UNIFORM STANDARD
FOR
WOOD CONTAINERS

National Wooden Pallet and Container Association
1421 Prince Street
Suite 340
Alexandria, VA 22314-2805
Phone: 703-519-6104
Fax: 703-519-4720
www.palletcentral.com

National Wooden Pallet and Container Association
1421 Prince Street
Suite 340
Alexandria, Virginia 22314-2805
USA
www.palletcentral.com

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Wood containers are manufactured or repaired for the sole purpose of storing and/or transporting material. Under no circumstances should any person stand, step, or lean upon them or otherwise use them for support. The wood container user has the obligation and responsibility to inspect for damage prior to each container use and to determine that the container design is appropriate for that particular unit load application. All wood containers should be removed from service if determined to be unsafe and dangerous to persons or goods.

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2012

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Staff Liaison

Edgar Deomano, PhD

TABLE OF CONTENTS

1 PURPOSE

The purpose of this Uniform Standard for Wood Containers (hereinafter referred to as the Standard) is to establish nationally recognized minimum quality requirements for the principal types of wood containers and to provide a basis for common understanding among manufacturers, repairers, distributors, and users of wood containers.

2 SCOPE

This Uniform Standard applies only to new wood containers as well as their lumber components, panels, and fasteners. Criteria contained in this Standard are applicable only at the completion of manufacture.

This Standard is in three parts. Part I is the Prescriptive Standard that concerns the manufacture of the container. This includes container terminologies, definitions, classifications, material descriptions, manufacture and assembly requirements. Part II is the Performance Standard that concerns the functionality of the container. This contains references to the physical testing to assist manufacturers, recyclers , distributors, and users to determine the performance level of a specified container. Use of the Performance Standard is required for new container constructions, along with conformance to Part I of the Prescriptive Standard. Part III covers Phytosanitation of Wood Containers.

This Standard does not describe other established special requirements for export containers, and does not address the safety problems, if any, associated with the use of wood container. It is the responsibility of the user of this Standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to its use.

To assist the user of this Standard, other related standards and specifications are listed in Annex A.

In any dispute regarding dimensions of components or defects, the U.S. customary units are governing.

PART I PRESCRIPTIVE STANDARD

3 TERMINOLOGY AND DEFINITION

base – lower portion of the container on which its content rests

batten – reinforcement on wood containers used to hold a series of boards together to create rigidity – generally set in from each end to prevent board splitting. When used flushed with the end it becomes a cleat.

blank – a flat unassembled pallet box exclusive of pallet base and top

box – a container with structural framework and panel members fastened together to form a rigid enclosure. The panels used to create this enclosure can be made of corrugated paper, plywood, OSB or any product strong enough to perform containment of given products. Most boxes are fully enclosed and can have any section (i.e. side, end, top, base and cap) removable for filling.

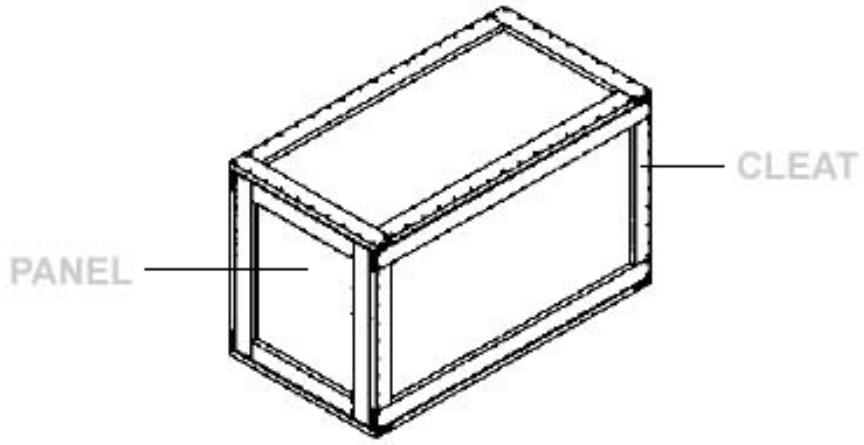

Figure 1. Typical wood box with principal parts labeled.

cleat – a piece of lumber used to strengthen or support the framework of a container

batten cleat – cleat oriented perpendicular to the lumber sheathing in order to provide rigidity to the lumber

diagonal cleat – cleat oriented diagonally to the lumber sheathed panel for added lateral support to the panel

filler edge cleat - cleat oriented flush with edge of a panel, but placed between the through edge cleat.

framing cleat – a cleat positioned at or near the edge of a panel with the intent of adding rigidity to the panel and increase the surface for fastening

intermediate cleat – cleat which is placed between through edge cleats and/or filler edge cleats to reduce unsupported span.

support cleat – a cleat positioned anywhere other than at the edge of a panel

through edge cleat – cleat that run the full length of a panel and are positioned flush with the panel edge

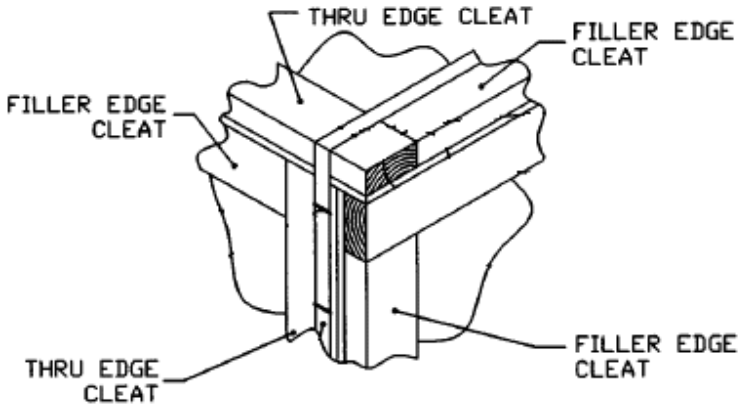

Figure 2. Types of cleats.

container – a general wood packaging terminology for a receptacle designed for efficient handling or storage of cargo.

container dimensions – interior container measurements typically expressed as length x width x height

container height – container measurement from top to bottom

container length – container measurement from left to right or perpendicular to runners if required

container width – container measurement from front to back

crate – a container with structural framework fastened together to form a rigid structure enclosure. Typically having an open construction concept with little or no panel support.

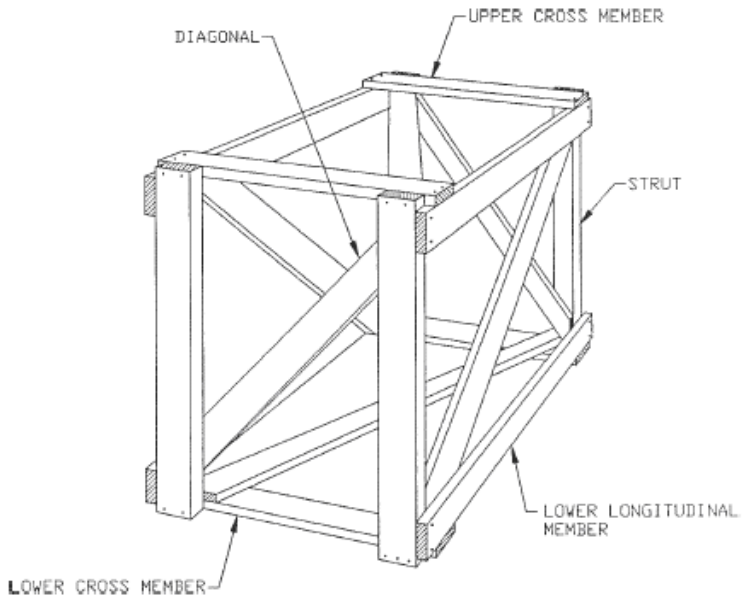

Figure 3. Typical wood crate with principal parts labeled.

diagonals – angle members placed between vertical and horizontal members within a section or panel to provide rigidity to the container

ends – composed of faceboards to which battens or cleats are attached forming a structural component along the width of a container

faceboards – sheathing boards used for the top, bottom, sides and ends of a container

floorboards – sheathing for the base fastened to the skids

header – end cross members of the base. Headers are bolted to the skids and act as fastening members for assembly of the end panels.

joists – load-supporting members of the top, spanning the width of the crate

liner – thin board stapled to the end to reinforce the end faceboard of wirebound containers

member – parts that form the fundamental structure of both sheathed and open crate – members are typically boards. This terminology can also refer to export boxes where structure is inside panel or sheathing.

> *bottom/lower member*_ - horizontal members at the bottom of the side and end panels
>
> *cross member* - member running perpendicular to longitudinal members
>
> *end member* – edge crosswise member of the top, located at each end of the panel

intermediate member – lengthwise members of the top, located between the side members

longitudinal member - lengthwise member of any panel

side member – edge members of a top without a joist, parallel to the length in sheathed containers.

top/upper member – horizontal members at the top of the side and end panels

pallet base – base of a pallet box

pallet box – a container with minimum openings an any face of the blank and having a pallet base to facilitate handling with mechanical equipment. Can also refer to a bulk container made from either lumber, plywood or cleated plywood sheathed material.

pallet collars – lumber or wood-based components fastened together with hinges to form the walls of a rigid or folding structure placed on top of a pallet.

sides – composed of faceboards or panels to which battens or cleats are attached forming a structural component along the length of a container

sill base – framework of load-bearing members called side, end and intermediate sills.

sills – member that, along with the sill bridging, form the framework of sill-base.

skid base – consists of longitudinal skids that are assembled with such cross members as headers, load-bearing floorboards, diagonals and plywood or lumber flooring

skids – lengthwise members of the base

strut – members placed vertically between upper and lower members

top - top most panel of any container. Also referred by “lid” or “cover”

wirebound container – May be in the form of a box, crate or pallet box. Manufactured by stapling faceboards, liners or panels together with cleats and battens with a binding wire. Produced in mat form these containers are assembled with a twist wire or loop-type closure.

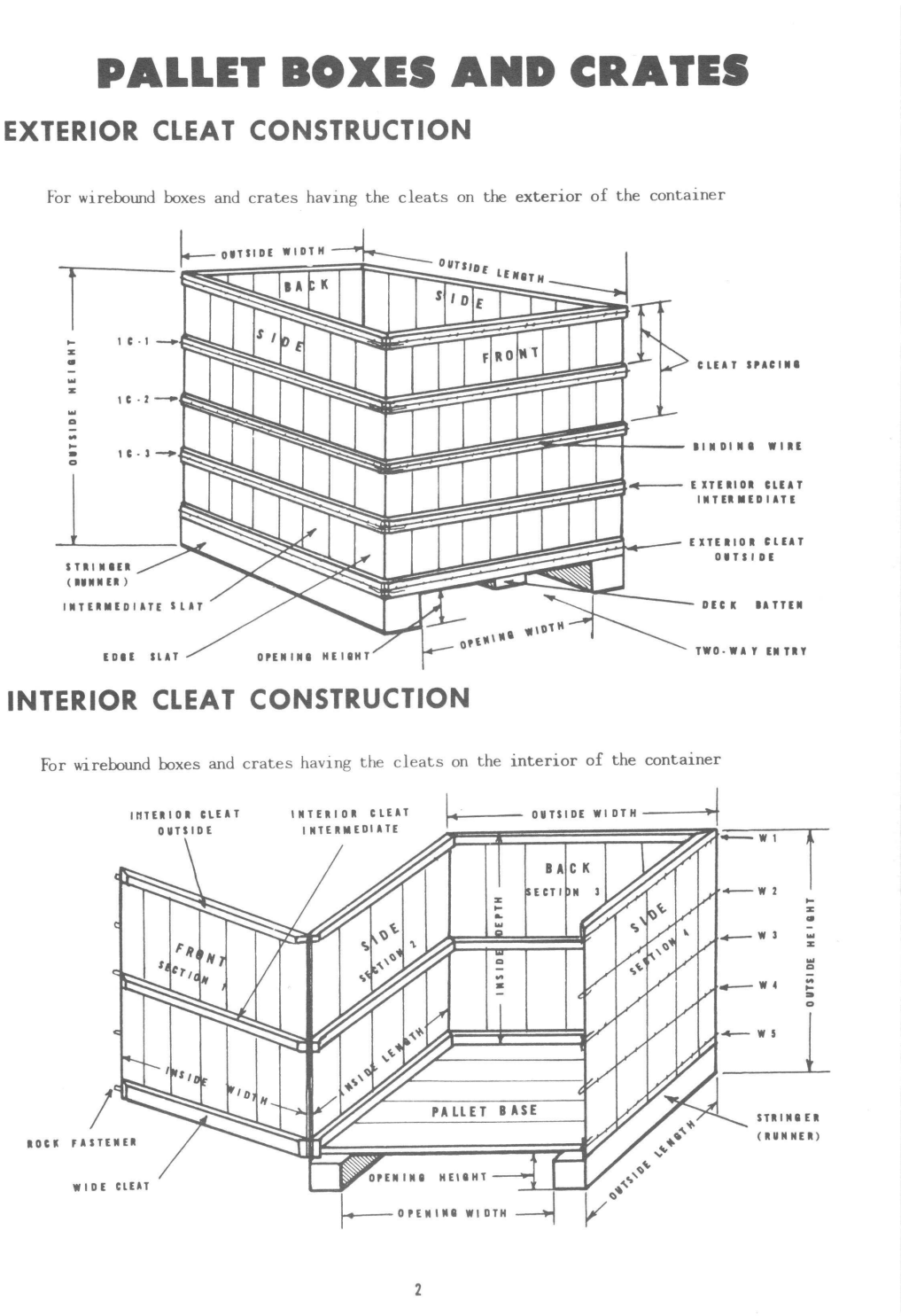

Figure 4. Typical pallet box with principal parts labeled.

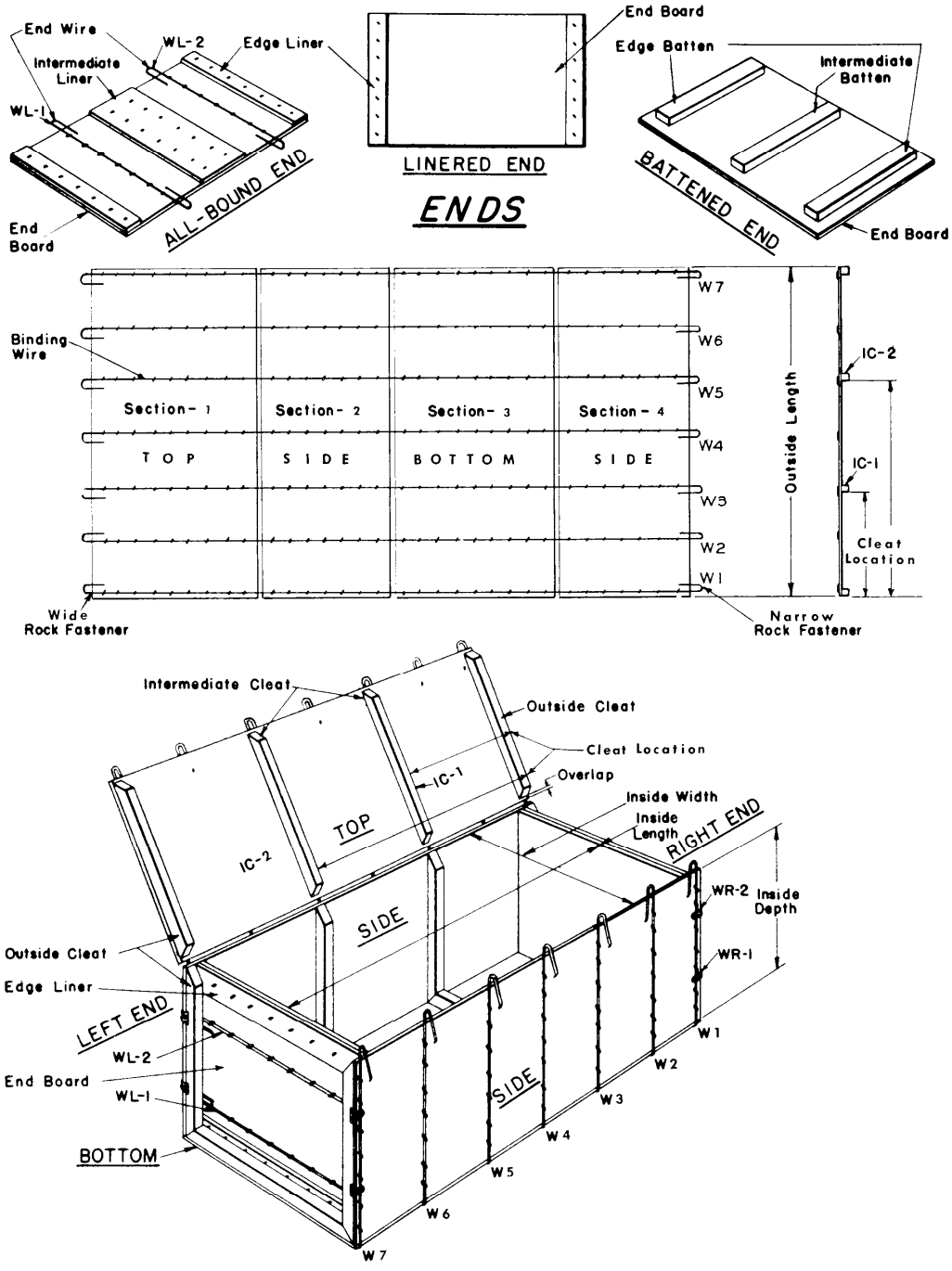

Figure 5. Typical wirebound container with principal parts labeled.

4 CONTAINER CLASSIFICATIONS

4.1 Box

4.1.1 Cleated panel box style (ASTM D 6251 wood-cleated panelboard boxes)

- Style A – this standard corner box style is the most common and with the correct filler panel can be built 48” in any direction before adding more structural cleats. Horizontal cleats give the panel rigidity but most of the strength comes from the corners. When increasing sizes, supports cleats or thicker panels may be used.

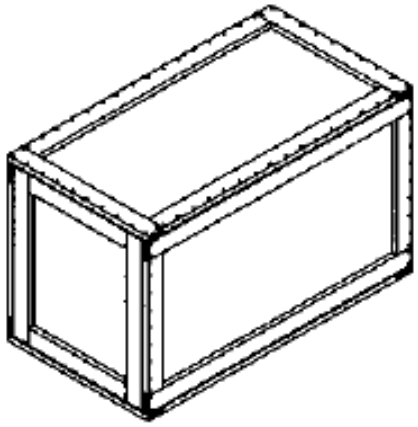

Figure 6. Style A cleated panel box (ASTM, 2006).

- Style B – box with interlocking three-way corners.

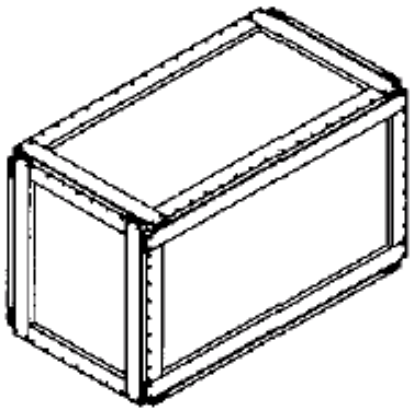

Figure 7. Style B cleated panel box (ASTM, 2006).

- Style C – the removal of cleats generally means a lighter duty application. However, the increase the panel thickness or product type can achieve certain desired results.

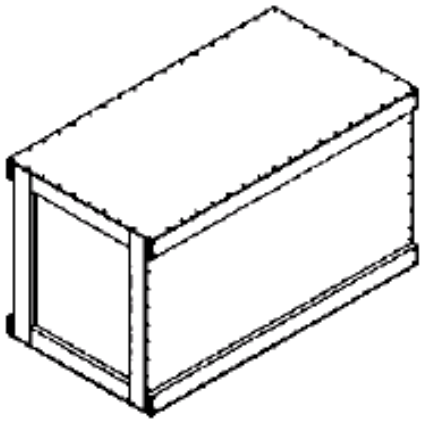

Figure 8. Style C cleated panel box (ASTM, 2006)

- Style E – this box style with the top having two cleats allows for the base to be locked in for stacking. For added strength, place vertical cleat inline with runner or riser to drive loads to ground level.

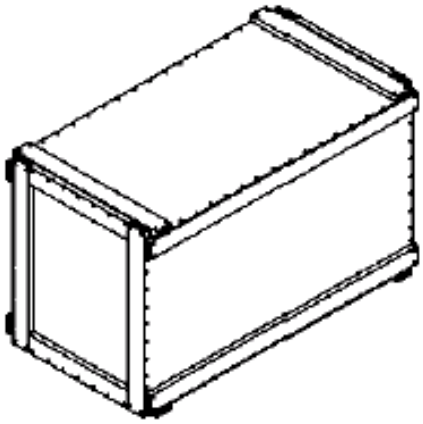

Figure 9. Style E cleated panel box (ASTM, 2006)

- Style F – additional cleats add rigidity to the panel product.

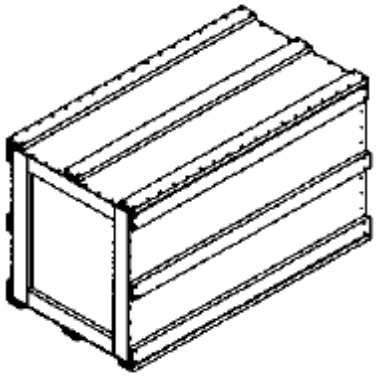

Figure 10. Style F cleated panel box (ASTM, 2006)

- Style G – interior cleating, commonly used for export shipments.

4.1.2 Box cleating arrangement (ASTM D 6256 wood-cleated boxes with skidded, load-bearing bases)

- Regular cleating

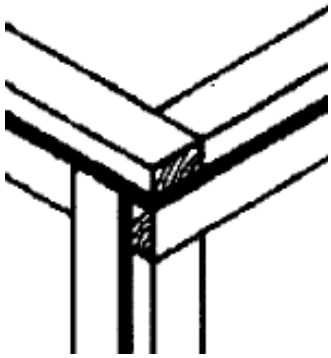

Figure 11. Regular cleating (ASTM, 2006)

- Lock corner cleating

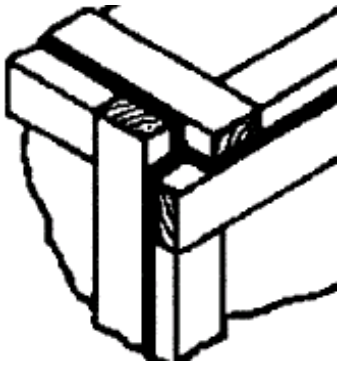

Figure 12. Lock corner cleating (ASTM, 2006)

4.1.3 Nailed wood box style (ASTM D 6880 wood boxes)

- Style 1 – uncleated ends

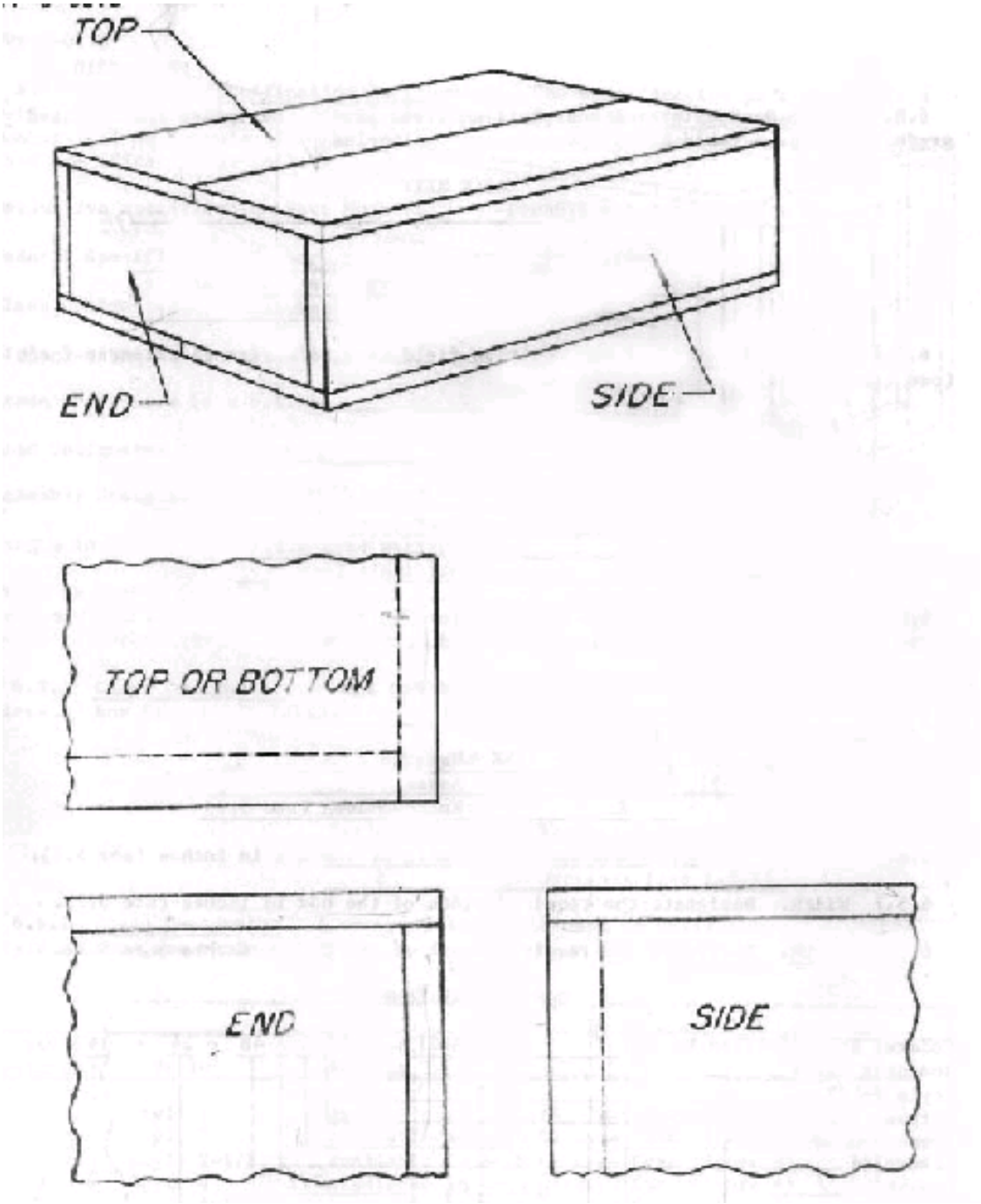

Figure 13. Style 1 nailed box

- Style 2 – full cleated ends, butt joints

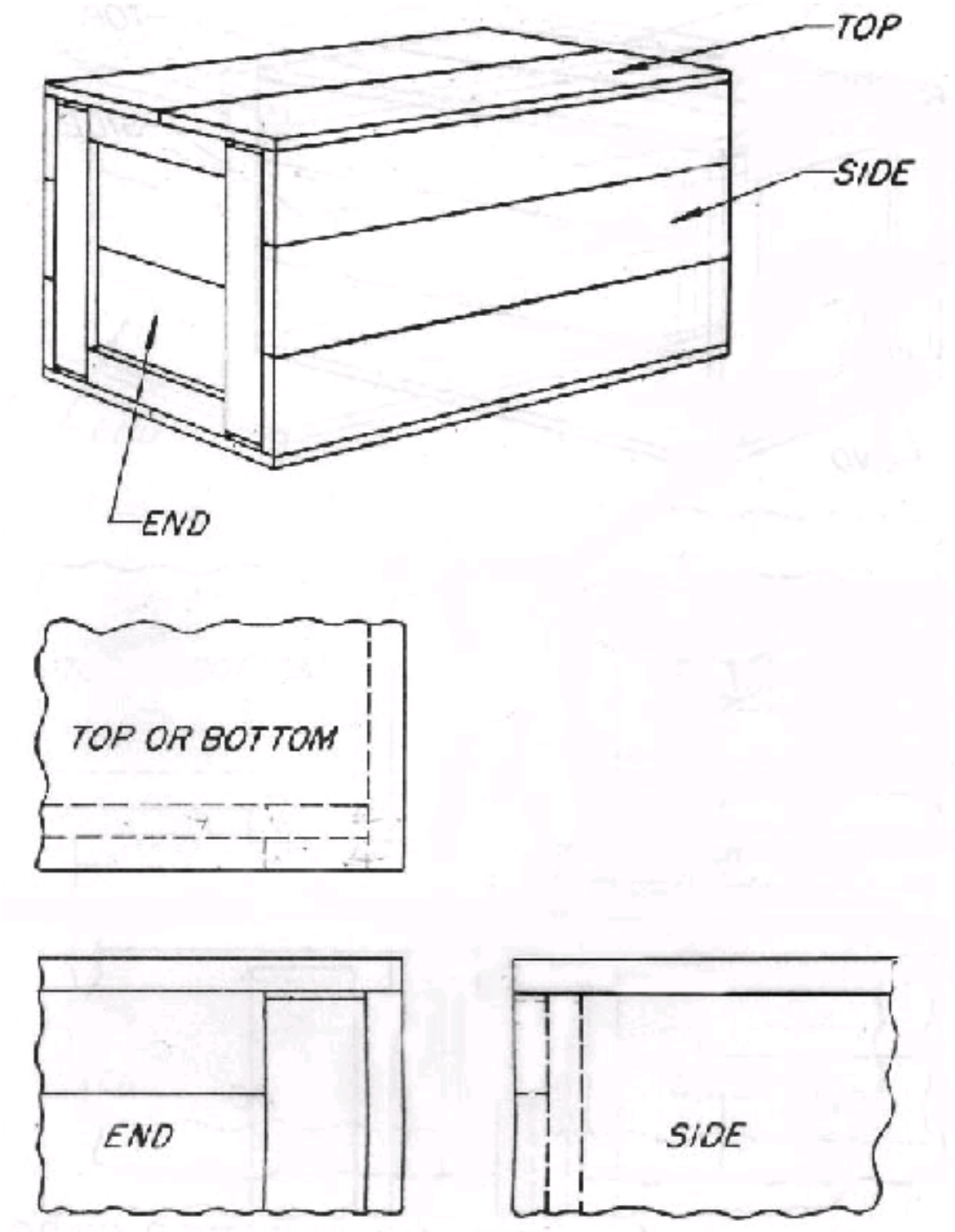

Figure 14. Style 2 nailed box

- Style 2 ½ - full cleated ends, notched cleats

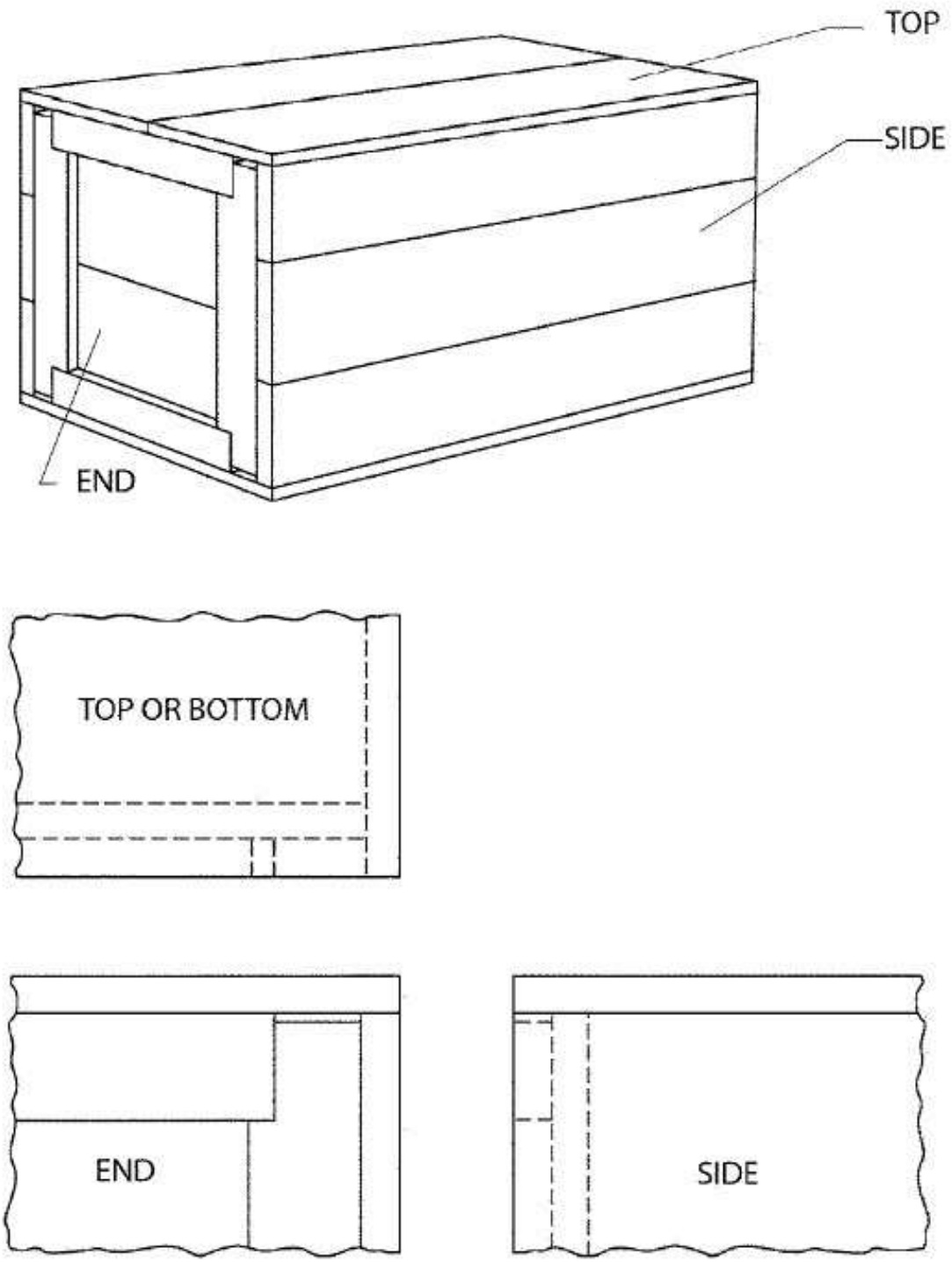

Figure 15. Style 2 ½ nailed box.

- Style 4 – two exterior cleat ends

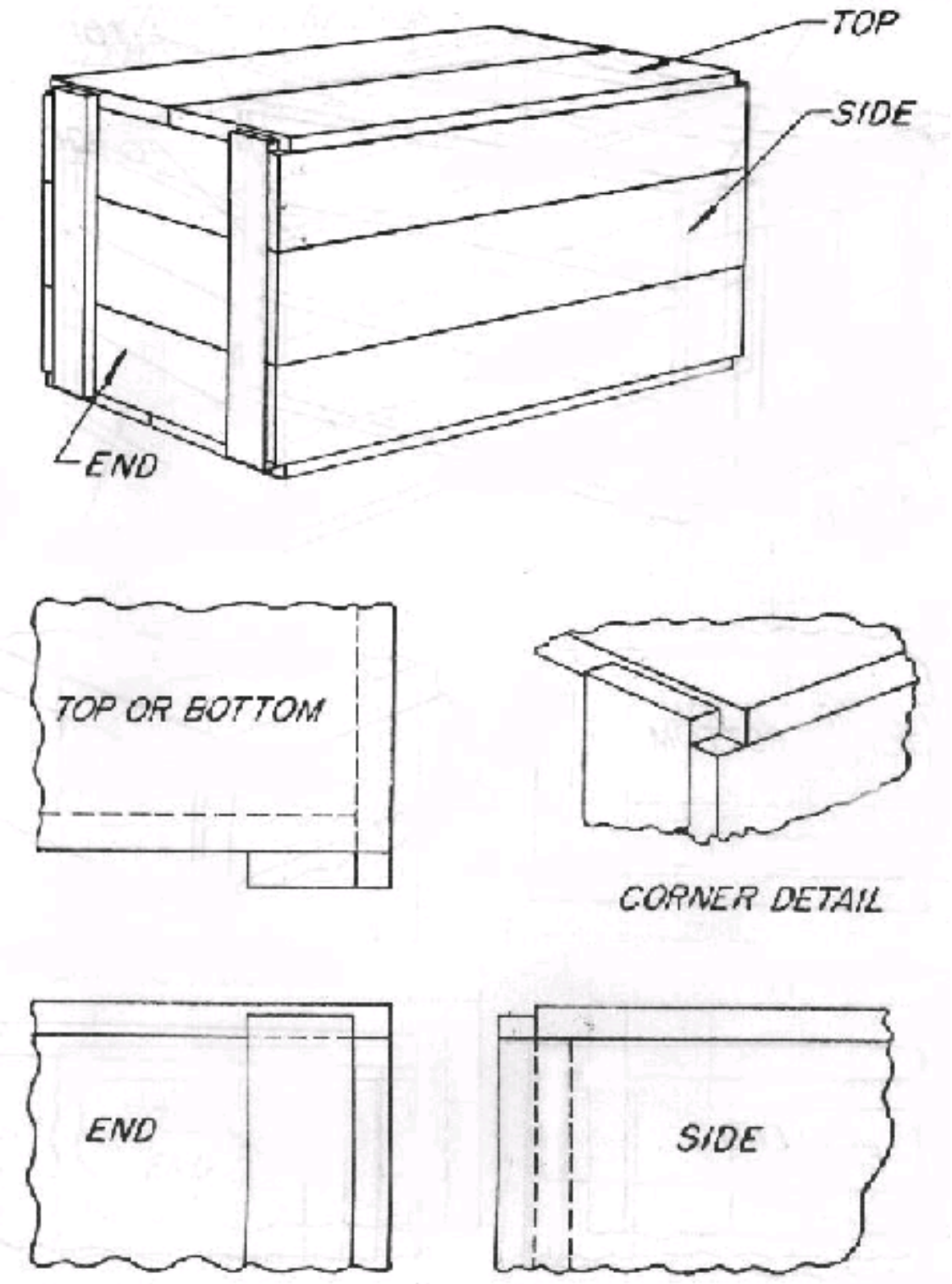

Figure 15. Style 4 nailed box

- Style 4 ½ - horizontal exterior cleat ends

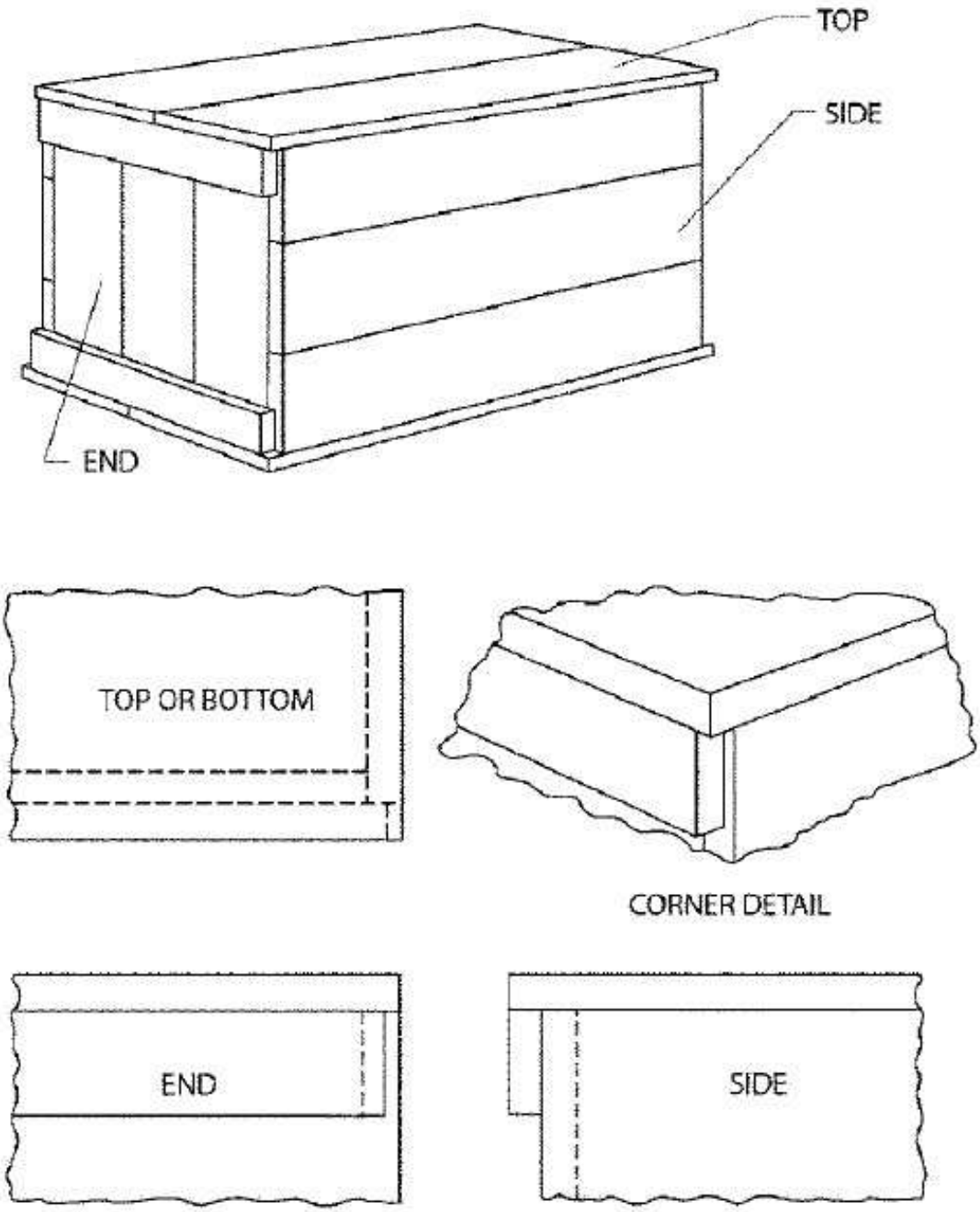

Figure 17. Style 4 ½ nailed box.

- Style 5 – interior end cleats

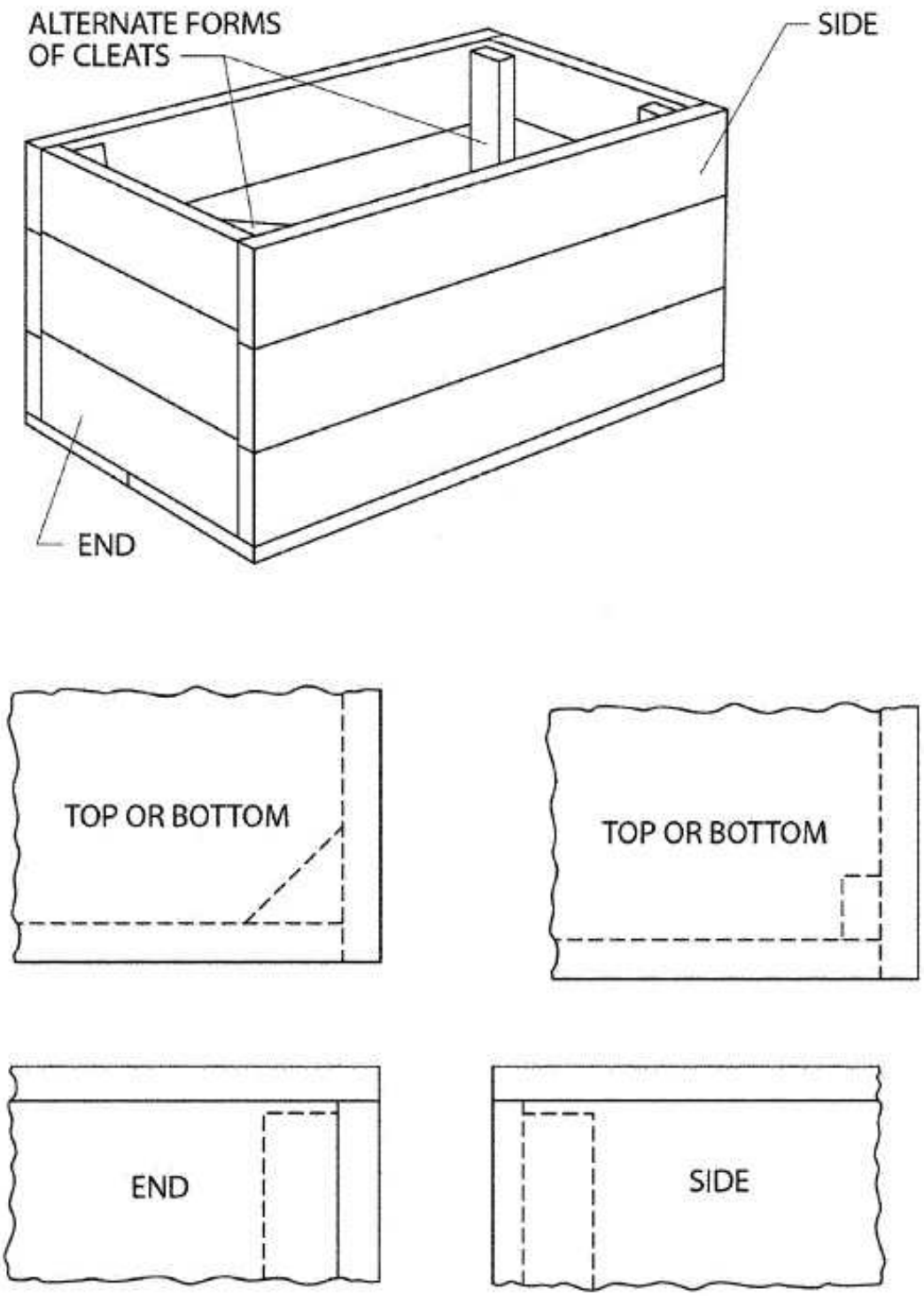

Figure 18. Style 5 nailed box.

- Style 7 – skidded base with separate hood

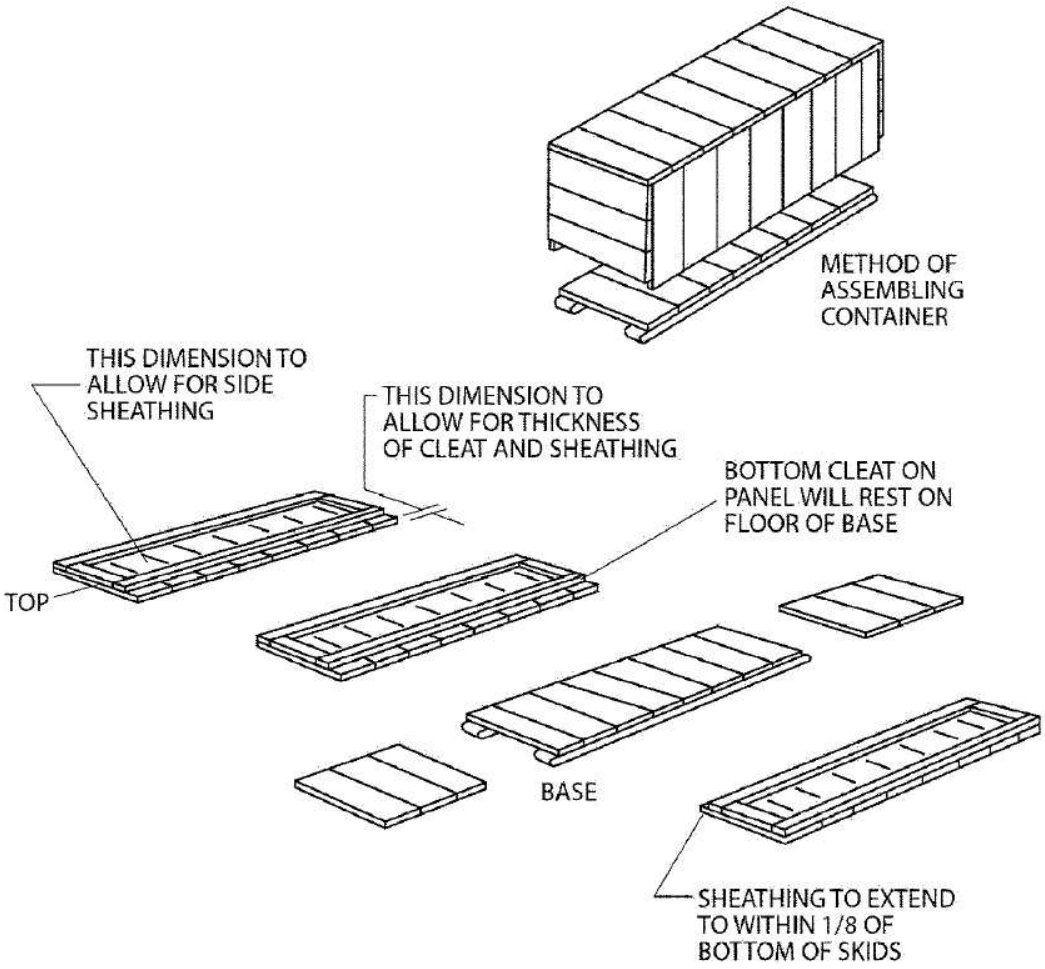

Figure 19. Style 7 nailed box.

4.1.4 Box panel composition type (ASTM D 6251)

- Type I - Corrugated plastic
- Type II - Corrugated and solid fiberboard
- Type III - Plywood
- Type IV - Oriented Strand Board (OSB)

4.1.5 Box base type (ASTM D 6256)

- Type I - Plywood base
- Type II - Lumber base

4.2 Crate

4.2.1 Open and covered crates type (ASTM D 6039)

- Type I

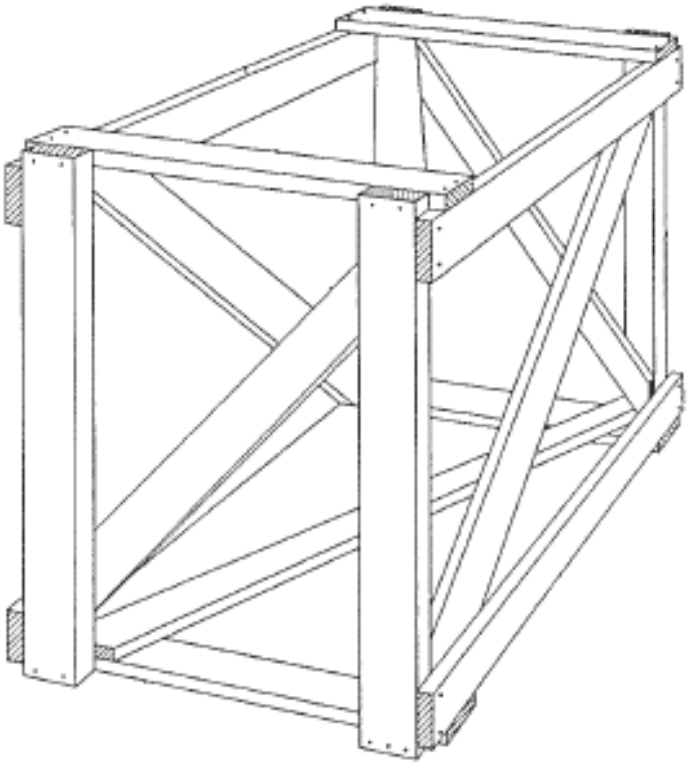

Figure 20. Type I crate assembly (ASTM, 2006)

- Type II

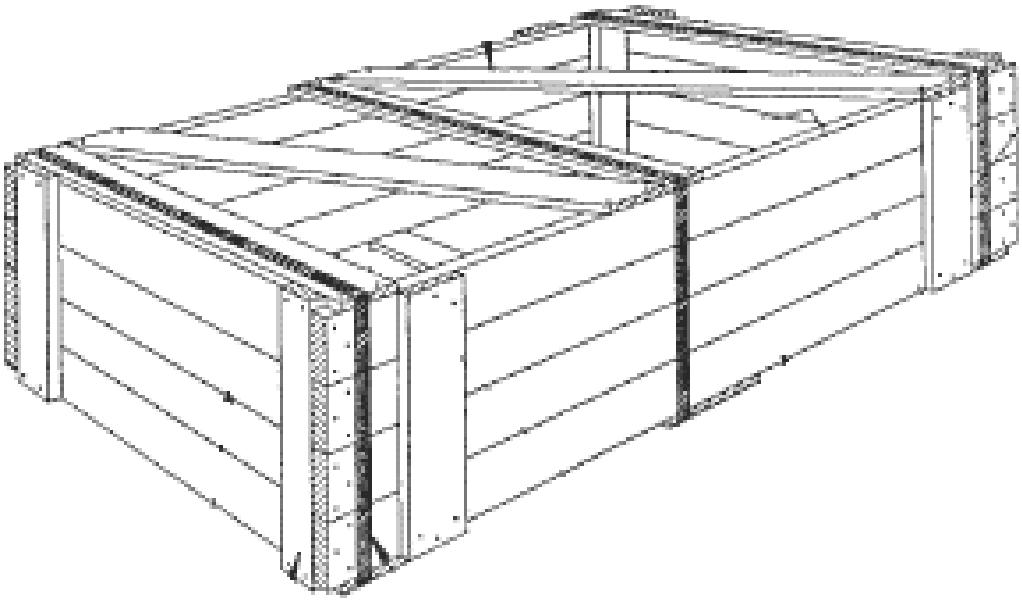

Figure 21. Type II crate assembly (ASTM, 2006)

- Type IV

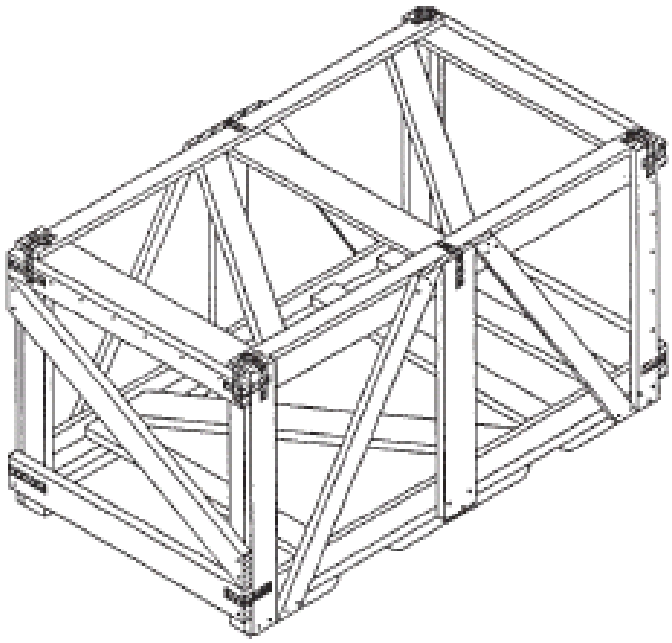

Figure 22. Type IV crate assembly (ASTM, 2006)

4.2.2 Heavy duty sheathed crate type (ASTM D 7478)

- Type I – nailed
- Type II – bolted

4.2.3 Heavy duty sheathed crate type (ASTM D 7478)

- Class I – lumber sheathed
- Class II – plywood sheathed

4.2.4 Heavy duty sheathed crate type (ASTM D 7478)

- Style A – skid base
- Style B – sill base

4.3 Wirebound Container Style (ASTM D 6573)

- Style 1 - twisted wire closure

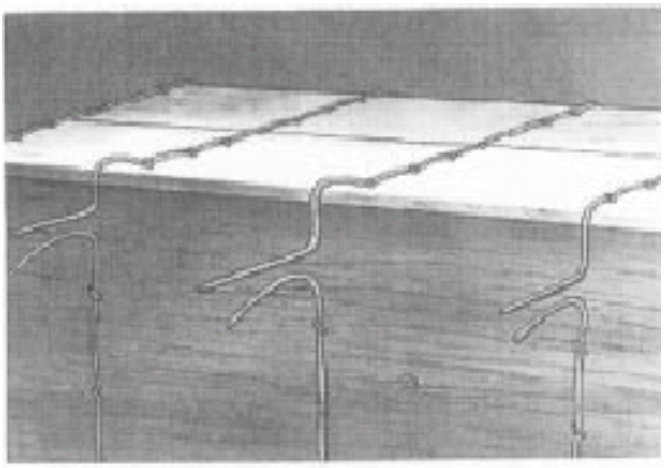

Figure 23. Style 1 wirebound box (ASTM, 2064)

- Style 2 - looped wire closure

Figure 24. Style 2 wirebound box (ASTM, 2006)

- Style 3 - looped wire closure with wired ends

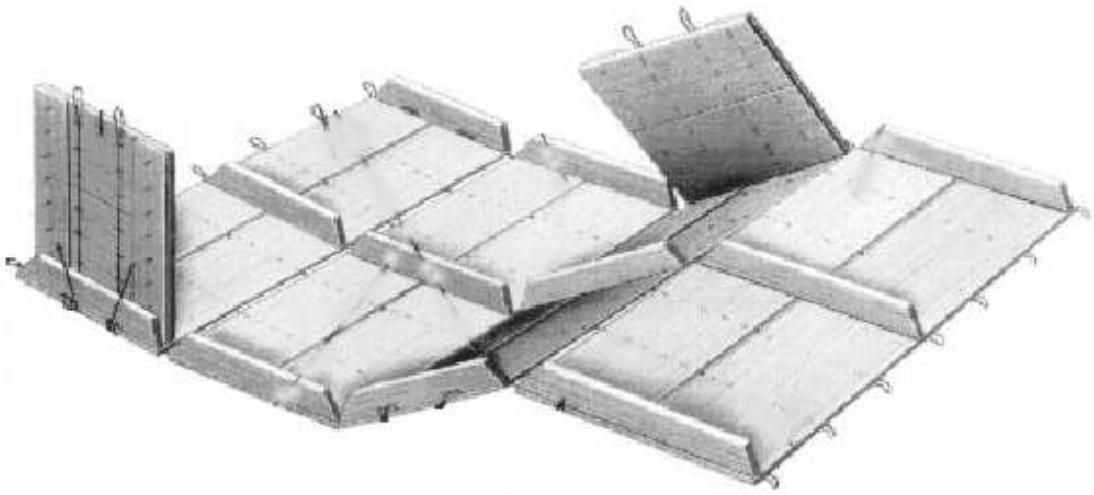

Figure 25. Style 3 wirebound box (ASTM, 2006)

4.4 Wirebound Pallet-type Box (ASTM D 6254)

4.4.1 Type

- Type I - Partial four-way entry base
- Type II - Two-way entry base
- Type III - Partial four-way entry base with two different length sidewalls
- Type IV- Two-way entry base with two different length sidewalls

4.4.2 Class

- Sheathed lumber, 2500-lb. (1134-kg) maximum load
- Sheathed lumber and veneer, 1500-lb. (680-kg) maximum load
- Sheathed lumber and veneer with tow different sidewalls, 1500-lb. (680-lb) maximum load
- Sheathed plywood, 2500-lb. (1134-lb) maximum load

4.5 Paller Collar

4.5.1 Class

- Class 1 - Heavy duty/general purpose
- Class 2 - Light duty

4.5.2 Construction

- Rigid
- Folding

4.6 Load type (ASTM D 996, D 6251)

- Easy – contents of low or moderate density conforming to the shape of the container and lending support to all faces of the container. (e.g. a corrugated box which sits inside the outer box)

- Average - contents of low or moderate density providing, when packed directly into a shipping container, nonshifting support at several points on the face of the container (e.g. items packed in partitions or cell dividers)

- Difficult – contents of irregular shape not lending support to the container or by great density or extreme fragility (e.g. Items that must be blocked or braced inside the container)

4.7 Destination class (ASTM D 6251, D 6256 and D 6573)

- Domestic – containers where protected storage and commercial type handling equipment is expected, no maritime shipment testing required.

- Overseas – containers for primitive supply systems, subject to repeated handling, unprotected storage, and extreme climactic hazards, temperature and humidity.

5 MATERIALS

5.1 Lumber Components

5.1.1 Wood species

The species used in wood container manufacture are numerous. As an aid to the container designer, Table 1 classifies commercially available North American species according to density. Woods listed in ASTM D6199 and various military specifications for wood containers are also based on density. Annex B provides a cross reference between the species classes used herein and those listed in ASTM D6199, the Pallet Design System (PDS), the NWPCA Uniform Standard for Wood Pallets, and MH1 Pallets, Slip Sheets, and Other Bases for Unit Loads.

5.1.2 Quality of wood components

Lumber components shall meet or exceed the minimum quality indicated by growth-related defect limitations and the manufactured defect limitations specified below. Definitions of growth-related defects can be found in Annex C.

Growth-related

Checks, splits and shakes – these types of defect that are no longer than the width of the member are permitted. Checks that do not extend through the full thickness of the member are permitted.

Cross grain – shall not deviate more than 25 mm (1 in.) in 100 mm (4 in.) of length

Decay - any form of visible decay is not permitted. Stains or discolorations, not associated with decay, are acceptable provided they are not located on the outer edge or on the exposed sides of components

Sound knot – shall not exceed 7/8 of the cross section affected

Unsound knot – shall not exceed 2/3 of the cross section affected
Wane - wane is permitted on any component provided it is not located on the outer edge or on the exposed sides of components

Warp - the bow in a member shall not exceed 2 mm (1/16 in.) per 300 mm (1 ft.) of length. The cup in a member shall not exceed 6 mm (1/4 in.) in a 200 mm (8 in.) width, 3 mm (1/8 in.) in a 100 mm (4 in.) member, or a like proportion in other widths. The twist in a member shall not exceed 6 mm (1/4 in.) in a 200 mm (8 in.) width, 3 mm (1/8 in.) in a 100 mm (4 in.) member, or a like proportion in other widths.

Table 1. Wood Species Groups.

DENSITY	HARDWOODS	SOFTWOODS
High density	American beech Ash (green, Oregon, white) Birch (yellow, sweet) Black cherry Black locust Dogwood Elm (rock, slippery) Hickory Maple (bigleaf, black, red, sugar) Oak (Eastern red and white) Persimmon Tanoak	
Medium density	Ash (black, pumpkin) Cascara Chinquapin Hackberry Magnolia Myrtle Oak (California black, Oregon white) Pacific (madrone) Paper birch Red alder Sweetgum Sycamore Tupelo Yellow-poplar	Baldcypress Douglas fir (coast, Interior North, Interior South, Interior West) Eastern hemlock Fir (balsam, California red, grand, noble, Pacific silver, subalpine, white) Hemlock (mountain, Western) Pine (Eastern white, jack, lodgepole, Monterey, Norway, Ponderosa, sugar, Western white) Redwood Southern pine (pitch, pond, spruce, Virginia) Southern yellow pine (loblolly, longleaf, shortleaf, slash) Spruce (black, Engelmann, red, sitka, white) Western larch Western red cedar
Low density	American basswood Aspen (bigtooth, quaking) Buckeye Butternut Catalpa Cottonwood (balsam poplar, black, eastern)	Cedar (Alaska, Atlantic white, Eastern red, incense, Northern white, Port Orford),

Manufactured defect

Step - otherwise called saw (arbor) mismatch; not to exceed 0.75 mm (1/32 in.) on exposed face of components.

Bevel sawing - acceptable if no more damaging than allowable wane or allowable size tolerance for members, diagonals, headers and struts.

Manufactured (unintentional) hole - same as unsound knot

Saw cuts - same as unsound knot

5.1.3 Moisture content of components

The moisture level of wood components is not limited. For measuring the moisture content of wood, use the following methods:

– ASTM D4442 Standard test methods for direct moisture content measurement of wood and wood-base materials
– ASTM D7438 Standard practice for field calibration and application of hand-held moisture meters

5.1.4 Preparation of components

Lumber component tolerances apply at any moisture content.

Dimensions

Lumber components shall have a target thickness and width uniform in dimension and 50% of components shall meet or exceed the target dimension at the time of component manufacture. Based on current Good Manufacturing Practices (GMP), the target thickness of components may deviate ±0.8 mm (±1/32 in.).

The following are acceptable manufacturing tolerances allowed on established target dimensions of lumber components:

Width: ±1.6 mm (±1/16 in.) maximum deviation
Height: ±1.6 mm (±1/16 in.) maximum deviation
Length: +3 mm (+1/8 in.), -6 mm (-1/4 in.) maximum deviation

Conformance to these manufacturing tolerances can be expressed using standard statistics reflecting variations equal to or less than those permitted in this Standard. Two standard deviations from target size shall be less than the tolerances specified.

Chamfer

Chamfers, if specified, shall be located on both outside faces of bottom end boards and all interior edges of bottom boards adjoining wheel openings. The chamfers shall be at least 305 mm (12 in.) long at an angle between 35 to 45°, located 6 mm (¼ in.), ±3 mm (±1/8 in.) from the bottom of the board. Chamfers shall not extend into connections.

Notches

Notches, if required, shall be specified by location (distance from end), depth and length. The recommended opening sizes to be provided by the notch and bottom deck, if present, are 50 mm (2 in.) to the top of the notch and 230 mm (9 in.) in length with a minimum flat surface of 180 mm (7 in.) recommended for the notch top. Notches shall have rounded or filleted corners with a radius not less than 13 mm (½ in.), nor greater than 38 mm (1 ½ in.). Square notches are not acceptable. Manufacturing tolerances shall be ±3 mm (±1/8 in.) of actual specified dimensions except for the notch location which shall be within ±9.5 mm (±3/8 in.) of target.

5.2 Wood Panel (Plywood or OSB) Components

5.2.1 Quality of panel components

Panels shall conform to the latest edition of one of the following standards:
- PS 1-95 Construction and Industrial Plywood
- PS 2-04 Performance Standard for Wood-based Structural-use Panels
- PRP 108 Performance Standards and Policies for Structural-Use Panels

Each panel used to produce container components shall be identified with the appropriate trademark of a recognized grading agency *(see Annex D)*. The firm supplying the panels shall furnish certification that the original panels were trademarked.

All panels used for container components shall be bonded with moisture resistant adhesive and be identified as either Exposure 1 or Exterior on the panels' agency trademarks. Panels that have manufacturing defects such as areas where adjacent veneers are not adequately bonded together that exceed the limits by the Standards listed in this Section as a result of their manufacturing process are not permitted to be used for new or repaired containers.

5.2.2 Grade of panel components

Unless specified otherwise by the purchaser, panels shall be either: Rated Sheathing, Exposure 1; or Rated Sturd-I-Floor, Exposure 1. Exterior is an acceptable alternative to Exposure 1.

5.2.3 Preparation of panel components

Wood panel components shall have a target thickness and width uniform in dimension and 50% of components must meet or exceed the target dimension at the time of component manufacture. Based on current GMP, the target thickness of panel may deviate ±0.8 mm (±1/32 in.).

Blocks may be laminated from panel components. The target width, length, and height of finished panel component blocks may exceed the specified dimensions by a maximum of 3 mm (1/8 in.). Sides shall not deviate from being square to the block top or bottom by more than 3 mm (1/8 in.), and any deviation from square shall not be in addition to the target width and length.

The following are acceptable manufacturing tolerances allowed on established target dimensions.

Thicknesses: ±0.8 mm (±1/32 in.) maximum deviation
Length and Width: ±3 mm (±1/8 in.) maximum deviation

Conformance to these manufacturing tolerances can be expressed using standard statistics reflecting variations equal to or less than those permitted in this Standard. Two standard deviations from target size shall be less than the tolerances specified.

5.3 Fasteners

Fasteners are classified as driven nails and staples, bolts, wood screws, lag bolts, wires and strappings. The types and properties of fasteners dramatically affect container performance.

5.3.1 Driven fasteners

Driven fasteners include nails and staples. As used in containers, nails are classified as plain-shank, helically threaded, annularly threaded, fluted, or twisted square wire. Staples have either round-wire or approximately square-wire legs, referring to the cross-sectional shape of the wire. All driven fasteners shall be specified using either of three methods:

1. Direct measurement of the physical and mechanical characteristics (Table 2 and Figure 19)
2. Specification of connection design properties, or
3. Both 1 and 2.

Table 2. Physical and Mechanical Characteristics of Driven Fasteners Used in Wood Containers[a].

NAILS[b]				STAPLES	
Plain shank	Helically threaded	Annularly threaded	Fluted/Squared wire	Round wire	Square wire
Length	Length	Length	Length	Length	Length
Wire diameter	Wire diameter	Wire diameter	Wire diameter	Wire diameter	Wire diameter
	Thread length	Thread length		Crown length	Crown length
	Thread-crest diameter	Thread-crest diameter	Flute-crest diameter	Crown width	Crown width
	Number of helixes	Number of rings	Number of helixes		
	Number of flutes		Number of flutes		
MIBANT angle[c] or bending yield strength[d]	MIBANT angle or bending yield strength	MIBANT angle or bending yield strength	MIBANT angle or bending yield strength	MIBANT angle or bending yield strength	MIBANT angle or bending yield strength

a ASTM F680

b Nail heads shall be flat or slightly countersunk in shape. Nails shall have no point or a blunt point, not to exceed 5/32 in. (4 mm) in length. In chisel point nails, the point width shall not exceed the wire diameter.

c When the MIBANT test is performed, not more than 8% of the fastener shall show partial or complete shank failure.

d ASTM F1575

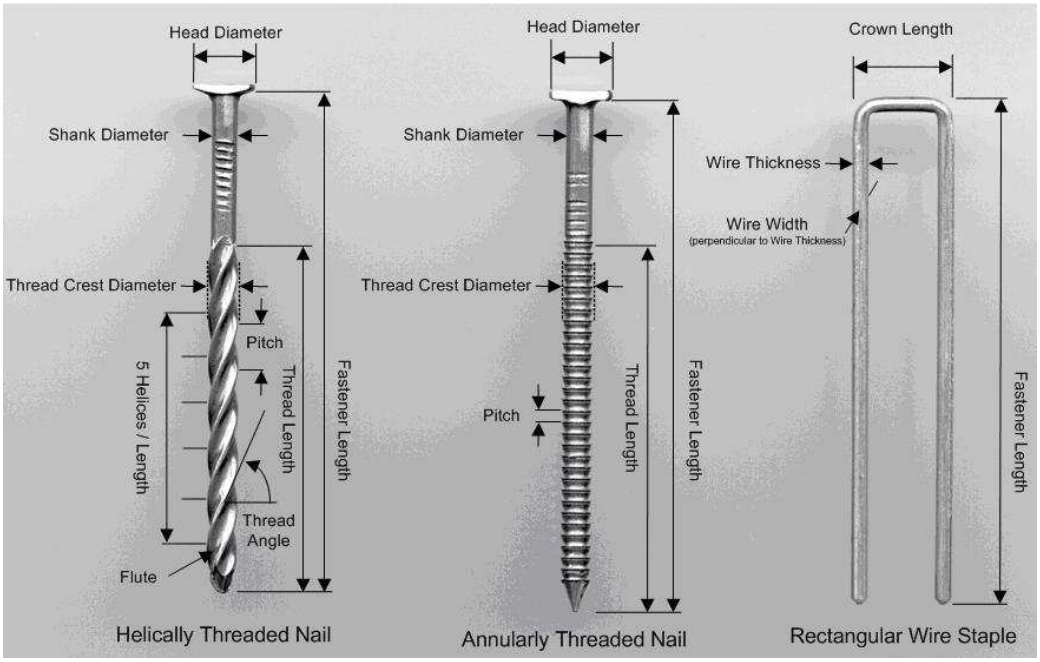

Figure 19. Schematic diagram of driven fasteners used in wood containers, indicating the measurements of the physical characteristics in Table 2.

The fastener length shall be sufficient to provide a minimum penetration of 1-1/4 in. (32 mm) into the stringer or block for all deckboard thicknesses over 1/2 in. (13 mm) and a minimum penetration of 1 in. (25 mm) for deckboard thicknesses of 1/2 in. (13 mm) or less. Manufacturing tolerances shall conform to those specified in ASTM F1667 and bending yield strength shall not be less than 100,000 psi (690 MPa).

Staples used fastening binding wires to faceboards, veneer, plywood, cleats, etc of wirebound containers shall be made from low carbon steel wire. The wire tensile strength shall be between 95,000 and 125,000 lbs./in^2 (655,000 and 861,844 kPa).

5.3.2 Bolts

For bolted constructions, standard steel carriage bolts can be used. Unless otherwise specified, these bolts shall be furnished in the coarse thread series, Class 2A tolerance (ASME B1.1). When steel carriage bolts are employed, washers under the head of the bolt shall be used if specified. If bolts with underhead fins are specified, instead of carriage bolts, washers under the head shall be not be used. Washers shall be located under the bolt nut.

The sizes of the holes drilled through components shall be 1/32 in. (0.75 mm) larger in diameter than the bolt diameter for bolts less than 1/2 in. (13 mm) diameter. For 1/2 in. (13 mm) or larger diameter bolts, the hole shall be 1/16 in. (1.5 mm) larger. When two or more bolts are connecting green members, the over sizing of holes shall be twice that specified above.

The head and nut bearing surfaces shall be washer faced with a flat or lock washer as specified. If "Teenuts," or equivalent, are specified, washers below the head shall be not be used.

5.3.3 Wood screws and lag bolts

Screws and lag bolts, provided with cut or rolled, single or double threads along two-thirds of their shank length, shall be inserted into the components to be assembled with a screwdriver or screw motion machine tool. Overdriving and overtightening of the connection shall be avoided. Approximately two-thirds of the screw length and seven times the shank diameter shall be the penetration length into the fastening member. Where predrilling is required, the maximum lead-hold diameter shall be the fastener-shank diameter, and the pilot-hole diameter shall not be larger than the thread-root diameter. Where lag bolts are used, washers under the head of the bolts shall be used.

5.3.4 Metal connector plates

Plates shall be minimum of 38 mm (1.5 in.) in width and 76 mm (3 in.) in length and 7100 mm^2 (11 $in.^{2)}$ in area as determined by external plate dimensions. Minimum thickness is 20-gauge, uncoated commercial grade sheet metal. At least 4 teeth per 645 mm^2 (4 teeth per $in.^2$) of plate area as determined by external dimensions. Length of teeth shall be at least 8 mm (0.325 in.) excluding plate thickness.

5.3.5 Binding wires

Binding wire shall be galvanized. Binding wire shall be continuous around the container girth. One binding wire shall be placed over each row of cleats. When possible, the remaining wires shall be spaced uniformly between the wires that are placed over each row of cleats. Closures should be either looped wire or twisted loop wire closures.

5.3.6 Hinges

Hinges used in pallet collars must be galvanized. Hinge thickness varies between 1.25 – 2 mm.

5.3.7 Strapping and additional support

Container type, configuration, and contents weight should be considered when determining strapping requirements. Strapping shall be located so that nailing is through a cleat. Straps shall be drawn tight so as to sink into the wood at the edges. Corner strapping shall be prepunched or drilled.

Where strapping is required in wirebound containers, the top cleats shall be brought into contact with the side cleats and strapping applied before wires at closing edges are twisted or looped.

6 MANUFACTURE

6.1 Location of Defects

For description and definitions, *see Section 5.1.2 and Annex C.*

6.1.1 Sound knots

Fasteners may be driven through sound knots.

6.1.2 Unsound knots and holes

Fasteners shall be compensated when associated with unsound knots or holes. Unsound knots or holes shall not be permitted in the outer edge and on the exposed ends of components.

6.1.3 Wane and decay

Wane may appear on other surface of components; but in no case shall fasteners be driven into or through either defect. Not more than one third (33%) of the components in a container may contain wane. Any fastener associated with maximum wane shall be compensated.

6.1.4 Splits and shake

Splits and shakes running the full thickness of a component (not applicable to nail splits) shall be straddled with fasteners.

6.2 Assembly

Container dimensions

Container dimensions shall be specified by length, width and height. Box dimensions shall be inside measurements, side to side and end to end. Dimensions of wirebound containers are measured between the inside surfaces of the faceboards.

The container size shall be limited to plus +6 mm (+¼ in.) and minus -13 mm (-1/2 in.) of the target dimension, as measured at specific points along the length, width and height. The container must be flat on their top and bottom surfaces to within 6 mm (¼ in.) maximum deviation from the corner-to-corner straight line.

Squareness

Square or rectangular container shall be limited to 1.5% or 25 mm (1 in.) difference in the measured top member diagonals, whichever is greater.

Fastening

Container members shall be assembled by nailing, stapling, bolting, screwing, wiring, hinges, adhesive or any method that can be supported by appropriate documentation of performance. Container panels shall be attached to cleats by nailing, stapling, wire stitches or gluing side and end panel. Adjacent side and end panel edges shall be lapped and fastened similarly.

Apply hinges and plates with mechanical, hydraulic, or pneumatic power, using machinery designed and manufactured for this purpose. Hinges and plates shall be aligned in such a way that they do not overhand the cleat end or edges.

Alternative fastening systems can be used to secure the container together. The systems shall be installed per manufacturer directions in accordance to container contents weights and construction.

Jointing

Members to be used for the sides, ends, tops or bottoms may be built up by joining pieces together at their edges using one of the following methods: Linderman joint and glue; butt joint and glue; or tongue and groove joint and glue.

Adjacent panel edges shall be butted at the mid-width of a joint cleat and each piece fastened to the cleat.

Splices

Splices and butt joints made in frame members and skids using nails, bolts and metal plates are allowed. Although it is desirable for wood members to be a single wood piece without any joints.

Box Assembly

Sides, tops and ends of boxes must be of cleated lumber or panel construction. Panel must either be plywood, OSB or fiberboard.

Lumber flooring shall be laid at right angles to the skids. Board ends must be flushed with the outer edges of the skids. Each box shall be provided with a minimum of two skids. When skids are used, strapping is required.

Any box panel having the load concentrated near the center of an unframed area shall be reinforced with an additional cleat of the same width and thickness of the edge cleat.

Boxes can be provided with ventilation holes or slots, which shall be located at each end, or at ends and sides, or around the box perimeter. When load-bearing floor members are placed over panel bases, at least one drainage hole shall be placed on each side of the base between the load-bearing floor members.

Crate Assembly

Diagonals, struts, cross members and longitudinal members shall be fastened together in patterns. Top and bottom cross members must be directly opposite each other. Longitudinal members shall coincide with the vertical struts of the ends. Joists must be placed flat and should coincide with each strut of the side. Diagonals must be between 30 and 60° and used between each two adjacent struts. Bottom diagonals shall be in reverse direction with the top diagonals. Top lateral members shall coincide with the vertical struts of the sides and equal in number. Sides, ends, base and top shall be fastened together.

Sides of crates shall be of lumber or cleated-plywood or OSB.

Treatment

Wood containers can be treated with various water-repellant wood preservatives such as: copper napthanate with a minimum concentration of 2.0% copper metal, 3% zinc naphthenate, and oxine copper with a minimum concentration of 1.8% copper metal, and borates. Refer to customer requirements for specific treatment.

Marking

Customer specified or as called out in associated specifications.

PART II. PERFORMANCE STANDARD

7 CONDITIONS OF CONTAINER USE

The use conditions which containers shall sustain during unit-load material handling vary. Therefore, the conditions of use shall be specified, including performance levels. Where conditions of use vary, the condition which results in the highest stress levels shall be used as a basis for determining performance.

7.1 Load Conditions

Provide the description of the load of packages or units to be placed on or inside the container (i.e. bags, boxes, barrels, bulk containers, blocks and machinery including the use of load stabilizers).

Provide measurements and location of bearing areas for the packages or units to be placed on or inside the container and the container top and bottom panels or cleats.

Provide maximum and average load levels and load level variations.

7.2 Support Conditions

Indicate maximum unsupported free span along the container length or width.

Indicate maximum number of unit-loads in a stack.

Indicate measurements and locations of bearing areas between the support members.

7.3 Handling Conditions

Identify the handling devices that will be used to move the containers such as: fork trucks, pallet jacks, slip-sheets, conveyor types, automated storage and retrieval system (ASRS), automated guided vehicle (AGV), by hand. Also identify the mode of transport: ship, rail, truckload, parcel delivery, etc.

8 MEASURES OF CONTAINER PERFORMANCE

8.1 Strength

Determine design or safe working loads for each condition of use. The container and container component performance shall be based on the minimum design or safe working load.

8.2 Stiffness

Determine maximum deflection of container and container components for each condition of use.

8.3 Durability

Single-use containers are intended for one-way shipment and shall survive at least one cycle of performance tests.

Reusable containers are intended for repeated uses and shall survive at least ten cycles of performance tests.

Export containers are intended to ship to multiple stop-off points with the potential of traveling over rough terrain. Wood container must meet the phytosanitary requirements of the countries where the container travels.

The criteria for the classification of wood containers are given in the documentation of the test procedures provided in Section 9.

9 TEST PROCEDURES

When possible, actual loads and supports shall be used in the test. The following test methods and their design criteria are recognized:

ASTM D1185. Standard Test Methods for Pallets and Related Structures Employed in Material Handling and Shipping

ASTM D4169-01^{e1} Standard Practice for Performance Testing of Shipping Containers and Systems

ASTM D6055-96(2002) Standard Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates

ASTM D6179-97 Standard Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates

ASTM D6251M-01 Standard Specification for Wood-cleated Panelboard Shipping Boxes

EN 13545 Pallet superstructures – Pallet collars – Test Methods and performance requirements

PART III PHYTOSANITATION STANDARD

10 PHYTOSANITATION OF WOOD CONTAINERS

Treatment and marking of wood containers must conform to the International Standards for Phytosanitary Measures Publication No. 15 (ISPM 15) Regulations of wood packaging material in international trade. ISPM 15 has been adopted by the United States and its trading partners as their import requirements for wood containers.

Treatment or quality mark (Figure 20) should include the following:
- IPPC logo
- Two-letter U.S. abbreviation
- Unique number assigned by an inspection agency to the facility
- HT or MB abbreviation

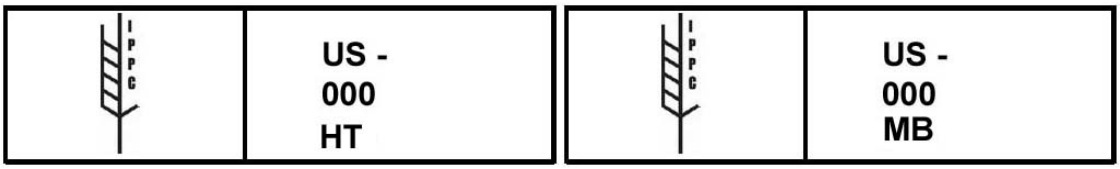

Figure 20. HT and MB treatment marks.

Wood containers can be ISPM 15-compliant by adhering to any of the following:

10.1 Debarked

Wood containers must be made of debarked wood. Any number of visually separate and clearly distinct small pieces of bark may remain if they are:
- Less than 3 cm ($1^{3}/_{16}$ in.) in width (regardless of length), or
- Greater than 3 cm ($1^{3}/_{16}$ in.) in width, with the total surface area of an individual piece of bark less than 50 cm^2

10.2 Heat Treatment

Heat treatment and marking of wood containers shall conform to the enforcement regulations and policy of the American Lumber Standards Committee (ALSC) Wood Packaging Material (WPM) Program.

10.3 Methyl Bromide (MB) Fumigation

MB fumigation and marking of wood container sshall conform to the enforcement regulations and policy of the Export WPM Fumigation Program.

10.4 New Wood Containers

New containers that will be used for export shipment must be ISPM 15-compliant.

10.5 Recycled wood containers

Reusing ISPM 15-compliant wood containers do not require retreatment and remarking. However, repaired containers must be retreated and remarked in order to be ISPM 15-compliant. Old marks must be obliterated.

ANNEX A
STANDARDS AND SPECIFICATIONS CONCERNING WOOD CONTAINERS

ASTM International
www.astm.org

D10 Packaging
D10.11 Terminology
- D 996 Standard Terminology of Packaging and Distribution Environments

D10.12 Shipping containers, crates, pallets, skids and related structures
- D6039/D6039M Standard Specification for Open and Covered Wood Crates
- D6199 Standard Practice for Quality of Wood Members of Containers and Pallets
- D6251/D6251M Standard Specification for Wood-Cleated Panelboard Shipping Boxes
- D6254/D6254M Standard Specification for Wirebound Pallet-Type Wood Boxes
- D6256/D6256M Standard Specification for Wood-Cleated Shipping Boxes and Skidded, Load-Bearing Bases
- D6573/D6573M Standard Specification for General Purpose Wirebound Shipping Boxes
- D6880 Standard Specification for Wood Boxes
- D7478/D7478M Standard Specification for Heavy Duty Sheathed Wood Crates

D10.21 Shipping containers and systems – Application of performance test methods
- D1185 Standard Test Methods for Pallets and Related Structures Employed in Material Handling and Shipping
- D4169 Standard Practice for Performance Testing of Shipping Containers and Systems
- D6055 Standard Test Methods for Mechanical Handling of Unitized Loads and Large Shipping Cases and Crates
- D6179 Standard Test Methods for Rough Handling of Unitized Loads and Large Shipping Cases and Crates
- D6198 Standard Guide for Transport Packaging Design

APA – The Engineered Wood Association
- Big bin
- Slim bin
- Containers and bins
- PRP 108 Performance Standards and Policies for Structural-Use Panels

Department of Defense
assist.daps.dla.mil/quicksearch/
- MIL-DTL-2427H Box, Ammunition Packing: Wood, nailed
- MIL-C-3774B Crates, wood: Open 12,000- and 16,000-pound capacity
- MIL-C-21215A(1) NOT 1 Crates, pallets, ammunition

- MIL-PRF-11264E Containers: Shipping, reusable-for tank automotive engines, transmissions, differentials, transfers, final drives, drive axles, and similar assemblies
- MIL-STD-299 Visual inspection standards for nailed wood boxes and wirebound wood boxes used in small arms ammunition
- QSTAG-880 ED.1 Military pallets, packages and containers
- STANAG-2828 Military pallet, packages and containers

International Plant Protection Organization (IPPC)
www.ippc.int
- International Standards for Phytosanitary Measures Publication No. 15 (ISPM 15) Regulation of wood packaging material in international trade (2009)

Michigan State University
School of Packaging
packaging.msu.edu
Diana Twede and Susan E.M. Selke
- Cartons, Crates and Corrugated Board

National Institute of Standards and Technology (NIST)
www.nist.gov
- PS 1-07 Construction and Industrial Plywood
- PS 2-04 Performance Standard for Wood-based Structural-use Panels
- PS 20-05 American Softwood Lumber Standard

National Hardwood Lumber Association (NHLA)
www.natlhardwood.org
- Rules for the measurement and inspection of hardwood and cypress

National Motor Freight Traffic Association, Inc.
www.nmfta.org
- National Motor Freight Classification

European Committee on Standardization (CEN)
www.cen.eu
- EN 13545 Pallet superstructures – Pallet collars – Test methods and performance requirements

University of Florida
Institute of Food and Agricultural Sciences
- Pallet boxes for Florida citrus

US Department of Agriculture-Forest Service
Forest Products Laboratory
www.fpl.fs.fed.us

- Wood Crate Design Manual

ANNEX B
WOOD SPECIES CLASSIFICATION CROSS REFERENCE

SPECIES	DENSITY	ASTM D6199 GROUP*	Pallet Design System CLASS**
American beech	High density hardwood	IV	1
Ash (green, Oregon, white)	High density hardwood	III IV (white)	1 2 (Oregon)
Birch (yellow, sweet)	High density hardwood	IV	1
Black cherry	High density hardwood		1
Black locust	High density hardwood		1
Dogwood	High density hardwood		1
Elm (rock, slippery)	High density hardwood	III IV (rock)	1
Hickory	High density hardwood	IV	1
Maple (bigleaf, black, red, sugar)	High density hardwood	IV	1 2 (bigleaf)
Oak (Eastern red and white)	High density hardwood	IV	21
Pecan		IV	
Persimmon	High density hardwood		1
Tanoak	High density hardwood		1
Ash (black, pumpkin)	Medium density hardwood	III	3
Cascara	Medium density hardwood		4
Chinquapin	Medium density hardwood		4
Hackberry	Medium density hardwood		3
Magnolia	Medium density hardwood	I	3
Maple (silver, stripped)	Medium density hardwood	III	3
Myrtle	Medium density hardwood		4
Oak (California black, Oregon white)	Medium density hardwood	III	4
Pacific (madrone)	Medium density hardwood		4
Paper birch	Medium density hardwood		3
Red alder	Medium density hardwood	I	6
Sweetgum	Medium density hardwood	III	3
Sycamore	Medium density hardwood	III	3
Tupelo	Medium density hardwood	III	3
Yellow-poplar	Medium density hardwood	I	29

SPECIES	DENSITY	ASTM D6199 GROUP	Pallet Design System (PDS) CLASS
Baldcypress	Medium density softwood		13
Douglas fir (coast, Interior North, Interior South, Interior West)	Medium density softwood	II	11
Eastern hemlock	Medium density softwood	II	13
Fir (balsam, California red, grand, noble, Pacific silver, subalpine, white)	Medium density softwood	I	12 13 (balsam & subalpine)
Hemlock (mountain, Western)	Medium density softwood	II	12
Pine (Eastern white, jack, lodgepole, Monterey, Norway, Ponderosa, sugar, Western white)	Medium density softwood	I	13
Southern pine (pitch, pond, spruce, Virginia)	Medium density softwood	II	13
Southern yellow pine (loblolly, longleaf, shortleaf, slash)	Medium density softwood	II	22
Spruce (black, Engelmann, red, sitka, white)	Medium density softwood	I	13
Redwood	Medium density softwood	I	13
Tamarack (Eastern larch)		II	
Western larch	Medium density softwood	II	11
Western red cedar	Medium density softwood	I	13

SPECIES	DENSITY	ASTM D6199 GROUP	Pallet Design System (PDS) CLASS
American basswood	Low density hardwood	I	7
Aspen (bigtooth, quaking)	Low density hardwood	I	7
Buckeye	Low density hardwood	I	7
Butternut	Low density hardwood		7
Catalpa	Low density hardwood		7
Chestnut		I	
Cottonwood (balsam poplar, black, eastern)	Low density hardwood	I	7
Willow		I	
Cedar (Alaska, Atlantic white, Eastern red, incense, Northern white, Port Orford)	Low density softwood	I	14

* **Group I** embraces the softer softwoods and hardwoods. These species are relatively free from splitting in nailing, have moderate fastener withdrawal resistance, moderate strength as a beam, and moderate shock resisting capacity. They are soft, light in weight, easy to work, hold their shape well in manufacture, and normally easy to dry.

Group II consists of medium density softwoods. These woods usually have a pronounced contrast in the hardness of the earlywood and the latewood. They have a greater fastener withdrawal resistance than Group I species, but are more likely to split.

Group III consists of medium density hardwoods. These woods have about the same fastener withdrawal resistance and strength as a beam as the Group II species, but they are less likely to split and shatter at impacts. These species are the most useful for constructing container ends and cleats. They also furnish most of the rotary-cut veneers for wirebound containers and plywood panels for plywood boxes.

Group IV consists of high density hardwoods. They have greatest shock resisting capacity and fastener withdrawal resistance, but because of their extreme hardness present difficulties with respect to the driving of nails, plus the tendency to split at the nails.

** The Pallet Design System (PDS) pallet component species classes are listed according to similarities in mechanical properties, regional availability, and commercial use. The same classification is used in the NWPCA Uniform Standard for Wood Pallets and the Material Handling Industry (MHIA) MH1 Pallets, Slip Sheets, and Other Bases for Unit Loads.

ANNEX C
DESCRIPTION AND CLASSIFICATION OF DEFECTS

DEFINITIONS	CLASSIFICATIONS
Checks, splits and shakes – Separation within a wood member not confined to the wood surface, usually intersecting two surfaces. For the purpose of this Standard, a split intersecting only one face of the container part will be treated as split only when it exceeds ½ the depth, width or thickness of the piece and a check *Cross grain* – Fibers not parallel with the axis of a piece. May be either diagonal or spiral grain or a combination of the two. *Decay* - A disintegration of the wood substance due to actions of wood-destroying fungi, also known as dote, rot and unsound wood *Sound knot* - A knot that is tight, solid, without voids and at least as hard as the surrounding wood in at least one face, exhibiting structural strength *Unsound knot* – A knot that is loose and/or, due to decay, has no structural strength *Wane* - Bark of lack of wood from any cause, except eased edges, on the edges or corners of the container component *Warp* – any variation from a true or plane surface. Warp includes bow, crook, cup and twist.	<u>Critical defects</u> Broken components Protruding nails on panels and members Nonconforming containers due to size, flatness or squareness Missing wood exceeding allowable limits <u>Other defects</u> Checks Component placing Compression wood Crook Decay Decayed knot Fastener in knot Fastener in decay Fastener in maximum wane Holes Honeycomb Inside shiner Knots Missing fastener Moisture content Overhang Pitch Sawcut Shake Slope of grain Splits Step Underhang Wane Wane above notch Wane on edge of leading deckboard or exposed stringer

ANNEX D
WOOD PANEL GRADING AGENCIES

APA – The Engineered Wood Association
7011 So. 19th
Tacoma, WA 98466

PFS Corporation
Madison, WI

Timber Engineering Company (TECO)
Sun Prairie, WI