is the 40-inch dimension of the pallet.

3.16 Lightweight units. Units weighing not more than 15 pounds per cubic foot.

3.17 Load. As used in this handbook, "load" indicates a stable palletized unit.

3.17.1 Load (or pallet) pattern. The arrangement of layers on a pallet in such a manner as to use the greatest number of units within weight and dimension limits. Whenever possible, layers should interlock, and void spaces should be eliminated.

3.17.2 Load type. A qualitative description of the contents of a container with respect to density, fragility, and degree of blocking, bracing, and cushioning necessary.

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3.18 Margin. The amount of pallet deck at the edge or edges of a load, which is not covered by the load.

3.19 Medium weight units. Units weighing over 15 pounds but not more than 32 pounds per cubic foot.

3.20 MILVAN. Military-owned, demountable container, conforming to US and international standards, operated in a centrally controlled fleet for movement of military cargo.

3.21 Narrow unit. A unit, which has a base not greater than 6- by 6-inches square or 6 inches in diameter when stacked in the load.

3.22 Nest. A group of articles, cans, baskets, or boxes of various sizes that fit one within the other.

3.22.1 Nested packer. A container provided with interior partitions into which small units can be packed.

3.23 Overhang. Distance of deck or deckboard extending from outer face of outer pallet stringer, stringerboard, or block; wing; lip; cantilever; distance unit load extending beyond deck.

3.24 Pallet. A low, portable, horizontal platform device used as a base for assembling, storing, handling, and transporting materials and products in a unit load.

3.24.1 Pallet design. Construction of a pallet to allow for easy entry. The most common designs of wooden pallets are two- and four-way entry.

3.24.1.1 Pallet, full four-way entry. Pallet with openings at both opposite ends and sides, with accessibility of all openings not limited to common handling equipment; block pallets with unidirectional perimeter boards or without bottom deck.

3.24.1.2 Pallet, partial four-way entry. Pallet with openings at both ends and sides, with limiting accessibility of openings to common handling equipment; notched stringer pallet and block pallet with overlapping bottom stringerboards and deckboards.

3.24.1.3 Pallet, two-way entry. Pallet with openings, accepting handling equipment, only at two opposite ends; pallet without notches in stringers.

3.24.2 Pallet length. Pallet dimension between the extreme pallet ends, parallel to and corresponding to the length of the stringers or top stringerboards; refers to first dimension when describing pallet size. For this handbook, the length is the 40-inch dimension of the pallet.

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3.24.3 Pallet strips. Narrow lengths of light wood, which are nailed to the pallet deck, or inside an inverted cap, to provide slots for the rigid positioning of vertical separators.

3.25 Palletized unit load. Quantity of any item, packaged or unpackaged, which is arranged on a pallet in a specified manner and securely strapped or fastened thereto so that the whole is handled as a unit.

3.26 Pallet width. Pallet dimension between extreme pallet sides, parallel to and corresponding to the length of top deckboards; refers to second dimension when describing pallet size. For this handbook, the width is the 48-inch dimension.

3.27 SEAVAN. A commercial- or Government-owned (or-leased) shipping container that is moved via ocean transportation without bogie wheels attached. It is similar in design to a MILVAN.

3.28 Separator. Any material interposed between articles or packing components.

3.28 Separators, container. Strips of fiberboard used between empty containers when nested inside one another to prevent them from binding and making their separation difficult.

3.28.1 Separators, horizontal. Pieces of fiberboard or light wood placed between layers in a load to prevent damage to the units or to make a stable load.

3.28.2 Separators, vertical. Strips of fiberboard or lightweight wood placed on edge between rows of units in alternate layers. The separators run crosswise and lengthwise on the pallet to form cells for the individual units and are used as a protection against damage to the units.

3.29 Sheathing. Lumber or sheet materials, such as plywood, fiberboard or other suitable panel or sheet material fastened to the frame across the openings of a crate to deter pilferage, or entry of dirt or water or of other articles.

3.30 Shrink wrapping. A process of enclosing a load (usually pallet size) in a preformed polymer bag or polymer roll stock. With the application of heat, a reduction of the enclosure size occurs, thus creating a firm form fit around the load.

3.31 Side of the load. The vertical surface of a load along the 48-inch width of the pallet.

3.32 Spacer, notched. A piece of heavy lumber cut out across one face or opposing faces at regular intervals, which is placed underneath and between layers of horizontally stacked units. It protects the units against damage or makes a stable load by supporting the units.

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3.33 Storage aids. Materials used to form a stable load by containment, compression, compaction, or support when bonding alone is insufficient. Also used as protection against damage to, or pilferage of, the material in the load.

3.34 Strap. A length of metal or nonmetallic material placed around a load to compact and bond the load under tension.

3.34.1 Strap, auxiliary. Any over-the-load strap, either tie-down or load, which is not a primary or secondary strap.

3.34.2 Strap, horizontal. A strap secured around the load parallel to the pallet deck.

3.34.3 Strap, load. An over-the-load strap that passes under the load but not under the pallet deck.

3.34.4 Strap, over-the-load. A strap, which is secured on the top of the load, either, a tie-down strap or a load strap.

3.34.5 Strap, tie-down. An over-the-load strap, which passes under the pallet deck.

3.34.6 Straps, primary. The first two tie-down straps secured to a load passing over the load and under the pallet deck in the 40-inch direction inside the outboard pallet stringers.

3.34.7 Straps, secondary. The first two tie-down straps secured to a load passing over the load and under the pallet deck in the 48-inch direction and through the strapping slots in the stringers.

3.35 Strapped load. A load, which is bonded to the pallet by the proper number and type of tie-down straps.

3.36 Strapped unit. A unit, which has been bound by flat or round strapping.

3.37 Stretch wrap. Tightly fitting, stretched, extensible, plastic film around loose or palletized goods often including pallet, held under tension by heat-sealing or frictional device.

3.38 Stringer. Continuous, longitudinal, solid, built-up, or notched beam component of pallet, supporting and spacing deck components, often identified by location as outer, interior, or center stringer; bearer, runner.

3.39 Substantial unit (box). A unit or filled box, which, with other like units, will form a stable load without additional storage aids.

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3.40 Support load. A load, which will safely support a minimum, superimposed weight of 9,000 pounds or three loads of like material without rocking, buckling, listing, or causing damage to the material in the load.

3.41 Supports, separator. Boards of at least 1-inch nominal thickness used horizontally on edge to separate rows of units in a layer and to support the weight of superimposed pallet loads.

3.42 Supports, vertical. Boards of at least 1- by 4-inch nominal measurement applied vertically within corners of wood caps to prevent compaction of nested, tapered cans.

3.43 Top nesting units. Units with tops which have flared or raised rims and bottoms of such dimension that they may be placed or nested within the tops of like units for loading.

3.44 Underhang. That portion of the unit load less than the length or width dimension(s) of a pallet.

3.45 Unit. The container or item that forms a part of the load.

3.46 Unit load. An item or assemblage of items assembled or restrained for handling and transportation as a single entity.

3.47 Unitized load. A single item or a number of items packaged, packed, or arranged in a specified manner and capable of being handled as a unit. Unitization may be accomplished by placing the item or items in a container or by banding them securely together.

3.48 Unstable unit. A unit that will not form a stable load unless storage aids such as caps, trays, or frames are used in addition to bonding.

3.49 Vertical row. A column of units in a load, perpendicular to the pallet deck, which is not in an interlocking pattern.

3.50 Weight/volume categories of units. Weight/volume categories into which units have been divided in order to determine the bonding and storage aids to be used in forming stable loads.

3.51 Width of pallet. The horizontal dimension at right angles to the pallet length. For this handbook, the width is the 48-inch dimension.

3.52 Wing pallet. A pallet whose decks protrude along two sides beyond the outer edges of the deck spacers.

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4. GENERAL GUIDANCE

4.1 Abbreviations. The following authorized abbreviations are provided for information purposes only and should not be misinterpreted by contractors for unit of issue abbreviations. The correct unit of issue for marking is the unit of issue shown in the contract or requisition. Abbreviations of the item descriptions will be permitted when approved by the cognizant activity concerned. Periods are not used with abbreviations.

a. Package units:

Assembly	(AY)	Key	(KE)	Pallet	(PT)
Carton	(CT)	Kit	(KT)	Piece	(PC)
Case	(CS)	Packaging	(PG)	Set	(SE)
Crate	(CR)	Pail	(PL)	Unit	(UN)

b. Quantitative units/expressions:

Bale	(BE)	Coil	(CL)	Pair	(PR)
Barrel	(BL)	Dozen	(DZ)	Reel	(RL)
Box	(BX)	Drum	(DR)	Roll	(RO)
Bundle	(BD)	Each	(EA)	Spool	(SP)
Can	(CN)	Hundred	(HD)	Thousand	(MX)

c. Weights and measure units:

Centimeter	(cm)	Inch	(in)	Ounce	(oz)
Cubic foot	(cf)	Kilogram	(kg)	Pint	(pt)
Cubic inch	(ci)	Kilometer	(km)	Pound	(lb)
Cubic meter	(cm)	Liter	(li)	Quart	(qt)
Foot	(ft)	Meter	(m)	Square foot	(sf)
Gallon	(gal)	Milliliter	(ml)	Square inch	(si)
Gram	(gm)	Millimeter	(mm)	Square meter	(sm)

d. Miscellaneous abbreviations:

Ammunition	(ammo)	Invoice	(inv)	Quantity	(qty)
Battery	(btry)	Manufactured	(mfd)	Report	(rept)
Copy	(cy)	Mark	(mk)	Requisition	(rqn)
Dimension	(dmn)	Military	(mil)	Vehicle	(ve)
Engine	(eng)	Packed	(pkd)		
Identification	(ident)	Pallet	(plt)		

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4.2 Formation of the load.

4.2.1 Load types. Loads are grouped into load types for the designation of bonding methods and storage aids.

4.2.2 Load size. Limitations on weights and dimensions have been established for uniform loads that meet the requirements of military and nonmilitary agencies and can be handled by existing Materials Handling Equipment (MHE). Variations in load size should not affect the standard pallet size of 40- by 48-inches.

4.2.3 Load patterns. Units of uniform size and content are to be loaded on the pallet in a pattern, which will incorporate the greatest number practicable to effect maximum utilization of the area permitted by weight and dimension limits. The 124 load patterns shown in figure B-1 of appendix B provide for efficient use of at least 80 percent of the 40- by 48-inch pallet surface and encompass containers ranging in size from 6 inches by 6 inches to 43 inches by 52 inches. These load patterns do not apply to ammunition, weapons, and components. To determine the proper load pattern number for containers of any size in the above range, refer to table B-I of appendix B.

4.2.4 Use of appendixes when forming the load. Units have been grouped into load types according to their physical characteristics for subsequent designation of bonding methods and application of storage aids. The various load types, bonding methods, and storage aids associated with palletized unit loads are discussed in detail in section 5. Each load type covers one or more types of units intended for formation into palletized loads by the applications listed in appendix A. All load types, bonding methods, and storage aids are listed in appendix A. In addition, appendix A contains a list of commodities or units and containers, with specific load types, bonding methods, and storage aids identified for use with each. The various combinations listed are not binding or mandatory but are recommended as the preferred bonding methods and storage aids to be used with the applicable commodities and load types. It should be stressed that the unitization method selected should be the one that makes the best use of available space in both the carrier and in storage. Bonding methods and storage aids listed in parentheses in A.3 of appendix A are to be used to meet specific requirements, generally dictated by the physical nature of specific units or by the availability of the storage aid designated.

4.2.5 Wrapping. Canvas, paper, polyethylene (PE), polyvinyl chloride (PVC), and ethylene vinyl acetate (EVA) films may be used as wrapping to encase an entire load or part of a load as required.

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4.2.6 Types of pallets (see figure 1, page 16).

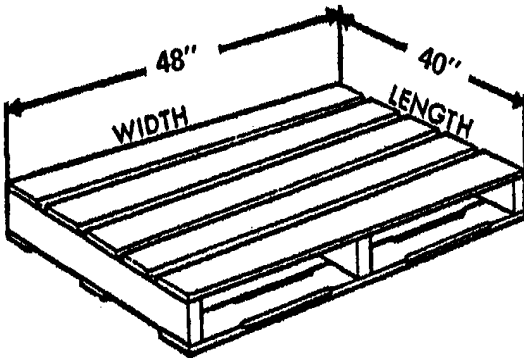
4.2.6.1 ASME MH1. Types of wood pallets intended for military use are provided in ASME MH1, Part 9. These pallets are commonly used by DoD activities for the handling, storage, and transportation of materials. The preferred pallets used in the DoD distribution system are ASME MH1 part numbers MH1/9-02SW4048, MH1/9-03SW4048, or MH1/9-10BW4048. For shipments when the total weight is less than 1,500 pounds evenly distributed, pallets should comply with ASME MH1, part number MH1/9-02SW4048. For shipments when the total weight is greater than 1,500 pounds, but less than 3,000 pounds evenly distributed, pallets should comply with either ASME MH1, part numbers MH1/9-03SW4048 or MH1/9-10BW4048.

4.2.6.2 MIL-P-15011. The 4-way entry, double-wing, block pallet of MIL-P-15011, also listed in ASME MH1, Part 9, should be used for the palletization of military supplies whenever 4-way entry is required in the storage and distribution system and in support of NATO forces. Nonstandard 4-way entry 40- by 48-inch pallets should be reused for the storage and shipment of materiel to CONUS consignees. It is noted that STANAG 2828 allows for the use of both 32- by 48-inch and 40- by 48-inch post construction pallets. The primary ammunition pallet that meets STANAG 2828 complies with ASME MH1, part number MH1/9-11BW4048P.

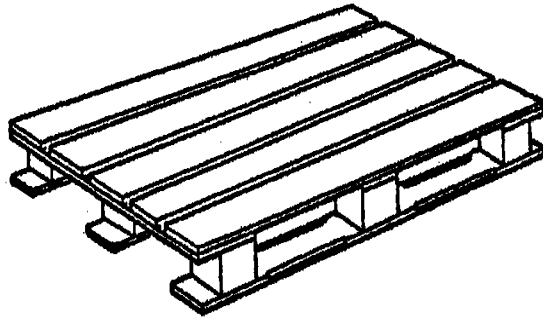
4.2.6.3 Other wood pallets. Other types of wood pallets include the 2-way entry, double-wing, stringer and partial 4-way entry, flush, stringer pallets.

4.2.7 Lumber quality. Lumber used in the construction of palletized loads is to be well-seasoned, commercially dry lumber, which is also be free from decay, wanes, loose knots, knots that would interfere with nailing, and from other defects that would materially lessen its strength. Guidelines for lumber quality can be found in ASTM D 6199 and ASME MH1, Part 3. Wood should meet guidelines of ISPM 15 issued by the IPPC.

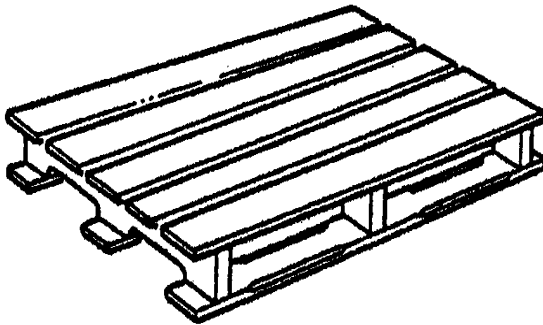
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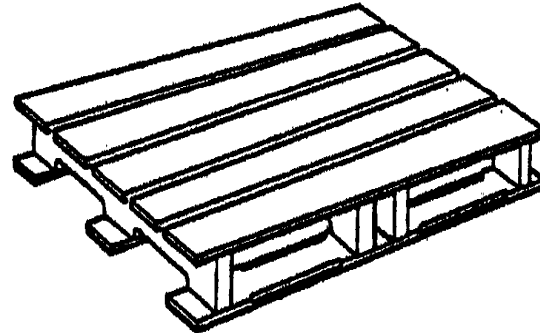
2-way entry, flush, stringer
(MH1/9-04SF4048)



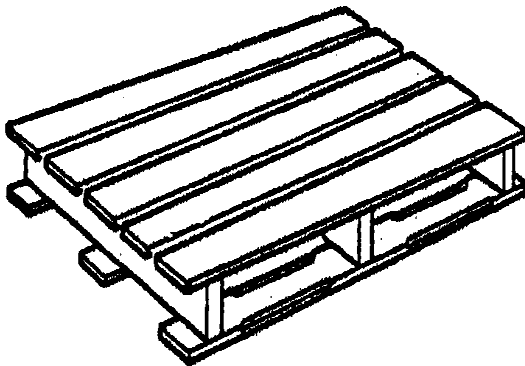
4-way entry, double-wing, block
(MH1/9-10BW4048, MH1/9-11BW4048P)



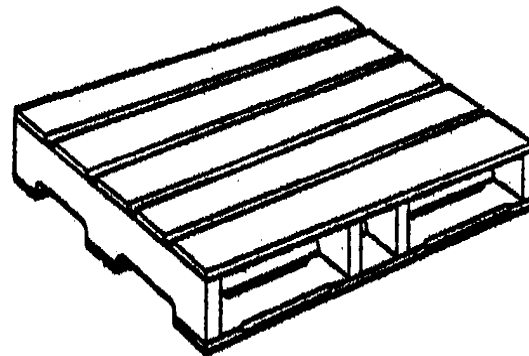
Partial 4-way entry, double-wing, stringer
(MH1/9-02SW4048)



Partial 4-way entry, double-wing, stringer
(MH1/9-03SW4048)



2-way entry, double-wing, stringer



Partial 4-way entry, flush, stringer

FIGURE 1. Types of pallets (See 4.2.6).

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5. DETAILED GUIDANCE

5.1 Formation of the palletized load (see figures 2 and 3, page 40). Shipping containers in each palletized unit load is to be uniformly arranged in a load or pallet pattern as determined by table B-I and shown in figure B-1 of appendix B. When the size of the individual shipping container does not fit any of the load patterns of table B-I, the proposed load pattern or request to use a different size pallet should be submitted to the contracting officer for guidance. The amount of materiel to be loaded on a pallet should exceed 250 pounds (excluding the pallet) or a volume of 20 cubic feet. The overall dimensions of palletized loads should not exceed the applicable dimensions as shown. Shipping containers are to be stacked to form a compact squared load centered on the load base and should be squared with all corners of the pallet. Overhang is to be avoided because of containerization requirements. Uniform sized containers on a pallet for shipment are to be stacked in a column and should have a sheet of paper or fiberboard placed between every other layer to increase load stability. Generally, 50-pound basis weight kraft paper is used for lightweight containers under 10 pounds. However, solid or corrugated fiberboard is to be used for heavier containers. Shipping containers of type I loads, providing complete and uniform support to all faces of the shipping container, may be interlocked in a pallet load by reversing the patterns for each layer. Shipping containers of load types II and III should be column stacked on a pallet to provide greater stackability and supporting strength to the load. The top surface of the loading pallet should be level or made level for stacking purposes. Applying a wooden top frame or leveling boards with supporting framework can accomplish this. Palletized loads for NATO forces are to be in accordance with 5.1.2.3. Whenever equalizing container sides with the side or ends of the pallet creates voids or gaps, any spaces created are to be filled with an appropriately shaped storage aid (separator supports or chimney filler).

5.1.1 Palletized unit load size and weight. Dimensional and weight limitations are to apply to the complete load including pallet, bonding, and storage aids, and not merely to the stacked units.

5.1.1.1 Size (see figure 2, page 40). Unless otherwise specified by the procuring activity, unit loads prepared for shipment in SEAVANs, MILVANs, and passenger aircraft modified to transport cargo in the Civil Reserve Air Fleet (CRAF) should not exceed 40 inches in length (end of load) and 48 inches in width (side of load). Unit loads prepared for shipment in SEAVANs are not to exceed 43 inches in height and in MILVANs 41 inches in height when 2-pallet high stacking is desirable. The height of the pallets should be related directly to their stackability in the carrier. (When palletizing ammunition for truck or MILVAN, unit loads are not to exceed 45½ inches in one horizontal dimension.)

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5.1.1.2 Weight limits. Weight limits apply to the entire load including the pallet, bonding methods, storage aids, and units. The maximum weight of a load for domestic, intercoastal, or overseas shipments is not to exceed 3,000 pounds per single pallet load. Shipments to NATO forces are not to exceed 2,500 pounds.

5.1.1.3 Decreasing weight of unit loads. When it is necessary to decrease the dimensions of a load in order to remain within the weight limitations, the height of the load is to be decreased rather than decreasing its length or width.

5.1.2 Other palletized unit load sizes (see figure 3, page 40). This paragraph applies to unit load shipments that are not shipped by the containerization media or by CRAF. Unless otherwise specified, these unit loads are not to exceed 43 inches in length, 52 inches in width, and 54 inches in height.

5.1.2.1 Modular size unit loads. Unit loads of fiberboard modular sized containers conforming to the requirements in appendix C are not to exceed 41 inches in height for MILVAN and SEAVAN shipments to ensure compatibility with various vertical door openings. The length and width of the containers are to be as shown in appendix C, with no overhang permitted.

5.1.2.2 Pallet load sizes for Navy afloat units. Unit loads for delivery to Navy afloat units are not to exceed 40 inches in length when the unit containers are not fully supported internally. When unit containers are fully supported, unit loads are not to exceed 43 inches in length. This permits an overhang of 1½ inch at each side of the pallet for fully supported unit containers. In addition, the height of palletized unit loads for delivery to Navy afloat units is not to exceed 41 inches (not applicable to petroleum products).

5.1.2.3 Pallet load sizes for NATO forces. The MIL-P-15011 pallet is to be used for shipments of palletized loads to NATO forces. The outer dimensions of the load in principle should not exceed the outer dimension of the pallet base however, the load may be permitted to exceed the outer pallet dimension by 1½ inches on each side of the short dimension (40 inches) and by 2 inches on each end of the long dimension (48 inches). The maximum height and weight of the load is not to exceed 41 inches and 2,500 pounds, respectively. STANAG 2828 allows for the use of both 32- by 48-inch and 40- by 48-inch post construction pallets.

5.2 Load types. Wood used to fabricate caps, corner posts, and separators for the various load types is to conform to the requirements of ASTM D 6199. In addition, guidelines for lumber quality are found in paragraph 4.2.7.

5.2.1 Load type I (see figure 4, page 41). Load type I consists of wood or metal boxes or other stable, hard surface units stacked in single or multiple layers.

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5.2.1.1 Load type Ia (see figure 5, page 41). Load type Ia consists of fiberboard boxes stacked in single or multiple layers. Containers not fully supported internally are not permitted pallet overhang.

5.2.2 Load type II (see figure 6, page 41). Load type II consists of rectangular-shaped bales or bundles enclosed in paper or cloth stacked in single or multiple layers.

5.2.3 Load type III (see figure 7, page 42). Load type III consists of closed-head, top-nesting, cylindrical or rectangular cans, pails, or buckets stacked in multiple layers utilizing an inverted wood cap under the load and a wood cap over the load.

5.2.3.1 Load type IIIa (see figure 8, page 42). Load type IIIa consists of closed-head, top-nesting, cylindrical cans, pails, or buckets stacked in multiple layers for shrink- or stretch-wrap palletization. Wood caps should not be used with this type load. Shrink-wrap bonding is to be used for nonflammable loads only.

5.2.4 Load type IV (see figure 9, page 42). Load type IV consists of cylindrical or rectangular cans or pails with removable covers containing paints, plastics, and semi liquids (grease and lard) and non-top-nesting, closed-head cans stacked in multiple layers with wood caps between layers.

5.2.5 Load type V (see figure 10, page 43). Load type V consists of tapered empty containers without covers such as buckets and trashcans nested inside one another to form telescoped stacks. Units are to be internally nested one on top of another to form alternately inverted stacks and should be placed on an inverted wood cap. Corner supports, cut approximately $\frac{1}{4}$ of an inch shorter than the height of the stacks of nested units, should be positioned accordingly, and a wood cap is placed over the units. The corner supports are to be nailed to the wood cap, with appropriate strapping applied. After tensioning, the corner supports are to be nailed to the inverted wood cap.

5.2.6 Load type VI (see figure 11, page 43). Load type VI consisting of units of flat paper stock or printed matter not encased in containers and rolls of cloth or fabric which require special weather protection is to be stacked in multiple layers, encased in a waterproof wrapping, and framed. An inverted wood cap is to be placed under and over the load.

5.2.7 Load type VII (see figure 12, page 44). Load type VII consists of individual units of storage batteries or glass window lights that are isolated from superimposed loads by vertical wood separators arranged on the pallet in single layers with an inverted wood cap over and under the load. The height of each unit is not to exceed 11 inches. Units containing glass window lights are to be stacked in the load so that the glass is on edge.

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5.2.8 Load type VIII (see figure 13, page 44). Load type VIII consists of rectangular units with irregular surfaces, nonuniform shapes, or nonlocking surfaces such as coffee cans which have double tray caps between layers and an inverted wood cap under the load and a wood cap over the load. Strapping is also used. Lightweight, metal, rectangular units may use fiberboard caps or horizontal fiberboard separators in lieu of a double tray cap.

5.2.9 Load type IX (see figure 14, page 45). Load type IX consisting of large cylinders for the containment of oxygen, and other gases under pressure are arranged in a vertical unnested position on the pallet. A wood collar is to be used over the load, with battens placed around the bottom of the load with the lower edges resting on the pallet. Lumber is in nominal sizes.

5.2.10 Load type X (see figure 15, page 46). Load type X consists of cellular load formations such as cylindrical or rectangular cans containing welding electrodes, which require separation of units to prevent damage caused by component contact. Units are to be arranged in a single layer of perpendicular rows, with vertical wood separators placed between the rows to create cells for each of the units. The load is to be framed on the sides, ends, and top.

5.2.11 Load type XI (see figure 16, page 46). Load type XI consists of flexible, thin material such as rope, wire, or hose wound or coiled on reels or spools which are arranged in multiple layers consisting of not less than two rows in each direction. A cap, top frame, or battens may be used. Some of the units may be placed on edge along the center line of the load if their dimensions do not permit placing them in the preferred position.

5.2.12 Load type XII (see figure 17, page 47). Load type XII consists of kegs arranged vertically in a single layer, with each row in the layer staggered. A wood cap should be inverted under the load, and one should be placed over the load. When shipping 55-gallon drums (empty or full), there will be no more than 3 drums per pallet, except as designated in the Arctic Supply System.

5.2.12.1 Load type XIIa (see figure 18, page 47). Load type XIIa consists of drums, kegs, or barrels arranged vertically in a single layer, with each row in the layer staggered and with an inverted wood cap on the bottom and a wood cap over the top of the layer. Internal dimensions of the tray and cap are approximately 41 by 46 inches, and it is to be placed on the pallet with the 46-inch side arranged along the 48-inch dimension of the pallet.

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5.2.12.2 Load type XIIb (see figure 19, page 48). Load type XIIb consists of drums, kegs, or barrels, arranged vertically in a single layer with each row staggered, but without caps. Shrink-wrap bonding may be used when the load is nonflammable. If the load is flammable, use load type XIIIa. Stretch-wrap bonding may also be used for lightweight loads. When stretch wrap is used, horizontal fiberboard separators should also be used to increase the load-bearing area.

5.2.13 Load type XIII (see figure 20, page 48). Load type XIII consists of cylindrical shaped items in rolls such as wire, cloth, canvas, wrapping paper, and sheet metal, which are stacked vertically in single or multiple layers. When kegs and small drums are stacked in multiple layers, the unit is to have a wood cap over and under the load and a double tray wood cap between layers.

5.2.14 Load type XIV (see figure 21, page 49). Load type XIV consists of small units, not normally in overpack containers but capable of supporting superimposed loads, which are packed in a fiberboard nested packer.

5.2.15 Load type XV (see figure 22, page 49). Load type XV consists of units in cloth bags, plain paper bags, or lined paper bags, which are arranged in interlocking layers. Lined paper bags or multi-wall paper bags will generally require compression for bonding purposes. Fiberboard sheets should be placed on the deck of the pallet to prevent material such as flour or sugar from shifting through the slots. Shrink- or stretch-wrap bonding may be used with this type load.

5.2.16 Load type XVI (see figure 23, page 50). Load type XVI consists of units of great value or extreme fragility, or items of irregular shape, which cannot in themselves be formed into a stable load when overpacking is required to preclude pilferage or damage. These items may be packed in sectional pallet boxes.

5.2.17 Load type XVII (see figure 24, page 50). Load type XVII consists of units not over packed such as narrow and short drums and cans, small gas cylinders, hand fire extinguishers, and unstable units such as bags stacked on a long edge. These units are to be made up in framed loads.

5.2.18 Load type XVIII (see figure 25, page 50). Load type XVIII consists of minimum framed pallets to be used for loads that are not normally capable of supporting superimposed loads caused by the stacking of pallets in the normal depot fashion of 3 or 4 pallets high. The wood frame will be set on top of the deck of the pallet even with the outside of the perimeter.

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5.3 Bonding methods.

5.3.1 Glue bonding. Glue bonding methods A (glue stripes) and B (glued strips), as applicable to load type I, is to be used only when specified by the procuring activity. Bonding methods A and B may be used by themselves or in combination with other bonding methods when forming palletized unit loads. Glue bonding is not to be used with bagged material, metal containers, non-capped loads of substantial wooden boxes, or any load having both primary and secondary tie-down straps. Bonding with glue stripes should be made on unstrapped fiberboard containers. The adhesive should set in approximately 10 minutes, binding the containers together, and, when unloaded at the destination, the containers should pull apart without disfiguring or tearing the fiber surfaces of the boxes. Bonding methods A and B may be accomplished with commercially available glue dispensing equipment. Although various types of adhesives may be used A-A-59692, MMM-A-260, or commercial equivalent, they are to be performed as specified herein. Use bonding methods A and B only in loads when filled, lined paper bags can be compacted and are to be glued. When glue is not used for such units, horizontal straps, tie-down straps, canvas covers, and battens are to be employed.

5.3.1.1 Glue bonding method A (glue stripes) see figure 26, page 51). Glue bonding method A consists of three glue stripes half an inch in width evenly spaced, running the full length of each unit. In mechanical application, the glue stripes should be applied to the bottom surface by a power driven glue wheel applicator. In manual application, nine glue spots, approximately 3 inches in diameter and evenly spaced, should be heavily brushed on the top deck boards of the pallet prior to formation of glued loads. When mechanical glue application is not available, gluing may be done manually with a small paintbrush. Three stripes are required for fiberboard boxes and fiberboard containers.

5.3.1.2 Glue bonding method B (glued strips) (see figure 27, page 51). Glued strips consist of chipboard or news board not less than 0.03 inch thick, 4 inches wide, and 20 to 24 inches long, coated uniformly on both sides with glue applied either manually or mechanically. Glued strips are to provide an adequate bonding surface for the bonding of loads of rectangular nonmetal units, which have cleats, nails, staples, straps, or even tops or bottoms. Glued strips should be applied to the pallet deck and to the top of each layer of a load before the next layer is positioned. At least six strips should be placed around the perimeter of the load at each level of application in conjunction with four strips placed within the perimeter to form an "X". This will allow the strips to effectively contact every unit in the adjacent layers.

5.3.2 Strapping. Strapping is to be metallic or nonmetallic as specified in 5.3.2.1 and 5.3.2.2, respectively. Guidance on the selection and use of flat strapping materials, both flat carbon steel and plastic, is contained in ASTM D 4675.

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5.3.2.1 Metallic strapping. Metallic strapping should be flat steel conforming to the appropriate type and finish of ASTM D 3953. Breaking strength of the strapping is to be as shown in the ASTM. Straps are to be held in tension on the load by double crimped steel seals of a size suited to the flat steel strapping used or of a type approved by the procurement agency.

5.3.2.2 Nonmetallic strapping. Nonmetallic strapping is to conform to the appropriate type and grade of ASTM D 3950. Unless otherwise specified in the ordering data or by the procuring activity, nonmetallic strapping is not authorized for the strapping of palletized loads of plywood or metal shipping containers. Strapping seals are as specified in ASTM D 3950.

5.3.2.3 Determination of strap size.

5.3.2.3.1 Tie-down strap size. The gross weight of a load divided by the total number of tie-down straps to be used determines the weight, which must be borne by each strap. This weight is compared with strap capacities listed in ASTMs D 3950 or D 3953. Strapping having the same or next higher capacity is to be used.

5.3.2.3.2 Horizontal strap size. The gross weight of the layer compared with strap capacities listed in ASTMs D 3950 or D 3953 determines the strapping size required. Horizontal straps used in conjunction with tie-down straps are to be the same size as the tie-down straps.

5.3.2.4 Securing straps. All metallic and nonmetallic straps applied to a load should be applied straight and are to be tensioned equally to a degree that precludes looseness on the side or top of the load and prevents excess strain on some straps that may cause looseness or breaking during handling and shipment. Straps are held in tension by appropriate seals.

5.3.2.4.1 Sequence of securing straps. When straps are used in combinations, they should be secured in proper sequence to acquire and maintain a stable load. Horizontal straps are always secured first, beginning with the lowest one of the load and working upward. Primary and secondary straps are next to be secured. When both are used, the strap which spans the greatest number of units should be secured first, followed by one strap positioned at right angles to the first. Next, the strap paralleling the second strap is to be secured. Auxiliary straps are secured last.

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5.3.2.4.2 Edge protectors. Metallic edge protectors should be a one piece sheet of strip steel pickled and oiled having a minimum gauge of 0.042 inch, a minimum width of 2 ¾ inches, and a minimum leg length of 2 inches. Nonmetallic edge protectors (fiberboard or plastic) should be selected based on the size, weight, and configuration of the load. Fiberboard edge protectors are to be of weather resistant, double-faced, corrugated fiberboard, minimum 3 inches square, with or without a center score line. Although there are no restrictions on the types of plastic edge protectors to be used, they should provide the same degree of protection as other nonmetallic edge protectors. Edge protectors are to be used in conjunction with straps at corners or edges of containers.

5.3.2.4.3 Crossties or intersection seals (see figure 6, page 41). Straps applied to a load at right angles to each other and in the same plane (vertical and horizontal) should be prevented from lateral movement and displacement by the application of crossties or intersection seals of a size appropriate for the strapping used.

5.3.3 Strap bonding methods.

5.3.3.1 Bonding method C (horizontal straps) (see figures 28 through 34, pages 52-55). Except for shrink- and stretch-wrap bonded loads, horizontal straps may be used around virtually all other loads, from glued loads of rectangular units to framed loads which are capped by a top frame. The type and position of horizontal straps will vary depending on the load type. Horizontal straps may be placed around a load as follows: top layer or single layer, each layer, each layer except the top, bottom of a framed load outside the frame, top of a framed load outside the frame, center of a framed load outside the frame, and one strap at the bottom of a load of compressed gas cylinders outside the battens. Figures 28 through 34 illustrate the various types of horizontal straps used with different load types. These illustrations are for guidance only. When palletizing a load, various situations or problems may arise which might affect the number and placement of the various horizontal straps to be used. Therefore, actual load configurations may vary from those illustrated herein.

- a. For load type II, use a horizontal strap around each layer when under-strap battens are required to stabilize bales or bundles.
- b. For load types III and IIIa, use a horizontal strap around each layer except the top layer for wood-capped loads of nesting, cylindrical units. Position the strap just below the tops of units in each layer except for the top layer.
- c. For load types VII and VIII, use a horizontal strap around the center of all multiple-layer, framed loads and all single-layer, framed loads, which exceed 30 inches in height.

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d. For load type VIII, use horizontal straps around each layer in non-capped, multiple-layer loads in conjunction with horizontal fiberboard separators or cross-strap battens.

e. For load type XV, use a horizontal strap around the top layer or single layer of a load of substantial cloth bags made of a material, which will not be damaged by straps or edge protectors.

f. For load type XVII, use a horizontal strap around the center of multiple- and single-layer, framed loads, which exceed 30 inches in height. Use a horizontal strap around the top of framed loads when the top frame is used in lieu of a wood cap over the top of the load.

5.3.3.2 Bonding method D (tie-down straps) (see figure 35, page 55). There are three types of tie-down straps: primary, secondary, and auxiliary (see 3.34.6, 3.34.7, and 3.34.1, respectively, for definitions). Primary straps pass under the pallet deck in the 40-inch direction, while secondary straps pass under type pallet deck in the 48-inch direction. Primary and secondary straps are the first two tie-down straps secured to a load; auxiliary straps are the third and subsequent straps added to secure the load. Primary straps are used on all loads except glued loads intended for domestic shipment. When primary straps are used with edge protectors, they are positioned so the edge protectors will bridge two rows of units, if practicable, to create integral bonding. Secondary straps are used on all loads except glued loads of compressed gas cylinders intended for domestic shipment. Auxiliary tie-down straps are to be used with all framed loads, capped loads, and loads of reels, spools, coils, or rolls with three or more units in width. Auxiliary straps should be positioned over the load and under the pallet deck boards in the 40-inch direction and will be evenly spaced. When used with non-capped, non-glued loads, auxiliary straps will be positioned at the horizontal center of each row in excess of two.

a. For load type VIII, use auxiliary tie-down straps on capped loads of bricks, refractories, or similar material made up of heavy individual items in smaller rectangular unit packages, and on non-capped loads of medium through extra heavy rectangular units bonded with cross-strap (vertical) battens.

b. For load type IX, use secondary tie-down straps with loads of cylinders for overseas shipments but not for such loads intended for domestic shipment only. Also, use auxiliary tie-down straps with both domestic and overseas loads containing only oxygen cylinders.

c. For load type XI, use auxiliary tie-down straps with large rolls or reels of barbed wire and other material on reels, spools, or rolls not contained in an overpack when such units stack more than two units wide in the 48-inch direction of the load.

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d. For load type XIIa, use both primary and secondary tie-down straps in conjunction with wood caps for loads of 55-gallon drums or barrels.

e. For load type XV, use both primary and secondary tie-down straps with all loads of bagged material with canvas covers.

5.3.3.3 Bonding method E (load straps, auxiliary) (see figure 36, page 56). Load straps secure only the load because they pass under the load but not under the pallet deck. They are used with framed, capped, or non-capped loads. When non-capped, non-glued loads contain more than two rows of units in both directions, with the greater number of rows in the 40-inch direction, load straps are to be used in the 48-inch direction over the intermediate rows. As stated above, they may be used when the pallet stringers preclude the use of auxiliary tie-down straps. The specified number of load straps should be positioned on the pallet deck in the proper direction with the ends of the strapping free. The load is then stacked on the pallet, and the straps are drawn over the complete load, tensioned in proper sequence, and secured with strapping seals. Use auxiliary load straps on load type I loads containing units of dry packaged or unpackaged storage batteries, small glass window lights, or similar heavy units in substantial wood boxes, or use the straps with crates as needed to stabilize the load. In these type loads, the applicable strap(s) should be placed in the one lateral direction, which spans the intermediate row(s) containing the greater number of units. If the same number of units is positioned both ways, use these straps only one way.

5.3.4 Shrink- and stretch-wrap bonding.

5.3.4.1 Bonding method F (shrink wrap) (see figure 37, page 56). Shrink-wrap bonding is appropriate for all commodities except ammunition; nuclear explosives; petroleum, oil, and lubricants (POL); and other flammable materials. PE shrink wrap for use in pallet load bonding is to conform to type IV, class 3, grade A, finish 1, of A-A-3174. The film will be a bag encapsulated over the entire load and will extend at least evenly with the underside of the bottom deck board of the pallet. Unless otherwise specified, wing-type pallets, conforming to ASME MH1, Part 9 and MIL-P-15011, should be used in order to properly anchor the load to the pallet. For example, part number MH1/9-04SF4048 of ASME MH1, Part 9 is a flush-type pallet (without wings) and is not as suitable as wing-type pallets (part numbers MH1/9-02SW4048, MH1/9-03SW4048, or MH1/9-10BW4048 of ASME MH1, Part 9 and MIL-P-15011) for anchoring the load to the pallet when either shrink wrap or stretch wrap is applied. Thermoplastic films of 6-mil PE or 2.5-mil PVC are acceptable for loads up to 2,000 pounds. Loads from 2,000 to 3,000 pounds need a PE film of 8-mil thickness or a PVC film of 4-mil thickness.

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5.3.4.2 Bonding method G (stretch wrap) (see figure 38, page 57). Stretch wrap is appropriate for all commodities and types of palletized loads of materiel shipped in the continental United States (CONUS) or when shipped containerized. When specified, variations in size and type of pallets are permitted for CONUS shipments only. As described in the previous paragraph, wing-type pallets should be used in order to properly anchor the load to the pallet. Stretch wrap should be clear, extruded FE, 0.9 mil minimum thickness, or when specified, pigmented or tinted; PVC; or EVA, 0.8 mil minimum thickness. Multiwraps of PE need to add up to a minimum of 2.7 mils thickness, prior to wrapping, on loads up to 1,000 pounds, 4.5 mils thickness on loads up to 2,000 pounds, and 5.6 mils thickness on loads up to 3,000 pounds. When using PVC or EVA film, a minimum thickness of 1.6 mils is required for loads up to 1,000 pounds, 2.4 mils thickness for loads up to 2,000 pounds, and 3.2 mils thickness for loads up to 3,000 pounds. Film is to be wrapped around the load in multiple wraps, either by the spiral, full wrap method or by the push-through method. Wrap the load from the top of the bottom deck board to not less than 2 inches above the height of the load. To provide additional protection, a sheet of weather-resistant fiberboard or plastic film, the same size as the perimeter of the load, should be placed on top of the load prior to wrapping. When handheld, stretch-wrap equipment is used, ensure that a uniform tension exists throughout the load.

5.4 Storage aids. Storage aids should always be used when bonding alone is insufficient or when the containers require protection from bonding methods. Storage aids are constructed of paper, wood, PE sheet, canvas, fiberboard, steel, or other materials. Storage aids constructed of wood are to be made of lightweight material consistent with the type of protection required.

5.4.1 Metallic edge protectors (storage aid 1) (see figure 33, page 54). In order to add structural strength, metallic edge protectors are to be used at the edges of crates fabricated from light wood, at intersections of side and top frames, and under a strap crossing the long edge of substantially constructed wood boxes containing breakable material such as glass in non-capped loads. If the use of edge protectors directly applied to units of cloth, paper, or other fragile material could result in damage, battens should be substituted for edge protectors. Metallic edge protectors should not be used with nonmetallic strapping.

a. This note applies to load types I, II, VI, VII, VIII, XIII, XV, and XVII. Do not use storage aid 1 at edges of wood boxes, except for non-capped loads of glass window lights as described above on battened gas cylinders, wood caps, and collars; or at the pallet deck where margin exists. Also, do not use on loads with cloth or paper units when battens are utilized. Use on non-capped loads with cartons, crates with thin slats, framed loads where two frames meet, and on non-battened loads of bales when such application will not damage the material.

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5.4.2 Nonmetallic edge protectors (storage aid 2) (see figure 28, page 52). Nonmetallic edge protectors are to be used under horizontal straps on loads to protect against damage to the finish on the units and to provide a compressible base for tensioning each strap to preclude slipping. These type protectors are to be placed under each horizontal strap at points adjacent to the corners of the pallet after the strap has been positioned but before it is tensioned. Fiberboard edge protectors are to consist of narrow strips of double-faced, corrugated fiberboard (CF) folded in the middle to form a 90-degree angle. Other nonmetallic edge protectors are authorized, but they must provide the required protection.

5.4.3 Caps. Caps are to be used over, or under and over, loads when required for the creation of stable loads or for protection, containment, compression, or compaction of the units in the load.

5.4.3.1 Canvas cap (storage aid 3). This cap should be made from cotton duck cloth, which is fire, water, weather, and mildew resistant. Canvas, 60 inches in width, is preferable to preclude splicing and should be prepared to the size of the load for which it is intended. The cap should cover the load and extend down on the sides and ends to a point at least halfway down the top layer. The load is then subjected to a superimposed weight of 6,000 pounds or 3 loads of like material, whichever is lesser, after which the sides of the cap should be pulled down tightly and secured with a horizontal strap around the top layer over the canvas. Kraft paper conforming to A-A-203 may be substituted for the canvas.

5.4.3.2 Fiberboard cap (storage aid 4) (see figure 39, page 57). This cap is to be made from a piece of solid fiberboard (SF) or CF conforming to ASTM D 4727 class weather-resistant, and is to be creased with corners cut to form the top. It will be prepared to fit its intended load. This cap is to be used with non-glued loads of lightweight rectangular units to hold the units securely and to preclude lateral movement. These caps may be used in pairs, with one over the load and one under the load or one over and one under each layer. The depth of the cap can be extended up to 12 inches for loads such as boxed wire fabric, which require more stability.

a. For load type VIII, use storage aid 4 under and over each layer in loads of lightweight, rectangular units. Do not use in loads utilizing sectional pallet boxes or in lieu of wood caps over the top and bottom of loads, intermediate wood caps, or cross-strap battens for units heavier than lightweight.

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5.4.3.3 Wood cap (storage aid 5) (see figure 40, page 58). Wood caps are to be of the open sheathing type except when specified by the procuring activity. Closed sheathing wood caps are to be used for loads of cloth or paper, which require special protection. The outside dimensions of the wood cap should not be less than the dimensions of the pallet unless otherwise specified and are never to exceed outside dimensions of 43 inches by 52 inches when providing for an allowable overhang. When the dimensions of the unit load are less than the wood cap, the space between the load and the inside of the wood cap should be blocked as necessary to prevent shifting of containers when pallets are impacted. The end and side slats of wood caps are not to be less than nominal 1- by 4-inch lumber secured at each end with two 8d cement-coated nails. Corner straps are to conform to ASTM D 3953 and extend a minimum of 6 inches on the end and side slats. Corner straps should be secured to the slats with a minimum of 6 nails (3 per slat) clinched not less than a quarter of an inch. Sheathing for open type wood caps is to be not less than nominal 1- by 4-inch lumber spaced not more than 2 inches apart. Unless otherwise specified, lumber for slats and sheathing is to conform to group II, III, or IV of ASTM D 6199. Sheathing for closed-type wood caps should not be less than ½-inch plywood conforming to A-A-55057, PS-1, grade C-D, interior with exterior glue, or PS-51, grade 3 or 4, type I. Sheathing is to be secured to side and end slats with 8d cement-coated nails, conforming to ASTM F 1667, spaced not more than 3 inches on center, with no less than 2 nails used per sheathing board. Wood caps may be used with framed or unframed loads and may be used over, or over and under a load. When used under a load, the cap is inverted on the pallet and the first layer of units is arranged therein. When a closed sheathing-type wood cap is used under the load, drainage holes half an inch in diameter is to be drilled in the wood cap over spacing in the deck boards of the pallet located in a manner to ensure drainage. When wood caps are used with a framed load, the bottoms of the side frames are to be enclosed in the inverted cap. When used to cover a framed load, the cap should be made to enclose the top of the side frame. Dry packed or unpacked storage batteries, glass window lights, or similar material in cartons or non-substantial containers will be capped under and over the load.

- a. For load types III, VI, VII, XII, and XIIa, use storage aid 5 under and over the load. (Not required if stretch-wrap bonding is used.)
- b. For load type V, use storage aid 5 over the load only.
- c. For load type VIII, use storage aid 5 under and over the load when double tray caps are used intermediately in multiple-layer loads; when loads of brick, refractories, or similar material in multiple- or single-layer loads are utilized; and when single-layer loads contain tapered units which are heavier than lightweight. Do not use storage aid 5 on load type VIII loads when units are lightweight or are of medium to extra heavy weight in multiple layers when cross- and under-strap battens are employed.

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d. For load type XI, a wood cap may be used in lieu of top battens to facilitate placement of over-the-load straps.

e. For load type XIII, do not use storage aid 5 over, under, or intermediately in loads utilizing sectional pallet boxes or nested packers.

f. For load type XVII, top frames should be used. If they cannot be used, use storage aid 5. Use inverted wood caps under all loads except those, which stack with margin on pallet and those whose units will remain stacked without aid while the load is completed. In addition, use between layers, over the lower layers, and in framed loads of metal or metal encased units, except when horizontal wood or plywood separators can be utilized or when notched wood spacers are required.

5.4.3.4 Tray caps (storage aid 6) (see figure 41, page 59). Tray caps are to be of the open or closed sheathing type, with two longitudinal partitions, which serve to separate the rows of units in a layer to prevent damage around the top edges of the units. Tray caps are to be fabricated in accordance with wood cap requirements (see 5.4.3.3) and may be modified by the addition of two longitudinal partitions of not less than nominal 1- by 4-inch lumber. These partitions are to be secured to the sheathing and slats with 8d cement-coated nails spaced not more than 3 inches on center, with no less than two nails used per sheathing board. For load type IV, a tray cap is to be used to cover each layer of units in the load, including the top layer, when loading 5-gallon pails with removable covers such as paint pails.

5.4.3.5 Double tray cap (storage aid 7) (see figure 42, page 59). This cap is to be fabricated in accordance with requirements for open sheathing wood caps (see 5.4.3.3) except that the slats need to extend equally in both perpendicular directions from the sheathing to enclose the top of the units in one layer and the bottoms in another. The sheathing should be secured to the bottom cleat prior to securing the top cleat. Cleats are to be not less than nominal 1-inch lumber and secured to the slats with cement-coated nails clinched a minimum of a quarter of an inch and spaced not less than 3 inches on center. Strapping is to conform to ASTM D 3953. It is to be centered on the slats around the entire perimeter of the cap and is to be secured to the slats with a minimum of eight staples conforming to ASTM F 1667. Staples should be spaced 6 to 8 inches from each corner. For load types VIII and XIII, use double tray caps between layers only with loads, which have multiple layers and are capped over the top and under the bottom with wood caps.

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5.4.4 Canvas cover (storage aid 8). This cover is to consist of a piece of canvas large enough to cover at least the upper two-thirds of the load. It differs from the canvas cap by having much longer sides. The canvas cover should be used with loads of plain paper bags and loads of cloth bags to protect against damage to bags or contained material. The cover is to be placed over the load, centered, and folded down around the sides. The load is to be subjected to a superimposed weight of at least 6,000 pounds, or three loads of like material, whichever is lesser, after which the cover should be pulled down tightly at the sides of the load and secured by horizontal straps. Kraft paper, conforming to A-A 203, may be substituted for the canvas. A canvas cover is to be used with load type XV units such as lined or plain paper bags, which could be damaged by strapping or edge protectors. When using a canvas cover for this type load, battens should be placed over or under the load. Two battens should be placed horizontally at each side of the load to form two layers or tiers of battens around the load. The load should then be secured with horizontal straps placed around each layer in conjunction with the required number of primary and secondary tie-down straps.

5.4.5 Waterproof wrapping (storage aid 9). Waterproof wrapping should consist of two pieces of duplex, asphalted-laminated, water-proof paper per load. Each piece of paper is to cover the top of the load and should fold around the sides to enwrap at least two-thirds of the load. This wrapping is to be used with framed loads of horizontally stacked, cylindrical units of fabric and with loads of flat, paper stock or printed matter not contained in cartons or boxes provided with inside waterproof protection. The wrapping is to be positioned outside all the units in the load and inside the frames. One piece of paper is to be placed in an empty inverted wood cap on a pallet, with the units of the first layer arranged in the cap on the paper and other layers added until the load is stacked within its limitations. Then the paper should be folded up tightly around the sides of the load and secured with waterproof tape conforming to ASTM D 5486 or water-resistant adhesive conforming to MMM-A-260. The other piece of paper is then be placed over the load, folded down tightly around the sides of the load, and secured with water-proof tape or water-resistant adhesive, as described above. All spliced seams need to be sealed in a like manner. The load is then framed, capped, and strapped. Loads of non-boxed horizontally stacked rolls or cylindrical units of fabric are handled differently. After the first layer of units has been arranged in the inverted wood cap on the paper, the paper is to be folded in over the load and two opposing side frames, set inside the inverted cap, and is to be secured temporarily in a vertical position. The paper is then folded out to the frames, and the remainder of the load is stacked.

5.4.6 Frames (see figure 43, page 60). Frames are to be used to protect the load or to help make a stable load by containing, compacting, compressing, or supporting the units in the load.

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5.4.6.1 Side frames (storage aid 10). Side frames are to be prepared to size for the load. They are to be constructed of not less than nominal 1- by 4-inch lumber conforming to ASTM D 6199 or ½-inch plywood conforming to PS-1, grade C-D, interior with exterior glue. The intermediate stringer may be applied diagonally when racking needs to be prevented to make a stable load. When the load contains compressible or compactable materiel, the frame dimensions are to be less than the corresponding dimensions of the unsecured load by an amount, which will allow for compression or compaction so that the framed load will be stable when strapped. When the load is bonded and frames are used on all four sides of the load, frames in the 48-inch direction should overlap those in the 40-inch direction. Side frames are to be used on all sides of the following loads: unstable or odd-shaped units; flat paper stock or printed matter (except when in waterproof cartons or boxes); cylindrical units stacked horizontally; side-rimmed cylindrical units or units which are narrow and short; and plastic-type containers requiring protection from superimposed loads and racking during storage and shipment. A top frame or wood cap over the load should be used in conjunction with side frames in the aforementioned loads. For loads of glass window lights or storage batteries, which exceed 11 inches in height and are not encased in substantial wood boxes, side frames will be used only at the ends. The frames are to be positioned around the load with the bottom edges inside the inverted wood cap, when used, so that the weight of the frames rests upon the wood caps, the frame supports, or the pallet deck. When used with loads of cylindrical units stacked horizontally, two opposing side frames should be placed along the length of the units with the bottom edges inside the wood cap, and they should be temporarily braced in a vertical position to prevent movement of the units while the load is being completed.

a. For load type VII, use side frames at the 40-inch ends of the load only in conjunction with separator supports. Also, use side frames intermediately in this type load when the overall height of the units in the load exceeds 11 inches.

b. For load type VIII, use side frames on four sides of a load of non-contained fiberboard sheets.

5.4.6.2 Top frame (storage aid 11). The top frame is to be constructed in the same manner as the side frames and should be built to size for the load for which it is intended and should overlap the side frames when the load is bonded. When used with loads of compressible or compactable materiel, the dimensions of the top frame are to be less than the corresponding dimensions of the unsecured load by an amount, which will allow for compression or compaction so that the framed load will be stable when strapped. A top frame should be used to reduce weight with any framed load, which does not require the heavier wood cap. The top frame is to be placed over the load and secured after the side frames have been positioned.

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- a. For load type VIII, use storage aid 11 in lieu of wood caps, when practicable, over loads of non-contained sheets of fiberboard. Such loads have four side frames.
- b. For load type XI, a top frame may be used in lieu of top battens to ease the placement of over-the-load straps.
- c. For load type XVII, use side frames on four sides of the load.

5.4.6.3 End frames (storage aid 12). These frames are to be constructed similar to the side frames except that they will be made from nominal 2-inch thick lumber. End frames should be used with loads such as glass window lights or storage batteries not encased in substantial wood boxes when separator supports cannot be used intermediately in the load due to the size of the units. Before the wood cap is placed over the load, end frames are to be positioned at the 48-inch ends of the load, with their bottom edges inside the inverted wood cap used under the load.

- a. For load type VII, use end frames at the 40-inch ends of loads only when separator supports cannot be used intermediately in the load.
- b. For load type XVII, use end frames in framed loads in lieu of wood caps over loads whenever they can be used effectively. Do not use storage aid 12 in lieu of wood caps in framed loads containing "unstable units."

5.4.7 Frame supports (storage aid 13). Frame supports are to consist of plain boards cut to length for the load and made from substantial lumber of random widths from 2 to 12 inches. At least two supports used with a load are to be not less than 4 inches in width. The boards are to be of nominal 1-inch thickness to provide adequate support for a superimposed minimum weight of 6,000 pounds or 3 loads of like material, whichever is lesser. Frame supports may be used in lieu of the inverted wood cap under framed loads of unstable or odd-shaped units to effect a reduction in tare weight. The frame supports are to overhang all four sides of the pallet by an amount which will make them flush with the bottom edges of the frames when the load is bonded securely. Frame supports should be laid on the pallet parallel to the deck boards and positioned with proper overhang at the ends and sides. The outboard supports, which overhang the sides of the pallet are to be not less than 4 inches in width. One or more additional supports are to be spaced intermediately between the outboard supports, as required, to bridge approximately half of the bottom surface of each unit in the bottom layer and provide for a level, stable load. If the area occupied by the frame supports required for a load is more than 60 percent of the pallet deck, an inverted wood cap of open sheathing should be used in lieu of the frame supports.

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5.4.8 Separator supports (storage aid 14) (see figure 12, page 44). These supports are to consist of substantial lumber of not less than 1-inch nominal thickness, cut to length for the load so that they will extend flush with the outside edges of the outboard units in the rows they separate. The lumber should be strong enough that the load with which the supports are used, will support a superimposed minimum weight of 6,000 pounds or 3 loads of like material, whichever is lesser. Separator supports are to be used with framed loads to provide support for the wood cap used over the loads, thus preventing the cap from resting on the units in the load. The supports may be spaced intermediately and across the ends of the load or spaced intermediately alone in the 40-inch direction. When units in a load do not exceed 11 inches in height, 1 separator support should be placed at each end of the load and 1 placed intermediately in the center if 3 supports are used, or on equal sides of the center if 4 supports are used. When the load is composed of units exceeding 11 inches in height, 1 or 2 separator support sets (2 or more boards each) are to be placed intermediately in the load provided 1 set could be located within 6 inches of the center of the load. Side frames (see 5.4.6.1) are to be used at the ends in lieu of separator supports when units are over 11 inches high.

a. For load type VII, use separator supports at the 40-inch ends of the load and intermediately in the load when the height of the units in the load does not exceed 11 inches; otherwise, use the separators in multiple sets intermediately in the load only in conjunction with side frames at the 40-inch ends of the load.

b. For load type XVII, use separator supports in lieu of inverted wood caps under small or narrow, framed loads when units are stable and when the combined area of the supports does not total more than 60 percent of the pallet area.

5.4.9 Separators. Separators are to be used to protect and support the individual units in a load.

5.4.9.1 Horizontal fiberboard separator (storage aid 15) (see figure 44, page 60). This separator is to consist of a single piece of double-faced CF or SF conforming to ASTM D 4727, class weather-resistant. Storage aid 15 may be used between layers of non-framed loads containing lightweight units when fiberboard caps are not available. In such cases, a separator is to be placed over each layer of units (except the top layer) after each layer has been horizontally strapped. Storage aid 15 may be used between layers in framed loads of unstable or odd-shaped units which have tops and bottoms of metal, or within sectional pallet boxes as practicable, in lieu of a horizontal wood separator when such use will not result in damage to the units or contained material. Storage aid 15 may also be used with load types VIII and XVI when palletizing cylindrical or rectangular units.

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5.4.9.2 Horizontal wood separator (storage aid 16) (see figure 44, page 60). This storage aid will be made from lightweight wood and may be used between layers in framed loads of unstable or odd-shaped units, which have metal tops and bottoms. Its use will reduce tare weight in those instances when wood caps are not required to stabilize the load. It may also be used for separating layers of material in load type XIV, nested packer.

5.4.9.3 Separator for nested containers (storage aid 17) (see figure 21, page 49). This separator is to consist of a narrow strip of plain fiberboard cut to length so that when placed on the outside of a unit it will span the bottom and extend along the sides beyond the points at which the unit would normally bind when nested inside another/like unit. Storage aid 17 may be used whenever practicable in lieu of wood caps between layers in framed loads of metal or metal-encased units. It may also be used, when necessary, in load type XVI, sectional pallet box.

5.4.9.4 Vertical wood separators (storage aid 18) (see figure 45, page 60). These separators are to be made of box lumber, three-sixteenths of an inch in thickness and nominal 4 to 6 inches in width, cut so they extend to the extreme outside of the outer-most units in the rows they separate. Vertical wood separators are to be used with framed loads of side-rimmed, cylindrical or rectangular units to preclude damage to the units or to the contained material through pressure or friction resulting from handling or shipment. These type separators should be placed on a long edge between rows of units, with at least two layers of separators used for each layer of units in the load. The first layer of separators should be placed between rows in the 40-inch direction, with succeeding layers placed at right angles to the layers immediately beneath. This will create individual cells for the units and will separate each one from the other units in the layer. When used with loads in which the units or contained material could be damaged by contact with the wood cap or top frame used over the entire load, the cumulative height of the several layers of separators should be such that the top layer will extend about one-eighth of an inch above the tops of the units in the layer; otherwise, the top layer of separators will extend flush with the tops of the units.

5.4.10 Pallet strips (storage aid 19) (see figure 46, page 61). Pallet strips are to be used with vertical wood separators and will be the same thickness as the lumber used for separators. They should be the same width as the units in the load and are to extend to the extreme outside of the outboard units in the rows running in the 40-inch direction of the pallet. The pallet strips are to be nailed flat to the pallet deck in the 40-inch direction and should be spaced approximately one-sixteenth of an inch further apart than the thickness of the strips to create slots into which the bottom edges of the lower tier separators will fit.

5.4.11 Battens. Battens are used to fill space, protect against damage, provide additional strapping surface, or help create a more stable load.

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5.4.11.1 Battens, cross-strap (storage aid 20) (see figure 47, page 61). Battens are to be made of nominal 1-inch thick lumber or ½-inch plywood and should be 4 to 6 inches wide (as dictated by the weight of the units). The length of the battens is to equal the height of the load. Three or more battens are to be placed in a vertical position at each 48-inch width and at the 40-inch length, when necessary. Each batten should, if practical, bridge two rows of units. Straps should be held firmly in place by staples in accordance with ASTM F 1667. Use cross-strap battens with non-capped load type VIII loads of rectangular units of medium through extra heavy weight. Three battens are to be placed at each 48-inch side of the load, and, when required, 1 or 2 battens will be placed at each end of the load, in vertical position, with each batten bridging 2 vertical rows of units, when practical.

5.4.11.2 Battens, under- or over-the-load (storage aid 21) (see figure 48, page 62). Used for load types I and IX, these battens are to be made of nominal 1-inch thick lumber or ½-inch plywood and be 6 inches wide. Battens are cut to a length that will extend approximately to the edges of the load in the 48-inch width. When the load is compactable or compressible, the battens should be shorter than the applicable dimensions. These battens may also be used in conjunction with cross-strap battens. When over-the-load battens are used, the battens should be positioned in the 48-inch width to bridge 2 rows of units.

a. For load type II, use storage aid 21 at sides and tops of loads in conjunction with bonding methods C and D (horizontal straps around each layer and tie-down straps) when bales or bundles of material cannot be formed into stable loads with strapping alone.

b. For load type VIII, use storage aid 21 with non-capped loads of rectangular units of medium through extra heavy weight in conjunction with cross-strap battens. Two battens will be positioned on top of the load in the 48-inch direction.

c. For load type XI, use storage aid 21 with all rolled loads, including barbed wire on reels, spools, or coils, stacked more than 2 rows in the 48-inch direction. The battens will be positioned on top of the load in the 40-inch direction and will be secured with secondary tie-down straps.

d. For load type XV, use storage aid 21 in conjunction with canvas covers. Two battens will be placed at each side of the load in a horizontal position to form two layers or tiers of battens around the load. They are to be secured with horizontal straps.

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5.4.11.3 Battens, oxygen cylinder or gas cylinder (storage aids 22 and 23) (see figure 14, page 45). These battens are to be made of nominal 1-inch thick by 4-inch width lumber cut so that they extend to the center lines of the outboard rows of units. The ends are to be beveled along one face and will be placed against the load with the bevels outboard. They should be positioned in one horizontal layer around the bottom of the load at the pallet level and held in place against the load by one horizontal steel strap 1 ¼ inches wide by .030-inch thick. The straps should be secured to the battens with staples driven fully into the batten after the straps have been secured. When deemed necessary, battens made from nominal 2-inch thick by 4-inch width lumber may be used.

5.4.12 Wood collar (storage aid 24) (see figure 14, page 45). Wood collars are to be used with loads of compressed gas cylinders to make a stable load by creating integral bonding of the units and preventing lateral movement of the unit cylinders. A wood collar also provides a level platform for superimposed loads. Wood collars are constructed so that their height extends beyond the tops of the units encompassed. The outside member of a collar should enclose the tops of the units around the perimeter of the load. The inner partitions will contain or separate the rows of gas cylinders with the edges of the collar resting upon the shoulder of the cylinders. The collar should be placed over the load after the units have been arranged on the pallet and before positioning the battens. The tops of all units should be enclosed by the sides of the collar and its partitions. The collar is to be held in position by the appropriate number of tie-down straps.

5.4.13 Notched wood spacer (storage aid 25) (see figures 49 and 50, page 63). This spacer is made from heavy lumber and notched or recessed across opposing faces at regular intervals along its length. The notches are to be cut to fit snugly around part of the perimeter of the units of the load. The notched wood spacer is used with framed loads of unboxed cylindrical units stacked horizontally to stabilize the load and to protect the units against damage from handling during shipment. Two or more spacers are required for the safe stacking of cylindrical units, and they should be placed under the load at right angles to the length of the units. An equal number of spacers are to be used between each course, but none on the top of the load. The length of the spacers in a load should be sufficient to extend to or slightly beyond the edge of the load. For load type XVII, use storage aid 25 under the load, on top of inverted caps, and between layers of framed, cylindrical, self-supporting units stacked horizontally such as metal or concrete pipes or axles. Do not use notched wood spacers with rolls of cloth, screening, or similar material.

5.4.14 Sectional pallet box (storage aid 26) (see figure 23, page 50). This box is made from nominal 1-inch lumber or 5/8-inch thick plywood panel, using a pallet as the base or bottom of the box. Each section is to consist of four boards of the same width nailed together to form a hollow rectangle of the same size as the pallet deck. An approximate 1- by 2-inch piece of lumber with its length equal to the width of the boards is nailed inside each corner of the section

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and positioned so that all extend about 1 inch beyond the same edge of the section. These corners or posts serve to keep superimposed sections correctly positioned. By constructing sections from various widths of lumber or plywood, the pallet box may be assembled to the exact height required by the units comprising any load. One section of the box should be placed on an empty pallet, with the units arranged inside up to the height of the section. The superimposed sections are then positioned and individually stacked until the load has been completed. Horizontal fiberboard or wood separators may be used at intermediate top levels of each section. The box should be covered by a one-piece lid of fiberboard, closed wood, or plywood sheathing, nailed in place and secured by the prescribed number of tie-down straps.

5.4.15 Nested packer storage aid 27 (see figure 21, page 49). This packer is to be constructed of fiberboard or wood. It will have a base the size of the pallet deck and will consist of interior interlocking partitions. Requirements for packaging items going into the nested packer will depend on the nature of the item.

5.4.16 Chimney filler (storage aid 28) (see figure 50, page 63). The chimney filler is to be made from SF or double-wall CF, minimum 275 pounds bursting strength, scored and folded to the required size to fit into the chimney or void which occasionally develops in a load due to the size or shape of the units. The filler should fill the void snugly in the top layer of rectangular units to preclude the lateral movement of such units away from the perimeter of the load. When the pallet pattern results in voids, which are staggered from layer to layer, the filler should be required only in the top layer. When the voids in each layer are superimposed, the filler should extend the full length of the chimney. This filler is primarily used with load types I and VIII for non-capped, non-framed, or non-boxed strapped loads when voids exist between rectangular units within the load. A framework of lightweight wood may be used in lieu of solid fiberboard for the chimney filler.

5.4.17 Polyethylene sheeting, 1 mil (storage aid 29). This aid consists of a sheet of PE, large enough to drape over the top of a palletized load and extend at least 6 inches down each side and each end. The sheet should be placed over the top after the first wrap is applied. For load types Ia, II, and XV, use storage aid 29 over the top of a stretch-wrap load prior to wrapping the load to provide bonding and water protection. This storage aid is only required when protection from water is necessary.

5.5 Marking. Except as noted below, marking is in accordance with MIL-STD-129.

5.5.1 Marking variations. Marking of petroleum and petroleum related products are as specified in MIL-STD-290. Marking of tires is as specified in MIL-STD-129 and in MIL-DTL-4.

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6. NOTES

6.1 Intended use. This handbook provides guidance on the methods, materials, and techniques to be used in the formation of bonded palletized unit loads of military supplies, which are adapted to unit loading. The methods prescribed herein are to be utilized with the standard, general purpose, 40- by 48-inch pallet.

6.2 Superseding information. This handbook supersedes MIL-HDBK-774, 25 March 1996, MIL-STD-147D Notice 1, 1 February 1994, and MIL-STD-1187(1) Notice 2, 30 December 1988.

6.3 Subject term (key word) listing.

Load patterns
Palletized unit loads
Pallets
Unit loads

6.4 International standardization agreement implementation. This handbook implements STANAG 2828. When changes to, revision, or cancellation of this handbook are proposed, the preparing activity must coordinate the action with the U.S. national point of contact for the international standardization agreement, as identified in the ASSIST database at www.dodssp.daps.mil.

6.5 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

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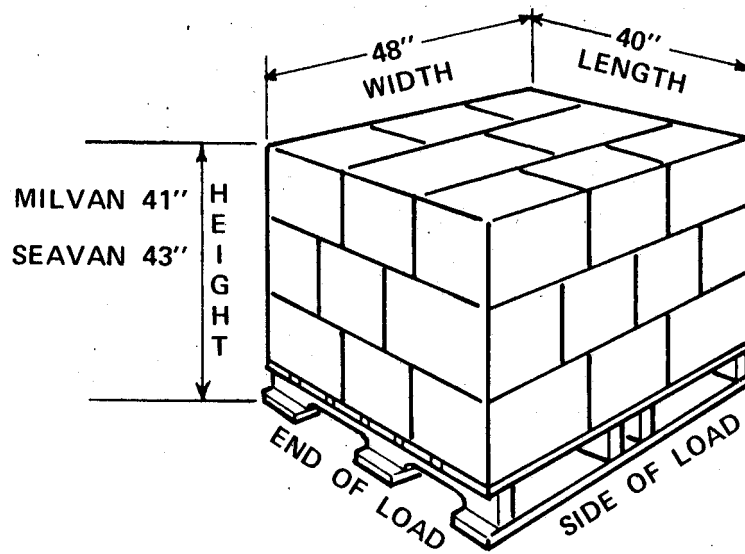


FIGURE 2. Palletized unit load sizes (See 5.1.1.1).

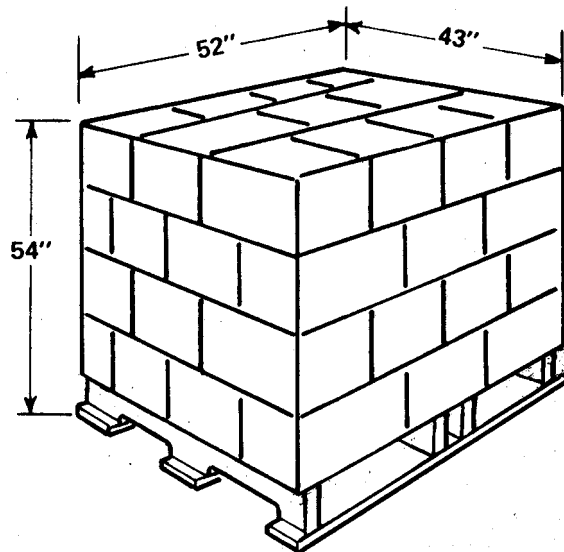


FIGURE 3. Other palletized unit load sizes (See 5.1.2).

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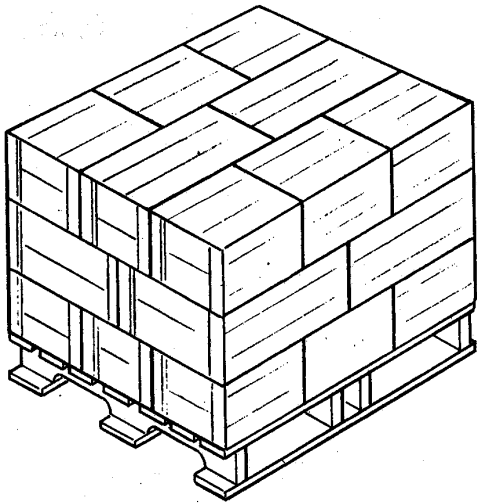


FIGURE 4. Load type I (See 5.2.1).

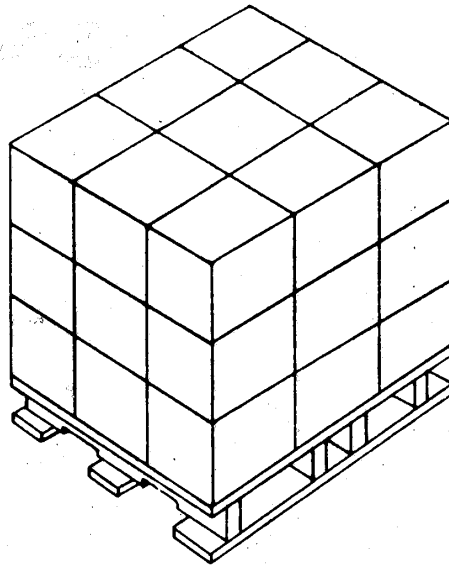


FIGURE 5. Load type Ia (See 5.2.1.1).

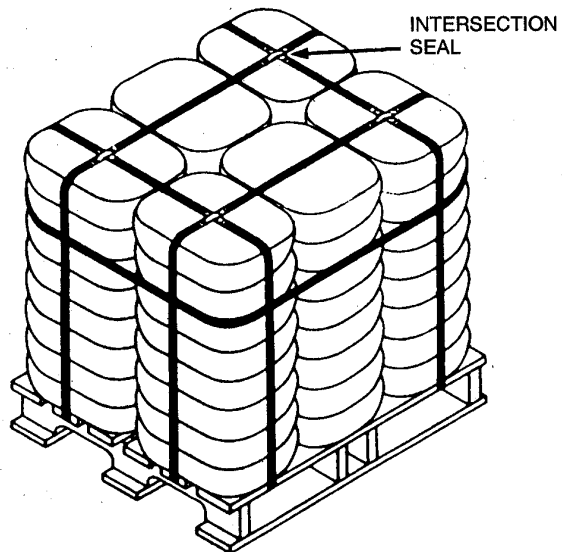
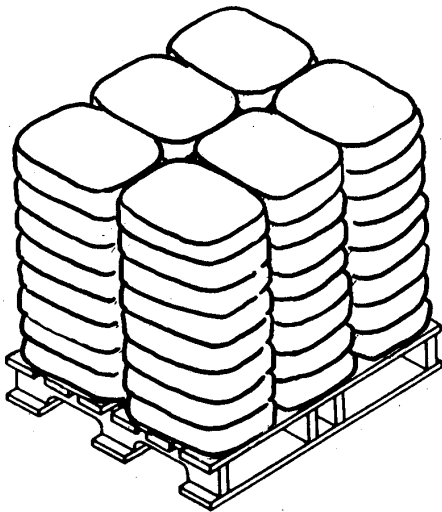


FIGURE 6. Load type II (unstrapped and strapped) (See 5.2.2).

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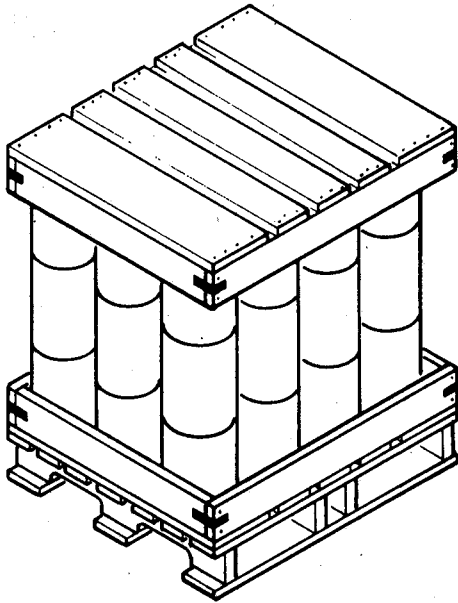


FIGURE 7. Load type III (See 5.2.3).

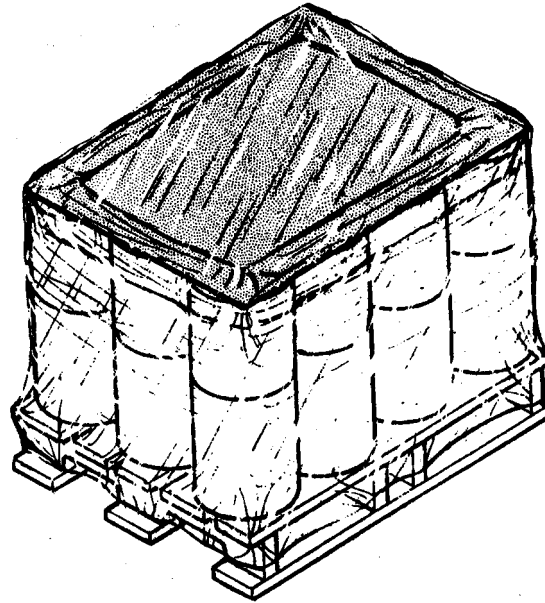


FIGURE 8. Load type IIIa (See 5.2.3.1).

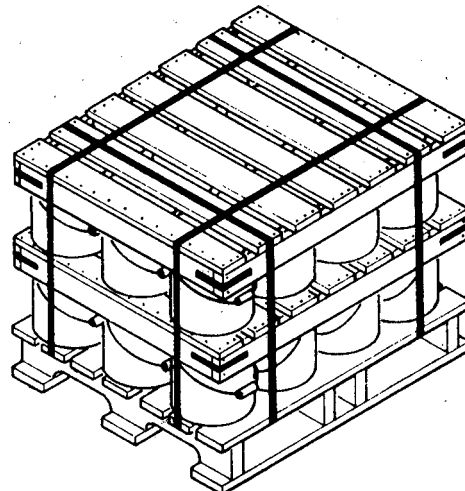
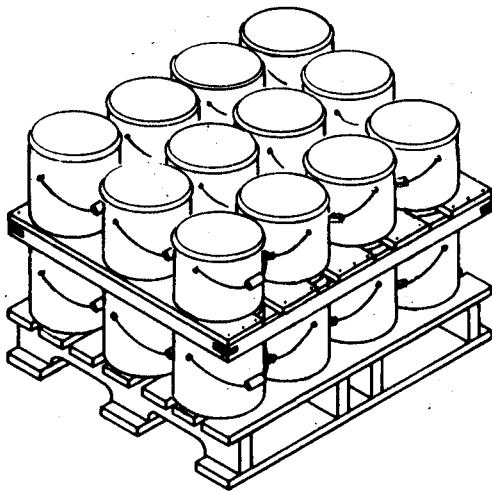


FIGURE 9. Load type IV (unstrapped and strapped) (See 5.2.4).

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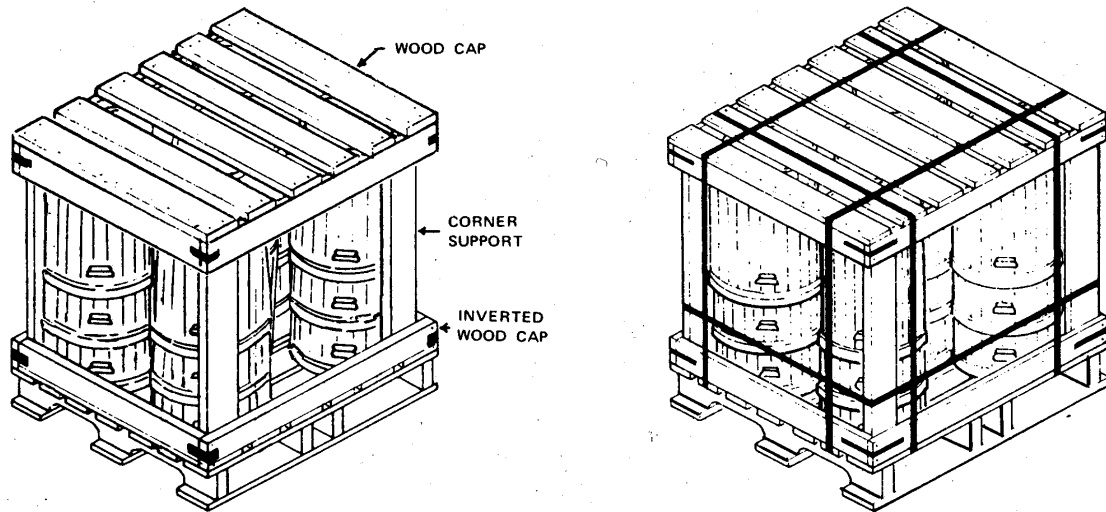


FIGURE 10. Load type V (unstrapped and strapped) (See 5.2.5).

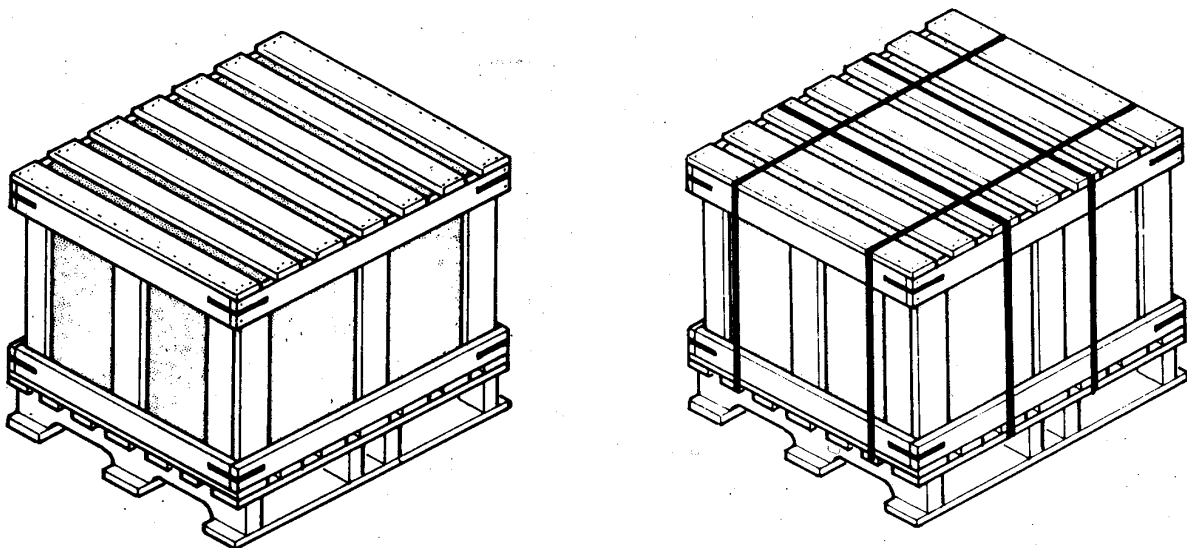


FIGURE 11. Load type VI (unstrapped and strapped) (See 5.2.6).

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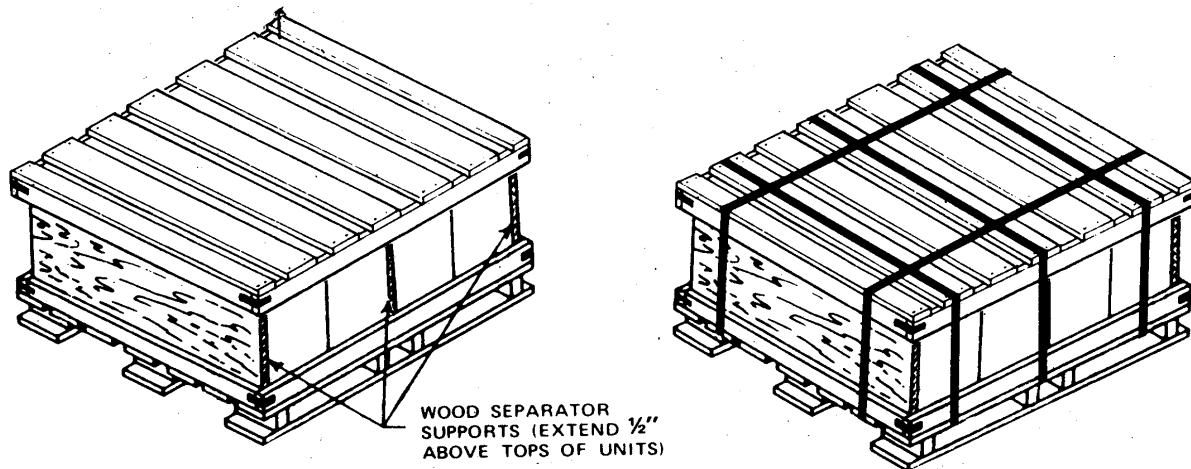


FIGURE 12. Load type VII (unstrapped and strapped) (See 5.2.7 and 5.4.8).

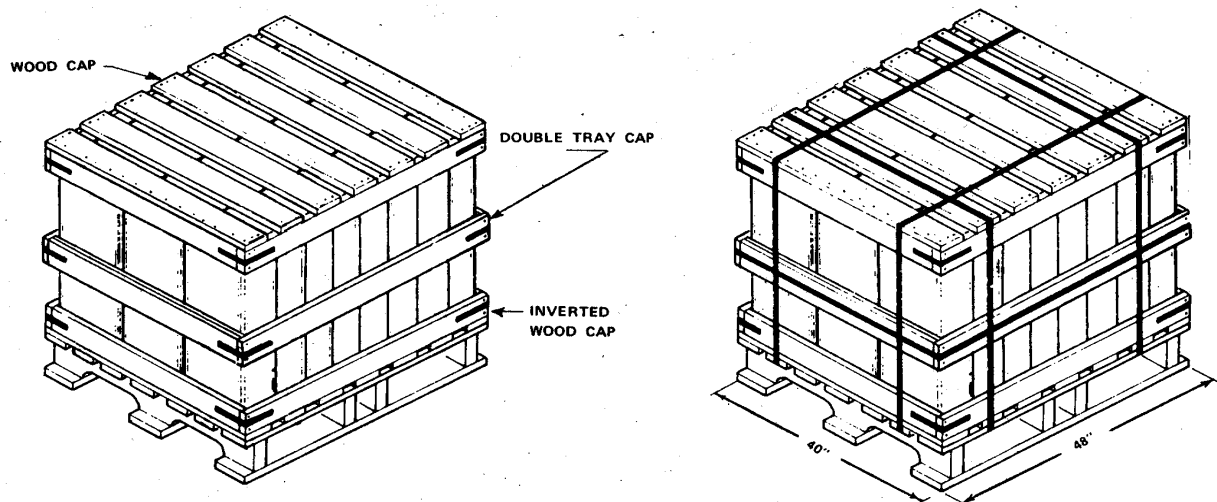
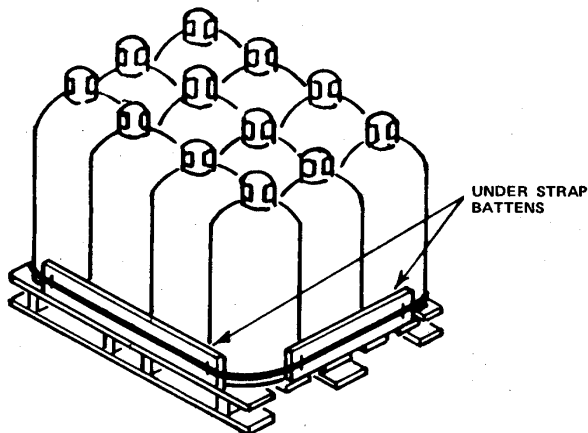


FIGURE 13. Load type VIII (unstrapped and strapped) (See 5.2.8).

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BILL OF MATERIALS			
(a)			
WOOD COLLAR FOR ACETYLENE CYLINDERS			
ITEM	DESCRIPTION	QTY	SIZE
A	SIDE SLATS	2	2"X8"X42"
B	END SLATS	2	2"X8"X33½"
C	PARTITIONS	2	2"X8"X30½"
D	STEEL STRAP	1	1¼"X.035"X15'6"
E	STRAPPING SEALS	1	1¼"
F	STAPLES	8	1¼"
G	COATED NAILS	40	12d
(b)			
WOOD COLLAR FOR OXYGEN CYLINDERS			
ITEM	DESCRIPTION	QTY	SIZE
A	SIDE SLATS	2	2"X8"X41"
B	END SLATS	2	2"X8"X35 ¼"
C	PARTITIONS	2	2"X8"X32 ¼"
D	STEEL STRAP	1	1¼"X.035"X14'6"
E	STRAPPING SEALS	1	1¼"
F	STAPLES	8	1¼"
G	COATED NAILS	40	12d
(c)			
WOOD COLLAR FOR FREON CYLINDERS			
ITEM	DESCRIPTION	QTY	SIZE
A	SIDE SLATS	2	2"X8"X45½"
B	END SLATS	2	2"X8"X41"
C	PARTITIONS	2	2"X8"X38 ½"
D	STEEL STRAP	1	1¼"X.035"X15'6"
E	STRAPPING SEALS	1	1¼"
F	STAPLES	8	1¼"
G	COATED NAILS	40	12d

NOTE: USE 5 12d COATED NAILS AT EACH JOINT

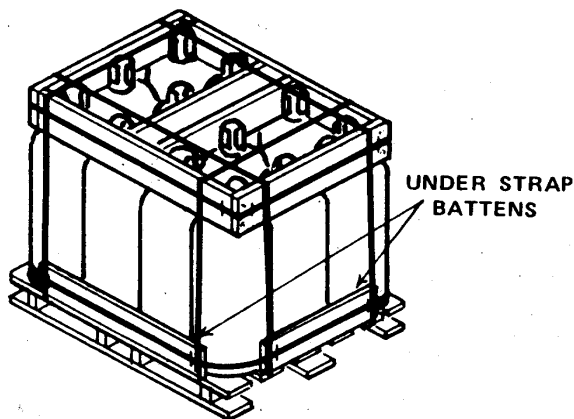
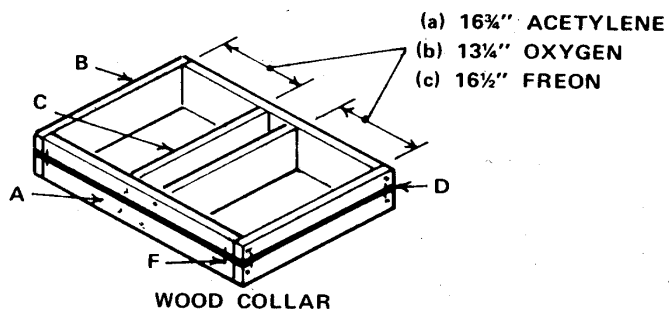


FIGURE 14. Load type IX (unstrapped and strapped) (See 5.2.9, 5.4.11.3, and 5.4.12).

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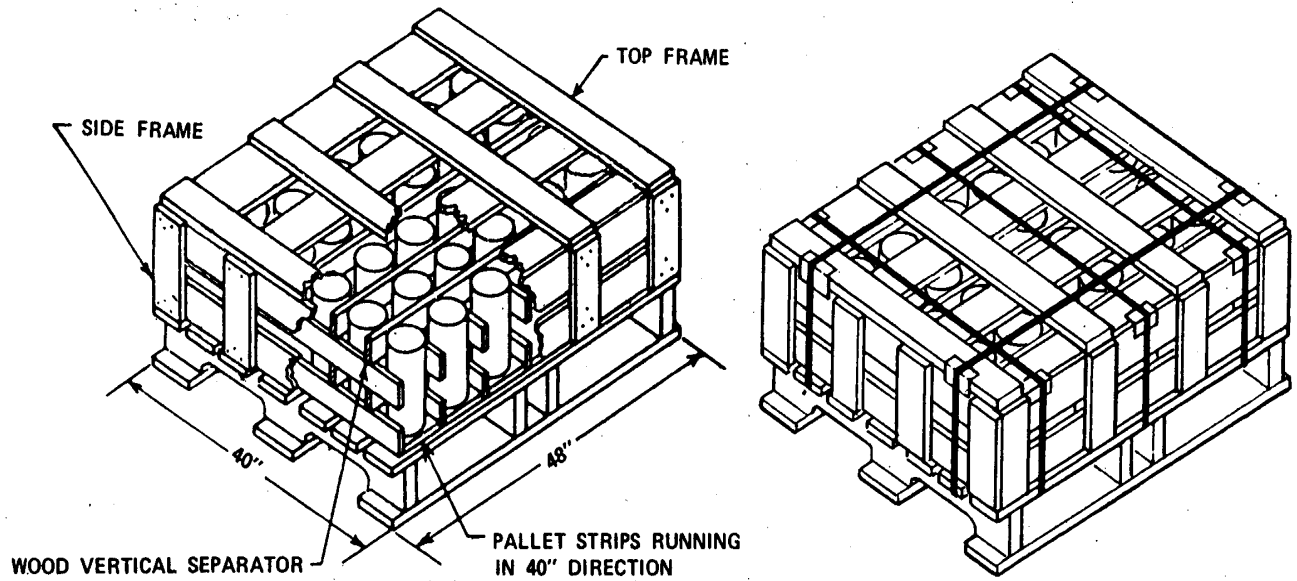


FIGURE 15. Load type X (unstrapped and strapped) (See 5.2.10).

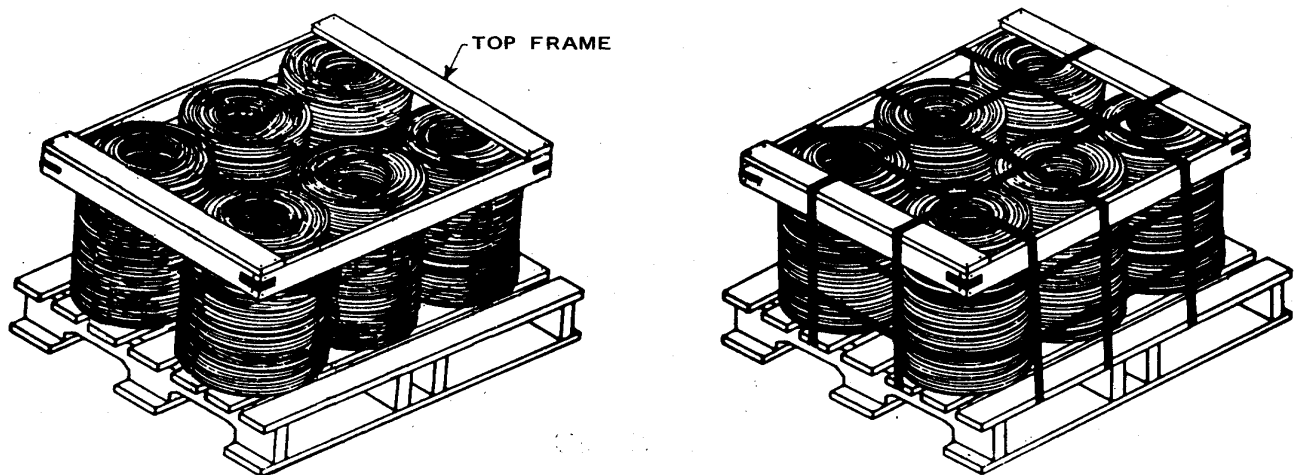


FIGURE 16. Load type XI (unstrapped and strapped) (See 5.2.11).

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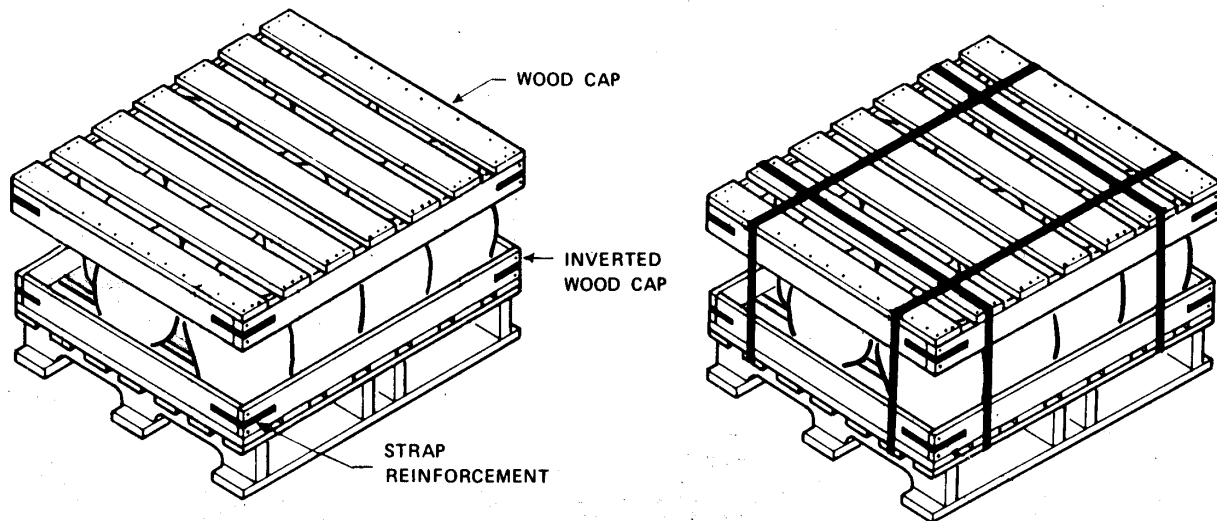


FIGURE 17. Load type XII (unstrapped and strapped) (See 5.2.12).

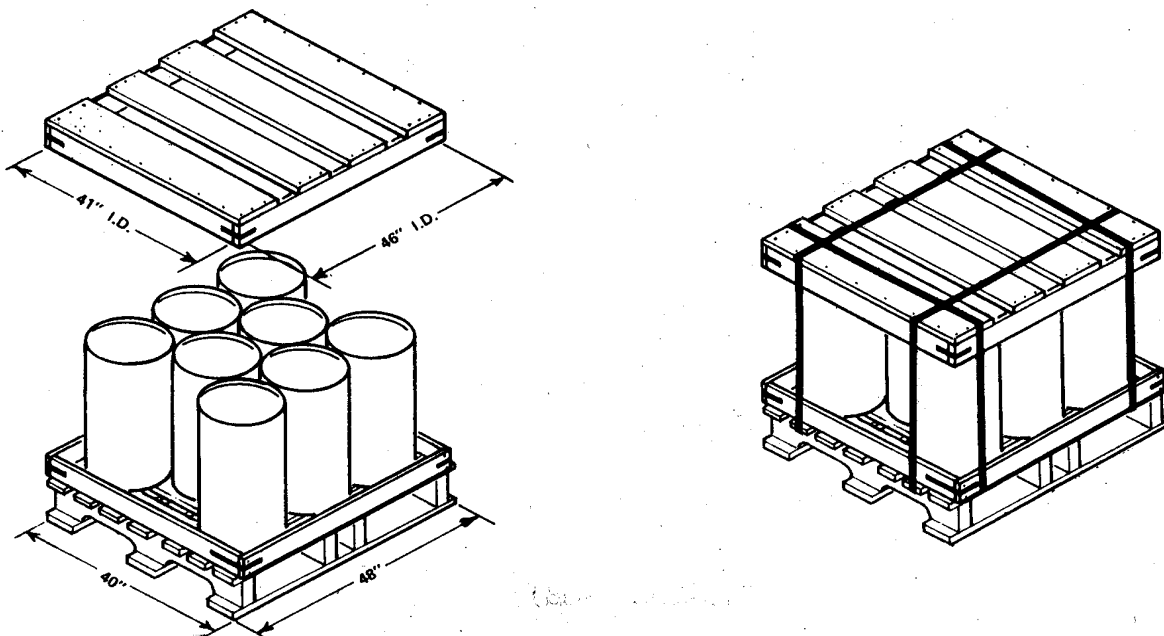


FIGURE 18. Load type XIIa (unstrapped and strapped) (See 5.2.12.1).

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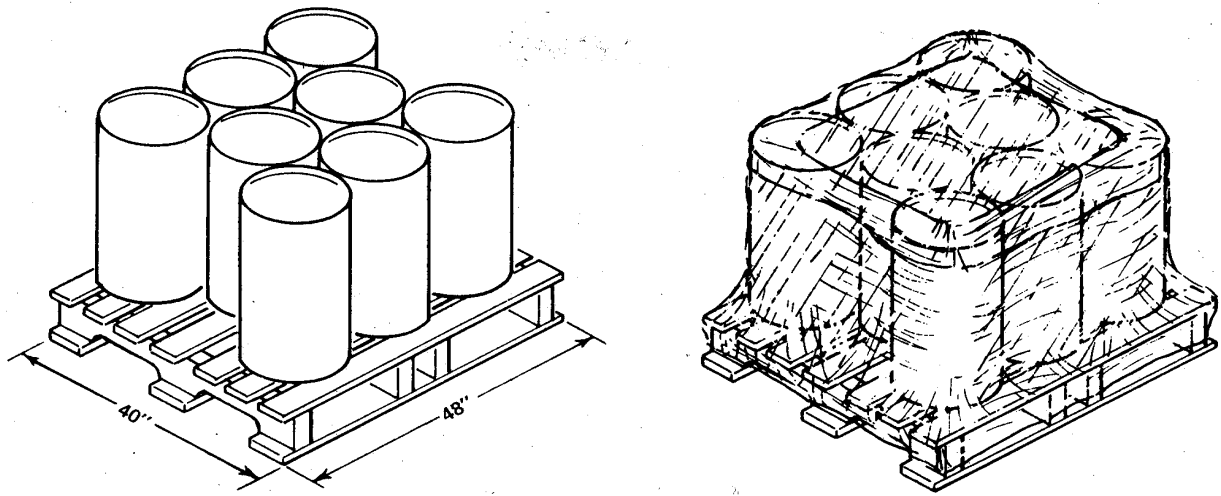


FIGURE 19. Load type XIIb (uncovered and stretch-wrapped) (See 5.2.12.2).

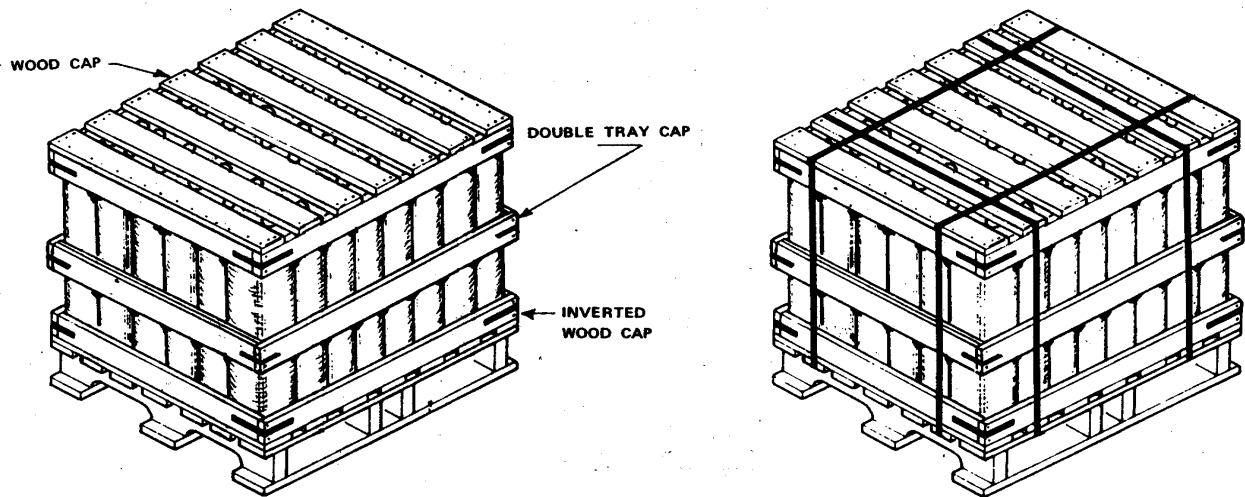


FIGURE 20. Load type XIII (unstrapped and strapped) (See 5.2.13).

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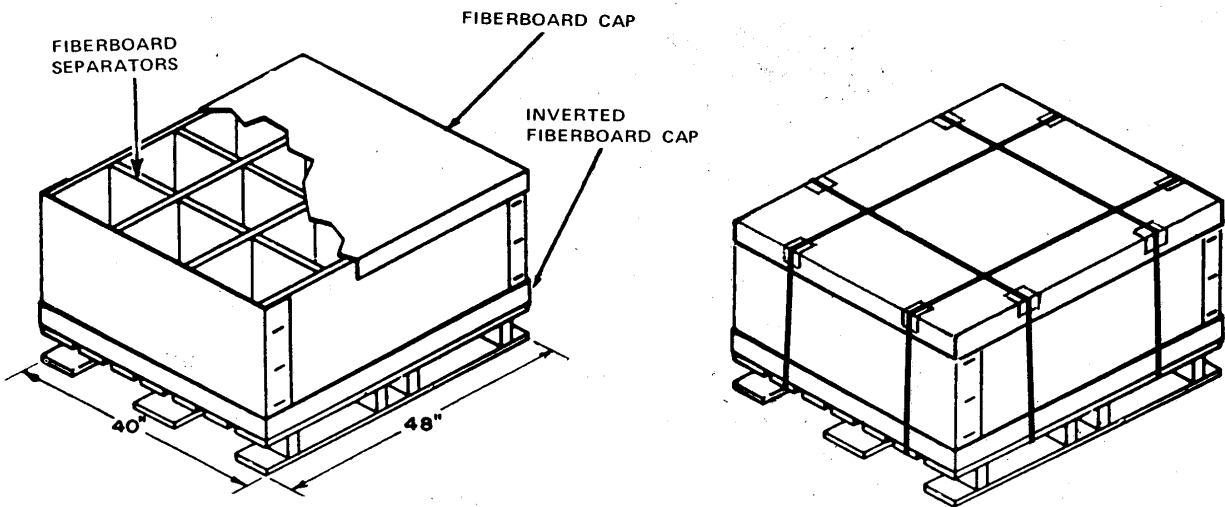


FIGURE 21. Load type XIV (unstrapped and strapped) (See 5.2.14, 5.4.9.3, and 5.4.15).

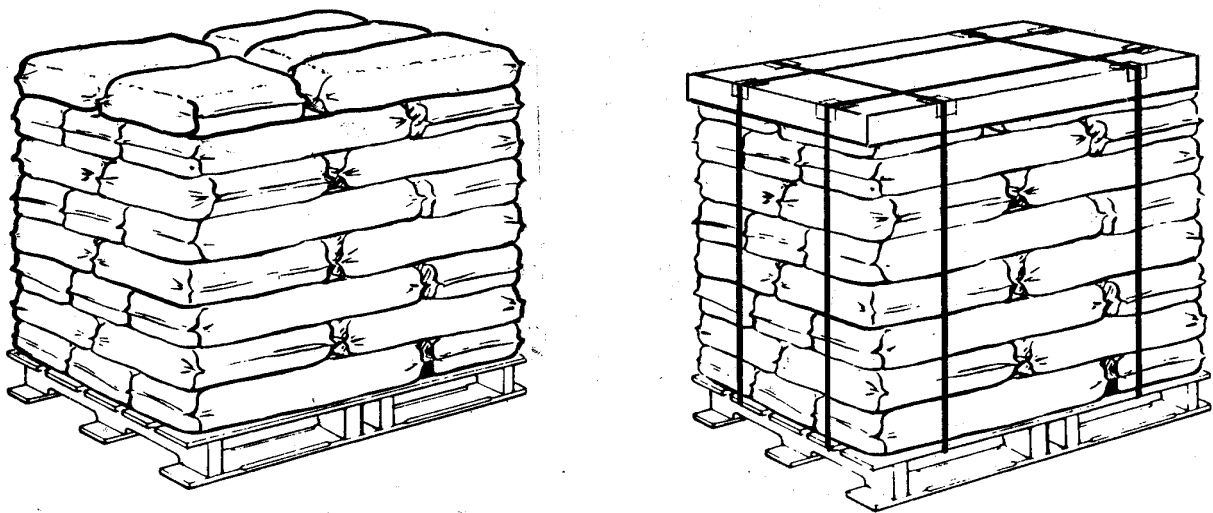
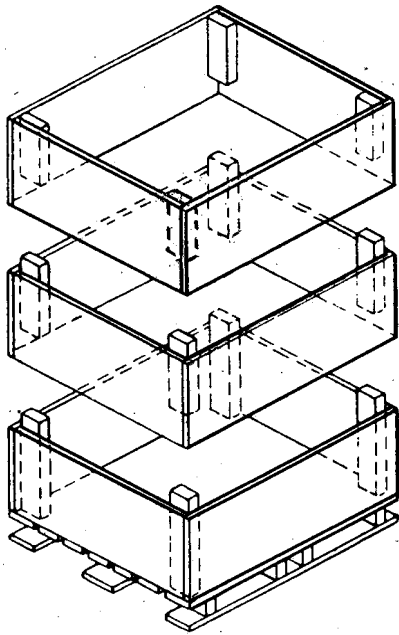


FIGURE 22. Load type XV (unstrapped and strapped) (See 5.2.15).

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SECTIONAL PALLET BOX IN USE

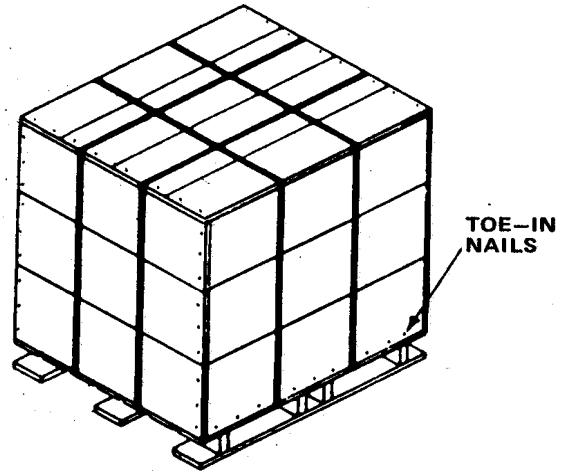


FIGURE 23. Load type XVI (See 5.2.16 and 5.4.14).

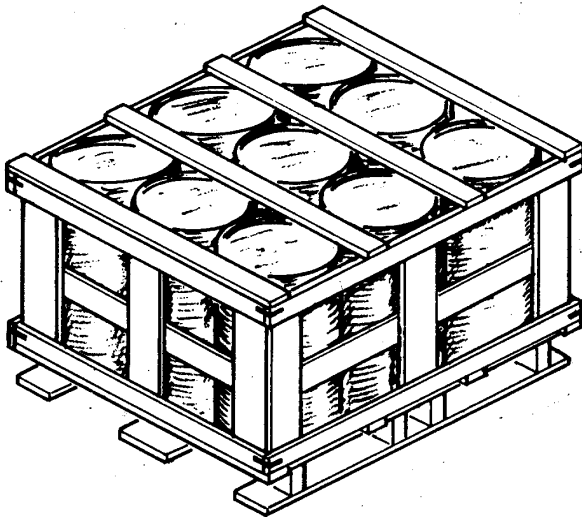


FIGURE 24. Load type XVII (See 5.2.17).

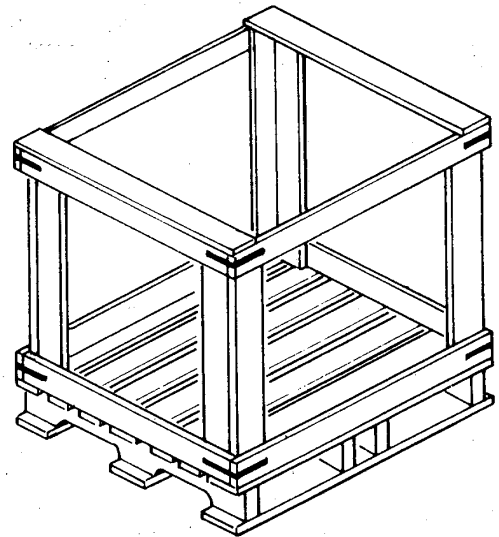


FIGURE 25. Load type XVIII (See 5.2.18).

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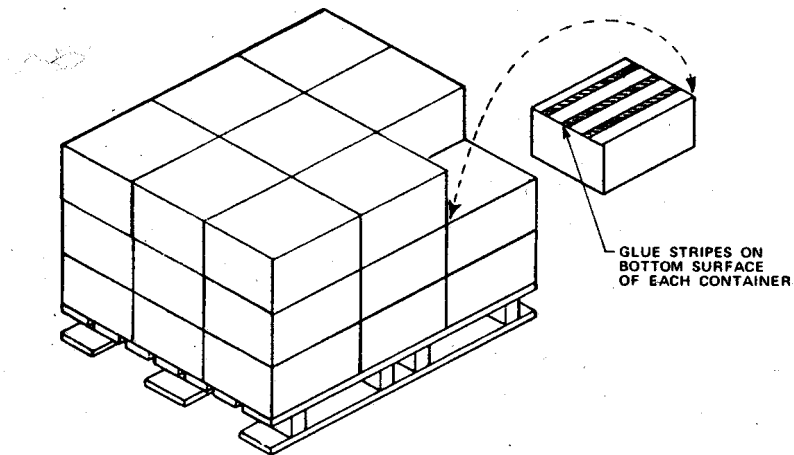


FIGURE 26. Bonding method A (glue strips) (See 5.3.1.1).

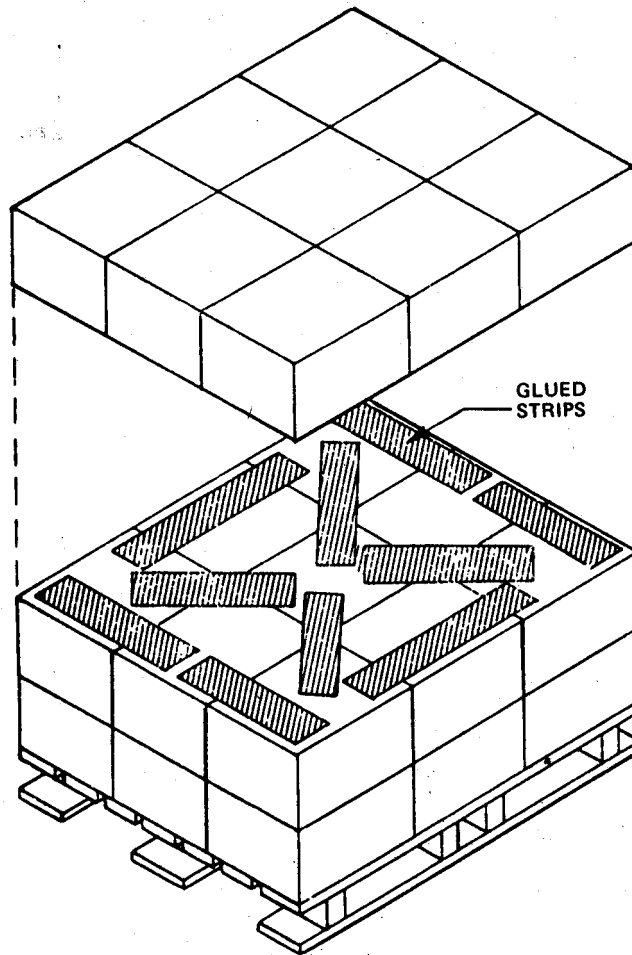


FIGURE 27. Bonding method B (glued strips) (See 5.3.1.2).

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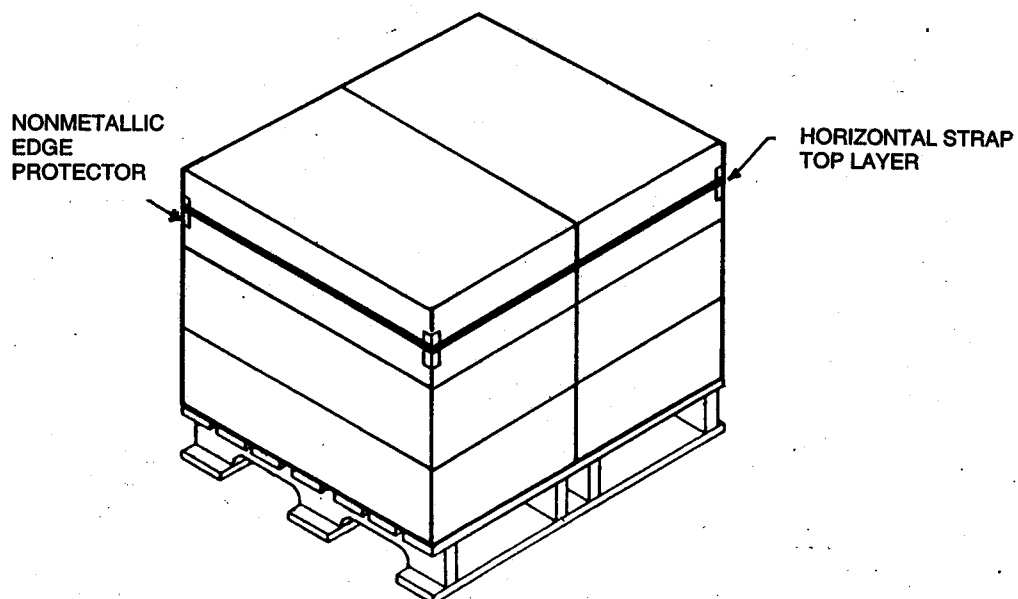


FIGURE 28. Bonding method C (top layer or single layer) (See 5.3.3.1 and 5.4.2).

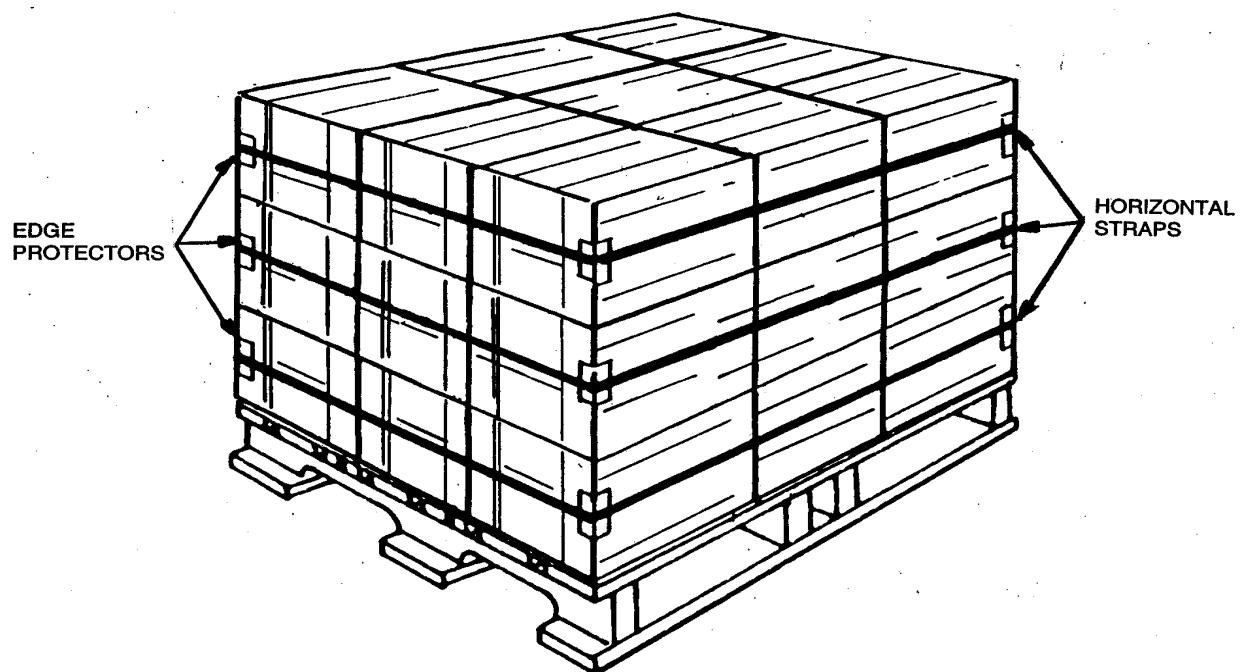


FIGURE 29. Bonding method C (each layer) (See 5.3.3.1).

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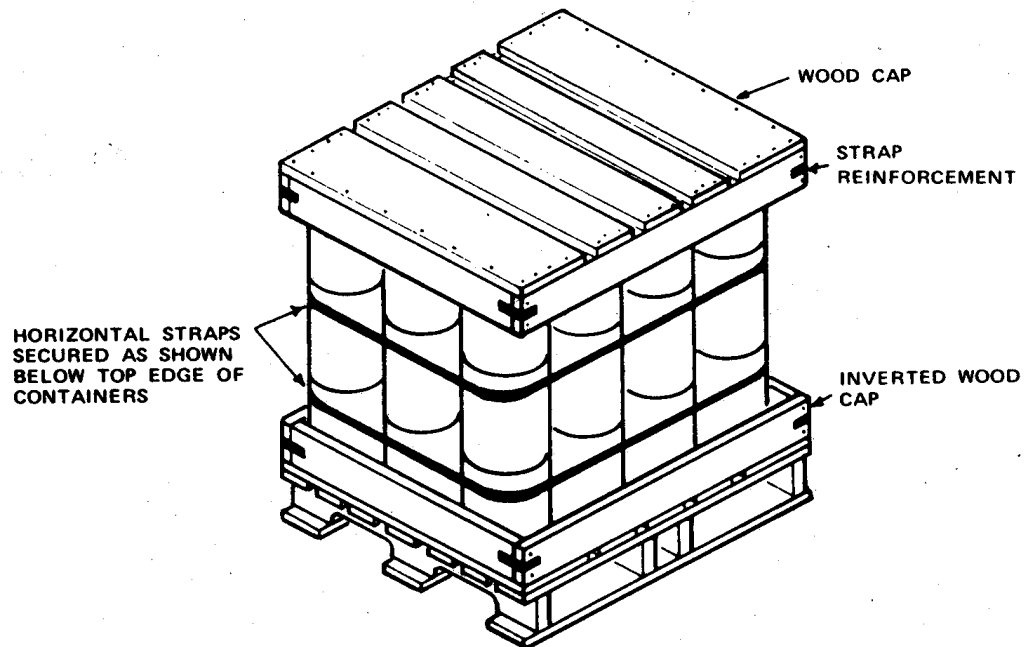


FIGURE 30. Bonding method C (each layer except top layer) (See 5.3.3.1).

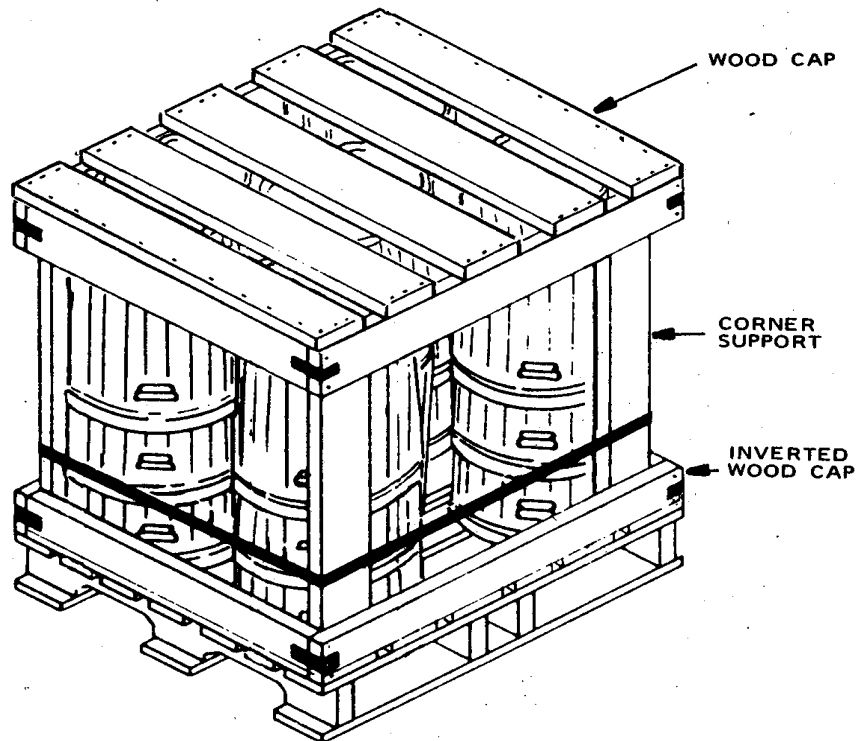


FIGURE 31. Bonding method C (bottom of framed load outside the frame) (See 5.3.3.1).

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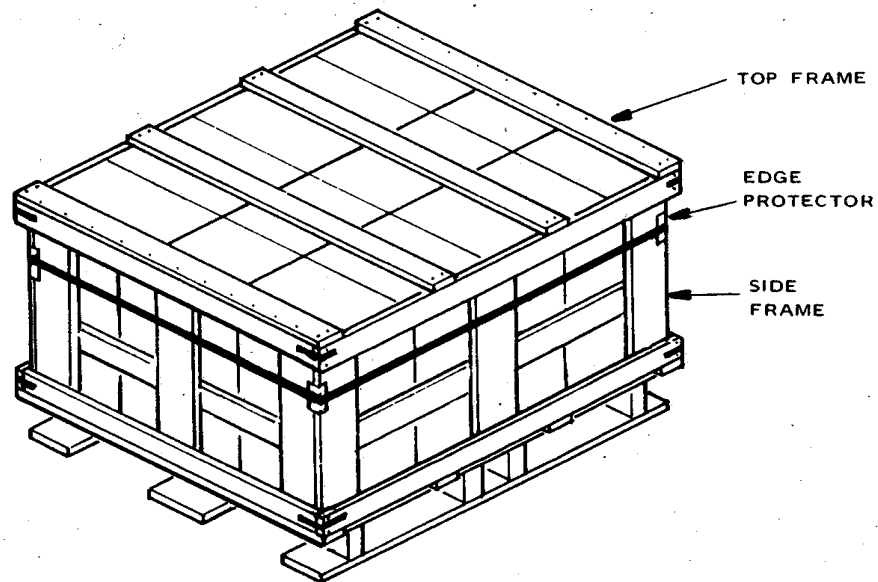


FIGURE 32. Bonding method C (top of a framed load outside the frame) (See 5.3.3.1).

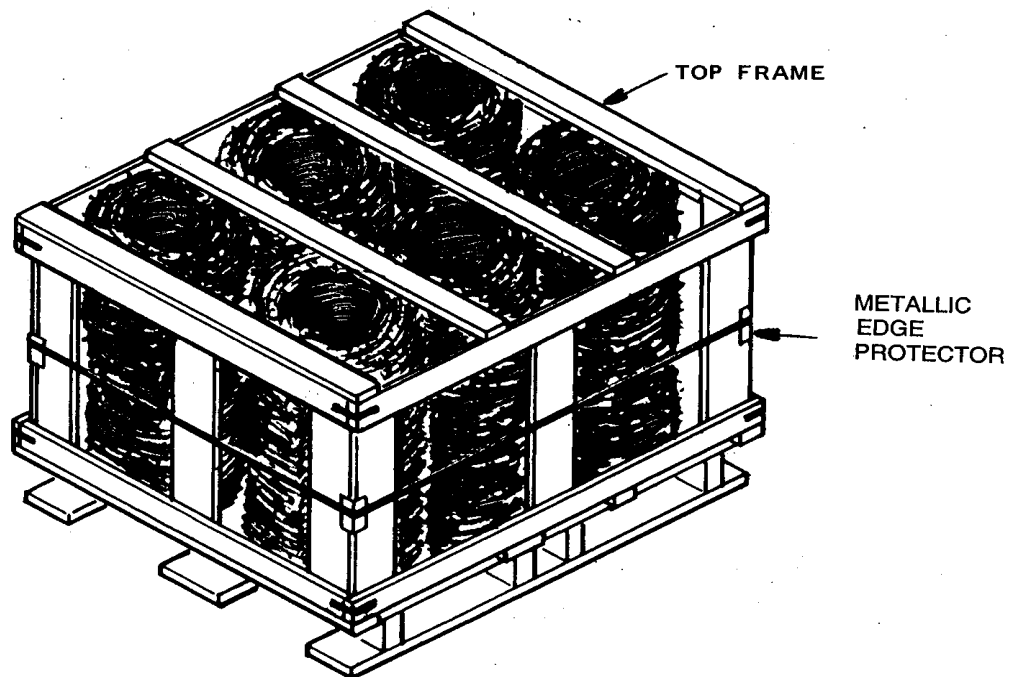


FIGURE 33. Bonding method C (center of a framed load outside the frame) (See 5.3.3.1 and 5.4.1).

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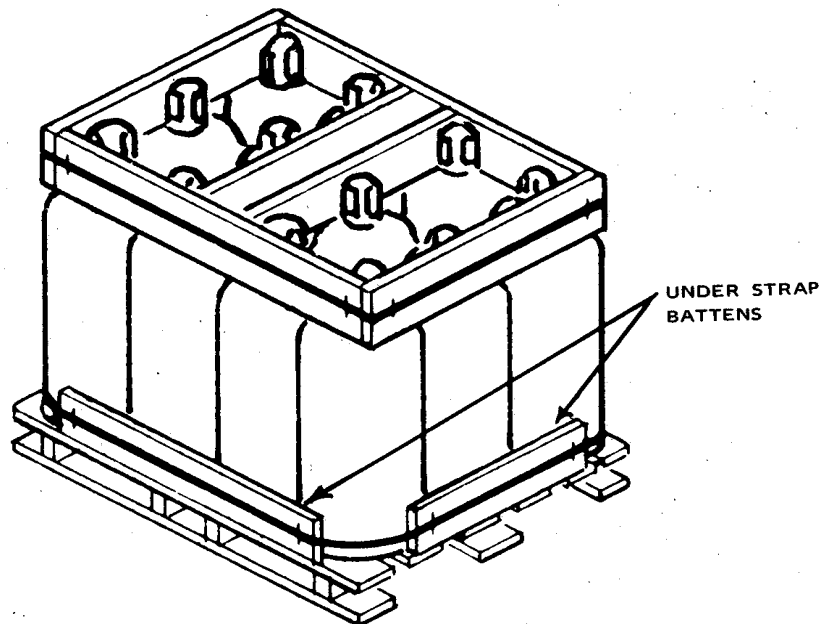


FIGURE 34. Bonding method C (one strap at bottom of a load of compressed gas cylinders outside the battens) (See 5.3.3.1).

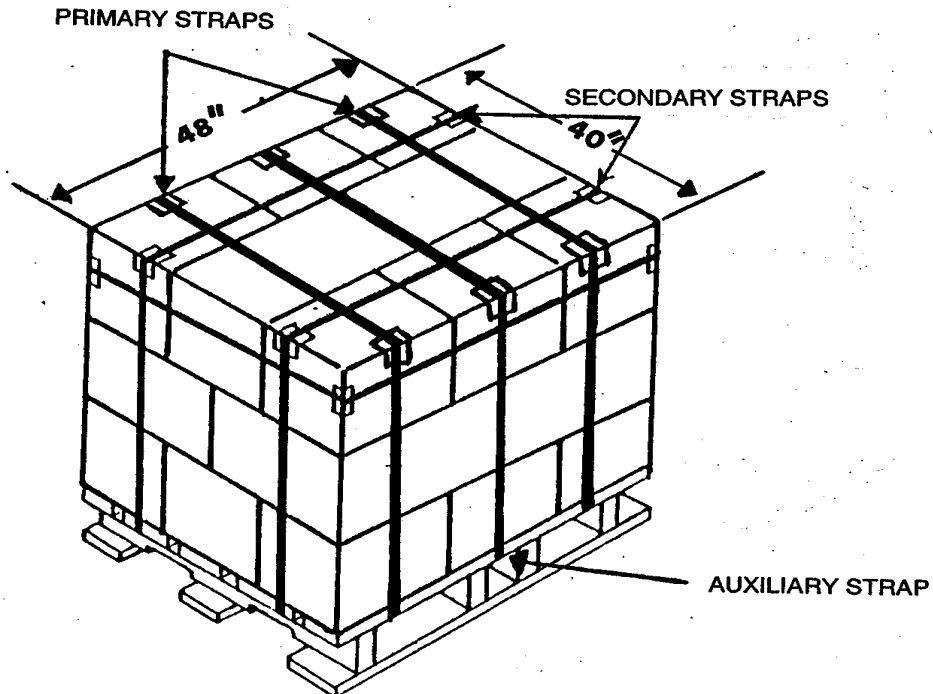


FIGURE 35. Bonding method D (tie-down straps) (See 5.3.3.2).

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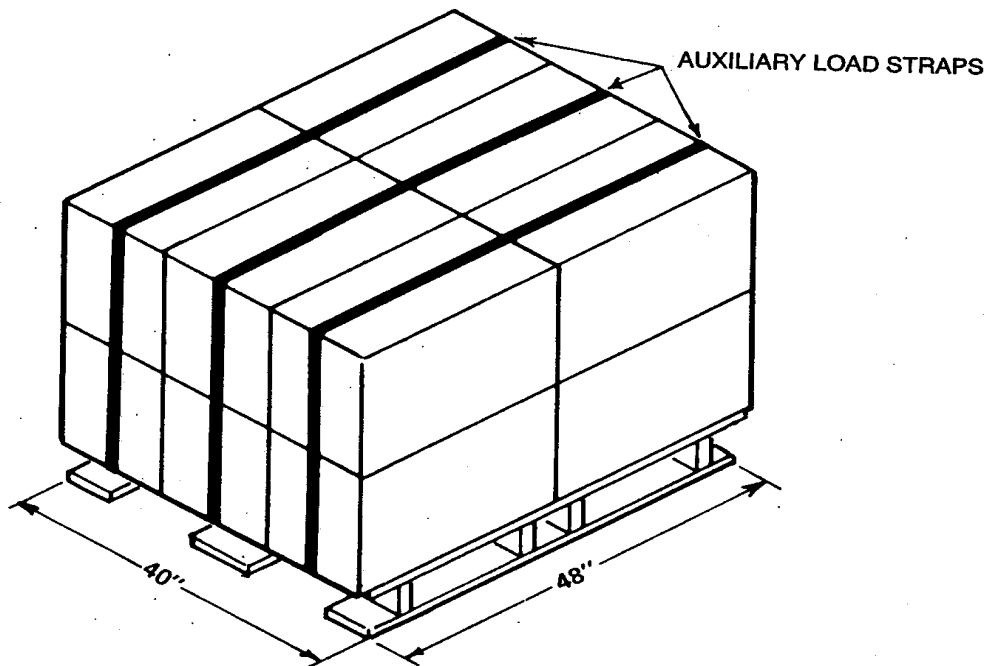


FIGURE 36. Bonding method E (auxiliary straps) (See 5.3.3.3).

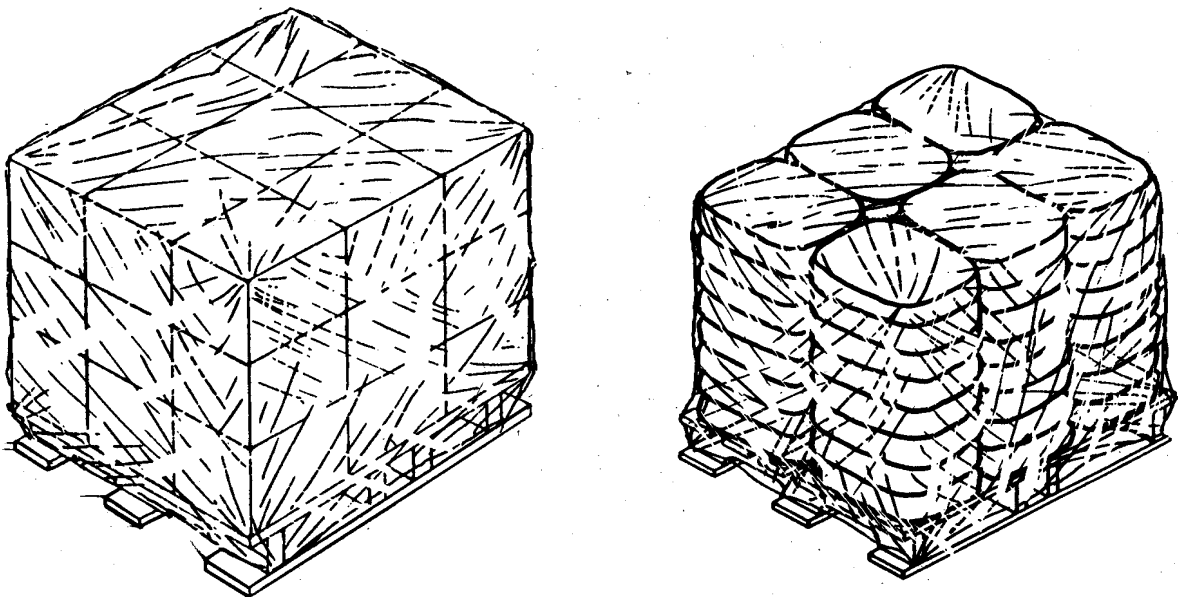


FIGURE 37. Bonding method F (shrink wrap) (See 5.3.4.1).

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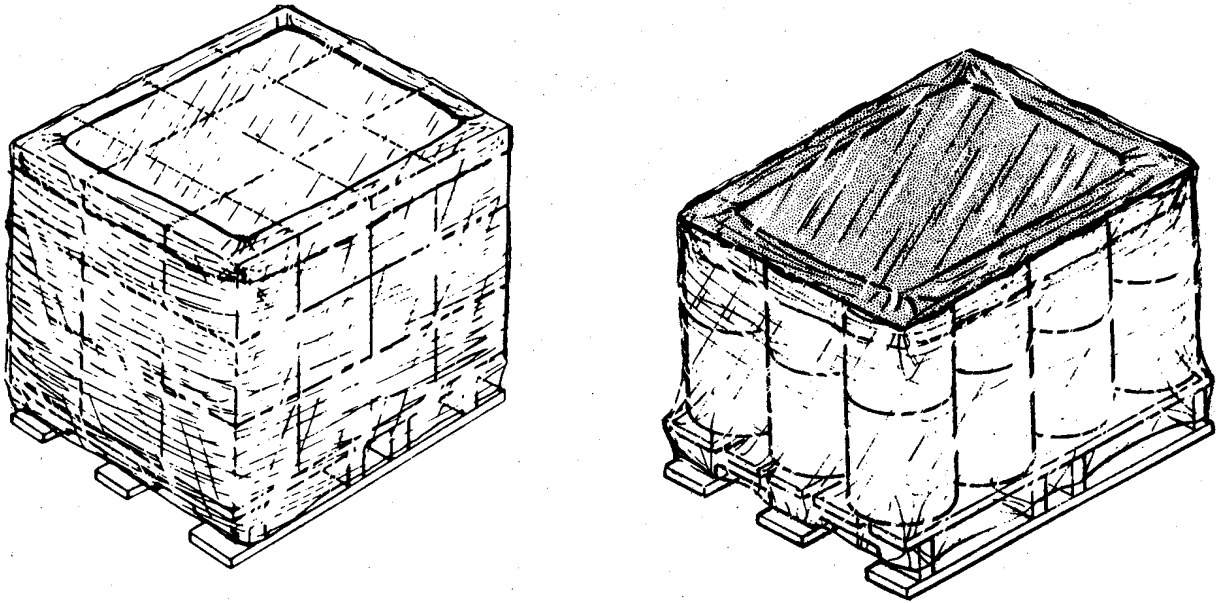


FIGURE 38. Bonding method G (stretch wrap) (See 5.3.4.2).

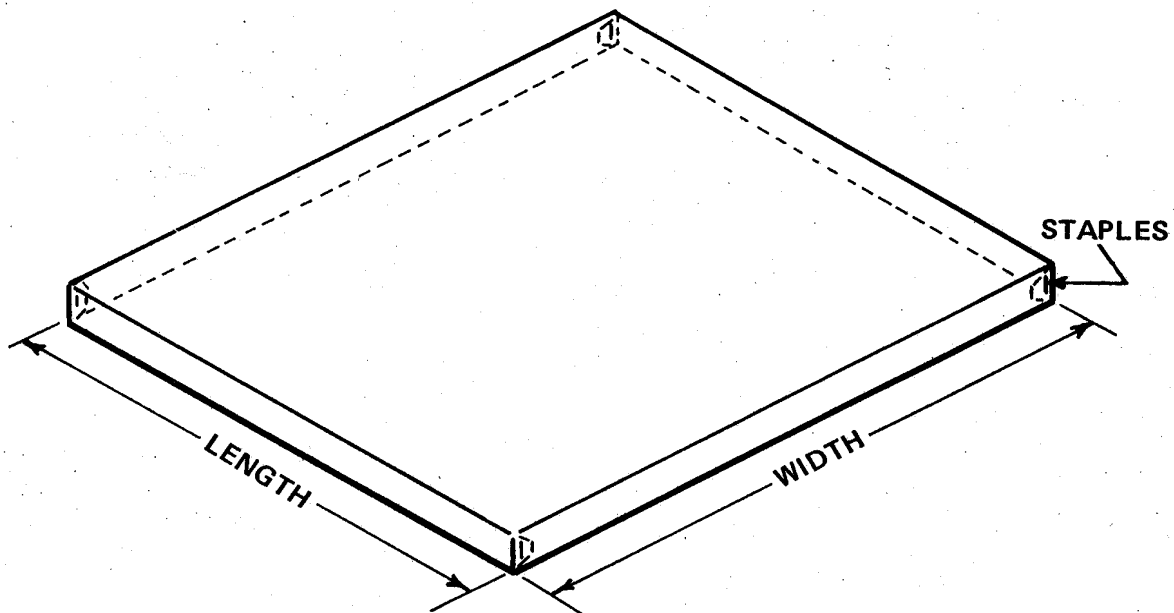


FIGURE 39. Fiberboard cap (one piece construction) (See 5.4.3.2).

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(OPEN CAP)

NOTE: WHEN THE DIMENSIONS OF THE UNIT LOAD ARE LESS THAN THE WOOD CAP, THE SPACE BETWEEN THE LOAD AND INSIDE OF THE WOOD CAP SHALL BE BLOCKED TO PREVENT SHIFTING OF THE LOAD.

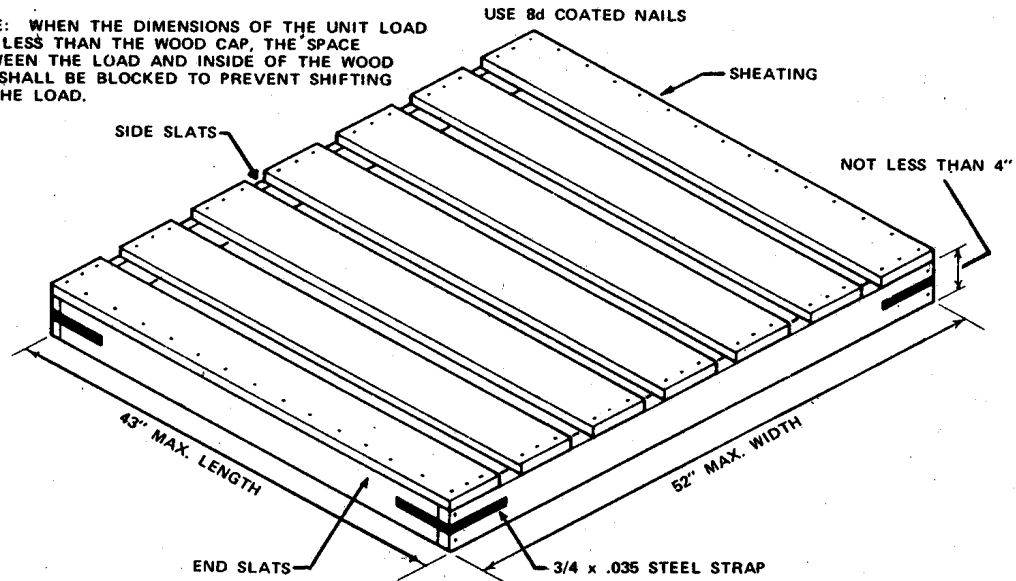
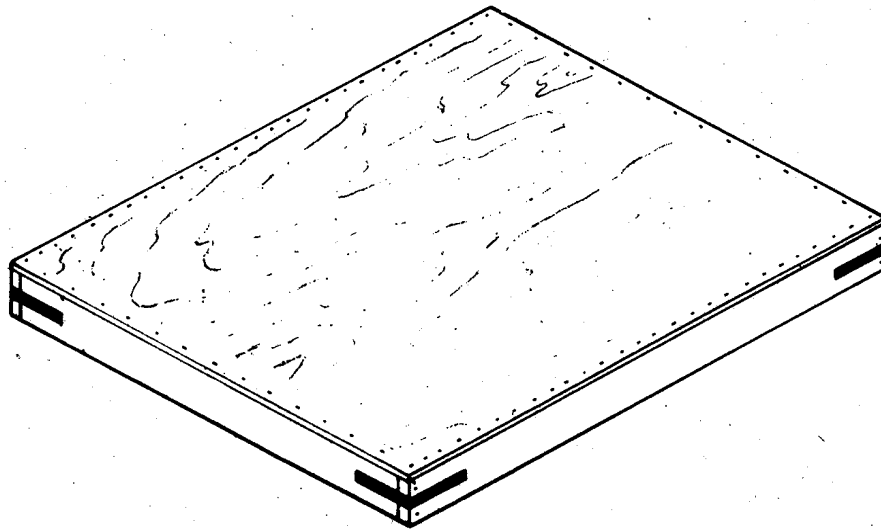
**(CLOSED CAP)**

FIGURE 40. Open and closed wood caps (See 5.4.3.3).

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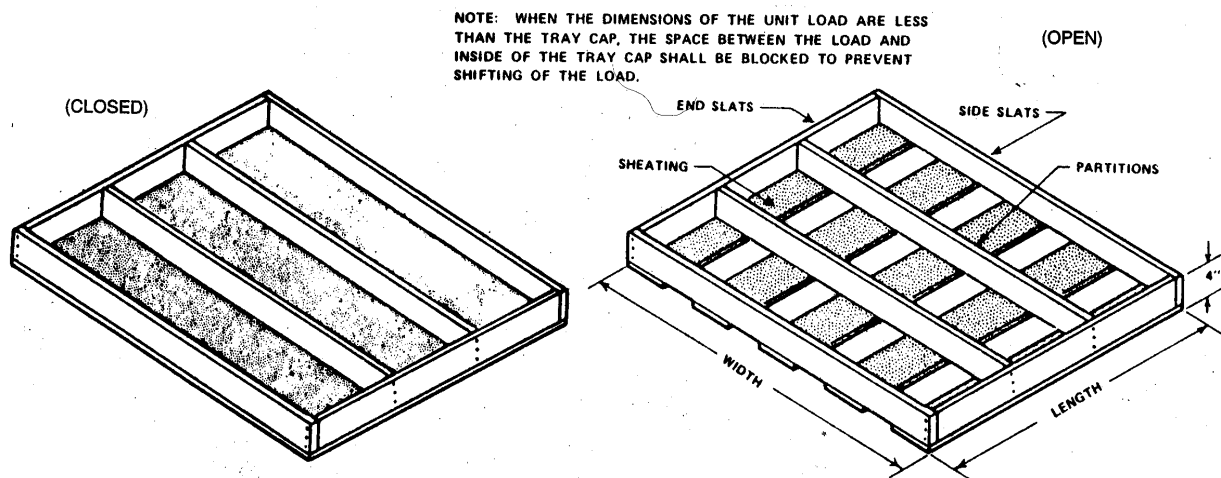


FIGURE 41. Open and closed tray caps (See 5.4.3.4).

NOTE: WHEN THE DIMENSIONS OF THE UNIT LOAD ARE LESS THAN THE DOUBLE TRAY CAP, THE SPACE BETWEEN THE LOAD AND INSIDE OF THE DOUBLE TRAY CAP SHALL BE BLOCKED TO PREVENT SHIFTING OF THE LOAD.

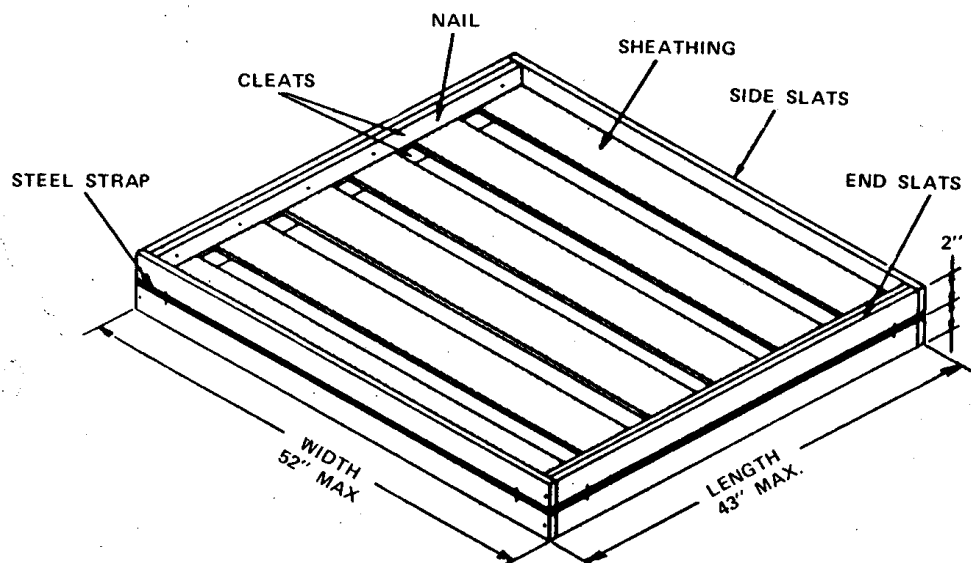


FIGURE 42. Double tray caps (See 5.4.3.5).

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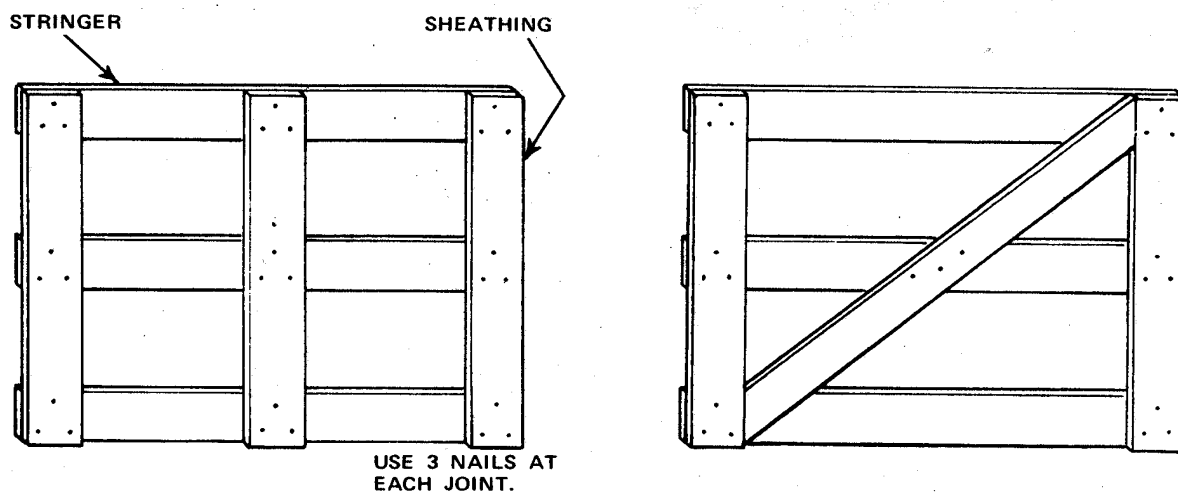


FIGURE 43. Top, side, or end frame (typical) (See 5.4.6).

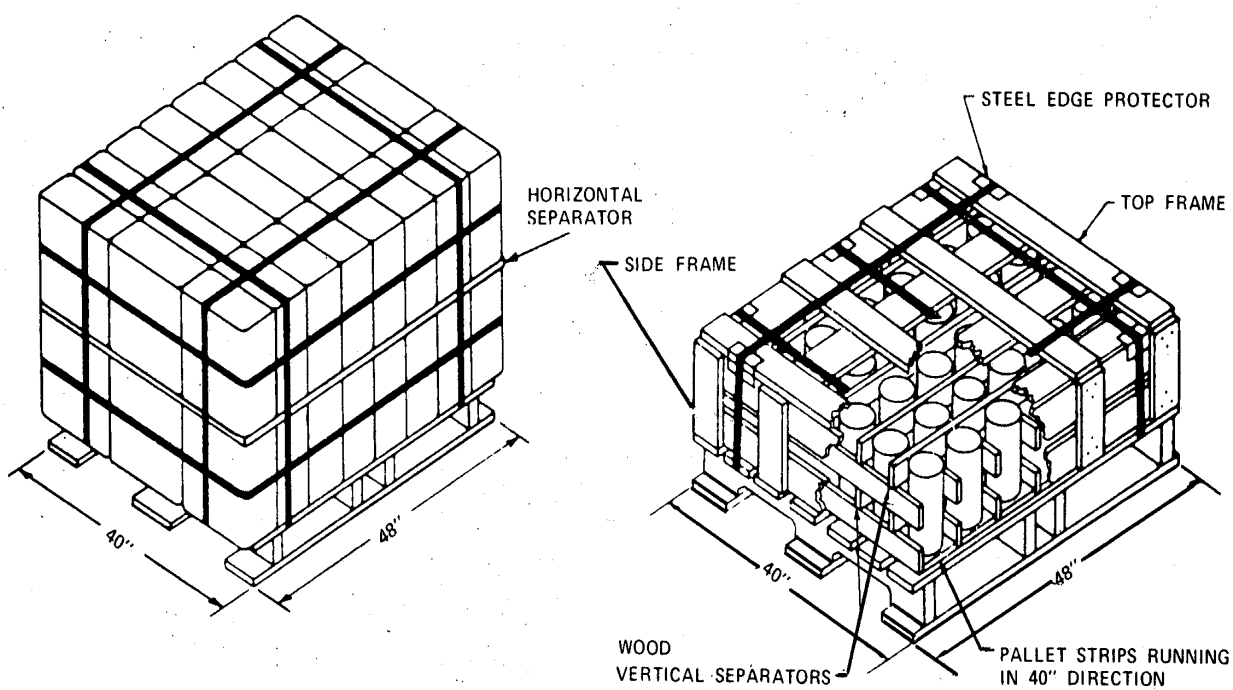


FIGURE 44. Horizontal separator
(fiberboard or wood).
(See 5.4.9.1 and 5.4.9.2).

FIGURE 45. Vertical wood separator.
(See 5.4.9.4).

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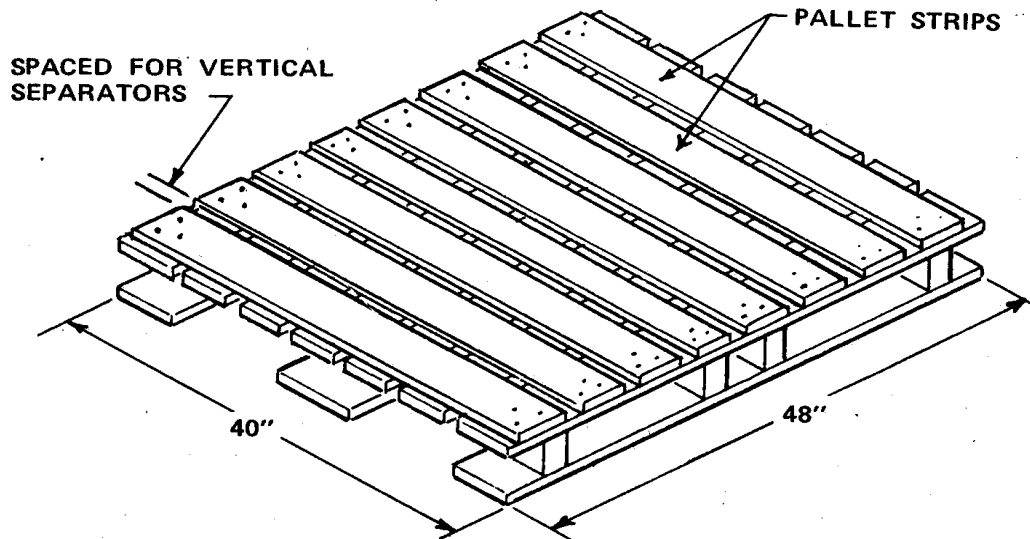


FIGURE 46. Pallet strips (See 5.4.10).

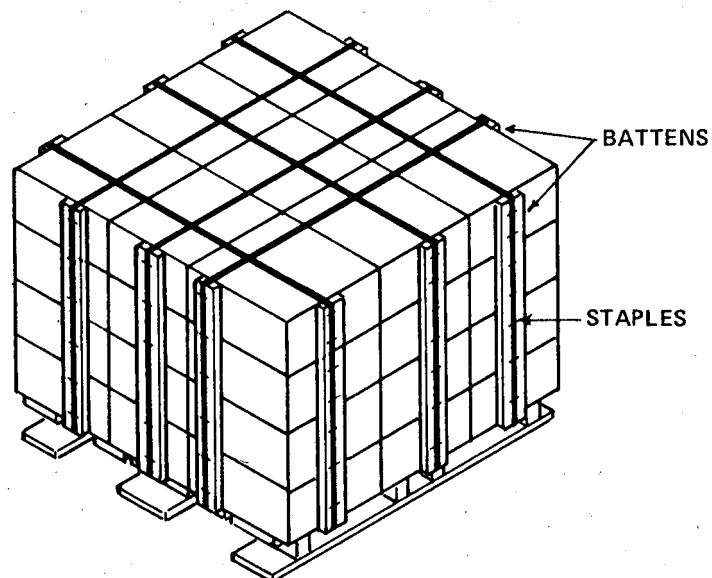


FIGURE 47. Cross-strap battens (See 5.4.11.1).

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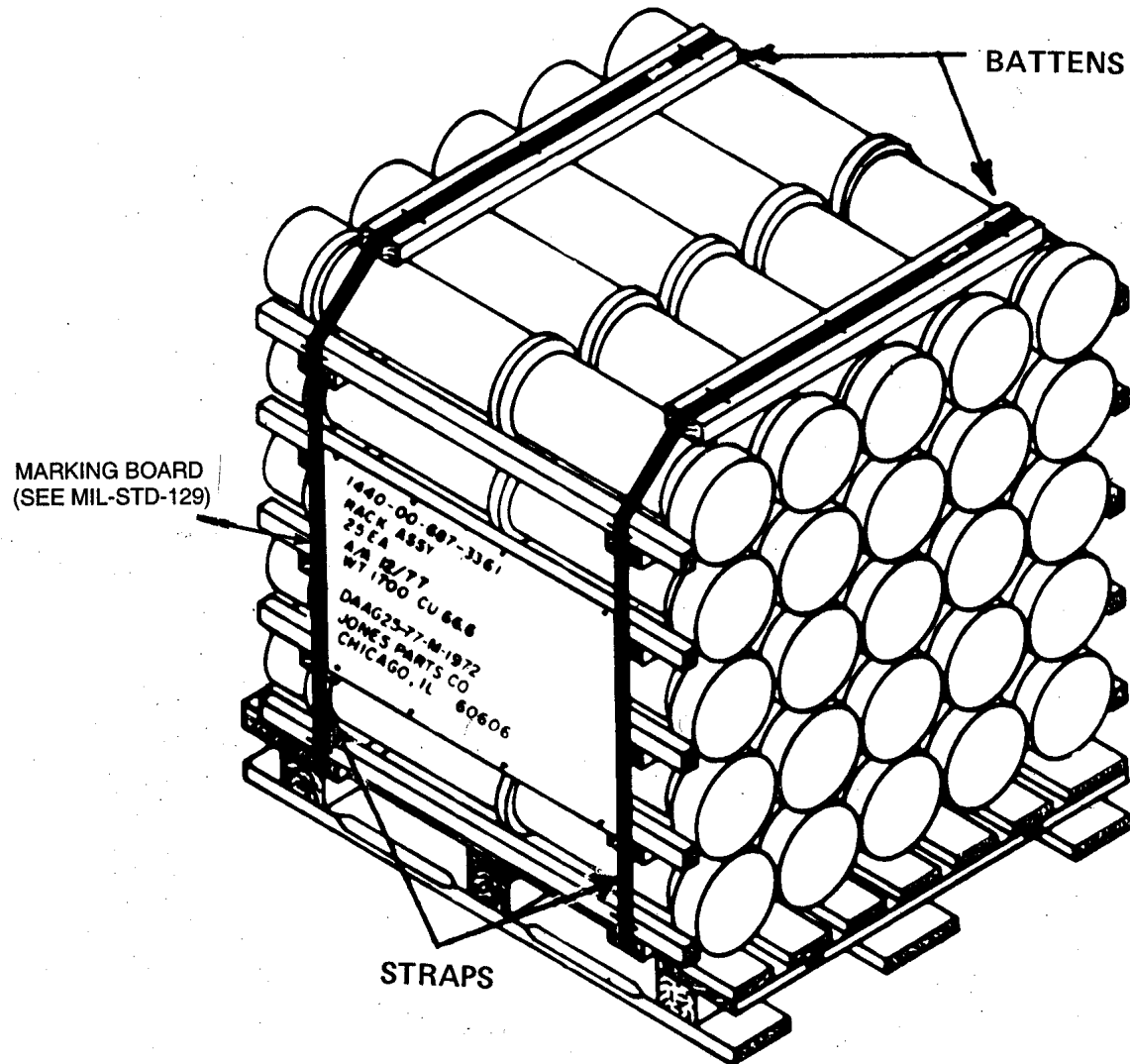


FIGURE 48. Battens under- or over-the-load (See 5.4.11.2).

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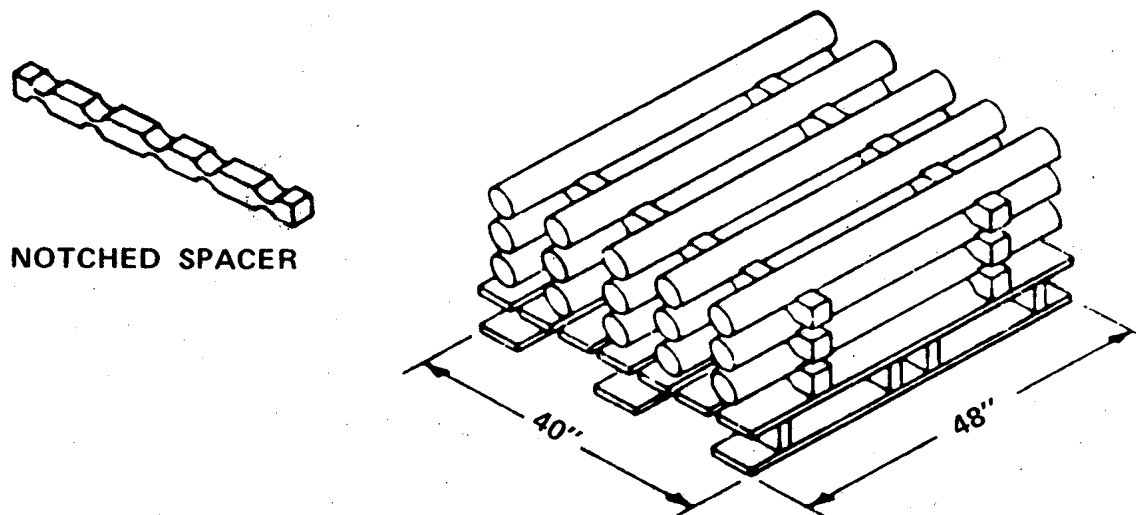


FIGURE 49. Notched spacers (See 5.4.13).

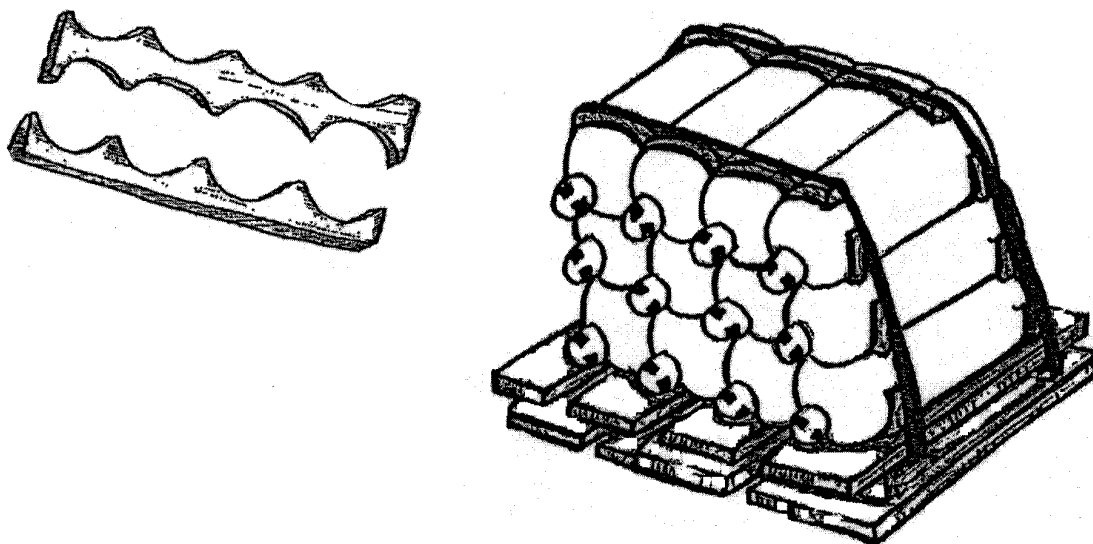


FIGURE 50. Notched spacers (See 5.4.13).

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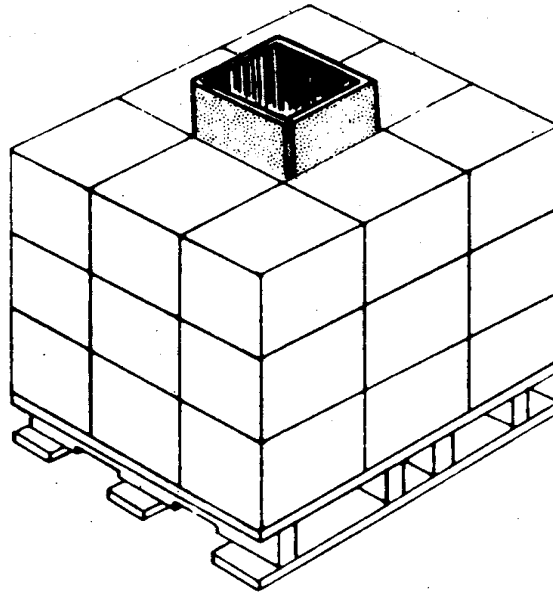


FIGURE 51. Chimney filler (See 5.4.16).

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APPENDIX A

CLASSIFICATION OF COMMODITIES OR UNITS BY LOAD TYPE (See 4.2.4)

A.1 SCOPE

A.1.1 Scope. The various load types, bonding methods, and storage aids associated with palletized unit loads are discussed in detail in section 5. When determining the bonding method(s) and storage aid(s) to be used with a specific load type, many variables associated with the physical characteristics of the commodities or units need to be considered. For most commodities or units, there are no right or wrong bonding methods or storage aids to be used. There are usually several combinations available which will provide the necessary unitized load protection. To assist in developing palletized unit loads, the load types, bonding methods, and storage aids are listed in this appendix. In addition, there is a list of commodities, units, and containers with their associated load types and recommended bonding methods and storage aids for use during palletization of the unit load.

A.2 LOAD TYPES, BONDING METHODS, AND STORAGE AIDS

A.2.1 Load types. Loads are grouped into load types for the designation of bonding methods and storage aids. The load types are:

- a. Load type I - Rectangular wood boxes, metal boxes, or other stable, hard surface units.
- b. Load type Ia - Fiberboard boxes stacked in single or multiple layers.
- c. Load type II - Rectangular bales or bundles.
- d. Load type III - Closed-head, top-nesting, cylindrical or rectangular cans, pails, or buckets utilizing wood caps.
- e. Load type IIIa - Same as load type III except that stretch wrap is used instead of wood caps.
- f. Load type IV - Cylindrical or rectangular cans or pails with removable covers (5-gal, filled, paint cans).
- g. Load type V - Nested, empty cans, pails, buckets, etc., and non-covered, internal nesting units.

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- h. Load type VI - Flat paper stock or printed matter and rolls of cloth or fabric requiring waterproof wrapping.
- i. Load type VII - Storage batteries, window lights, and similar units requiring separator supports.
- j. Load type VIII - Rectangular units with irregular surfaces requiring storage aids.
- k. Load type IX - Compressed gas cylinders (oxygen, or other gases).
- l. Load type X - Cellular load configurations requiring vertical separators.
- m. Load type XI - Reels, spools, coils, or rolls of wire, rope, and hose.
- n. Load type XII - Heavy, vertically nested kegs, casks, or small drums in a single layer requiring a wood cap over and under the load.
- o. Load type XIIa - Drums, kegs, or barrels on a 40- by 48-inch pallet, with an inverted tray and cap having internal dimensions of 41 inches by 46 inches.
- p. Load type XIIb - Drums, kegs, or barrels arranged vertically but without caps, suitable for shrink- or stretch-wrap bonding.
- q. Load type XIII - Cylindrical units such as rolls of wire and kegs and small drums stacked vertically in multiple layers.
- r. Load type XIV - Fiberboard nested packer.
- s. Load type XV - Bagged units (units packed in cloth bags, plain paper bags, or lined paper bags) arranged in inter-locking layers.
- t. Load type XVI - Sectional pallet box (units of great value or extreme fragility).
- u. Load type XVII - Unstable, small and odd-shaped units that require a framed load.
- v. Load type XVIII - Contents incapable of supporting loads and requiring a minimum framed pallet.

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A.2.2 Bonding methods. Bonding methods are used to secure units of material and a pallet together into a consolidated and stable load which itself can be handled as a unit. The number of bonding methods has been reduced from 15 to 7 by combining the 7 horizontal strap methods into 1 method (horizontal straps) and the 3 tie-down strap methods into 1 method (tie-down straps). These changes will permit more leeway when selecting the types of horizontal and tie-down straps to be placed on a palletized unit load. The bonding methods are:

- a. Bonding method A – Glue stripes.
- b. Bonding method B - Glued strips.
- c. Bonding method C - Horizontal straps. Horizontal straps may be placed around a load as follows: top layer or single layer, each layer, each layer except the top, bottom of a framed load outside the frame, top of a framed load outside the frame, center of a framed load outside the frame, and one strap at the bottom of a load of compressed cylinders outside the battens. The selection of horizontal straps will vary depending on the load type and physical characteristics of the units comprising the load.
- d. Bonding method D - Tie-down straps. There are three types of tie-down straps. Primary tie-down straps pass under the pallet deck in the 40-inch direction. Secondary tie-down straps pass under the pallet deck in the 48-inch direction. Auxiliary tie-down straps are placed on a load after the primary and secondary straps are applied.
- e. Bonding method E - Auxiliary load straps. They secure only the load because they pass under the load but not under the pallet deck.
- f. Bonding method F - Shrink wrap.
- g. Bonding method G - Stretch wrap.

A.2.3 Storage aids. Storage aids are always to be used when bonding alone is insufficient. They are constructed of paper, PE sheeting, canvas, fiberboard, wood, steel, or other materials. The storage aids are:

- a. Storage aid 1 - Metallic edge protector.
- b. Storage aid 2 - Nonmetallic edge protector.
- c. Storage aid 3 - Canvas cap.
- d. Storage aid 4 - Fiberboard cap.

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- e. Storage aid 5 - Wood cap.
- f. Storage aid 6 - Tray cap.
- g. Storage aid 7 - Double tray cap.
- h. Storage aid 8 - Canvas cover.
- i. Storage aid 9 - Waterproof wrapping.
- j. Storage aid 10 - Side frames.
- k. Storage aid 11 - Top frame.
- l. Storage aid 12 - End frame.
- m. Storage aid 13 - Frame supports.
- n. Storage aid 14 - Separator supports.
- o. Storage aid 15 - Horizontal fiberboard separator.
- p. Storage aid 16 - Horizontal wood separator.
- q. Storage aid 17 - Separator for nested container.
- r. Storage aid 18 - Vertical wood separator.
- s. Storage aid 19 - Pallet strips.
- t. Storage aid 20 - Cross-strap battens.
- u. Storage aid 21 - Under- or over-the-load battens.
- v. Storage aid 22 - Oxygen cylinder battens.
- w. Storage aid 23 - Gas cylinder battens.
- x. Storage aid 24 - Wood collar.

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- y. Storage aid 25 - Notched wood spacer.
- z. Storage aid 26 - Sectional pallet box.
- aa. Storage aid 27 - Nested packer.
- bb. Storage aid 28 - Chimney filler.
- cc. Storage aid 29 - Polyethylene sheeting, 1 mil.

A.3 CLASSIFICATION OF COMMODITIES AND CONTAINERS

A.3.1 List of commodities and containers. The following list of commodities or units and containers indicates the classification by load type and also denotes the preferred bonding methods and storage aids to be used with each commodity or unit. Various combinations of bonding methods and storage aids may be used with each palletized unit load predicated on such variables as the size and weight of the units comprising the load, the load type to be used, and the cost to palletize the load. Because of similarities among the load types, some commodities or units may qualify as more than one load type. Because of this, there are no right or wrong combinations. Each palletization effort must be evaluated on its own merit. Bonding methods and storage aids listed in parentheses are to be used to meet specific requirements. These requirements are explained in the paragraphs in section 5 for the specific bonding method or storage aid being considered.

a. Paragraphs 5.3.4.1 and 5.3.4.2 describe bonding methods F (shrink wrap) and G (stretch wrap), respectively. When shrink-wrap bonding is selected, other methods of bonding do not apply. When stretch-wrap bonding is selected, other methods of bonding are not necessary but may be used such as over-the-load straps to bond a unitized load to the pallet.

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Commodity or unit	Load type	Bonding methods	Storage aids
<u>Accessories:</u>			
In cartons, without cleats, staples or straps	I, Ia	A, C, D, F, G	1, 2, (28), (29)
In other cartons or wood wood boxes	I, Ia	B, C, D, F, G	(1), 2, (28), (29)
In small containers	XVII	C, D, F, G	1, 2, 10, (11), 13
In unstable containers	XVII	C, D	1, 2, (5), 10
Unboxed, stacked horizontally, tubes, axles, pipes (long narrow items), miscellaneous items	XVII	(C)	1, 5, 10, (25)
<u>Air hose on spools or reels:</u>			
	XI	C, D	(21)
<u>Batteries, storage, single layer:</u>			
In substantial wood boxes	I	C, D, (E)	(1)
Units not over 11" high	VII	D	(5), (14)
Units over 11" high	VII	(C), D, (E)	(5), (10), (12), (14)
<u>Batteries, packaged dry storage, storage, multiple layers:</u>			
	I	(C), D, (E)	1, 2, (5), (28)
<u>Boxes, fiberboard:</u>			
Without cleats, staples or straps	I, Ia	A, C, D, F, G	1, 2, (28), (29)
<u>Boxes, multiple-layer loads:</u>			
Metal, lightweight	VIII	C, D	(1), (4), 15, (28)
Metal, medium, heavy and extra heavy weight, with nonlevel tops or bottoms	VIII	D	(5), (7)
Metal, medium thru extra heavy weight, with level tops and bottoms	VIII	C, D	(20), (21), (28)
Wood (except containing storage batteries or small glass window lights)	I	B, C, D	(28)
Wood or metal, small size	XVII	(C), D	1, 10, (11)
Wood or metal, unstable	XVII	C, D	1, (5), 10, 13, (16)

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Commodity or unit	Load type	Bonding methods	Storage aids
<u>Cargo net (not boxes):</u>	XVII	(C), D	1, 2, (5), 10
<u>Cartons, fiberboard:</u>			
Without cleats, staples or straps (see boxes, fiberboard)	I, Ia	A, C, D, F, G	1, 2, (28), (29)
<u>Cartons (other):</u>			
Fire extinguishers, portable	XVII	(C), D	1, 2, (5), 10, (16)
Cartons, without cleats, staples, or straps	I, Ia	A, (C), (D), F	1, 2, (28), (29)
Other waterproof cartons or wood boxes	I, Ia	B, (C), (D)	(1), 2, (28), (29)
Packed any method (not waterproof)	VI	C, D	1, 2, (5), 9, 10
<u>Coils:</u>			
Jute, in coils, unboxed	XI	C, (D)	(5), (11), (21)
Rope, large coils	XI	C, (D)	(5), (11), (21)
Rope, small coils	XI	C, (D)	(5), (11), (21)
Rope, stable coils	XI	C, (D)	(5), (11), (21)
Rope, unstable coils	XVII	(C), D	1, (5), 10
Wire rope, unboxed (not on reels)	XVII	(C), D	1, (5), 10
Wire (not wire rope) not reeled, unboxed	XVII	(C), D	1, (5), 10
<u>Cylinders:</u>			
Stacked horizontally in a load:			
Gas or liquid	XVII	(C), D	(21), 23, 24
Stacked vertically in a load:			
Carbon dioxide, small	XVII	(C), (D)	1, (5), 10
Compressed gas:			
Oxygen	IX	C, (D)	(21), 23, 24
Miscellaneous gases	IX	C, (D)	(21), 23, 24
Cylinders not over 20" long, multiple layers	XVII	(C), D	1, 10, 11, 13, (16)
Other cylinders	XVII	(C), D	1, (5), 10, (25)

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Commodity or unit	Load type	Bonding methods	Storage aids
<u>Drums, filled:</u>			
(Usually 30-gal size or less, excluding 55-gal size):			
Metal or nonmetal, non-tapered, without bilges, single layer	XII, XIIa, XIIb	D, F, (G)	1, 2, (5), (15), (29)
Metal or nonmetal, tapered or with bilges, single layer	XII, XIIa, XIIb	D, F, (G)	1, 2, (5), (15), (29)
Metal or nonmetal, multiple layers	XIII	D, F, G	1, 2, (5), (7)
<u>Drums or barrels, 55-gal size, filled or empty:</u>	XIIa, XIIb	C, (D), (F)	1, 2, (5)
<u>Fiberboard sheets, noncontained:</u>	VIII	C, D	1, 2, (10), (11)
<u>Gas, compressed (stacked horizontally):</u>			
Other (in cylinders not exceeding load limits or not restricted to vertical placement)	XVII	(C), D	1, (5), 10, (25)
<u>Hose:</u>			
In cartons without cleats, staples, or straps	I	A, C, D	1, 2, (28)
In unstable cartons or boxes	XVII	(C), D	1, 2, (5), 10
In wood boxes or cartons with cleats, staples, or straps	I	B, C, D	(1), (28)
Unboxed, on reels or spools	XI	C, (D)	(5), (11), (21)
<u>Items of great value:</u>	XVI	D	(15), (17), 26
<u>Kerosene in rectangular cans, cans, unboxed:</u>	VIII	C, D	(15), (20), (21)

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Commodity or unit	Load type	Bonding methods	Storage aids
<u>Liquids or semi liquids:</u>			
(In contained, cylindrical cans or pails):			
Multiple layers, non-top nesting	XIII	D	(5), (7)
Single layer, nontapered	XVI	C, D	5, (15)
Single layer, tapered	XIII	D	(5), (7)
Small size, unboxed	XVII	(C), D	1, 2, 10, (11), 13, (16)
Pails, 5-gal paint type, removable cover	IV	D	6
<u>Pails:</u>			
Cartons with cleats, staples, or straps, or in wood boxes (not crates)	I	B, (C), D	(1), (2), (28), (29)
Cartons without cleats, staples, or straps	I	A, (C), D	1, 2, (28), (29)
5-gal paint type, removable cover	IV	D	(6)
Multiple layers, non-top nesting	XIII	D	(5), (7)
<u>Printed matter (books), pamphlets, other paper products):</u>			
In cartons or wood boxes with inner waterproof protection:			
Cartons with cleats, staples, or straps, or in wood boxes	I, Ia	B, (C), (D), F	(1), (2), (28), (29)
Cartons, without cleats, staples, or straps	I, Ia	A, (C), (D), F	1, 2, (28), (29)
Packed any method, not waterproof	VI	(C), D	1, 2, (5), 9, (10)

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Commodity or unit	Load type	Bonding methods	Storage aids
<u>Provisions in bags:</u>			
Cloth, liable to damage by strapping	XV	C, (D), F, G	(1), 2, 8, (21), (29)
Cloth, other	XV	C, D	(1), 2, 8, 21
Paper, lined, compactable	XV	(A), C, (D), F, G	(1), 2, 8, (21), (29)
Paper, plain (unlined)	XV	C, (D), F, G	(1), 2, 8, (21), (29)
<u>Provisions in cartons:</u>			
In wood boxes	I	B, C, D	(1), (28)
Other boxes	I, Ia	B, C, D, F	(1), 2, (28)
Without cleats, staples, or straps	I, Ia	A, C, D, F	(1), 2, (28)
<u>Reels or rolls of:</u>			
Barbed wire, large	XI	C, (D)	(5), (11), (21)
Barbed wire, small	XI	C, (D)	(5), (11), (21)
Electrical wire or cable	XI	C, (D)	(5), (11), (21)
Seizing wire	XI	C, (D)	(5), (11), (21)
Wire rope	XI	C, (D)	(5), (11), (21)
<u>Spare parts or tools:</u>			
In cartons with cleats, staples, or straps, or in wood boxes (not crates)	I, Ia	B, C, D, F	(1), (2), (28)
In cartons without cleats, staples, or straps	I, Ia	A, C, D, F, G	1, 2, (28), (29)
In metal boxes (spare parts or tools):			
Lightweight	VIII	C, D	1, 4, 15, (28)
Multiple layers, medium, heavy, and extra heavy weight, with nonlevel tops and bottoms	VIII	D	(5), (7)
Multiple layers, medium thru extra heavy weight, with level tops and bottoms	VIII	C, D	(20), (21), (28)

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Commodity unit	Load type	Bonding methods	Storage aids
Not boxed, cylindrical or long and narrow	XVII	(C), D	1, (5), 10, 25
Not boxed, large, odd-shaped	XVII	(C), D	1, (5), 10, (16)
Single layer, nontapered	I	C, D	1, 2, (28)
Single layer, tapered	XVII	D	(5), (7)
Small sized	XVII	(C), D	1, 10, (11), 13, (16)
Unstable containers (spare parts or tools)	XVII	(C), D	1, (5), 10

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APPENDIX B

LOAD PATTERN SELECTION (See 5.1)

B.1 SCOPE

B.1.1 Scope. Shipping containers in each palletized unit load are to be uniformly arranged in a load pattern as determined by table B-I, pages 77 through 79, and shown in figure B-1, pages 80 through 84. When the size of the individual shipping container does not fit any of the load patterns of table B-1, the proposed load pattern or request to use a different size pallet is to be submitted to the contracting officer for approval. This is only required when the contract calls for palletizing in accordance with MIL-HDBK 774; otherwise, this type deviation would not be in violation of MIL-HDBK 774 requirements.

B.2 DETERMINATION OF LOAD PATTERN

B.2.1 Use of table B-I. The following steps are to be followed when using table B-I:

- a. Determine the length and width of the individual shipping container. For fractions, round up to the nearest half inch.
- b. Locate the length of the container at the top of the table and the width of the container at the left side of the table. The container pattern number is to be found at the intersection of the two columns. Height may be substituted for width or length when the containers are of sufficient strength to withstand superimposed loads, and where such placement will cause no adverse effect in the shipment or storage of the materiel.
- c. Where no pattern is listed, the area efficiency is below 80 percent and palletization cannot be accomplished by these methods (see section 5).

B.2.2 Use of figure B-1. After determining the container pattern number from table B-I, the corresponding load pattern may be found in figure B-1. This load pattern will be used when constructing the palletized unit load. Void spaces, marked by dark areas, should be filled with dunnage or with a storage aid such as a chimney filler.

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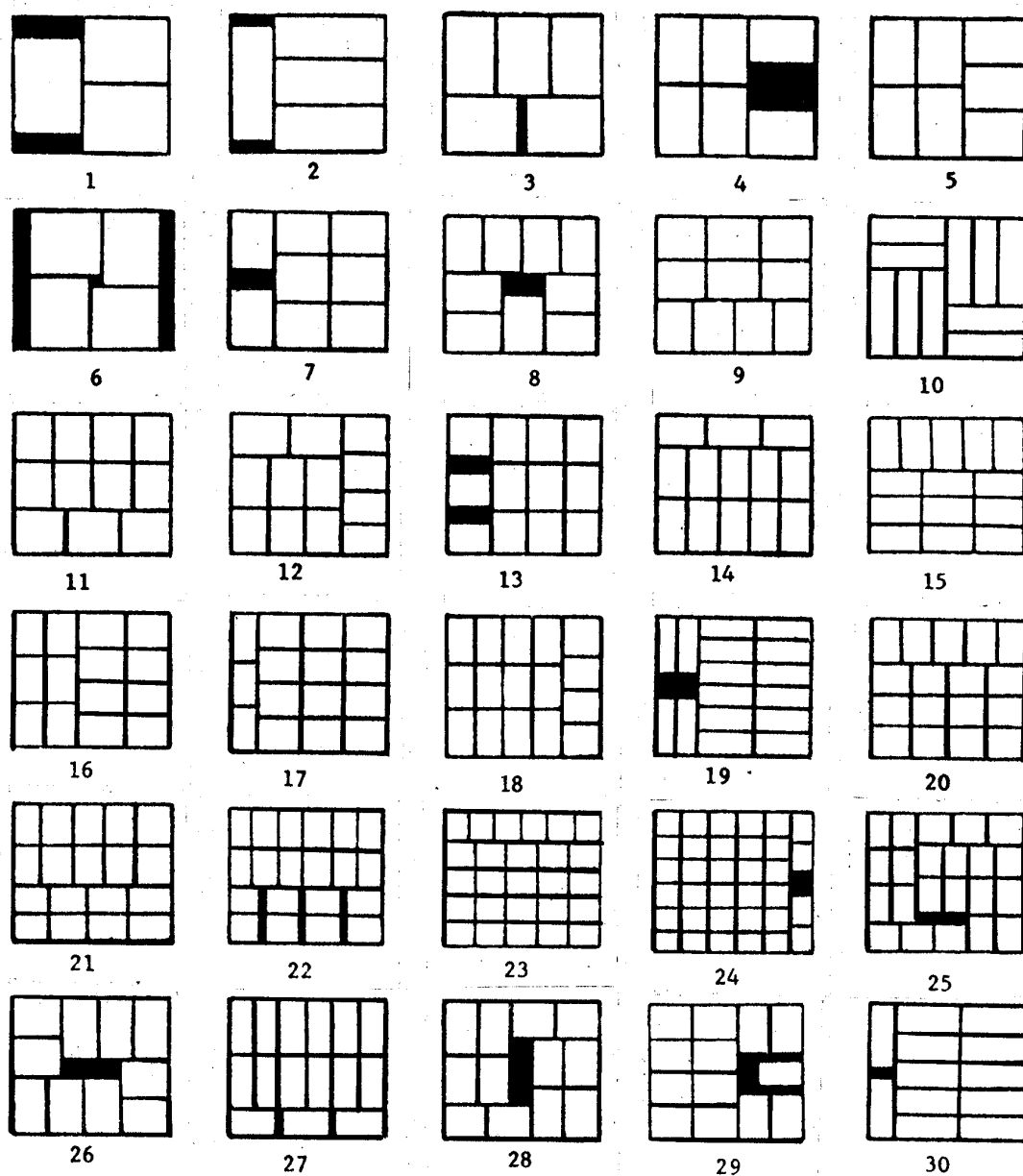
APPENDIX B

TABLE B-I. Load pattern determination.

INCHES IN LENGTH

INCHES IN WIDTH

	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	12½	13	13½	14	14½	15	15½	16	16½	17	17½	18	18½	19	19½	20	20½	21	21½		
6	122	122	118	115	115	115	71	77	111	120		65	65	60	106	106	46	45	45	62	100	100	100	78	78	78	78	78	76	76	76	76		
6½		121	121	67	67	67	24	61	61	120	65	65	38	63	63	75	75	62	62	58	58	58	58	47	47	19	19	119	42	42	42	42		
7				117	66	59	114	24	110	110	116	49	49	49	105	75	75	39	99	99	99	99	99	19	19	19	19	42	42	42	42	42		
7½						113	113	64	64	64	74	25	25	57	57	57	73	73	73				27	27	27	77	77	77	72	72	72	72	72	
8						113	113	64	64	23	74	25	25	22	22	22	44	44		27	27	27	27	27	77	77	72	72	72	72	30	30	30	
8½							113	74	74	109	112	25	25	22	22	22	44	44	27	27	27	27	27	98	72	72	30	30	30	30	30	30	30	
9									108	108	48	21	21	21	21	20	18	18	15	15	15	15	14	97						26	26	26	26	
9½										108	108	48	21	20	20	20	18	18	14	14	14	14	14	97				26	26	26	26	26	26	
10											108	21	21	20	20	17	17	17	14	14	14	14	14	97			26	26	26	26	26	26	36	
10½												104	104	104	104	104	17	16	29	29	12	12	97	97	26	26	26	26	26	26	26	26	82	
11																	28	28	28	11	11	9	9	26	26	26	26	26	8	8	8	102	102	
11½																	28	28	28	11	11	9	9	26	8	8	8	8	8	8	102	102	102	
12																	28	28	28	13	11	11	9	9	9	8	8	8	8	7	7	102	102	102
12½																	28	28	13	11	11	9	9	9	9	8	7	7	7	7	102	102	102	
13																13	103	103	11	11	9	9	9	9	7	7	7	7	7	7	102	102	102	102
13½																			37	37	37	96	96	7	7	7	7	7	5	5	5	5	5	
14																		37	37	91	91	91	91	7	7	7	7	5	5	5	5	5	5	
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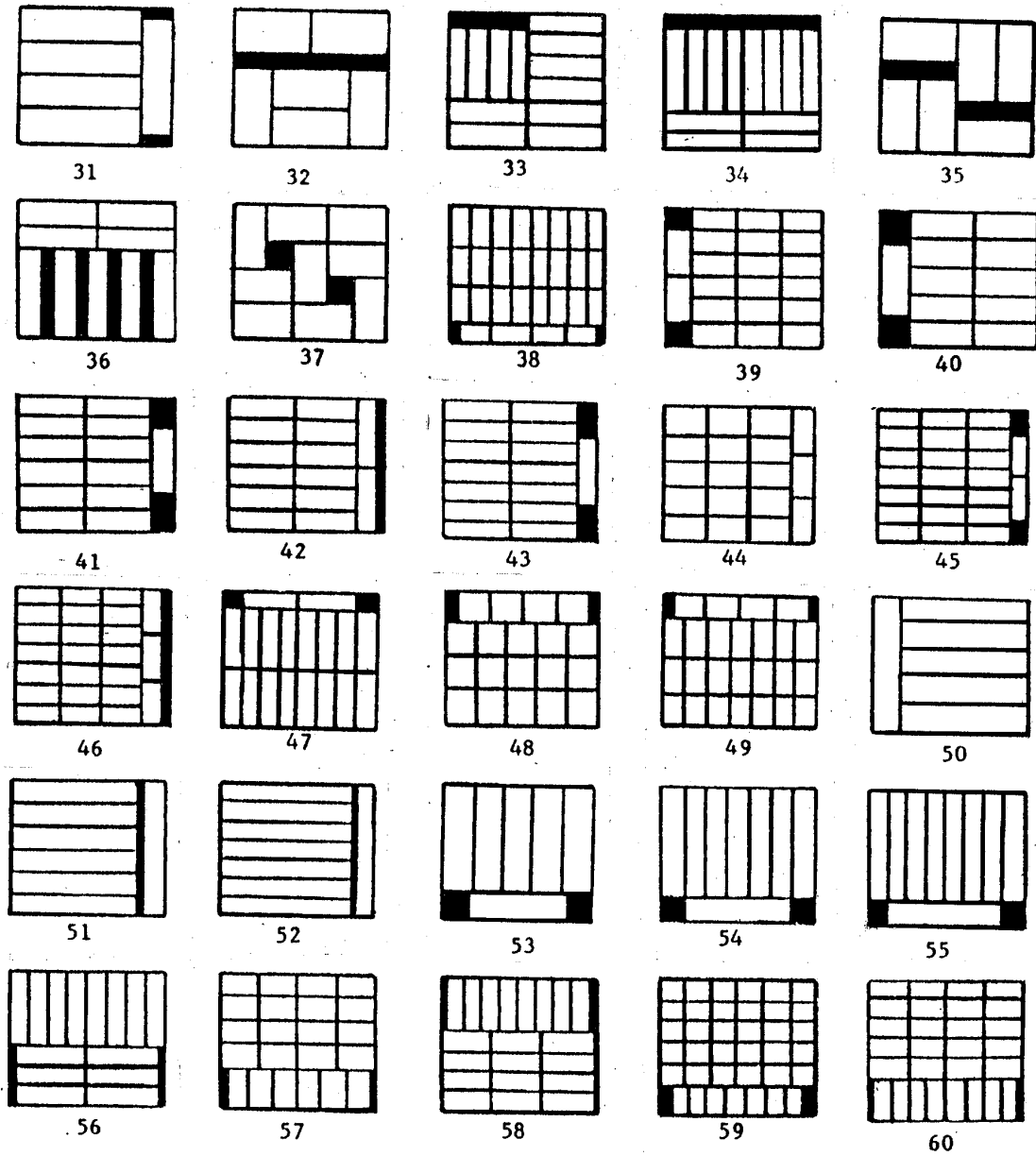


FIGURE B-1. Load patterns on 40'' by 48'' pallets (See A.2.2) (Continued).

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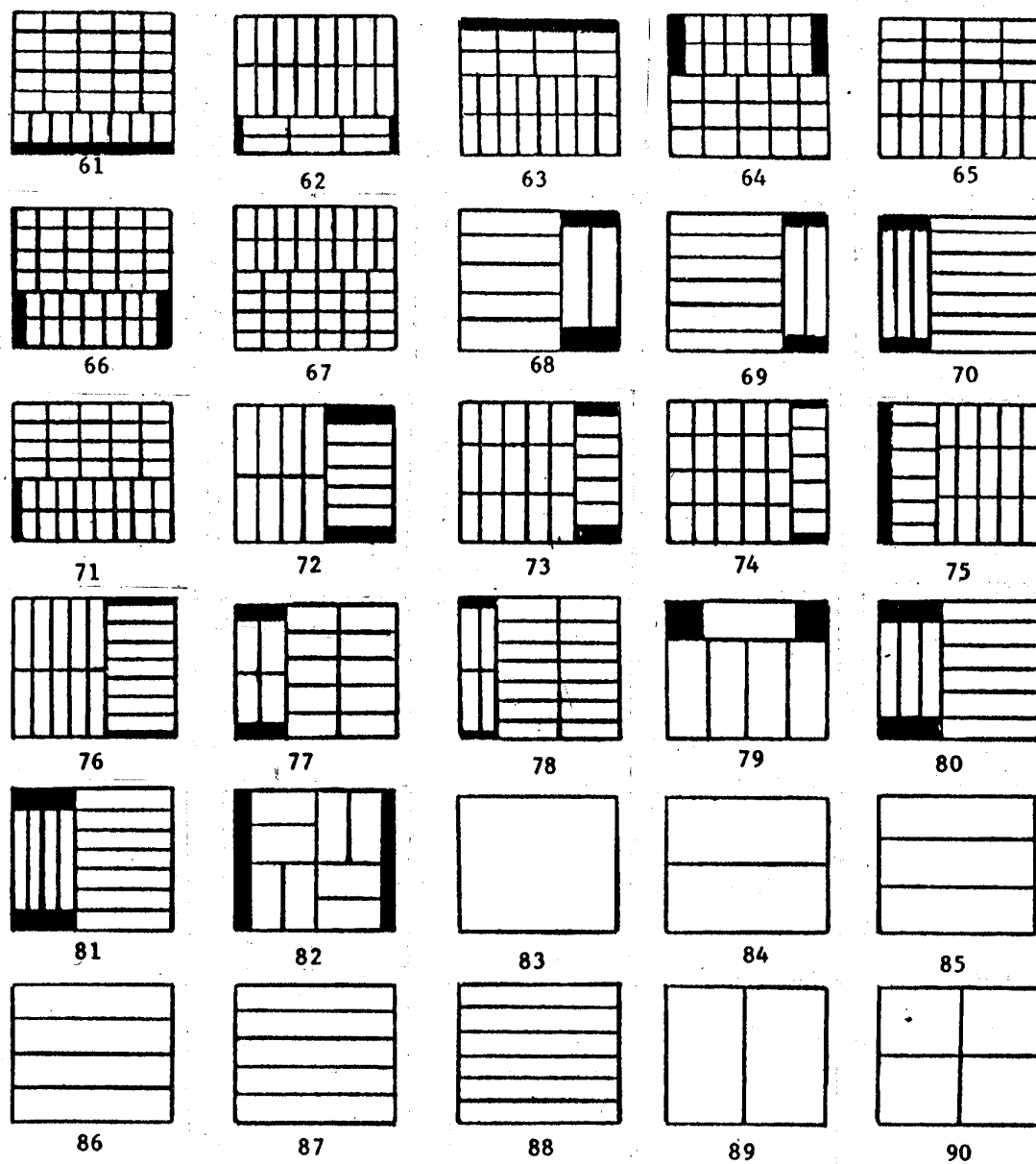


FIGURE B-1. Load patterns on 40'' by 48'' pallets (See A.2.2) (Continued).

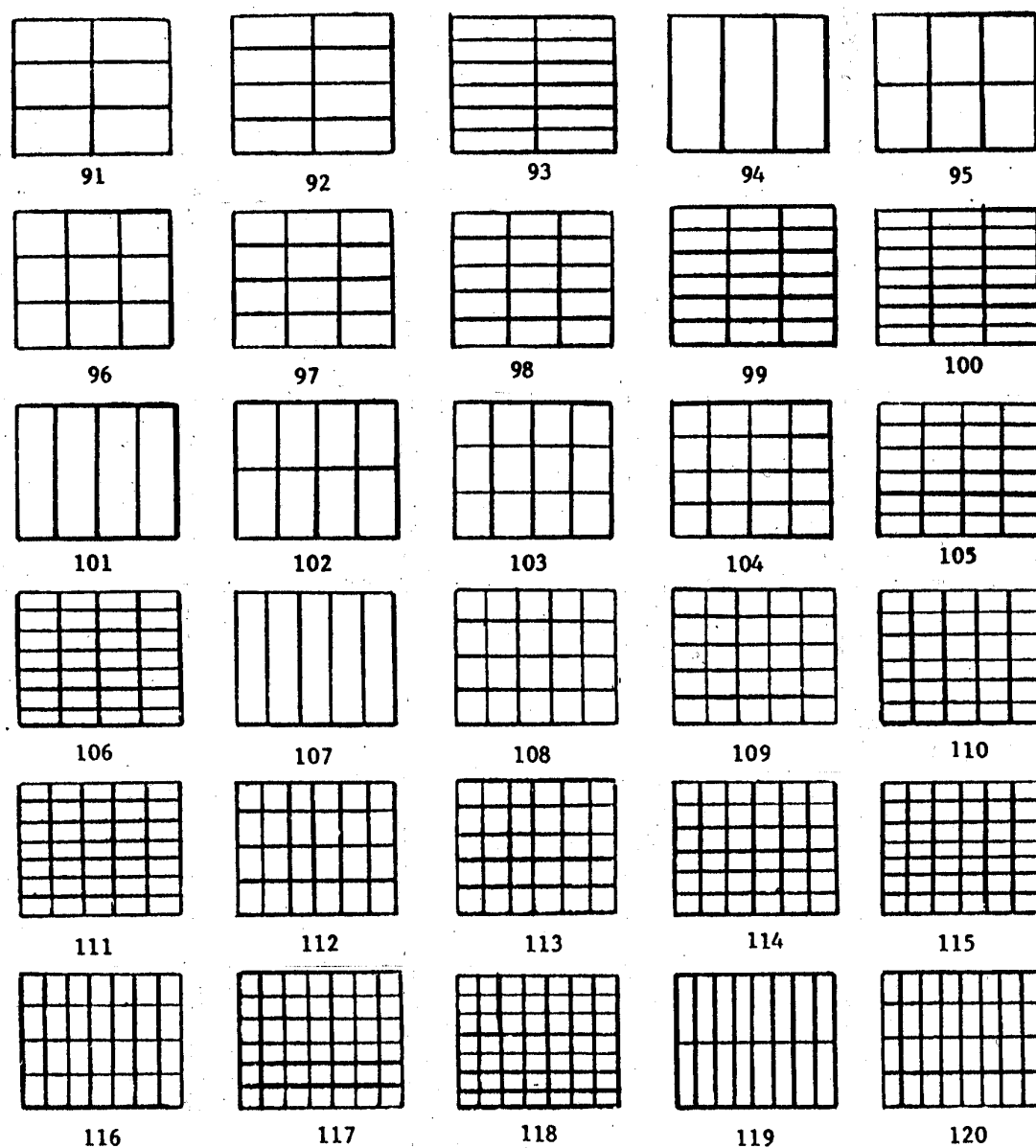
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FIGURE B-1. Load patterns on 40'' by 48'' pallets (See A.2.2) (Continued).

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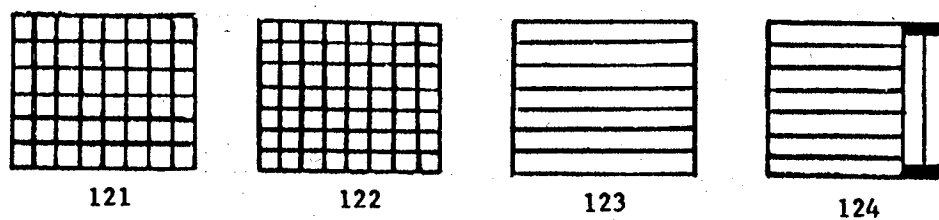


FIGURE B-1. Load patterns on 40'' by 48'' pallets (See A.2.2) (Continued).

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APPENDIX C

STANDARD CONTAINERS FOR MODULAR PACKAGING UNITIZATION (See 5.1.2.1)

C.1 SCOPE

C.1.1 Scope. In order to achieve maximum utilization of cubic space when shipping materiel in MILVANS and SEAVANS, basic data is provided herein for a series of standard size unit, intermediate, and exterior containers fabricated from fiberboard, plywood, or wood for use in modular packaging unitization applications. The modular containers are designed so that the dimensions of the unit pack fit the intermediate container, which in turn fits the exterior container for eventual unitization in MILVANS and SEAVANS. The standard containers listed herein are to be used when appropriate but are not mandatory for use when separate containers designed for specific categories of commodities have been established.

C.2 APPLICABLE DOCUMENTS

C.2.1 General. The documents listed below are not necessarily all of the documents referenced herein, but are those needed to understand the information provided by this Appendix.

C.2.2 Government documents.

C.2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein.

FEDERAL SPECIFICATIONS

PPP-B-566 - Boxes, Folding, Paperboard

(Copies of these documents are available online at <http://assist.daps.dla.mil/quicksearch/> or www.dodssp.daps.mil or from the Document Automation and Production Service, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

ASTM INTERNATIONAL

ASTM D 1974	-	Standard Practice for Methods of Closing, Sealing, and Reinforcing Fiberboard Boxes
ASTM D 5118/D 5118M	-	Standard Practice for Fabrication of Fiberboard Shipping Boxes

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- | | |
|-------------|---|
| ASTM D 5168 | - Standard Practice for Fabrication and Closure of Triple-Wall Corrugated Fiberboard Containers |
| ASTM D 6251 | - Standard Specification for Wood-Cleated Panelboard Shipping Boxes |

(Copies of ASTM International standards are available at www.astm.org or from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, telephone 610-832-9585, fax 610-832-9555.)

C.3 STANDARD UNIT AND INTERMEDIATE CONTAINERS

C.3.1 General specifications and classifications. Standard unit and intermediate container requirements, including weight limitations and classifications, are in accordance with the applicable documents referenced in tables C-I and C-II.

C.3.2 Dimensions. Inside dimensions expressed in inches for the standard unit and intermediate containers should be as indicated in tables C-I and C-II. Sizes were designed to fit standard exterior cleated panel board (ASTM D 6251) and standard exterior nailed wood boxes, which have the smallest inside dimensions. Dimensions for the ASTM D 6251 box are based on the use of ½-inch plywood with 7/8-inch cleats, while dimensions for the standard exterior nailed wood box are based on the use of ¾-inch lumber. The actual thickness of the plywood and wood is determined by the weight of the contents of each box. Detailed information is included in the applicable box specification.

C.4. STANDARD EXTERIOR CONTAINERS

C.4.1 General specifications and classifications. Standard exterior container requirements and classifications are in accordance with the applicable specifications referenced above tables C-III through C-VII.

C.4.2 Dimensions. Inside dimensions in inches and inside cubic measurements for standard exterior containers are as specified in tables C-III through C-VII.

C.4.3 Maximum weight limitations. Maximum weight limitations for standard size exterior containers are to be in accordance with the applicable box specification.

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C.5 STANDARD CARTON DETERMINATION, SELECTION, AND
APPLICABILITY

C.5.1 Standard carton determination. Determination of the most effective packaging procedure(s) and standard container(s) to be utilized is to be in accordance with prescribed packaging policies and procedures. Consideration should be given to such things as load type, level(s) of protection, and size of items to be shipped.

C.5.2 Unit and intermediate standard container selection. When determined to be needed in the packaging procedure, the appropriate standard unit container or unit and intermediate container is to be selected from tables C-I and C-II according to the corresponding specification listed above each table and the appropriate dimensions determined by the size of the items being packaged. The standard container sizes are numerically designated 1 through 13 and are listed in column 1 of these tables. The standard quantity per modular container (intermediate or exterior) is indicated in column three of each table. Standard intermediate containers, which have been modularly presized to hold unit containers 1 through 5 are to be selected from column 4 of table C-I, and standard exterior containers which have been modularly pre-sized to hold intermediate I containers 6 through 13 are to be selected from column 4 of table C-II. The five different standard exterior containers listed herein are numbered 14 through 18.

C.5.3 Exterior standard container selection. Standard exterior containers are to be selected from tables C-III through C-VII according to the applicable specification cited above each table and the appropriate dimensions and cubes determined from the items' sizes. The exterior container sizes, designated 14 through 18 in all five tables, are considered to be the "same size" for modular grouping, and reference purposes. Actual sizes differ slightly because of the inherent physical characteristics of each type container (i.e., wood, plywood, and fiberboard). To illustrate the use of tables C-III through C-VII, consider the selection of box No.3 of PPP-B-566 as the standard unit container for a modular packaged unitized load. Columns 3 and 4 of table C-I show that 75 of the No.3 containers can be placed in standard intermediate container No.7, which is box No.7 of ASTM D 1974 shown in table C-II. Columns 3 and 4 of table C-II show that 12 of the No.7 containers can be placed in standard exterior container No. 14, which can be any No. 14 container of the 5 different box specifications listed in tables C-III through C-VII.

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C.6 PALLETIZED UNIT LOADS

C.6.1 Palletized unit load arrangements. Palletized unit loads of standard exterior containers are to be arranged on 40- by 48-inch pallets without overhangs and voids to provide maximum cube utilization when containerized in MILVANS and SEAVANs.

C.6.2 Palletized unit load arrangements for standard exterior cartons of the same size. Palletized unit load arrangements for standard exterior containers, which are all of the same size when formed on a 40- by 48-inch pallet are shown in table C-VIII. The table describes each arrangement in terms of number of boxes per layer, number of layers per unit load, and total number of boxes per unit load. These arrangements are illustrated in figures C-1 through C-4 to show unit load arrangements for box Nos. 15 through 18, respectively. Box No. 14, consisting of 1 palletized container, which in itself constitutes a unit load, is not shown.

C.6.3 Palletized unit load arrangements for standard exterior cartons of mixed sizes. Palletized unit load arrangements of standard exterior containers, which are comprised of different size cartons within the unit load are illustrated in figures C-5 and C-6.

C.6.4 Palletized unit load arrangement applicability. Palletized unit load arrangements shown herein are not intended to be all inclusive or mandatory for use. Other arrangements may be used when dictated by specific packaging requirements.

C.6.5 Palletized unit load height and weight limitations. The unit load weight limitations are not to exceed 3,000 pounds per single pallet load (see 5.1.1.2), while the height limitations are not to exceed 41 inches for MILVANS and 43 inches for SEAVANs including the pallet base.

C.6.6 Securing unitized loads to pallets. Unitized loads are secured to pallets by the application of shrink-wrap bonding (see 5.3.4.1) or by strapping (see 5.3.3.1 through 5.3.3.3).

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TABLE C-I. Standard unit containers.
PPP-B-566, variety 1, style II, type D, classes a and e.

Box size No.	Inside dimensions (inches)			No. per intermediate container	Intermediate container No.
	Length	Width	Depth		
1	10 7/8	by 5 7/8	by 7 5/8	12	6
2	7 3/4	by 5 7/8	by 4 1/8	30	6
3	5 7/8	by 4 1/4	by 1 3/4	75	7
4	4 1/4	by 2 7/8	by 1 3/4	120	8
5	2 7/8	by 1 7/8	by 1 3/4	150	11

TABLE C-II. Standard unit and intermediate containers.
ASTM D 5118/D 5118M, types CF, SF; class domestic and weather-resistant; variety single-wall; grades 125, 175, 200, 275, V3c, W5c; style RSC, other styles may be applicable.

Box size No.	Inside dimensions (inches)			No. per exterior container	Exterior container No.
	Length	Width	Depth		
6	22 1/8	by 18 1/4	by 15 7/8	8	14
7	22 1/8	by 18 1/4	by 10 1/4	12	14
8	22 1/8	by 18 1/4	by 7 1/2	16	14
9	22 1/8	by 18 1/8	by 6 7/8	8	15
10	18 1/8	by 10 3/8	by 15 7/8	8	16
11	18 1/8	by 10 3/8	by 10 1/4	12	16
12	18 1/8	by 10 3/8	by 6 7/8	8	17
13	10 1/8	by 8 1/4	by 6 7/8	8	18

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TABLE C-III. Standard exterior cleated plywood containers.
ASTM D 6251, type domestic and overseas; styles A, B, I, and J.

Box size No.	Inside dimensions (inches)			Inside cube
	Length	Width	Depth	
14	45 1/4	by 37 1/4	by 33 1/4	32.43
15	45 1/4	by 37 1/4	by 15 1/4	14.88
16	37 1/4	by 21 1/4	by 33 1/4	15.23
17	37 1/4	by 21 1/4	by 15 1/4	6.98
18	21 1/4	by 17 1/4	by 15 1/4	3.23

TABLE C-IV. Standard exterior nailed wood containers.

Box size No.	Inside dimensions (inches)			Inside cube
	Length	Width	Depth	
14	45	by 38 1/2	by 34 1/2	34.59
15	45	by 38 1/2	by 16 1/2	16.54
16	37	by 22 1/2	by 34 1/2	16.62
17	37	by 22 1/2	by 16 1/2	7.94
18	21	by 18 1/2	by 16 1/2	3.71

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TABLE C-V. Standard exterior wirebound containers.

Box size No.	Inside dimensions (inches)			Inside cube
	Length	Width	Depth	
14	45 1/2	by 39 1/4	by 35 1/4	36.43
15	45 1/2	by 39 1/4	by 17 1/4	17.83
16	39 1/4	by 23 1/4	by 35 1/4	18.62
17	39 1/4	by 23 1/4	by 17 1/4	9.11
18	23 1/4	by 19 1/4	by 17 1/4	4.47

TABLE C-VI. Standard exterior triple-wall fiberboard containers.

ASTM D 5168, class 1, weather and nonweather-resistant, fire-retardant, weather-resistant, style A, B, C.

Box size No.	Inside dimensions (inches)			Inside cube
	Length	Width	Depth	
14	47	by 39	by 34	36.07
15	47	by 39	by 16	16.97
16	39	by 23	by 34	17.65
17	39	by 23	by 16	8.31
18	23	by 19	by 16	4.05

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TABLE C-VII. Standard exterior double-wall fiberboard containers.
ASTM D 5118/D 5118M, type CF, class domestic and class weather-resistant,
variety double-wall, style RSC, other styles may be applicable.

Box size No.	Inside dimensions (inches)			Inside cube
	Length	Width	Depth	
14	47 1/2	by 39 1/2	by 35	38.00
15	47 1/2	by 39 1/2	by 17	18.46
16	39 1/2	by 23 1/2	by 35	18.80
17	39 1/2	by 23 1/2	by 17	9.13
18	23 1/2	by 19 1/2	by 17	4.51

TABLE C-VIII. Unit load arrangements of exterior containers on a 40- by 48-inch pallet.

Box size No.	No. of boxes per layer	No. of layers per unit load	No. of boxes per unit load
14	1	8	14
15	1	12	14
16	2	16	14
17	2	8	15
18	4	8	16

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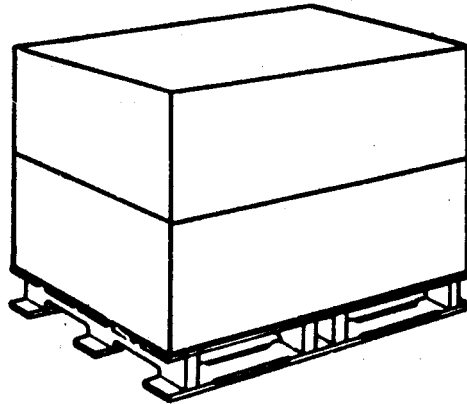


FIGURE C-1. Unit load arrangement for standard exterior container No. 15 (same size)
(See C.6.2).

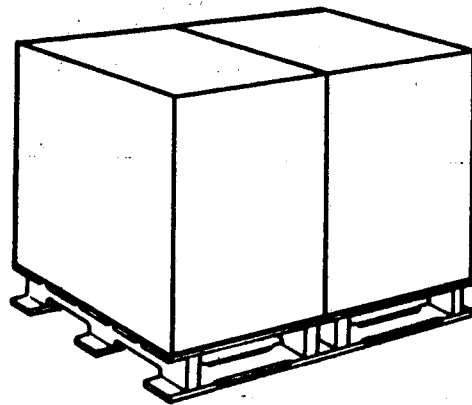


FIGURE C-2. Unit load arrangement for standard exterior container No. 16 (same size)
(See C.6.2).

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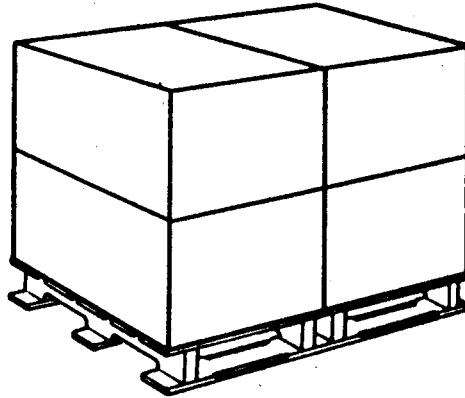


FIGURE C-3. Unit load arrangement for standard exterior container No. 17 (same size)
(See C.6.2).

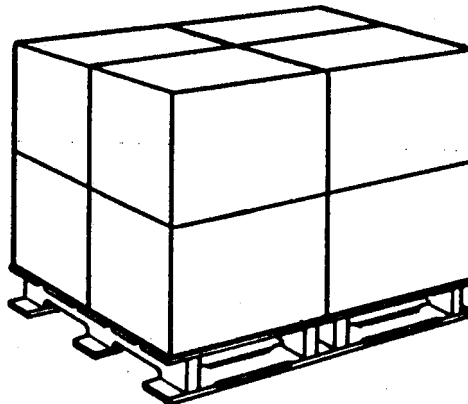


FIGURE C-4. Unit load arrangement for standard exterior container No. 18 (same size)
(See C.6.2).

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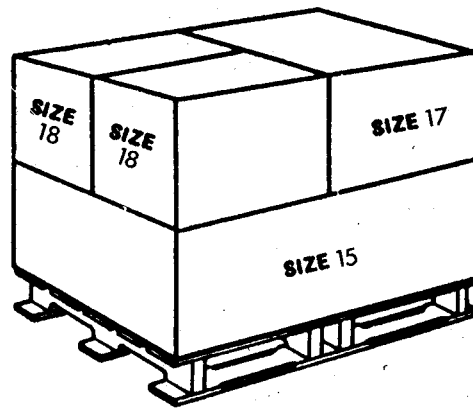


FIGURE C-5. Unit load arrangement for standard exterior containers Nos. 15, 17, and 18 (mixed sizes) (See C.6.3).

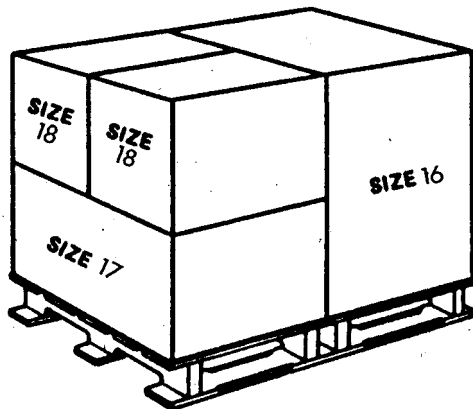


FIGURE C-6. Unit load arrangement for standard exterior containers Nos. 16, 17, and 18 (mixed sizes) (See C.6.3).

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CONCLUDING MATERIAL

Custodians:

Army - SM

Navy - SA

Air Force - 99

DLA – DH

Preparing activity:

Army -SM

(Project PACK-1143)

Review activities:

Army - AR, AT, AV, CR3, EA, GL3, MI, MT, PT

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NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at www.dodssp.daps.mil.