



# Standard Practice for Quality of Wood Members of Containers and Pallets<sup>1</sup>

This standard is issued under the fixed designation D6199; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope

1.1 This practice covers the quality requirements for three classes of hardwood and soft-wood members, excluding man-made or fabricated wood composites, used in the construction of boxes, crates, pallets, and blocking and bracing.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units given in parentheses are for information only.

1.3 *This practice does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of the regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

[D9 Terminology Relating to Wood and Wood-Based Products](#)

[D996 Terminology of Packaging and Distribution Environments](#)

[D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials](#)

2.2 *MHIA/ANSI Standard:*<sup>3</sup>

[MHIA/ANSI MH1–2005 Pallets, Slip Sheets, and Other Bases for Unit Loads](#)

## 3. Terminology

3.1 *Definitions*—General definitions for packaging and distribution environments are found in Terminology [D996](#). General definitions for wood are found in Terminology [D9](#).

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee [D10](#) on Packaging and is the direct responsibility of Subcommittee [D10.12](#) on Shipping Containers, Crates, Pallets, Skids and Related Structures.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from Material Handling Industry MHI Secretariat, 8720 Red Oak Blvd., Suite 201, Charlotte, NC 28217, <http://www.mhiastore.org>.

## 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *brash, n*—decay characteristic, which is the breaking of the grain without splintering.

3.2.2 *crate frame members, n*—those parts which form the fundamental structure upon which the strength and rigidity of crates depend.

3.2.3 *diagonals, n*—frame members placed at angles of nearly 45° to other frame members, to ensure the rigidity of the crate.

3.2.4 *linderman joint, n*—glued dove-tailed joint between two or more pieces of wood.

3.2.5 *longitudinal frame members, n*—horizontal members of the side, end, and top panels of crates.

3.2.6 *punk, n*—decay characteristic, which is very dry, powdery, and crumbly wood.

3.2.7 *siftproofness, n*—the prohibition of the migration of material, of any size, from the interior to the exterior of a container.

3.2.8 *struts, n*—vertical frame members placed between the upper and lower frame members of the side and end panels of a crate that serve as columns for supporting vertical stacking loads.

## 4. Significance and Use

4.1 Each wood member contains a combination of characteristics which affects the performance of the container or pallet in which it is used. The requirements for classes, herein specified, have been established as these characteristics are related to the functional application of members in container and pallet construction and to the service that the container or pallet may be called upon to perform.

4.2 Any other specified requirements or limitations peculiar to a particular container or pallet construction or use, such as prohibiting knotholes or loose knots to provide siftproofness, limitation to certain wood groups or species, or the selection of applicable classes for specific members or types of containers or pallet shall be the responsibility of the standard for that container or pallet.

## 5. Wood Member Classification

- 5.1 *Class 1*—Structural (highly stressed members).
- 5.2 *Class 2*—Structural (moderately stressed members).
- 5.3 *Class 3*—Non-structural (lightly stressed members).

## 6. Wood Characteristics

### 6.1 Classification:

6.1.1 *Groups*—For the purposes of this practice, North American wood species are broken into four groupings. These groupings are general in nature (Table 1) and do not include all species of wood. Woods used specifically in pallet construction are listed in MHIA/ANSI MH1–2005 Appendix A3–1 according to similarities in mechanical properties, regional availability, and commercial uses in pallets. Table X1.1 provides a cross reference between the wood groups used herein and those listed in MHIA/ANSI MH1–2005.

6.1.1.1 *Group I*—This group embraces the softer woods of both the coniferous and the broad-leafed species. These woods 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 are normally easy to dry.

6.1.1.2 *Group II*—This group consists of heavier coniferous woods, only. These woods usually have a pronounced contrast in the hardness of the springwood and the summerwood. They have a greater fastener withdrawal resistance than Group I woods, but are more likely to split, and the hard summerwood bands occasionally deflect the nails causing them to run out at the sides of the piece.

6.1.1.3 *Group III*—This group consists of hardwoods of medium density. These woods have about the same fastener withdrawal resistance and strength as a beam as the Group II woods, but are less likely to split and shatter under impacts. The species in this group are the most useful for constructing box ends and cleats. They also furnish most of the rotary-cut veneers for wirebound boxes and plywood panels for construction of plywood boxes.

6.1.1.4 *Group IV*—This group consists of the high density hardwood species. They have both the 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 greatest tendency to split at the nails.

They are the heaviest and hardest domestic woods and are difficult to work. They are especially useful where high fastener withdrawal resistance is required and many of them make excellent rotary cut veneers for wirebound and plywood boxes.

6.1.2 *Species*—The species of wood, in the four groups, that may be used for wood members of containers or pallets are classified as indicated in Table 1 (see Appendix X1, Table X1.1, for groups specific to pallet construction). When it is stipulated that members shall be fabricated from a particular wood group, the species within that group may be mixed together or used interchangeably.

6.2 *Surfaces*—Rough lumber is permitted in the construction of the crate bases, sheathed-crate framing, boxes, and pallets. For box and crate sheathing, at least one surface of all wood members will be sufficiently smooth to permit legible marking.

### 6.3 Dimensional Requirements:

6.3.1 When nominal sizes of lumber are specified, the minimum sizes shall be as shown in Table 2.

6.3.2 When sizes of wood members other than the nominals cited in Table 2 are specified, undersizing in thickness and width shall not be permitted in more than 10 % of the number of pieces. In addition, these parts shall be no thinner than  $\frac{7}{8}$  of the stated thickness and no narrower than  $\frac{1}{4}$  in. (6 mm) less than the stated width. An exception to this requirement is that if members of nailed-wood boxes  $\frac{3}{8}$  in. (10 mm) or more in thickness are surfaced on both sides (to protect the contents) then the thickness may be  $\frac{1}{32}$  in. (1 mm) less than stated.

6.3.3 When nominal 2 in. (50 mm) thick lumber is resawn to obtain 1 in. (25 mm) nominal thick members, the resulting minimum thickness shall be  $\frac{11}{16}$  in. (18 mm) for dry lumber; except that for Class 1 structural members, which shall be  $\frac{3}{4}$  in. (20 mm).

6.4 *Moisture Content*—Container and pallet members shall have a moisture content (as measured by an electric type moisture meter or by the oven drying method), at the time of fabrication, of not greater than 19 % nor less than 9 % of their oven-dry weight.

### 6.4.1 Methods of Determination:

6.4.1.1 *Moisture Meters*—Meters measuring moisture contents ranging as high as 30 % shall be used to determine

**TABLE 1 Wood Groups**

<i>Group I</i>					
Cottonwood	Aspen	Basswood	Buckeye	Cedar	Chestnut
Redwood		Cypress	Fir (true firs)	Magnolia	Pine <sup>A</sup>
		Spruce	Willow	Yellow poplar	Red alder
<i>Group II</i>					
	Douglas fir	Hemlock	Southern yellow pine	Tamarack	
	Western larch				
<i>Group III</i>					
Soft Elm	Ash <sup>B</sup>	California black oak	Sycamore	California maple	
	Soft maple	Sweetgum		Tupelo	
<i>Group IV</i>					
	Beech	Birch	Hackberry	Hard maple	Hickory
	Oak	Pecan	Rock elm	White ash	

<sup>A</sup> Except Southern yellow pine.

<sup>B</sup> Except White ash.

**TABLE 2 Relationship of Nominal to Minimum Dimensions for Dry Lumber**

Thickness (Smaller Dimension)		Width (Larger Dimension)	
Nominal in. (mm)	Minimum in. (mm)	Nominal in. (mm)	Minimum in. (mm)
1 (25)	¾ (20)	2 (50)	1 ½ (40)
2 (50)	1 ½ (40)	3 (75)	2 ½ (65)
3 (75)	2 ½ (65)	4 (100)	3 ½ (90)
4 (100)	3 ½ (90)	5 (125)	4 ½ (115)
5 (125)	½ (12) off	6 (150)	5 ½ (140)
and thicker		7 (175)	6 ½ (165)
		8 (200)	¾ (20) off and wider

moisture content of Group IV pallet members. Meters measuring moisture contents as high as 25 % shall be used for all other wood members. The accuracy of the meter used shall be ± 1 % of true moisture content. Electric-type moisture meters may be either the resistance type or radio frequency power loss type except that only the resistance type may be used on rough sawn lumber. In addition, readings using the resistance type meters shall be made only after the pins have penetrated to a depth of one-fourth the thickness of the piece being tested.

6.4.1.2 *Oven-Drying Method*—Samples shall be tested in accordance with Method A or B of Test Method D4442, except that no sample shall be less than 1 oz (2835 mg).

6.5 *Wood Defects*—Members shall be so selected and cut so that allowable defects or imperfection will not occur in positions that would interfere with the prescribed fabrication or assembly of the container or pallet.

6.5.1 *Decay*—Any form of visible decay shall not be permitted. Stains or discoloration, not associated with decay, will be acceptable, except for discoloration that would interfere with marking on the outside of the container or the pallet. Decay shall be detected by use of the pick test. The pick test is performed with a knife or chisel by lifting up some of the grain or fibers. If the material is softer, more punky, or more brash than healthy wood of the same species, it is decay. Suspicious areas are usually abnormally brown, bleached looking, or mottled and indicated by the absence of luster that is present in normal wood.

6.5.2 *Checks, Splits, and Shakes*—Checks, splits, and shakes that are not longer than the width of the member will be permitted. Checks that do not extend through the full thickness of the member are permitted.

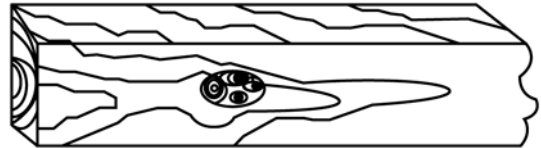
6.5.3 *Warp*—The bow in a member shall not exceed 1/16 in. (2 mm) per foot (300 mm) of length. The cup in a member shall not exceed ¼ in. (6 mm) in an 8 in. (200 mm) width, ½ in. (3 mm) in a 4 in. (100 mm) width, or a like proportion in other widths. The twist in a member shall not exceed ¼ in. (6 mm) per foot of length in an 8 in. (200 mm) width, ½ in. (3 mm) per foot of length in a 4 in. (100 mm) width, or a like proportion in other widths.

6.5.4 *Knots*—Sound knots, loose knots, knot holes, and knot clusters shall be measured and restricted as specified in Table 3. The sum of the width of the knots within a length equal to the width of the member in which they occur shall not exceed the maximum allowable width of a single knot for that piece (see Fig. 1).

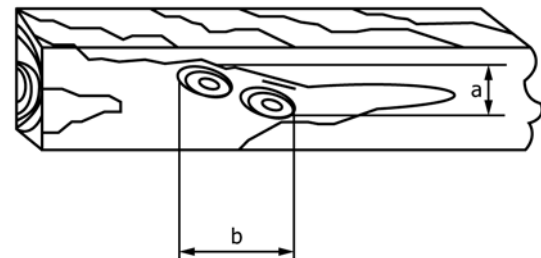
**TABLE 3 Allowable Dimensions of Defects**

Classification of Members	Maximum Allowable Width of Knots	Maximum Allowable Slope of Cross Grain
Structural (highly stressed)	2 in. (50 mm), but not over ¼ of the width of the member	No steeper than 1 in 10
Structural (moderately stressed)	3 in. (75 mm), but not over ⅓ of the width of the member	No steeper than 1 in 10
Non-structural	<sup>A</sup> 4 in. (100 mm), but not over ½ of the width of the member	No steeper than 1 in 8

<sup>A</sup> The maximum allowable width of knots in face boards of wirebound boxes shall be 1 ½ in. (40 mm).



**KNOT CLUSTER**



**TANDEM KNOTS**

NOTE 1—The distance (a) is taken as the width when (b) is twice the width of the piece or less.

**FIG. 1 Knot Clusters and Tandem Knots**

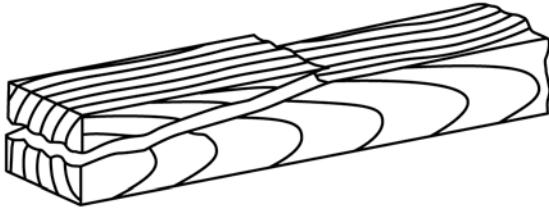
6.5.5 *Wane*—Wane shall not be permitted on any member.

6.6 *Cross Grain*—The slope of the cross grain shall be limited in accordance with Table 3. The slope of the cross grain shall be measured by the angle between the general direction of the grain and the longitudinal axis of the member and shall be expressed as a ratio. Slight local deviations of the grain shall be disregarded.

6.7 *Combined Grains*—When a member has both diagonal and spiral grain (see Fig. 2), the combined damaging effect shall be taken into account. This effect can be computed by combining the apparent slope of grain on the two adjacent faces of the member. When each of the slopes are expressed as a ratio to 1, that is, 1 in 18 and 1 in 12, the combined slope is



**DIAGONAL GRAIN**



**SPIRAL GRAIN**

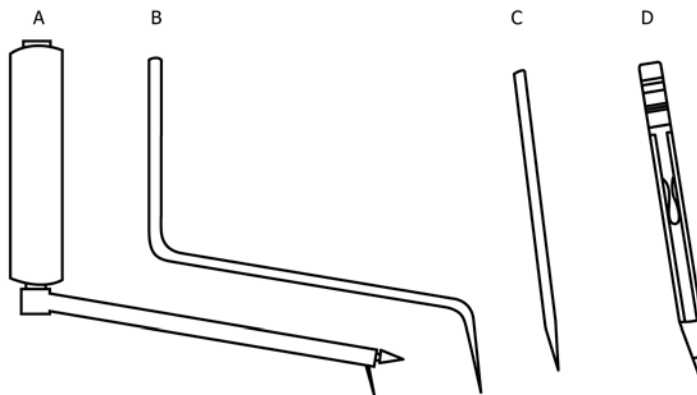


**SPIRAL AND DIAGONAL GRAIN  
IN COMBINATION**

FIG. 2 Cross Grain

the square root of the sum of the squares of the slopes (combined slope = square root of  $(\frac{1}{18})^2 + (\frac{1}{12})^2 = 0.1000$  or 1 in 10). A convenient method of measuring the slope of cross grain is by using a sharply pointed steel scribe (see Fig. 3). The scribe should be drawn in the direction in which the grain seems to run. Apply enough pressure so that the point penetrates the wood slightly. Allow enough freedom of lateral movement to permit the point to follow the grain.

6.8 *Built-Up Sheathing Members*—Members to be used for the sheathing of sides, ends, tops, or bottoms of boxes or crates 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. The glue shall be of a water-resistant type that will provide the desired strength characteristics as determined by testing, in accordance with 6.8.1. In addition, the strength of the glued joint shall not be weakened or compromised by the moisture content of the wood sample.



- A. Swivel-Handled Scribe with Phonograph Needle Point.
- B. One-Piece Drill Rod Bent To Shape and Point Slightly Hardened.
- C. A Straight Piece of Drill Rod With Point Slightly Hardened.
- D. Mechanical Pencil With Phonograph Needle Point.

FIG. 3 Scribes for Determining Direction of the Fibers On the Surface of Wood

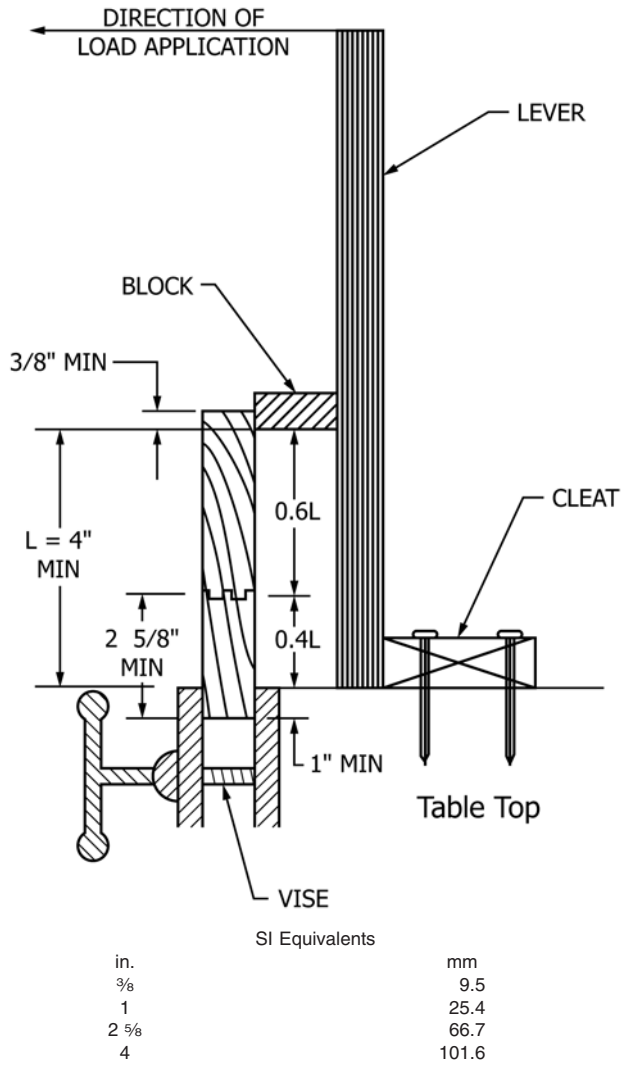


FIG. 4 Setup for Testing Quality of Edge Joints

6.8.1 *Strength Test, see Fig. 4*—Fifteen samples shall be cut at random from each lot. The samples shall be  $2 \pm \frac{1}{8}$  in. ( $50 \pm 3$  mm) wide, parallel to the grain, by a length equal to the width (perpendicular to the grain) of the member being tested. Any sample that has visible splits, shakes, pitch pockets, or checks across the entire width shall be discarded and replaced. Also the joint shall be located at least  $2\frac{5}{8}$  in. (70 mm) from the edge of the test piece. The 15 samples shall be tested as cantilever beams. The length of the samples shall be placed perpendicular to the top edge of the vise. The size of the block and the position of the cleat shall be such that the lever is parallel to the sample. The lever shall be a minimum of 30 in.

(750 mm) in length. The sample shall be positioned vertically so that the joint is 0.4 times the clear span above the top face of the vise. A slow even pull shall be applied to the top of the lever until the sample fails in bending. The position of the break with respect to the joint shall be recorded. Any break that is wholly or partially at the joint shall constitute a failure. Three such failures will mean rejection of the lot.

## 7. Keywords

7.1 characteristics; classification; defects; definitions; grain; terminology; wood; wood boxes; wood pallets

**APPENDIX**
**(Nonmandatory Information)**
**X1. WOOD SPECIES CLASSIFICATION**

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**TABLE X1.1 Wood Species Classification Cross-Reference**

Species	Group Number	Class Number
	D6199	MHIA /ANSI M1–2005
Aspen	I	7
Basswood	I	7
Buckeye	I	7
Cedar(s)	I	14
Chestnut	I	7
Cottonwood	I	7
Baldcypress	I	13
True Fir	I	12
Magnolia	I	3
Pine(s)	I	13
Red Alder	I	6
Redwood	I	13
Spruce(s)	I	13
Willow	I	7
Yellow Poplar	I	29
Douglas Fir	II	11
Hemlock	II	12
Southern Yellow Pine(s) <sup>A</sup>	II	22
Tamarack (Eastern Larch)	II	12
Western Larch	II	11
Ash (Black, Pumpkin)	III	3
California Black Oak	III	4
California (Bigleaf) Maple	III	2
Soft (Slippery) Elm	III	1
Soft Maple	III	3
Sweetgum	III	3
Sycamore	III	3
Tupelo	III	3
Beech	IV	1
Birch	IV	1
Hackberry	IV	3
Hard Maple	IV	1
Hickory	IV	1
Oak (Eastern)	IV	21
Pecan	IV	1
Rock Elm	IV	1
American Elm	IV	1
White Oak	IV	1
Green Oak	IV	1

<sup>A</sup> Loblolly, Stark, Shortleaf, and Longleaf only. All other Southern Yellow Pines – Group I/Class 13.

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