SUMMARY of CHANGE

DA PAM 746–1
Pallets and Storage Aids for Army Use

This major revision, dated 29 August 2018--

o Adds new storage aids (chap 9).

o Adds procedures for the Wood Packaging Materials Program (chap 10).

o Updates procedures and national stock numbers for pallets (throughout).

o Updates points of contact (throughout).
Marking, Packing, and Shipment of Supplies and Equipment
Pallets and Storage Aids for Army Use

Applicability. This pamphlet applies to the Regular Army, the Army National Guard/Army National Guard of United States, and the U.S. Army Reserve. Also, it applies to all personnel who perform packaging and storage functions.

Proponent and exception authority. The proponent of this pamphlet is the U.S. Army Materiel Command. The proponent has the authority to approve exceptions or waivers to this pamphlet that are consistent with controlling law and regulations. The proponent may delegate this approval authority, in writing, to a division chief within the proponent agency or its direct reporting unit or field operating agency, in the grade of colonel or the civilian equivalent. Activities may request a waiver to this regulation by providing justification that includes a full analysis of the expected benefits and must include formal review by the activity’s senior legal officer. All waiver requests will be endorsed by the commander or senior leader of the requesting activity and forwarded through their higher headquarters to the policy proponent. Refer to AR 25–30 for specific guidance.

Suggested improvements. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications and Blank Forms) directly to the Logistics Support Activity (Packaging, Storage, and Containment Center) (AMXLS–P) Tobyhanna, PA 18466–5097.

Distribution. This pamphlet is available in electronic media only and is intended for the Regular Army, the Army National Guard/Army National Guard of the United States, and the U.S. Army Reserve.

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Glossary
Chapter 1
Introduction

1–1. Purpose
This pamphlet serves as a guide to Army shippers in the selection of pallets for shipment and storage of materiel. It also describes the different types of storage aids and how they should be reported and obtained.

1–2. References
See appendix A.

1–3. Explanation of abbreviations and terms
See glossary.

1–4. Procedures
a. Palletization practices have been revised to allow the most practical and economical pallet to be used without compromising item protection. Palletized unit loads will be used subject to the following considerations:
   (1) The amount of materiel to be loaded on a pallet will exceed either a total of 250 pounds (excluding the pallet) or a volume of 20 cubic feet and will compactly occupy at least 80 percent of the pallet’s load bearing surface.
   Note. Ammunition items must fill out or slightly overhang the pallet’s load bearing surface.
   (2) The maximum weight limit for palletized unit loads is 3,000 pounds for domestic, intercoastal, or overseas shipments. Ammunition unit loads are limited to a maximum weight of 4,000 pounds. Palletized unit loads to North Atlantic Treaty Organization (NATO) forces should not exceed 2,500 pounds, except ammunition from the United States and United Kingdom which can be 4,000 pounds.
   (3) Pallet requirements for NATO shipments of packages and ammunition are stated in STANAG 2828.
   (4) Pallets for air shipments, when possible, should be lightweight (5 to 15 pounds).
   (5) When using expendable type pallets, no overhang is permitted beyond the perimeter of the pallet deck.
   b. This pamphlet summarizes and illustrates the changing pallet concepts along with the already established reusable pallets for shipment and storage of materiel.

1–5. General
Pallets fall into three general groups—expendable, general purpose, and special purpose.
   a. Expendable pallets are usually, as the name implies, a one–trip affair. Cost for the shipper is the essential factor, as well as design and construction.
   b. General purpose pallets are constructed of hardwood or softwood and used for the shipment and storage of general supplies.
   c. Special purpose pallets are generally designed and constructed for the commodity to be carried such as ammunition or explosives.

Chapter 2
Principles of Wooden Pallet Construction

2–1. General
In order to select the proper pallet, it is necessary to have an understanding of basic wooden pallet construction principles. This section deals briefly with a description of the principal parts of wooden pallets and variations in designs, styles, and construction.

2–2. Principal parts
Figure 2–1 shows some commonly used construction features and principal parts of wooden pallets together with standardized nomenclature for mutual understanding between pallet manufacturers and buyers.
2–3. Pallet designs
The most common designs of wooden pallets are two-way and four-way entry.
   a. **Two-way entry.** This pallet design permits entry of fork or hand pallet trucks from two sides only and in opposite directions (see fig 2–2).

   ![Figure 2–1. Construction features and principal parts of wooden pallets](image1)

   ![Figure 2–2. Typical two-way pallet](image2)

   b. **Four-way entry.** This pallet design permits entry of handling equipment from four sides. The following two designs are for four-way pallets:
(1) Partial four-way entry (also called notched stringer design). This pallet allows four-way entry only with forklift trucks and two-way entry with hand pallet trucks (see fig 2–3).

Figure 2–3. Typical partial four-way design

(2) Full four-way entry (also called post design). Full four-way entry allows four-way entry of both forklift and hand pallet trucks (fig 2–4).

Figure 2–4. Typical full four-way entry design

2–4. Pallet styles
The two styles of wooden pallets are single–face and double–face.
   a. Single–face. Single–face pallets have only one deck which is the top surface (currently not authorized for Army use in accomplishing level A or B shipments) (see fig 2–5).
b. **Double-face.** Double-face pallets have both top and bottom decks. The bottom deck helps distribute the load when tiered and adds strength to the pallet by helping tie the stringers together. Double-face pallets are usually manufactured in one of the two following forms:

1. **Reversible pallets.** This style pallet has identical top and bottom decks. Goods may be stacked on either deck (see fig 2–6).

2. **Nonreversible pallets.** This style pallet has dissimilar top and bottom decks allowing goods to be stacked only on the top deck (see figs 2–7 and 2–8). The wider spacing arrangement of bottom deckboards permits use of hand pallet trucks, or it is used to reduce the amount of lumber in the pallet. Consequently, the result is a savings in weight and cost, while still retaining the other physical advantages of double-face pallets.
2–5. Pallet construction
The three principal construction features used to classify wooden pallets are described below:

a. Flush stringer. This pallet is constructed with runners or blocks flush with ends of the deckboards (see fig 2–9).
b. *Single wing*. This pallet is made with stringers set in a certain distance with respect to ends of top deckboards and flush with ends of bottom deckboards (currently not authorized for Army use) (see fig 2–10).

c. *Double wing*. This pallet is constructed with stringers set in toward the center of the pallet a certain distance with respect to the ends of both top and bottom deckboards (see fig 2–11).
Chapter 3
Choosing the Correct Pallet

3–1. General
The selection of the correct pallet involves choosing the right type and the right size pallet. No two handling problems are identical. This section serves as a basic guide in making the selection.

3–2. Right type pallet
a. First, to determine the type of handling equipment to be used (for example, fork or hand pallet trucks or pallet jacks). This will narrow the choices of pallet type.
   b. Next, the nature of materiel to be palletized will determine whether a general or special purpose pallet will be used. Some physical characteristics to consider are as follows:
      (1) Dimensions.
      (2) Weights.
      (3) Densities.
      (4) Type and size of container if the materiel is packaged.
      (5) Physical properties (for example, embodied in explosives and ammunition) that require special handling methods.
      (6) Mode of transportation.
   c. Finally, transportation costs must be a consideration in choosing the right type pallet. Since the cost to ship cargo by air is based on weight, considerable savings can result by using lightweight pallets.

3–3. Right size pallet
a. The ideal pallet size for shipping and storing general supplies is 40 inches by 48 inches. These dimensions permit use of the pallet two abreast in the 48-inch dimension across railroad freight cars and one in the 40-inch dimension and one in the 48-inch dimension across the average motor truck body.
   b. Nonstandard pallet sizes will be permitted for palletization only where general supply items are too large to fit the 40-inch by 48-inch pallet. Palletized shipments of ammunition and military explosives will be made in accordance with specifically approved drawings and procedures.

3–4. Pallet features
The following features should be considered in selecting a pallet:
   a. Deckboards. The type of merchandise to be palletized is one factor in determining the amount of lumber coverage on decks as well as the spaces between deckboards. For instance, wooden boxes, crates, and some corrugated boxes could be palletized satisfactorily on decks that have widely spaced boards. On the other hand, material packed in cloth or paper sacks should not be loaded on pallet decks with widely separated boards since items would tend to sag between the deckboards and would be subject to damage by fork or hand pallet trucks (see fig 3–1).
b. **Wood preservatives.** A wood preservative is recommended for pallets to be used outdoors, in cold storage warehouses, or where the wood is subject to a variety of moisture conditions. Pentachlorophenol has been defined as a “limited use” chemical by the Environmental Protection Agency and should not be used to preserve pallets. It was removed from DOD pallet specifications back in the mid-1980s. Recommended preservatives are copper-8-quinolinolate, zinc naphthenate, or copper naphthenate.

c. **Lumber.**

(1) A wooden pallet may be constructed of a range of low density softwoods to high density hardwoods. Each offers certain advantages. Softwood pallets are usually lighter, and therefore, particularly suitable for use as shipping pallets. Hardwood pallets are generally more costly; however, they will withstand the stresses of handling equipment, impact force to dropping, tiering, and operations with bar slings (shiploading).

(2) All wood pallets manufactured to NN–P–71 must also comply with the provisions of International Standard for Phytosanitary Measures (ISPM) 15, which are regulations governing the use of wood packaging materials in international trade.

**Chapter 4**

**General and Special Purpose Pallets**

4–1. **General**

Specifications have been developed to serve as standards for wooden pallets used by the Government. The following specifications are prescribed for certain general and special purpose pallets:

a. NN–P–71, Stringer construction, two–way and four–way partial pallets, hardwood or softwood.

b. MIL–DTL–15011, Post construction, four–way pallets, 40 by 48 inches, hardwood or softwood.

c. MIL–P–15943, two–way pallets, 48 by 72 inches, hardwood stevedore pallet.


(1) ANSI MH1 was adopted for use by the Department of Defense. Part 9 of this standard applies to wood pallets used by the DOD.

(2) See figure 4–1 for a cross reference between existing pallet national stock numbers (NSNs) and ANSI MH1 part numbers.
### Cross Reference List and Characteristics, Part No. to National Stock Number

<table>
<thead>
<tr>
<th>Part No., ANSI</th>
<th>National Stock Number</th>
<th>Class</th>
<th>Type</th>
<th>Style</th>
<th>Size</th>
<th>No. of Stringers</th>
<th>No. of Blocks</th>
<th>Species Class</th>
<th>See Figure</th>
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<tr>
<td>MH1/9-015SW3240</td>
<td>3990 00-542-3232</td>
<td>1</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>3</td>
<td>0</td>
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<td>2</td>
<td>3</td>
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<td>3990 00-555-0458</td>
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<td>3</td>
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<td>MH1/9-075SW4848</td>
<td>3990 00-959-0743</td>
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<td>MH1/9-085SF4860</td>
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<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>5</td>
<td>0</td>
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<td>2</td>
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<td>3</td>
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<td>2</td>
<td>3</td>
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<td>3</td>
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<td>1, 4, 21</td>
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<td>3990 01-093-8648</td>
<td>2</td>
<td>3</td>
<td>6</td>
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<td>2</td>
<td>6</td>
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<td>3990 01-105-9584</td>
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<td>1, 3, 4, 21</td>
<td>9-13</td>
</tr>
</tbody>
</table>

**NOTES:**

(1) Fig. 9-3 is a partial 4-way pallet with 4 stringers. Part No. MH1/9-025SW4048 and MH1/9-055SW4048 have 3 stringers.

(2) Fig. 9-1 depicts a partial 4-way pallet; however, Part No. MH1/9-045SF4048 describes a 2-way pallet for procurement purposes.

(3) Part No. MH1/9-025SW4048 has a 30% limit on moisture content (see Table 9-4) and top deckboards shall be 3 inch (maximum) apart.

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**Figure 4–1. Cross Reference of DOD and ANSI MH1 Pallet Characteristics with national stock number**

a. **Intended use.** Pallets covered by this specification are intended for use with forklift and hand lift trucks (see fig 4–2). Pallets may be loaded wherever materials enter a supply system for storage and shipment. Preservative treated pallets may be used for storage in both covered and open areas. Of the eight different types of pallets contained in the specification,
six are prescribed for use by Army (see table 4–1). Types I, II, and III are intended for use in storage operations. Types IV and V are for use in storage and shipment worldwide regardless of mode of transportation. Types IV and VIII are single use pallets, not to be used for NATO shipments.

b. Characteristics. The pallets in this specification may be procured in many variations. Some are available either assembled or disassembled—the latter to provide economical shipment. As many as six different sizes are covered in both low density and high density woods. If all possible variations were to be procured, 194 NSNs would be required. With a few exceptions, each type with its variations is available in any of four wood groups and with or without preservative treatment. (See chap 3 for a discussion on choosing certain characteristics for pallets.)

c. Types of pallets. Of the eight types of pallets in NN–P–71, types I, II, III, IV, V, and VIII are prescribed for Army use. (Types VI and VII are not the 40–inch by 48-inch size prescribed for Army use.)


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Table 4–1
NN–P–71 Pallet Characteristics with national stock number

<table>
<thead>
<tr>
<th>Type</th>
<th>Class</th>
<th>Style</th>
<th>Size</th>
<th>Group</th>
<th>Grade</th>
<th>NSN</th>
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<tr>
<td>I</td>
<td>1</td>
<td>A</td>
<td>4</td>
<td>III</td>
<td>A</td>
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</tr>
<tr>
<td>I</td>
<td>2</td>
<td>A</td>
<td>4</td>
<td>III</td>
<td>A</td>
<td>3990–00–222–1051</td>
</tr>
<tr>
<td>I</td>
<td>1</td>
<td>A</td>
<td>2</td>
<td>II or III</td>
<td>A</td>
<td>3990–00–555–0458 (replaces 3990–00–063–9075)</td>
</tr>
<tr>
<td>II</td>
<td>1*</td>
<td>A*</td>
<td>2</td>
<td>II or III</td>
<td>A</td>
<td>3990–00–663–9075 (canceled, replaced by 3990–00–555–0458)</td>
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<tr>
<td>IV</td>
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<td>A*</td>
<td>2</td>
<td>I, II, or III</td>
<td>A</td>
<td>3990–00–936–7960 (replaces 3990–01–386–0594)</td>
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<tr>
<td>V</td>
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<td>A</td>
<td>1</td>
<td>IV</td>
<td>A</td>
<td>3990–00–542–3294</td>
</tr>
<tr>
<td>V</td>
<td>1</td>
<td>B*</td>
<td>2</td>
<td>IV</td>
<td>A</td>
<td>3990–00–599–5326 (replaces 3990–00–926–1047)</td>
</tr>
<tr>
<td>VII</td>
<td>1</td>
<td>A</td>
<td>2</td>
<td>III or IV</td>
<td>A or B</td>
<td>3990–01–041–8803 (replaces 3990–01–035–6508)</td>
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</tbody>
</table>

Classes
1 – Assembled
2 – Unassembled

Styles
A - Non-reversible
B – Reversible

Sizes
1- 32 x 40 in.
2 - 40 x 48 in.
3 - 48 x 48 in.
4 - 48 x 60 in.

Group (Wood)
I - Low density woods (softwoods and hardwoods)
II - Medium density woods (softwoods)
III - High density woods (hardwoods)
IV - Very high density woods (hardwoods)

Grades
A - Untreated
B - Treated

Notes:
*The characteristic listed is standard for the type of pallet listed. Other choices are not listed in the specification.

a. **Intended use.** This specification describes pallets to be used in the DA storage and distribution system, whenever full four-way entry is required. The MIL–DTL–15011 is one of two pallets specified for palletization in MIL–STD–147 and the only reusable–type pallet to be used for NATO shipments (see fig 4–3). The pallet will be used in DA for the palletization of military supplies having a high density. Pallets may be loaded wherever materials enter the supply system for storage purposes and may be shipped loaded from storage. Pallets may be used for long–term storage in both covered and uncovered areas. For wood pallets used on ammunition unit loads see paragraph 6–2.

b. **Characteristics.** Pallets covered by this specification are 4-way entry, wood post construction.

c. **Stock number.**
   (1) NSN–3990–00–141–7261, any species of wood or combination thereof from ASTM D6199, group IV.
   (2) Style I—General storage, Size – 40” L X 48” W.
   (3) Size—40 inches by 48 inches.
   (4) Weight—72–80 pounds.
   (5) Class 1 - Seasoned lumber.
   (6) Type I – Assembled.

d. **Source of supply.** Defense Logistics Agency Enterprise Business Systems is the source for these pallets.


a. **Intended use.** This specification describes pallets used for unloading seagoing vessels and for storage of materials on piers, transit sheds, and other ship loading and unloading areas (see fig 4–4).

b. **Characteristics.** Pallets covered by this specification are wood, stringer type construction, two-way entry, double–wing, and 48 inches by 72 inches.

(c. **Stock number.**
   (1) NSN–3990–00–202–2217.
   (2) Size—48 inches by 72 inches.
   (3) Weight—140 pounds.
   (4) Type I – Ship cargo (stevedoring).
   (5) Grade B – Hardwood components with screw nails and bolt construction.
   (6) Class I - Assembled

d. **Source of supply.** Defense Logistics Agency Enterprise Business Systems is the source for these pallets.
Chapter 5
Expendable Pallets

5–1. General
   a. Expendable pallets are designed generally for one trip and then discarded. When the cost of using them is equaled or exceeded by the savings realized during a single trip, they are truly expendable pallets.
   b. Expendable pallet construction is usually of wood, fiberboard, plastics, or a combination of these materials.
   c. In choosing a specific expendable pallet, consideration should be given to the type of material to be palletized, shape and size of containers or items, and weight, density, and distribution of the load.
   d. Details of design and construction are matters for negotiations between buyers and manufacturers. Because of these factors, combined with fluctuation of prices of decking material and quantities ordered, price quotations can vary widely.
   e. Expendable pallets will not be used for NATO shipments.

5–2. Intended use
   a. Since expendable pallets are usually used for one trip, they can be used when no pallet return program exists. Thus, cost and adequate strength are essential factors. The lightweight expendable pallets are economical for air shipments. Pallets for air shipments, when possible, should be lightweight (5 to 15 pounds).
   b. Any expendable pallet design not complying with an approved standard or specification may be validated for limited applications by contacting, USAMC LOGSA PSCC to arrange for testing and evaluation.

Chapter 6
Ammunition Pallets

6–1. MIL–DTL–45449 (Pallet, Units, Wood, for Shipment of Projectile Metal Parts, and Projectile Ammunition)
   a. Pallets.
      (1) Used in palletizing 155mm projectiles, empty or loaded, and is for worldwide shipment by all modes of transportation and for storage in magazines and open storage (see fig 6–1).
         (b) Size—131/2 by 29 inches.
         (c) Weight—20 pounds.
         (d) Drawing number—9362571 Cover and 9362570 Bottom (ARDEC).
(2) Used to palletize 155mm separate loading projectiles (HE and GB Hollow Base Type) and is authorized for worldwide shipment by all modes of transportation and for storage in magazines and open storage.

(b) Size—29 1/8 by 14 1/2 inches.
(c) Weight—50 pounds.
(d) Drawing number—8837839 (ARDEC)


a. Intended use. These pallets are used for the palletization of ammunition for worldwide shipment by any mode and for storage in various magazines and open storage (see fig 6–2).
b. **Stock numbers.** The following pallets are some of several types specified in MIL–DTL–15011.

   (a) Style 1 (General storage, size 40" L x 48" W).
   (b) Size—40 by 48 inches.
   (c) Weight—72 to 80 pounds.
   (d) Class 1 (Seasoned lumber).
   (e) Type I (Assembled).
   (a) Style 1A (General storage, size 35" L x 45–1/2" W).
   (b) Size—35 by 451/2 inches.
   (c) Weight—65 to 70 pounds.
   (d) Class 1 (Seasoned lumber).
   (e) Type I (Assembled).
   (a) Style 1B (General storage, size 42" L x 53" W).
   (b) Size—42 by 53 inches.
   (c) Weight—75 to 90 pounds.
   (d) Class not identified.
   (e) Type not identified.


**Chapter 7**

**Missile Pallets**

**7–1. Lance missile pallets**

The following pallets are designated for use with the Lance missile:

a. Special pallet for shipping and storing of the Lance missile, control surface, M29, packed in M597 container. There are five packages per pallet. Used for palletization of the designated item only. The palletized item may be transported worldwide by all modes of transportation and may be used for storing in warehouses and other storage areas. The use of special missile pallets (Drawing number—19–48–5236–GM20P8 (AMC)) for the Lance missile will be directed by the U.S. Army Aviation and Missile Command (AMCOM).

b. Special pallet for shipping and storing of the Lance missile, control surface, M30, packed in M596 container. There are five packages per pallet. Used for palletization of the designated items only. The palletized item may be transported worldwide by all modes of transportation and may be used for storing in warehouses and other storage areas. The use of special missile pallets (Drawing number—19–48–5263–GM20P8 (AMC)) for the Lance missile will be directed by AMCOM.
7–2. **Chaparral missile pallet**

This is a special pallet for shipping and storage of the Chaparral missile packed in the M570 container. There are four packages (M570) per pallet. This pallet may be used for the Chaparral missile packed in the M570 container only. The palletized item may be transported worldwide by all modes of transportation, and may be used for the storing of items in magazines and other approved structures including outdoor storage. The use of special missile pallets (Drawing number—19–48–5235–GM20CHI (AMC)) for Chaparral missiles will be directed by AMCOM.

7–3. **Redeye guided missile pallets**

The following pallets are designated for use with the Redeye guided missile:

a. Special pallet for aerial delivery of the Redeye guided missile in monopak containers. May be used for aerial delivery only of the Redeye missile packed in monopak containers. The size and quantity of the honeycomb pads may be adjusted to suit the quantity of missiles on the pallet which ranges from three to nine. The use of special missile pallets (Drawing number—19–48–5214–GM20P11 (AMC)) for Redeye missiles will be directed by AMCOM.

b. Special pallet for aerial delivery of Redeye guided missile in unipack containers XM585. It is used for palletization of designated items only. The palletized item may be transported worldwide by all modes of transportation and may be used for storing in warehouses and other storage areas. The use of special missile pallets (Drawing number—19–48–5215–GM20P10 (AMC)) for Redeye missiles will be directed by AMCOM.

**Chapter 8**

**Recent Developments in Pallet Technology**

8–1. **General**

Recent technological and design advances within the pallet industry have provided a variety of new pallet designs and materials of composition. These pallet designs may have limited application for storage and shipment in the military supply system.

8–2. **Intended use**

Any pallet design not complying with an approved standard or specification may be validated for limited applications by contacting, USAMC LOGSA PSRC to arrange for testing and evaluation.

**Chapter 9**

**Storage Aids**

9–1. **General**

Department of the Army activities are reminded of the importance of using excess storage aids to the maximum extent possible, precluding procurement of such items. Excess storage aids should be placed in standby storage for subsequent redistribution.

9–2. **Pallet support sets**

a. Description. The pallet support set consists of two vertical frame members, each made up of two tubular members connected at the base and near the top; a tie rod which extends along and between two pallet deckboards to tie the bases of the two frames together; and two upper crossmembers which fit over the tops of the tubular upright members to hold the upper ends in place and form a support for the superimposed pallet. They are constructed in sizes for 32-inch by 40-inch, 40- by 48-inch, and 48- by 60-inch flat pallets (see fig 9–1).
b. **Intended use.** The support set is used in storage of fragile or crushable materials, which cannot withstand superimposition as in ordinary bulk storage. Its principal advantage is easy storage when disassembled and not in use.

c. **Models.** The following standard types are available:

1. Support set, stacking, material handling pallet, slip–fit assembly type, components consisting of two steel top frames, two steel angle base plates, and four steel tubular uprights, accommodates two-way entry pallet, 40 inches long wide, 13/4 inches maximum thickness of stringer, 36 inches maximum distance accommodated (NSN 3990–00–542–4772).

2. Support set, stacking, material handling pallet, slip–fit assembly type, components consisting of two steel top frames, two steel angle base plates, and four steel tubular uprights, accommodates two-way entry pallet, 40 inches long, 48 inches wide, 13/4 inches maximum thickness of stringer, 36 inches maximum distance accommodated (NSN 3990–00–542–4771).

3. Support set, stacking, material handling pallet, slip–fit assembly type, components consisting of two steel top frames, two steel angle base plates, and four steel tubular uprights, accommodates two-way entry pallet, 48 inches long, 60 inches wide, 13/4 inches maximum thickness of stringer, 36 inches maximum distance accommodated (NSN 3990–00–542–4769).

9–3. **Storage racks**

a. **Description.** Storage racks for military use have been standardized for use with either one (single opening) or two (double opening) 40-inch by 48-inch pallet loads of material per level (see fig 9–2). Each storage rack consists of upright frames, crossbeams, and front to rear supports (see fig 9–3). The height can be 10, 11 1/2, 12, or 14 feet. Single opening racks have platforms 54 inches wide and hold one 40- by 48-inch pallet per level. Normally, 4 feet should be allowed for each level opening. A building with a 20-foot maximum stacking height could therefore accommodate five stacking levels or a four-platform pallet rack.
STORAGE RACKS

8" or 14"
BACK-TO-BACK CONNECTORS

OPTIONAL UPRIGHT FRAME CONTR
(SINGLE ROW)

OPTIONAL UPRIGHT FRAME CONTR
(DOUBLE ROW)

STORAGE RACK ASSEMBLY

DETAIL “A”

TYPICAL STYLE “A” RACK SHELF UNIT

TYPICAL STYLE “B” RACK SHELF UNIT

Detail “B”

TYPICAL BEAM-TO-POST CONNECTOR

Figure 9–2. Storage racks
b. **Intended use.** Storage racks are used when the material to be stored is not strong enough to support a superimposed load; is irregular in shape; is too small for bulk storage and too large for bin storage; or when it is desirable to remove pallets from a lower tier without disturbing upper tiers.

c. **General Capability.** Standard units have a rated shelf capacity of 3,500 pounds per 54 inch opening, one 40 by 48 inch pallet; rated shelf capacity of 6,000 pounds for 108 inch opening, two 40 by 48 inch pallets.

d. **High-Rise Narrow Aisle Rack.** The narrow aisle high racking system is a major alternative to traditional 12 foot aisle racking systems. This rack is utilized for heights above 33 feet and are freestanding in the warehouse. The narrow aisle racking systems are characterized by the small amount of floor space that is required for aisles and the extremely large lift heights. Narrow aisle racking systems are used in particular when there is only a very limited space available and when there is a necessity for greater throughput in comparison with multi-bay racking systems.

e. **Tire Rack.** Units are constructed of heavy-gauge steel, and is similar in design to pallet storage racks. All racks feature flat areas where tires rest on beams to help prevent tire deformity. Sizes of uprights and load beams and capacity are variable. To ensure maximum protection against loss from deterioration tires should not be stored in an upright manner unless part of a stretch wrapped, unitized load. Tires should not be stored outside due to environmental policies and deterioration from the elements.

f. **Cantilever racks.** Cantilever racks are made of steel and are generally used for storage of metal sheet rod, or bar stock. These racks are also useful for storage of plywood and other bulky items not favorable for palletization. The height of a cantilever rack is normally limited only by the reach capability of MHE or the height of the warehouse. Rack specifications can be tailored with capabilities to meet individual storage requirements. Supporting rack columns are normally made of spaced from 4 to 6 feet apart. Arms vary from 2 to 4 feet in length and can be adjusted vertically on the columns to accommodate various types of material. Columns can have arms on only one side (single face) or on both sides (double face).

g. **Gravity Flow Rack.** The gravity flow storage consists of two elements: a static rack structure and dynamic flow rails (see fig 9–4). The flow rails are a track/roller system set at a decline along the length of the rack. The flow rails allow loads to move by gravity from the loading end to the unloading end. Each flow lane includes self-energized speed controllers (brakes) to gently control the speed of movement within the flow lanes. As a load is removed, the loads behind it move forward to the unloading position. The flow system depth, height, and width are limited only by the size of your facility and the capabilities of your material handling equipment. Gravity flow storage solutions are used in situations where storage density and inventory rotation are priorities.
h. **Weapons Rack.** Combat high density weapon racks are now available through the Defense Logistics Agency NSN program. Racks can be ordered through supply channels and loaded with weapons without having to be field certified by a physical security officer. The 9 and 10 point locking system weapon racks are U.S. Army TACOM Life Cycle Management Command (TACOM) approved for use in armories and exceed AR 190–11 and OPNAVINST 5530.13 requirements for stowage of small arms. Combat Weapon Storage Systems are ISO 9001, ISO 14001, and OHSAS 18001 manufactured, offering the highest quality manufacturing standards in the industry.

i. **Automated systems.** High density mobile storage rack systems provide you significantly greater storage capacity per square foot of floor space than conventional storage products. In many applications, high-density mobile storage systems are three times more space efficient than conventional racking.

9–4. **Storage and handling of small parts and hand-stackable items**

a. **Shelving.** The relationship between product size, transaction rate, method of order fulfillment, depth of inventory, and configuration of facilities generates a great number of conflicting criteria. Shelving is used for economical storage of small parts or hand-stackable items which are not suited to mechanized handling and storage due to their handling characteristics, activity, or quantity. Although standard shelf units are limited to approximately 7 feet in height, units can be stacked to achieve greater storage when used with mechanized material handling systems. When used with manual systems, mezzanine floors can be placed on shelving and multiple level storage systems can be constructed in this manner for manual order picking. In shelf storage operations there are several basic issues to be considered. The steel equipment industry has established certain basic standards for shelving. Typical units are shown in figure 9–5.
Figure 9–5. Shelving and storage bins
(1) Shelving units. Proper application of shelving units can minimize cube occupancy. Standard shelf structures can be made versatile and flexible by using a variety of bin drawers, shelf boxes, and tote boxes. An example is shown at figure 9–6.
NOTE

THE SHELF BOX ARRANGEMENTS SHOWN ABOVE ARE EXAMPLES OF ONLY SOME OF THE LAYOUTS THAT CAN BE USED. THE NUMBER OF SMALL OR LARGE BOXES OR WHOLE SHELVES TO BE USED DEPENDS UPON THE PHYSICAL CHARACTERISTICS AND VOLUME OF BIN STOCKS TO BE STORED.

THE MAIN PRINCIPLES TO BE FOLLOWED ARE:

1. USE SHELF BOXES EXTENSIVELY FOR EASE OF INVENTORY AND STOCK RELOCATION.

2. SMALL lots IN THE CENTER SO THAT THE MAJORITY OF ITEMS ARE IN THE CHEST HIGH POSITION FOR EASY PICKING

3. HEAVY, LARGE ITEMS TOWARD THE BOTTOM WITH MOST INACTIVE ON LOWEST SHELVES.

4. LIGHT, LARGE ITEMS TOWARD THE TOP WITH THE MOST INACTIVE ON THE HIGHEST SHELVES.

Figure 9–6. Typical bin shelf box arrangement
(2) Shelf boxes. The boxes can provide a flexible arrangement for efficient use of shelf space. Shelf boxes provide retainer walls on four sides of the materiel being stored thereby eliminating stock sloping which wastes usable cube space. Shelf boxes can also be “double-stacked” on a bin shelf to facilitate use of cubic space. When relocation of the item is required, it can be accomplished by moving the shelf box contents. The result is reduced handling of loose stock. Shelving design modules are typically based upon the use of fiber shelf boxes similar to those shown in figure 9–7 since these are the least expensive and most flexible type boxes available. They are also compatible with, although not identical to, the standards as described in TM 38–400. While a variety of sizes and materials are commercially available, the basic types of shelf boxes defined in TM 38–400 are small compartmented boxes, large metal one compartment boxes, and fiber shelf boxes.

![Figure 9–7. Typical corrugated shelf boxes](image)

(a) Small, one compartment-- 4½ inches high, 5½ inches wide, and 17 inches deep as shown by figure 9–8.
(b) Small, two or more compartments-- 4½ inches high, 5½ inches wide, and 17 inches deep as shown by figure 9–8.
Figure 9–8. Small, one and two compartment shelf boxes

(c) Large, metal, one compartment-- 10⅜ high, 11¼ inches wide, and 17½ inches deep as shown by figure 9–9.
Figure 9–9. Typical large metal shelf box

A. Steel  #18 ga.
B. Construction  Steel #18 ga. spot welded, all laps forming box shall be 1”.
C. Handle  Steel No. 20 to be spot welded to front (11 1/4" X 7 3/16") end of shelf box.
D. Label Holder  Steel No. 20 to be spot welded on front end of box to accommodate card 4 1/2” wide by 1 3/4” high.
(d) Large, corrugated--8 inches high, 10 inches wide, and 16 inches deep as shown by figure 9–10.

\[ \text{FLAPS FOLD INSIDE OF BOX} \]

\[ \text{NOTES} \]
\[ \text{SPECIFICATIONS:} \]
\[ \text{SHELF BOX, LARGE CORRUGATED IS MADE UP FROM A REGULAR SLOTTED FIBREBOARD BOX} \]
\[ \text{APPLICATION:} \]
\[ \text{THIS TYPE SHELF BOX IS USED FOR LIGHT WEIGHT MATERIALS. WHERE POSSIBLE, BULK STOCKS SHOULD BE PACKED IN THIS BOX TO FACILITATE BULK TO BIN TRANSFERS AS A SHELF BOX TO MAINTAIN SALVAGE VALUE.} \]

\[ \text{b. Bins.} \text{ Bin storage is, in most instances, identical in application to shelf storage but is generally applied to smaller items which do not need the entire width of a conventional shelf module. In general application, bin storage represents a small part of the total storage system in terms of physical space although it may represent a significant portion of total storage in terms of item positions.} \]

\[ \text{c. Modular drawer cabinets.} \text{ Modular drawer cabinets have certain application advantages over shelving and bin storage when considering selected applications (see fig 9–11). Drawer cabinets provide secure enclosed storage for small or high value parts. Drawer cabinets are inherently more efficient in use of storage space because the drawer is withdrawn from the cabinet and the operator has a clear view of all parts in storage, thereby reclaiming the reach space usually required} \]

\[ \text{Figure 9–10. Typical large corrugated shelf box} \]
in non-drawer applications. Additionally, modular drawers can be partitioned into much smaller storage cells. This provides higher density, improved organization, and greater utilization of storage space. Modular drawer cabinets can be used in high-level mechanized storage and order picking operations. The most common application of these units is in tool cribs, maintenance, or parts supply rooms where they can also serve as counters at the issue window. The most common heights are: 27-inch desk height, 30-inch table height, 33-inch bench height, 44-inch counter height, and 60-inch eye-level height.

**Figure 9–11. Modular drawer cabinets**

d. *Handling small parts.* Another aspect of small parts storage and handling involves the movement of products from order picking to packing and shipping operations and from receiving to the storage location. A standard conveyor tote box is shown in figure 9–12. Other tote box materials and sizes are commercially available.
e. **General.** Since the standard bin boxes shown in figures 9–8 and 9–9 have been found to be compatible with the products being handled from both the storage and order picking points of view, and the tote pan in figure 9–12 has been found to be compatible with conveying and handling systems, these two design standards have been established as the basis for system development.

f. **Pallet rack shelving.** Standard pallet racks can be equipped with shelf panel inserts so that the pallet rack can be used for storage of binnable, rackable, or palletized materials as needs change. This flexibility is valuable when used in combination with multipurpose vehicles such as the man–up turret truck. Such vehicles can be used for the storage and retrieval of palletized loads as well as the order picking of binnables and rackables pieces from pallets. This capability is especially useful when the mix of required bins (binnables), package shelving (rackables), and pallet load shelving is unknown or may be subject to periodic change.

g. **High-rise narrow aisle shelving.** This is a high density type of carton storage system that offers immediate access to every carton stored in very narrow aisles. Order pickers can be guided down aisles with floor angle guidance to protect the rack from lift truck damage or utilizing a narrow aisle order picker without guidance. Shelf elevations are easily adjustable to accommodate any carton size.

h. **Mechanized/automated systems.** High density mechanized binnable parts systems such as miniload or carousel units provide dense storage and maximize the use of available storage height. Carousels are generally one of two types, vertical, or horizontal. Both, however, serve the same function of presenting an item to the person doing the retrieving. This is referred to as part to picker technology and is a variant of Automatic Storage and Retrieval Systems (ASRS). These systems are particularly useful when high transaction rates and large inventory levels result in unacceptably high travel times for man–to–part order picking methods. By delivering the part to the order picker, operator travel time is eliminated. These systems are also effective in situations requiring additional packaging, checking, or processing which would be impractical to provide on a mobile order picking unit. The downside is possible high maintenance costs and downtime for repair. An alternative is the manual bin space saver for a low maintenance cost and no downtime shelving system A good contract is a prerequisite for the ASRS to be cost effective. High density mobile storage gives you significantly greater storage capacity per square foot of floor space than conventional storage products like lateral files or shelving. In many applications, high-density mobile storage systems are three times more space efficient than conventional filing and shelving.

## Chapter 10
**Wood Packaging Materials**
10–1. General
The United Nations guidelines protecting forests worldwide against pest infestation have imposed requirements to treat WPM. The requirements are found in ISPM 15.

10–2. Intended use

a. WPM includes pallets, crates, boxes, reels, and dunnage composed of non-manufactured wood.
b. Manufactured wood products are not affected by pest infestation and do not require treatment. Examples of manufactured wood products are plywood, particleboard, oriented strand board, and finished woods used in furniture.
c. Army activities engaged in packaging of materiel for transnational shipments will comply with the procedures contained within DA Pam 700–32 and DOD 4140.65–M. Issue, use, and disposal of WPM in order to gain access to aerial and water ports. The failure to follow these procedures creates a strong risk that uncertified, unmarked, or improperly marked materiel will become frustrated cargo and destroyed at the port of debarkation, or will be required to be repacked at the port or consolidation and containerization point, causing increased cost and time delays to the Army.
d. The Army will actively promote, implement, monitor, and measure procedures within DOD 4140.65–M to ensure the elimination of undesirable organisms using WPM as a host. As such, the intent is to treat, test, replace, or phase-out inventory of all noncompliant WPM over time.
Appendix A

References

Section I

Required Publications

ANSI MH1
Pallets, Slip Sheets, and Other Bases for Unit Loads (Available at http://www.mhi.org.) (Cited in para 4–1e.)

ARDEC Drawing 8837839
(Available at usarmy.pica.ardec.list.drawing-request-help-desk@mail.mil.) (Cited in para 6–1a(2)(d).)

ARDEC Drawing 9362570
Base (Cited in para 6–1a(1)(d).) (Available at usarmy.pica.ardec.list.drawing-request-help-desk@mail.mil.)

ARDEC Drawing 9362571
Cover (Cited in para 6–1a(1)(d).) (Available at usarmy.pica.ardec.list.drawing-request-help-desk@mail.mil.)

ASTM D6199
Standard Practice for Quality of Wood Members of Container and Pallets (Cited in para 4–3c(1).)

ISPM 15
Regulation of Wood Packaging Material in International Trade (Cited in para 3–4c(2).) (Available from www.ippc.int.)

MIL–DTL–15011
Pallets, Material Handling, Wood, Post Construction, 4-Way Entry (Cited in para 4–1b.)

MIL–DTL–45449
Pallet, Units, Wood, for Shipment of Projectile Metal Parts, and Projectile Ammunition (Cited in para 4–1d.)

MIL–P–15943
Pallet, Material Handling, Wood, Ship Cargo, Stevedoring, 48 Inches Long by 72 Inches Wide, 2-Way Entry (Cited in para 4–1c.)

NN–P–71
Pallets, Material Handling, Wood, Stringer Construction, 2-Way and 4 Way (Partial) (Cited in para 4–1a.)

STANAG 2828
NATO Standardization Agreement for Military Pallets, Packages and Containers (Cited in para 1–4a(3).)

Section II

Related Publications

A related publication is a source of additional information. The user does not have to read it to understand this publication. Unless otherwise indicated, DA forms are available on the Army Publishing Directorate website (http://armypubs.army.mil). DOD publications are available at http://www.dtic.mil/whs/directives. Standards and specifications are available at https://assist.dla.mil.

AR 25–30
The Army Publishing Program

AR 190–11
Physical Security of Arms, Ammunition, and Explosives

DA Pam 700–32
Packaging of Army Materiel

DOD 4140.65–M
Issue, Use, and Disposal of Wood Packaging Materials

DODI 4140.01
DoD Supply Chain Materiel Management Policy

DODM 4140.01, Volume 1
DoD Supply Chain Materiel Management Procedures: Operational Requirements
ISO 9001
Quality Management (Available at https://www.iso.org/home.html.)

ISO 14001
Environmental Management Systems (Available from https://www.iso.org/home.html.)

MIL–STD–147
Palletized Unit Loads

OHSAS 18001

OPNAVINST 5530.13
Department of the Navy Physical Security Instruction for Conventional Arms, Ammunition, and Explosives (AA&E) (Available at https://doni.documentservices.dla.mil/)

TM 38–400/NAVSUP PUB 572/AFMAN 23–210/MCO 4450–14/DLAM 4145.12
Joint Service Manual for Storage and Materials Handling

TT–W–572
Fungicide: Pentachlorophenol

Section III
Prescribed Forms
This section contains no entries.

Section IV
Referenced Forms
Unless otherwise indicated, DA forms are available on the Army Publishing Directorate website (http://armypubs.army.mil).

DA Form 2028
Recommended Changes in Publications and Blank Forms
Glossary

Section I
Abbreviations

AMCOM
U.S. Army Aviation and Missile Command

ANSI
American National Standards Institute

APD
Army Publishing Directorate

ARDEC
U.S. Army Armament Research, Development and Engineering Center

ASRS
Automatic Storage and Retrieval System

ASTM
ASTM, International (formerly known as American Society for Testing and Materials)

DA
Department of the Army

DLA
Defense Logistics Agency

DOD
Department of Defense

IPPC
International Plant Protection Convention

ISPM
International Standard for Phytosanitary Measures

LOGSA
Logistics Support Activity

MIL
military

MIL–DTL
military detail

MIL–STD
military standard

NATO
North Atlantic Treaty Organization

NSN
national stock number

TACOM
U.S. Army TACOM Life Cycle Management Command

WPM
wood packaging materials
Section II

Terms

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

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

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.

Frame supports
Boards placed 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.

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.

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

Glued load
A load bonded with glue or glued strips.

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

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

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

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.

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

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

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

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

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

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 standard, the length is the 40-inch dimension of the pallet.
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.

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 standard, the width is the 48-inch dimension.

Pallet, full four-way entry
Pallet with openings at both opposite ends and sides, with unlimited accessibility of all openings to common materials handling equipment. Block pallets with unidirectional perimeter boards or without bottom deck.

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

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

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.

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.

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

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, also known as bearer, runner.

Underhang
That portion of the unit load less than the length or width dimension(s) of a pallet, also known as margin.

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

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

Section III
Special Abbreviations and Terms
This section contains no entries.