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MILITARY HANDBOOK

LUMBER AND ALLIED PRODUCTS

FSC 55GP

DEPARTMENT OF DEFENSE
WASHINGTON D.C. 20301

MIL-HDBK-7B
Lumber and Allied Products
6 August 1982

1. This standardization handbook was developed by the Department of Defense with the assistance of the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, and the Defense Construction Supply Center, Defense Logistics Agency, in accordance with established procedure.

2. This publication was approved on 6 August 1982 for printing and inclusion in military standardization handbook series.

3. This document provides information to assist in obtaining lumber, plywood, poles, piles, and other wood products. The handbook is not intended to be referenced in purchase specifications except for informational purposes, nor shall it supersede any specification requirements.

4. Every effort has been made to reflect the latest information on lumber and allied products. It is intended that this handbook be reviewed periodically to insure completeness and currency. Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: US Army Mobility Equipment Research and Development Command, ATTN: DRDME-DS, Fort Belvoir, VA 22060, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

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CHAPTER 1. INTRODUCTION

The great quantities of lumber, plywood, poles, piles, railroad ties, and other wood products annually consumed by the Department of Defense establish procurement of these items as a matter of high importance. Large sums of money are involved, and the procurement task, embracing as it does a great variety of kinds, sizes, qualities, species, and quantities of wood products sold under many different commercial and government rules, standards, and specifications, is rendered highly complex. Summarized information to aid in this important job has been lacking.

The object of this handbook is to provide a ready source of information on lumber and wood products normally procured in considerable quantity for Department of Defense installations. Engineers are particular directed to the chapters dealing with strength of wood, preservative treatment, and moisture content. The chapters dealing with storage handling, tallying, inspection, grading, and sizes were written with the problems of inspectors, stock handlers, and supply clerks in mind. All of these chapters prove useful to the requisition writer by providing references useful in determining which species, qualities, and sizes of lumber, plywood, poles, railroad ties, and other wood products are usable for a given end use. This handbook also provides ready reference to the physical and mechanical properties of lumber products and the conditions of use that require special treatment with preservatives, fire retardants, or special surfacing and machining.

It is the primary purpose of this handbook to provide the kind of background information needed in making necessary decisions on all such problems. This type of information is not readily available elsewhere in a form directly related to supply problems involving lumber and allied products. To the extent that this handbook achieves its primary purpose, it is believed that important economies can be effected, greater assurance secured that the needed species, qualities, quantities, and sizes will be received, and requisitioning procedures facilitated.

The handbook also has as part of its purpose to provide information on the handling, storage, and use of wood products to the end that better service will be obtained at less cost. The large quantities of wood products normally required by the various branches of the Department of Defense make economy of use just as essential as economical procurement; failure in the one can quickly offset any gains realized through success in the other. Moreover, proper handling, storage, and use are essential in the interest of conservation of the forest resources.

Methods of Standardization

Three types of publications are the chief sources of information for the qualities, species, and sizes of lumber and allied products available. They are (1) the grading rules issued by lumber manufacturers' associations or their affiliated inspection services; (2) the voluntary product standards (PS) and commercial standards (CS) published by the National Bureau of Standards, U.S. Department of Commerce; and (3) Federal specifications issued by the General Services Administration, Washington, DC, and military specifications formulated and issued for specific products by the Department of Defense.

Grading rules. Grading rules define quality of lumber for general or specialized purposes. Lumber grading rules are administered by the associations issuing them and have general acceptance in the lumber trade. When made a part of purchase contracts, they have legal standing. Their nomenclature must be adhered to strictly. Careless references to "grades" such as "No. 1 Best" or "Double AA" are meaningless and have no legal standing. The grading rulebooks define the rules the industry works with and understands.

Product standards. Voluntary product standards or adopted commercial standards apply to plywood, softwood lumber, and special lumber products such as hardwood dimension stock, doors, windows, hardwood interior trim and moulding, hardwood wall paneling, and hardwood stair treads and risers. Generally speaking, they have the support of associations of manufacturers of the products involved, although some cover groups of manufacturers not officially organized in trade associations. Reference to them in contracts is also legally binding with respect to quality, sizes, and species.

Grading rules and commercial standards describe the products that industry manufactures and offers for sale. Their basic purpose is to bring order and standardization into a field where a great variety of products exists. When properly applied, they assure the buyer that he can expect certain qualities regardless of the particular supplier from whom he buys.

Materials furnished under terms of grading rules or commercial standards are items of regular production by the mills. Materials not covered by these rules and standards require special manufacture and involve special charges. It is always best, therefore, to use standard materials wherever possible. Only for exceptional products like boat hull or aircraft structural plywood is departure from the commercial sizes and qualities justified.

Government specifications. Government specifications guide purchasing of all Government departments and agencies. They provide directives as to purchasing procedures to be followed by Government agencies. Some are detailed specifications; others specify how commercial specifications are to be used. Government specifications for lumber recognize industry's grading rules as far as quality and sizes are concerned. Military specifications for particular products and materials provide a basis for purchases of the Department of Defense.

A list of specifications, product standards, commercial standards, and grading rules applicable to most lumber and allied products is presented in Section 2. These publications should be available wherever final requisitioning is done, and kept current with revisions and supplements as issued. Copies of the grading rule books may be obtained from the applicable grading associations. product standards, commercial standards, and Federal and military specifications can be obtained through official channels.

Preparing a requisition. Wood products in Federal Supply Class (FSC) 5500 are managed by the Defense Construction Supply Center (DCSC) on a bulk commodity basis. Requisitions for lumber and related basic wood materials (FSC 5510), millwork (FSC 5520), and plywood and veneer (FSC 5530), should be prepared in accordance with instructions contained in Federal Supply Catalog C 5500-IL and the following:

(a) Information pertaining to SSC 03 items (acquisition advice code H) are:

(1) Local purchase authority is authorized for requirements on a one-time basis when the line item value is $500 or less.
(2) Any requirement which exceeds $500 must be forwarded to DCSC for Central Procurement. Quantities may not be divided to evade the dollar limitation.
(3) The Communication Routing Identification (COMM RI) for DCSC is RUEDKFA.

(b) MILSTRIP Advice Code 2A should be entered in requisitions that are delegated for local purchase that cannot be economically procured from local sources. Also, any requiring activity may requisition any FSG 55 item via MILSTRIP from DCSC when local purchase is not considered feasible.

CHAPTER 2. WHAT IS WOOD

The Forest

Forest land. Of the 740 million acres of forest land in the United States, nearly two-thirds is "commercial," or capable of producing timber of commercial quantity and quality. About 43 percent of the commercial forests, however, are classed as sawtimber. Of the remainder, 28 percent consists of pole timber, 25 percent is seedlings and saplings, and 4 percent of nonstocked lands. Old growth stands are located almost entirely in the West. The fact that so little old growth remains is not necessarily bad, because over-ripe trees eventually die and decay. The typical growth cycle of forest stands is illustrated in Figure 1, showing how growth per acre increases, peaks, and then declines as trees age. Mature stands need to be harvested. Thus, the idea of raising trees like other crops has taken hold, especially in the South and West, where it has been noted that second growth forests reach sawtimber size in reasonably fast time. Private owners have joined the movement known as "tree farms," and many thousands of acres of forests are now dedicated to good forestry practices, which call for regular but selective cutting of mature trees in ways that do not harm the stand as a whole, and especially the young thrifty trees coming up. Table I indicates the forest landholdings of the Nation as of 1977. Figures 2 through 4 illustrate typical timber stands.

National forests. The Nation's most important forest reserves, however, are the National forest owned by the public and managed by the U.S. Forest Service. In 1977 these forests amounted to 89 million acres. These forests are harvested through selective cutting, yielding a large proportion of our total timber cut every year. Some, of course, are in mountainous regions practically inaccessible for lumbering operations, but as roads are built to them, and with development of other techniques such as helicopter and balloon logging, they are coming into use. Better fire protection and control of insect pests, on private and public lands alike, are also helping to assure the continued productivity of our forests.

TABLE I. Forest land: total and commercial area, 1/ volume of sawtimber, and growing stock. (millions of acres, billions of cubic feet)

	MILLIONS OF ACRES					BILLIONS OF CUBIC FEET			
US 1977 Total Forestland	Commercial timberland and owners					Net volume of sawtimber total 2/	Soft wood	Hard wood	Growing stock 3/
	All ownerships	Federal owned or managed	State city municipal	Private total	Percent of total				
740 4/	488	100	31	351	72	503	365	135	713

1/ All land producing or capable of producing usable crops of wood.

2/ Sawtimber comprises all live trees of commercial species which contain at least one saw log defined as follows:

Softwoods must be at least 9.0 inches in diameter, breast high, except California, Oregon, and coastal Alaska where the minimum diameter is 11.0 inches.

Hardwoods must be at least 11.0 inches in diameter in all states

3/ Growing stock comprises all live timber trees, pole timber trees, saplings, and seedlings meeting specified standards of quality or vigor, excludes cull trees.

4/ See footnote 1 of Table II.

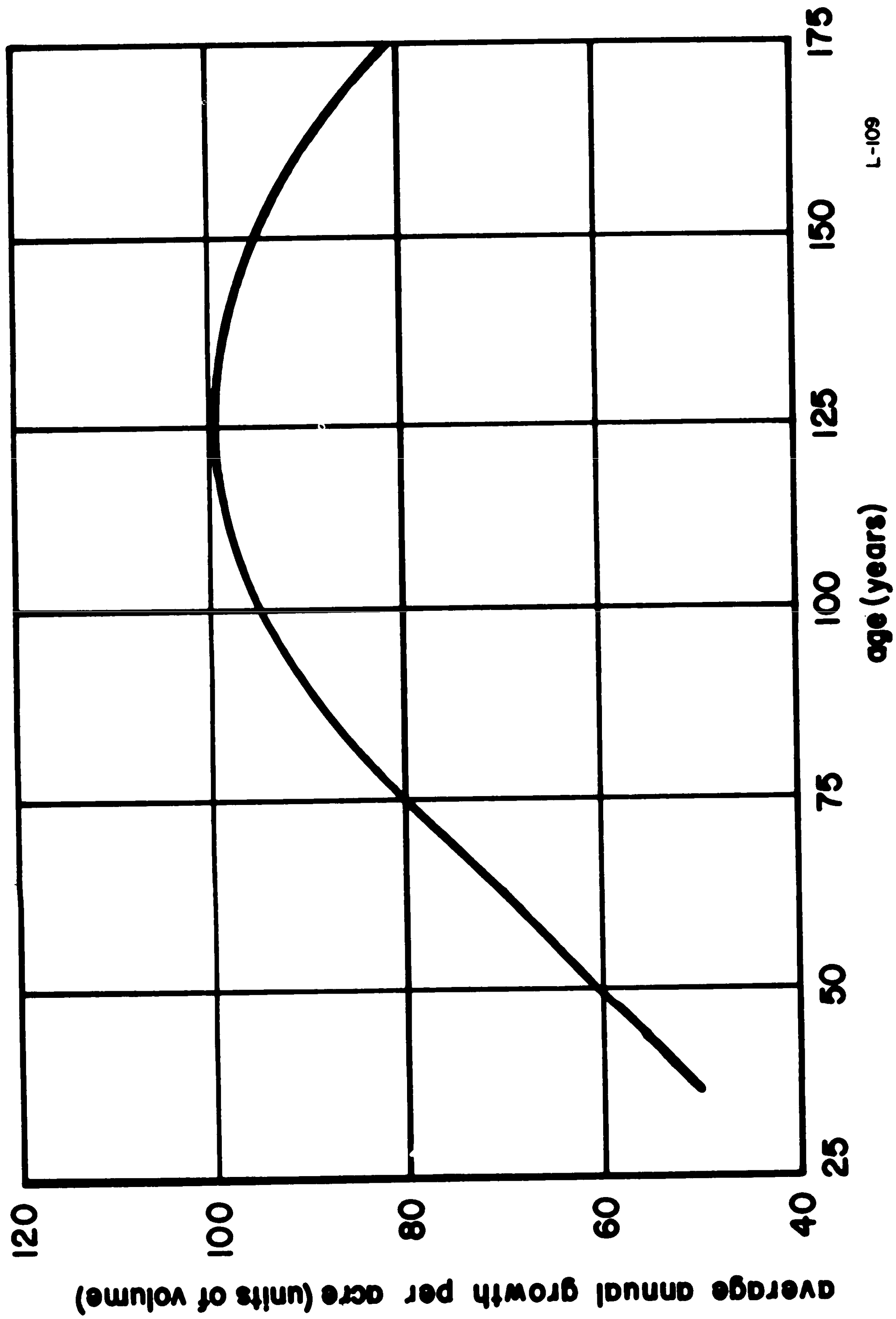

FIGURE I. Typical growth cycle of forest stands.

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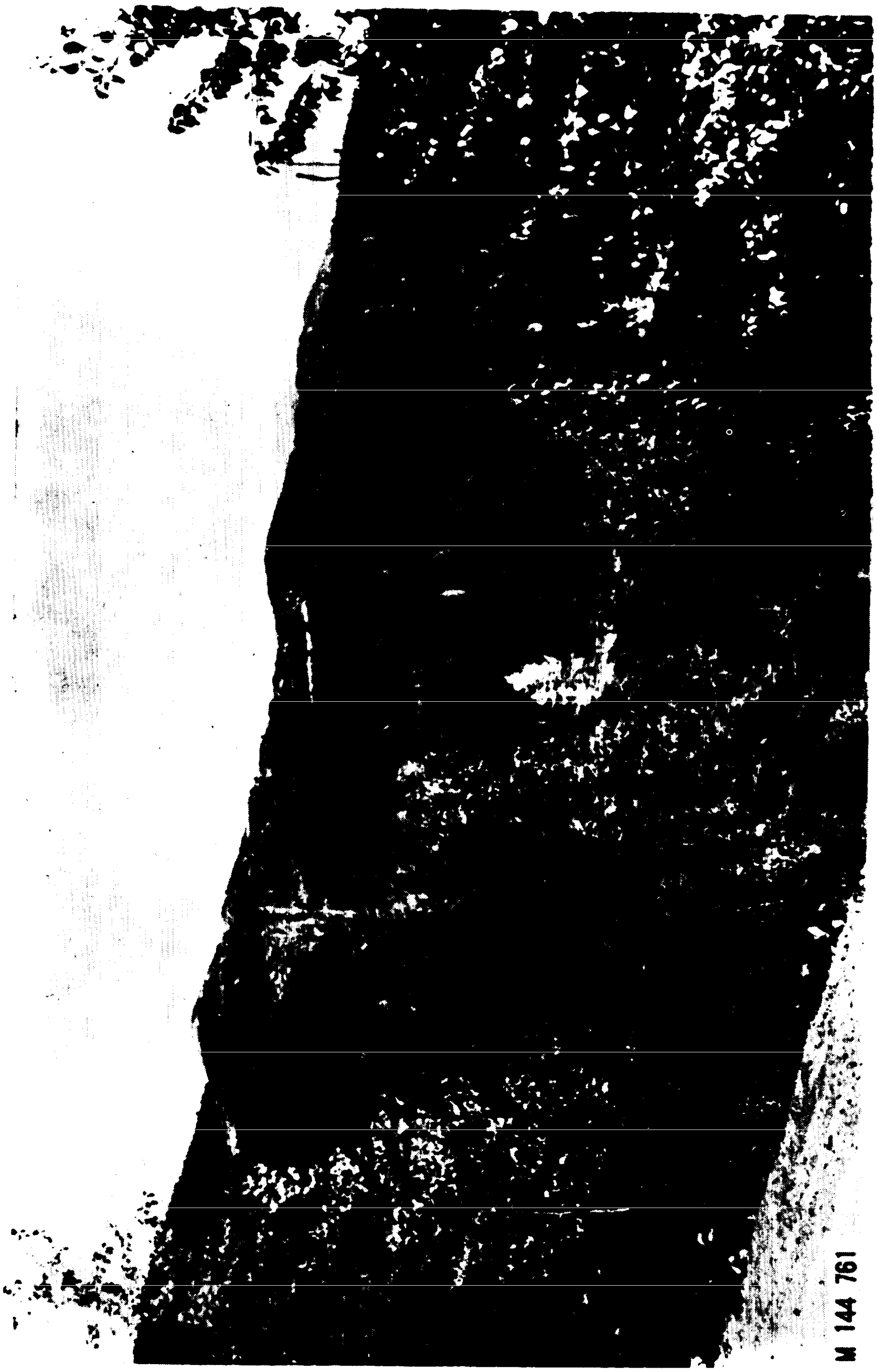

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FIGURE 2. Reforested area on the Kaniksu National Forest in Idaho, foreground is stocked with western larch and Douglas fir reproduced naturally. The central area edged by mature timber, is a field planted western white pine plantation.

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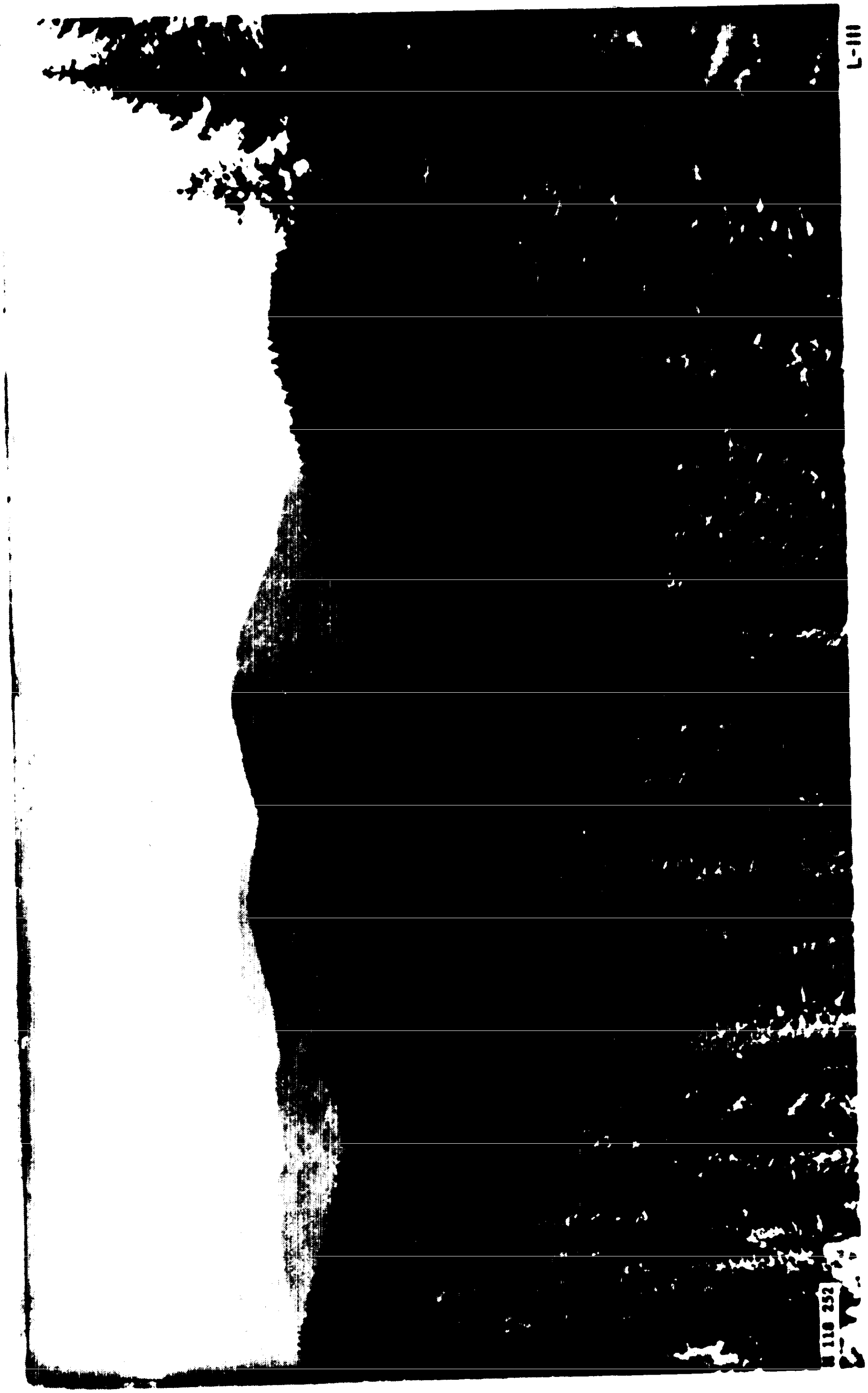

FIGURE 3 . Western white pine timber, mostly privately owned, viewed from Elk Butte in Clearwater National Forest in Idaho.

X-3799

Fugure 4. Mixed northern hardwoods on Ottawa National Forest in Michigan.

X-3800

Despite improved care of forests, however, with the passing years the kind of lumber available is definitely changing. The top quality lumber that only a tree 100 to 300 years old can produce - long, clear boards and timbers - simply won't exist in the natural state. That is, as long as need exists for such material in large volume, we will have to take selected small pieces and glue them together into more costly laminated timbers. For ordinary run-of-the-mill lumber uses, we will have to get along with more of the middle and lower grades, of shorter and narrower pieces.

To the requisition writer, this boils down to the responsibility of making sure that what is requisitioned is what is needed - no more, no less. If a shop needs a select grade, that quality should be requisitioned. But if it asks for that quality simply because it's more convenient to cut up - no bothersome cutting out of knots and the like - then the economy of buying lower grades should be pointed out. The same thing holds for large sizes, too; edge-glued boards consisting of narrower pieces bonded together, or laminated timbers likewise glued up of thinner stock should be called to the shop's attention.

Lumber production and consumption. A general comparison of lumber production and consumption (including imports and exports) for the United States appears in Table II.

TABLE II. Lumber production and consumption by kind of wood (for 1972). 1/

	(millions of board feet)					
Total production 2/				37745		
Softwood		30975				
Cedar	756					
Douglas fir	8459					
Hemlock	2474					
Ponderosa pine	4001					
Redwood	1242					
Southern yellow pine	7884					
White fir	2307					
White pine	1056					
Hardwoods		6770				
Ash	148					
Beech	182					
Cottonwood	268					
Elm	141					
Maple	624					
Oak	3121					
Sweet (red and sap) gum	332					
Tupelo and black gum	319					
yellow poplar	628					
Total domestic consumption						47166
Softwoods					39773	
Exports			1196			
Imports			8977			
Hardwoods					7393	
Exports			252			
Imports			457			

1/ Data taken from the Statistical Abstract of the United States published by the U.S. Department of Commerce for 1975.

2/ Includes kinds of wood not shown separately.

TIMBER PRODUCTION

Harvesting. Harvesting of timber is the trade we associate with the "lumberjack" of the great northwestern region of the United States. Timber harvesting may be limited to selected trees in a particular stand or an entire area may be "clearcut," felling trees of all sizes and moving only the profitable boles to the mill. Figure 5 depicts a crew cutting the tree which will then be trimmed of branches and if the tree was not "topped" before felling this nonproductive section will be removed. On completion of this operation the bole is ready for skidding to the loading yard where it will be loaded on bolster type trailers for transporting to the mill. Figures 6 and 7 illustrate rubber tired log loaders with cable and hydraulically operated tongs loading trailers for shipment of boles to the saw mills. Figure 8 illustrates an average load of boles.

Forest management. The Federal Government as well as private owners are now pursuing a course toward improved management of our forest resources. Development of fast growing species, establishment of nurseries for growing the seedlings needed to replace the trees we are cutting are important steps in forest management. Despite all of our efforts in improving our forests, the time needed to produce one piece of sawtimber is the one element over which we have the least control.

Some idea of the time needed to restore an area is shown in the following photographs. Figure 9 depicts an area of what is now part of the Willow Creek area of the St. Joe National Forest in Northern Idaho.

This was a privately owned forest which was logged in 1938. The Forest Service acquired the land through an exchange and the logging debris was later burned. In 1939 the Civilian Conservation Corps (CCC) started planting young trees On the land. In Figure 10, six years after logging, a new forest is beginning to cover some of the open slopes.

In 1949, eleven years after harvesting the virgin timber, Figure 11, the hillsides are mantled with young trees. Thirty-one years after the timber was harvested, Figure 12, the new forest is beginning to dominate the scene, shading out many of the shrubs and grasses. This young forest should be periodically thinned to insure maximum wood yields at maturity. As can be seen from the photographs, the growth cycle is extremely lengthy and during this cycle the young trees must be protected from fires, insects, and disease.

To obtain the young trees needed in our reforestation programs, Federal, state, and some private industries are maintaining nurseries producing millions of new seedlings each year. Figures 13 and 14 show two stages in the growth of the seedling. Figure 15 depicts the transplanting of the young seedlings to its forest home. In 50 to 100 years this young seedling will have reached maturity.

The photographs and historical data used in this chapter are from the historical file of the Western Wood Products Association, Yeon Building, Portland, Oregon 97204 and the Weyerhaeuser Company, Tacoma, Washington 90401.

FIGURE 5 . Timber cutting crew at work.

X-3801

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FIGURE 6 . Ponderosa pine boles being loaded for shipment to saw mill.

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FIGURE 7. Loading a bolster type trailer using a cable operated log loader.

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FIGURE 8. Transporting boles to saw mill.

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FIGURE 9. Privately owned forest after logging operation in 1938.
(Now Willow Creek area of St. Joe National Forest.)

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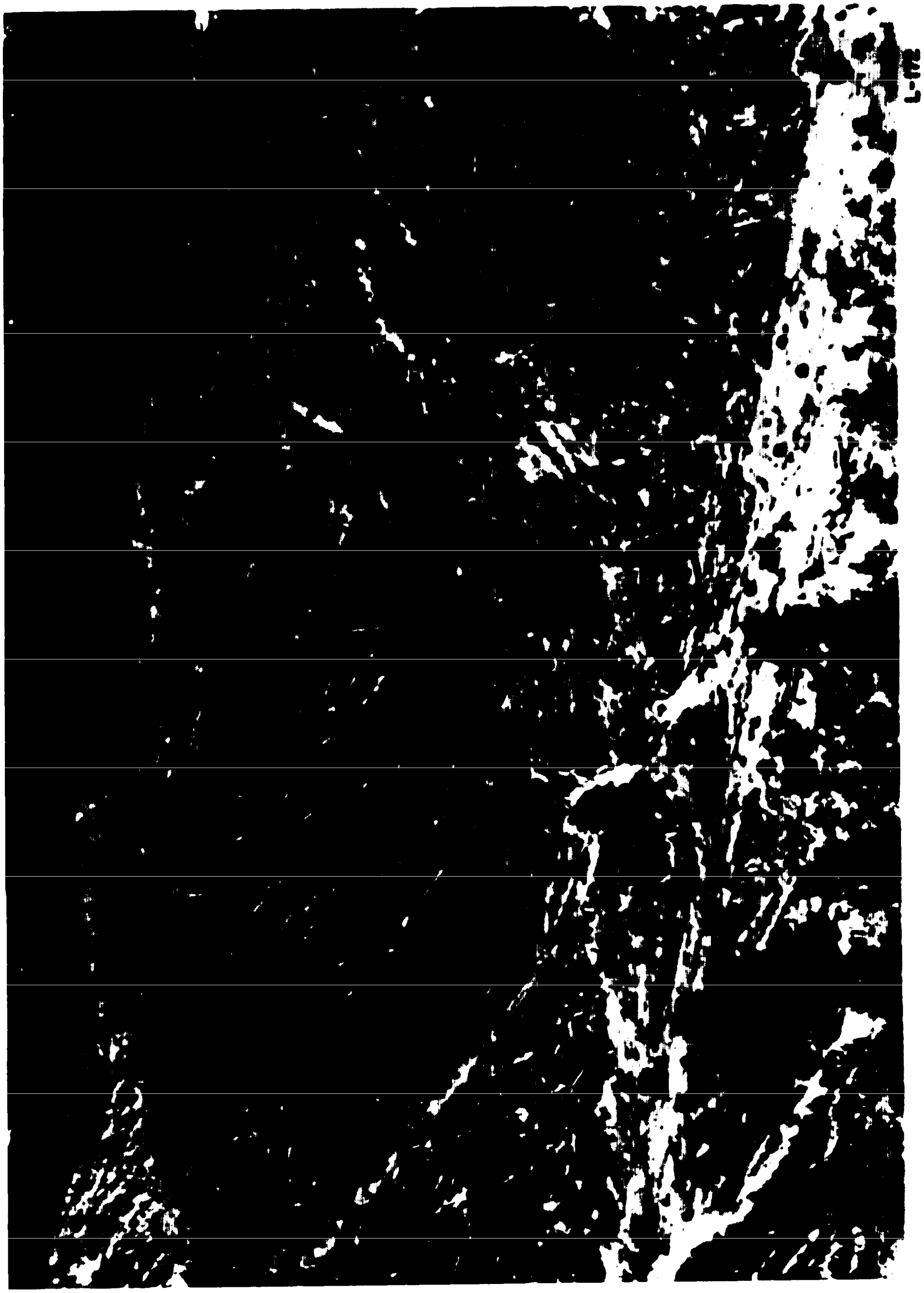

FIGURE 10. Willow Creek 1944.

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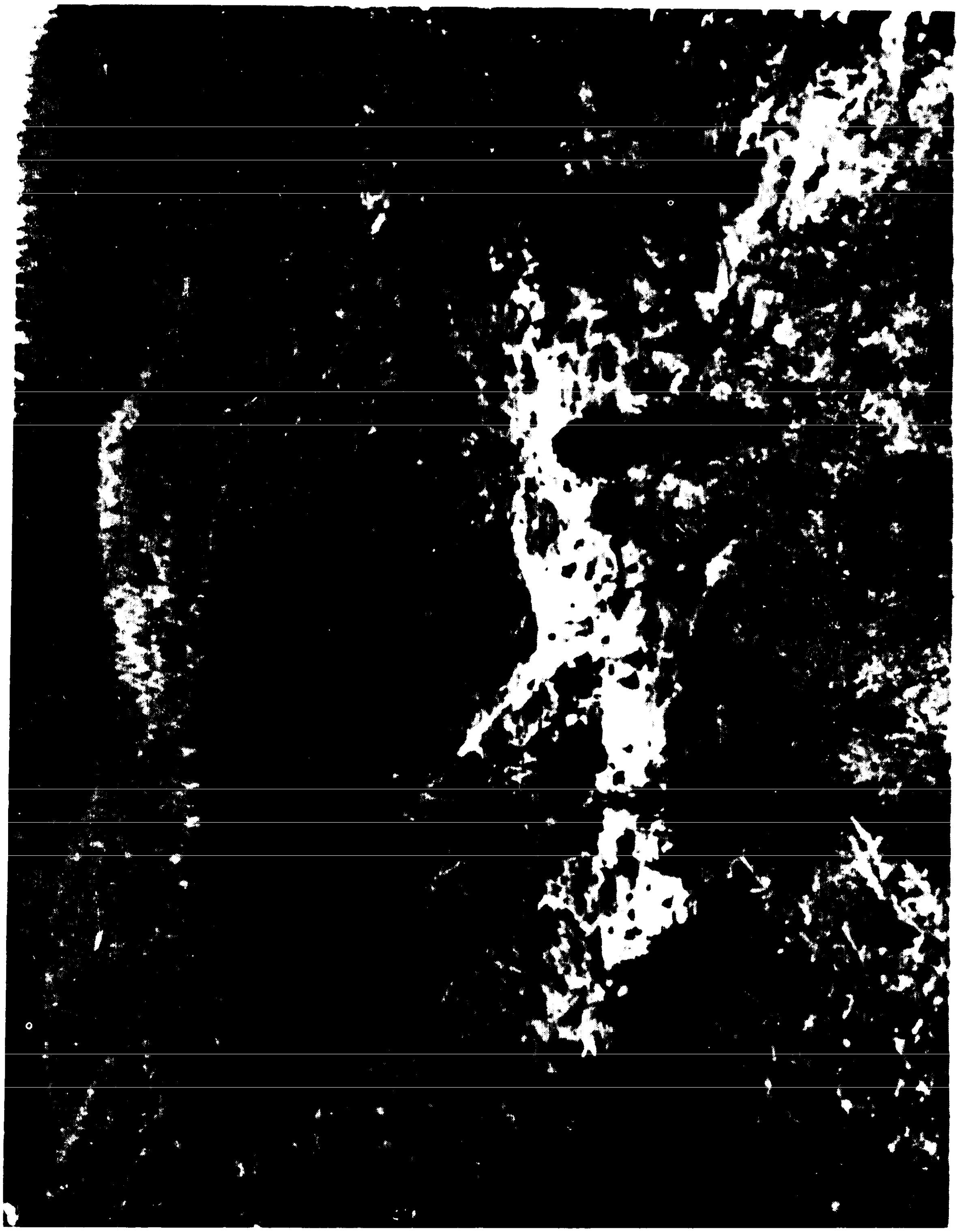

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FIGURE 11. Willow Creek 1949.

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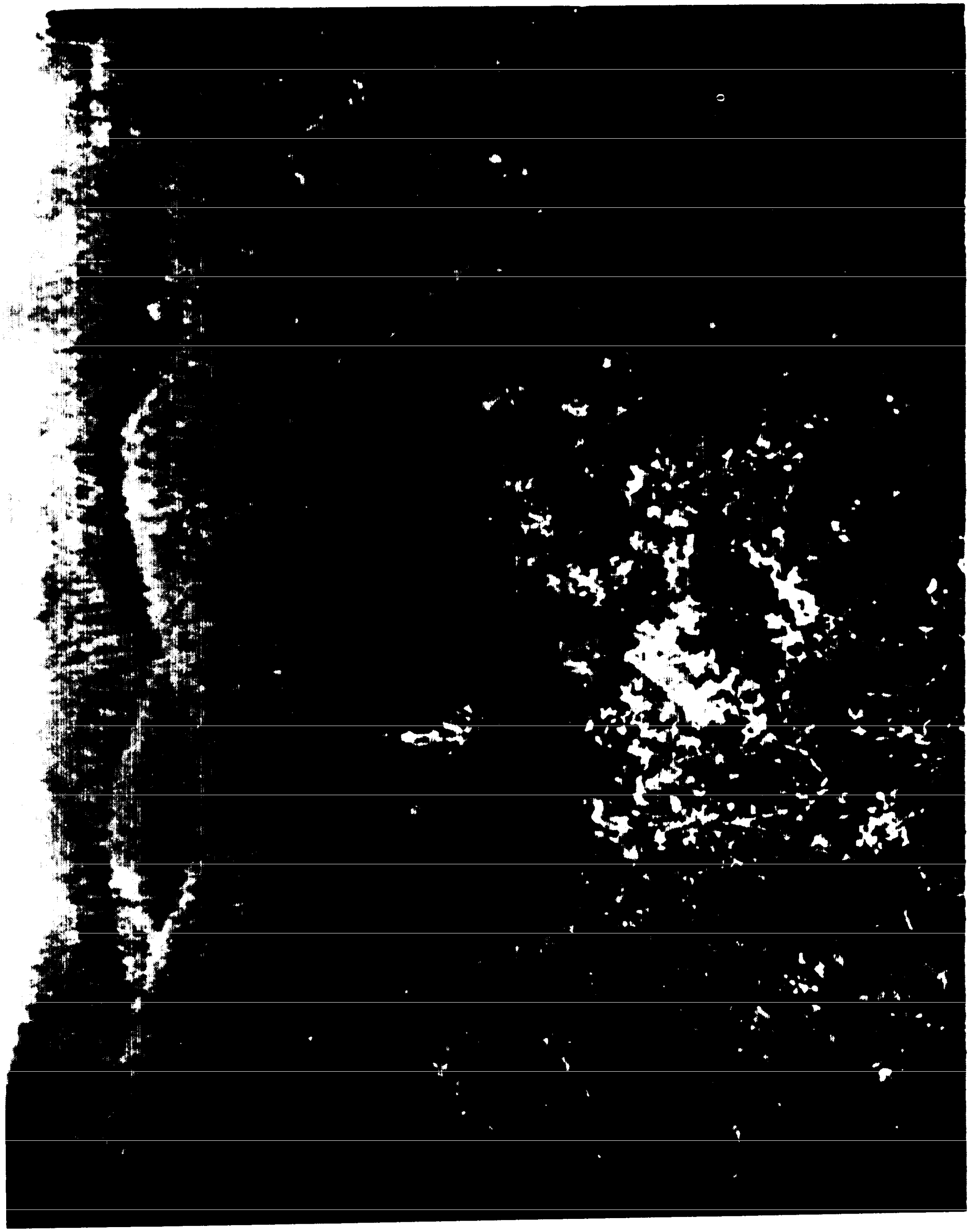

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FIGURE 12. Willow Creek Map.

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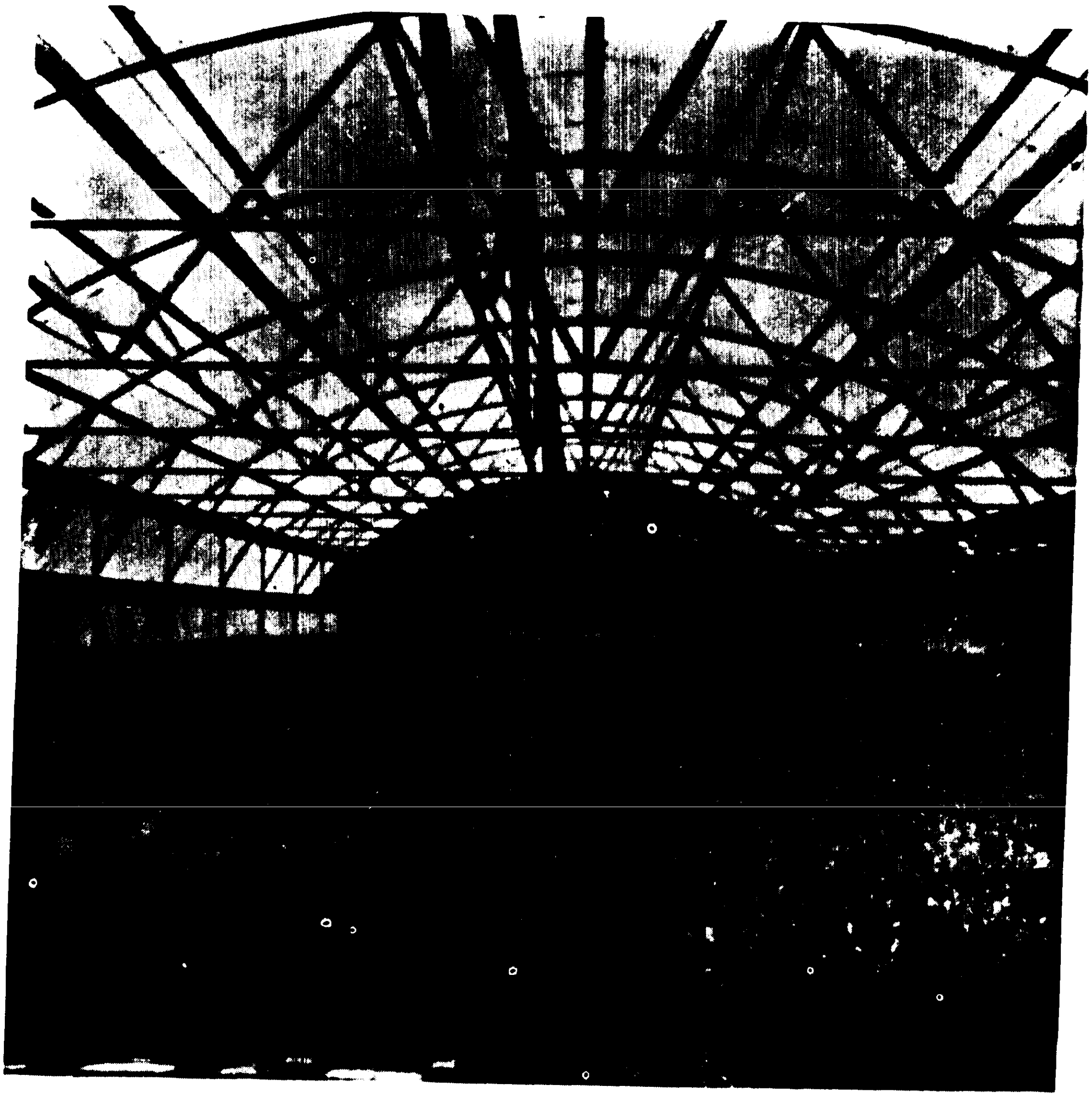

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FIGURE 13. Developing seedlings in a nursery.

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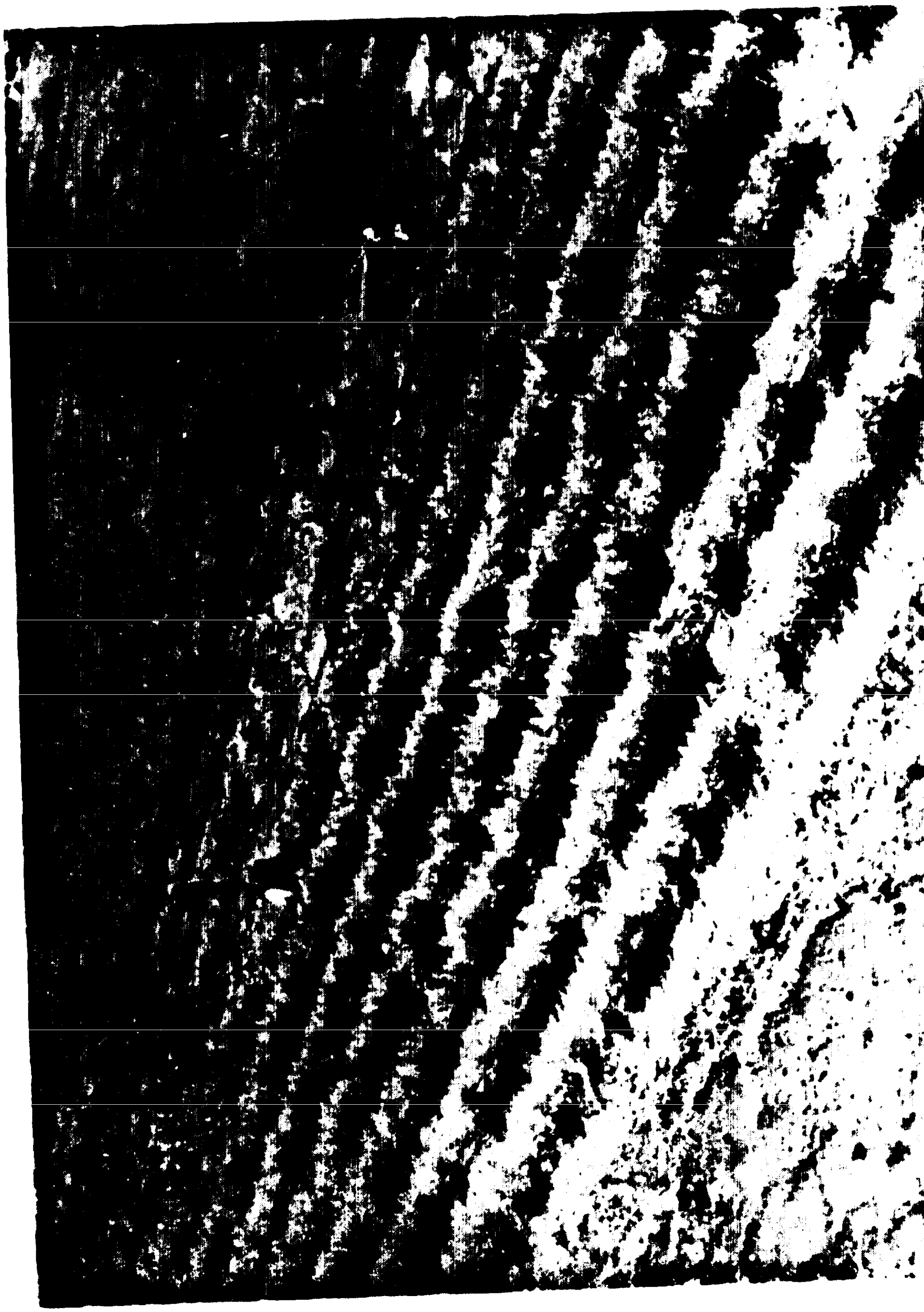

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FIGURE 14. The first transplanting of seedlings from a protected atmosphere to the outside.

X-3810

Figure 15. Transplanting a seedling to its forest home.

X-3811

MILL OPERATIONS

The headsaw. The headsaw or headrig is so named because this is the starting point for all further manufacturing processes. The headrig consists of a large band saw, the carriage on which the log is transported during the sawing operation, and a conveyor type loading platform for moving the logs to, and onto the carriage. Figure 16 depicts a log which has been cut one time and will now be rotated, full 90 degrees, on the carriage in preparation for the second cut. The sawyer, the person operating the headrig, will rotate and saw each log so as to produce the maximum sized, useable rough timber. These timbers may be sold and used as structural timbers without any further manufacturing process. Some timbers may be selected for resawing into rough lumber.

Gangsaw. Rough timbers selected for resawing, from the production of the headsaw, are passed through a gangsaw to produce rough lumber. A gangsaw is a large machine consisting of numerous cutting blades, conveyor, and feed rollers which move the timber past the saws. Figure 17 depicts a gangsaw in operation, producing ten individual boards with a single cut. The rough lumber coming from the gangsaw may move directly to the grading sheds on the “green chain” Figures 18 and 19.

Manufacturing procedures. Rough materials leaving the “green chain” may be stacked and air dried at the mill or may be shipped directly to a manufacturer for kiln-drying and subjected to additional machine operations. Figure 20 depicts the grading of material that has been passed through a planing machine and surfaced on all four sides (S4S). Material intended for use as box shook, where the lumber is cut to exact lengths for sides, tops, ends, etc. , can be run through a “trimmer,” Figure 21, where the saws may be moved as a group or operated individually to cut the lengths required. Lumber that has been dressed and trimmed may be sorted by size, automatically, as depicted in Figure 22.

Some select grades of boards may be subjected to machine operation that will dress and shape a pattern in one operation. Figure 23 depicts a machine producing patterned paneling. Other machine operations are available which allow mass production of lumber.

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FIGURE 16. Headsaw operation with loading platform and carriage in foreground, sawyer and bandsaw in background.

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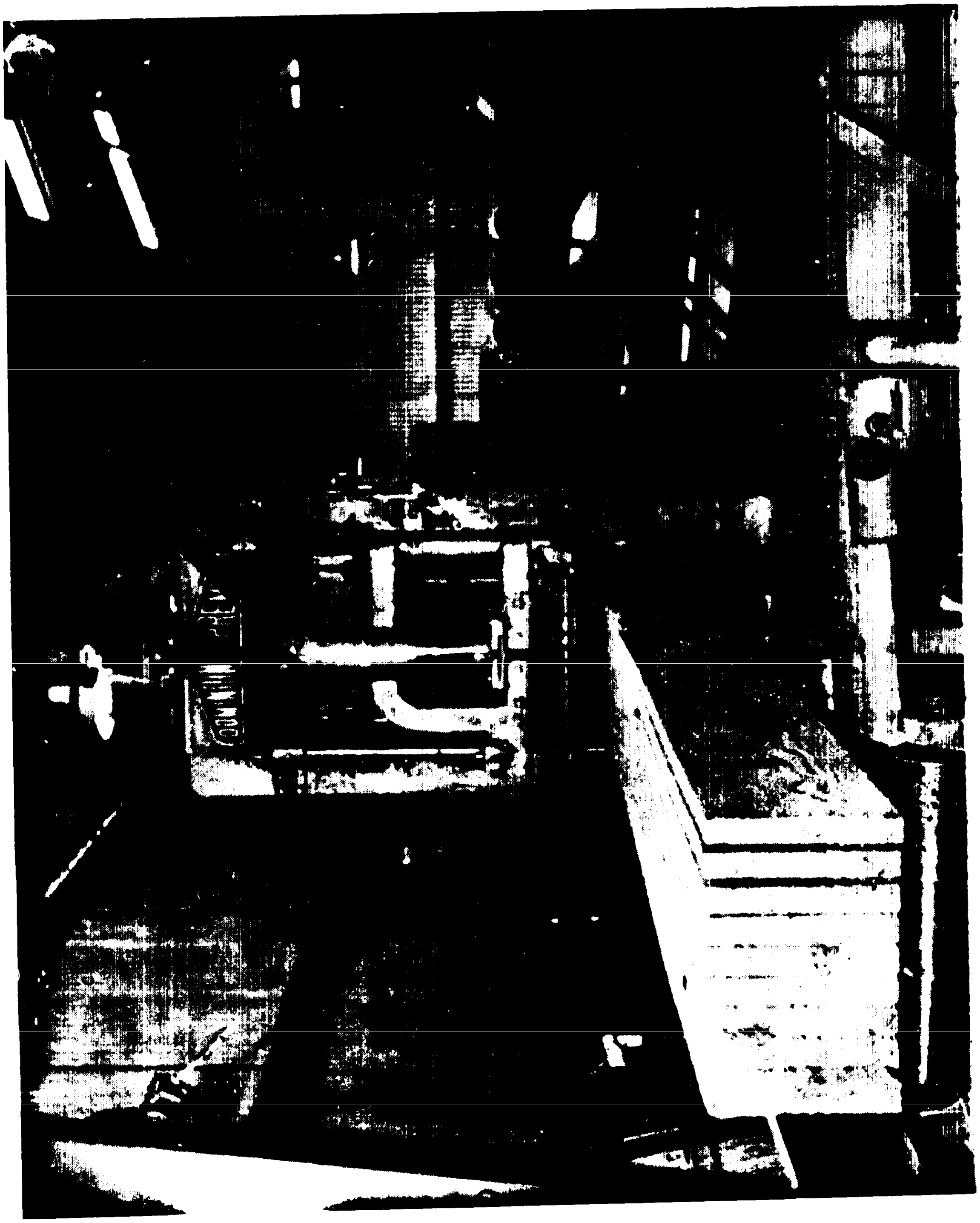

FIGURE 17. Gangsaw producing ten boards with a single cut.

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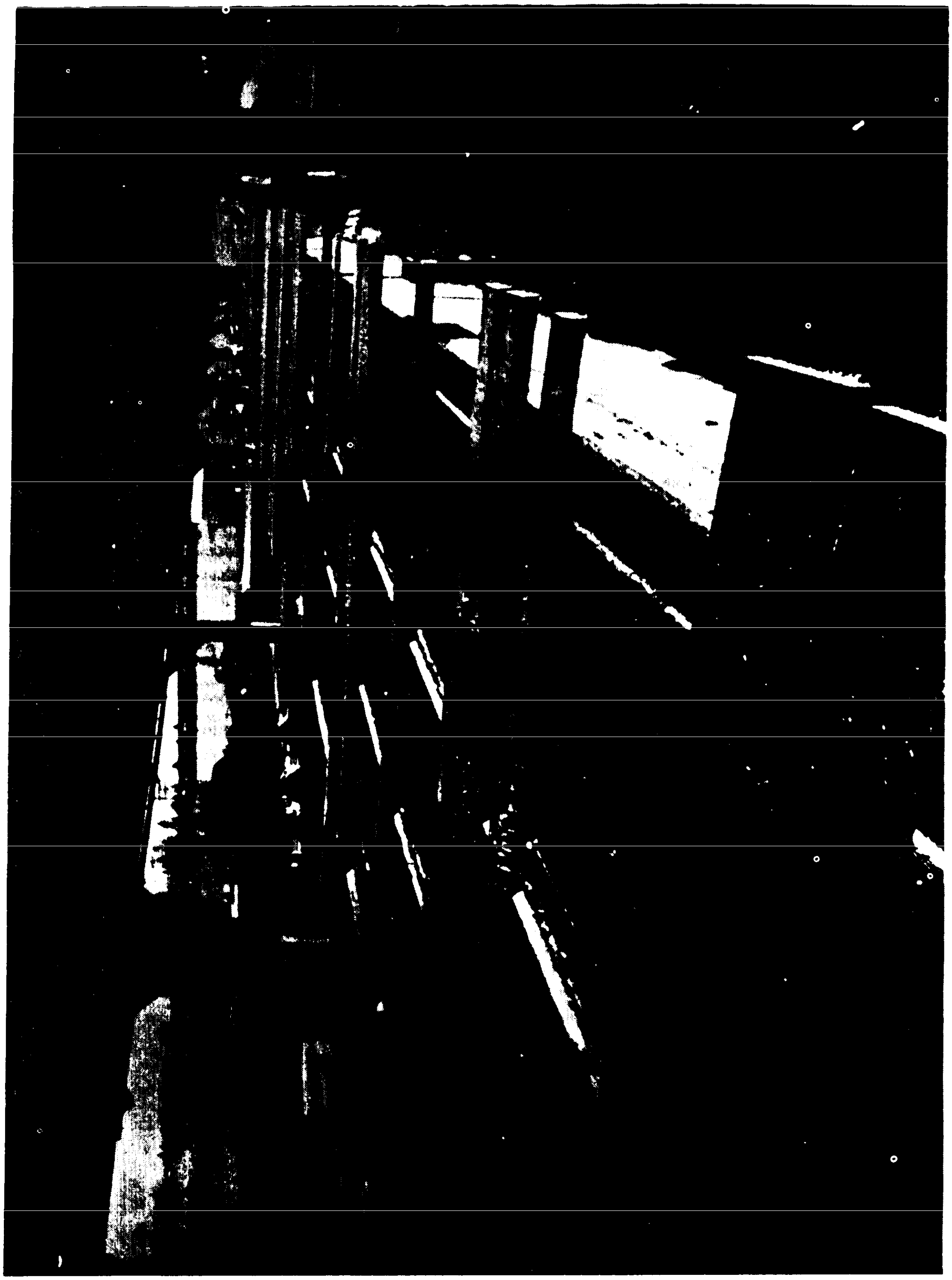

FIGURE 18. Rough lumber being moved by conveyor green chain.

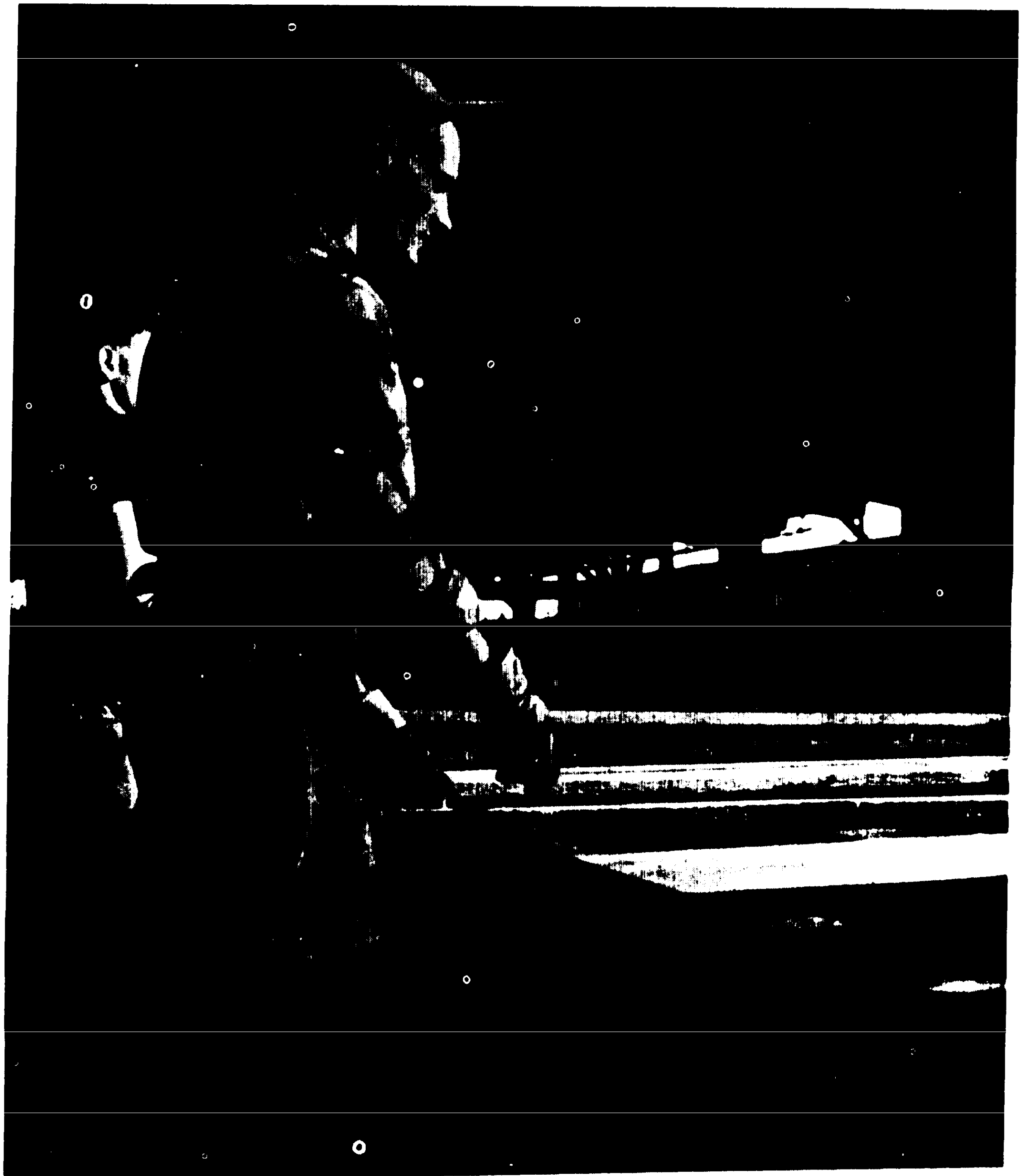

FIGURE 19. Grading rough lumber on the "green chain".

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FIGURE 20. Grading of surfaced boards.

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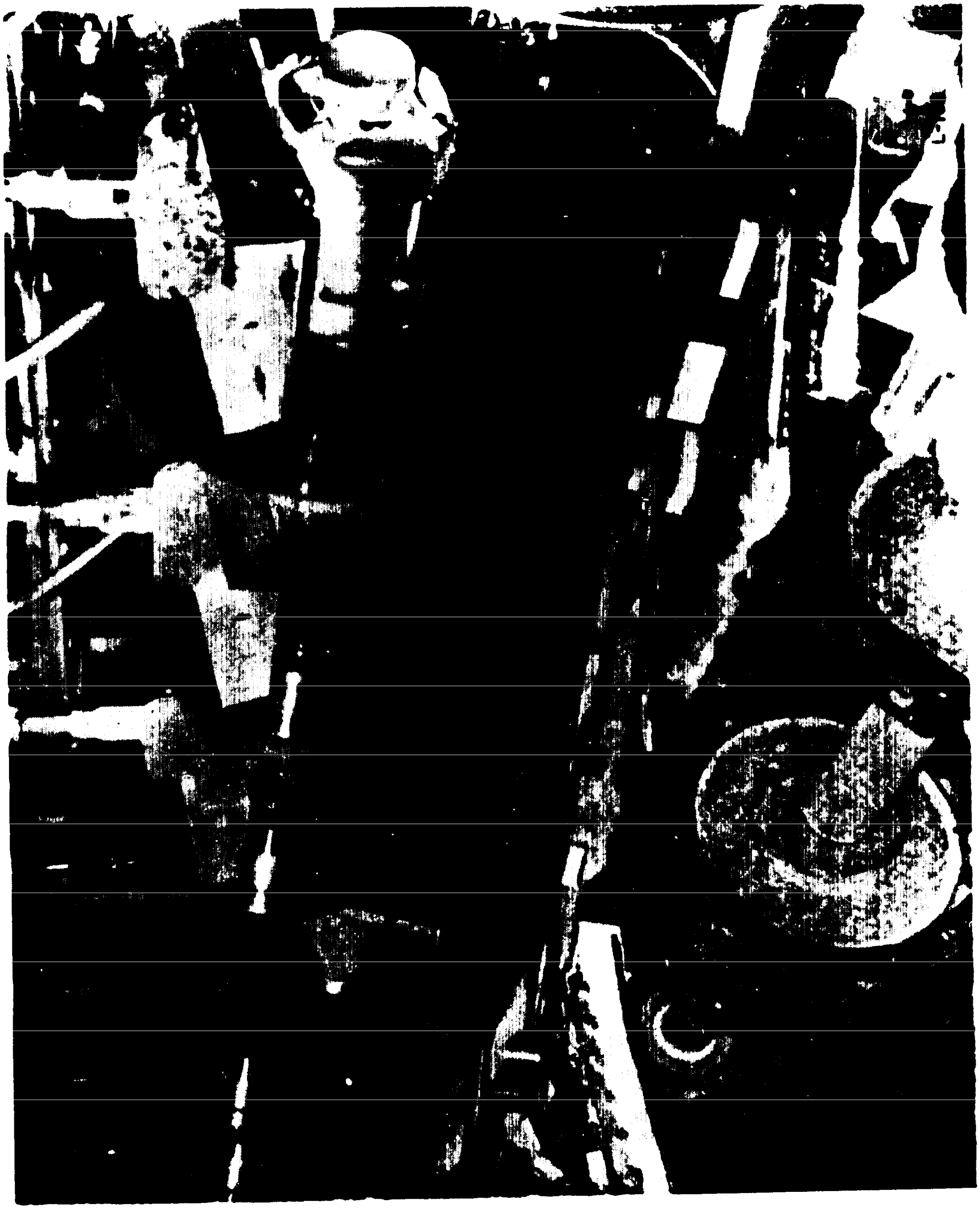

FIGURE 21. Trim saw or "trimmer" used for cutting large quantities of material to preselected lengths.

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X-3818

FIGURE 22. **Automatic sorting of lumber by machine.**

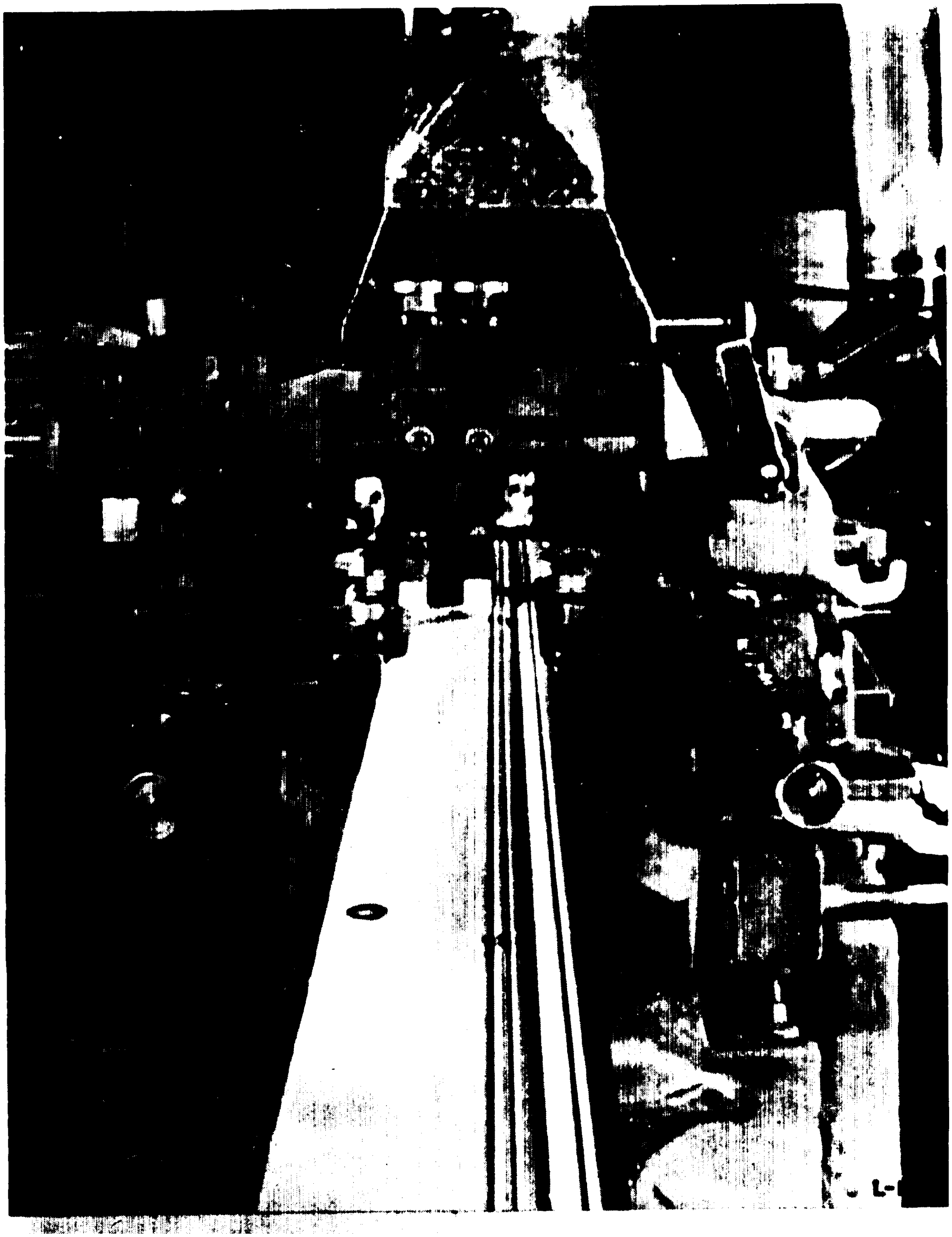

FIGURE 23. Machine operation producing patterned paneling.

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Characteristics of Wood

Wood growth. Wood forms as trees grow in both height and thickness. Growth is by small units called cells, that range in length from about one twenty-fifth inch for hardwoods to about one-eight inch for softwoods. Trunks lengthen as new cells develop from primary cell structure at the trunk tips, as do roots and branches.

Trees grow in diameter from a thin-walled layer of living cells between the bark and the wood. The cells are of various sizes and shapes firmly grown together, and except for the bark cells, constitute the structural elements of the wood. Many cells are quite long and pointed at the ends, and are commonly called fibers. The length of wood fibers is highly variable within a tree, as well as among species. In dry wood, cells may be empty or partly filled with deposits, such as gums and resins. Some cells in hardwood are relatively large in diameter and are known as pores or vessels. Through these pores or vessels flow the sap. The softwoods do not have vessels so the sap must flow through the fibers or tracheids. Both hardwoods and softwoods contain other cells that extend from the pith toward the bark. These cells also conduct sap and are called rays. In oaks and sycamores, the rays are conspicuous decorative features. Wood also has other cells, known as longitudinal, or axial parenchyma cells, that function mainly for the storage of food.

Structure. Figure 24 depicts a cross section of a tree showing the following well-defined features in succession from the outside to the center: (1) bark, which may be divided into the outer, corky, dead part that varies greatly in thickness with different species and with age of trees, and the thin inner living part; (2) wood, which unmerchantable trees of most species is clearly differentiated into sapwood and heartwood; and (3) the pith, indicated by a small central core, often darker in color, which represents primary growth formed when wood stem or branches elongate. Between the bark and the wood is a layer of thin-walled living cells called the cambium, invisible without a microscope, in which most growth in thickness of bark and wood arises by cell division. No new growth in either diameter or length takes place in wood already formed; new growth is purely the addition of new cells, not the further development of old ones. New wood cells are formed on the inside and new bark cells on the outside of the cambium. As the diameter of the woody trunk increases, the bark is pushed outward, and the outer bark layers become stretched, cracked, and ridged in patterns often characteristic of a species. A bark cambium forms from living cells and this tissue separates the outer bark from the inner bark. The inner bark (B) is moist, soft, and contains living tissues, carries prepared food from leaves to all growing parts of the tree. The outer bark (C) containing corky layers is composed of dry, dead tissues, and gives general protection against external injuries. Inner and outer bark are separated by a bark cambium. Sapwood (D) contains both living and dead tissues, and is the light-colored wood beneath the bark which carries sap from the roots to the leaves. The heartwood (E) consists of inactive cells formed by gradual changes in the living cells of the inner sapwood rings. The pith (F) is the soft tissue about which the first wood growth takes place in the newly formed twigs. Wood rays (G) connect the various layers from pith to bark for storage and transfer of food.

FIGURE 24, Cross section of a white oak tree trunk.

X-3820

Effects of environment. With most species in temperate climates, there is sufficient difference between the wood formed early and that formed late in a growing season to produce well-Marked annual growth rings. The age of a tree at the stump or the age at any cross section of the trunk may be determined by counting these rings (Figure 25) If the growth of trees in diameter is interrupted by drought or defoliation by insects, more than one ring may be formed in the same season. In such an event, the inner rings usually do not have sharply defined boundaries and are termed false rings. Trees that have only very small crowns or that have accidentally lost most of their foliage may form only an incomplete growth layer, sometimes called a discontinuous ring, until the crown is restored. Growth rings are most readily seen in species with sharp contrast between earlywood and latewood, such as the native ring-porous hardwoods as ash and oak, and most softwoods except the soft pines. In some other species, such as water tupelo, sweetgum, and soft maple, differentiation of early and late growth is slight, and the annual growth rings are difficult to recognize. In some tropical regions, growth may be practically continuous throughout the year, and no well-defined annual rings are formed.

Earlywood and latewood. The inner part of the growth ring formed first in the growing season is called earlywood or springwood, and the outer part formed later in the growing season, latewood or summerwood. Actual time of formation of these two parts of a ring may vary with environmental and weather conditions. Earlywood is characterized by cells having relatively large cavities and thin walls. Latewood cells have smaller cavities and thicker walls. The transition from earlywood to latewood may be gradual or abrupt, depending on the kind of wood and the growing conditions at the time it was formed. In some species, such as the maples, gums, and yellow-poplar, there is little difference in the appearance of the earlywood and latewood parts of a growth ring.

When growth rings are prominent, as in most softwoods and the ring-porous hardwoods, earlywood differs markedly from latewood in physical properties. Earlywood is lighter in weight, softer, and weaker than latewood; it shrinks less across and more lengthwise along the grain of the wood. Because of the greater density of latewood, the proportion of latewood is sometimes used to judge the quality or strength of wood. This method is useful with such species as the southern pines, Douglas fir, and the ring-porous hardwoods - ash, hickory, and oak.

Sapwood. Sapwood is located next to the cambium. It contains only a few living cells and functions primarily in the storage of food and the mechanical transport of sap.

The sapwood layer may vary in thickness and in the number of growth rings contained in it. Sapwood commonly ranges from 1-1/2 to 2 inches in radial thickness. In certain species, such as catalpa and black locust, the sapwood contains very few growth rings and sometimes does not exceed one-half inch in thichness. The maples, hickories, ashes, some of the southern pines, and ponderosa pine may have sapwood 3 to 6 inches or more in thickness, especially

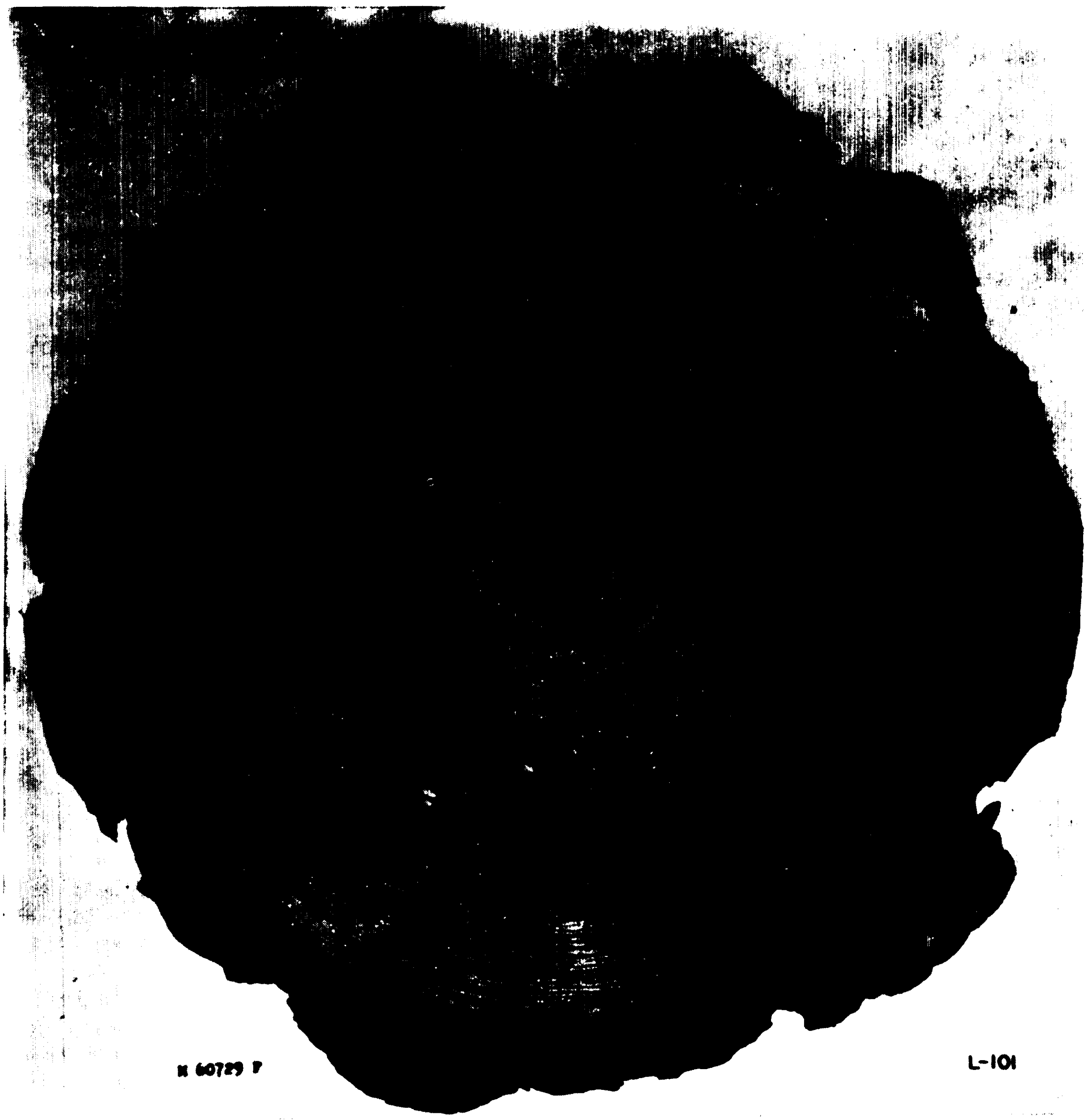

FIGURE 25. Cross section of a ponderosa pine log showing growth rings.

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in second-growth trees. As a rule, the more vigorously growing trees of a species have wider sapwood layers. Many second-growth trees of merchantable size consist mostly of sapwood. Unless treated, all sapwood is nondurable when exposed to conditions that favor decay.

Heartwood. Heartwood consists of inactive cells that have been slightly changed, both chemically and physically, from the cells of the inner sapwood rings. In this condition these cells cease to conduct sap. Heartwood cells may contain deposits of various materials which frequently give much darker color to the heartwood. All heartwood, however, is not dark colored. Species in which heartwood does not darken to a great extent include the spruces (except Sitka spruce), hemlock, and true firs, Port-Orford-cedar, basswood, cottonwood, and buckeye. The infiltrations or materials deposited in the cells of heartwood usually make the wood more durable when used in exposed situations. In some species, such as the ashes, hickories, and certain oaks, the pores become plugged to a greater or lesser degree with ingrowths, known as tyloses, before the change to heartwood is completed. Heartwood having pores tightly plugged by tyloses, as in white oak, is suitable for tight cooperage.

Heartwood has a higher extractives content than sapwood, and because of this, exhibits a higher specific gravity. For most species the difference is so small as to be quite unimportant. The weight and strength of wood are influenced more by growth conditions at the time the wood is formed than they are by the change from sapwood to heartwood. In some instances, as in redwood, western red cedar, and black locust, considerable amounts of infiltrated material may somewhat increase the weight of the wood and its resistance to crushing.

Old growth. Considering specifically the quality of the wood, “old growth” means timber from a fully stocked, mature forest, the trees of which have grown during most, if not all, of their individual lives in active competition with their companions for sunlight and moisture. Second growth lumber comes from trees that may have grown relatively fast under open conditions. Fast growth creates wide annual rings, which indicate strong, tough wood in hardwoods, such as ash, hickory, elm, and oak; but weak and brash wood in softwoods, such as pine and fir. For uses in which strength and toughness are essential, therefore, fast grown lumber is sought among the hardwoods, whereas in conifers slow growth usually is desired. In managed second-growth softwood stands, slow growth is therefore deliberately sought. Second growth timber stands are common in the East, Lake States, and the South. Practically all old growth softwood lumber now comes from the West; but even there, second growth timber is increasingly important.

Wood Defects

Common defects on which grading rules are based are knots, cross grain, stains, decay, insect damage, pitch pockets, pitch streaks, mineral streaks, checks, splits, shakes, and wane. Some other defects not recognized in grading rules and not discussed here include compression wood, tension wood, and compression failures.

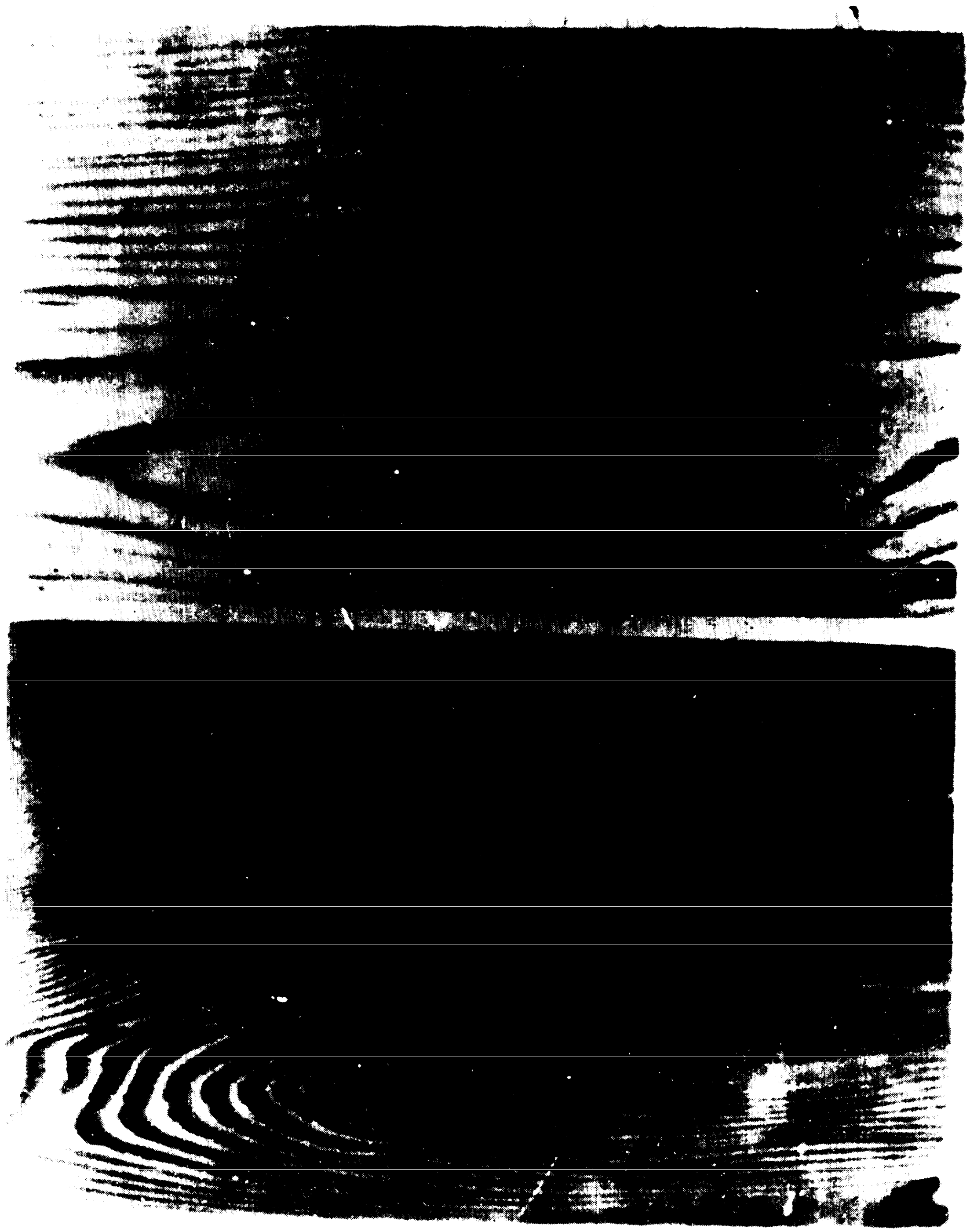
Defects impair quality by reducing strength or marring the appearance of finished surfaces. Features that might be a defect for one use are desirable for other uses; for example, intergrown knots reduce strength, yet in knotty finish lumber they add a valuable decorative effect. Stains may influence appearance because of discoloration without affecting strength. Decay, on the other hand, may have a marked influence on both appearance and strength because of the actual destruction of wood substance.

Some defects also impair the machining quality of wood for certain purposes, interfere with painting and other finishings, cause trouble in steam bending of wood boat and furniture parts, and cause waste in proportion to their extent and severity.

Knots. A knot is the base of a limb embedded in the tree trunk. As it appears in a sawed piece of lumber, a knot is merely a section of the limb from which it originated, and its shape depends upon the direction of the cut. When a knot is sawed through at right angles to its length, a round knot results; when cut diagonally, its surface is oval; and when sawed lengthwise, it is known as a spike knot. Knots are further classified as follows:

(a) Intergrown knot - Most branches originate at the pith, and their bases are intergrown with the wood of the trunk as long as they are alive. These living branch bases constitute intergrown knots. When sawed through at a right angle to the knot, the annual growth rings may be seen (Figure 26) emanating from the knot rather than surrounding it.
(b) Encased knot - After a tree branch has died, additional growth of the trunk encloses the dead limb (Figure 26), and an encased knot results. When sawn through at right angles to the knot, annual growth rings may be seen encircling rather than being intergrown with the knot. The encased knot may also be referred to as a “black knot”. This type knot is mechanically inferior to an encased knot in most applications. The intergrown knot may also be referred to as a “red knot”.
(c) Spike knot - A knot which has been sawn parallel to its axis.

Knots in round timbers, such as poles and piles, have less effect on strength than knots in sawed timbers. Although the grain is irregular around knots in both forms of timber, its angle with the surface is less in naturally round than in sawed timber.



A. Encased knot B. Intergrown knot

FIGURE 26. Types of wood knots.

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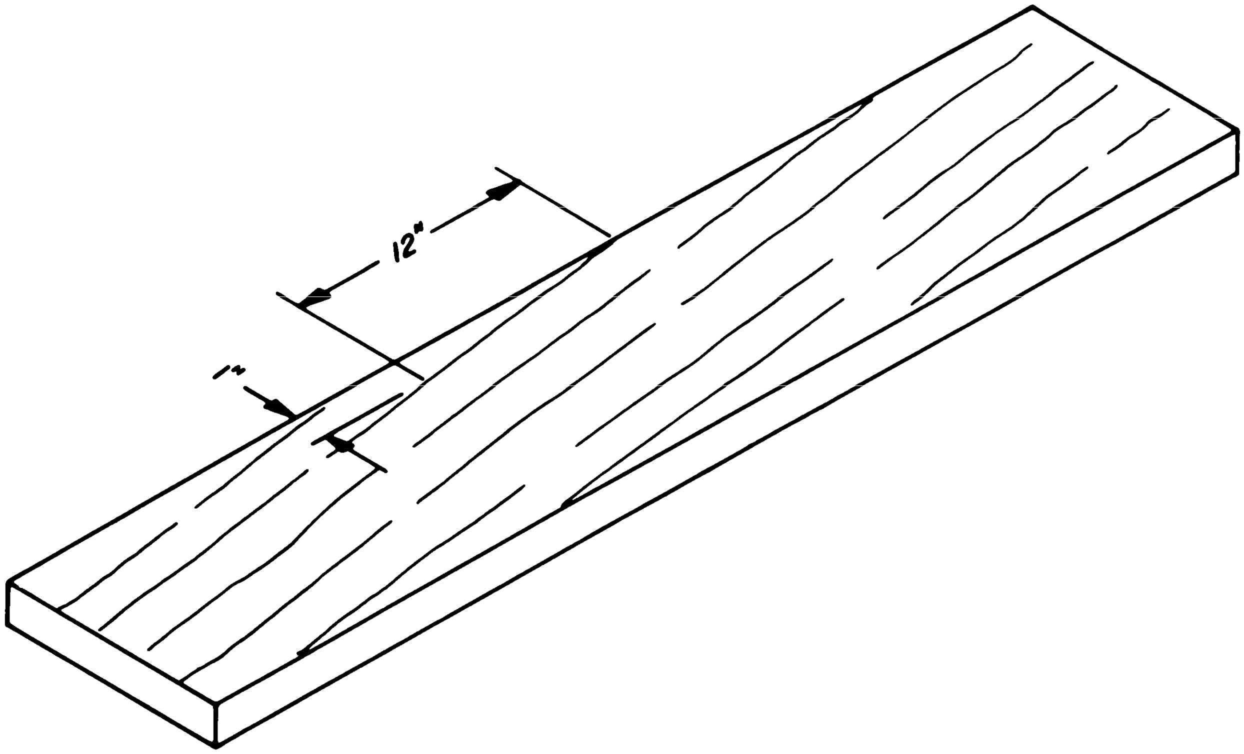
Cross grain. The term “grain” is often used in reference to the annual growth rings evident on lumber, i.e., fine grain or coarse grain, but it is also employed to indicate the direction of fibers as in “straight grain” or “cross grain”. The principal types of cross grain are spiral grain and diagonal grain. Other types are curly, interlocked, and wavy grain. Spiral grain is caused by fibers growing in a spiral or winding course about the bole of the tree instead of in a vertical course. Diagonal grain describes cross grain caused by growth rings not parallel one both surfaces of the sawn piece. Diagonal grain is produced by sawing parallel to the axis (pith) of the tree in a log having pronounced taper, and is a common occurrence in sawing crooked or swelled logs. Cross grain can be quite localized as a result of the disturbance of growth patterns by a branch. This condition, termed “local slope of grain”, may be present even though the branch (knot) may have been removed in a sawing operation. Often the degree of local grain may be difficult to determine. Any form of cross grain can have a serious effect on mechanical properties or machining characteristics. Spiral and diagonal grain may combine to produce a more complex cross grain.

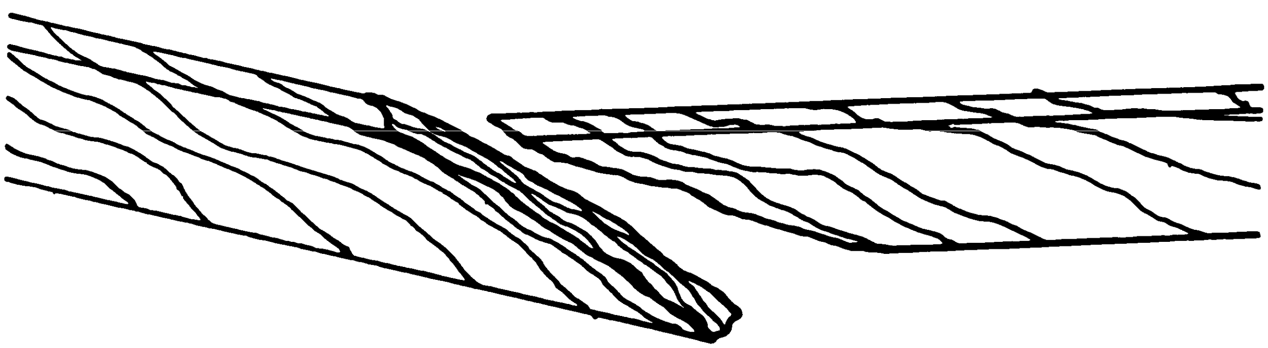
Slope of grain. The term “slope of grain” relates the fiber direction to the long centerline of the piece. Slope of the grain is usually expressed by the ratio between a 1 inch deviation of the grain from the edge or long axis of the piece and the distance in inches within which this deviation occurs. Figure 27A indicates that grain (fiber) direction in this board deviates from parallelism with the edge of the board by 1 inch in a distance of 12 inches, for a slope ratio of 1 to 12. Strength ratios corresponding to various slopes of grain are given in Table III. These ratios are expressed as percentages, as compared to straight-grained pieces. The piece depicted in Figure 27B broke under a comparatively low load because of the steep slope of grain through it.

TABLE III. Strength ratios corresponding to various slopes of grain.

Maximum slope of grain in member	Modulus of rupture	Impact bending - height of drop causing complete failure (50-lb. hammer)	Compression parallel to grain - maximum crushing strength
	Pet.	Pet.	Pet.
Straight-grained	100	100	100
1 in 25	96	95	100
1 in 20	93	90	100
1 in 15	89	81	100
1 in 10	81	62	99
l in 5	55	36	93



A. Slope of grain measurement.



B. Fracture at low load due to steep grain slope.

L-104

FIGURE 27. Strength as a function of grain structure.

X-3823

Pitch pockets. A pitch pocket is a well-defined opening extending parallel to the annual rings, and contains more or less free resin. Pitch pockets are confined to the pines, spruces, Douglas fir, tamarack, and western larch. The effect of pitch pockets on strength depends upon their number, size, and location in the piece; their effect on strength has often been overestimated. They interfere with painting and other finishing.

Pitch streaks. Pitch streaks are infiltrations of resin in the fibers usually extending greater distance along than across the grain. Pitch streaks add to the weight of wood. The pitch may exude in warm weather. They have no harmful effect on strength, but may mar paint and other finishes.

Mineral streaks. Mineral streaks are dark brown or black streaks, frequently tinged with green, often containing enough mineral matter to dull sharp-edged tools. They range up to a foot or more in length and an inch or more in width. They are frequently infected by fungus. They are common in some hardwoods, such as maple, hickory, basswood, and birch, and are believed due to bird pecks, tappings for maple sugar, and other wounds to the living tree.

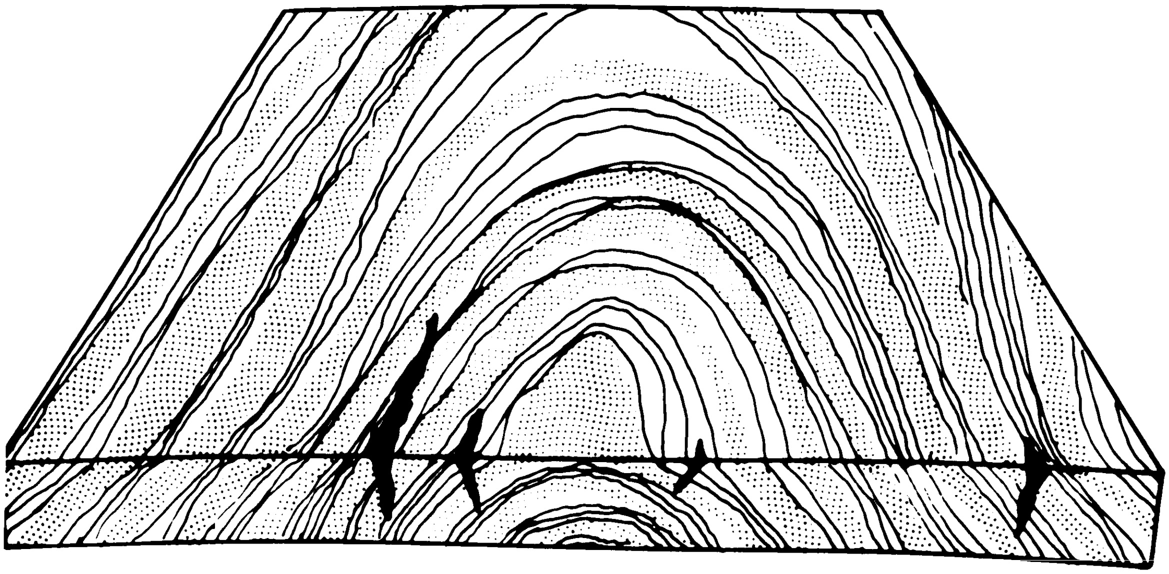
Checks, splits and shakes. A check is a longitudinal crack in wood, generally across the annual rings (Figure 28A). Checks are usually due to uneven shrinkage during seasoning. Thick lumber checks more severely than does thin lumber. A split is a longitudinal crack in wood caused by rough handling or other damaging forces, including seasoning stresses. Typically, it extends through the thickness of a piece.

A shake is a longitudinal crack in wood between two annual rings, as though the rings had shelled apart (Figure 28B). Shakes, unlike checks and most splits, are not the result of seasoning but, if not plainly evident in the green timber, may be accentuated in seasoning or during certain machining processes.

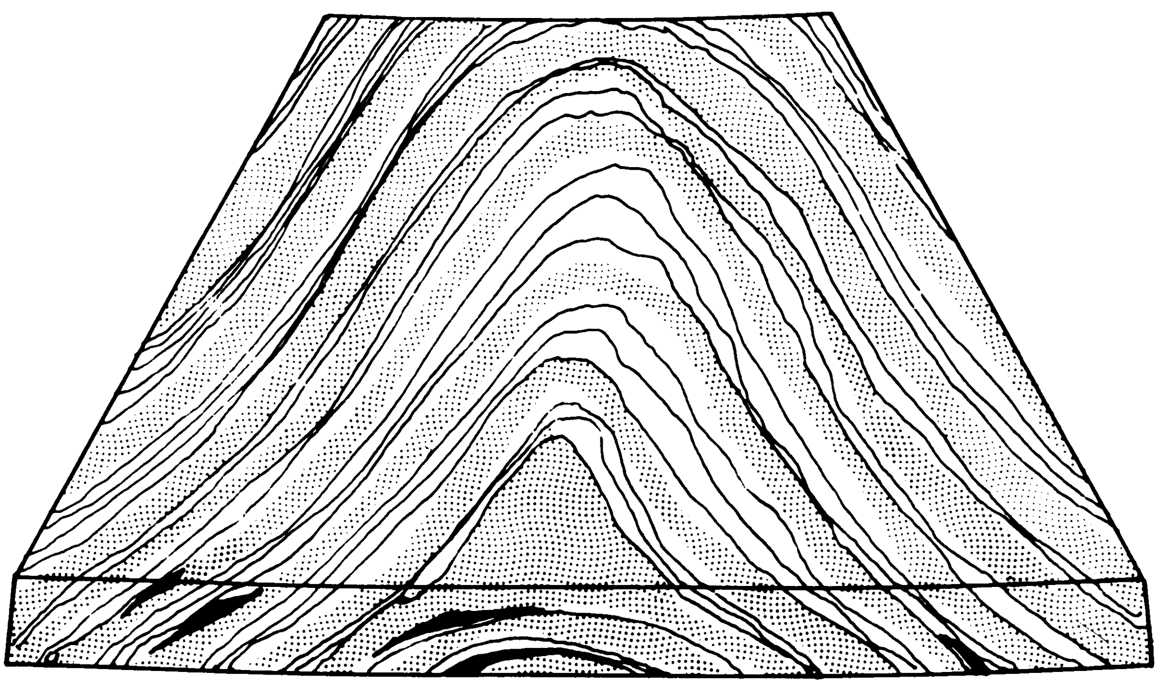
Relatively large checks, splits, and shakes may seriously weaken wood members in resistance to longitudinal shear.

Wane. Wane is bark or lack of wood from any cause on an edge or corner of a board or timber. Figure 29 illustrates wane on edge of a board. Bark may or may not be present.

Molds and staining fungi. Mold and staining fungi do not seriously effect most mechanical properties of wood because they feed upon substance within the structural cell wall rather than on the structural wall itself. Specific gravity may be reduced by from 1 to 2 percent, while most of the strength properties are reduced by a comparable or only sligtly greater extent.



A. Lumber checks.



B. Lumber shakes. L-105

FIGURE 28. Lumber defects as a result of seasoning.

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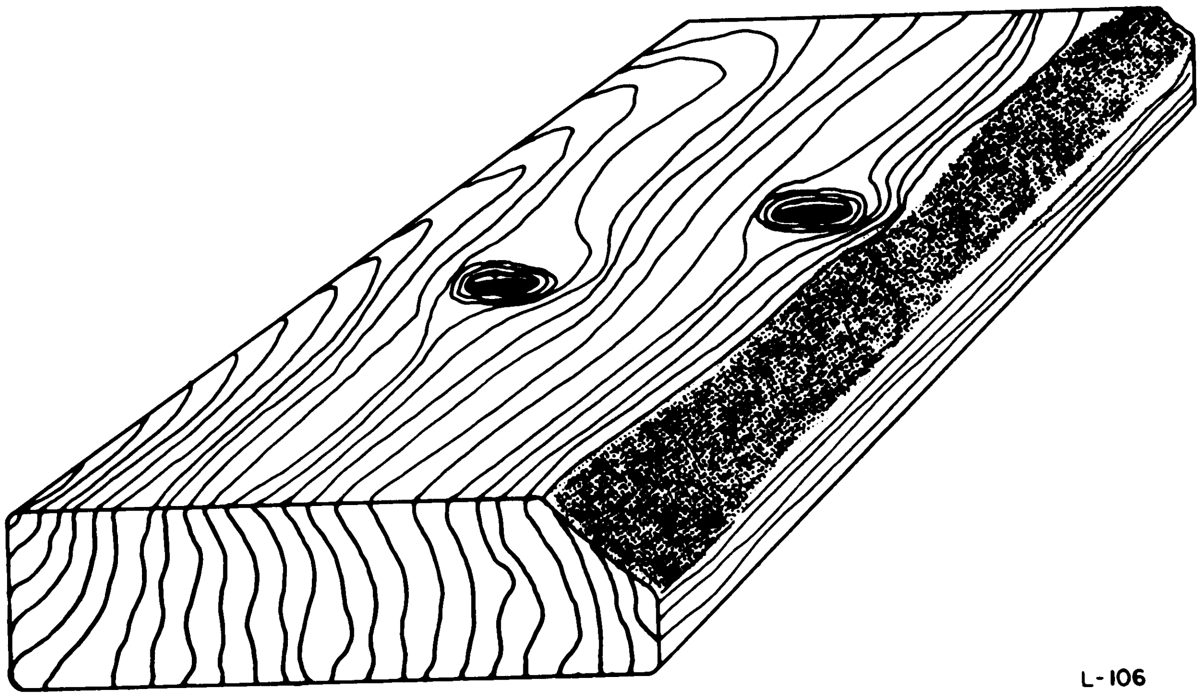

L-106

FIGURE 29. Wane on edge of board.

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Toughness or shock resistance, however, may be reduced by up to 30 percent. The duration of infection and the species of fungi involved are important factors in determining the extent of weakening.

Although molds and stains themselves often do not have a major effect on the strength of wood products, conditions that favor the development of these organisms are likewise ideal for the growth of wood-destroying (decay) fungi, which can greatly reduce mechanical properties.

Decay. Unlike the mold and staining fungi, the wood-destroying (decay) fungi seriously reduce strength. Even apparently sound wood adjacent to obviously decayed parts may contain hard-t-detect, early (incipient) decay that is decidedly weakening, especially in shock resistance.

All wood-destroying fungi do not affect wood in the same way. The fungi that cause an easily recognized pitting of the wood, for example, may be less injurious to strength than those that, in the early stages, give a slight discoloration of the wood as the only visible effect.

No method is known for estimating the amount of reduction in strength from the appearance of decayed wood. Therefore, when strength is an important consideration, the safe procedure is to discard every piece that contains even a small amount of decay. An exception may be pieces in which decay occurs in a knot but does not extend into the surrounding wood. Precise ratings of natural decay resistance of heartwood of different species are not possible because of differences within species, and the variety of service conditions to which wood is exposed. However, broad groupings of many of the native species, based on service records, laboratory tests, and general experience, are helpful in choosing heartwood for use under conditions favorable to decay. Table IV shows such groupings for some domestic woods, according to their average heartwood decay resistance. Table V gives similar groupings for some imported woods. Figure 30 indicates a piece of red oak infected by a white-rot fungus that leaves characteristic dark zone lines and a mottled effect.

Insect damage. Insect damage may occur in standing trees, logs, and unseasoned or seasoned lumber. Damage in the standing tree is difficult to control, but otherwise insect damage can be largely eliminated by proper control methods.

Insect holes are generally classified as pinholes, grub holes, and powderpost holes. The powderpost larvae, by their irregular burrows, may destroy most of the interior of a piece, while the surface shows only small holes, and the strength of the piece may be reduced virtually to zero.

No method is known for estimating the amount of reduction in strength from the appearance of insect-damaged wood, and, when strength is an important consideration, the safe procedure is to eliminate pieces containing insect holes. Figure 31 illustrates two types of insect damage. The upper piece shows large grub holes probably caused by round-headed borers. The lower piece shows small pinholes probably caused by beetles.

TABLE IV. Groupings of some domestic woods according to heartwood decay resistance.

Resistant or very resistant	Moderately resistant	Slightly or nonresistant
Baldcypress	Baldcypress	Alder
(old growth) 1/	(young	Ashes
Catalpa	growth) 1/	Aspens
Cedars	Douglas-fir	Basswood
Cherry, black	Honeylocust	Beech
Chestnut	Larch,	Birches
Cypress, Arizona	western	Buckeye
Junipers	Oak, swamp	Butternut
Locust, black 2/	chestnut	Cottonwood
Mesquite	Pine, eastern	Elms
Mulberry, red 2/	white 1/	Hackberry
Oak:	Southern pine:	Hemlocks
Bur	Longleaf 1/	Hickories
Chestnut	Slash 1/	Magnolia
Gambel	Tamarack	Maples
Oregon White		Oak (red and
Post		black
White		species)
Osage orange 2/		Pines (other
Redwood		than long-
Sassafras		leaf, slash,
Walnut, black		and eastern
Yew, Pacific 2/		white)
		Poplars
		Spruces
		Sweetgum
		True firs
		(western
		and eastern)
		Willows
		Yellow-popular

1/ The southern and eastern pines and baldcypress are now largely second growth with a large proportion of sapwood. Consequently, substantial quantities of heartwood lumber of these species are not available.

2/ These woods have exceptionally high decay resistance.

TABLE V. Groupings of some imported woods according to approximate relative heartwood decay resistance.

Resistant or very resistant	Moderately resistant	Slightly or nonresistant
Angelique	Andiroba 1/	Balsa
Apamate	Apitong 1/	Banak
Brazilian rosewood	Avodire	Cativo
Caribbean pine	Capirona	Ceiba
Courbaril	European walnut	Jelutong
Encino	Gola	Limbs
Goncalo alves	Khaya	Lupuna
Greenheart	Laure1	Mahogany, Philippine:
Guijo	Mahogany, Philippine:	Mayapis
Iroko	Almon	White lauan
Jarrah	Bagtikan	Obeche
Kapur	Red lauan	Parana pine
Karri	Tanguile	Ramin
Kokrodua (Afrormosia)	Ocote pine	Sande
Lapacho	Palosapis	Virola
Lignum vitae	Sapele	
Mahogany, American		
Meranti 1/		
Peroba di campos		
Primavera		
Santa Maria		
Spanish-cedar		
Teak		

1/ More than 1 species included, some of which may vary in resistance from that indicated.

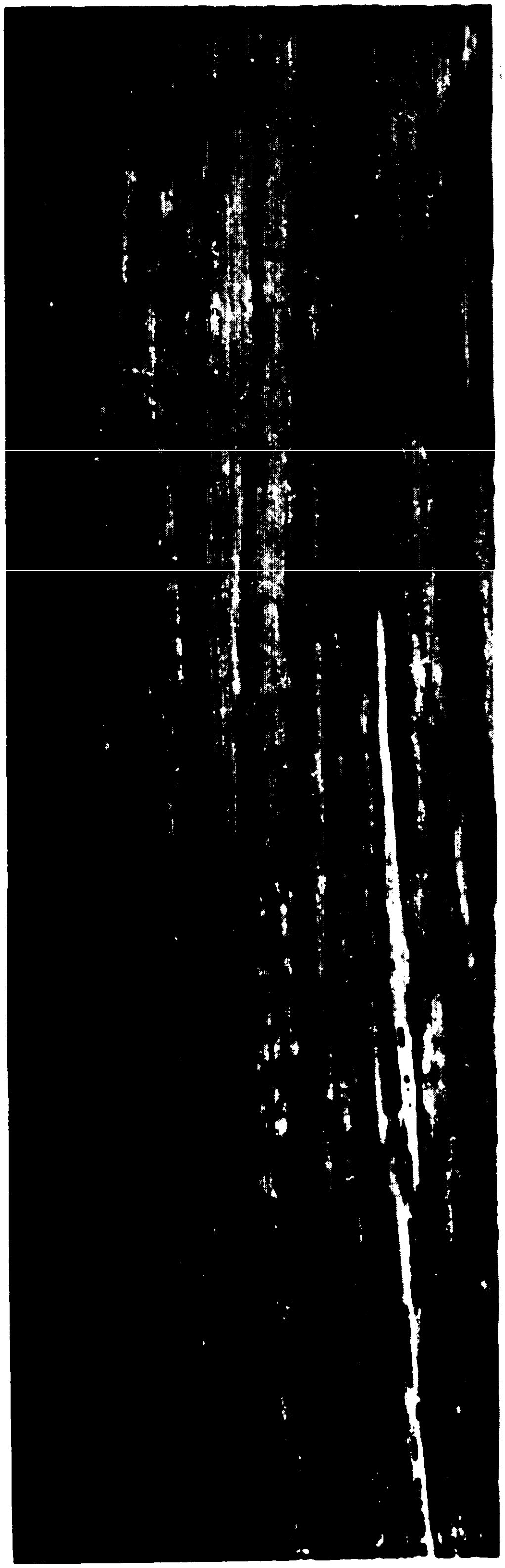

FIGURE 30. Typical appearance of advanced decay in wood.

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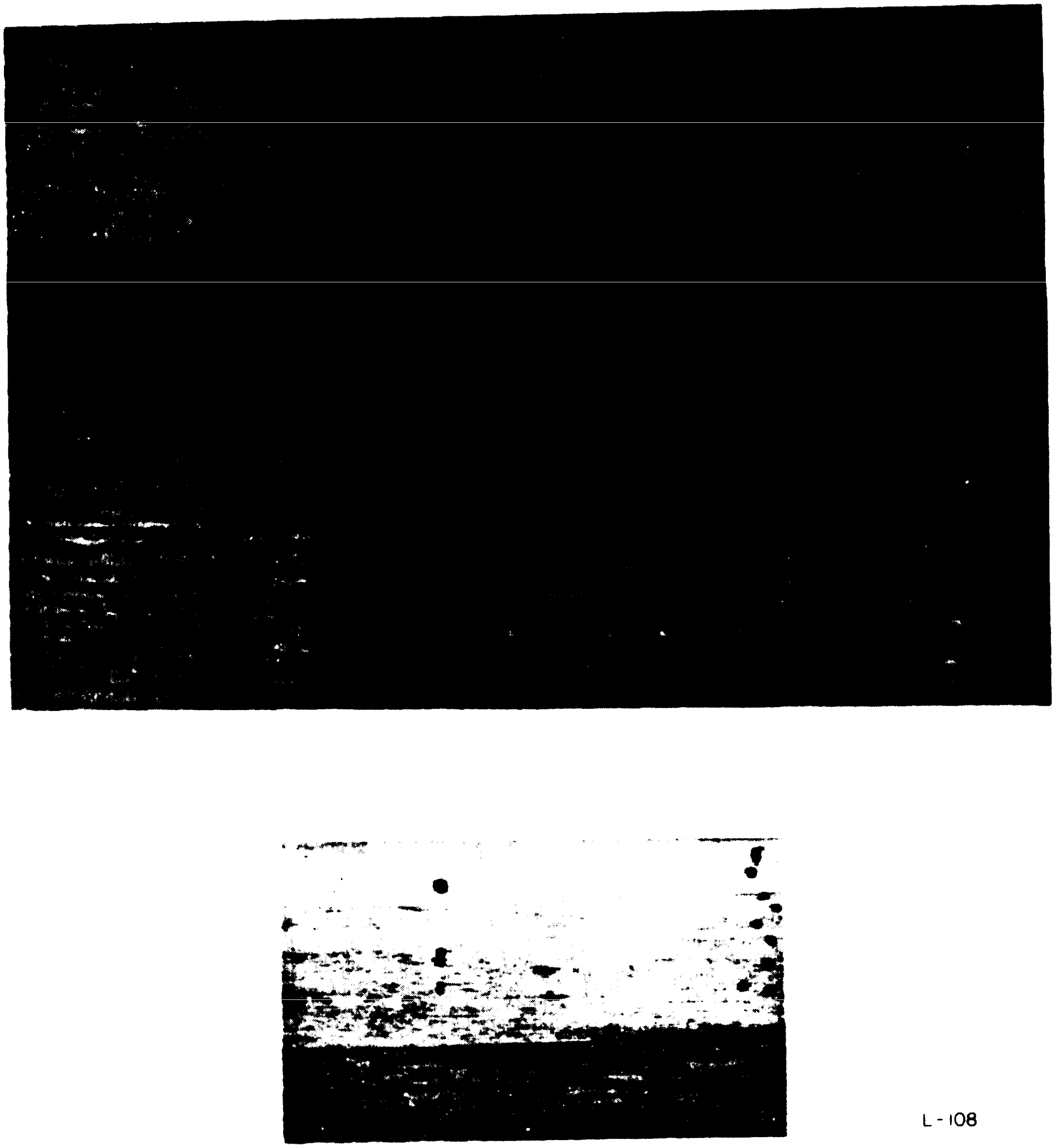

FIGURE 31. Insect damage.

X-3827

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(2) Koehler, A.
1943. Guide to Determining Slope of Grain in Lumber and Veneer. U.S. Forest Products Laboratory Report No. 1585, 25 pp. Illus.

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CHAPTER 3. COMMERCIALLY IMPORTANT WOODS

Native species of trees are divided into two classes; hardwoods which have broad leaves and softwoods which have scalelike leaves, as the cedars, or needlelike leaves as the pines. Hardwoods, except in the warmest regions, shed their leaves at the end of each growing season. Native softwoods, except cypress, tamarack and western larch, are evergreen. Softwoods are known also as conifers, because all our native species of softwoods bear cones of one kind or another.

With respect to the wood itself, the terms hardwood and softwood are not descriptively exact, because some softwoods, such as southern yellow pine and Douglas fir, are harder than some hardwoods, such as basswood and cottonwood. The terms have been used so long, though, that their meaning is definite. A general comparison of lumber production and consumption (including imports and exports) for the United States appears in Table II.

Softwoods

Most of our softwood timber (about 70%) is west of the Great Plains. Western softwood timber stands of Washington and Oregon contain about three-fourths of the western softwood timber, those of California about one-eight, and the rest is scattered along the mountains from Idaho and Montana southward. About two-thirds of the Eastern softwood stands are in the South.

In 1977, the cut of softwood timber amounted to about 80 percent of the total timber harvested in the United States. Douglas fir leads with around 22 percent followed by southern yellow pine with 21 percent and ponderosa pine with 10 percent of the 37 billion board foot total. The rest of the softwood timber is chiefly cedar, hemlock, white fir, white pine, sugar pine, redwood, spruce, and larch.

The important localities of growth, characteristics, and uses of woods of the main commercial softwood species or groups of species are described in the following paragraphs. The names of lumber used by the trade are not always identical. To avoid confusion, the requisition writer should use the common names for softwood lumber prescribed in the American Softwood Lumber Standard and the hardwood lumber names current in the trade. These preferred common names precede the Latin botanical names in the descriptions here given.

Alaska cedar. Alaska cedar (chamaecyparis nootkatensis) or Alaska yellow cedar, grows in the Pacific coast region of North America from southeastern Alaska southward through Washington to southern Oregon. In Washington and Oregon, it is confined to the west side of the Cascade Mountains, usually above an elevation of 2,000 feet. It reaches its best development along the coast and on the nearby islands of southern Alaska and British Columbia.

The heartwood of Alaska cedar is bright, clear yellow. The sapwood is narrow, white to yellowish, and hardly distinguishable from the heartwood. The wood is fine-textured and generally straight-grained. It is moderately heavy, averaging 31 pounds a cubic foot at 12 percent moisture content. It is moderately strong and stiff, moderately hard, and moderately high in resistance to shock. Alaska cedar shrinks little in drying, stays in place well after seasoning, and the heartwood is very resistant to decay. The wood has a mild, unpleasant odor.

Alaska cedar is used locally for interior finish, furniture, small boats, cabinet work, and novelties.

Cypress. Baldcypress (Taxodium distichum) is commonly known as southern cypress, red cypress, yellow cypress, and white cypress. Commercially, the terms "tidewater red cypress," "gulf cypress," "red cypress (coast type)," and "yellow cypress (inland type)," are frequently used.

Cypress grows along the Atlantic Coastal Plain from Delaware to Florida, westward throuth the Gulf coast region to the Mexican border in Texas, and up the Mississippi Valley to southern Indiana. The heaviest stands are found in the extensive swamps of the lower Mississippi Valley and in Florida. About one-half of the cypress lumber comes from the Southern States and one-fourth from the South Atlantic States.

Sapwood of cypress is narrow and nearly white. The color of the heartwood varies widely, ranging from light yellowish brown to dark brownish red, brown, or chocolate. The wood is moderately heavy, averaging 32 pounds a cubic foot at 12 percent moisture content. It is moderately strong and moderately hard, and its heartwood is one of our most decay-resistant woods. Shrinkage is moderately small, but somewhat greater than that of cedar and less than that of southern yellow pine.

Frequently the wood of certain cypress trees contains pockets or localized areas that have been attacked by a fungus. Such wood is known as "pecky" cypress. The decay caused by this fungus is arrested when the wood is cut into lumber and dried. Pecky cypress therefore is durable and useful where appearance is not important and watertightness is unnecessary.

Cypress is used principally for building construction, especially where resistance to decay is required. It is used for beams, post and other members in docks, warehouses, factories, bridges, and heavy construction.

It is well suited for siding and porch construction. It is also used for caskets, burial boxes, sash, doors, blinds, and general millwork, including interior trim and paneling. Other used are tanks, vats, ship and boat building, refrigerators , railroad car construction, greenhouse construction, cooling towers, and stadium seats. It is also used for railway ties, poles, piles, shingles, cooperage, and fence posts.

Douglas fir. Douglas fir (Pseudotsuga menziesii) is also known locally as red fir, Douglas spruce, yellow fir, and Oregon Pine.

The range of Douglas fir extends from the Rocky Mountains to the Pacific coast and from Mexico to central British Columbia. More than half of Douglas fir production comes from Oregon, nearly 20 percent from Washington, 15 percent from California, and about 6 percent from Idaho and Montana.

Sapwood of Douglas fir is narrow in old growth trees but may be as much as 3-inches wide in second growth trees of commercial size. Fairly young trees of moderate to rapid growth have reddish heartwood and are called red fir. Very narrow-ringed wood of old trees may be yellowish brown in color and is known on the market as yellow fir.

The wood of Douglas fir varies widely in weight and strength. Average material from the Pacific coast is rated as strong, moderately hard and heavy, and very stiff. It averages 34 pounds a cubic foot at 12 percent moisture content. Interior Douglas fir average somewhat lower in weight than old growth Coast type. In strength, Coast type Douglas fir is given equal rank with southern yellow pine.

Douglas fir is used principally for building and construction purposes in the form of lumber, timbers, piles, and plywood. Considerable quantities go into fuel, railway ties, cooperage stock, mine timbers, and fencing. Douglas fir lumber is used in the manufacture of various products, including sash, doors, general millwork, railroad car construction, boxes, and crates. Small amounts are used for flooring, furniture, ship and boat construction, wood pipe, and tanks.

Firs, true. Eight commercial species make up the group of true firs: Subalpine fir (Abies lasiocarpa), balsam fir (Abies balsamea), California red fir (Abies magnifica), Fraser fir (Abies fraseri), grand fir (Abies grandis), noble fir (Abies procera), Pacific silver fir (Abies amabilis), and white fir (Abies concolor). Of these, all but balsam and Fraser fir are often marketed together as commercial white fir. Balsam fir and Fraser fir grow in the East, the other six in the West.

In the United States, balsam fir grows principally in New England, New York, Pennsylvania, and the Lake States. Fraser fir grows in the Appalachian Mountains of Virginia, North Carolina, and Tennessee. White fir grows from the Rocky Mountains to the Pacific coast. Subalpine fir grows at high altitudes in the Rocky Mountain region and the Cascade Mountains of Oregon and Washington. Grand fir’s range is western Montana, northern Idaho, northeastern Oregon, and along the coast from Washington to northern California. Noble fir grows in the mountains of northwestern Washington, western Oregon, and northern California. California red fir is limited to the mountains of southwestern Oregon and northern and eastern California.

The wood of the true firs is creamy white to pale brown in color. Heartwood and sapwood are generally indistinguishable. Because of their similiarity of structure, wood of the true firs cannot be separated from an examination of the wood alone.

Balsam fir averages about 25 pounds per cubic foot at 12 percent moisture content. It is rated as light in weight, weak in bending and compressive strength, moderately limber, soft, and low in resistance to shock. White fir averages 26 pounds; grand fir, 28 pounds; Pacific silver fir, 27 pounds; California red fir, 27 pounds; noble fir, 26 pounds; and subalpine fir, 23 pounds per cubic foot at 12 percent moisture content. The western firs, except grand fir, have somewhat higher strength properties than balsam fir. Shrinkage of the wood is rated from small to moderately large; noble fir and California red fir shrink the most.

The western true firs (commercial white fir) are cut for lumber primarily in California, Oregon, and Washington. The rest comes from the Rocky Mountain areas. The eastern firs are used principally for pulpwood, although some are cut into lumber, especially in New England and the Lake States.

High grade lumber from noble fir goes principally into interior finish, mouldings, siding, and sash and door stock. During World War 11, some of the best material *was* used for aircraft construction. Other special and exacting uses for noble fir are for venetian blinds and ladder rails. Lower grade lumber is used for boxes. Lumber from white fir and the other western true firs goes principally into building construction, boxes and crates, planing-ill products, sash, doors, and general millwork. In small house construction, the lumber is used for framing, subflooring, and sheathing.

Hemlock, eastern. Eastern hemlock (Tsuga canadensis) grows from New England southward *along* the Appalachian Mountains to northern Alabama and Georgia, and in the Lake States. Other names are Canadian hemlock and hemlock spruce.

Production of hemlock lumber is divided fairly evenly between the New England States, the Middle Atlantic States, and the Lake States. North Carolina, South Carolina, and Virginia also produce considerable amounts.

The heartwood of eastern hemlock is pale brown with a reddish hue. Sapwood is not distinctly separated from the heartwood, but may be lighter in color. Growth rings are distinct. The wood is coarse, and uneven in texture; old trees tend to have considerable shake. It is moderately light in weight, averaging 28 pounds a cubic foot at 12 percent moisture content, moderately hard and weak, moderately limber and moderately low in shock-resisting ability.

Eastern hemlock is used principally for lumber and pulpwood. The lumber is used largely in building construction for framing, sheathing, subflooring, and roof boards, and in the manufacture of boxes and crates.

Hemlock, West Coast. West Coast hemlock (Tsuga heterophylla) is also known by several other names, including hemlock spruce, western hemlock spruce, western hemlock fir, Prince Albert fir, gray fir, silver fir, and Alaska pine. It grows along the Pacific coast of Oregon and Washington and in the northern Rocky Mountains, north to Canada and Alaska.

The heartwood and sapwood of West Coast hemlock are almost white with a purplish tinge. Sapwood, which is sometimes lighter in color, is generally not more than l-inch thick. Growth rings are distinct. The wood contains small, sound, black knots that are usually tight and stay in place. Dark streaks often found in the lumber and caused by hemlock bark maggots as a rule do not reduce strength.

West Coast hemlock is moderately light in weight, averaging 29 pounds a cubic foot at 12 percent moisture content. It is moderate in its hardness, weakness, stiffness, and shock resistance. It has moderately large shrinkage, about the same as Douglas fir. Green hemlock lumber contains considerably more water than Douglas fir, but it is comparatively easy to kiln dry.

West Coast hemlock is used principally for pulpwood and lumber. The lumber goes largely into building material, such as sheathing, subflooring, siding, joists, studding, planking, and rafters. Considerable quantities are used in the manufacture of boxes and crates, flooring, and smaller amounts for walk-in refrigerators, furniture, and ladders.

Incense cedar. Incense cedar (Libocedrus decurrens) grows in California, southwestern Oregon, and to a small extent in Nevada. Most of the incense cedar lumber comes from the northern half of California and the balance from southern Oregon.

Sapwood of incense cedar is white or cream-colored, and the heartwood is light brown, often tinged with red. The wood has a fine uniform texture and a spicy odor. Incense cedar weighs 25 pounds a cubic foot at 12 percent moisture content. It is moderately weak, soft, low in shock-resisting ability, and lacking in stiffness, It has small shrinkage and is easy to season with little checking or warping.

Incense cedar is used principally for lumber, fence posts, and ties. Nearly all the high-grade lumber is used for pencils and venetian blinds. Some is used for chests and toys. Much of the incense cedar lumber is more or less “pecky”; that is, it contains pockets or areas of disintegrated wood caused by advanced stages or localized decay in the living tree. There is no further development of peck once the lumber is seasoned. This lumber is used locally for rough construction where cheapness and decay resistance are important. Because of its resistance to decay, incense cedar is well-suited for fence posts. It makes satisfactory ties, but requires tie plates because of the softness of the wood. Other products are poles and split shingles.

Larch, western. Western larch (Larix occidentals) grows in western Montana, northern Idaho, northeastern Oregon, and on the eastern slope of the Cascade Mountains in Washington. It is found at elevations of 2,000 to 7,000 feet. About two-thirds of the lumber of this species is produced in Idaho and Montana and one-third in Oregon and Washington.

The heartwood of western larch is yellowish brown and the sapwood yellowish white. Sapwood is generally not more than l-inch thick. Growth rings are distinct; they are generally quite uniform and range from 15 to 30 per radial inch. The wood is stiff, moderately strong and hard, and moderately high in shock-resisting ability; it averages 36 pounds a cubic foot at 12 percent moisture content. It has moderately large shrinkage. The wood is usually straight-grained, splits easily and is subject to ring shake. Knots are common but small and tight.

Western larch is used principally in building construction for rough dimension, small timbers, planks, and boards, and for railroad ties and mine timbers. It is used also for piles, poles, and posts. Some high grade material is manufactured into interior finish, flooring, sash, and doors.

Pine, northern white. Northern or eastern white pine (Pinus strobus) grows in the United States from Maine southward along the Appalachain Mountains to northern Georgia and in the Lake States. It is also known as white pine, Weymouth pine, and soft pine.

Lumber production of northern white pine is confined principally to the New England States, which produce about one-half the total. About one-third comes from the Lake States and most of the remainder from the Middle Atlantic and Southern Atlantic States.

The heartwood of northern white pine is light brown, often with a reddish tinge. It turns considerably darker on exposure. Growth rings are distinct. The wood has comparatively uniform texture, and is straight-grained. It is easily kiln dried, has small shrinkage, and ranks high in ability to stay in place. It is also easy to work and can be readily glued.

Northern white pine is light in weight, averaging 25 pounds a cubic foot. It is moderately soft and weak, and low in resistance to shock.

Practically all northern white pine is converted into lumber, which is put to a great variety of uses. The largest proportion, which is largely second growth knotty material of lower grades, goes into boxes. High grade lumber goes into patterns for castings. Other important uses are sash, doors, furniture, trim, knotty finish, caskets and burial boxes, shade and map rollers, toys, and dairy and poultry supplies.

Pine, jack. Jack pine (Pinus banksiana), sometimes known as scrub pine, gray pine, or black pine in the United States, grows naturally in the Lake States and in a few scattered areas in New England and northern New York. In lumber, jack pine is not seperated from the other pines with which it grows, including red pine and northern white pine.

Sapwood of jack pine is nearly white, and the heartwood is light brown to orange. Sapwood may make up one-half or more of the volume of a tree. The wood has a rather coarse texture and is somewhat resinous. It is moderately light in weight, averaging 30 pounds a cubic foot at 12 percent moisture content; moderately weak in bending strength and compressive strength; moderately low in shock resistance; and lacks stiffness. It also has moderately small shrinkage. Lumber from jack pine is generally knotty.

Jack pine is used for pulpwood, box lumber, and fuel. Less important uses include railway ties, mine timber, slack cooperage, poles, and posts.

Pine, lodgepole. Lodgepole pine (*Pinus contorta*), also known as shore pine, knotty pine, black pine, spruce pine, and jack pine, grows in the Rocky Mountain and Pacific Coast regions as far northward as Alaska. Well over four-fifths of the cut of lodgepole pine comes from the Central Rocky Mountain States; other producing regions are Idaho, Oregon, and Washington.

The heartwood of lodgepole pine varies from light yellow to light yellow brown. The sapwood is yellow or nearly white. The wood is generally straight-grained with narrow growth rings.

The wood is moderately light in weight, averaging 29 pounds a cubic foot at 12 percent moisture content. It is fairly easy to work, and it has moderately large shrinkage. In strength properties, lodgepole pine rates as moderately weak and soft, moderately stiff, and moderately low in shock resistance.

Lodgepole pine is used for lumber, mine timbers, railway ties, and poles. Less important uses include posts and fuel. Lumber is used mostly for local rough construction and for boxes. It is being used in increasing amounts for siding, finish, and flooring.

Pine, ponderosa. Ponderosa pine (*Pinus ponderosa*) is known also as pondosa pine, western soft pine, western pine, California white pine, bull pine, and black jack. Jeffery pine (*Pinus jeffreyi*), which grows in close association with ponderosa pine in California and Oregon, is usually marketed with ponderosa pine and sold under that name.

Major producing areas are Oregon, Washington, California, and Nevada. Other important producing regions are in Idaho and Montana; lesser amounts come from the States of the South Rocky Mountain region.

Botanically, ponderosa pine belongs to the yellow pine group rather than the white pine group. A considerable proportion of the wood, however, is somewhat similar to the white pines in appearance and properties. Heartwood is light reddish brown, and the wide sapwood is nearly white to pale yellow. Growth rings are generally distinct when not exceedingly narrow.

The wood of the outer portions of ponderosa pine of saw-timber size is generally moderately light in weight, averaging 28 pounds a cubic foot at 12 percent moisture content. It is moderately weak and soft, moderately stiff, and moderately low in shock resistance. It is generally straight-grained and has moderately small shrinkage. It is quite uniform in texture and has little tendency to warp and twist.

Ponderosa pine is used principally for lumber and to a lesser extent for piles, poles, posts, mining timbers, veneer, and hewed ties. The clear wood goes into sash, doors, blinds, mouldings, paneling, mantels, trim, and built-in cases and cabinets. Lower grade lumber is used for boxes and crates. Much of the lumber of intermediate or lower grade goes into sheathing, subflooring, and roof boards. Knotty ponderosa pine is used for interior finish.

Pine, Norway. Norway pine (Pinus resinosa) is frequently called red pine. It is occasionally known as hard pine and pitch pine. Norway pine grows in the New England States, New York, Pennsylvania, and the lake States. In the past, lumber from Norway pine has been marketed with white pine without distinction as to species.

The heartwood of Norway pine varies in color from pale red to a reddish brown. The sapwood is nearly white with a yellowish tinge, and is generally from 2- to 4-inches wide. The wood resembles the lighter weight wood of southern yellow pine. SummerWood is distinct in the growth rings.

Norway pine is moderately heavy, averaging 34 pounds a cubic foot at 12 percent moisture content. It is moderately strong and stiff, moderately soft, and moderately high in shock resistance. It is generally straight-grained, not so uniform in texture as eastern white pine, and somewhat resinous. The wood has moderately large shrinkage, but is not difficult to dry and stays in place well when seasoned.

Norway pine is used principally for lumber and to a lesser extent for piles, poles, cabin logs, hewed ties, posts, and fuel. The wood is used for many purposes for which northern white pine is used. It goes principally into building construction, siding, piles, flooring, sash, doors, blinds, general millwork, and boxes and crates.

Pine, southern yellow. There are a number of species included in the group marketed as southern yellow pine lumber. The most important, and their growth range are:

(1) Longleaf pine (Pinus palustris), which grows from eastern North Carolina south into Florida, and westward into eastern Texas; (2) shortleaf pine (pinus echinata), which grows from southeastern New York and New Jersey southward to northern Florida and westward into eastern Texas and Oklahoma; (3) loblolly pine (Pinus taeda), which grows from Maryland southward through the Atlantic Coastal Plain and Piedmont Plateau into Florida and westward into eastern Texas. (4) slash pine (Pinus elliottii), which grows in Florida and the southern parts of South Carolina, Georgia, Alabama, Mississippi, and Louisiana east of the Mississippi River.

Lumber from any one or from any mixture of two or more of these species is classified as southern yellow pine by the grading standards of the industry. These standards provide also for lumber that is produced from trees of the longleaf and slash pine species to be classified as longleaf pine if conforming to the growth rate and summerwood requirements of such standards. The lumber that is classified as longleaf in the domestic trade is known also as pitch pine in the export trade.

Southern yellow pine lumber comes principally from the Southern and South Atlantic States. The states leading in production are Georgia, Alabama, North Carolina, and Texas, each producing more than a billion board feet.

The wood of the various southern yellow pines is quite similar in appearance. The sapwood is yellowish white and the heartwood reddish brown. Growth rings in the southern yellow pines are usually prominent. The sapwood is usually white in second growth stands. Heartwood begins to form when the tree is about 20 years old. In old, slow growth trees, sapwood may be only 1 or 2 inches in width.

Longleaf and slash pine are classed as heavy and strong, slash pine averaging 43 pounds and longleaf pine 41 pounds a cubic foot at 12 percent moisture content. Longleaf and slash pine are classed as stiff, hard, and moderately high in shock resistance.

Shortleaf and loblolly pine are usually somewhat lighter in weight than longleaf, averaging 36 pounds a cubic foot at 12 percent moisture content. The other less important species of southern yellow pine have properties similar to shortleaf and loblolly pine. All the southern yellow pines have moderately large shrinkage but stay in place well when properly seasoned. In order to obtain heavy, strong wood of the southern yellow pines for structural purposes, a “density rule” has been written which specifies certain visual characteristics for structural timbers.

Dense southern yellow pine is used extensively in construction of factories, warehouses , bridges, trestles, and docks in the form of stringers, beams, posts, joists, and piles. Lumber of lower density and strength finds many uses for building material, such as interior finish, sheathing, subflooring, and joists, and for boxes and crates. Southern yellow pine is used also for tight and slack cooperage. When used for railway ties, telephone and telegraph poles, and mine timbers, it is treated with preservatives.

Pine, spruce. Spruce pine (Pinus glabra), also known as cedar pine, poor pine, Walter pine, and bottom white pine, is found growing most commonly on low moist lands of the coastal regions of southeastern South Carolina, Georgia, Alabama, Mississippi, and Louisiana, and northern and northwestern Florida.

Heartwood is light brown, and the wide sapwood zone is nearly white. Spruce pine wood is lower inmost strength values than the major southern pines. It compares favorably with white fir in important bending properties, in crushing strength perpendicular and parallel to the grain, and in hardness. It is similar to the denser species such as coast Douglas-fir and loblolly pine in shear parallel to the grain.

Until recent years the principal uses of spruce pine were locally for lumber, and for pulpwood and fuelwood. The lumber, which is classified as one of the minor southern pine species, reportedly was used for sash, doors, and interior finish. In recent years it has qualified for use in plywood.

Pine, sugar. Sugar pine (Pinus lambertiana) is sometimes called California sugar pine. The range of sugar pine extends from the Coast and Cascade Mountain Ranges of southern Oregon along the Coast Ranges and the Sierra Nevada mountains of California. Most of the sugar pine lumber is produced in California and the remainder in southwestern Oregon.

The heartwood of sugar pine is buff or light brown, sometimes tinged with red. Sapwood is creamy white. During seasoning the wood frequently becomes discolored by blue stain fungi or a chemical reaction resulting in brown stain. These stains do not affect the strength properties of the wood but do affect its appearance and suitability for natural finishes. The wood is straight-grained, fairly uniform in texture, and easy to work with tools. It has very small shrinkage, is readily seasoned without warping or checking, and stays in place well. Sugar pine is light in weight, averaging 25 pounds a cubic foot at 12 percent moisture content. It is moderately weak and soft, low in ability to resist shock, and lacks stiffness.

Sugar pine is used almost entirely for lumber products. The largest amounts are used in boxes and crates, sash, doors, frames, blinds, general millwork, building construction, and foundry patterns. Like northern white pine, sugar pine is suitable for use in nearly every part of a house because of the ease with which it can be cut, its ability to stay in place, and its good nailing properties. It is coming into increasing use as pattern wood in foundries. It is readily available in wide, thick pieces practically free from defects.

Pine, Idaho white. Idaho white pine (Pinus monticola) is also known as western white pine or white pine. In the United States, it grows in western Montana, northern Idaho, and along the Cascade and Sierra Nevada Mountains through Washington and Oregon to central California.

About four-fifths of the cut comes from Idaho, and a considerable amount from Washington; small amounts are cut in Montana and Oregon.

Heartwood of Idaho white pine is cream-colored to light reddish brown and darkens on exposure. The sapwood is yellowish white and generally from 1- to 3-inches wide. The wood is straight-grained, easy to work, easily kiln dried, and stays in place well after seasoning.

Idaho white pine is moderately light in weight, averaging 27 pounds a cubic foot at 12 percent moistrue content. It is moderately weak and soft, moderately stiff, moderately low in shock resistance, and has moderately large shrinkage.

Practically all Idaho white pine is sawed into lumber and used principally for building construction, matches, boxes, and millwork products, such as sash, frames, doors, and blinds. In building construction, boards of the lower grades are used for sheathing, subflooring, and roof strips. High grade material is made into siding of various kinds, exterior and interior trim, and knott finish. It has practically the same uses as northern white pine and sugar pine.

Port Orford cedar. Port Orford cedar (Chamaecyparis lawsoniana) is sometimes known as Lawson cypress, Oregon cedar, and white cedar. It grows along the Pacific coast from Coos Bay, Oregon, southward to California. It does not extend more than 40 miles inland.

The heartwood of Port Orford cedar is light yellow to pale brown in color. Sapwood is thin and hard to distinguish. The wood has fine texture, generally straight grain, and a pleasant spicy odor. It is moderately light in weight, averaging 29 pounds a cubic foot at 12 percent moisture content. It is stiff, moderately strong and hard, and moderately resistant to shock. Port Orford cedar heartwood is highly resistant to decay. The wood shrinks moderately, has little tendency to warp, and stays in place well after seasoning.

A large proportion of the high grade Port Orford cedar is used in the manufacture of battery separators and venetian blind slats. Other uses are "mothproof" boxes, sash and door construction, flooring, interior finish, furniture, and boat building.

Red cedar, eastern. Eastern red cedar (Juniperus virginiana) grows throughout the eastern half of the United States, except Maine, Florida, a narrow strip along the Gulf coast, and at the higher elevations in the Appalachian Mountain range. Commercial production is principally in the southern Appalachian and Cumberland Mountain regions. Another species, southern red cedar (Juniperus silicicola), grows over a limited area in the South Atlantic and Gulf Coastal P1ains.

Commercial production of eastern red cedar is now becoming restricted to rather small areas in Tennessee and Kentucky.

The heartwood of red cedar is bright red or dull red, and the thin sapwood is nearly white. The wood is moderately heavy, averaging 33 pounds a cubic foot at 12 percent moisture content. It is moderately weak, hard, and high in shock resistance, but lacks stiffness. It has very small shrinkage and stays in place well after seasoning. The texture is fine and uniform. Grain is usually straight, except where deflected by knots, which are numerous. Eastern red cedar heartwood is very resistant to decay.

The greatest quantity of eastern red cedar is used for fence posts. Lumber is manufactured into chests, wardrobes, and closet lining. Other uses include flooring, pencils, scientific instruments, and small boats. Southern red cedar is used for the same purposes.

Red cedar, western. Western red cedar (Thuja plicata) grows in northern California, western Oregon, western and northeastern Washington, northern Idaho, and northwestern Montana. It grows also along the Pacific coast northward to Alaska. Western red cedar is also called canoe cedar, giant arborvitae, shinglewood, and Pacific red cedar. Western red cedar lumber is produced principally in Washington, followed by Oregon, Idaho, and Montana.

The heartwood of western red cedar is reddish brown in color, and the sapwood is nearly white. Sapwood is narrow, often not over l-inch in width. The wood is generally straight-grained and has a uniform but rather coarse texture. It has very small shrinkage. Western red cedar is light in weight, averaging 23 pounds a cubic foot at 12 percent moisture content. It is moderately soft, weak when used as a beam or post, and low in shock-resisting ability. Its heartwood is very resistant to decay.

Western red cedar is used principally for shingles, lumber, poles, posts, and piles. The lumber is used for exterior siding, interior finish, greenhouse construction, ship and boat building, boxes and crates, sash, doors, and millwork.

Redwood. Redwood (Sequoia sempervirens) is a very large tree growing on the coast of California. Another sequoia (S. gigantea) grows in a limited area in the Sierra Nevada of California. Other names for redwood are coast redwood, California redwood, and sequoia. Production of redwood lumber is limited to California.

The heartwood of redwood varies in color from a light cherry to a dark mahogany. The narrow sapwood is almost white. Typical old growth redwood is moderately light in weight, averaging 30 pounds a cubic foot at 12 percent moisture content. It is moderately strong and stiff, and moderately hard. The wood is easy to work, generally straight-grained, and shrinks and swells comparatively little. The heartwood has high durability under conditions favorable to decay.

Most redwood lumber is used for building. It is remanufactured extensively into siding, sash, doors, blinds, finish, casket stock, and containers. Because of its durability, it is useful for cooling towers, tanks, silos, wood-stave pipe, and outdoor furniture. It is used in agriculture for buildings and equipment. Its use as timbers and large dimension in bridges and trestles is relatively minor. The wood splits readily, and the manufacture of split products, such as posts and fence material, is an important business in the redwood area.

Spruce, eastern. The term eastern spruce includes three species, red (Picea rubens), white (P. glauca), and black spruce (P. mariana). White spruce and black-spruce grow principally in the Lake States and New England, and red spruce in New England and the Appalachian Mountains. All three species have about the same properties, and in commerce no distinction is made between them. The wood dries easily, stays in place well, moderately light in weight and easily worked, has moderate shrinkage and is moderately strong, stiff, tough, and hard. The wood is light in color, and there is little difference between the heartwood and sapwood.

The largest use of eastern spruce is for paper pulp. It is used for framing material, general millwork, boxes and crates, ladder rails, and piano sounding boards.

Spruce, Engelmann. Engelmann spruce (Picea engelmannii) grows at high elevations in the Rocky Mountain regions of the United States. Engelmann spruce is sometimes known by other names, such as white spruce, mountain spruce, Arizona spruce, silver spruce, and balsam. About two-thirds of the lumber is produced in the southern Rocky Mountain States and Oregon.

The heartwood of Engelmann spruce is nearly white with a slight tinge of red. The sapwood varies from 3/4 inch to 2 inches in width and is often difficult to distinguish from heartwood. The wood has medium to fine texture and is without characteristic taste or odor. It is generally straight-grained. Engelmann spruce is rated as light in weight, averaging 23 pounds a cubic foot at 12 percent moisture content. It is low in strength as a beam or post. It is limber, soft, low in ability to resist shock, and has moderately small shrinkage. The lumber contains small knots.

Engelmann spruce is used principally for lumber and for mine timbers, railway ties, and poles. It is used also in building construction in the form of dimension stock, flooring, sheathing, and studding. It is finding use in the pulp industry because of its excellent pulp- and paper-making properties.

Spruce, sitka. Sitka spruce (Picea sitchensis) is a tree of large size growing along the northwestern coast of North America from California to Alaska. It is generally known as Sitka spruce, although other names may be applied locally, such as yellow spruce, tideland spruce, western spruce, silver spruce, and west coast spruce.

About two-thirds of the production of Sitka spruce lumber comes from Washington and one-third from Oregon. Small amounts are produced in California.

The heartwood of Sitka spruce is a light pinkish brown. Sapwood is creamy white and shades gradually into the heartwood. Sapwood may be 3- to 6-inches wide or even wider in young trees. The wood has a comparatively fine, uniform texture, generally straight grain, and no distinct taste or odor. It is moderately light in weight, averaging 28 pounds a cubic foot at 12 percent moisture content. It is moderately weak in bending and compressive strength, moderately stiff, moderately soft, moderately low in resistance to shock, and has moderately small shrinkage. On the basis of weight, it rates high in strength properties and can be obtained in clear, straight-grained pieces of large size.

Sitka spruce is used principally for lumber, pulpwood, and cooperage. Boxes and crates consume about one-half of the remanufactured lumber. Other important uses are furniture, planing mill products, sash, doors, blinds, millwork, cooperage, and boats.

Sitka spruce has been by far the most important wood for aircraft construction. Other specialty uses are ladder rails and sounding boards for pianos.

Tamarack. Tamarack (Larix laricina) is a small to medium-sized tree with a straight, round, slightly tapered trunk. In the United States it grows from Maine to Minnesota, with the bulk of the stand in the Lake States. It was formerly used in considerable quantity for lumber, but in recent years production of tamarack lumber has been small.

The heartwood of tamarack is yellowish brown to russet brown. The sapwood is whitish, generally less than an inch wide. The wood is coarse in texture and without odor or taste.

The transition from springwood to summerwood is abrupt. The wood is intermediate in weight and in most mechanical properties.

Tamarack is used principally for pulpwood, lumber, railroad ties, mine timbers, fuel, fence posts, telegraph poles, and scaffolding poles. Lumber goes into framing material, tank construction, and boxes and crates.

White cedar, northern and southern. There are two species of white cedar in the eastern part of the United States. They are northern white cedar (Thuja occidentalis) and southern white cedar (Chamaecyparis thyoides). Northern white cedar is also known as arborvitae, or simply cedar. Southern white cedar is also known as juniper, Atlantic white cedar, swamp cedar, and boat cedar.

Northern white cedar grows from Maine southward along the Appalachian Mountain range and westward through the northern part of the Lake States. Southern white cedar grows near the Atlantic coast from Maine to northern Florida and westward along the Gulf coast to Louisiana. It is strictly a swamp tree.

Production of northern white cedar lumber is probably greatest in Maine and the Lake States. Commercial production of southern white cedar centers in North Carolina and along the Gulf coast.

Heartwood of the white cedars is light brown, and the sapwood is white or nearly so. Sapwood is usually thin. The wood is light in weight, northern white cedar averaging 22 pounds and southern white cedar 23 pounds a cubic foot at 12 percent moisture content. It is rather soft and weak and is low in shock-resisting ability. It shrinks little in drying. It is easily worked, holds paint well, and the heartwood is highly resistant to decay. The two species are used for similar purposes, principally for poles, ties, lumber, and posts. White cedar lumber is used principally where high degree of durability is needed, as in tanks and boats and for woodenware.

Hardwoods

Hardwoods comprise less than 20 percent of the total timber resources of the United States and are mostly species grown east of the Great Plains. The predominant hardwood species are the oaks, constituting about 7 percent of the total sawtimber volume.

The important localities of growth, the characteristics, and the uses of the main commercial hardwood species or groups of species are described in the following paragraphs.

Alder, red. Red alder (Alnus rubra) grows along the Pacific coast between Alaska and California. It is used commercially along the coasts of Oregon and Washington. Red alder is the most abundant commercial hardwood species in these two States.

The wood of red alder varies from almost white to pale pinkish brown in color and has no visible boundary between heartwood and sapwood. It is moderately light in weight, averaging 28 pounds a cubic foot at 12 percent moisture content and has relatively low shrinkage. It is intermediate in most strength properties but low in shock resistance.

The principal use of red alder is for furniture, but it is also used for sash, doors, and millwork.

Ash. Important species of ash are white ash (Fraxinus Americana), green ash (Fraxinus pennsylvanica), blue ash (Fraxinus quadrangulata), black ash (Fraxinus nigra), pumpkin ash (Fraxinus profunda), and Oregon ash (Fraxinus latifolia). The first six of these species grow in the eastern half of the United States. Oregon ash grows along the Pacific coast.

Commercial white ash is a group of species that consists mostly of white ash and green ash. Black ash is important commercially in the Lake States.

States with the greatest production of ash are Louisiana, Pennsylvania, Wisconsin, Michigan, Ohio, and Tennessee.

Heartwood of commercial white ash is brown; the sapwood is light colored or nearly white. Second growth trees have a large proportion of sapwood. Old growth trees with little sapwood are scarce.

Second growth commercial white ash is particularly sought because of the inherent qualities of this wood; it is heavy, averaging 42 pounds a cubic foot at 12 percent moisture content; strong, hard, stiff, and has high resistance to shock. Because of these qualities, such "tough ash" is used principally for handles, oars, vehicle parts, and sporting goods. Some handle specifications call for not less than 5 or more than 17 growth rings per inch for handles of the best grade. The addition of a weight requirement of 43 or more pounds a cubic foot at 12 percent moisture content will assure excellent material.

Black ash and pumpkin ash run considerably lighter in weight, black ash averaging 34 pounds and pumpkin ash 36 pounds a cubic foot at 12 percent moisture content. Ash trees growing in southern river bottoms, especially in areas that are frequently flooded for long periods, produce buttresses that contain relatively light and weak wood. Such wood is sometimes separated from "tough" ash when sold. Oregon ash has somewhat lower strength properties than white ash, but it is used locally for the some purposes.

Ash wood of lighter weight, including black ash, is sold as cabinet ash, and is suitable for cooperage, furniture, and shipping containers. Some ash is cut into veneer.

As pen. Aspen is a generally recognized name applied to bigtooth aspen (Populus grandidentata) and to quaking aspen (Populus tremuloides). Aspen does not include balsam popular (Populus balsamifera) and the species of Populus that make up the group of cottonwoods. In lumber statistics of the U.S. Bureau of the Census, however, the term "cottonwood" includes all of the above species. Also, the lumber of aspens and cottonwood may be mixed in trade and sold either as poplar or cottonwood. The common term "popple" is sometimes applied to the aspens. The name "popple" should not be confused with poplar (Liriodendron tulipifera).

Aspen lumber is produced principally in the Northeastern and Lake States. There is some production in the Rocky Mountain States.

Heartwood of aspen is grayish white to light grayish brown. Sapwood is lighter-colored and generally merges gradually into heartwood without being clearly marked. Aspen wood is usually straight-grained with fine, uniform texture. It is easily worked. Well-seasoned aspen lumber does not impart odor or flavor to foodstuffs.

The wood of aspen is light in weight. Quaking aspen and bigtooth aspen average 26 and 27 pounds a cubic foot, respectively, at 12 percent moisture content. The wood is weak, soft, moderately stiff, moderately low in resistance to shock, and has a moderately high shrinkage.

Aspen is cut for lumber, boxes and crating, pulpwood, excelsior, matches, veneer, and miscellaneous turned articles.

Basswood. American basswood (Tilia americana) is the most important of the several native basswood species; next in importance is white basswood (Tilia heterophylla). Other species occur only in very small quantities. Because of the uniformity of the wood of the different species, no attempt is made to distinguish between them in lumber form. Other common names of basswood are linden, linn, and beetree.

Basswood grows in the eastern half of the United States from the Canadian provinces southward. Basswood lumber comes from the Lake, Middle Atlantic, and Central States. In commercial usage, the term “white basswood” is used to specify white wood or sapwood of either species.

The heartwood of basswood is pale yellowish brown with occasional darker streaks. Basswood has wide, creamy-white or pale-brown sapwood that merges gradually into the heartwood. When dry, the wood is without odor or taste. It is soft and light in weight, averaging 26 pounds a cubic foot at 12 percent moisture content. It has fine, even texture, and is straight-grained and easy to work with tools. Shrinkage in width and thickness during drying is rated as large; however, basswood stays in place well and does not warp while in use.

Basswood lumber is used mainly as venetian blinds, sash and door frames, moulding, apiary supplies, woodenware, and boxes. Some basswood is cut for veneer, cooperage, excelsior, and pulpwood.

Beech. Only one species of beech (Fagus grandifolia) is native to the United States. The terms “red beech” or “red heart beech” are applied to the darker-colored heartwood and “white beech” or “white heart beech” to the lighter-colored heartwood.

Beech grows in the eastern one-third of the United States and adjacent Canadian provinces. Greatest production of beech lumber is in the Central and Middle Atlantic States.

Beech wood varies in color from nearly white sapwood to reddish-brown heartwood in some trees. Sometimes there is no clear line of demarcation between heartwood and sapwood. Sapwood may be 3- to 5-inches thick. The wood has little figure and is of close, uniform texture. It has no characteristic taste or odor.

The wood of beech is classed as heavy, weighing 45 pounds a cubic foot at 12 percent moisture content. It is hard, strong, high in resistance to shock, and highly adaptable for steam bending. Beech has large shrinkage and requires careful drying. It machines smoothly, wears well, and is rather easily treated with preservatives.

Large amounts of beech go into flooring, furniture, handles, veneer, woodenware, containers , cooperage, and laundry appliances. When treated, it is suitable for railway ties.

Birch. The important species of birch are yellow birch (Betula alleghaniensis), sweet birch (Betula lenta), and paper birch (Betula papyrifera). Other birches of some commercial importance are river birch (Betula nigra), gray birch (Betula populifolia), and western paper birch (Betula papyrifera var. commutata).

Yellow birch, sweet birch, and paper birch grow principally in the Northeastern States and the Lake States. Yellow and sweet birch also grow along the Appalachian Mountains to northern Georgia. They are the sources of most birch lumber and veneer.

Yellow birch has white sapwood and light reddish-brown heartwood. Sweet birch has light-colored sapwood and dark-brown heartwood tinged with red. Yellow birch averages 43 pounds; sweet birch, 46 pounds; and paper birch, 38 pounds a cubic foot at 12 percent moisture content. Wood of yellow birch and sweet birch is heavy, hard, strong, and has good shock-resisting ability. The wood is fine and uniform in texture. Paper birch, as indicated by its lower weight, is softer and lower in strength than yellow and sweet birch. Birch shrinks considerably during drying.

Yellow and sweet birch lumber and veneer go principally into the manufacture of furniture, boxes, baskets, crates, woodenware, cooperate, interior finish, and doors. Birch veneer goes into plywood used for flush doors, furniture, radio and television cabinets, aircrafts, and other specialty uses. Paper birch is used for spools, bobbins, and toys.

Cherry. Cherry (Prunus serotina) is sometimes known as black cherry, wild black cherry, wild cherry, or choke cherry. It is the only native species of the genus Prunus of commercial importance for lumber production. It occurs scatteringly from southeastern Canada throughout the eastern half of the United States.

The heartwood of cherry varies in color from light to dark reddish brown and has a distinctive luster. Sapwood is narrow in old trees and nearly white. The wood has a fairly uniform texture and very satisfactory machining properties. It is moderately heavy, averaging 35 pounds a cubic foot. It is strong, stiff, moderately hard, and has high shock-resisting ability and moderately large shrinkage. It stays in place well after seasoning.

Cherry is used principally for furniture and for backing blocks on which electrotype plates are mounted. Other uses include burial caskets, woodenware novelties, patterns, and paneling in buildings and railway coaches. It has proved satisfactory for gunstocks.

Chestnut. American chestnut (Catenea dentata) is known also as sweet chestnut. Before chestnut was attacked by a blight, it grew in commercial quantities from New England to northern Georgia. Practically all standing chestnut has been killed by blight, and supplies come from dead timber. There are considerable quantities of standing dead chestnut in the Appalachian Mountains, which may be available for some time because of the great natural resistance to decay of its heartwood.

The heartwood of chestnut is grayish brown or brown and becomes darker with age. Sapwood is very narrow and almost white. The wood is coarse in texture and the growth rings are made conspicuous by several rows of large, distinct pores at the beginning of each year's growth. Chestnut wood is moderately light in weight, averaging 30 pounds a cubic foot at 12 percent moisture content. It is moderately hard and weak, moderately low in resistance to shock, and lacks stiffness. It seasons well and is easy to work with tools.

Chestnut is used for poles, railway ties, furniture, caskets, boxes, crates, and core stock for veneer panels.

Cottonwood. Cottonwood includes several species of the genus Populus. Most important are eastern cottonwood (Populus deltoids), also known as Carolina poplar and whitewood; swamp cottonwood (Populus heterophylla), also known as cottonwood , river cottonwood, and swamp poplar; and black cottonwood (Populus trichocarpa), also known as cottonwood and balm cottonwood.

Eastern cottonwood and swamp cottonwood grow throughout the eastern half of the United States. Greatest production of lumber is in the Southern and Central States. Black cottonwood grows in the West Coast States and in western Montana, northern Idaho, and western Nevada.

The heartwood of the three cottonwoods, eastern, black, and swamp, is grayish white to light brown. Sapwood is whitish in color and merges gradually with the heartwood. The wood is comparatively uniform in texture, and generally straight-grained. It is odorless when well-seasoned.

Eastern cottonwood averages 28 pounds and black cottonwood 24 pounds a cubic foot at 12 percent moisture content. Eastern cottonwood is moderately weak in bending and compression, moderately limber, moderately soft, and moderately low in ability to resist shock. Black cottonwood is slightly below eastern cottonwood in most strength properties. Both eastern and black cottonwood have moderately large shrinkage. Some cottonwood gives difficulty in working with tools because of fuzzy surfaces.

Principal uses of cottonwood are for lumber, veneer, pulwood, excelsior, and fuel. The lumber and veneer go largely into boxes, crates, and baskets.

Elm. There are six species of elm in the United States: American elm (Ulmus americana), slippery elm (Ulmus rubra), rock elm (Ulmus thomasi), winged elm (Ulmus alata), cedar elm (Ulmus crassifolia), and September elm (Ulmus serotina). Ameican elm is also known as white elm, water elm, and gray elm; slippery elm as red elm; rock elm as cork elm or hickory elm; winged elm as wahoo; cedar elm as red elm or basket elm; and September elm as red elm.

American elm grows throughout the eastern half of the United States, except in higher elevations of the Appalachian Mountains. Slippery elm occupies about the same area, excepting the Atlantic Coastal Plain, most of Florida, and along the Gulf coast. Rock elm occurs from New Hampshire to northern Tennessee and Nebraska. Winged elm grows from the Ohio Valley southward to the Gulf, and westward to Texas. Cedar elm extends from southern Arkansas and eastern Mississippi into Texas. Slippery elm is most abundant in the central Mississippi Valley.

The sapwood of the elms is nearly white and the heartwood light brown, often tinged with red. The elms may be divided into two general classes, Soft and Rock elms, based on the weight and strength of the wood. Rock elms include rock elm, winged elm, cedar elm, and September elm. American elm and slippery elm are the Soft elms. Soft elms are moderately heavy, averaging 35 and 37 pounds a cubic foot, respectively, at 12 percent moisture content. It has a high degree of shock-resisting ability and is moderately hard and stiff. Rock elms average about 44 pounds a cubic foot and have excellent bending qualities.

Production of elm lumber is chiefly in the Lake, Central, and Southern States.

Elm lumber is used principally in boxes, baskets, crates, and slack barrels; furniture, agricultural supplies and implements, caskets and burial boxes; and vehicles. For some uses, the hard elms are preferred. Elm veneer is used for fruit, vegetable, and cheese boxes, baskets, and panels.

Gum. Gum (Liquidambar styraciflua) is frequently called red gum, star-leaved gum, or sweetgum. The lumber is usually divided into two classes - sap gum, the light-colored wood from the sapwood, and red gum, the heartwood.

Gum grows from southwestern Connecticut westward into Missouri and southward to the Gulf. Lumber production is almost entirely from the Southern and South Atlantic States.

Gum has interlocked grain, a form of cross grain, and must be carefully dried. The wood averages 34 pounds a cubic foot at 12 percent moisture content and is rated as moderately heavy and hard. It is moderately strong, moderately stiff, and moderately high in shock resistance.

Gum is used principally for lumber, veneer, plywood, slack cooperage, crossties, fuel, and pulpwood. The lumber goes principally into boxes and crates, furniture, radio and phonograph cabinets, interior trim, and millwork. Gum veneer and plywood are used for boxes, crates, baskets, and interior woodwork.

Hackberry. Hackberry (Celtis occidentalis) and sugarberry (Celtis laevigata) supply the lumber known in the trade as hackberry. Hackberry grows east of the Great Plains from Alabama, Georgia, Arkansas, and Oklahoma northward, except along the Canadian boundary. Sugarberry overlaps the southern part of the range of hackberry and grows throughout the Southern and South Atlantic States.

The sapwood of both varies in color from pale yellow to greenish or grayish yellow. Heartwood is commonly darker in color. The wood resembles elm in structure.

Hackberry lumber is moderately heavy, averaging 37 pounds a cubic foot at 12 percent moisture content. It is moderately strong in bending, moderately weak in compression parallel to the grain, moderately hard to hard, high in shock resistance, but low in stiffness. It has moderately large to large shrinkage but keeps its shape well during seasoning.

Most hackberry is cut into lumber, with small amounts going into dimension stock and some into veneer. Most of it is used for furniture and some for containers.

Hickory. True hickories are found throughout most of the eastern half of the United States. The species most important commercially are shagbark (Carya ovata), pignut (Carya glabra), shellbark (Carya laciniosa), and mockernut (Carya tomentosa) hickory (see Pecan).

The greatest commercial production of the true hickories is the Middle Atlantic and Central States. The Southern and South Atlantic States produce nearly half of all hickory lumber.

Sapwood of hickory is white and usually quite thick, except in old, slowly growing trees. Heartwood is reddish in color. From the standpoint of strength no distinction should be made between sapwood and heartwood having the same weight.

The wood of true hickory is very tough, heavy, hard, and strong, a combination not found in any other native commercial wood. Hickory shrinks considerably in drying. Average weights per cubic foot at 12 percent moisture content are: shagbark, 50 pounds; shellbark, 48 pounds; pignut, 52 pounds; and mockernut, 51 pounds.

About three-fourths of the hickory production is used for tool handles. It is also used for ladder rungs, athletic goods, agricultural implements, dowels, gymnasium apparatus, poles, shafts, well pumps, and furniture.

A considerable quantity of lower grade hickory is not suitable because of knottiness or other defects and low density for the special uses of high quality hickory. It appears particularly useful for pallets, blocking, and similar items.

Holly. Holly (Ilex opaca) is commonly known as American holly; less frequently it is called white holly, evergreen holly, and boxwood. The natural range of holly extends along the Atlantic coast, Gulf coast, and Mississippi Valley.

Both heartwood and sapwood are white in color, the heartwood with an ivory cast. The wood has a uniform and compact texture; it is heavy, hard, moderately weak when used as a beam or column, not stiff, and ranks high in ability to resist shock. It is readily penetrable to liquids and can be satisfactorily dyed. It works well and cuts smoothly. It is used principally for scientific and musical instruments, furniture inlays, and athletic goods.

<u>Locust, black.</u> Black locust <u>(Robinia pseudoacacia)</u> is sometimes called yellow locust, white locust, green locust, or post locust. It grows from pennsylvania along the Appalachian Mountains to northern Georgia. It is also native to a small area in northwestern Arkansas. The greatest production of black locust timber is in Tennessee, Kentucky, West Virginia, and Virginia.

Locust has narrow, creamy-white sapwood. The heartwood, when freshly cut, varies from greenish yellow to dark brown. Black locust is very heavy, averaging 48 pounds a cubic foot at 12 percent moisture content. The wood is very hard, very high in resistance to shock, and ranks very high in strength and stiffness. It has moderately small shrinkage. The heartwood has high decay resistance.

Black locust is used extensively for round, hewed, or split mine timbers and for fence posts, poles, railroad ties, stakes, and fuel. An important product manufactured from black locust is insulator pins, a use for which the wood is well adapted because of its strength, decay resistance, and moderate shrinkage and swelling. Other uses are for rough construction, crating, ship treenails, and mine equipment.

<u>Magnolia.</u> Two species comprise commercial magnolia. They are southern magnolia <u>(Magnolia grandiflora),</u> and sweetbay <u>(Magnolia virginiana).</u> Other names for southern magnolia are evergreen magnolia, magnolia, big laurel, bull bay, and laurel bay. Sweetbay is sometimes called swamp magnolia, or more often simply magnolia.

The natural range of sweetbay extends along the Atlantic and Gulf coasts from Long Island to Texas, and that of southern magnolia from North Carolina to Texas. Louisiana leads in production of magnolia lumber.

The sapwood of southern magnolia is yellowish white, and the heartwood is light to dark brown with a tinge of yellow green. The wood closely resembles yellow poplar. It is moderately heavy, moderately low in shrinkage, moderately weak in bending and compression, moderately hard and stiff, and moderately high in shock resistance. Sweetbay is reported to be much like southern magnolia. The wood of southern magnolia at 12 percent moisture content weighs 35 pounds a cubic foot .

Magnolia lumber is used principally in the manufacture of furniture, boxes, venetian blinds, sash, doors, veneer, and millwork.

<u>Maple.</u> Commercial species of maple in the United States include sugar maple <u>(Acer saccharum),</u> black maple <u>(Acer nigrum),</u> silver maple <u>(Acer saccharinum)</u> red maple <u>(Acer rubrum),</u> boxelder <u>(Acer negundo),</u> and bigleaf maple <u>(Acer macrophyllum).</u> Sugar maple is also known as hard maple, rock maple, sugar tree; black maple as hard maple, black sugar maple, and sugar maple; silver maple as white maple, river maple, water maple, and swamp maple; red maple as soft maple, water maple, scarlet maple, white maple, and swamp maple; boxelder as ash-leaved maple, three-leaved maple, and cut-leaved maple; and bigleaf maple as Oregon maple.

Sugar maple grows from Maine to Minnesota, and southward to northern Georgia and Alabama, Louisiana, and Texas. Black maple occupies mainly a belt from New York through southern Michigan, southward to Kentucky, and westward through Iowa. Silver maple grows through most of the eastern United States except the southern Atlantic and Gulf coasts. Red maple grows east of the Great Plains and south to the Gulf of Mexico. Boxelder grows from Minnesota to Texas and eastward to the Middle Atlantic States. Bigleaf maple grows along the Pacific coast.

Maple lumber comes principally from the Middle Atlantic and Lake States, which together account for about two-thirds of the production.

The wood of sugar maple and black maple is known as hard maple; that of silver maple, red maple, and boxelder as soft maple. The sapwood of the maples is commonly white with a slight reddish-brown tinge. It is from 3 to 5 or more inches thick. Heartwood is usually light reddish brown, but sometimes is considerably darker. Hard maple has a fine uniform texture. It is heavy, averaging 44 pounds a cubic foot at 12 percent moisture content. It is strong, stiff, hard, resistant to shock, and has large shrinkage. Sugar maple is generally straight-grained. Soft maple averages 33 to 38 pounds a cubic foot at 12 percent moisture content.

Maple is used principally for lumber, veneer, crossties, distillation wood, and pulpwood. A large proportion is manufactured into flooring, furniture, boxes and crates, shoe lasts, handles, woodenware~ novelties, motor vehicle parts, spools, and bobbins.

Oak (red oak group). Among the numerous species of red oaks in the United States, 10 have considerable commercial importance.

1. Northern red oak (Quercus rubra), also known as eastern red oak, grows in the eastern half of the United States to the lower Mississippi Valley, Florida, and the Atlantic Coastal Plain. It is the most important lumber tree of the red oak group.
2. Scarlet oak (Quercus coccinea) grows in the eastern third of the United States, except the southern boarder states.
3. Shumard oak (Quercus shumardii), also known as Schneck oak, Texas oak, and southern red oak, grows chiefly along the Atlantic and Gulf coasts.
4. Pin oak (Quercus palustris), also known as swamp oak, grows principally in the central Mississippi Valley.
5. Nuttall oak (Quercus nuttallii), grows in the lower Mississippi Valley region from Missouri southward, and from Alabama to Texas.
6. Black oak (Quercus velutina), also known as yellow oak, grows in the eastern half of the United States to northern Florida.
7. Southern red oak (Quercus falcata) grows form New Jersey to Missouri, Arkansas, and Texas.
8. Water oak (Quercus nigra) grows in the South Atlantic and Gulf States from Maryland to Texas.
9. Laurel oak (Quercus laurifolia) grows in the South Atlantic and Gulf Coastal Plains from Maryland to Louisiana.
10. Willow oak (Quercus phellos) grows along the Atlantic and Gulf coasts and the lower Mississippi Valley.

Most red oak lumber comes from the Southern States, the southern mountain regions, and the Atlantic Coastal Plain.

Sapwood is nearly white in color and usually 1- *to* 2-inches thick. Heartwood is brown with a tinge of red. Sawed lumber of red oak cannot be separated by species on the basis of the characteristics of the wood alone. Red oak lumber can be separated from white oak by the number of pores in summerwood and because as a rule it lacks the hairlike growth known as tyloses in the pores. The open pores of the red oak make these species unsuitable for tight cooperage.

Wood of the red oaks ranges in weight from 43 to 49 pounds a cubic foot at 12 percent moisture content. The average is somewhat lower than that of the white oaks. Rapidly grown second-growth oak is generally harder and tougher than finer-textured old growth timber. The red oaks have fairly large shrinkage in drying.

The red oaks are largely cut into lumber, crossties, mine timbers, fence posts, veneer, and fuel-wood. Ties, mine timbers, and fence posts require preservative treatment for satisfactory service. Red oak lumber is remanufactured into flooring, furniture, general millwork, boxes and crates, agricultural implements, caskets and coffins, woodenware, and handles. It is also used in railroad cars and boats.

Oak (White oak group). There are nine commercially important species of the white oak group and all grow mainly in the eastern United States,

1. White oak (Quercus alba) grows throughout the eastern half of the United States and adjacent Canada. It is the most important lumber tree of the white oak group.
2. Chestnut oak (Quercus prinus), also known as rock chestnut oak or rock oak, grows from southern Vermont and New Hampshire southward along the Appalachian Mountains to central Georgia and Alabama.
3. Post oak (Quercus stellata) grows throughout the eastern half of the United States from southern New England to the Great Plains.
4. Overcup oak (Quercus lyrata), also known as swamp white oak, grows in the Atlantic Coastal States and westward to Texas through southern Illinois and Indiana.
5. Swamp chestnut oak (Quercus michauxii), also known as basket oak and cow oak, grows along the Atlantic coast and westward to Texas through southern Illinois and Indiana.
6. Bur oak (Quercus macrocarpa) grows mainly from New York to Montana and southward through Kentucky to Texas.
7. Chinkapin oak (Quercus muehlenbergii) grows from New York, southern Michigan, and southern Minnesota southward to the Gulf of Mexico, except for the Atlantic Coastal Plain.
8. Swamp white oak (Qercus bicolor) grows from southern Maine through the Central States to the Great Plains.
9. Live oak (Quercus virginiana) is limited to the Atlantic Coastal Plain, Florida, and the Gulf coast.

White oak lumber comes chiefly from the South, South Atlantic, and Central States, including the southern Appalachian area.

The heartwood of the white oaks is generally grayish brown, and the sapwood, which is from 1 to 2 or more inches thick, is nearly white. The pores of the heartwood of white oaks are usually plugged with a frothlike growth known as tyloses. These tend to make the wood impenetrable by liquids, and for this reason most white oaks are suitable for tight cooperage. Chestnut oak lacks tyloses in many of its pores.

The wood of white oak averages somewhat heavier than that of the red oaks, ranging from 45 to 50 pounds a cubic foot at 12 percent moisture content. Live oak is much the heaviest, averaging 62 pounds a cubic foot at 12 percent moisture content. Its heartwood has moderately good decay resistance.

White oaks are used for lumber, crossties, cooperage, mine timbers, fence posts, veneer, fuelwood, and many other products. High quality white oak is especially sought for tight cooperage. Live oak is considerably stronger than the other oaks, and was formerly used extensively for ship timbers. An important use of white oak is for planking and bent parts of ships and boats, heartwood often being specified because of its decay resistance. It is also used for flooring, agricultural implements, railroad cars, furniture, doors, millwork, and many other items.

Pecan. Species of the pecan group include bitternut hickory (Carya cordiformis), pecan (Carya illinoensis), water hickory (Carya aquatica), and nutmeg hickory (Carya myristicaeformis). Bitternut hickory grows throughout the eastern half of the United States. Pecan hickory grows from central Texas and Louisiana to Missouri and Indiana. Water hickory grows from Texas to South Carolina. Nutmeg hickory occurs principally in Texas and Louisiana.

The wood of pecan hickory resembles that of true hickory. It has white or nearly white sapwood, which is relatively wide, and somewhat darker heartwood. The wood is heavy and sometimes has very large shrinkage. Bitternut and pecan weigh 46 pounds, water hickory 43 pounds, and nutmeg hickory 42 pounds a cubic foot at 12 percent moisture content.

Heavy pecan hickory finds use in tool and implement handles and flooring. The lower grades are used in pallets. Many higher grade logs are sliced to provide veneer for furniture and decorative paneling.

Poplar. Poplar (Liriodendron tulipifera) is also known as yellow poplar, tulip poplar, tulipwood, and hickory poplar. Sapwood from yellow poplar is sometimes called white poplar or whitewood.

Poplar grows from Connecticut and New York southward to Florida and westward to Missouri. The greatest commercial production of yellow poplar lumber is in the South.

Poplar sapwood is white and frequently several inches thick. The heartwood is yellowish brown, sometimes streaked with purple, green, black, blue, or red. These colorations do not affect the physical properties of the wood. The wood is generally straight-grained and comparatively uniform in texture. It is moderately light in weight, old growth timber averaging 28 pounds a cubic foot at 12 percent moisture content; second growth may be considerably heavier. 01 d growth timber is reported as being moderately weak in bending, moderately soft, and moderatley low in shock resistance. It has moderately large shrinkage when dried from a green condition but is not difficult to season and stays in place well after seasoning.

Much of the second growth yellow poplar is heavier, harder, and stronger than virgin growth. Weights of more than 32 pounds per cubic foot at 12 percent moisture content are not uncommon. Selected trees produce wood heavy enough for gunstocks. Lumber goes mostly into furniture, interior finish, siding, core stock for plywood, radio cabinets, and musical instruments. Boxes and crates are made from lower grade stock. Yellow poplar plywood is used for finish, furniture, piano cases, and vairous other uses. Yellow poplar is used also for pulpwood, excelsior, and slack-cooperage staves.

Cucumber lumber (Magnolia acuminata) sometimes may be included in shipments of yellow poplar because of its similarity.

Sassafras. The range of sassafras (Sassafras albidum) covers most of the eastern half of the United States from southeastern Iowa and eastern Texas eastward.

The wood of sassafras is easily confused with black ash, which it resembles in color, grain, and texture. The sapwood is light yellow and the heartwood varies from dull grayish brown to dark brown, sometimes with a reddish tinge. The wood has an odor of sassafras on freshly cut surfaces.

Sassafras is moderately heavy, moderately hard, moderately weak in bending and endwise compression, quite high in shock resistance, and quite durable when exposed to conditions conductive to decay. It was highly prized by the Indians for dugout canoes, and some sassafras lumber is now used for small boats. Locally, it is used for fence posts and rails and general millwork, for foundation posts, and some wooden containers.

Sycamore. Sycamore (Platanus occidentals) is also known as American sycamore, and sometimes as buttonwood, buttonball tree, and plane tree. Sycamore grows from Maine to Nebraska, Texas, and northern Florida. In the production of sycamore lumber, the Central States rank first.

The heartwood of sycamore is reddish brown; sapwood is lighter in color and from 1-1/2- to 3-inches thick. The wood has a fine texture and interlocked grain. It shrinks moderately in drying. Sycamore wood averages 34 pounds a cubic foot at 12 percent moisture content. It is moderately hard, moderately stiff, moderately strong, and has good resistance to shock.

Sycamore is used principally for lumber, veneer, railway ties, cooperage, fence posts, and fuel. Sycamore lumber is used for furniture, boxes (particularly small food containers), flooring, handles, and butcher's blocks. Veneer is used for fruit and vegetable baskets.

Tanoak. In recent years tanoak (Lithocarpus densiflorus) has gained some importance commercially, primarily in California and Oregon. It is also known as tanbark-oak because at one time high-grade tannin in commercial quantities was obtained from the bark. This species is found in southwestern Oregon and south to Southern California, mostly near the coast but also in the Sierra Nevadas.

The sapwood of tanoak is light reddish brown when first cut and turns darker with age to become almost indistinguishable from the heartwood, which also ages to dark reddish brown. The wood is heavy, hard, and except for compression perpendicular to the grain has roughly the same strength properties as eastern white oak. Volumetric shrinkage during drying is more than for white oak, and it has a tendency to collapse during drying. It is quite susceptible to decay, but the sapwood takes preservatives easily. It has straight grain, machines and glues well, and takes staining readily.

Because of tanoak's hardness and abrasion resistance, it is an excellent wood for flooring in homes or commercial buildings. It is also suitable for industrial applications such as truck flooring. Tanoak treated with preservative has been used for railroad crossties. The wood has been manufactured into baseball bats with good results. It is also suitable for veneer, both decorative and industrial, and for high-quality furniture.

Tupelo. The tupelo group includes water tupelo (Nyssa aquatica), also known as tupelo gum, swamp tupelo, and gum; black tupelo (Nyssa sylvatica), also known as blackgum and sour gum; swamp tupelos (Nyssa sylvatica var. biflora), also known as swamp blackgum, blackgum, tupelo gum, and sour gum; and Ogeechee tupelo (Nyssa ogeche), also known as sour tupelo, gopher plum, tupelo, and Ogeechee plum.

All except black tupelo grow principally in the southeastern United States. Black tupelo grows in the eastern United States from Maine to Texas and Missouri. About two-thirds of the production of tupelo lumber is from the Southern States.

Wood of the different tupelos is quite similar in appearance and properties. Heartwood is light brownish gray and merges gradually into the lighter-colored sapwood, which is generally several inches wide. The wood has fine, uniform texture and interlocking grain. Tupelo wood is rated as moderately heavy. Wood of water tupelo and black tupelo at 12 percent moisture content averages 35 pounds per cubic foot in weight. It is moderately strong, moderately hard and stiff, and moderately high in shock resistance. Buttresses of trees growing in swamps or flooded areas for a considerable time contain wood that is much lighter in weight than that from upper portions of the same trees. For some uses, as in the case of buttressed ash trees, this wood should be separated from the heavier wood to assure material of uniform strength. Because of interlocked grain, tupelo lumber requires care in drying.

Tupelo is cut principally for lumber, veneer, pulpwood, and some railway ties and cooper age. Lumber goes into boxes, crates, baskets, and furniture.

Walnut. Walnut (Juglans nigra) is also known as black walnut and American black walnut. Its natural range extends from Vermont to the Great Plains and southward into Louisiana and Texas. About three-quarters of the walnut timber is produced in the Central States.

The heartwood of walnut varies from light to dark brown; the sapwood is nearly white, and in open-grown trees up to 3-inches wide. Walnut is normally straight-grained, easily worked with tools, and stays in place well. It averages 39 pounds a cubic foot at 12 percent moisture content. It is hard, strong, stiff, and has good resistance to shock.

The outstanding use of walnut is for furniture. Other important uses are gunstocks, cabinets, and interior finish. It is used either as solid wood or as plywood.

Willow, black. Black willow (Salix nigra) is the most important of the many willows that grow in the United States. It is the only one to supply lumber to the market under its own name.

Black willow is most heavily produced in the Mississippi Valley from Louisiana to southern Missouri and Illinois.

Heartwood of black willow is grayish brown or light reddish brown in color, frequently containing darker streaks. Sapwood is whitish to creamy yellow. The wood of black willow is uniform in texture, with somewhat interlocked grain. The wood is light in weight, averaging 26 pounds a cubic foot at 12 percent moisture content. It is exceedingly weak as a beam or post, moderately soft, and moderately high in shock resistance. It has moderately large shrinkage.

The wood of willow is cut principally into lumber. Small amounts are used for slack cooperage, veneer, excelsior, charcoal, pulpwood, artificial limbs, and fence posts. Black willow lumber is remanufactured principally into boxes, baskets, crates, caskets, and furniture. Willow lumber is suitable in building as roof and wall sheathing, subflooring, and studding.

Imported Woods

Foreign woods are becoming more important as the consumption of wood products in the United States continues to increase. Imports of foreign woods versus exports by the United States is running about 2 to 1 for hardwoods and about 8 to 1 for softwoods. Those species of imported woods considered to be of commercial importance are described in the following paragraphs. The same species may be marketed in the United States under other common names.

Andiroba. Because of the widespread distribution of andiroba (Carapa guianensis) in tropical America, the wood is known under a variety of names that include cedro macho, carapa, crabwood, and tangare. These names are also applied to the related species Carapa nicaraguensis, whose properties are generally inferior to those of C. guianensis.

The heartwood color varies from reddish brown to dark reddish brown. The texture (size of pores) is like that of mahogany (Swietenia). The grain is usually interlocked but is rated as easy to work, paint, and glue. The wood is rated as durable to very durable with respect to decay and insects. Andiroba is heavier than mahogany and accordingly is markedly superior in all static bending properties, compression parallel to the grain, hardness, shear, and toughness.

On the basis of its properties, andiroba appears to be suited for such uses as flooring, frame construction in the tropics, furniture and cabinetwork, millwork, and utility and decorative veneer and plywood.

Angelique. Angelique (Dicorynia guianensis), or basra locus, comes from French Guiana and Surinam and was previously identified under the name D. paraensis. Because of the variability in heartwood color between different trees, two forms are commonly recognized by producers. Heartwood that is russet colored when freshly cut, and becomes superficially dull brown with a purplish cast, is referred to as "grist". Heartwood that is more distinctly reddish and frequently shows wide bands of purplish color is called angelique rouge.

The texture is somewhat coarser than that of black walnut. The grain is generally straight or slightly interlocked. In strength, angelique is superior to teak and white oak, when either green or air dry, in all properties except tension perpendicular to grain. Angelique is rated as highly resistant to decay, and resistant to marine borer attack. Machining properties vary and may be due to differences in density, moisture content, and silica content. After the wood is thoroughly air dried or kiln dried, it can be worked effectively only with carbide-tipped tools.

The strength and durability of angelique make it especially suitable for heavy construction, harbor installations, bridges, heavy planking for pier and platform decking, and railroad bridge ties. The wood is particularly suitable for ship decking, planking, boat frames, and underwater members. It is currently being used in the United States for pier and dock fenders and flooring.

Apamate. Apamate (Tabebuia rosea) ranges from southern Mexico through Central America to Venezuela and Ecuador. The name roble is frequently applied to this species because of some fancied resemblance of the wood to that of oak (Quercus). Another common name for apamate in Belize is mayflower.

The sapwood becomes a pale brown upon exposure. The heartwood varies through the browns, from a golden to a dark brown. Texture is medium, and grain is closely and narrowly interlocked. Heartwood is without distinctive odor or taste. The wood weighs about 38 pounds per cubic foot at 12 percent moisture content.

Apamate has excellent working properties in all machining operations. It finishes attractively in natural color and takes finishes with good results.

Apamate averages lighter in weight than the average of the American white oaks, but is comparable with respect to bending and compression parallel to grain. The white oaks are superior with respect to side hardness and shear.

The heartwood of apamate is generally rated as durable to very durable with respect to fungus attack; the darker colored and heavier wood is regarded as more resistant than the lighter forms.

Within its region of growth, apamate is used extensively for furniture, interior trim, doors, flooring, boat building, ax handles, and general construction. The wood veneers well and produces an attractive paneling.

Apitong. Apitong is the most common structural timber of the Philippine Islands. The principal species are apitong (Dipterocarpus grandiflorus), panau (D. gracilis), and hagakhak (D. warburgii). All members of the genus are timber trees, and all are marketed under the name apitong. Other important species of the genus Dipterpcarpus are marketed as keruing in Malaysia and Indonesia, yang in Thailand, and gurjun in India and Burma.

The wood is light to dark reddish brown in color, comparatively coarse to comparatively fine textured, straight grained or very nearly so, strong, hard, and heavy. The wood is characterized by the presence of resin ducts, which occur in short arcs as seen on end grain surfaces.

Although the heartwood is fairly resistant to decay and insect attack, the wood should be treated with preservatives when it is to be used in contact with the ground.

In machining research on apitong and the various species of “Philippine mahogany,” apitong ranked appreciably above the average in all machining operations.

Apitong is used for heavy-duty purposes as well as for such items as mine guides, truck floors, chutes, flumes, agitators, pallets, and boardwalks.

Avodire. Avodire (Turraeanthus africanus) has rather extensive range from Sierra Leone westward to the Cameroons and southward to Zaire. It is a medium-sized tree of the rain forest in which it forms fairly dense but localized and discontinuous stands.

The wood is cream to pale yellow in color with a high natural luster and eventually darkens to a golden yellow. The grain is sometimes straight but more often is wavy or irregularly interlocked, which produces an unusual and attractive mottled figure when sliced or cut on the quarter.

Although its weight is only 85 percent that of English oak, avodire has almost identical strength properties except that it is lower in shock resistance and in shear. The wood works fairly easily with hand and machine tools and finishes well in most operations.

Figured material is usually converted into veneer for use in decorative work and it is this kind of material that is chiefly imported into the United States.

Bagtikan. The genus Parashorea consists of about seven species occurring in Southeast Asia. The principal species in the United States lumber trade is bagtikan (P. plicata) of the Philippines and Bronco. White saraya (P. malagnonan) from Sabah is also important. In the United States, bagtikan may be encountered under its usual common name or more frequently with the species comprising the light-red group of lauans. The heartwood is gray to straw colored or very pale brown and sometimes has a pinkish cast. It is not always clearly demarcated from the sapwood. The wood weighs about 34 pounds per cubic foot at 12 percent moisture content. The texture is similar to that of the light-red group of Philippine lauans. The grain is interlocked and shows a rather widely spaced stripe pattern on quartered surfaces.

With respect to strength, Philippine bagtikan exceeds the lauans in all properties. Its natural durability is very low and it is resistant or extremely resistant to preservative treatment.

The wood works fairly easily with hand and machine tools and has little blunting effect on tool cutting edges.

Bagtikan is used for many of the same purposes as the Philippine lauans, but in the solid form and in the thin stock it is best utilized in the quartersawn condition to prevent excessive movement with changes in moisture conditions of service. It is perhaps most useful as a veneer for plywood purposes. In Britain it is best known as decking timber which has been specially selected for this use in vessels.

Balsa. Balsa (Ochroma pyramidale) is widely distributed throughout tropical America from southern Mexico to southern Brazil and Bolivia, but Equador has been the principal area of growth since the wood gained commercial importance.

Balsa possesses several characteristics that make possible a wide variety of uses. It is the lightest and softest of all woods on the market. The lumber selected for use in the United States when dry weighs on the average about 11 pounds per cubic foot and often as little as 6 pounds. Because of its light weight and exceedingly porous composition, balsa is highly efficient in uses where bouyancy, insulation against heat and cold, or absorption of sound and vibration are important considerations.

The wood is readily recognized by its light weight, white to very pale gray color, and its unique "velvety" feel.

The principal uses of balsa are in life-saving equipment, floats, rafts, core stock, insulation, cushioning, sound modifiers, models, and novelties Balsa is imported in larger volume than most of the foreign woods entering the United States.

Banak. More than 40 species of Virola occur in tropical America, but only three species supply the bulk of the timber known as banak. These are: V. koschnyi of Central America, and V. surinamensis and V. sebifera of northern South America.

The heartwood is usally pinkish brown or grayish brown in color and is not differentiated from the sapwood. The wood is straight grained and is of a medium to coarse texture.

The various species are nonresistant to decay and insect attack but can be readily treated with preservatives. Their machining properties are very good, but fuzzing and grain tearing are to be expected when zones of tension wood are present. The wood finishes readily and is easily glued. It is rated as a first-class veneer species. Its strength properties are similar to yellow-poplar.

Banak is considered as a general utility wood in both lumber and plywood form.

Cativo. Cativo (Prioria copaifera) is one of the few tropical American species that occur in abundance and often in nearly pure stands. Commercial stands are found in Nicaragua, Costa Rica, panama, and Colombia. The sapwood is usally thick, and in trees up to 30 inches in diameter the heartwood may be only 7 inches in diameter. The sapwood that is utilized commercially may be a very pale pinkish color or may be distinctly reddish. The grain is straight and the texture of the wood is uniform, comparable to that of mahogany. Figure on flatsawn surfaces is rather subdued and results from the exposure of the narrow bands of parenchyma tissue. Odor and taste are not distinctive, and the luster is low.

The wood can be seasoned rapidly and easily with very little degrade. The dimensional stability of the wood is very good; it is practically equal to that of mahogany. Cativo is classed as a nondurable wood with respect to decay and insects. Cativo may contain appreciable quantities of gum, which may interfere with finishes. In wood that has been properly seasoned, however, the gum presents no difficulties.

The tendency of the wood to bleed resinous material in use and in warping of narrow cuttings kept this species in disfavor for many years. Improved drying and finishing techniques have materially reduced the prominence of these inherent characteristics, and the uses for this wood are rapidly increasing. Considerable quantities are used for interior trim, and resin-stabilized veneer has become an important pattern material, particularly in the automotive industry. Cativo is widely used for furniture and cabinet parts, lumber core for plywood, picture frames, edge banding for doors, and bases for piano keyboards.

Goncalo alves. The major and early imports of goncalo alves (Astronium graveolens & fraxinifolium) have been from Brazil. These species range from southern Mexico, through Central America into the Amazon Basin.

The heartwood ranges from various shades of brown to red with narrow to wide, irregular stripes of dark brown or nearly black. The sapwood is grayish white and sharply demarcated from the heartwood. The texture is medium and uniform. Grain is variable from straight to interlocked and wavy. The wood is very heavy and averages about 63 pounds per cubic foot at 12 percent moisture content.

It turns readily, finishes very smoothly, and takes a high natural polish. The heartwood is highly resistant to moisture absorption and the pigmented areas, because of their high density, may present some difficulties in gluing.

The heartwood is rated as very durable with respect to fungus attack.

The high density of the wood is accompanied by equally high strength values, which are considerably higher in most respects than those of any well known U.S. species. It is not expected, however, that goncalo alves will be imported for purposes where strength is an important criterion.

In the United States the greatest value of goncalo alves is in its use for specialty items such as archery bows, billiard cue butts, brush backs, cutlery handles, and for fine and attractive products of turnery or carving.

Greenheart. Greenheart (Ocotea rodiaei) is essentially a Guyana tree although small stands also occur in Surinam. The heartwood varies in color from light to dark olive-green or nearly black. The texture is fine and uniform.

Greenheart is stronger and stiffer than white oak and generally more difficult to work with tools because of its high density. The heartwood is rated as very resistant to decay and termites. It also is very resistant to marine borers in temperate waters but much less so in warm tropical waters.

Greenheart is used principally where strength and resistance to wear are required. Uses include ship and dock building, lock gates, wharves, piers, jetties, engine bearers, planking, flooring, bridges, and trestles.

Jarrah. Jarrah (Eucalyptus marginata) is native to the coastal belt of southwestern Australia and one of the principal timbers of the sawmill industry.

The heartwood is a uniform pinkish to dark red, often a rich, dark red mahogany hue, turning to a deep brownish red wth age and exposure to light. The sapwood is pale in color and usually very narrow in old trees. The texture is even and moderately coarse. The grain, though usually straight, is frequently interlocked or wavy. The wood weighs about 44 pounds per cubic foot at 12 percent moisture content. The common defects of jarrah include gum veins or pockets which, in extreme instances, separate the log into concentric shells.

Jarrah is a heavy, hard timber possessing correspondingly high strength properties. It is resistant to attack by termites and rated as very durable with respect to fungus attack. The heartwood is rated as extremely resistant to preservative treatment.

Jarrah is fairly hard to work in machines and difficult to cut with hand tools.

Jarrah is used for decking and underframing of piers, jetties, and bridges, and also for piles and fenders in dock and harbor installations. As a flooring timber it has a high resistance, but is inclined to splinter under heavy traffic.

Kapur. The genus Dryobalanops comprises some nine species distribution over parts of Malaya, Sumatra, and Borneo, including North Borneo and Sarawak. For the export trade, however, the species are combined under the name kapur.

The heartwood is light reddish brown, clearly demarcated from the pale colored sapwood. The wood is fairly coarse textured but uniform. In general appearance the wood resembles that of apitong and keruing, but on the whole it is straighter grained and not quite so coarse in texture. The Malayan timber averages about 48 pounds per cubic foot at 12 percent moisture content.

Strength property values available for D. lanceolata show it to be on a par with apitong or keruing of similar specific gravity.

The heartwood is rated as very durable and extremely resistant to preservative treatment. The wood works with moderate ease inmost hand and machine operations. A good surface is obtainable from the various machining operations, but there is a tendency toward "raised grain" if dull cutters are used. It takes nails and screws satisfactorily.

The wood provides good and very durable construction timbers and is suitable for all the purposes for which apitong and keruing are used in the United States.

Karri. Karri (Eucalyptus diversicolor) is a very large tree limited to Western Australia, occurring in the southwestern portion of the state.

Karri resembles jarrah (E. marginata) in structure and general appearance. It is usually paler in color, and, on the average, slightly heavier (57 lb. per cu. ft. at 12 percent moisture content).

The heartwood is rated as moderately durable and extremely resistant to preservative treatment.

Karri is a heavy hardwood possessing mechanical properties of a correspondingly high order.

The wood is fairly hard to work in machines and difficult to cut with hand tools. It is generally more resistant to cutting then jarrah and has slightly more dulling effect on tool edges.

It is inferior to jarrah for underground use and waterworks, but where flexural strength is required, such as in bridges, floors, rafters, and beams, it is an excellent timber. Karri is popular in the heavy construction field because of its strength and availability in large sizes and long lengths that are free of defects.

Khaya. The bulk of the khaya or "African Mahogany" shipped from west central Africa is Khaya ivorensis, which is the most widely distributed and most plentiful species of the genus found in the coastal belt of the so-called closed or high forest. The closely allied species, Khaya anthotheca, has a more restricted range and is found farther inland in regions of lower rainfall but well within the area now being worked for the export trade.

The heartwood varies from a pale pink to a dark reddish brown. The grain is interlocked, and the texture is equal to that of mahogany (Swietenia). The wood is very well known in the United States and large quantities are imported annually. The wood is easy to season, machines and finishes well. In decay resistance, it is generally rated below Amercian mahogany.

Principal uses include furniture, interior finish, boat construction, and veneer.

Kokrodus. Kokrodua (Pericopsis elata) is the vernacular name used in Ghana. It is also known as afrormosia, its former generic name.

This large West African tree shows promise of becoming a substitute for teak (Tectona grandis). The heartwood is fine textured, with straight to interlocked grain. The wood is brownish yellow with darker streaks, moderately hard and heavy, weighing about 44 pounds per cubic foot at 15 percent moisture content. The wood strongly resembles teak in appearance but lacks the oily nature of teak and is finer textured.

The wood seasons readily with little degrade and has good dimensional stability. It is somewhat heavier than teak and stronger. The heartwood is resistant to decay and durable under adverse conditions. The wood can be used for the same purposes as teak, such as boat construction, interior trim, and decorative veneer.

Lapacho. The lapacho group or series of the genus Tabebuia consists of about 20 species of trees and occurs in practically every Latin American country except Chile. Another commonly used name is ipe.

The sapwood is relatively thick, yellowish gray or gray brown and sharply differentiated form the heartwood, which is a light to dark olive brown. The texture is fine. Grain is closely and narrowly interlocked. Luster is medium. The wood is very heavy and averages about 64 pounds per cubic foot at 12 percent moisture content. Thoroughly air-dried specimens of heartwood generally sink in water.

Lapacho is moderately difficult to machine because of its high density and hardness. Glassy smooth surfaces can be readily produced.

Being a very heavy wood, lapacho is also very strong in all properties and in the air-dry condition is comparable to greenheart.

Lapacho is highly resistant to decay and insects, including both subterranean and drywood termites. It is, however, susceptible to marine borer attack. The heartwood is impermeable, but the sapwood can be readily treated with preservatives.

Lapacho is used almost exclusively for heavy duty and durable construction. Because of its hardness (two to three times that of oak or apitong) and very good dimensional stability, it would be particular well suited for heavy duty flooring in trucks and box cars.

Lauans. The term "lauan" or "Philippine mahogany" is applied commercially to Philippine woods belonging to three genera - Shorea, Parashorea, and Pentacme. These woods are usually grouped by the United States trade into "dark red Philippine mahogany" and "light red Philippine mahogany". The species found in these two groups and their heartwood color are:

"Dark red Philippine mahogany"

Red lauan, (Shores negrosensis)	Dark reddish-brown to brick red
Tanguile, (Shores polysperma)	Red to reddish brown
Tianong, (Shorea agsaboensis)	Light red to light reddish-brown

"Light red Philippine mahogany"

Almon, (Shorea almon)	Light red to pinkish
Bagtikan, (Parashorea plicata)	Grayish-brown
Mayapis, (Shorea squamata)	Light red to reddish-brown
White lauan, (Pentacme contorts)	Grayish to very light red

The species within each group are shipped interchangeably when purchased in the form of lumber. Mayapis of the light red group is quite variable with respect to color and frequently shows exudations of resin. For this reason, some purchasers of "Philippine mahogany" specify that mayapis be excluded from their shipments.

"Philippine mahoganies" as a whole have a coarser texture than mahogany or the "African mahoganies" and do not have dark colored deposits in the pores. Fores t products Laboratory studies showed that the average decay resistance was greater for mahogany than for either the "African mahoganies" or the "Philippine mahoganies". The resistance of "African mahogany" was of the moderate type and seemed no greater than that of some of the "Philippine mahoganies". Among the Philippine species, the woods classified as "dark red Philippine mahogany" usually were more resistant than the woods belonging to the light red group.

In machining trials made at the Laboratory, the Philippine species appeared to be about equal with the better of the hardwoods found in the United States. Tanguile was consistently better than average in all or most of the tests. Mayapis, almon, and white lauan were consistently below average in all or most of the trials. Red lauan and bagtikan were intermediate. All of the species showed interlocked grain.

The shrinkage and swelling characteristics of the Philippine species are comparable to those found in the oaks and maples of the United States

Principal uses include interior trim, paneling, flush doors, plywood, cabinets, furniture, siding, and boat construction. The use of the woods of the dark red group for boatbuilding in the United States exceed in quantity that of any foreign wood.

Mahogany. Mahogany (Swietenia spp.) is native to tropical America. One species, Swietenia mahogoni, grows in the Florida Keys, the Bahamas, and the West Indies. Swietenia macrophylla occurs in Mexico, Central America, and northern South America. They are among the more important tropical American species imported into the United States.

The wood stays in place very well, has attractive appearance, fine finishing qualities, and is easy to work with tools. The color of the heartwood varies from very pale to very dark reddish brown and grows richer and darker with age. Sapwood is pale yellow or nearly colorless. The wood is without characteristic odor or taste. It is uniform in texture.

Mahogany is variable in weight. The average weight of air-dry wood at 12 percent moisture content is about 35 to 40 pounds a cubic foot. Wood from Florida and the West Indies averages heavier than that from Central and South America. Hardness and strength vary with weight. Both radial and tangential shrinkage of mahogany are low.

The principal use of mahogany as a cabinet wood is for the more expensive types of house and office furniture and fixtures, as both lumber and veneer. Mahogany is used for doors, wall paneling, and other millwork.

Meranti. The trade name meranti covers a number of closely related species of Shorea from which light or only moderately heavy timber is produced. This timber is imported from Malaysia and Indonesia. On the Malay Peninsula this timber is commonly classified for export either as light red or dark red meranti. Each of these color varieties is the product of several species of Shorea. Meranti exported from Sarawak and various parts of Indonesia is generally similar to the Malayan timber. Meranti corresponds roughly to seraya from North Borneo and lauan from the Philippines, which are names used for the lighter types of Shorea and allied genera.

Meranti shows considerable variation in color, weight, texture, and related properties, according to the species. The grain tends to be slightly interlocked so that quartered stock shows a broad stripe figure. The texture is moderately coarse but even. Resin ducts with or without white contents occur in long tangential lines on the end surfaces of the wood, but the wood is not resinous like some of the keruing species. Wood from near the center of the log is apt to be weak and brittle.

Light red meranti is classed as a light-weight utility hardwood and comprises those species yielding a red or reddish but not a dark red timber. The actual color of the heartwood varies from pale pink to light reddish brown. The weight of the wood may vary over a rather wide range from 25 to 44 pounds per cubic foot in the seasoned condition.

Dark red meranti is darker in color than ordinary red meranti and appreciably heavier, weighing on the average about 43 pounds per cubic foot seasoned. This color variation is the product of a more limited number of species and consequently tends to be more uniform in character than light red meranti. Because of the number of species contributing to the production of meranti, appreciable variation may be encountered with respect to mechanical and physical properties, durability, and working characteristics.

The wood is used in both plywood and solid form for much the same purposes as the Philippine lauans.

Pine, Caribbean. Caribbean pine (Pinus caribaea) occurs along the Caribbean side of Central America from Belize to northeastern Nicaragua. It is also native to the Bahamas and Cuba. It is primarily a tree of the lower elevations.

The heartwood is a golden brown to red brown and distinct from the sapwood which is 1 to 2 inches in thickness and a light yellow. The wood has a strong resinous odor and a greasy feel. The wood averages about 51 pounds per cubic foot at 12 percent moisture content.

The lumber can be kiln dried satisfactorily using the same schedule as that for ocote pine.

Caribbean pine is easy to work in all machining operations but the high resin content may necessitate occasional stoppage to permit removal of accumulated resin from the equipment.

Caribbean pine is an appreciably heavier wood than slash pine (P. elliotti), but the mechanical properties of these two species are rather similar.

Caribbean pine is used for the same purposes as the southern pine of the United States.

Pine, Ocote. Ocote pine (Pinus oocarpa) is a species of the higher elevations and occurs from northwestern Mexico southward through Guatemala into Nicaragua. The largest and most extensive stands occur in northern Nicaragua and Honduras.

The sapwood is a pale yellowish brown and generally up to 3 inches in thickness. The heartwood is a light reddish brown. Grain is straight. Luster is medium. The wood has a resinous odor, and weighs about 41 pounds per cubic foot at 12 percent moisture content.

The strength properties of ocote pine are comparable inmost respects with those of longleaf pine (P. palustris).

Decay resistance studies show ocote pine heartwood to be very durable with respect *to* attack by a white-rot fungus and moderately durable with respect to brown rot.

Ocote pine is comparable to the southern pines in workability and machining characteristics.

Ocote pine is a general construction timber and is suited for the same uses as the southern pines.

Primavera. The natural distribution of primavera (Cybistax donnell-smithii) is restricted to southwestern Mexico, the Pacific coast of Guatemala and El Salvador, and northern central Honduras.

Primavera is regarded as one of the primary light-colored woods, but its use was limited because of its rather restricted range and the relative scarcity of wild trees within its natural growing area.

Plantations now coming into production have increased the availability of this species and provided a more constant source of supply.The quality of the plantation-grown wood is equal in all respects to that obtained from wild trees.

The heartwood is whitish to straw-yellow and in some logs may be tinted with pale brown or pinkish streaks. The wood has a very high luster.

Primavera produces a wide variety of figure patterns.

The shrinkage properties are very good, and the wood shows a high degree of dimensional stability. Although the wood has considerable grain variation, it machines remarkably well. With respect to decay resistance it is rated as durable to very durable.

The dimensional stability, ease of working, and pleasing appearance recommed primavera for solid furniture, paneling, interior trim, and special exterior uses.

Teak. Teak (Tectona grandis) occurs in commercial quantities in India, Burma, Thiland, Laos, Cambodia, North and South Vietnam, and the East Indies. Numerous plantations have been developed within its natural range and tropical areas of Latin America and Africa, and many of these are now producing timber.

The heartwood varies from a yellow-brown to a rich brown. It has a coarse texture, is usually straight grained, and has a distinctly oily feel. The heartwood has excellent dimensional stability and possesses a very high degree of natural durability.

Although not generally used in the United States where strength is of prime importance, the values for teak are generally on a par with those of our native oaks.

Teak generally works with moderate ease with hand and machine tools. Because of the presence of silica, its dulling effect on tools is sometimes considerable. Finishing and gluing are satisfactory although pretreatment may be necessary to ensure good bonding of finishes and glues.

Intrinsically, teak is one of the most valuable of all woods, but its use is limited by scarcity and high cost. Teak is unique in that it does not cause rust or corrosion when in contact with metal; hence, it is extremely useful in the shipbuilding industry. It is currently used in the construction of expensive boats, furniture, flooring, decorative objects, and veneer for decorative plywood.

Walnut, European. Although generally referred to as European walnut or by its country of origin, walnut (Juglans regia) is a native of western and central Asia, extending to China and northern India. Trees are grown in commercial quantities mainly in Turkey, Italy, France, and Yugoslavia.

Walnut is variable in color, with a grayish-brown background, marked with irregular dark-colored streaks. The figure, which is due to the infiltration of coloring matter, is sometimes accentuated by the naturally wavy grain. The highly figured veneers used in cabinetmaking and decorative paneling are obtained from the stumps, burls, and crotches of a relatively small percentage of the trees. The wood weighs about 40 pounds per cubic foot in the air-dry condition.

The product of any one locality may vary considerably in color, figure, and texture, but the selected export timber generally shows certain typical characteristics. French walnut is typically paler and grayer than English walnut, while the Italian wood is characterized by its elaborate figure and dark, streaky coloration. Because of the ease of machining, finishing, and gluing, walnut is used extensively in veneer form as well as in the solid form for furniture, paneling, and decorative objects. It and American black walnut are the classic woods for rifle stock.

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CHAPTER 4. LUMBER GRADES AND SIZES

GENERAL

The typical log yields a range of lumber qualities from the best to the poorest. Commercial lumber grades are set up to divide this range of qualities into a limited number of groupings, in each of which quality is fairly uniform.

This grade breakdown, of course, cannot be made fully uniform as between kinds or species of wood. Some species characteristically grow in such a way that they have relatively few but large knots; others relatively many but small knots. Some grow with the knots widely spaced; in others they are fairly close together. Some produce pitch pockets or diffused pitch; others produce no pitch. All species contain some decay in the trees and logs, but the species vary somewhat as to the form.

Yields of any given quality of lumber often differ widely in different species. In practice, therefore, two grades that are described separately in grading rules are sometimes combined in one species and sold separately in another. Some of the grades described in rule books are not made by all manufacturers, and some are made in very small volume.

The grading of lumber cannot be considered an exact science because it is based on either a visual inspection of each piece and the judgement of the grader, or on the results of a method of mechanically determining the stength characteristics of structural lumber. Grading rules, however, are sufficiently explicit to establish a maximum of 5 percent below grade as a reasonable variation between graders.

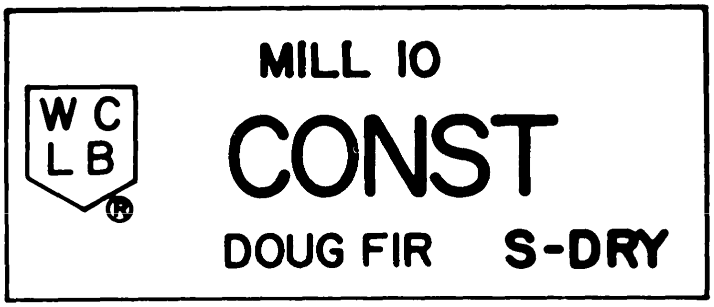
Lumber manufacturers and dealers have used these grading rules and periodically improved them over a long period of years. While not the essence of simplicity, the whole system of lumber grades becomes clear with reasonable study and experience.

Grade stamps. When American Standard Lumber is grade marked, the grade marking signifies that the lumber conforms to the size, grade, and seasoning provisions of the rules of the association under which it is graded. If lumber is dressed to a size below minimum American Softwood Lumber Standard requirements, or below the minimum sizes set forth in the applicable grading rules, the stamp must show size, and if thinner than 5 inch nominal, must state whether the lumber was dry or green when dressed, If lumber is dressed to less than the standard thickness of 1 inch nominal, the stamp must show the dressed thickness and whether the lumber was green or dry when dressed. Grade stamps are distinctive in design, registered with the American Lumber Standards Committee, and symbolize grading supervision by a certified agency.

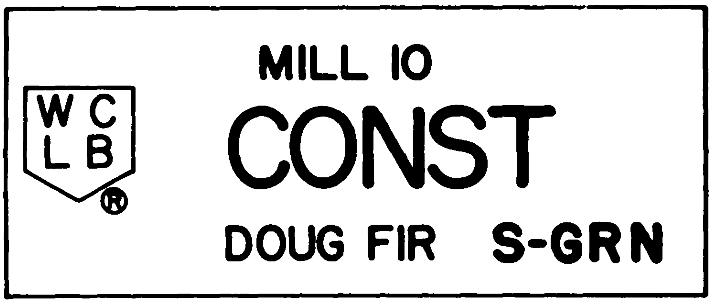
Grade marks or stamps include the registered association symbol; the producing mill is identified by either the name and identifying number or individual brand. Grade name for the lumber is shown by the standard grade name or abbreviation used by the association under which the piece was graded. Moisture content at time of dressing is shown by the notation S-dry (Surfaced-Dry), MC-15 (Moisture Content 15 percent), or S-GRN (Surfaced Green). Some associations indicate the paragraph number of their grading rules under which the piece was graded. Figure 32 has four examples of grade marks of the West Coast Lumber Inspection Bureau.

Grade stamp mechanically stress rated lumber. Mechanically stress rated (MSR) lumber is lumber that has been evaluated by mechanical stress rating equipment. This MSR lumber is distinguished from visually stress graded lumber in that each piece is nondestructively tested and marked to indicate the modulus of elasticity. The MSR lumber is also required to meet certain visual requirements as set forth in the applicable association grading rules, and procedures defined in ASTM D 2555 (Standard Methods for Establishing Clear Wood Strength Values) and ASTM D 245 (Standard Methods for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber).

A grade stamp on mechanically stress rated lumber indicates the stress rating system used meets the requirements of the grading agency's certification and quality control procedures. The grade stamp will show the agency trademark, the mill name or number, will include the phrase "Machine Rated", the species identification, and the "E" rating for the grade. The "E" rating is the rated modulus of elasticity in millions of pounds per square inch. The "f" portion of the "f-E" ratings indicates a correlated fiber stress bending for edge loading in pounds per square inch. Figure 33 is an example of a grade stamp that might appear on mechanically stress rated lumber.



Applied to lumber dried to 19% or less moisture content at time of surfacing. This moisture level qualifies the piece to be surfaced to the dry size, as denoted by the word "DRY" in the stamps.



Applied to lumber exceeding 19% moisture content at time of surfacing to standard surfaced green sizes.

Applied to stress graded lumber in board sizes, showing size and explanatory paragraph number.

Applied to a mixture of species surfaced unseasoned. Strength values of the weakest species will apply to lumber so marked.

L-117

FIGURE 32. Examples of grade stamps of the WCLB.

X-3828

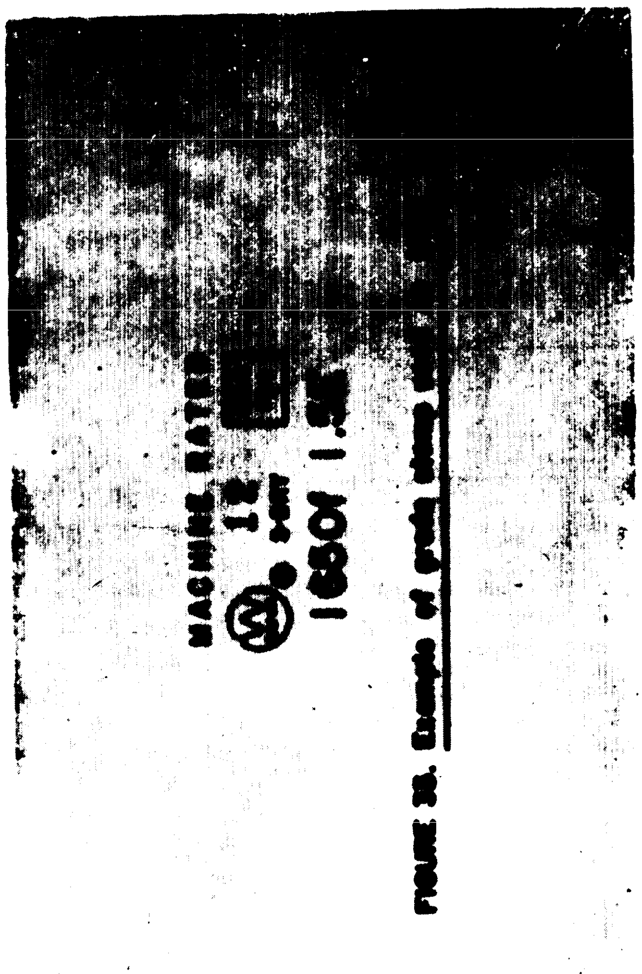


FIGURE 38. Example of grade stamp

Softwood Classifications

<u>Use classifications.</u> Softwood lumber is classified by use as follows:

(a) Yard lumber - Lumber of those grades, sizes, and patterns which is generally intended for ordinary construction and general building purposes.

(b) Structural lumber - Lumber that is 2 inches or more in nominal thickness and width for use where working stresses are required.

(c) Factory and shop lumber - Lumber that is produced or selected primarily for remanufacturing purposes.

An important exception to this generally applicable classification according to uses is the fact that boxes and containers are produced largely from the yard lumber grades rather than factory grades, because in this case clear pieces are not normally required. Some species are manufactured to sell under all three systems of grading, but for other species only one or two of the grading systems are used.

The bulk of softwood lumber is produced as yard lumber. Three to 4 percent of the softwood lumber produced is factory and shop lumber. Another 10 to 15 percent of softwood lumber is produced as structural lumber. Texture, straightness of grain, rate of growth, heartwood content, density, and similar properties pertaining to the clear wood are usually not taken into account in lumber grades. There are certain exceptions; for example, in certain special use grades of structural timber, density and straightness of grain are grading criteria; and in a few species there are provisions relative to heartwood content in yard lumber grades as well as special-use grades.

Lumber grading specifications have separate provisions for many important end products; notably siding, flooring, finish, casing and base, stepping, sash and door stock, railway car material, and vehicle lumber. Many of these end products are in the yard lumber category, some in factory lumber; some are predominantly softwood items, and some hardwood.

<u>Manufacturing classifications.</u> Softwood lumber is classified according to extent of manufacture as follows:

(a) Rough lumber - Lumber which has not been dressed (surfaced) but which has been sawed, edged, and trimmed at least to the extent of showing saw marks in the wood on the four longitudinal surfaces of each piece for its over-all length.

(b) Dressed (surfaced) lumber - Lumber that has been dressed by a planing machine (for purpose of attaining smoothness of surface and uniformity of size) on one side (S1S), two sides (S2S), one edge (S1E), two edges (S2E), or a combination of side and edges (S1S1E, S1S2E, S2S1E, S4S).

(c) Worked lumber - Lumber which, in addition to being dressed, has been matched, shiplapped, or patterned.

(1) Matched lumber - Lumber that has been worked with a tongue on one edge of each piece and a groove on the opposite edge to provide a close tongue-and-groove joint by fitting two pieces together; when end-matched, the tongue and groove are worked in the ends also.

(2) Shiplapped lumber - Lumber that has been worked or rabbeted on both edges of each piece to provide a close-lapped joint by fitting two pieces together.

(3) Patterned lumber - Lumber that is shaped to a pattern or to a molded form, in addition to being dressed, matched, or shiplapped, or any combination of these workings.

Figure 34 contains examples of standard patterns of worked lumber under the grading rules of the Southern Pine Inspection Bureau. Figure 34E illustrates a piece of rough and finished oak flooring under rules of the National Oak Flooring Manufacturers' Association.

Size classifications. Softwood lumber is classified according to size as follows :

(a) Nominal size. Softwood lumber is classified by nominal size as follows :

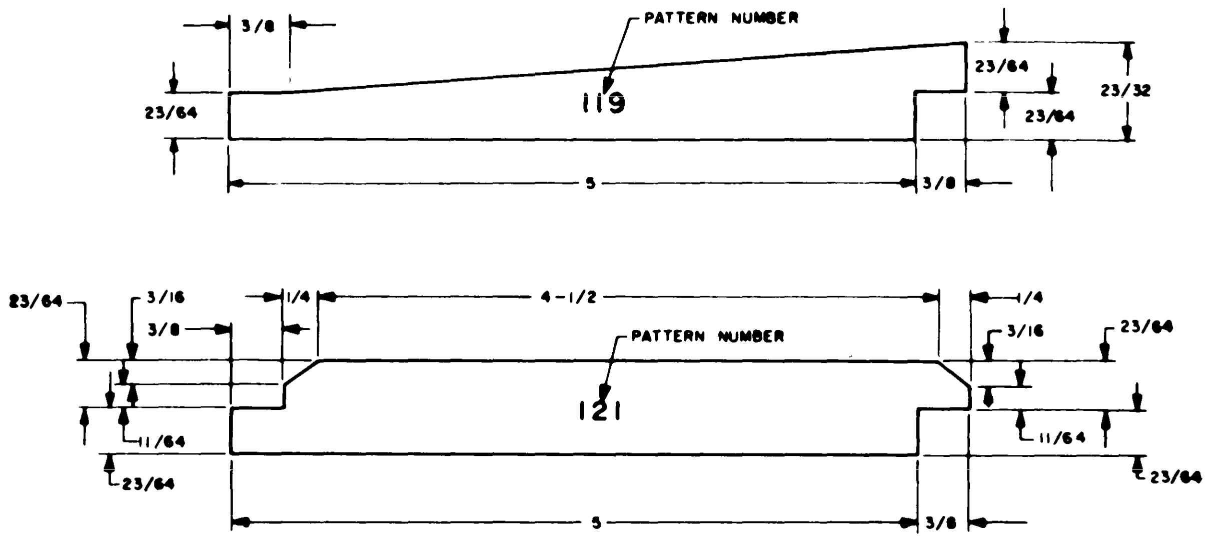
(1) Boards. Lumber less than 2 inches in nominal thickness and 2 or more inches in nominal width. Boards less than 6 inches in nominal width may be classified as strips.

(2) Dimension. Lumber from 2 inches to, but not including, 5 inches in nominal thickness, and 2 or more inches in nominal width. Dimension may be classified as framing, joists, planks, rafters, studs, small timbers, etc.

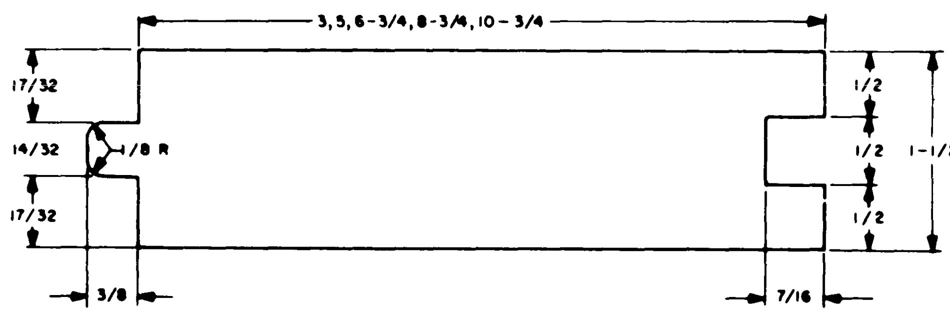
(3) Timbers. Lumber 5 or more inches nominally in least dimension. Timber may be classified as beams, stringers, posts, caps, sills, girders, purlins, etc.

Lumber Association Grades

General. All commercial species are covered by the grading rules size standards of a particular association or grading bureau, which in the case of softwood lumber is a regional manufacturer's association; in the case of hardwood lumber there is but one national association. In a few cases, a softwood species growing in more than one region is graded under rules of two different associations. There is great advantage to the purchaser, whether large or small,



A. Two standard patterns of drop siding.

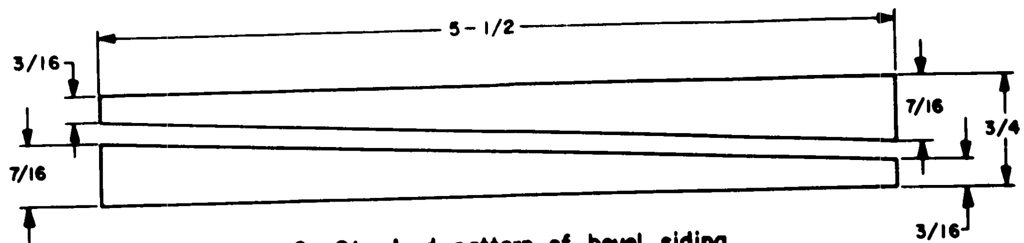


B. Standard 2-inch S2S+CM flooring or docking. (same tonge and groove for 2-1/2-inch).

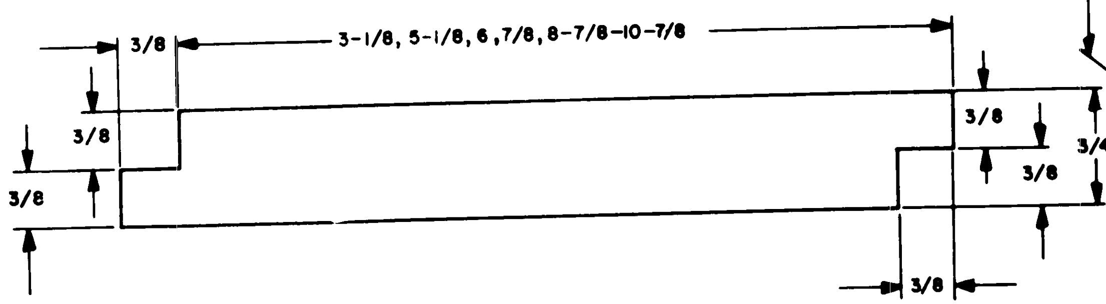
FIGURE 34. Patterns of worked lumber.

X-3830-1

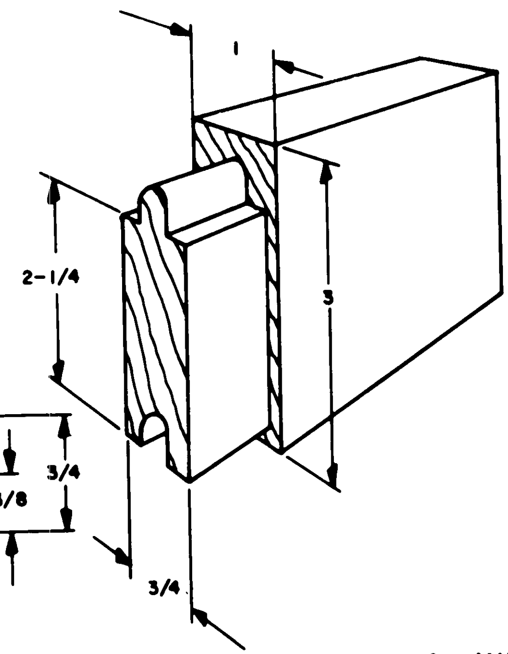
NOTE: ALL DIMENSIONS ARE IN INCHES



C. Standard pattern of bevel siding.



D. Standard 1-inch shiplap.



E. Rough and finished sizes for 1X3 dressed and matched hardwood flooring.

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FIGURE 34. Patterns of worked lumber (continued).

X-3830-2

to buy according to these association grades rather than to attempt to buy according to his own individual specifications unless the requirements are actually very unusual. Occasionally a departure from the standard grade provision is necessary to cover unusual requirements. This is best handled as an exception to a standard grade rather than as an entirely special grade.

Lumber associations that issue grading rules and size standards and provide inspection services are listed at the end of this chapter.

The softwood lumber association rules are standardized and unified within the limits of species differences and manufacturing conditions already discussed by the American Softwood Lumber Standard. The American Softwood Lumber Standard does not detail grade specifications in themselves, but serve as a guide and measuring stick to various regional manufacturers' associations in their attempts to eliminate unnecessary variations between associations. The American Softwood Lumber Standard cannot be used directly as a basis of purchase, nor can it be used as a substitute for association grading rulebooks, but it can be used to help attain familiarity with the detailed provisions of official association grades and sizes (see Voluntary Product Standard PS-20).

<u>Select softwood.</u> Select softwood yard lumber is of good appearance and finishing qualities, and usually comes in four grades designated as A, B, C, and D. The first two are suitable for natural finishes, grade A being practically free from defects and grade B of high quality, generally clear.

The select grades suitable for paint finishes are grade C, adapted to high quality paint finishes, and grade D, intermediate between higher finishing grades and common grades and partaking somewhat of the nature of both. The designations A, B, C, and D are used to denote four grades of Selects but may be indicated under another designation in the various association grade rules. Grade "A" may be known as "C & BTR. Select", or "C Select" under the grading rules of the Northeastern Lumber Manufacturers Association, depending on whether the species is eastern white pine or of one of the other species graded under these rules. When inspecting lumber the appropriate association grading rules should be consulted in determining applicable characteristics and limiting provisions for the various grades.

American Lumber Standards do not provide specific requirements or limitations with respect to the different grades or for the same grade in different species. There are general characteristics, however, that are fairly common to all association grades and serve as a guide to understanding of detailed grading rules. These general characteristics are as follows:

(a) Grade A. Grade A is practically clear wood. It is manufactured for such items as finish, flooring, ceiling, partition, and siding. A large number of manufacturers do not segregate the grade even in these items, and some of the lumber associations do not recognize the quality as a separate grade. Where the grade is not segregated it is combined with B grade and sold as B grade and Better. Grade A lumber is used almost entirely for interior and exterior trim and for flooring. The demand is small and confined largely to high-class construction, such as office buildings and high-cost residences.

(b) Grade B. Grade B allows a few small imperfections. In practice, these small imperfections mainly take the form of minor skips in manufacture and small checks or stain due to seasoning, and depending on the species, small pitch areas, pin knots, or the like. Grade A pieces in the mixed grade are practically clear, but the average board contains 1 to 2 small imperfections. B and Better is the grade most commonly used for high-class interior and exterior trim, especially where these are to receive a natural finish. It is the principal grade used for flooring in homes, offices, and public buildings. In industrial uses it meets the special requirements for large-sized, practically clear stock.

(c) Grade C. Grade C allows a limited number of small imperfections that can be easily covered with paint. Specifically, the number of these per board averages about twice that of B and Better. In addition, grade C permits a limited number of small knots. Grade C lumber is especially adapted to use where a high-class paint finish is desired. It is, therefore, popular for cornice and other exterior parts of dwellings, porch flooring, porch columns, trim for bedrooms and kitchens, built-in kitchen fixtures, and siding for the better class of structures, It is used to some extent for natural finishes in medium-priced dwellings and offices.

(d) Grade D. Grade D allows a number of surface imperfections that do not detract from the appearance of the finish when painted. In practice the number of such surface features per board averages 3 to 5 times as many as in B and Better. Certain natural and manufacturing imperfections are not much more numerous in grade D than in grade C, but the number and size of the knots in grade D are considerably greater than in grade C, and usually the back is of somewhat lower quality. Commercial grading permits an occasional coarse knot or hole in grade D that may be cut out with restrictions as to waste. Grade D is in reality a one-faced grade that is, only one face shows in actual use. Grade D is used in construction for the same uses as grade C. It goes into moderate-priced houses, furnishing medium-priced lumber for casing, cornice Work, shelving, and built-in fixtures that are to be painted. It is also used extensively for millwork and molding, and is adaptable to industrial uses requiring short-length, clear lumber.

(e) Defects. The knots occurring in B and Better are predominantly under one-half inch in diameter and have smooth, hard surfaces. A small proportion of the knots in C are as large as 1 inch in diameter. A few knots in D lumber are more than 1 inch in diameter, and in quality are slightly soft, rough, or loose.

Except for B and Better, which is normally sold as one grade, combination grades are not recommended for military requisitions except where the actual proportions of the mixed grades are clearly specified. For example, C and Better might require at least 15 percent of B and Better.

Seasoning faults, such as checks either in flat surfaces or at the ends of board, are among the more frequent imperfections in the select grades. Imperfect seasoning often causes a lowering of grade, but the number of such occurrences is considerably reduced at plants of careful manufacturers.

Pitch pocket is a relatively common feature in the select grades of several species but occurs less frequently than knots in all the important species except one. The variation among grades in the number and size of pitch pockets is not so marked as in the case of knots. The frequency of pitch pockets as compared with other formations of pitch varies considerably among the species.

Among the other features that are factors in the select grades are stain and chipped and torn grain.

Common softwood. Common softwood yard lumber is not of finishing quality, but is suitable for general utility and construction purposes. Five common grades are recognized and usually designated by the number 1 to 5. (The grades of Construction, Standard, Utility, and Economy are used in some associations.) Grade by grade, defects become progressively larger and more objectionable from both the appearance and utility standpoints, but not necessarily more numerous. No. 1 is classed as suitable for better type construction, No. 2 for good standard construction, and No. 3 for low cost or temporary construction. Nos. 4 and 5 are classed as suitable for less exacting construction uses; No. 4 rates as low quality lumber and No. 5 as the lowest recognized grade, but must be usable.

These basic grade descriptions apply primarily to boards but also to dimension, and primarily to softwoods but also to some hardwoods. Hardwood yard grades of No. 1, No. 2, and No. 3 construction boards are available and, with less dense hardwood species, give qualities comparable to common grades of softwood lumber.

The grade of yard lumber boards is determined from the better or face side of the piece. The association grading rules for most woods prescribe the defects permitted in the poorest pieces admissible in each grade. A grade must be representative, however, and not comprised only of low-level pieces. For certain woods the rules describe typical boards in the grade rather than the minimum quality of board.

Common yard grades and use. Grades of boards contain features that detract from smooth appearance but are suitable for general utility purposes. The differences between the various board grades are due to the character more than to the number of such features as knots , pitch, and the like.

In most species practically all No. 1 boards contain knots. The size of the knots varies with the species. From one-half to three-fourths of the knots are usually intergrown; the remaining knots are encased, a small proportion of which are unsound, broken, or checked. The general characteristics for the common yard grades are as follows:

(a) No. 1 common. Lumber of this grade, while not usually carried in stock in large quantities, may be ordered when the ultimate in fine appearance of knotty material is required. This grade includes all sound, tight-knotted stock with the size and character of the knot, the determining factor of the grade.

(b) NO. 2 common. Lumber of this grade is intended primarily for use in housing and light construction where it is exposed such as in paneling, shelving, and other uses where knotty type of lumber with fine appearance is required. Since knots can easily be sealed off for painting, this also is an excellent grade for siding, cornice, soffits, facia, and other exterior uses.

(c) No. 3 common. Lumber of this grade is widely used for a large range of building purposes where appearance and strength are both important. With characteristics limited to assure a high degree of serviceablilty, this grade is often used for shelving, paneling, and siding and is especially suited for fences, boxes, crating, sheathing, and many industrial uses.

(d) No. 4 common. Lumber of this grade is more widely used than other grades for general construction purposes. Boards of this grade are used for sub-floors, roof and wall sheathing, concrete forms, low cost fencing, crating, and similar types of construction. It is a popular grade in general construction and industry use. Although appearance is given consideration, pieces are graded chiefly for serviceability, as they are seldom used in exposed construction.

(e) No. 5 common. Lumber of this grade is intended for use in construction where lumber of a higher grade is not needed. This grade permits characteristics such as stain, large knots, very large holes, unsound wood, massed pitch, heavy shake, splits, and wane in varying stages or degrees singly or in combinations. Many pieces in this grade are only slightly lower than the No. 4 common grade while others will be at the opposite end of the grade level. Although No. 5 common is the lowest common board grade, it is suitable for uses in economical construction where appearance and strength are not basic requirements.

(f) Defects. Where commercial grading practices divide the entire range of boards into fewer than the five grades provided for in American Lumber Standards, the grades will normally cover a wider range in quality than where five grades are made. This fact and the differences in inherent properties of different species make it impossible to consider the common grades of corresponding name for the different woods as interchangeable in quality.

In most species one-third to two-thirds of the knots in the grades of boards are intergrown; these knots may check if large but normally they do not loosen or drop out. Wood that contains small areas of clearly evident decay is not permitted in grades better than No. 3 common boards. Other defects allowable in the various common boards should be determined through referral to the applicable association grading rules. Figure 35 depicts examples of four grades of common boards in descending order of quality.

Dimension grades and uses. For purposes of the National Grading Rule for Dimension Lumber, "dimension" is limited to surfaced softwood lumber of nominal thickness from 2 inches through 4 inches; and which is designed for use as framing members such as joists, planks, rafters, studs, and small timbers. It does not apply to those grades that are segrated for special uses but which are sometimes manufactured to the "dimension" sizes, provided that descriptions for such special grades are included in the applicable agency grading rules. The following are examples of special products excluded from the National Grading Rule for Dimension Lumber:

- Crossarms
- Factory and Shop Lumber
- Finish (Selects)
- Foundation Lumber
- Industrial Clears
- Ladder Stock
- Laminating Stock
- Railroad Stock
- Rough Lumber
- Scaffold Planks
- Ship Decking and Plank Stock
- Stadium Plank
- Worked Lumber

Classification. The National Grading Rule for Dimension Lumber classifies dimension into 3 width categories and 5 use categories. Dimension 2 to 4 inches wide is classified as "Structural Light Framing", and "Light Framing". Dimension 2 to 6 inches wide is classified as "studs". Dimension 5 inches and wider is classified as "Structural Joists and Planks". In addition, a single "Appearance Framing" grade of 2-inch and wider dimension is designed for those special uses where a high bending strength ratio coupled with high appearance is needed. The National Grading Rule for Dimension Lumber categories are described in part, in the following paragraphs. Complete grading characteristics may be determined by referral to the applicable association grading rules.

Dimension is graded primarily for strength, stiffness, and straightness. In the stress rated grades, slope of grain is considered. Grading is based principally on the requirements of framing for buildings. The dimension grades are best adapted to use where stiffness is the controlling factor, as in joists and studs , or where the size of the member is determined by common building practice rather than specially designed to carry definite live and dead loads. Stress values based on bending strength are sometimes asssigned to dimension grades for use in calculating allowable spans of joists and rafters in light-frame residential construction.

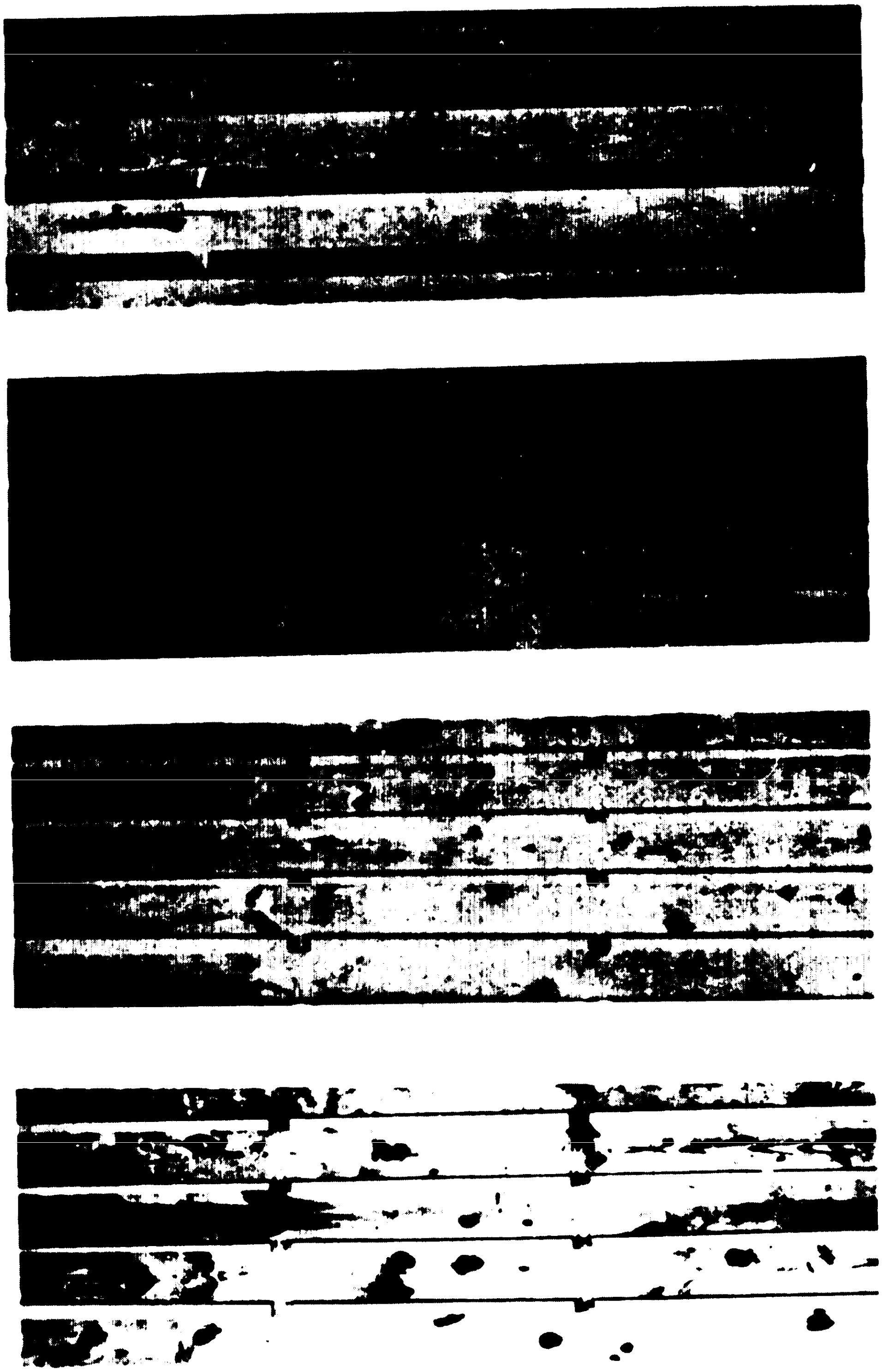

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FIGURE 35. Samples of Four grades of common boards.

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(a) Structural light framing - select structural grade. Dimension lumber of this quality is limited in characteristics that affect strength and stiffness values to provide a fiber stress in bending value of 67 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 100 percent of that allowed for the clear wood average. This grade is recommended for use in applications where both high strength and stiffness values and good appearance may be required. Seasoning checks are allowed and firm encased and pith knots are allowed based on the nominal width of the piece and the size and location of the knot. Slope of grain ratio is limited to 1 in 12. This lumber is 2-inches to 4-inches thick and 2 inches to 4 inches in width.

(b) Structural light framing - No. 1 grade. Dimension lumber of this quality is limited in characteristics that affect strength and stiffness values to provide a fiber stress in bending value of 55 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 100 percent of that allowed for the clear wood average. This grade is recommended for construction where high strength and stiffness and good appearance are desired. Surface seasoning checks are allowed; sound, firm encased and pith knots, if tight and well spaced are allowed, based on width of piece and diameter of knot. Slope of grain limited to 1 in 10. This lumber is 2-inches to 4-inches thick and 2 inches to 4 inches in width.

(c) Structural light framing - No. 2 grade. Dimension lumber of this quality is limited in characteristics that affect strength and stiffness values to provide a fiber stress in bending value of 45 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 90 percent of that allowed for the clear wood average. This grade is recommended for most general construction uses. Seasoning checks are allowed, well spaced knots of any quality are permitted, based on width of piece and diameter of knot. Slope of grain limited to 1 in 8. This lumber is 2-inches to 4-inches thick and 2 inches to 4 inches in width.

(d) Structural light framing - No. 3 grade. Dimension lumber of this quality is limited in characteristics that affect strength and stiffness values to provide a fiber stress in bending value of 26 percent of that allowed for clear, straight-grained wood and to provide a modulus of elasticity of 80 percent of that allowed for the clear wood average. Although characteristics affecting appearance and strength allowed in this grade are restricted less than the higher grades, many pieces are of this grade because of a single characteristic. This grade is appropriate for use in general construction where appearance generally is not a factor. Slope of grain limited to 1 in 4. This lumber is 2-inches to 4-inches thick by 2 inches to 4 inches in width.

(e) Light framing - Construction grade. This lumber is 2-inches to 4-inches thick and 2 inches to 4 inches in width. Lumber of this grade is recommended and widely used for general framing purposes. pieces of this grade are of good appearance, but are graded primarily for strength and serviceability. This lumber grade allows seasoning checks, sound, firm encased and pith knots, some torn and raised grain, with the slope of grain limited to 1 in 6.

(f) Light framing - Standard grade. This lumber is 2-inches to 4-inches thick and 2 inches to 4 inches in width. Lumber of this grade is customarily used for the same purposes or in conjunction with "Construction" grade. Characteristics are limited to provide good strength and excellent serviceability. This lumber grade allows seasoning checks, knots, heart center, streaks of unsound wood and a grain slope of 1 in 4.

(g) Light framing - Utility grade. This lumber is 2-inches to 4-inches thick and 2 inches to 4 inches in width. Lumber of this grade is recommended and widely used where a combination of good strength and economical construction is desired for such purposes as studdings, blocking, plates, bracing, and rafters. This grade allows checks, knots, unsound wood in streaks or spots, torn and raised grain, and a grain slope of 1 in 4.

(h) Stud grade. This dimension lumber is 2-inches to 4-inches thick, 2-inches to 6-inches wide and 10 feet in length or shorter. Lumber of this grade is limited in characteristics that affect strength and stiffness values so that the grade is suitable for all stud uses, including use in load-bearing walls. The grade has a fiber stress in bending value of 26 percent of that allowed for clear, straight-grained wood and a recommended design value for modulus of elasticity of 80 percent of that allowed for clear wood average. Ibis grade allows seasoning checks; knots are not limited by quality but are limited by size and placement, grain slope limited to 1 in 4.

(i) Structural joists and planks - Select structural grade. This lumber is 2-inches to 4-inches thick and 5 inches or more in width. Dimension lumber of this quality is limited in characteristics that affect strength stiffness values to provide a fiber stress in bending value of 65 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 100 percent of that allowed for the clear wood average. This grade is recommended for use in application where both high strength and stiffness values and good appearance may be required. This grade allows a slope of grain of 1 in 12, seasoning checks, firm encased, and pith knots if tight and well spaced.

(j) Structural joists and planks - No. 1 grade. This lumber is 2-inches to 4-inches thick and 5 inches or more in width. Dimension lumber of this quality is limited in characteristics that affect the strength and stiffness values to provide a fiber stress in bending value of 55 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 100 percent of that allowed for the clear wood average. This grade is recommended for construction where high strength and stiffness and good appearance are desired. This grade allows a slope of grain of 1 in 10, seasoning checks, firm encased, and pith knots if tight and well spaced.

(k) Structural joists and planks - No. 2 grade. This lumber is 2-inches to 4-inches thick and 5 inches or more in width. Dimension lumber of this quality is limited in characteristics that affect strength and stiffness values to provide a fiber stress in bending value of 45 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 90 percent of that allowed for the clear wood average. This grade is recommended for most general construction uses. This grade allows knots of any quality if well spaced and in sizes not exceeding grading rule limits, slope of grain limited to 1 in 8.

(l) Structural joists and planks - No. 3 grade. This lumber is 2-inches to 4-inches thick and 5 inches or more in width. Dimension lumber of this quality is limited in characteristics that affect strength and stiffness values to provide a fiber stress in bending value of 26 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity of 80 percent of that allowed for the clear wood average. Although characteristics affecting appearance and strength allowed in this grade are restricted less than the higher grades, many pieces are of this grade because of a single characteristic. This grade is appropriate for use in general construction where appearance generally is not a factor.

(m) Appearance framing. This lumber is 2-inches to 4-inches thick and 2 inches or more in width. Dimension lumber of this grade is intended primarily for exposed use in housing and light construction where knotty-type lumber of high strength and finest appearance is required. Characteristics that affect strength and stiffness are limited to provide fiber stress in bending value of 55 percent of that allowed for clear, straight-grained wood and to provide a recommended design value for modulus of elasticity value of 100 percent of that allowed for clear wood average. This grade allows medium checks, must be free of heart center (FOHC).

<u>Softwood cut stock.</u> Cut-to-size material from softwood species comparable to hardwood dimension is commonly known as cut stock. It is manufactured to buyers' specifications. There is no commercial standard governing its manufacture, nor any manufacturers' association.

Standard sizes in yard lumber. There is considerably more uniformity in size standards among the various associations than in grade qualities. Likewise, American Lumber Standards provide a more specific guide in size standards than in grade standards. For a given species, however, the individual association rule books should be consulted relative to the actual size standards used. Short of a detailed examination and comparison of individual association rule books , the sizes listed in Tables VI through X from American Softwood Lumber Standard (PS 20) may be used as a guide and preliminary reference. These tables give the nominal and dressed dimensions. Standard lengths of softwood yard lumber are multiples of one or two feet as specified in the applicable association grading rules.

TABLE VI. Nominal and minimum-dressed dry sizes of finish, flooring, ceiling, partition, and stepping at 19 percent maximum-moisture content.

ITEM	THICKNESSES 1/		FACE WIDTHS	
	NOMINAL 2/	MINIMUM DRESSED	NOMINAL	MINIMUM DRESSED
		Inches		Inches
Finish	3/8	5/16	2	1-1/2
	1/2	7/16	3	2-1/2
	5/8	9/16	4	3-1/2
	3/4	5/8	5	4-1/2
	1	3/4	6	5-1/2
	1-1/4	1	7	6-1/2
	1-1/2	1-1/4	8	7-1/4
	1-3/4	1-3/8	9	8-1/4
	2	1-1/2	10	9-1/4
	2-1/2	2	11	10-1/4
	3	2-1/2	12	11-1/4
	3-1/2	3	14	13-1/4
	4	3-1/2	16	15-1/4
Flooring 3/	3/8	5/16	2	1-1/8
	1/2	7/16	3	2-1/8
	5/8	9/16	4	3-1/8
	1	3/4	5	4-1/8
	1-1/4	1	6	5-1/8
	1-1/2	1-1/4		

TABLE VI. Nominal and minimum-dressed dry sizes of finish, flooring, ceiling, partition, and stepping at 19 percent maximum-moisture content. - Continued

ITEM	THICKNESSES 1/		FACE WIDTHS	
	NOMINAL 2/	MINIMUM DRESSED	NOMINAL	MINIMUM DRESSED
		Inches		Inches
Ceiling 3/	3/8 1/2 5/8 3/4	5/16 7/16 9/16 11/16	3 4 5 6	2-1/8 3-1/8 4-1/8 5-1/8
Partition 3/	1	23/32	3 4 5 6	2-1/8 3-1/8 4-1/8 5-1/8
Stepping 3/	1 1-1/4 1-1/2 2	3/4 1 1-1/4 1-1/2	8 10 12	7-1/4 9-1/4 11-1/4

1/ The thicknesses apply to all widths and all widths to all thicknesses except as modified.

2/ For nominal thicknesses under 1 inch, the board measure count is based on the nominal surface dimensions (width by length). With the exception of nominal thickness under 1 inch, the nominal thicknesses and widths in this table are the same as the board measure or count sizes.

3/ In tongued-and-grooved flooring and in tongued-and-grooved and shiplapped ceiling of 5/16-inch, 7/16-inch, and 9/16-inch dressed thicknesses, the tongue or lap shall be 3/16-inch wide, with the over-all widths 3/16 inch wider than the face widths shown in the table above. In all other worked lumber of dressed thicknesses of 5/8 inch to 1-1/4 inches, the tongue shall be l/4-inch wide or wider in tongued-and-grooved lumber, and the lap 3/8-inch wide or wider in shiplapped, lumber, and the over-all widths shall be not less than the dressed face widths shown in the above table plus the width of the tongue or lap.

TABLE VII. Nominal and minimum-dressed dry sizes of siding at 19 percent maximunm-moisture content.

ITEM	THICKNESSES 1/		FACE WIDTHS	
	NOM. 2/	MINIMUM DRESSED	NOM.	MINIMUM DRESSED
		Inches		Inches
Bevel Siding	1/2 9/16 5/8 3/4 1	7/16 butt, 3/16 tip 15/32 butt, 3/16 tip 9/16 butt, 3/16 tip 11/16 butt, 3/16 tip 3/4 butt, 3/16 tip	4 5 6 8 10 12	3-1/2 4-1/2 5-1/2 7-1/4 9-1/4 11-1/4
Bungalow Siding	3/4	11/16 butt, 3/16 tip	8 10 12	7-1/4 9-1/4 11-1/4
Rustic and drop Siding (shiplapped, 3/8-in. lap)	5/8 1	9/16 23/32	4 5 6	3 4 5
Rustic and Drop Siding (shiplapped, 1/2-in. lap)	5/8 1	9/16 23/32	4 5 6 8 10 12	2-7/8 3-7/8 4-7/8 6-5/8 8-5/8 10-7/8
Rustic and Drop Siding (dressed and matched)	5/8 1	9/16 23/32	4 5 6 8 10	3-1/8 4-1/8 5-1/8 6-7/8 8-7/8

1/ The thicknesses apply to all widths and all widths to all thicknesses.

2/ For nominal thicknesses under 1 inch, the board measure count is based on the nominal surface dimensions (width by length). With the exception of nominal thicknesses under 1 inch, the nominal thicknesses and widths in this table are the same as the board measure or count sizes.

TABLE VIII. Nominal and minmum-dressed sizes of boards, dimensions, and timbers.

ITEM	THICKNESSES 1/			FACE WIDTHS		
	NOMINAL	Minimum Dressed Dry 2/ Inches	Minimum Dressed Green 2/ Inches	NOMINAL	Minimum Dressed Dry 2/ Inches	Minimum Dressed Green 2/ Inches
Boards 3/				2	1-1/2	1-9/16
				3	2-1/2	2-9/16
				4	3-1/2	3-9/16
				5	4-1/2	4-5/8
	1	3/4	25/32	6	5-1/2	5-5/8
				7	6-1/2	6-5/8
	1-1/4	1	1-1/32	8	7-1/4	7-1/2
				9	8-1/4	8-1/2
	1-1/2	1-1/4	1-9/32	10	9-1/4	9-1/2
				11	10-1/4	10-1/2
				12	11-1/4	11-1/2
				14	13-1/4	13-1/2
				16	15-1/4	15-1/2
Dimension 4/				2	1-1/2	1-9/16
				3	2-1/2	2-9/16
				4	3-1/2	3-9/16
	2	1-1/2	1-9/16	5	4-1/2	4-5/8
	2-1/2	2	2-1/16	6	5-1/2	5-5/8
	3	2-1/2	2-9/16	8	7-1/4	7-1/2
	3-1/2	3	3-1/16	10	9-1/4	9-1/2
				12	11-1/4	11-1/2
				14	13-1/4	13-1/2
				16	15-1/4	15-1/2

TABLE VIII. Nominal and minmum-dressed sizes of boards, dimensions, and timbers. - Continued

ITEM	THICKNESSES 1/			FACE WIDTHS		
	NOMINAL	Minimum Dressed Dry 2/ Inches	Minimum Dressed Green 2/ Inches	NOMINAL	Minimum Dressed Dry 2/ Inches	Minimum Dressed Green 2/ Inches
Dimension 4/	4 4-1/2	3-1/2 4	3-9/16 4-1/16	2 3 4 5 6 8 10 12 14 16	1-1/2 2-1/2 3-1/2 4-1/2 5-1/2 7-1/4 9-1/4 11-1/4	1-9/16 2-9/16 3-9/16 4-5/8 5-5/8 7-1/2 9-1/2 11-1/2 13-1/2 15-1/2
Timbers 4/	5 & Thicker		1/2 Off	5 & Wider		1/2 Off

1/ The thicknesses apply to all widths and all widths to all thicknesses.

2/ The American Lumber Standard defines dry lumber as having been seasoned or dried to a moisture content of 19 percent or less. Green lumber is defined as having a moisture content in excess of 19 percent.

3/ Boards less than the minimum thickness for 1 inch nominal but 5/8 inch or greater thickness dry (11/16 inch green) may be regarded as American Standard Lumber, but such boards shall be marked to show the size and condition of seasoning at the time of dressing. They shall also be distinguished from l-inch boards on invoices and certificates.

4/ Joist and planks are dimension lumber; beams, stringers, and posts are timbers.

TABLE IX. Nominal and minimum-dressed sizes of (2-inch and under) shiplap, centermatch, and D & M.

ITEM	THICKNESSES 1/			FACE WIDTHS		
	NOMINAL	Minimum Dressed Dry 2/ Inches	Minimum Dressed Green 2/ Inches	NOMINAL	Minimum Dressed Dry 2/ Inches	Minimum Dressed Green 2/ Inches
Shiplap, 3/8-in. lap	1	3/4	25/32	4 6 8 10 12 14 16	3-1/8 5-1/8 6-7/8 8-7/8 10-7/8 12-7/8 14-7/8	3-3/16 5-1/4 7-1/8 9-1/8 11-1/8 13-1/8 15-1/8
Shiplap, 1/2-in, lap	1	3/4	25/32	4 6 8 10 12 14 16	3 5 6-3/4 8-3/4 10-3/4 12-3/4 14-3/4	3-1/16 5-1/8 7 9 11 13 15
Center-match 1/4-in. tongue	1 1-1/4 1-1/2	3/4 1 1-1/4	25/32 1-1/32 1-9/32	4 5 6 8 10 12	3-1/8 4-1/8 5-1/8 6-7/8 8-7/8 10-7/8	3-3/16 4-1/4 5-1/4 7-1/8 9-1/8 11-1/8
2" D & M, 3/8-in. tongue	2	1-1/2	1-9/16	4 6 8 10 12	3 5 6-3/4 8-3/4 10-3/4	3-1/16 5-1/8 7 9 11
2" Shiplap 1/2-in.	2	1-1/2	1-9/16	4 6 8 10 12	3 5 6-3/4 8-3/4 10-3/4	3-1/16 5-1/8 7 9 11

1/ The thickness apply to all widths and all widths to all thicknesses.

2/ See Footnote 2 of TABLE VIII.

TABLE X. Worket lumber such as factory, heavy roofing, decking, and sheet piling.

THICKNESSES 1/, 2/, 3/			FACE WIDTHS		
NOMINAL	MINIMUM DRESSED Inches		NOMINAL	MINIMUM DRESSED Inches	
TONGUE AND GROOVED					
	Dry	Green		Dry	Green
2-1/2	2	2-1/6	4	3	3-1/16
3	2-1/2	2-9/16	6	5	5-1/8
3-1/2	3	3-1/16	8	6-3/4	7
4	3-1/2	3-9/16	10	8-3/4	9
4-1/2	4	4-1/16	12	10-3/4	11
SHIPLAP					
	Dry	Green		Dry	Green
2-1/2	2	2-1/16	4	3	3-1/16
3	2-1/2	2-9/16	6	5	5-1/8
3-1/2	3	3-1/16	8	6-3/4	7
4	3-1/2	3-9/16	10	8-3/4	9
4-1/2	4	4-1/16	12	10-3/4	11
GROOVED-FOR-SPLINES					
	Dry	Green		Dry	Green
2-1/2	2	2-1/16	4	3-1/2	3-1/16
3	2-1/2	2-9/16	6	5-1/2	5-5/8
3-1/2	3	3-1/16	8	7-1/4	7-1/2
4	3-1/2	3-9/16	10	9-1/4	9-1/2
4-1/2	4	4-1/16	12	10-1/4	11-1/2

1/ See Footnote 2 of TABLE VIII.

2/ In worked lumber of nominal thicknesses of 2 inches and over, the tongue shall be 3/8-inch wide in tongued-and-grooved lumber and the lap 1/2-inch wide in shiplapped lumber, with the overall widths 3/8-inch and 1/2-inch wider, respectively, than the face widths shown in the above table. Double tongued-and-grooved decking may be manufactured with a 5/16-inch tongue.

3/ See Table VIII for information on 2-inch dimension.

Factory and shop lumber. Most softwood factory and shop lumber is produced from the soft pines, but some is also cut from Douglas fir, redwood, cypress, and southern pine. Ibis lumber is graded under the rules of the association covering each species.

The grading is based on the area of the piece suitable for cuttings of certain sizes and qualities. The grade is determined from the “poorest” face.

The same association grading rule books that list the grades and sizes of yard lumber list those for shop lumber.

Grades. Association rules dealing with this class of lumber vary somewhat, so that for a given species the individual association rule books must be consulted

Factory plank is 1-1/4 inches or more in thickness and is used largely for door and sash cuttings. The No. 1 cuttings usually must be free of defects on both sides. The No. 2 cuttings generally may contain only one of the following defects; a limited amount of blue or brown stain, a sound tight knot, a small pitch pocket or streak, small season checks, and slightly torn grain. The cuttings are of various lengths and widths, depending on the door (or sash) parts for which they are used.

Shop lumber is used for general cut-up purposes. The (a) cuttings must be at least 9-1/2-inches wide and 18-inches long, and the (b) cuttings at least 5-inches wide and 3-feet long. All (a) cuttings less than 3-feet long must be free from defects on both sides. Other (a) cuttings, together with (b) cuttings, must have a C or better face in all softwoods except Douglas fir, Sitka spruce, and West Coast hemlock where the face of the cuttings must be B or better finish.

Sizes. Standard lengths of factory and shop lumber are 6 feet and over in multiples of 1 foot, except the box grade of shop lumber, in which the standard lengths are 4 feet and over.

Standard widths are 5 inches and over, and are usually shipped in random widths.

Standard thicknesses are given in association grading rules.

Structural lumber. Selection of sizes and grades in structural lumber depends upon engineering design requirements.

Some of the higher structural grades are available in limited quantity or are cut only on special order. Purchase request should specify the lowest structural grade that has a strength value usable for the intended purpose; a lower grade in a strong species may have as much strength as a high grade in a species that is basically less strong.

Size is related to grade in that a lower grade may require a larger size for a specific strength usage. The choice between a small size of high grade and a larger size of lower grade may depend upon on-the-spot inquiry from dealers as to what is available. In general, sizes 12 by 12 inches by 20-feet long, or larger, are now hard to find except in Coast-type Douglas fir. Sizes up to 4 by 12 inches and 20-feet long can be obtained in many species. As the supply of large-sized old growth trees becomes depleted and lumber production moves toward the sustained-yield basis, the smaller sizes of structural lumber become relatively more plentiful and large sizes relatively less so.

Use classification. To promote efficiency in grading and use, structural lumber is put in three classifications according to its size and use. These are:

(a) Beams and stringers. Pieces of rectangular cross section, 5 by 8 inches and up, graded with respect to their strength as beams when loaded on the narrow face (edgewise).

(b) Joist and planks. pieces of rectangular cross section, 2-to 4-inches thick by 5 inches or more in widths graded with respect to their strength as beams when loaded either edgewise as joists or flatwise as planks.

(c) Posts and timbers. Pieces of square or nearly square cross section, 5 by 5 inches and larger, graded primarily for use as posts or columns, but adapted to miscellaneous uses in which strength in bending is not especially important.

Size standards. Size standards for structural stress grades are given in PS-20.

The minimum dressed dimensions of structural joist and planks, beams and stringers, and posts and timbers are shown in Table VIII (see footnote 4).

Rough lumber shall be sawn full to nominal dimensions except that occasional slight variation in sawing is permissible. In any one shipment, as least 80 percent of the pieces shall be of full nominal dimensions, and the remainder not more than l/16-inch scant.

Standard lengths in all three use classes are multiples of 1 or 2 feet.

Structural design with lumber is based on the actual size; as noted above, this actual size in dressed lumber is somewhat less than the nominal size. Tables of permitted sizes of knots in the detailed grading rules are related to the nominal rather than to the actual width to face.

Hardwood standard grades. The National Hardwood Lumber Association issues and administers grading rules for all commercial hardwood species. Hardwood lumber is graded according to three basic marketing categories: Factory Lumber, Dimension Parts, and Finished Market Products. Lumber for factory and shop uses, rather than building construction, comprises the bulk of hardwood production, and the grading rules accordingly parallel those for softwood factory and shop lumber. The following is a guide reference to the principles of the rules, not the rules themselves.

Factory lumber. In rules for standard grades of hardwood lumber for factory and shop use, the grade of a piece of lumber is determined by the proportion of the piece that can be cut into a certain number of smaller pieces of material clear on one side, and of not less than a certain size. In other words, the grade classification is based upon the amount of clear, usable lumber in the piece rather than upon the number or size of the defects. This clear material, commonly termed “clear cuttings,” must have one face clear and the reverse face sound, which means free from rot, heart center, shake, and other features that materially impair the strength of the cutting. Some grades require only that cuttings be sound.

The highest grade of hardwood is termed “Firsts” and the next grade "Seconds". The term “First and Seconds,” generally written FAS, practically always designates the highest commercial grade. The third grade is termed “Selects,” followed by No. 1 Common, No. 2 Common, Sound Wormy, No. 3A Common, and No. 3B Common. Table XII presents cutting requirements for the various hardwood factory grades.

The grade of hardwood lumber is generally determined from the poorest face. There are exceptions, such as Selects, where both faces must be considered, and also in No. 3A Common, which also admits pieces that grade not below No. 2 Common on the better face, with the reverse face sound. In walnut and cherry the heart face dictates the side for inspection inmost grades.

Standard lengths are 4 to 16 feet in multiples of 1 foot, but not more than 50 percent of odd lengths are admitted.

Standard thicknesses are 3/8 inch, 1/2 inch, 5/8 inch, 3/4 inch, 1 inch, 1-1/4 inches , 1-1/2 inches, 1-3/4 inches, 2 inches, 2-1/2 inches, 3 inches, 3-1/2 inches, 4 inches, 4-1/2 inches, 5 inches, 5-1/2 inches, and 6 inches.

Thicknesses of 1 inch and more usually expressed in quarter inches, thus, 4/4, 5/4, 6/4, 8/4, 10/4.

Hardwood lumber is usually sold rough rather than dressed. There are no fixed thicknesses for the piece as a whole corresponding to the various nominal thicknesses in which softwood lumber is usually sold. The “cuttings” used as the basis of grade determination must, however, be standard thickness and there must be no greater variation in the thickness of the board than is allowed under the description of miscut lumber which is given in the grading rulebook.

For lumber that is sold surfaced, the dressed thicknesses are as follows:

Rough Inch		Surfaced two sides Inch
3/8	S2S to	3/16
1/2	S2S to	5/16
5/8	S2S to	7/16
3/4	S2S to	9/16

Rough Inch		Surfaced two sides Inch
1	S2S to	13/16
1-1/4	S2S to	1- 1/16
1-1/ 2	S2S to	1- 5/16
2	S2S to	1- 3/4
2-1/2	S2S to	2- l/4
3	S2S to	2- 3/4
3-1/2	S2S to	3- 1/4
4	S2S to	3- 3/4

Dimension parts and finished market products. The hardwood dimension industry - or the wood parts industry, as it is frequently called - processes hardwood lumber to wood parts made to the specific requirements of a product. These are further processed in fabrication by producers who manufacture such products as furniture, vehicle bodies, cabinets, and tools. Hardwood dimension stock is produced under the rules of the Hardwood Dimension Manufacturers Association.

Hardwood dimension lumber and products are defined as hardwoods, normally kiln dried, which have been processed to a point where the maximum waste is left at the mill and the maximum utility delivered to the user. They are manufactured from rough lumber to specific length, width, or thickness, in a specific grade, and to the specific requirements of a particular plant or industry.

Hardwood dimension lumber and products may be purchased in rough planks, sawed and ripped to approximate size, or may be further fabricated by one or more additional operations. Hardwood dimension is produced in solid or glued-up form (edge-glued and laminated) and is classified as rough hardwood dimension, semifabricated hardwood dimension, or completely fabricated hardwood dimension.

Table XI is a reference chart of cutting requirements for standard grades of hardwood. For exceptions and other requirements for respective grades and species, refer to the “Rules for Measurement and Inspection of Hardwood and Cypress Lumber” issued by the National Hardwood Lumber Association.

Table XI indicates the yield of clear-face cuttings admitted to each grade by limiting the number of cuts to specified widths and lengths; i.e., a piece 6-inches wide, having a surface measurement (S.M.) of 4 to 9 feet must yield 11/12 or (91 2/3 percent) of clear-faced material in one cut in order to be admitted or graded as “Firsts”; 10 to 14 feet S.M. must yield 11/12 or (91 2/3 percent) clear-face in two cuts. Paragraph 70 of Rule for Measurement and Inspection of Hardwood and Cypress Lumber defines special rules governing pieces 4 and 5 inches in width.

Availability of Grades and Sizes

There is a large and adequate production of lumber, but the bulk is in certain grades and sizes. Most of our timber stands consist of trees that yield relatively small proportions of high grade lumber in the larger widths, lengths, and thicknesses. Only a very small percentage of trees produce logs yielding mainly high grade lumber in large sizes.

TABLE XI. Standard hardwood cutting grades. 1/

FIRSTS	SECONDS	SELECTS	NO. 1 COMMON	NO. 2 COMMON
Widths: 6" and wider Lengths: 8 to 16 feet S.M. 2/ % Cl.Face Cuts 4' to 9' 91-2/3 1 10' to 14' " 2 15' & up " 3	Widths: 6" and wider Lengths: 8 to 16 feet S.M. 2/ % Cl.Face Cuts 4' & 5' 83-1/3 1 6' & 7' " 1 8' to 11' " 2 12' to 15' " 3 16' & up " 4 6' to 15' S.M. will admit 1 additional cut to yield 91-2/3% Cl. Face. 3/	Widths: 4" and wider Lengths: 6 to 16 feet S.M. 2/ % Cl.Face Cuts 2' & 3' 91-2/3 1 Reverse side cutting sound or not below No. 1 Common. 4 and over shall grade on one face as required in Seconds with reverse side of board not below No. 1 Common on reverse side of cuttings sound. See Rule (Par. 70) defining edges of boards 4" and 5" wide.	Widths: 3" and wider Lengths: 4 to 16 feet S.M. 2/ % Cl.Face Cuts 1' Clear 2' 75 1 3' & 4' 66-2/3 1 5' to 7' " 2 8' to 10' " 3 11' to 13' " 4 14' & up " 5 3' to 7' S.M. will admit 1 additional cut to yield 75% Cl. Face.	Widths: 3" and wider Lengths: 4 to 16 feet S.M. 2/ % Cl.Face Cuts 1' 66-2/3 1 2' & 3' 50 1 4' & 5' " 2 6' & 7' " 3 8' & 9' " 4 10' & 11' " 5 12' & 13' " 6 14' & up " 7 2' to 7' S.M. will admit 1 additional cut to yield 66-2/3% Cl. Face.
Minimum cutting 4" x 5' or 3" x 7'			Minimum cutting 4" x 2' or 3" x 3'	Minimum cutting 3" x 2'

1/ Some species and items may vary from these standards.

2/ Surface measure.

3/ Admits also pieces 6" to 9" wide of 6' to 12' surface measure that will yield 97% in two clear-face cuttings of any length, full width of the board.

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Availability of grades is affected not only by what mills produce but also by the degree to which grade selection is correlated with actual use requirements. Careful ordering is important not only to save money but to get orders filled more promptly.

The most available sizes for species commonly used at military installations are 2 inches and under in thickness, 10 inches and less in width, and 16 feet and less in length. Softwood species, such as pine and fir, are normally sold on the standard dressed-thickness basis of yard lumber, the widths in specified l-inch multiples and the lengths in specified l-foot multiples. Hardwood species, such as oak and maple, are most readily available in rough thicknesses and in the random widths and lengths characteristic of factory and shop lumber.

All species are available in nominal l-inch thickness. Some are mainly in this thickness, some mainly 2-inches and thicker, and some largely 1-1/4 and 1-1/2 inches for use in sash and door manufacture or for resawing into thinner box material. Lumber less than l-inch thick, such as is adapted to use in many containers used by the military, is not produced in the majority of sawmills. Mills producing soft pine lumber, however, are more accustomed than other to filling orders for resawn lumber. Resawing denser species presents some difficulty in preventing cupping of the thin resawed stock. This difficulty can be obviated by special seasoning and piling treatments, but often this is not considered practical.

Resawing to get thin lumber for box sides, tops, and bottom is not done at military establishments, nor is thin lumber purchased to any large degree. The result is that many containers that could be made from 3/8, 7/16, or 9/16 inch lumber are made of 1 inch. Sometimes 1 inch lumber is dressed down to one-half inch, but that is extremely wasteful of lumber even though shipping costs are thus reduced. provision for wider use of resawn lumber for many military containers is highly desirable by contracting with sawmills or other commercial concerns .

Widths of 8 inches and under are most readily available in all species; 10 inch widths are not scarce. In widths 12 inches and over the supply is tighter and largely confined to western species.

Length specifications are very important with respect to availability and cost. Most of the National Stock Numbers for hardwood and softwood will cover a requirement to permit random lengths to be furnished. These lengths will permit quantities of short length of mostly 6 feet to 9 feet to be furnished along with longer lengths that may be 14 feet and longer. The random lengths specified will generally be those that are readily available in the market.

Military installations that order minimum lengths that exceeds the lengths available in the market can expect to pay premium prices. Most military containers are of such size that lumber lengths of 6 and 8 feet are suitable. If standard random length shipments are not practical due to standard end uses, such as car blocking and bracing, orders for specific lengths may be practical. Even for these orders, every effort should be made to eliminate excessively long lengths, which may be difficult to obtain.

Thickness and length preferences on the part of military installations introduce some problems in relation to availability, as discussed above. On the other hand, some malpractice can be easily corrected when a fuller understanding of the subject is reached. It is extremely wasteful of costly high grade lumer, for example, to saw up 20-foot boards of Select lumber a foot wide into ordinary box dimensions. Yet this has occurred, with the explanation that it minimized stocking and storage problems.

The sizes in which lumber items are most generally available do not mean that larger sizes cannot be obtained where actually required. If the largest sizes are not available on the market for those who must have them, they can be made available by the application of modern gluing and laminating methods.

Economy can sometimes be gained by ordering box shook, dimension stock, or softwood cut stock, all of which are delivered in the rough or finished sizes wanted.

Lumber Associations

The following lumber associations issue grading rules and sizes and provide inspection services. Organizations appearing in Section 2 are not included in this listing.

Hardwood Dimension Manufacturers Association 3813 Hillsboro Road Nashville, TN 37215	Hardwood Dimension Parts Hardwood Interior Trim and Moldings Hardwood Stair Treads and Risers
National Lumber Grades Authority 1055 W. Hastings Street Vancouver, Canada	Standard Grading Rules for Canadian Lumber
Maple Flooring Manufacturers Association 2400 E. Devon Ave. Des Plaines, IL 60018	Hard Maple Flooring - Standard specifications and official grading rules
National Hardwood Lumber Association P. 0. Box 34518 Memphis, TN 38134	Rules of the measurement and inspection of hardwood and cypress lumber
Northeastern Lumber Manufacturers Association 4 Fundy Road Falmouth, ME 04105	Standard grading rules for Northeastern lumber

Northern Hardwood and Pine Manufacturers Association, Inc. 501 Northern Building Green Bay, WI 54301	Official grading rules for eastern white pine, Norway pine, jack pine, eastern spruce, balsam fir, eastern hemlock and tamarack
Red Cedar Shingle and Handsplit Shake Bureau 5510 White Building Seattle, WA 98101	Grading and packing rules for certisplit red cedar shakes Grading and packing rules for centigrade shingles
Redwood Inspection Service One Lombard St. San Francisco, CA 94111	Standard specification for grades of California redwood lumber
Southern Cypress Manufacturers Association 805 Sterrick Building Memphis, TN 38103	Standard specifications for grades of tidewater red cypress
Southern Pine Inspection Bureau P.O. BOX 846 Pensacola, FL 32502	Standard grading rules for southern pine lumber
West Coast Lumber Inspection Bureau P.O. Box 23145 Portland, OR 97223	Standard grading rules for West Coast lumber
Western Wood Products Association 1500 Yeon Building Portland, OR 97204	Grading rules for Western lumber

CHAPTER 5. MEASURING LUMBER

The standard unit of measurement for lumber is the board foot. Lumber less than l-inch thick is based on surface measure. Some types of finish lumber, such as mouldings and trim, are sold by the linear foot. Common commercial quantity units are “per 1,000 feet board measure,” or “per MBF,” or “per MSF,” or “per 100 lineal feet” or “per CLF,” and prices are generally quoted in terms of these quantity units.

A board foot represents the quantity of lumber contained in a board that is l-inch thick, 12-inches wide and 1 foot long or its cubic equivalent. For example a board l-inch thick, 6-inches wide and 2 foot long is also 1 board foot and these calculations are explained in the narrative that follows:

It is important to note that, in practice, the board foot calculations for lumber is based on its nominal thickness, nominal width, and actual length. As noted in Table VIII, nominal sizes are not actual sizes.

Table XII gives the actual board-foot content of various sizes of boards and dimension lumber. The cross sectional sizes given are “nominal,” that is, those commonly used for rough lumber. For most species, American Lumber Standards sizes for yard lumber are used.

Table XII can be used in computing board footage if the number of pieces needed is known. Thus, 1,000 2 by 4’s 12-feet long would contain 8,000 board feet of 1 umber.

Another way of computing board measure is to multiply the number of pieces by the nominal thickness in inches by the nominal width in inches by the length in feet, and then divide the result by 12, thus -

$$\frac{\text{Pieces X thickness (inches) X width (inches) X length (feet)}}{12} = \text{BF.}$$

As an example:

$$\frac{\text{220 pcs. X 2 inches X 6 inches X 24 feet}}{12} = \text{5,280 BF.}$$

To calculate surface measure, which is simply square feet, forget about the thickness. For example:

$$\frac{\text{180 pcs. X 8 inches (width) X 16 feet (length)}}{12} = \text{1,920 SF.}$$

Stock mouldings are sold by lineal measure. Sometimes it is necessary, however, to calculate the number of lineal feet on the basis of a board foot estimate. When the thickness and width of the mouldings are such that they must come out of

TABLE XII. Lumber tally footage by lengths, widths, and thicknesses.

Nominal cross section	Footage tally for length of -					
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet
Inches	Board feet	Board feet	Board feet	Board feet	Board feet	Board feet
1 x 3	2	2-1/2	3	3-1/2	4	4-1/2
1 x 4	2-2/3	3-1/3	4	4-2/3	5-1/3	6
1 x 6	4	5	6	7	8	9
1 x 8	5-1/3	6-2/3	8	9-1/3	10-2/3	12
1 x 10	6-2/3	8-1/3	10	11-2/3	13-1/3	15
1 x 12	8	10	12	14	16	18
1-1/2 x 4	4	5	6	7	8	9
1-1/2 x 6	6	7-1/2	9	10-1/2	12	13-1/2
1-1/2 x 8	8	10	12	14	16	18
1-1/2 x 10	10	12-1/2	15	17-1/2	20	22-1/2
1-1/2 x 12	12	15	18	21	24	27
2 x 4	5-1/3	6-2/3	8	9-1/3	10-2/3	12
2 x 6	8	10	12	14	16	18
2 x 8	10-2/3	13-1/3	16	18-2/3	21-1/3	24
2 x 10	13-1/3	16-2/3	20	23-1/3	26-2/3	30
2 x 12	16	20	24	28	32	36
3 x 4	8	10	12	14	16	18
3 x 6	12	15	18	21	24	27
3 x 8	16	20	24	28	32	36
3 x 10	20	25	30	35	40	45
3 x 12	24	30	36	42	48	54
4 x 4	10-2/3	13-1/3	16	18-2/3	21-1/3	24
4 x 6	16	20	24	28	32	36
4 x 8	21-1/3	26-2/3	32	37-1/3	42-2/3	48
4 x 10	26-2/3	33-1/3	40	46-2/3	53-1/3	60
4 x 12	32	40	48	56	64	72

TABLE XII. Lumber tally footage by lengths, widths, and thicknesses. - Continued

Nominal cross section	Footage tally for length of -					
	8 feet	10 feet	12 feet	14 feet	16 feet	18 feet
Inches	Board feet	Board feet	Board feet	Board feet	Board feet	Board feet
6 x 6	24	30	36	42	48	54
6 x 7	28	35	42	49	56	63
6 x 8	32	40	48	56	64	72
6 x 10	40	50	60	70	80	90
6 x 12	48	60	72	84	96	108
7 x 9	42	52-1/2	63	73-1/2	84	94-1/2
8 x 8	42-2/3	43-1/3	64	74-2/3	85-1/3	96
8 x 10	53-1/3	66-2/3	80	93-1/3	106-2/3	120
8 x 12	64	80	96	112	128	144

lumber nominally l-inch thick and wide, or more, use this formula:

$$\frac{\text{Board measure X 12}}{\text{Thickness (inches) X width (inches)}} = \text{lineal feet.}$$

For example, how many lineal feet of l-1/4 by 3-inch stock are there in 500 board feet? Using the formula:

$$\frac{500 \times 12}{1\text{-}1/4 \times 3} = \text{1,600 lineal feet.}$$

Board rule. The board rule, Figure 36, is a simplified computor used to determine the quantity of "board-feet" contained in a piece. To use the board rule in determining the board feet in a piece 6-inches wide, 14-feet long, and 1 inch in thickness, lay the rule across the board and read the board feet directly above the 6 inch mark and on line with the known length (14 feet). The board feet contained in this piece would be 7. For lengths of 12 feet, the inch markers correspond to the board feet contained in the piece. Both sides of the board rule are marked and are accurate for the standard nominal sizes of lumber. In lumber specified to be measured with a board rule on actual widths, pieces measuring to the even half foot are alternately counted as of the next higher and lower foot count. Fractions below the half foot are dropped and fractions above the half foot are counted as of the next higher foot.

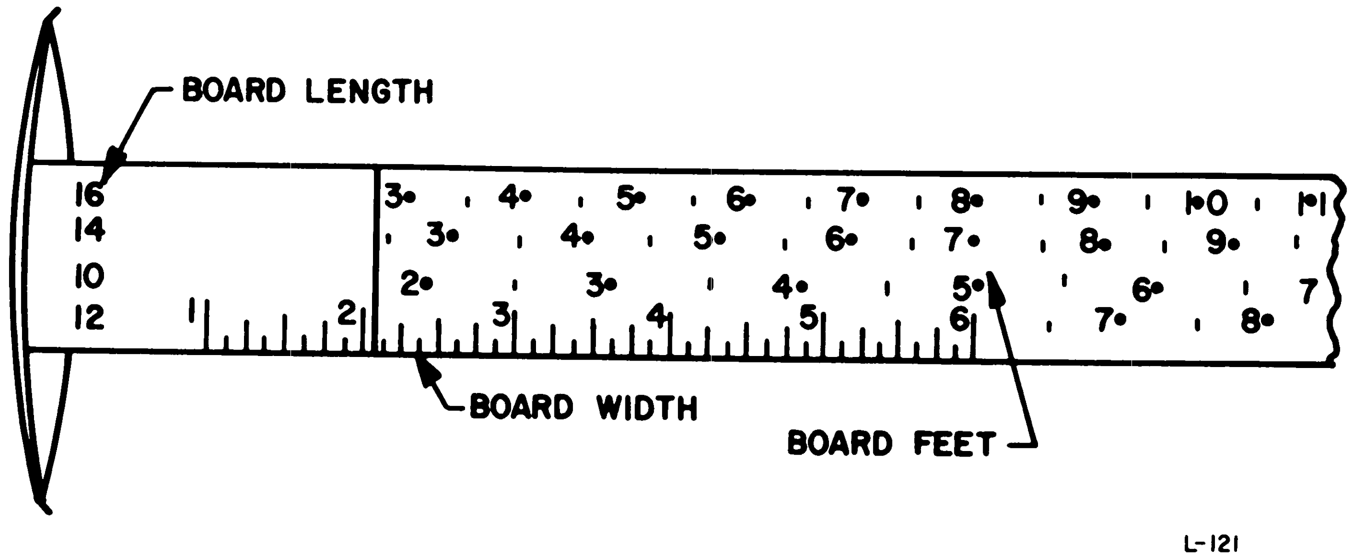


FIGURE 36. Board rule for tallying lumber footage.

X-3833

CHAPTER 60 STRUCTURAL GLUED-LAMINATED TIMBER

General

While' the art of wood gluing is very old -- dating back to the time of the ancient Egyptians -- structural gluing as it is thought of today dates from the turn of the twentieth century, when many glued laminated timber bridges and buildings were built in Europe using softwoods and casein adhesives. Structural timber laminating was introduced into the United States in the early 1930's. In 1934 a building using glued laminated timber three-hinged arches was constructed on the grounds of the U.S. Forest Products Laboratory in Madison, Wisconsin. This building is still in use by the Laboratory.

World War II created a great demand for heavy timber construction for military and industrial uses and accelerated the development of the laminating industry. Another important factor in the growth of the laminating industry was the formation in 1952 of the American Institute of Timber Construction (AITC). The Institute was formed by a group of the nation's leading fabricators of both sawn and glued laminated structural timber as a means of advancing properly engineered, fabricated, and erected structural timber framing. It has established standards, specifications, and design recommendations for engineered timber construction.

The laminating industry, acting through AITC, developed and submitted to the U.S. Department of Commerce a proposed voluntary product standard for structural glued laminated timber. This document gained approval and was first promulgated in 1963. It was revised in 1973 and re-issued as Voluntary Product Standard PS 56. It covers the minimum requirements for the production of structural glued-laminated timber.

The term "structural-glued laminated timber," or "glulam," as used in this chapter, refers to an engineered stress rated product of a timber laminating plant, comprising assemblies of suitably selected and prepared wood laminations securely bonded together with adhesives. The grain of all laminations is approximately parallel longitudinally. The separate laminations may not exceed 2 inches in net thickness. They may be comprised of pieces end-joined to form any length, of pieces placed or glued edge to edge to make wider ones, or of pieces bent to curved form during gluing.

The advantages of glued-laminated wood construction are many and significant. They include the following:

(a) Ease of manufacturing large structural elements from standard commercial sizes of lumber. Laminated beams of over 100 feet and arches and domes with clear spans exceeding 300 feet have been built.

(b) Achievement of excellent architectural effects and the possibility of individualistic decorative styling in interiors, as nearly unlimited curved shapes are possible.

(c) Minimization of checking or other seasoning defects associated with large one-piece wood members, in that the laminations are thin enough to be readily seasoned before manufacture of members.

(d) The opportunity of designing on the basis of the strength of seasoned wood, for dry service conditions, inasmuch as the individual laminations can be dried to provide members thoroughly seasoned throughout. Lumber used for laminating must be seasoned prior to gluing to meet the requirements of PS 56.

(e) The opportunity to design structural elements that vary in cross section along their length in accordance with strength requirements.

(f) The possible use of lower grade material for less highly stressed laminations, without adversely affecting the stuctrual integrity of the member.

(g) The manufacture of large laminated structural members from the smaller pieces is increasingly adaptable to future timber economy, as more lumber comes in smaller sizes and in lower grades. Figure 37 illustrates the handling of a glued laminated timber beam in a fabricating plant.

Neither building materials alone, nor building features alone, nor detection and fire extinguishing equipment alone can provide the maximum safety from fire in buildings. A proper combination of these will provide the necessary degree of protection for the occupants and for the property.

Wood, when exposed to fire, forms a self-insulating surface layer of char and thus provides its own fire protection. Although the surface chars, the undamaged wood below the char retains its strength and will support loads equivalent to the capacity of the uncharred section. Very often, heavy timber members will retain their structural integrity through long periods of fire exposure and still remain serviceable after the surface has been cleaned and refinished. Ibis fire endurance and excellent performance of heavy timber is attributable to the size of the wood members and to the slow rate at which the charring penetrates.

In 1961, a comparative fire test of an unprotected structural glued-laminated timber beam and an exposed structural steel beam was conducted at the Southwest Research Institute. The following is quoted from a report on the test, entitled, “Comparative Fire Test of Timber and Steel Beams” available from the National Forest Products Association.

“The wood beam continued to support its full design load, throughout the test, with a maximum deflection of only 2-1/4 inches at 30 minutes. The uniform deflection rate of the wood beam demonstrates the dependability of heavy timber framing under fire conditions.

L-122

FIGURE 37. Glued-laminated timber beam, 97 feet long.

X-3834

"At the conclusion of the test, the wood beam was sawed though at a representative section, revealing a depth of char penetration of approximately 3/4 inch on each side and 5/8 inch on the bottom.

"While the penetration of char at the glue line was slightly greater, the deflection record demonstrates that the integrity of the casein adhesive board was maintained during fire exposure.

"Thus, after 30 minutes of fire exposure, during which temperatures in excess of 1500° F were recorded, 75 percent of the original wood section remained undamaged and the beam continued to support its full design load."

It is also significant to note, in the case of all wet-use adhesives used by the structural timber laminating industry and required by PS 56, that the glue line is not consumed by fire any faster than the wood.

How well a structure performs in protecting life and property in a fire, rather than the composition of the materials used, is therefore, the important criterion by which to judge the ultimate safety of the structure.

Economy. The economic success of the construction of a project may be greatly influenced by design. The designer must recognize that the entire building, not merely one component such as a beam or a truss, should be properly designed and engineered to obtain maximum economy. Often, it is less expensive to call for a fabricator's standard glued-laminated arch, beam, or truss pattern than for a custom design. However, each structure should be analyzed so that its own requirements for utility and economy will be satisfied and so that it will not be forced arbitrarily to conform with a stereotyped structural frame work design.

Applications. Structural glued-laminated timber is used in a great variety of applications. Among its structural applications are highway and railway bridges, industrial buildings, and farm buildings, to name only a few. Glued-laminated timber is also used in the construction of ships, dredge spuds, and various nonstructural applications. Figures 38 and 39 illustrates two of the applications for glued-laminated timbers. Glued-laminated timber is purchased by the Government for ship and boat use under MIL-W-2038, MIL-W-15154, and MIL-W-24126.

Limiting Factors

There are certain limiting factors concerning glued-laminated timber which must also be considered. Among these are:

(a) The cost of the laminating process raises the cost of the finished member above that of a solid sawn member. However, because of the design variations made possible through the use of glued-laminated timber, sizes and shapes not available in solid sawn timbers may be produced.

L-127

FIGURE 38. Glued laminated timber beams and columns utilized in a warehouse.

X-3835

FIGURE 39. Pressure treated laminated timber stringers support this 104 foot long road bridge.

(b) Great care and continuous quality control must be provided by the laminator during production in order to meet the requirements of PS 56. On the other hand, this greater degree of control results in better assurance of a quality product.

(c) Large curved laminated members may create shipping difficulties. The laminating industry has offset this limitation to a large extent by designing special connections which permit assembly of the member at the job site, and by the development of special rail cars and truck trailers to handle these members. Figure 40 illustrates the special care required in planning the design in order to facilitate shipping.

Species Used for Laminating

Lumber used for structural laminating includes those species whose allowable unit stresses have been developed by the industry and the U.S. Forest Products Laboratory. Allowable unit stresses for structural glued-laminated timber are set forth in AITC-117, AITC-119, and AITC-120.

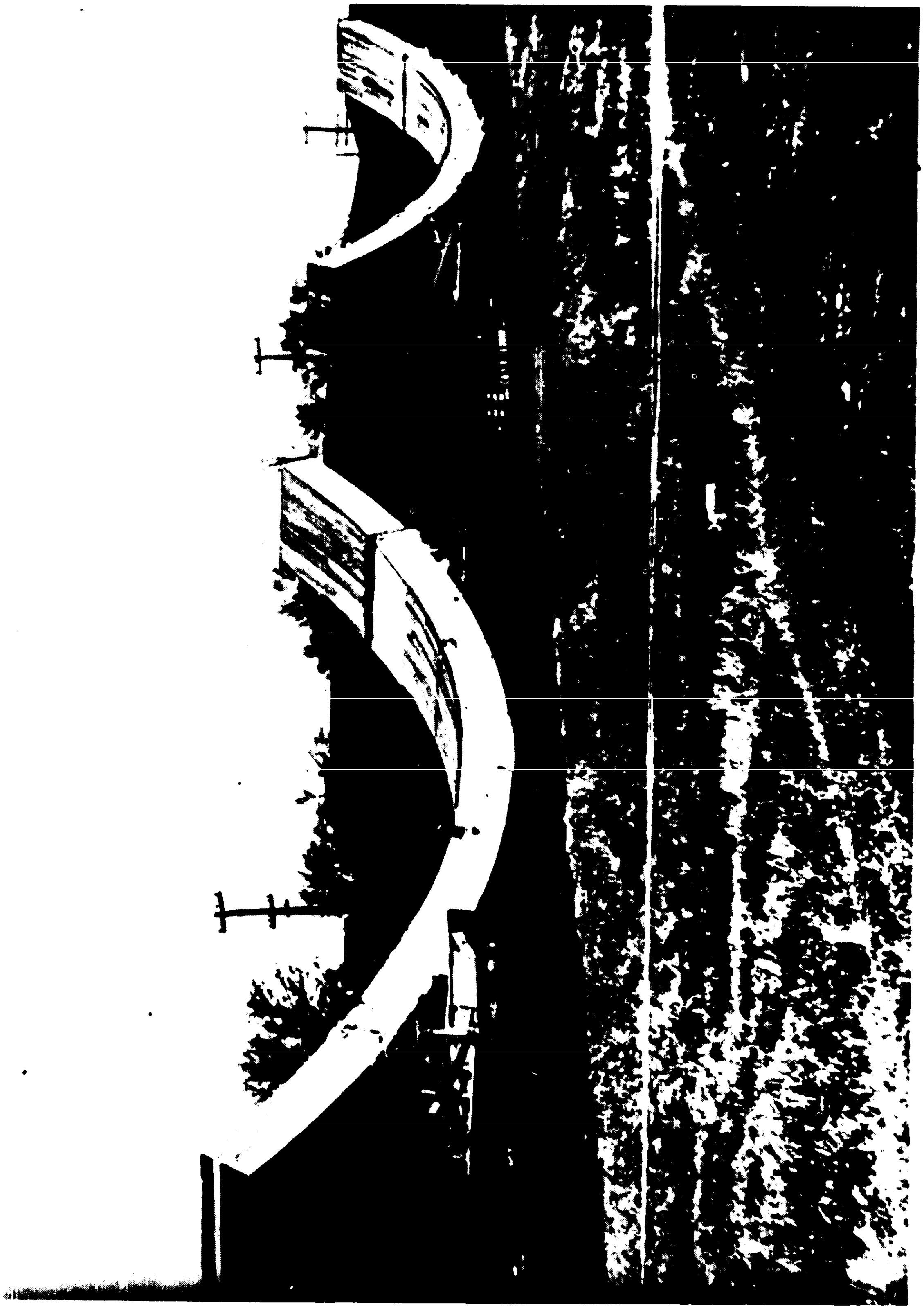
Softwoods, principally Douglas-fir and southern pine, are most commonly used for laminated timbers. Other softwoods used include western hemlock, larch, and redwood. Boat timbers, on the other hand, are often made of white oak because it is moderately durable under wet conditions. Red oak, treated with preservative, has also been laminated for ship and boat use. Other species can also be used, of course, when their mechanical and physical properties are suited for the purpose.

Lumber for laminating is carefully selected for knot size and location, slope of grain, rate of growth, density, and other factors that affect the strength or appearance of the finished product. The lumber maybe based on commercial grades or on special laminating grades. Where it is based on commercial grades, it must meet special requirements for laminating.

The finished member must function as a unit; therefore, the lumber must be surfaced so that the faces can be brought into close contact. This requires that individual laminations have a smooth surface and be of uniform thickness across the width and along the length.

The moisture content of the lumber at the time of gluing should approximate that which it will attain in service but may not exceed 16 percent. Moisture content is measured by means of portable electric meters or by automatic metering devices in the production line.

Standard sizes. The most efficient and economical production of glued-laminated structural members or timbers results when standard lumber sizes are used for the laminates. Industry recommended practice uses nominal 2-inch thick lumber of standard nominal width to produce straight members and curved members



L-123

FIGURE 40. Laminated timber radial arch segments loaded on rail cars.

X-3837

where the radius of curvature is within the bending radius limits for that thickness of the species. The use of nominal l-inch and 2-inch thick laminates is generally the most economical and is, therefore, recommended for all normal uses.

Proper gluing procedures require surfaces planed uniformly smooth to exact thickness with a maximum allowable variation of plus or minus 0.008 inch. Recommended standard practice is to surface nominal 2-inch laminations to a net l-1/2-inch thickness, and nominal l-inch laminations to a net 3/4-inch thickness. Finished depths of members are thus increments of these net thicknesses. Laminations of special thicknesses may be used because of bending radius or the mixing of thicknesses for special purposes, thus resulting in net finished depths which may be nonstandard.

It is necessary to surface wide faces of members to remove the glue squeeze-out and provide a uniformly smooth surface. Therefore the net finished width of the glued-laminated member is less than the net finished width of industry standard boards and dimension stock. Industry standard finished widths for glued-laminated structural members are given in Table XIII.

TABLE XIII. Standard widths of Structural glued-laminated timbers.

Nominal width, inches	4	6	8	10	12	14	16
Net finished width, inches	3-1/8	5-1/8	6-3/4	8-3/4	10-3/4	12-1/4	14-1/4

Manufacturing and Quality Control

The integrity of glued-laminated timber is of primary importance for the protection of life and property whenever the product is used for structural applications. The quality of the product is determined by the quality of the lumber, the suitability of the adhesive and the techniques used in bonding the lumber together with the adhesive.

The manufacture of glued-laminated timber differs from many other manufacturing operations in that most of the production is for custom products; that is, the product is manufactured for a specific use. This makes true random sampling of the product difficult, and to assure the proper level of quality, PS 56 requires that the laminator have a quality control system that provides a continous detailed check of each production process, a visual inspection of the finished production, and physical tests on samples of finished production.

The manufacturing procedures outlined below are followed, in general, by laminating plants in the United States, although individual plants may vary in the detailed procedures. The quality control procedures indicated below meet the requirements of PS 56 and the “Inspection Manual,” AITC 200.

Adhesives. Laminating adhesives must comply with the specifications given in Voluntary Product Standard PS 56. Adhesives are available which are suitable for all applications of glulam, including exposure to the weather, marine use, and pressure treatment. They will withstand the most severe conditions of exposure.

Adhesive manufacturers' quality control is of a high caliber; however, as an additional safeguard, the laminator also performs tests for strength and durability on each batch of adhesives received at his plant.

Adhesives must be spread with suitable equipment so as to produce a uniform application of a predetermined amount of adhesive. Weight of adhesive spread can be determined by one of several different methods, but must meet requirements of PS 56.

End joints. For a large proportion of laminated timbers, because of their size, pieces of wood must be joined end-to-end to provide laminations of sufficient length. In most cases, the strength of timbers is reduced by the presence of end joints.

The highest strength values are obtained with well-made plain scarf joints, the lowest values are with butt joints. This is because scarf joints with flat slopes have essentially side grain surfaces that can be well bonded and develop high strength while butt joints are end grain surfaces that cannot be bonded effectively. Finger joints are a compromise between scarf and butt joints and strength varies with joint design. The thickness of assembled end joints must be within 0.020 inch to 0.005 inch to assure full pressure during the joint cure period. Both the plain scarf joints and finger joints can be manufactured with adequate strength for structural glued-laminated timbers. The adequacy is determined by the physical testing procedures outined in PS 56. Figure 41 illustrates three types of end joints.

Butt joints. Butt joints generally can transmit no tensile stress and can transmit compressive stress only after considerable deformation or if a metal bearing plate is tightly fitted between the abutting ends. In normal assembly operations, such fitting would not be done, and it is therefore necessary assume that butt joints are ineffective in transmitting both tensile and compressive stresses. Because of this ineffectiveness, and because butt joints cause concentration of both shear stress and longitudinal stress, they are not recommended for use in horizontally laminated structural glued-laminated timbers.

Edge joints. A lamination may consist of two or more pieces of lumber placed edge to edge. The edge joints need not be glued except when occuring in members loaded normal to lamination edges, or in members where the edge joint is loaded in shear.

Face joint assembly and bonding. The individual laminations are passed though equipment that spreads adhesive on one or both faces. As the laminations emerge from the spreader, each is placed in a clamping form. Prior to this time, the clamping form will have been set to the desired shape of the finished

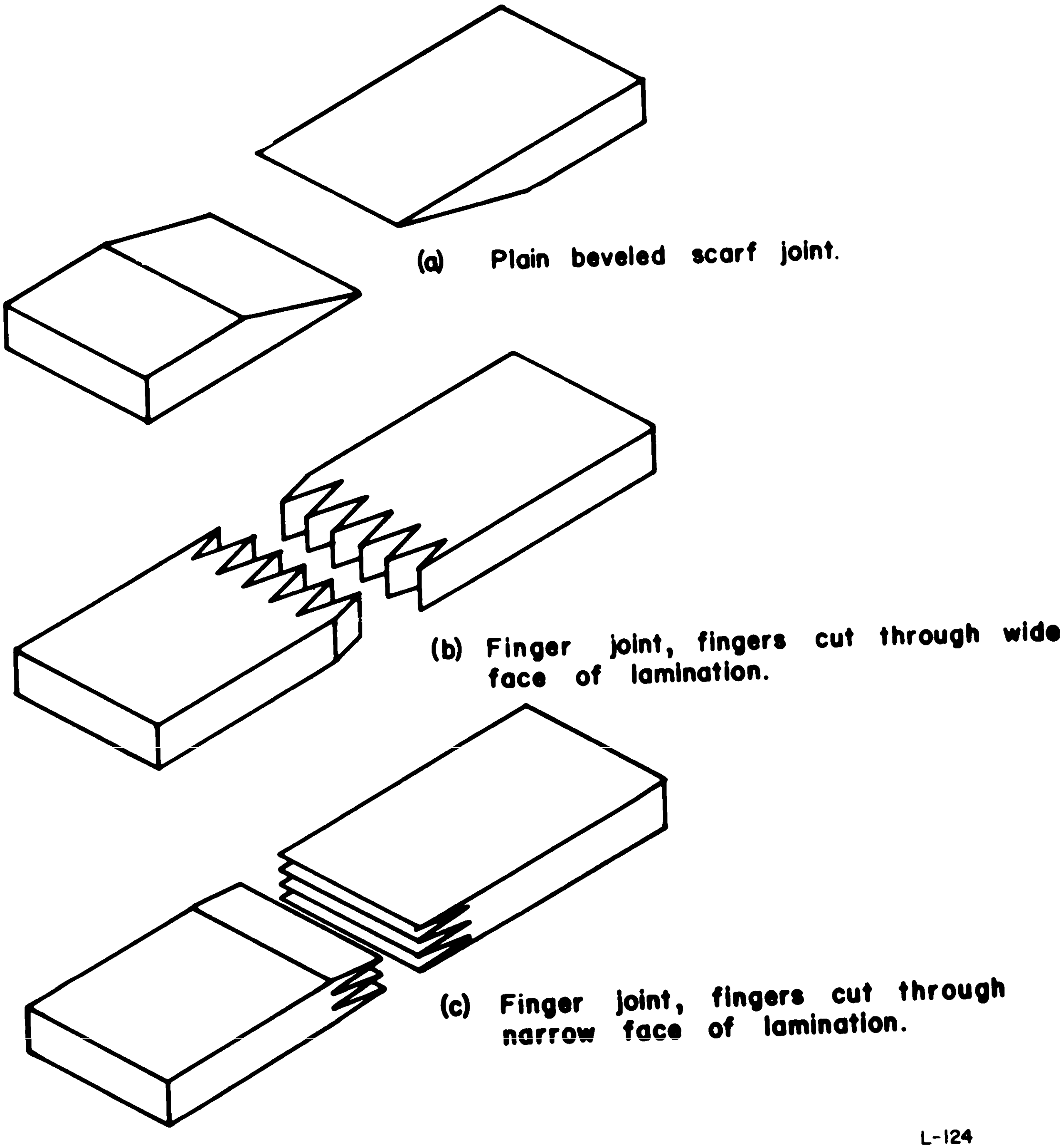


FIGURE 41. Typical end joints for structural glued laminated timber.

X-3838

member by means of full-scale lumber or plywood templates which are built in the plant.

As the laminations are placed in the form, quality-control personnel carefully check to determine that proper assembly times are observed. Assembly time consists of open assembly, which is the time elapsed between spreading the adhesive and assembling the spread surfaces into close contact with another, and closed assembly, which is the time elapsed from the assembly of the first laminations of the package into intimate contact until final application of pressure or heat or both to the entire package.

Clamping and pressure are necessary to bring the surfaces of the laminations being bonded into intimate contact, to pull the member into shape, to force out excessive adhesive, and to hold the pieces firmly together until the adhesive has developed sufficient strength. The means of pressure application must be such that uniform pressure is applied and maintained throughout the curing period of the adhesive. The entire member is tightened as a unit. In most plants evenly spaced clamps are progressively and uniformly tightened with an air impact wrench. Some plants use hydraulic presses for applying pressure to smaller members. Where clamps are used, bolts are checked with a torque wrench to ensure that the correct pressure has been applied and is being maintained. PS 56 prohibits the nailing of the structural portion of laminations in lieu of clamping or other positive methods of controlling pressure.

Glue-1ine cure is important. Some adhesives cure at room temperatures, while others require added heat. Heat may be supplied in a number of ways. Some plants raise the plant temperature overnight, some place space heaters near the curing members, some use special curing chambers, and some place canvas or plastic “tents” over the members and introduce heat.

Finishing. After the laminated member has been removed from the clamps, it is transported to the plant’s finishing area where it is planed and cut to length, fabrication of holes or claps for connections is performed, and the member is sealed, stained, or painted in accordance with job specifications.

Three appearance grades have been established for structural glue-laminated members. They are “industrial,” which is ordinarily suitable for construction in industrial plants, warehouses, garages, and other uses where appearance is not of primary concern; “architectural,” which is ordinarily suitable for construction where appearance is an important requirement; and “premium,” which is suitable for uses which demand the finest appearance. The appearance grades apply to the surfaces of glued-laminated members. They do not apply to laminating procedures, nor do they modify design stresses, fabrication controls, grades of lumber used, or other provisions of standard laminating specifications. Figure 42 illustrates a laminated timber undergoing a finishing process.

Quality control. In order to determine conformance to PS 56 and the job specifications, all production is visually inspected for dimensions; shape, including camber and cross section; type, quality, and location of edge and end

L-125

FIGURE 42. Curved laminated timber being planed to standard dimensions.

X-3839

joints; appearance grade; lumber species and orientation of grades; moisture content; adhesive type; and glue-line thickness.

Physical tests, consisting of in-line tests and tests on samples of finished production, are run by the laminator to assure a proper day-to-day level of quality. Face, edge, and end-joint bonding and each combination of wood species and adhesive type used by the plant are represented by samples cut either from production members or from special samples made under production conditions.

Quality of face joint bonding is determined by a block shear test. In this test, sample of laminations adjacent to glue lines are cut with the glue lines intact. The forces necessary to shear the blocks along glue line and the wood failure on the sheared surfaces are measured. The block shear test may also be used to evaluate scarf joint bonding.

For wet-use service and additional test for integrity of glue bonds, known as the cyclic delamination test, is performed. In it, a production sample is saturated with water in an autoclave or similar pressure vessel, a vacuum is drawn, and then pressure is applied. After removal from the autoclave the sample is dried in an oven. The soaking-drying cycle is then repeated twice. At the end of the final drying period, the total length of open glue lines (delamination) is measured and compared to the total length of glue line on the sample.

The plant quality control department maintains careful records of block shear tests, delamination tests, and other laboratory tests to ensure conformance to PS 56. Figure 43 shows a Quality Inspector checking a completed lamination timber.

Marking and Certification

Provision is made in PS 56 for marking or certifying structrual glued-laminated timber members with the identification mark or certificate of a qualified inspection and testing agency as evidence that the members are in conformance with the Product Standard and the applicable job specifications. In permitting the use of its marks or certificates, the qualified inspection and testing agency must determine (a) that the quality control system of the manufacturer of the product, including his quality and procedures manuals and their application enable him to manufacture products that conform with PS 56; and (b) by periodic inspection, that the manufacturer applies identification marks of conformance to PS 56 and the applicable job specifications only on products which in fact so conform.

The laminating industry, in developing PS 56 through AITC, added the provisions on marking and certification of products as a means of assuring the purchaser that he is getting structrual glued-laminated timber of the grade and quality specified. The Institute established the AITC Inspection Bureau, which is a qualified inspection and testing agency as defined in PS 56, and permits only qualified laminators to use AITC quality marks and certificates of conformance PS 56.

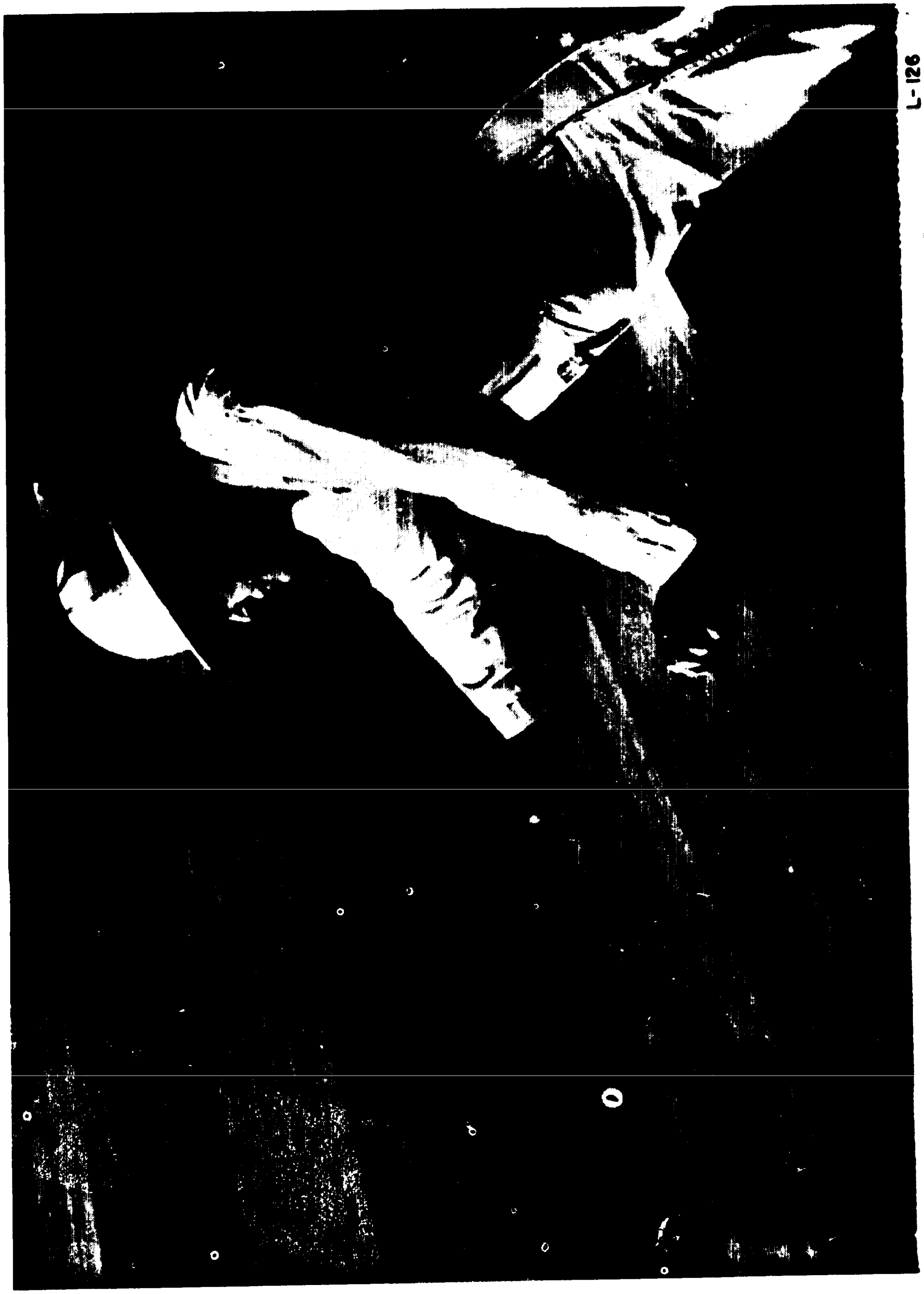


FIGURE 43. Quality inspector checking glued laminated timber dimensions.

X-3840

CHAPTER 7. PLYWOOD

GENERAL

Plywood, an engineered product of real wood, is manufactured with an odd number of layers, each layer consisting of one or more sheets of veneer (thin sheets of wood) called plies. These layers are glued together with the grain of adjacent layers at right angles (see Figure 44).

Today, veneer for construction and industrial plywood panels usually is rotary peeled rather than sliced or sawn, as is frequently done with decorative hardwoods. Plywood is manufactured from peeler logs cut into "blocks" usually about 8-1/2 feet long. The blocks are placed in a giant lathe (Figure 45) and rotated against a long knife which peels the wood off in long, continuous, thin sheets. The veneer is conveyed to clippers which cut it to desired widths, after which it is run through dryers and reduced to about two to five percent moisture content. After careful grading, the veneer goes to the glue spreaders (Figure 46) where adhesive is applied and the plywood panel is laid up l The plywood is then generally hot-pressed (Figure 47) in a large multi-opening hydraulic press. The application of both heat and pressure cures the glue in a matter of minutes. After removal from the press the panels are trimmed to size, and some grades are sanded.

Wood species. Some 70 wood species are used in the manufacture of construction and industrial plywood under PS 1. They are classified into five groups (Table XIV) based on stiffness and strength properties with the stiffest and strongest woods in Group 1. Most of the woods listed in Table XIV are individual species, but some are trade groups of related species commonly traded under a single name without further identification.

Design stresses are published for Groups 1 through 4. All woods within a group are assigned the same working stress so that the designer/builder need only concern himself with four design stress groups instead of 70 wood species.

FIGURE 44. How plywood is constructed. Note grain direction of adjoining plies.

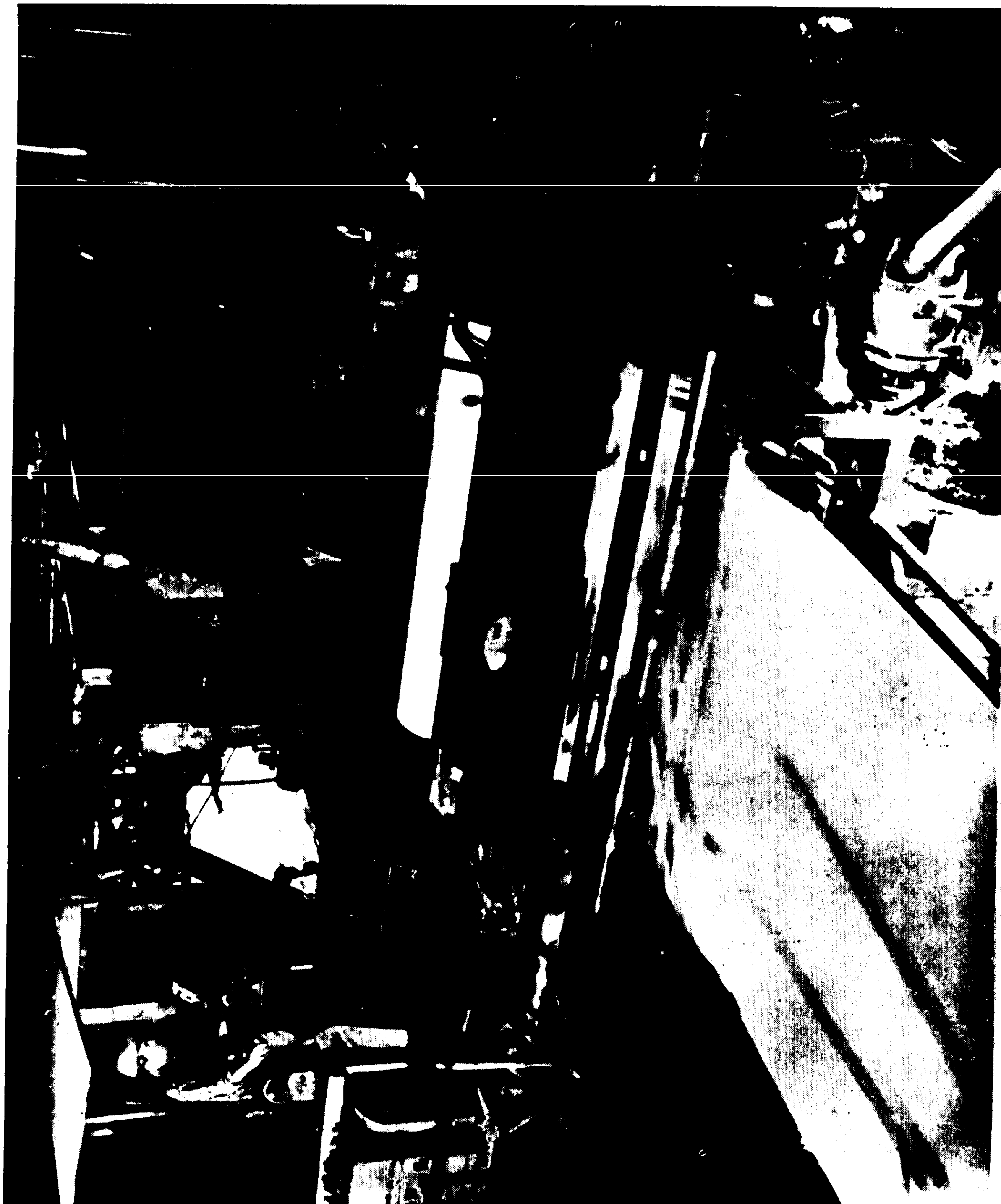


FIGURE 45. Veneer is "peeled" from the log as it revolves against a long knife.

X-3842

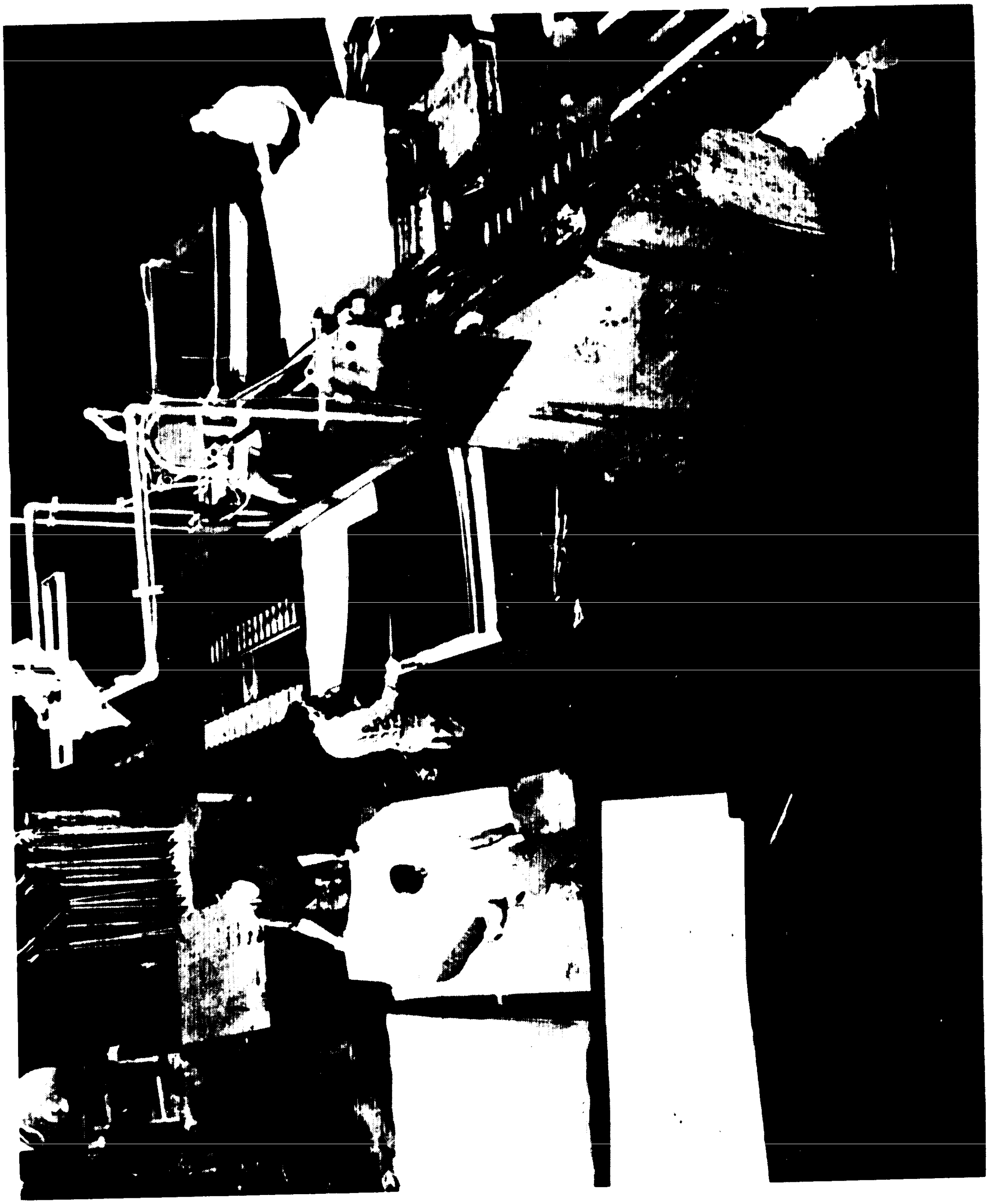


FIGURE 46. Inner ply gluing during layup.

X-3843

L-132

FIGURE 47. Hot-press bonding of layups into plywood panels.

X-3844

TABLE XIV. Classification of species.

Group I	Group 2		Group 3	Group 4	Group 5
Apitong[a][b]	Cedar, Port Orford	Maple, Black	Alder, Red	Aspen	Basswood
Beech, American	Cypress	Mengkulang[a]	Birch, Paper	Bigtooth	Poplar, Balsam
Birch	Douglas Fir 2[c]	Meranti, Red[a][d]	Cedar, Alaska	Quaking	
Sweet	Fir	Mersawa[a]	Fir, Subalpine	Cativo	
Yellow	Balsam	Pine	Hemlock, Eastern	Cedar	
Douglas Fir 1[c]	California Red	Pond	Maple, Bigleaf	Incense	
Kapur[a]	Grand	Red	Pine	Western Red	
Keruing[a][b]	Noble	Virginia	Jack	Cottonwood	
Larch, Western	Pacific Silver	Western White	Lodgepole	Eastern	
Maple, Sugar	White	Spruce	Ponderosa	Black (Western Poplar)	
Pine	Hemlock, Western	Black	Spruce	Pine	
Caribbean	Lauan	Red	Redwood	Eastern White	
Ocote	Almon	Sitka	Spruce	Sugar	
Pine, Southern	Bagtikan	Sweetgum	Engelmann		
Loblolly	Mayapis	Tamarack	White		
Longleaf	Red Lauan	Yellow Poplar			
Shortleaf	Tangile				
Slash	White Lauan				
Tanoak					

(a) Each of these names represents a trade group of woods consisting of a number of closely related species.

(b) Species from the genus Dipterocarpus are marketed collectively: Apitong if originating in the Philippines; Keruing if originating in Malaysia or Indonesia.

(c) Douglas fir from trees grown in the states of Washington, Oregon, California, Idaho, Montana, Wyoming, and the Canadian Provinces of Alberta and British Columbia shall be classed as Douglas fir No. 1. Douglas fir from trees grown in the states of Nevada, Utah, Colorado, Arizona and New Mexico shall be classed as Douglas fir No. 2.

(d) Red Meranti shall be limited to species having a specific gravity of 0.41 or more based on green volume and oven dry weight.

X-3845

STANDARDS AND GRADING

The grading of plywood is closely linked to the product standard under which it is produced. Plywood that carries the grade-trademark of the American Plywood Association conforms with NBS Voluntary Product Standard PS 1 for Construction and Industrial Plywood.

Periodically updated and revised, the purpose of PS 1 is to establish nationally recognized requirements for the principal types and grades of construction and industrial plywood; and to provide a basis for common understanding among producers, distributors, and users of the product.

The product standard PS 1 covers the wood species, veneer grading, glue bonds, panel construction and workmanship, dimensions and tolerances, marking, moisture content, and packing of plywood intended for construction and industrial uses. Hardwood and decorative plywood is covered under Product Standard PS 51, initiated by the Hardwood Plywood Manufacturers Association. Product Standard PS 51 covers plywood intended for use as decorative wall panels, for cut-to-size and stock panels used for furniture, cabinets, containers, and specialty products, and some marine applications.

Those concerned with military standards for plywood generally follow NN-P-530, for Plywood, Flat Panel, which adopts by reference PS 1 and PS 51 thus permitting military contractors to make purchases using standards referred to by the trade.

Plywood is manufactured in two types, Interior and Exterior, with classification made on the basis of resistance of the panels to moisture. Within each type of plywood is a variety of plywood grades which fall into one of two broad categories: appearance and engineered grades.

Exterior plywood. Exterior plywood has a fully waterproof glueline and is distinguished from interior plywood by its superior resistance to moisture and weather. If the plywood is to be permanently exposed to the weather, or used in other conditions where its equilibrium moisture content continuously or repeatedly will exceed 18 percent, exterior plywood should be used.

The veneers used in the backs and inner plies of exterior plywood are of a higher grade than those used for interior plywood. No veneer grade below C is allowed for exterior plywood.

Interior plywood. Interior plywood is manufactured with three different types of glue: exterior, intermediate, and interior. Interior plywood with exterior glue is excellent for projects where durability is required for long but not permanent construction delays. Interior plywood with exterior glue has another advantage; it permits the use of the same shear stresses as those for exterior plywood. Shear strength varies with the kind of glue used, whereas other allowable stresses vary with the type of panel, whether interior or exterior.

Interior plywood with intermediate glue may be used where moderate delays in providing protection are expected during construction, or where high humidity or water leakage may occur temporarily. Interior plywood with interior glue is recommended for indoor applications or where only short exposure to inclement weather or high humidity is anticipated.

Appearance grades. Appearance grades (Table XV) of plywood are identified in terms of the veneer grade used on the face and back of the panel. Veneer grades (Table XVI) define the appearance of the panel, and specify allowable numbers and sizes of repairs that may be made in veneers during manufacture, as well as natural unrepaired growth characteristics.

The species group number is assigned on the basis of the species used for the face and back veneers. Where these outer veneers are not of the same species, the group number refers to the weaker species. An exception is made for decorative and sanded panels 3/8-inch thickness or less. These panels are identified by the group number of the face species.

Inner veneers are allowed to be of a different group. MARINE and the STRUCTURAL I grades, however, are required to have all plies of Group 1 species.

Engineered grades. Engineered grades are now designated as Performance Rated Panels because they may be fabricated as nonveneered panels (waferboard, particle-board, or composites) as well as plywood, Table XVII. Appearance is secondary to strength. Performance Rated Panels include interior and exterior sheathing panels which may be designated as Structural I or 11. These Structural grades are used where strength properties are of maximum importance, as in shear walls. Both have restrictions as to the wood species group from which they can be manufactured; size and number of defects and how they are repaired; and the fact that they must be made with exterior glue. Panels conforming to this rating system are designated by thickness and span rating, rather than be referenced to the wood species group, and the grade designations of face and back veneers.

TABLE XV. Guide to appearance grades of plywood. (1)

Interior Type

Grade Designation (2)	Description and Most Common Uses	Typical Grade-trademarks	Veneer Grade Face	Veneer Grade Back	Veneer Grade Inner Plies	Most Common Thicknesses (inch) (3)					
N-N, N-A, N-B INT-APA	Cabinet quality. For natural finish furniture, cabinet doors, built-ins, etc. Special order items.	NN·G1·INT·APA·PS 1·74 NA·G2·INT·APA·PS 1·74	N	N,A, or B	C						3/4
N-D-INT-APA	For natural finish paneling. Special order item.	ND·G3·INT·APA·PS 1·74	N	D	D	1/4					
A-A INT-APA	For applications with both sides on view. Built-ins, cabinets, furniture and partitions. Smooth face; suitable for painting.	AA·G4·INT·APA·PS 1·74	A	A	D	1/4		3/8	1/2	5/8	3/4
A-B INT-APA	Use where appearance of one side is less important but two smooth solid surfaces are necessary.	AB·G4·INT·APA·PS 1·74	A	B	D	1/4		3/8	1/2	5/8	3/4
A-D INT-APA	Use where appearance of only one side is important. Paneling, built-ins, shelving, partitions, and flow racks.	A-D GROUP 1 INTERIOR PS 1-74 000 APA	A	D	D	1/4		3/8	1/2	5/8	3/4
B-B INT-APA	Utility panel with two smooth sides. Permits circular plugs.	BB·G3·INT·APA·PS 1·74	B	B	D	1/4		3/8	1/2	5/8	3/4
B-D INT-APA	Utility panel with one smooth side. Good for backing, sides of built-ins. Industry: shelving, slip sheets, separator boards and bins.	B-D GROUP 3 INTERIOR PS 1-74 000 APA	B	D	D	1/4		3/8	1/2	5/8	3/4
DECORATIVE PANELS—APA	Rough-sawn, brushed, grooved, or striated faces. For paneling, interior accent walls, built-ins, counter facing, displays, and exhibits.	DECORATIVE·BD·G1·INT·APA·PS 1·74	C or btr.	D	D		5/16	3/8	1/2	5/8	
PLYRON INT-APA	Hardboard face on both sides. For counter tops, shelving, cabinet doors, flooring. Faces tempered, untempered, smooth, or screened.	PLYRON·INT·APA·PS 1·74			C & D				1/2	5/8	3/4

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TABLE XV. Guide to appearance grades of plywood.– Continued

Exterior Type	A-A EXT-APA	Use where appearance of both sides is important. Fences, built-ins, signs, boats, cabinets, commercial refrigerators, shipping containers, tote boxes, tanks, and ducts. (4)	AA·G3·EXT·APA·PS 1-74	A	A	C	1/4		3/8	1/2	5/8	3/4
	A-B EXT-APA	Use where the appearance of one side is less important. (4)	AB·G1·EXT·APA·PS 1-74	A	B	C	1/4		3/8	1/2	5/8	3/4
	A-C EXT-APA	Use where the appearance of only one side is important. Sidings, soffits, fences, structural uses, boxcar and truck lining, farm buildings. Tanks, trays, commercial refrigerators. (4)	A-C GROUP 1 INTERIOR APA PS 1-74 000	A	C	C	1/4		3/8	1/2	5/8	3/4
	B-B EXT-APA	Utility panel with solid faces. (4)	BB·G1·EXT·APA·PS 1-74	B	B	C	1/4		3/8	1/2	5/8	3/4
	B-C EXT-APA	Utility panel for farm service and work buildings, boxcar and truck lining, containers, tanks, agricultural equipment. Also as base for exterior coatings for walls, roofs. (4)	B-C GROUP 2 INTERIOR APA PS 1-74 000	B	C	C	1/4		3/8	1/2	5/8	3/4
	HDO EXT-APA	High Density Overlay plywood. Has a hard, semi-opaque resin-fiber overlay both faces. Abrasion resistant. For concrete forms, cabinets, counter tops, signs and tanks. (4)	HDO·AA·G1·EXT·APA·PS 1-74	A or B	A or B	C or C plgd		5/16	3/8	1/2	5/8	3/4
	MDO EXT-APA	Medium Density Overlay with smooth, opaque, resin-fiber overlay one or both panel faces. Highly recommended for siding and other outdoor applications, built-ins, signs, and displays. Ideal base for paint. (4)	MDO·BB·G4·EXT·APA·PS1-74	B	B or C	C		5/16	3/8	1/2	5/8	3/4
	303 SIDING EXT-APA	Proprietary plywood products for exterior siding, fencing, etc. Special surface treatment such as V-groove, channel groove, striated, brushed, rough-sawn. (6)	303 SIDING 16 oc GROUP 1 EXTERIOR APA PS 1-74 000	(5)	C	C			3/8	1/2	5/8	
	T 1-11 EXT-APA	Special 303 panel having grooves 1/4" deep, 3/8" wide, spaced 4" or 8" o.c. Other spacing optional. Edges shiplapped. Available unsanded, textured, and MDO. (6)	303 SIDING 16 oc T1-11 GROUP 1 EXTERIOR APA PS 1-74 000	C or btr.	C	C					5/8	
	PLYRON EXT-APA	Hardboard faces both sides, tempered, smooth or screened.	PLYRON·EXT·APA·PS 1-74			C				1/2	5/8	3/4
	MARINE EXT-APA	Ideal for boat hulls. Made only with Douglas fir or western larch. Special solid jointed core construction. Subject to special limitations on core gaps and number of face repairs. Also available with HDO or MDO faces.	MARINE·AA·EXT·APA·PS 1-74	A or B	A or B	B	1/4		3/8	1/2	5/8	3/4

(1) Sanded both sides except where decorative or other surfaces specified
(2) Available in Group 1, 2, 3, 4, or 5 unless otherwise noted
(3) Standard 4x8 panel sizes, other sizes available
(4) Also available in Structural I (all plies limited to Group 1 species) and Structural II (all plies limited to Group 1, 2, or 3 species)
(5) C or better for 5 plies. C Plugged or better for 3 ply panels
(6) Stud spacing is shown on grade stamp

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TABLE XVI. Veneer grades.

Grade	Description
N	Smooth surface "natural finish" veneer. Select, all heartwood or all sapwood. Free of open defects. Allows not more than 6 repairs, wood only, per 4x8 panel, made parallel to grain and well matched for grain and color.
A	Smooth, paintable. Not more than 18 neatly made repairs, boat, sled, or router type, and parallel to grain, permitted. May be used for natural finish in less demanding applications.
B	Solid surface. Shims, circular repair plugs and tight knots to 1 inch across grain permitted. Some minor splits permitted.
C	Tight knots to 1-1/2 inch. Knotholes to 1 inch across grain and some to 1-1/2 inch if total width of knots and knotholes is within specified limits. Synthetic or wood repairs. Discoloration and sanding defects that do not impair strength permitted. Limited splits allowed.
C Plugged	Improved C veneer with splits limited to 1/8 inch width and knotholes and borer holes limited to 1/4 x 1/2 inch. Admits some broken grain. Synthetic repairs permitted.
D	Knots and knotholes to 2-1/2 inch width across grain and 1/2 inch larger within specified limits. Limited splits are permitted.

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TABLE XVII. Guide to APA Performance-rated panels.

	Grade Designation	Description & Common Uses	Typical Trademarks	Most Common Thicknesses (in.) 5/16	3/8	1/2	5/8	3/4
PROTECTED OR INTERIOR USE	APA RATED SHEATHING EXP 1 or 2	Specially designed for subflooring and wall and roof sheathing, but can also be used for a broad range of other construction and industrial applications. Can be manufactured as conventional veneered plywood, as a composite, or as a nonveneered panel. For special engineered applications, including high load requirements and certain industrial uses, veneered panels conforming to PS 1 may be required. Specify Exposure 1 when construction delays are anticipated.	APA RATED SHEATHING 32/16 1/2 INCH SIZED FOR SPACING EXPOSURE 1 000 PS 1-74 C-D INT/EXT GLUE NRB-108	●	●	●	●	●
	APA STRUCTURAL I & II RATED SHEATHING EXP 1	Unsanded all-veneer PS 1 plywood grades for use where strength properties are of maximum importance: structural diaphragms, box beams, gusset plates, stressed-skin panels, containers, pallet bins. Made only with exterior glue (Exposure 1). STRUCTURAL I more commonly available. (3)	APA RATED SHEATHING STRUCTURAL I 24/0 3/8 INCH SIZED FOR SPACING EXPOSURE 1 000 PS 1-74 C-D INT/EXT GLUE NRB-108	●	●	●	●	●
	APA RATED STURD-I-FLOOR EXP 1 or 2	For combination subfloor-underlayment. Provides smooth surface for application of resilient floor covering and possesses high concentrated and impact load resistance. Can be manufactured as conventional veneered plywood, as a composite, or as a nonveneered panel. Available square edge or tongue-and-groove. Specify Exposure 1 when construction delays are anticipated.	APA RATED STURD-I-FLOOR 24 oc 23/32 INCH SIZED FOR SPACING T&G NET WIDTH 47-1/2 EXPOSURE 1 000 INT/EXT GLUE NRB-108 FHA-UM-66				● 19/32	● 23/32
	APA RATED STURD-I-FLOOR 48 oc (2-4-1) EXP 1	For combination subfloor-underlayment on 32- and 48-inch spans and for heavy timber roof construction. Provides smooth surface for application of resilient floor coverings and possesses high concentrated and impact load resistance. Manufactured only as conventional veneered plywood and only with exterior glue (Exposure 1). Available square edge or tongue-and-groove.	APA RATED STURD-I-FLOOR 48 oc 2-4-1 1-1/8 INCH SIZED FOR SPACING EXPOSURE 1 T&G 000 INT/EXT GLUE NRB-108 FHA-UM-66			1-1/8		
EXTERIOR USE	APA RATED SHEATHING EXT	Exterior sheathing panel for subflooring and wall and roof sheathing, siding on service and farm buildings, crating, pallets, pallet bins, cable reels, etc. Manufactured as conventional veneered plywood.	APA RATED SHEATHING 48/24 3/4 INCH SIZED FOR SPACING EXTERIOR 000 PS 1-74 C-C NRB-108	●	●	●	●	●
	APA STRUCTURAL I & II RATED SHEATHING EXT	For engineered applications in construction and industry where fully waterproof panels are required. Manufactured only as conventional veneered PS 1 plywood. Unsanded. STRUCTURAL I more commonly available. (3)	APA RATED SHEATHING STRUCTURAL I 24/0 3/8 INCH SIZED FOR SPACING EXTERIOR 000 PS 1-74 C-C NRB-108	●	●	●	●	●
	APA RATED STURD-I-FLOOR EXT	For combination subfloor-underlayment under resilient floor coverings where severe moisture conditions may be present, as in balcony decks. Possesses high concentrated and impact load resistance. Manufactured only as conventional veneered plywood. Available square edge or tongue-and-groove.	APA RATED STURD-I-FLOOR 20 oc 19/32 INCH SIZED FOR SPACING EXTERIOR 000 NRB-108 FHA-UM-66				● 19/32	● 23/32

(1) Specific grades, thicknesses, constructions and exposure durability classifications may be in limited supply in some areas. Check with your supplier before specifying.
(2) Specify Performance-Rated Panels by thickness and Span Rating.
(3) All plies in STRUCTURAL I panels are special imporved grades and limited to Group 1 species. All plies in STRUCTURAL 11 panels are special improved grades and limited to Group 1, 2, or 3 species.

SPECIAL USE PLYWOODS

There are requirements for plywood which for various reasons require closer tolerances in manufacture or require conformance with certain durability and bending tests as well as being limited to manufacture from certain species of wood l

Aircraft use. Plywood and veneer intended for use in the fabrication of structural or highly stressed parts of aircraft such as wing and fuselage covering, wing rib webs, etc., must conform to requirements of MIL-P-6070. This plywood is manufactured in only one grade with the adhesives limited to those conforming to MMM-A-181.

Plywood for boat and ship use. Plywood used for boat and ship construction is of the quality necessary for special applications on vital equipment for extreme environments. It is not intended for general construction where commercial exterior grades can be used. Distinguishing quality features under MIL-P-18066 provide: decay resistance, limitation of defects affecting strength, paint serviceability, and ply construction necessary for marine exposure to insure the necessary stiffness and resistance to ply delamination. This type of plywood may be ordered in the treated or untreated condition. Treated plywood shall conform to requirements of MIL-P-19140, or MIL-P-19550, as specified.

Metal-faced plywood. Metal-faced plywood intended for use in fabricating ground equipment and for nonstructural parts of aircraft must comply with requirements of MIL-P-8053. This plywood is not intended to be used for either primary or secondary structural aircraft purposes. It may be used as covering to prevent damage to the structural floor of cargo aircraft or as side plates for fuselage rings to prevent damage to equipment which is being parachuted or as covering for loading ramps.

Plywood for Boxes. Most plywood used in shipping boxes must conform to PS 1 or PS 51. These boxes are usually ordered or manufactured to comply with PPP-B-601. Treatment of plywood used for boxes complying with PPP-B-601 must conform to requirements of TT-W-572.

CHAPTER 8. STRENGTH OF WOOD

GENERAL

Strength is important in everything that is built. In the framing of a building, strength is the primary requirement, almost to the exclusion of other properties. In boxes, strength is one of the essentials. If a board in a box is strong enough and properly fastened, the box will safely protect its contents. If a column or girder in a structure is of proper size and grade and is properly placed, it will fulfill its intended use and give satisfactory service. Knowledge of strength properties will help to avoid waste, reduce weight, and serve economy through the use of box boards no thicker, and structural parts no larger than necessary. The box lumber thicknesses given in Specification PPP-B-621 for example, are based on known strength values, thus permitting important savings in lumber costs if followed.

Much confusion exists in regard to the meaning of “strength.” In its broader sense, strength includes all the properties that enable wood to resist different forces or loads. In its more restricted engineering sense, strength can apply to any one of the mechanical properties; in which event the name of the property under consideration should be stated. A wood may rank better in one kind of resistance to load than in another. Longleaf pine averages higher than white oak in compressive strength (endwise) but is lower in hardness. Hence it cannot be said that longleaf pine is “stronger” than white oak without stating the kind of strength referred to. To compare species precisely, it is necessary to consider the kind of strength properties or combination of properties essential to the particular use, since different kinds of strength are essential in different uses. Thus, longleaf pine, because of its higher compressive strength (endwise), is superior to oak for use in short posts that carry heavy endwise loads, whereas oak, because of greater hardness, is superior in resistance to the wear and marring to which some floors are subjected.

Wood differs greatly in its strength properties with or across the grain. The difference in the two kinds of compressive strength has already been mentioned. Some other properties, such as stiffness, are affected even more. When a force or load is applied in the direction inclined at an angle to the grain, the strength is intermediate between the values with and across the grain. Simple comparative strength figures are given in Table XVIII. These figures are composite values, or, in effect, index numbers. They are mainly for comparative purposes, and cannot be used for calculating the load-carrying capacity of wood. The figures in Table XVIII are, however, an excellent and easy means of determining the relative merits of different species for various uses. Average strength and related properties of clear, straight-grained wood of a number of species can be found in the U.S. Department of Agriculture Handbook 72, entitled Wood Handbook.

TABLE XVIII Comparative ratings in several strength and related properties of clear wood of the more important construction species.

Name of species	Weight per cubic foot at 12 percent Moisture Content	Composite strength values				
		Bending strength	Compression strength (endwise)	Stiffness	Hardness	Shock resistance
1	2	3	4	5	6	7
HARDWOODS	Lb.	Comparative fig.	Comparative fig.	Comparative fig.	Comparative fig.	Comparative fig.
Ash, commercial white (Av. of 4 species)	41	110	106	161	108	139
Birch, sweet	46	116	105	206	104	157
Cottonwood, eastern	28	61	63	122	36	72
Elm, American	36	84	74	129	66	126
Elm, rock	44	106	97	147	104	190
Gum, red	34	85	78	148	61	106
Hickories, pecan and true (Av. of 8 species)	50	135	122	184	142	279
Maple, sugar	44	114	104	178	115	137
Oaks, commercial red and white (av. of 15 species)	45	100	92	161	105	134
Tupelo, water	35	82	86	127	77	80
Yellow poplar	28	76	72	151	44	76

TABLE XVIII Comparative ratings in several strength and related properties of clear wood of the more important construction species. - continued

Name of species	Weight per cubic foot at 12 percent Moisture Content	Composite strength values				
		Bending strength	Compression strength (endwise)	Stiffness	Hardness	Shock resistance
1	2	3	4	5	6	7
SOFTWOODS	Lb.	Comparative fig.	Comparative fig.	Comparative fig.	Comparative fig.	Comparative fig.
Cedar, western red	23	60	75	108	38	52
Cedar, southern white	23	53	60	93	35	51
Cypress	32	79	93	139	52	72
Douglas fir (coast type)	34	90	104	185	58	86
Douglas fir (Mountain type)	30	75	83	142	52	66
Fir, white (av. of 4 species)	26	72	76	141	41	66
Hemlock, eastern	28	72	79	121	51	67
Hemlock, west coast	29	74	85	145	50	73
Larch, western	36	97	106	179	63	107
Pine, longleaf	41	103	115	186	71	109
Pine, shortleaf	38	87	92	161	56	96
Pine, Idaho	27	68	76	145	34	66
Pine, ponderosa	28	64	69	113	41	57
Redwood	30	82	102	136	54	66
Spruces (av. of red, white, Sitka)	28	71	74	136	42	71

SPECIFIC PROPERTIES

Weight (density). Wood species vary greatly in weight, whether green or dry. In order to be specific, various stages of drying or dryness must be recognized in establishing the weight, not only because of the effect of the moisture content on weight, but because of change in volume due to shrinkage and swelling with changes in moisture content. Moisture content also affects most strength properties, well-seasoned wood being stronger than green wood. The figures given in column 2 of Table XVIII are for 12 percent moisture content. The moisture content of commercially air-dry material is generally 3 to 5 percent higher except in very dry climates like the southwest. Large timbers have a higher average moisture content when thoroughly air-dry than small pieces.

Bending strength. Bending strength is a measure of the load-carrying capacity of beams, which are horizontal structural parts usually resting on two supports. Figure 48 shows a beam, or joist, carrying a bending load as it transfers the weight of the house and contents to the foundation and column supporting it. Other examples of parts subjected to bending are framing of crates or boxes, floor joists, girders, bridge stringers, ladder steps, shovel handles, stadium seats, and scaffold planks. The bending strength of a beam is proportional to its width and to the square of its depth. For instance, a 6- by 8-inch beam is 50 percent stronger and also 50 percent larger than a 4 by 8, but a 4-by 10-inch beam is 56 percent stronger while only 25 percent larger than a 4 by 8. Comparative bending strength figures for various species are given in column 3 of Table XVIII. In general, those species of greater weight, as shown in column 2 of Table XVIII, are also higher in bending strength.

Compressive Strength (endwise). Endwise compressive strength is a measure of the ability of a short column to carry load. Figure 49 shows a column carrying a compressive load as it transfers the weight of the house and contents to the earth. Columns are generally square in cross section, usually upright, and support loads that act in the direction of the length. Some examples of endwise compression members are upright members in grandstands, mine props, and vertical posts that support girders in buildings. The comparative values given in column 4 of Table XVIII are applicable to columns in which the length is not more than 11 times the least dimension, either thickness or width. When the length exceeds 11 times but is less than about 25 times the least dimension, both stiffness and compressive strength affect the load capacity. Still longer columns fail by buckling or bending, where stiffness alone is the controlling factor.

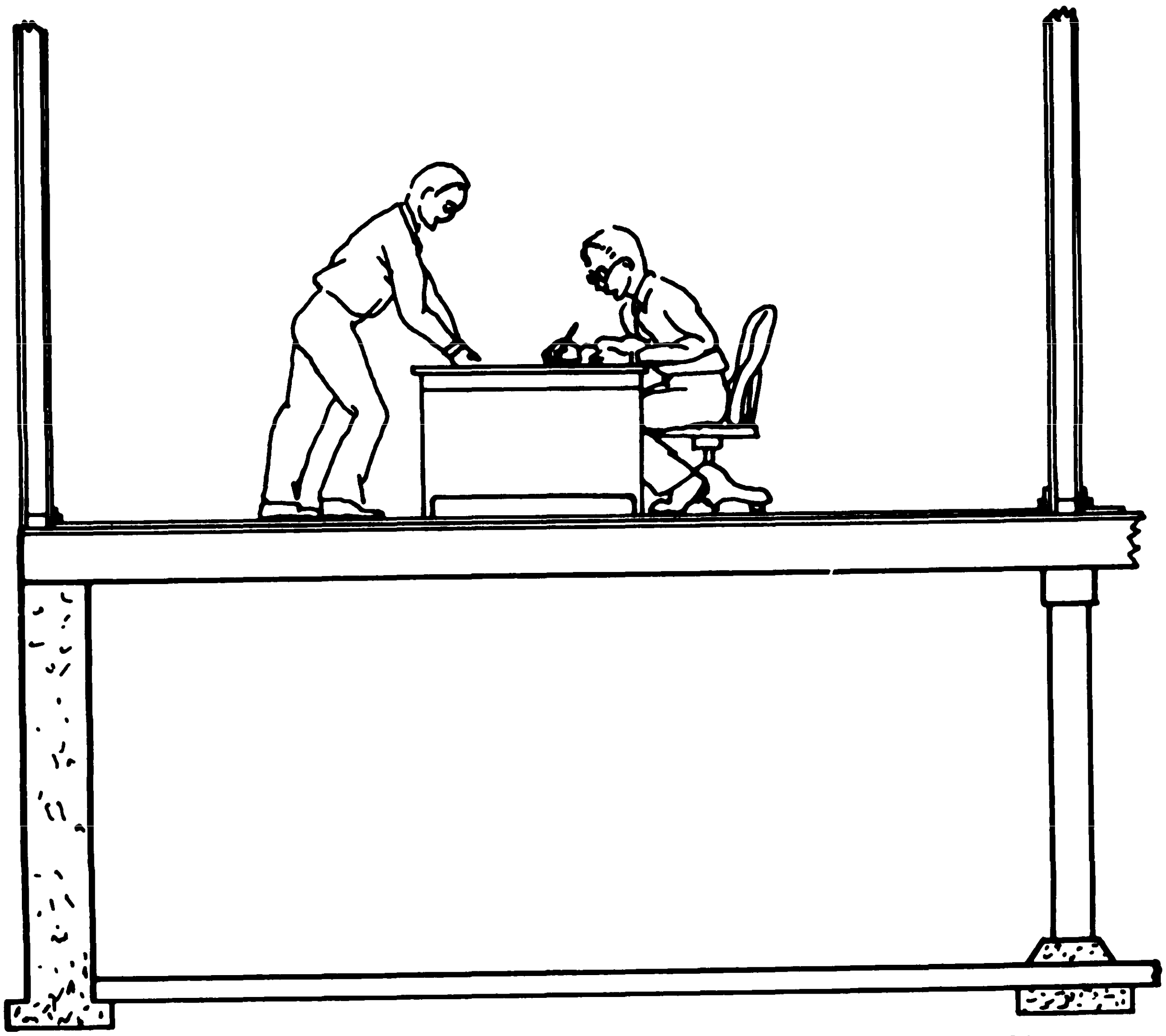

FIGURE 48. Bending bad.

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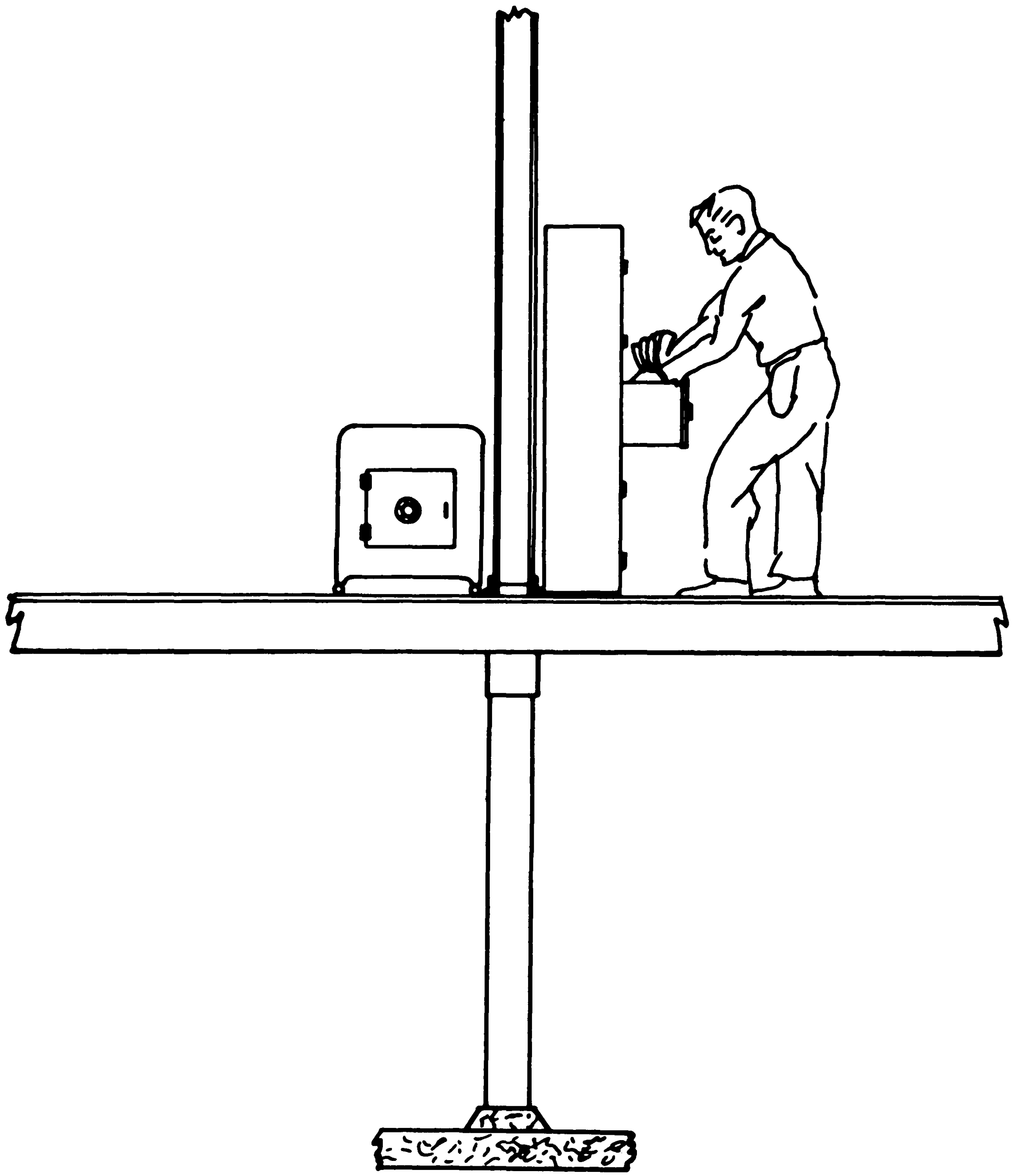

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FIGURE 49. Compressive lood.

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Compressive strength (crosswise). Compressive strength in the crosswise direction is a measure of the ability of wood to resist indentation when a concentrated load is applied to the side grain of the wood. Examples would include girders bearing on posts and rails bearing on cross ties. Wood is four to five times as strong in compression parallel as in compression perpendicular to its grain, and precautions such as steel bearing plates are often necessary to prevent excessive crushing of side grain of girders and railroad ties.

Stiffness. When any weight or load is placed on a member, such as a beam, deflection or bending occurs. Stiffness is a measure of this resistance to deflection. It is one of the properties required in floor joists, girders, rafters, ladder side rails, and golf-club shafts as well as in long columns. Differences in stiffness between species can be compensated for by using a member of different thickness and width. The stiffness of a beam is proportional to its width but to the cube of its depth. For instance, a joist 10-inches deep is about twice as stiff as one of equal width and quality, but 8-inches deep. Stiffness index figures are given in column 5 of Table XVIII.

Hardness. Hardness is the property that makes a surface difficult to dent or scratch. The harder the wood, other things being equal, the better it resists wear, the less it crushes or mashes under loads, and the better it can be polished; on the other hand, the more difficult it is to cut with tools, the harder it is to nail, and the more it splits in nailing. Hardness is desirable in such uses as flooring, furniture, railroad ties, and small tool handles. Floors, for example, must be hard in order to resist indentation by truck wheels and other objects bringing concentrated loads to bear on them, as in Figure 50. Some lack of hardness - that is, a degree of softness - is particularly desirable for uses such as drawing boards. Hardness comparative values are shown in column 6 of Table XVIII.

Shock resistance. Shock resistance is the capacity to withstand suddenly applied loads. Hence, woods high in shock resistance withstand repeated shocks, jars, jolts, and blows such as are given ax handles, or hammer handles. Hickory possesses this shock-resistance property to the highest degree of any of the common and well-known woods, as shown in column 7 of Table XVIII.

Puncture resistance. Puncture resistance of wood is its ability to resist a large load applied over a relatively small area. High puncture resistance is of particular importance when an object must resist a suddenly applied concentrated load, as when a heavy box drops cornerwise onto the side of another box (Figure 51). Plywood has this property to a high degree.

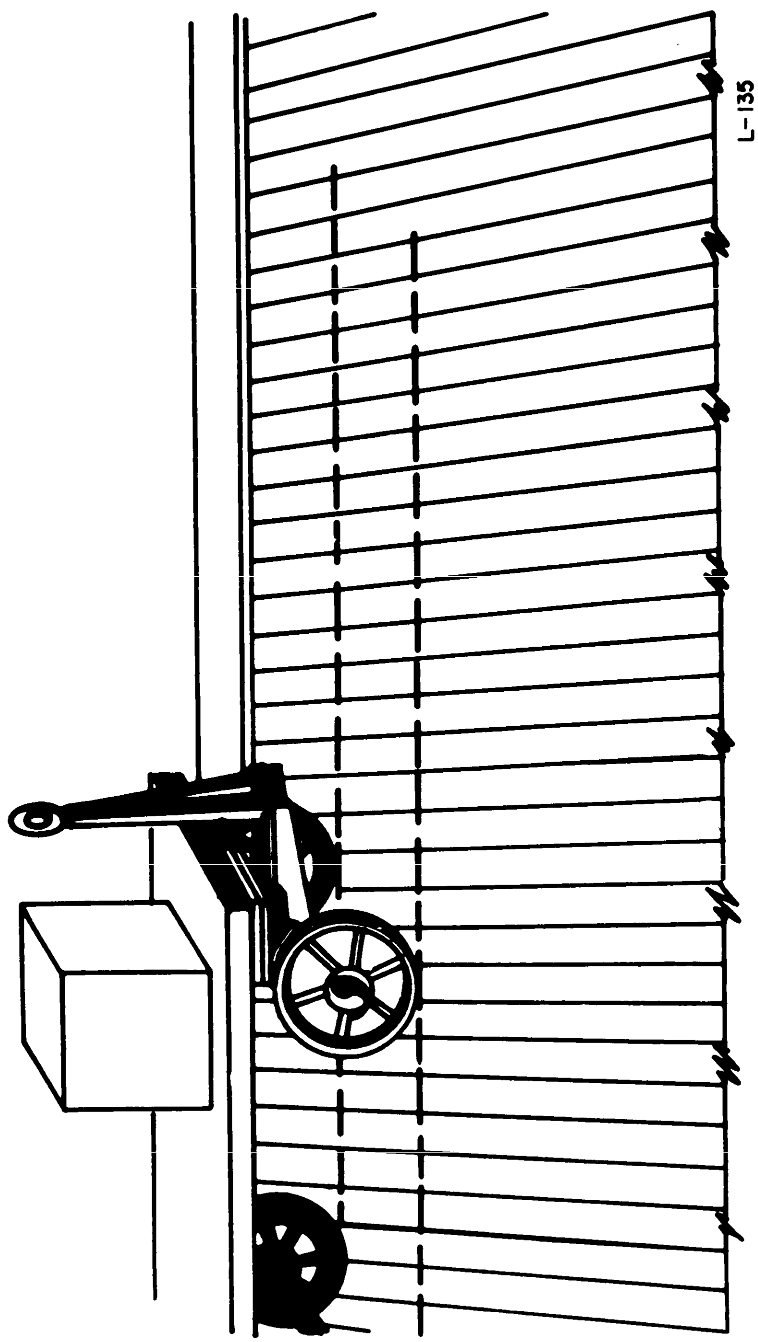

FIGURE 50. Hardness in floors.

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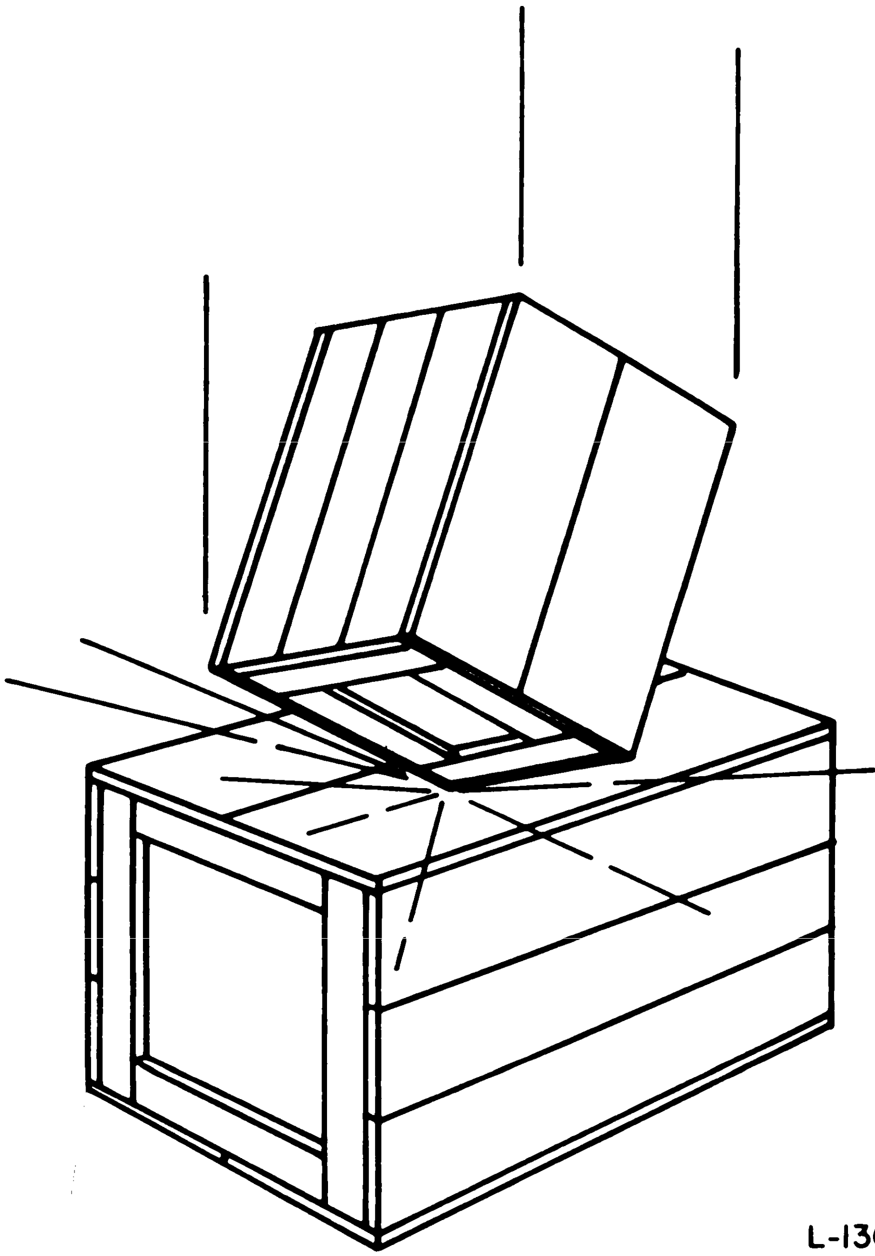


FIGURE 51. Puncture resistance.

Strength differences between species

Different species of wood have different strength values. The strength is related to the amount of wood substance per unit volume; that is, a heavy wood, such as birch, is stronger than a lightweight wood such as spruce. There are differences, too, among the different trees within one species - a heavy piece is stronger than a lightweight piece, though both may be of the same size and species.

Table XVIII includes the species of wood that are commonly used in building construction, and thus affords a comparison of those woods for that purpose.

Differences in strength between species are reflected in design specifications. For example, design requirements may call for 2- by 8-inch floor joists over a 13 foot span if of Iongleaf pine, but 2- by 10-inch joists if Engelmann spruce. The reason is that the basic strength of Engelmann spruce is lower, and thus joists to carry the same load must be larger as compared to longleaf pine for comparative grades.

The most common species used in the framing of buildings are the southern yellow pines (longleaf and shortleaf) and Douglas fir; these are species of comparatively high strength and stiffness. At the same time, any of the species listed in Table XVIII have usable strength properties, and many others not listed may be used if available. The advantage of using a strong species like longleaf pine is that members of smaller size can withstand the same load. Such an advantage may be offset, of course, by the lower cost or easier availability of a species not so strong.

Differences in strength as well as in other properties are reflected in the species groupings for containers and pallets discussed below. Group 1 embraces the woods of only moderate weight and strength, while other groups include harder and stronger woods, group 4 being the hardest and strongest.

Grouping of woods by species does not carry the implication that one group is superior to another for general container and pallet manufacture. These groupings point out those woods generally alike in various characteristics.

Group 1 species. Group 1 includes the lighter and softer woods of both the softwoods and hardwoods. Group 1 woods are comparatively free from splits during nailing; they have moderate nail-holding power, moderate strength as a beam, and moderate shock-resisting capacity. They are soft, light in weight, easy to work, hold their shape well after manufacture; and, as a rule, are easy to dry.

Group 1 includes the following woods:

Aspen, bigtooth	Fir, Pacific silver
Aspen, quaking	Fir, white
Basswood, American	Magnolia
Buckeye, yellow	Pine, northern white
Butternut	Pine, jack
Cedar, Alaska-yellow	Pine, lodgepole
Cedar, northern white	Pine, ponderosa
Cedar, Port Oxford	Pine, red
Cedar, western red	Pine, sugar
Chestnut, American	Pine, Idaho white
Cottonwood, black	Redwood
Cottonwood, eastern	Spruce, Engelmann
Cypress	Spruce, red
Fir, Subalpine	Spruce, Sitka
Fir, balsam	Spruce, white
Fir, California red	Willow, black
Fir, grand	Willow, western black
Fir, noble	Yellow-poplar

Group 2 species. Group 2 consists entirely of the heavier softwoods, which have a pronounced difference in hardness between the springwood (the lighter colored portion of each annual ring) and summerwood (the darker portion of the annual ring). They have a greater nailholding power than Group 1 woods, but greater tendency to split in nailing, since both nail-holding and splitting increase with hardness. The hard bands of summerwood sometimes have a tendency to deflect nails and cause them to run out at the side of the board.

Group 2 woods are:

Douglas fir	Pine, pitch
Hemlock, eastern	Pine, pond
Hemlock, west coast	Pine, shortleaf
Larch, western	Pine, slash
Pine, loblolly	Pine, table mountain
Pine, longleaf	Tamarack

Group 3 species. Group 3 woods are hardwoods of medium density. These woods have about the same nail-holding power and strength as a beam as the Group 2 woods, but are less inclined to split or shatter under impact. These are the most useful woods for box ends and cleats. They also furnish most of the rotary-cut veneer for wire-bound and plywood boxes.

Group 3 includes:

Ash, black	Red and sap gum
Ash, pumpkin	Sycamore
Elm, American or white	Tupelo
Maple, soft	

Group 4 species. Group 4 is made up of dense hardwood species. These species have great shock-resisting capacity and nail-holding power, but are hard to drive nails into and have more tendency to split at the nails than any of the other groups of woods, since they are our hardest and heaviest domestic woods. They are, however, especially useful where high nail-holding power is required, for blocking and skids, and many of them make excellent rotary-cut veneer for wire-bound and plywood boxes.

Group 4 woods are:

- Ash, white
- Beech
- Birch
- Elm, rock
- Hackberry
- Hickory
- Maple, hard
- Oaks
- Pecan

Strength differences between grades

The strength of a piece of lumber depends as much upon its grade as upon its species. The strength values of a grade depend upon the size and number of the strength-reducing defects, chief of which are knots, cross grain, shakes, splits, and wane. It is possible for high grade material of a species basically low in strength to be stronger than low grade material of a stronger species.

Unlike strength, stiffness is little affected by grade. The same working values for modulus of elasticity (a measure of stiffness) are commonly used for all grades of any one species.

Structural grades consist of material selected for its strength and stiffness. Pieces of similar strength values are grouped in a structural grade, and all pieces in that grade are assigned the same working stress for use in the engineering design of structures. Such grades are thus sometimes known as strength grades or stress grades. The permitted sizes of knots and other defects are related to their position in the piece and to the width of the face in which they appear; it follows that a piece so graded loses its grade when cut to smaller size or shorter length and must be regarded. An exception is the grading rules of the Southern Pine Inspection Bureau, which apply the same restrictions to defects anywhere in the piece, so that the piece can be shortened without affecting its grades. Decay or rot in any form is excluded from stress grades, but a few permit limited amounts of decay, usually in knots only.

Most grades of yard lumber are not graded primarily for strength. They are widely used, however, as joists and rafters in light construction, where their vending strength is important. Minimum Property Standards as shown in HUD 4900-1 give allowable spans for joists and rafters in 1- and 2-family dwellings, and show the strength and stiffness values for the grades of yard and structural lumber for which the spans were calculated. A yard grade can be used for joists, rafters, studs, or in similar framing of light buildings, but should not be used as a primary structural member, such as a main column or girder, in a large structure. Like most structural grades, the yard or dimension grades are intended for use as a whole piece, and cutting to short lengths or smaller sizes requires regrading, except in the case of southern pine. Minor trimming of ends, notching, boring, or otherwise fitting for a particular use does not change the grade.

Small or short pieces of wood can be used as diagonal braces in boxes or crates, bracing in freight cars, or wherever else strength is important. Such parts will often be cut from larger pieces of yard or dimension grade. They should be sorted for strength after they are so cut, excluding pieces that contain large knots or splits, bad cross grain (as indicated by seasoning checks that are inclined at an angle to the edges of the piece), or streaks or spots of decay. The larger piece can often be cut in such a way that these defects can be eliminated. A good rule is to exclude knots that occupy more than one-third the width of the face in which they appear, end splits whose length is more than the width of the piece, and cross grain that slopes more than 1 inch across the piece in 8 inches of its length.

CHAPTER 9. RECEIVING AND INSPECTION

GENERAL

The final responsibility for seeing that shipments of lumber conform to requirements set forth in the contract lies with DOD inspection personnel who receive and inspect incoming shipments. The purpose of this section is to outline means of tallying and inspection that will be mutually satisfactory to the installation, the defense construction supply center (DCSC), and the commercial suppliers who must make good on any proven shortages or inferior qualities. Systematic and thorough checking and inspection are essential if the installation is to be assured of getting what it is paying for and the supplier is to be promptly paid or notified why payment is being held up. It is to the long term interest of the Government that businesslike methods of tallying and inspection, so far as possible in keeping with commercial practices, be followed at the installation. For purposes of clarity and simplicity, tallying and inspection are discussed separately. In actual practice, however, competent employees can do certain phases of both more or less simultaneously.

Tallying

Tallying means the actual counting, measure, and recording of quantities and sizes received. The importance of accurate tallying cannot be overstressed. Reports of shortages are among the most common received by shippers from military installations. Needless to say, such reports must be based upon accurate checks of shipments; inaccurate tallying is wasteful of time and money to both the shipper and the receiver.

Procedure

Immediately upon receipt of the shipment, the following steps should be taken to insure accurate tallying:

(a) Before unloading is begun, the car should be examined for evidence of pilfering or damage en route, broken seals on boxcars should be recorded, and in open cars such evidence as missing stakes and broken strapping should be noted. The carrier should be notified immediately when there is evidence of pilferage or damage en route.

(b) Record the car seal numbers on the installation's tally sheet and compare them with the invoice, if it is available.

(c) Open the car and secure the shipper's tally card, which should be affixed inside. If none is included, the contracting office should be notified by phone immediately.

Note. If it is not possible to identify the shipment, the local railroad agent should be requested to furnish information as to point of origin and name of shipper, and this information should be sent to the contracting office together with a brief description of the car's contents.

(d) Unload the material in piles according to size and grade.

(e) Make the receiver's tally.

(f) Compare the receiver's tally with the shipper's tally.

(g) If any shortages are found, notify the contracting office within 10 days, and the entire shipment shall be held intact for retally. Failure to hold the entire shipment intact will result in loss of claim.

For efficient performance of the task of tallying, the lumber should be properly handled. With unpackaged lumber, either of two methods may be used, the "piece" tally or the "check" tally.

Piece tally. Piece tallying involves recording each piece on a tally sheet (Figure 52) as it is unloaded. This method is most practical for factory and shop lumber, which comes in random widths varying by fractions of an inch in various lengths, hence cannot be sorted into different widths before tally is made. As each piece is handled, the checker measures its width and length to determine its dimensions in order to record the piece properly on the tally sheet.

Although it is the only practical method of tallying the cutting grades of hardwoods and the factory and shop grades of softwoods, the piece tally method, lumbermen agree, allows many opportunities for error. If the attention of the one doing the tallying is distracted, he is likely to be uncertain as to whether particular pieces have been tallied. It is not unusual to find that some pieces are not recorded, others are tallied twice, and some are recorded in the wrong place. For these reasons, the check-tally method is preferred for tallying all lumber purchased in specific thicknesses and widths.

Check tally. Check tallying involves piling all lumber according to width, thickness, and length, as well as working and grade, as it is unloaded from the car. Thus, each item is piled by itself. This makes it comparatively easy to get an accurate count, or check. Such checking might be satisfactorily accomplished in many cases merely by counting the pieces in a tier and multiplying by the number of tiers. This is unreliable, however, because of occasional irregularities that occur in piling lumber in tiers and courses of different sizes, workings, and grades.

The usual commercial practice is for the checker to count the pieces of each item in the car after they are piled, recording them as he goes along (Figure 53). As evidence that this method is actually followed, the checker is usually required to mark the end of each piece with a colored crayon as it is counted.

(SPECIES)		(GRADE)				(THICKNESS)					(DATE)					
WIDTH	LENGTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	PCS
3	6																
	8	III															3
	10																
	12	II															2
	14																
	6	III															3
4	6																
	8	II															2
	10																
	12	III															3
	14																
	16	卌	I														6
5	6																
	8	I															1
	10																
	12																
	14	I															1
	16																
6	6	卌	I														7
	8	卌	卌	卌	卌	I											21
	10	III															3
	12	卌															5
	14	III															3
	16	卌	卌	II													12
8	6																
	8																
	10																
	12																
	14																
	16																
10	6																
	8																
	10																
	12																
	14																
	16																
12	6																
	8																
	10																
	12																
	14																
	16																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	

L-137

52. Tally sheet for factory and shop lumber.

X-3853

(SPECIES) (GRADE) (THICKNESS) (DATE)

SURFACE MEASURE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	NO. PCS.			TOTAL SURFACE MEASURE
1	𝍸															5			5
2																			
3																			
4	𝍸	III														8			32
5	𝍸	𝍸	I													11			55
6	III															3			18
7	𝍸	𝍸	II													12			84
8																			
9																			
10																			
11																			
12																			
13																			
14																			
15																			
16																			
17																			
18																			
19																			
20																			
21																			
22																			
23																			
24																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15				

L-138

53. Tally sheet for yard lumber.

X-3854

Where volume justifies, it is recommended that two checkers count the lumber in the same shipment. This tends toward greater accuracy and makes rechecking easier if errors are found. If only one checker is used, it is recommended that he double check each shipment.

For packaged lumber, a version of the check tally system is used. The checker counts each piece in the bundle and records it. Where all lumber in the package is of one thickness, width, and length, checking is a simple matter. Bundles must be carefully examined to see whether they contain different widths; difference in length are easily detected. Lumber of different thicknesses is rarely, if ever, put in the same bundle. See MIL-L-14362.

Plywood tallying is done similarly. For softwood plywood of standard commercial grades and qualities, it is necessary only to count the number of sheets, or panels, of each surface size and thickness. For hardwood plywood, it may also be necessary to check the number of plies as well as the overall thickness of the panels, if the order includes more than one number of plies for the same thickness.

Inspection

Inspection for quality involves examination of material received for species, moisture content, grade, type, and sometimes class. The scope of each inspection depends to some extent upon the type of grading or inspection made by the shipper. In all cases, however, material must be inspected to see that it conforms with the requirements of the contractual document covering it.

Generally speaking, the term “quality” includes not only such things as lumber defects and plywood glue lines but also size and, sometimes, density. Communication poles, for example, while produced in only one quality, are bought by classes based on size and hence must be inspected for size to determine whether the correct class has been supplied. Likewise, certain grades of structural lumber must be inspected for density, upon which their stress rating is largely based. All lumber must be inspected for conformance to requirements for length and width.

The great complexity of the various rules and standards governing lumber and allied products imposes heavy responsibilities upon those charged with their acceptance or rejection. These responsibilities are considerable lightened by certain industry practices, notably grade marking and certified inspection services.

The decision for acceptance or rejection, however, still rests finally with those responsible for acceptance. Inspectors must be familiar enough with the various commercial species and grades to be able to determine whether grademarked or certificated material is actually up to grade. Graders can make mistakes, and instances have occurred where grademark stamps have been fraudulently used. The importance of inspecting all material for conformance with the contractual document, therefore, cannot be overemphasized. Material offered for Government inspection which contains woodboring insects or marine borers, in any state of development at the time of inspection, will be rejected.

Softwood lumber. The inspection standards and all other provisions of the grading rules of the associations and bureaus cited in Government purchase solicitations shall govern the inspection and acceptance by the Government of softwood lumber offered for delivery unless otherwise stipulated in a contract. Each piece of softwood lumber offered for delivery under a contract shall have been inspected, graded, and trademarked with an official grademark and registered symbol of the applicable association or bureau or an inspection agency approved by the Board of Review, American Lumber Standards Committee, at the contractor's expense prior to Government inspection. If no official grademark exists for the species or grade to be furnished, a certificate of inspection shall be issued at the contractor's expense for each truck or rail car shipment.

Hardwood lumber. The inspection standards and provisions of the grading rules of one of the following associations shall govern the inspection of hardwood lumber:

(a) Maple Flooring Manufacturers Association
(b) National Hardwood Lumber Association (NHLA)
(c) National Oak Flooring Manufacturers Association

Each piece of the NHLA Standard Grades of hardwood lumber, except No. 3A and 3B commons, shall be, unless otherwise specified in a contract, graded and hammer branded by an NHLA National Inspector prior to offering the material to the Government. The National Inspector shall complete a Certificate for each shipment certifying that the grade and tally of the lumber meets the contract requirements.

The contractor shall bear the cost of the Certificate, including incidental expenses of the National Inspector. For shipments to overseas activities, the Certificate shall be furnished the Defense Contract Administration Services representative. For shipments to CONUS activities, the Certificate shall be furnished with the contractor's invoice mailed to the destination Quality Assurance Representative. The Certificate may be used by the Government as evidence that the material conforms to the grade requirements of the contract.

Shipments. For shipments to overseas activities, material will be inspected and accepted at origin. A Certificate of Conformance, may be required from the contractor certifying that the moisture content, end-coating, and sizes, as well as grade and tally, satisfies the contract requirements.

For shipments to CONUS activities, wood products will be inspected and accepted at destination. The one exception is pressure treated wood products which will require origin inspection. Government inspection shall be for tally, moisture content, and coating and sizes, as well as grade.

Plywood . Plywood furnished in accordance with Federal Specification NN-P-530, "Plywood, Flat Panel", shall be inspected by the contractor prior to Government inspection. Each softwood plywood panel shall be grade trademarked in accordance with the applicable product standard and shall bear the stamp of one of the following qualified inspection agencies:

(a) American Plywood Association
(b) Timber Engineering Company
(c) Pittsburgh Testing Laboratory

Hardwood and softwood plywood, other than specified above, shall be inspected by the contractor prior to Government inspection. When trademarking requirements are provided in the applicable specification, the contractor shall grademark each panel, otherwise the contractor shall furnish a Certificate from the manufacturer stating that the material meets the requirements of the applicable specification.

Other Wood Products. The contractor shall inspect and grade each piece of material offered for delivery prior to Government inspection. Tests set forth in the applicable specification will be performed by the contractor at his expense. Test records and other data shall be furnished to the Government on each shipment.

Complaints

When the complaint relates to grade, size, or working and does not involve tally, the buyer is required to accept the portion of shipment which is of proper grade, size, or working, as the case may be, holding intact the portion thereof which is in dispute for Bureau inspection. Grade complaints may be made on lumber only when it is in the form in which it was shipped. Any change in manufacture or working, or through kiln drying, fabrication, or use, relieves the seller of responsibility for recognizing any grade complaint. If a complaint is made on moisture content, the buyer shall notify the shipper within 72 hours after lumber is unloaded, and the shipper shall either adjust the complaint within 72 hours in a way that is satisfactory to the buyer or arrange for inspection. In case of inspection on a complaint for moisture content, each piece shall be tested and a separation made of all pieces conforming to the maximum allowable moisture content from any portion exceeding such maximum. All lumber on which complaint is made as to moisture content must be fully protected from conditions which would tend to increase its moisture content, and if there is evidence upon arrival of the Quality Supervisor that these provisions have not been observed, the seller shall be relieved of responsibility for any excess moisture found in the lumber.

Rights and responsibilities of complainant buyers. The rights and responsibilities of complainant buyers are:

(a) Acceptance and use by the buyer of a portion of shipment shall not be construed as his acceptance of the entire shipment.

(b) Buyer shall pay in accordance with the terms of sale for the portion he accepts or for any portion not held intact for inspection, but his acceptance of a part of a shipment does not prejudice his just claim on any unused lumber alleged by him to be below grade or not of the size or working ordered.

(c) Complainant buyer shall hold disputed lumber intact, properly protected, for a period not exceeding 30 days after date of request for inspection, and shall file complaint with seller within 10 days from receipt of shipment.

(d) Because of the unusual conditions that apply to lumber that is shipped in wrapped or strapped packages, the time limit for filing a complaint on the grade, size, or working of such lumber does not have to be restricted to 10 days in all cases.

(e) Complaints on lumber shipped in wrapped or strapped packages shall be recognized if filed later than 10 days but not later than 90 days after receipt of shipment provided:

(1) the lumber is grademrked or marked in some other acceptable manner for establishing its identity in a positive way,

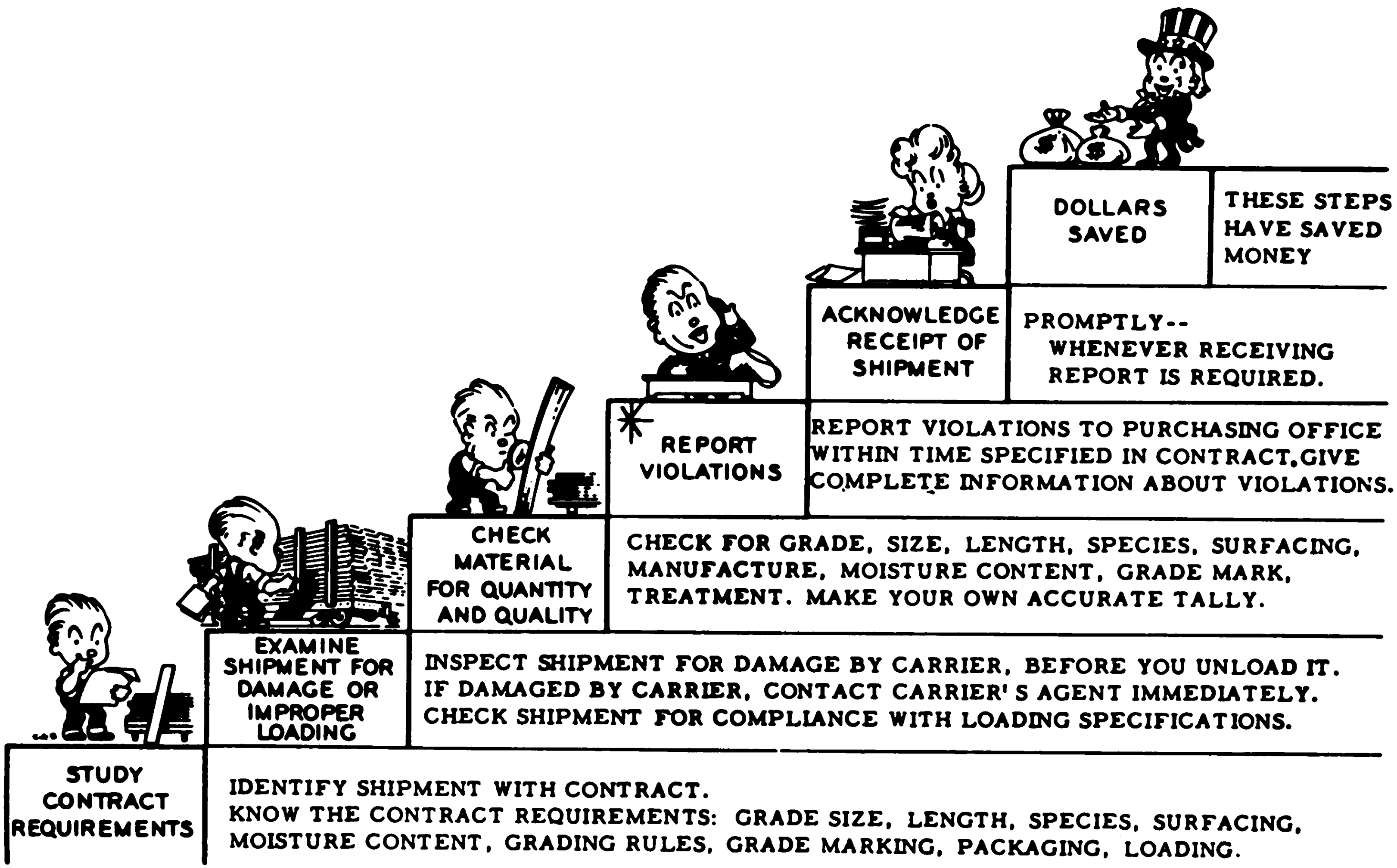
(2) there is no evidence of handling abuse or inadequate protection, and

(3) the seller’s responsibility for below grade lumber shall apply only to the portion which patently did not conform to the grade requirements at the time of shipment as shown in the Quality Supervisor’s report.

Figure 54 illustrates responsibilities of the buyer in receiving lumber and allied products.

Authorized Inspection Agencies

Agencies authorized to grade mark lumber under DCSC contracts are certified by the Board of Review of the American Lumber Standards Committee. Following, are the names and addresses of the agencies, along with a sample of their typical grade stamp: (Certification by the Board of Review is limited to the inspection and grading of untreated lumber in yard, structural, and shop grades. It does not include the grading or inspection of any treated material, poles, piles, cross-arms, car lumber, ties, etc., which are not within the scope of American Lumber Standards).



✱Report violations to Purchasing Office promptly so that Contracting Officer may notify the supplier within 10 days after arrival on grade or tally and within 24 hours after unloading on moisture content violations. Protect material from weather pending settlement.

FIGURE 54. Important steps in receiving lumber and allied products. L-139

X-3855

CALIFORNIA LUMBER INSPECTION SERVICE
1190 Lincoln Avenue
San Jose, California 95125

Approval as an inspection agency including mill supervisory service under the rules of the West Coast Lumber Inspection Bureau, Western Wood Products Association, Redwood Inspection Service and the National Grading Rule (NGR) portion of the Standard Grading Rules for Canadian Lumber, and for Boards and the NGR portion of the rules of Southern Pine Inspection Bureau rules.

Note: Grading done under rules indicated in grademark. Redwood indicates grading under Redwood Inspection Service rules.

MILL 467
CLIS ® STAND
S-GRN WCLB
DOUG. FIR

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION, INC.
4 Fundy Road
Falmouth, Maine 04105

Approval of rules they publish and as an inspection agency including mill supervisory service under these rules and the NGR portion of the 1970 Standard Grading Rules for Canadian Lumber.

Note: Grading done under Northeastern Lumber Manufacturers Association, Inc., rules which they publish unless National Lumber Grades Authority of Canada grading rules indicated in gradestamp.

S-GRN
CONST
EASTERN
HEM-TAM
NELMA ®

X-3856-I

NORTHERN HARDWOOD AND PINE MANUFACTURERS ASSOCIATION, INC.
Suite 207, Northern Building
Green Bay, Wisconsin 54301

Approval of grading rules they publish as an inspection agency including mill supervisory service under these rules.

Note: Grading done under Northern Hardwood and Pine Manufacturers Association, Inc., rules which they publish.

EASTERN SPRUCE
NORTHERN
SEL. STR.
S-DRY
LICENSE NO.1
NHPMA

PLIB®
W-10
CONST
S-GRN
HEM-FIR WCLB RULES

PACIFIC LUMBER INSPECTION BUREAU, INC.
1411 Fourth Avenue Building (Suite 1130)
Seattle, Washington, 98101

Approval of an inspection agency including mill supervisory service under the rules of West Coast Lumber Inspection Bureau, Western Wood Products Association, Redwood Inspection Service, and the NGR portion of the 1970 Standard Grading Rules ofr Canadian Lumber.

Note: Grading done under rules indicated in the grademark.

REDWOOD INSPECTION SERVICE
617 Montgomery Street
San Francisco, California 94111

Approval of rules they publish and as an inspection agency including mill supervisory service under these rules, rules of West Coast Lumber Inspection Bureau and Western Wood Products Association.

Note: Grading done under Redwood Inspection Service rules, which they publish, unless West Coast Lumber Inspection Bureau or Western Wood Products Association rules indicated in grademark.

50
FDTN
S-GRN
REDWOOD RIS®

SPIB® No. 2 MG
S-DRY 1450f (7)

SOUTHERN PINE INSPECTION BUREAU
4709 Scenic Highway, P.O. Box 846
Pensacola, Florida 32594

Approval of rules they publish and as an inspection agency including mill supervisory service under these rules and the National Grading Rule portion of the rules of Northeastern Lumber Manufacturers Association.

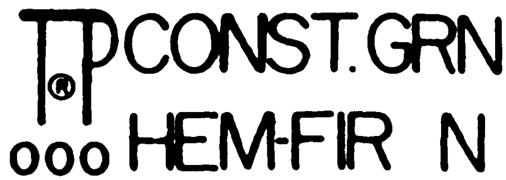
Note: Grading done under Southern Pine Inspection Bureau rules which they publish unless Northeastern Lumber Manufacturers Association rules indicated in grademark.

X-3856-2

TIMBER PRODUCTS INSPECTION & TESTING SERVICE, INC.
6440 Hillandale Road, P.O. Box 456
Lithonia, Georgia 30058

Approval as an inspection agency including mill supervisory service under the rules of the Redwood Inspection Service, Southern Pine Inspection Bureau, West Coast Lumber Inspection Bureau, Western Wood Products Association, the NGR portion of Northeastern Lumber Manufacturers Association, Inc., and the NGR portion of the 1970 Standard Grading Rules for Canadian Lumber.

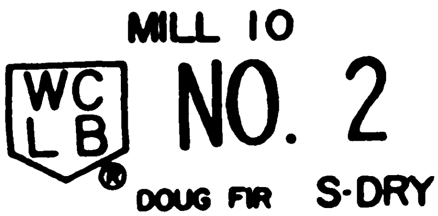
Note: Grading done under rules indicated in grademark.



WEST COAST LUMBER INSPECTION BUREAU
Box 23145
Portland, Oregon 97223

Approval of rules they publish and as an inspection agency including mill supervisory service under these rules, the rules of the Redwood Inspection Service, Western Wood Products Association and NGR portion of the 1970 Standard Grading Rules for Canadian Lumber.

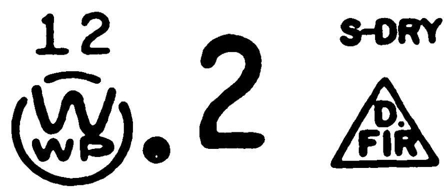
Note: Grading done under West Coast Inspection Bureau rules, which they publish, unless Western Wood Products Association or National Lumber Grades Authority of Canada rules indicated in grademark. Redwood indicates grading under Redwood Inspection Service rules.



WESTERN WOOD PRODUCTS ASSOCIATION
1500 Yeon Building
Portland, Oregon 97204

Approval of rules they publish and as an inspection agency including mill supervisory service under rules they publish, the rules of West Coast Lumber Inspection Bureau and for Studs under the rules of the Redwood Inspection Service and the NGR portion of the 1970 Standard Grading Rules for Canadian Lumber.

Note: Grading done under Western Wood Products Association rules, which they publish, unless West Coast Lumber Inspection Bureau or National Lumber Grades Authority of Canada rules indicated in grademark. Redwood indicates grading under Redwood Inspection Service rules.



X-3856-3

The following Canadian agencies have been certified by the Board of Review of the American Lumber Standards Committee as inspection agencies including mill supervisory service under the Standard Grading Rules for Canadian Lumber.

A.F.P.A.® 00
S—P—F
S-DRY STAND

Alberta Forest Products Association,
204 - 11710 Kingsway Avenue,
Edmonton, Alberta T5G 0X5

C L®A
S-P-F
100
No. 1
S-GRN.

Canadian Lumberman's Association,
27 Goulburn Avenue,
Ottawa, Ontario K1N 8C7

CLMA® 2 S-DRY 3
D FIR

Cariboo Lumber Manufacturers Association,
301 - 197 Second Avenue North,
Williams Lake, B.C. V2G 1Z5

CFPA® 38
S-P-F S-GRN
CONST

Central Forest Products Association
(formerly Manitoba Forest Products Association),
14 G-1975 Corydon Avenue,
Winnipeg, Manitoba R3P 0R1

COFI HEM-FIR
S-GRN
00 No1

Council of Forest Industries of British Columbia
1500 - 1055 West Hastings Street,
Vancouver, B.C. V6E 2H1

NILA® 278
S·P·F
S-DRY 1

Council of Forest Industries of British Columbia,
Northern Interior Lumber Sector,
514 - 550 Victoria Street,
Prince George, B.C. V2L 2K1

ILMA® S-DRY 1
00 S—P—F

Interior Lumber Manufacturers Association,
295 - 333 Martin Street,
Penticton, B.C. V2A 5K7

0 0 CONST
S-GRN
D FIR
NLGA RULES

MacDonald Inspection,
125 East 4th Avenue,
Vancouver, B.C. V5T 1G4

M L B SPRUCE PINE FIR STAND S-GRN
MILL 11 - 466

Maritime Lumber Bureau,
P.O. Box 459,
Amherst, Nova Scotia B4H 4A1

O.L.M.A.® 01-1
CONST S-DRY
SPRUCE-PINE-FIR

Ontario Lumber Manufacturers Association,
159 Bay Street, Suite 414,
Toronto, Ontario M5J 1J7

PLIB® NLGA RULE
No 1
S-GRN
00 HEM-FIR

Pacific Lumber Inspection Bureau,
Suite 1130,
1411 Fourth Avenue Building,
Seattle, Washington 98101
B.C. Division:
1460 - 1055 West Hastings Street
Vancouver, B.C. V6E 2G8

QLMA®
72
SPRUCE-PINE-FIR
CONST. S-DRY

Quebec Lumber Manufacturers Association,
Suite 540, 580 Grande-Allee
Quebec, Quebec G1R 2K2

S.T.B.® 101
S-P-F CONST
S-GRN

Saskatchewan Forest Products Corporation,
101 First Avenue East
Prince Albert, Sask. S6V 2A5

X-3856-4

CHAPTER 10. SEASONING OF LUMBER

GENERAL

Seasoning of lumber is absolutely essential for some uses; for other uses it is highly advisable. Seasoning takes time - from a few days for kiln drying of boards and 2 inch dimension of most softwoods, up to many months for air drying under such adverse conditions as cold or humid weather. Kiln drying, too, has its limitations; for lumber in thicknesses above 2 inches, kilns must be operated with extreme care over comparatively long periods of time if it is necessary to prevent checking, honeycombing, and other seasoning defects. Walnut gunstock blanks green from the saw, for example, may take 45 days or longer in the kiln. Lumber more than 2 inches thick dries very slowly. For this reason, seasoning of such thick stock is not recommended for most construction uses. It should be understood that dry stock in the thicker dimension and timber sizes is not commonly available in a seasoned condition - say 20 percent moisture content or less.

The seasoning processes discussed herein consist of removing moisture from wood by exposing it to the outdoor air or to the air in a heated kiln. The moisture content of wood is determined by dividing the weight of the water by the weight of the ovendry wood and is expressed as a percentage. For example, if the present weight of a sample is 5 pounds and its weight when ovendry is 4 pounds, the weight of the moisture is 5 minus 4 pounds or 1 pound. The weight of the moisture divided by the weight of the ovendry wood is one-fourth, or 25 percent, which is the moisture content of the sample. Generally, weighing for sampling purposes, as in kiln drying, is done under the metric system, using gram units.

Moisture is held in wood in two ways. It is contained within the cell cavities and also within the cell walls. The liquid within the cavities is called “free” water and that within the cell walls is termed “bound” water. Wood, like many other materials, shrinks as it loses moisture and swells as it absorbs moisture. When wood has dried to the point at which all the free water is evaporated and the cell walls remain saturated, wood is said to have reached the fiber-saturated point. For practical purposes, the fiber-saturated point is considered to be 30 percent moisture content for all species. Shrinkage occurs if the moisture content is reduced to a value below that of the fiber-saturation point - that is, as the adsorbed moisture begins to leave the cell walls. Wood dried to 15 percent moisture content has attained about one-half of its total shrinkage. For each 1 percent loss in moisture content, below the fiber-saturation point, wood shrinks about one-thirtieth of the total amount possible. Likewise, for each 1 percent increase in moisture content, up to the fiber-saturation point, the piece swells about one-thirtieth of the total amount possible. Shrinking and swelling are expressed as percentages of the green dimensions of the wood. As a piece of wood dries, the surfaces start to shrink considerably sooner than the inner parts. Thus , the whole piece may show some shrinkage before its average moisture content reaches the fiber-saturation point.

A flat-sawed board shrinks more in width than in thickness, and very little as a rule along its length. Table XIX gives average shrinkage values for commercially important species during drying from the green condition to 20, 6, and O percent moisture content. Tangential shrinkage is the shrinkage in width of a flat-sawn board; radial shrinkage, the shrinkage in thickness of a flat-sawn board, and volumetric shrinkage, the combined shrinkage of width, thickness, and length. Tangential shrinkage is about twice as great as radial. Figure 55 shows the characteristic shrinkage and distortion of flats, squares, and rounds as affected by the direction of the annual rings. Suppose a board has 25 percent moisture content when used to make a box, and the box is stored so that it dries to 10 percent. One-half of the total shrinkage possible then takes place. For a flat-sawn, 10 inch southern yellow pine or Douglas fir board this would be about 0.4 inch in width, according to Table XIX. In general, the heavier species of wood shrink more across the grain than lighter ones. Heavier pieces also shrink more than lighter pieces of the same species. Hardwoods generally shrink more than softwoods. Not all species, however, conform to the general shrinkage pattern. For example, basswood is lightweight wood, but shrinks considerably more than black locust, a heavy wood.

The longitudinal shrinkage of normal wood is very small, usually ranging from 0.1 to 0.3 percent of the green length. Exceptionally light wood of any species tends to shrink excessively in length.

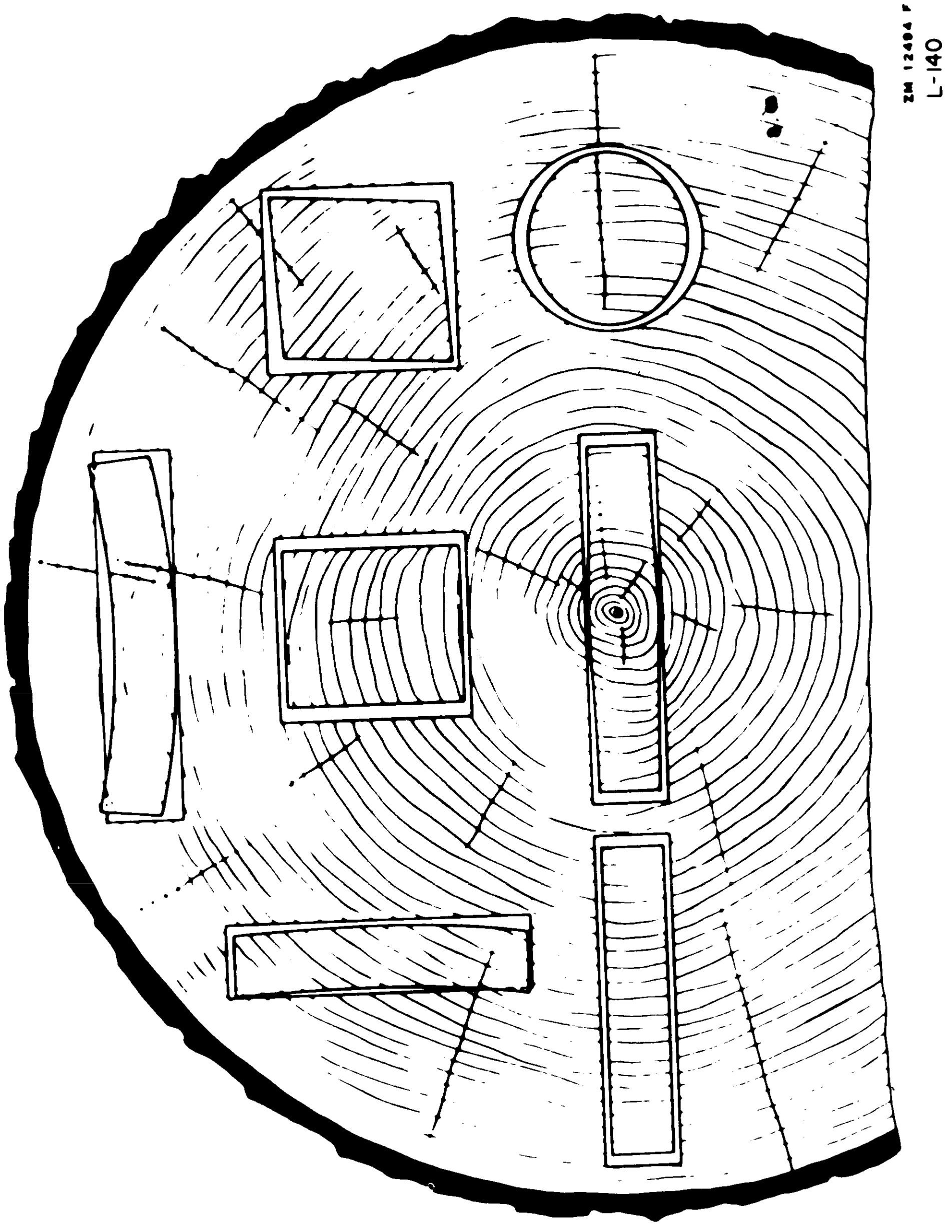


FIGURE 55. Tangential and radial shrinkage.

X-3857

TABLE XIX. Shrinkage values for commercially important woods.

Species	Shrinkage (percent of dimensions when green)								
	Dried to 20 percent moisture content 1/			Dried to 6 percent moisture content 2/			Dried to 0 percent moisture content		
	Radial	Tan-gential	Volu-metric	Radial	Tan-gential	Volu-metric	Radial	Tan-gential	Volu-metric
SOFTWOODS	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Cedar:									
Western red	0.8	1.7	2.3	1.9	4.0	5.4	2.4	5.0	6.8
Incense 1/	1.1	1.7	2.5	2.6	4.2	6.1	3.3	5.2	7.7
Cypress	1.3	2.1	3.5	3.0	5.0	8.4	3.8	6.2	10.5
Douglas fir:									
Coast type	1.7	2.6	3.9	4.0	6.2	9.4	4.8	7.6	12.4
Mountain type	1.2	2.1	3.5	2.9	5.0	8.5	3.6	6.2	10.6
Fir, white	1.1	2.4	3.3	2.6	5.7	7.8	3.3	7.0	9.8
Hemlock:									
Eastern	1.0	2.3	3.2	2.4	5.4	7.8	3.0	6.8	9.7
West Coast	1.4	2.6	4.0	3.4	6.3	9.5	4.2	7.8	12.4
Larch, western	1.4	2.7	4.4	3.4	6.5	10.6	4.5	9.1	14.0
Pine:									
Idaho white	1.4	2.5	3.9	3.3	5.9	9.4	4.1	7.4	11.8
Lodgepole	1.5	2.2	3.8	3.6	5.4	9.2	4.3	6.7	11.1
Northern white	0.8	2.0	2.7	1.8	4.8	6.6	2.3	6.0	8.2
Norway (red)	1.5	2.4	3.8	3.7	5.8	9.2	3.8	7.2	11.3
Ponderosa	1.3	2.1	3.2	3.1	5.0	7.7	3.9	6.2	9.7
Southern yellow longleaf	1.7	2.5	4.1	4.1	6.0	9.8	5.1	7.5	12.2
Sugar	1.0	1.9	2.6	2.3	4.5	6.3	2.9	5.6	7.9
Redwood (old growth)	0.9	1.5	2.3	2.1	3.5	5.4	2.6	4.4	6.8
Spruce:									
Engelmann	1.1	2.2	3.5	2.7	5.3	8.3	3.8	7.1	4.0
Sitka	1.4	2.5	3.8	3.4	6.0	9.2	4.3	7.5	11.5

TABLE XIX. Shrinkage values for commercially important woods. - Continued

Species	Shrinkage (percent of dimensions when green)								
	Dried to 20 percent moisture content 1/			Dried to 6 percent moisture content 2/			Dried to 0 percent moisture content		
	Radial	Tan-gential	Volu-metric	Radial	Tan-gential	Volu-metric	Radial	Tan-gential	Volu-metric
HARDWOODS	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Ash, white	1.6	2.6	4.5	3.8	6.2	10.7	4.9	7.8	13.3
Aspen, quaking	1.2	2.2	3.8	2.8	5.4	9.2	3.5	6.7	11.5
Basswood	2.2	3.1	5.3	5.3	7.4	12.6	6.6	9.3	15.8
Birch, yellow	2.4	3.1	5.6	5.8	7.4	13.4	7.3	9.5	16.8
Hickory, shagbark	2.3	3.3	5.6	5.6	8.0	13.4	7.0	10.5	16.7
Locust, black	1.5	2.4	3.4	3.7	5.8	8.2	4.6	7.2	10.2
Maple, sugar	1.6	3.2	5.0	3.9	7.6	11.9	4.8	9.9	14.7
Oak, northern red	1.3	2.7	4.5	3.2	6.6	10.8	4.0	8.6	13.7
Oak, white	1.8	3.0	5.3	4.2	7.2	12.6	5.3	9.0	15.8
Yellow poplar	1.3	2.4	4.1	3.2	5.7	9.8	4.6	8.2	12.7

1/ These shrinkage values have been taken as one-third the shrinkage to the ovendry condition as given in the last three columns of this table.

2/ These shrinkage values have been taken as four-fifths of the shrinkage to the ovendry condition as given in the last three columns.

METHODS OF SEASONING

The trade terms “ship ping-dry,” “air-dry,” and “kiln-dried,” although widely used, have no specific or generally agreed meaning with respect to quantity of moisture. The wide limitations of these terms as ordinarily used are covered in the following statements, which, however, are not exact definitions:

(a) Shipping-dry lumber. Lumber that is partially air dried to reduce freight charges.

(b) Air-dry lumber. Lumber that has been dried by exposure to the air either outdoors or in an unheated shed. If exposed for a sufficient length of time, it may have a moisture content ranging from 6 percent, as in the summer in the arid southwest, to 24 percent, as in the winter in the Pacific northwest. For the United States as a whole, the minimum moisture content range of thoroughly air-dry lumber is 12 to 15 percent, but the general average is closer to 20 percent.

(c) Kiln-dried lumber. Lumber that has been kiln dried for any length of time. Properly kiln-dried lumber in the finish grades of softwoods and hardwoods intended for general use will ordinarily have a moisture content of 6 to 10 percent. Kiln-dried softwood lumber of the common yard grades is likely to have a considerably higher moisture content.

Table XX gives recommended moisture content values for various parts of wood frame buildings and millwork at the time of installation. At these values, wood will shrink and swell a minimum under normal weather and interior heating conditions for the area indicated.

TABLE XX. Recommended moisture content values for various wood items at time of installation. 1/

Use of lumber	Moisture content for 2/					
	Dry Southwestern States		Damp Southern Coastal States		Remainder of the United States	
	Average	Individual pieces	Average	Individual pieces	Average	Individual pieces
	Percent	Percent	Percent	Percent	Percent	Percent
Interior finish woodwork and softwood flooring.	6	4-9	11	8-13	8	5-10
Hardwood flooring.	6	5-8	10	9-12	7	6-9
Siding, exterior trim, sheathing, and framing. 3/	9	7-12	12	9-14	12	9-14

1/ Applicable to dwelling with heating systems other than floor radiant-heating system.

2/ If the average is within ±1 percent of the optimum and the moisture content values of all the pieces fall within the prescribed range, the entire lot will probably be satisfactory.

3/ Framing lumber of higher moisture content is commonly used in ordinary construction because material of the moisture content specified may not be available except on special order.

Advantages of seasoning methods.

(a) Air drying. The principal advantages of air-dried wood over green wood are weight reduction, with a resulting decrease in shipping costs ; reduction in shrinkage, checking, honeycombing and warping while in service; less tendency for stain and decay fungi to attack the wood; less likelihood of attack by some insects; increase in strength; and better capacity to hold paint or receive preservative treatment.

(b) Kiln drying. Among advantages of kiln drying over air drying are the following: greater reduction in weight and, consequently, in shipping charges; reduction in moisture content to any desired value between 3 and 15 percent moisture content, which may be lower than that obtainable through air drying; reduction in drying time below that required in air drying; and the killing of any stain or decay fungi or insects that may be in the wood.

Measurement of Moisture Content

Electric moisture meters are convenient instruments for rapidly inspecting lumber for moisture content as it is received at the installation. Small, compact, and easy to handle, they can be used as lumber is unloaded from the car or truck. Two types of electric moisture meters are on the market - a resistance type (Figure 56) and a radio-frequency type (Figure 57).

Resistance type. The resistance of wood to the passage of electricity changes at a tremendous rate with changes in moisture content, especially below the fiber saturation point. In the resistance type of meter this quality of varying resistance is utilized to measure moisture content of a piece of wood. Above the fiber-saturation point, wood's resistance to the passage of an electric current changes only slightly and with no consistent pattern; on the other hand, below about 5 percent moisture content the resistance becomes so high that it is difficult to measure. Thus, moisture meters of the resistance type are most accurate in the range of about 7 to 25 percent moisture content. In this range their accuracy, when properly used, should be within 1 percent of the actual moisture content of the wood. Readings above 25 percent will probably not be as accurate as those in the lower range, but ordinarily they do not need to be.

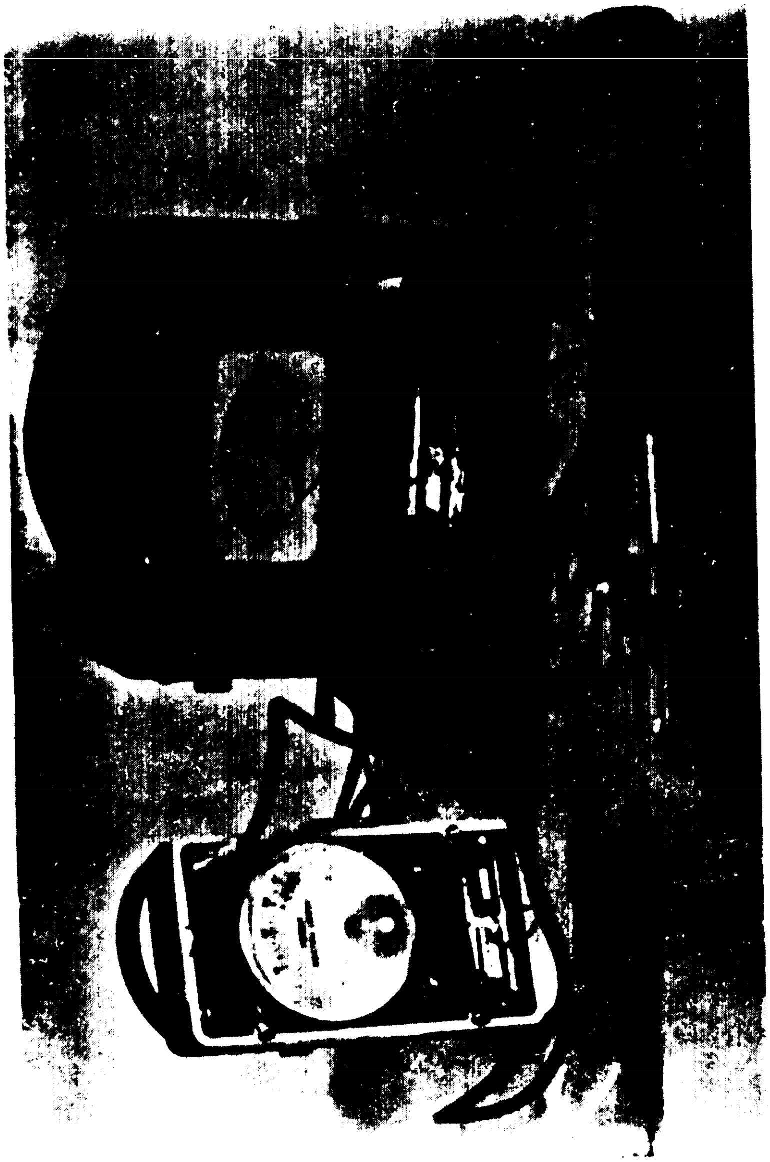


FIGURE 56. Two models of resistance-type moisture meters and two types of needle electrodes.

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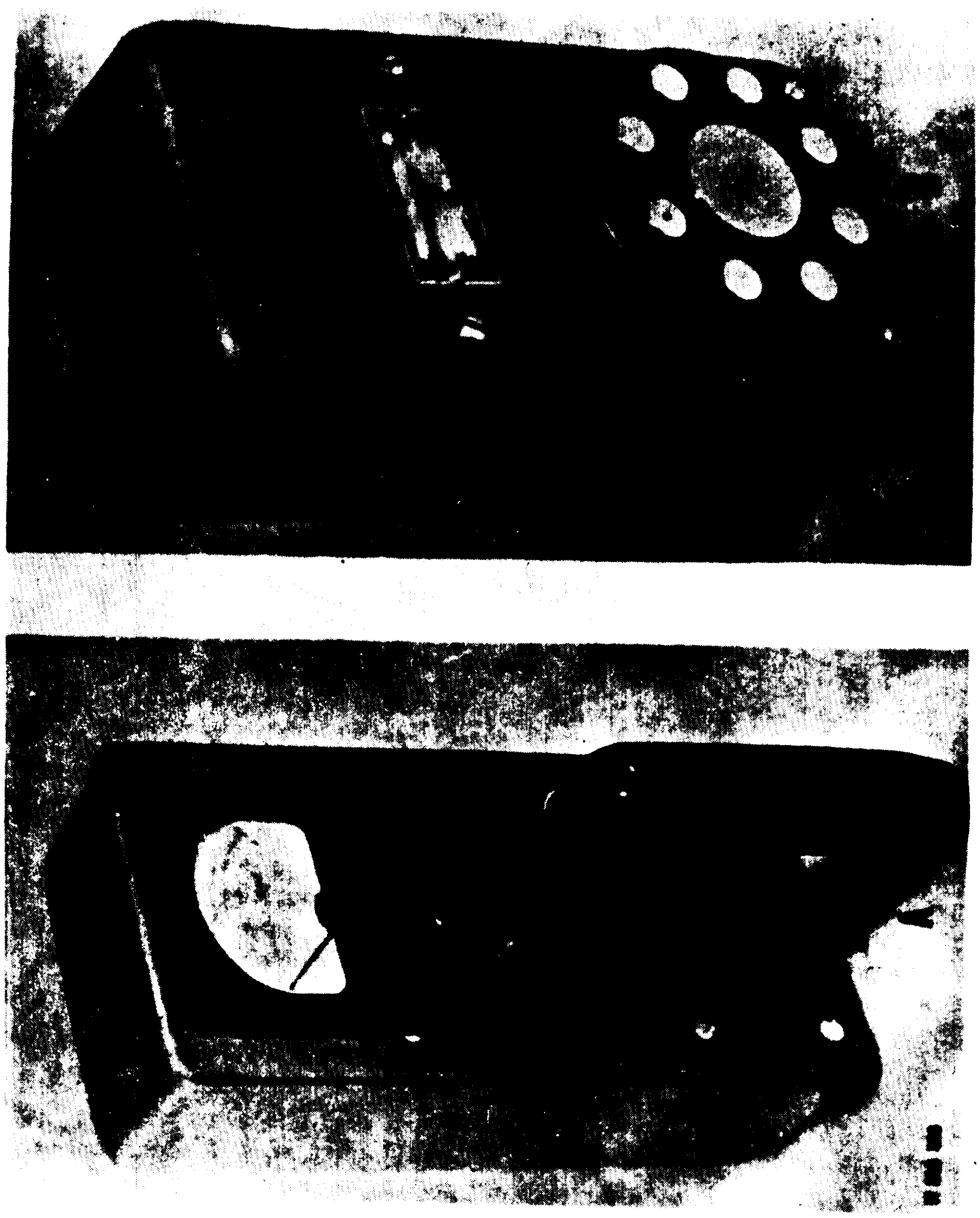


L-142

FIGURE 57. Radio-frequency type of moisture meter showing the top view, A, and the bottom side, B.

X-3859

To use a resistance-type meter, electrical contact must be made with the wood at two points. Usually this is done by driving needle electrodes into the wood. Current flow between the electrodes follows the path of least resistance, which is the path of the wettest wood between the needles. Therefore the percentage of moisture shown on the dial of the meter is always that of the wettest wood in contact with the needles. This can be misleading if the surface of the lumber is much wetter than the rest of the piece and uninsulated needle electrodes are used. The meter will give an untrue reading because the wet surface provides a low-resistance path between the needles, even though the needle points are embedded in wood that might be much dryer.

To get an accurate reading, it is desirable to use electrode needles that are covered, except for their tips, with an insulating resin. The resin insulates the needles so that the meter will be sure to indicate the moisture content of the wood at the tips of the needles.

Needles should be driven to a depth approximately one-fourth of the thickness of the piece being checked.

> Note: Temperature of the wood affects the readings, therefore to correct the meter reading from the standard of 70° F, add 1 percent to the reading for each 20° F that the wood is below that standard; subtract 1 percent for each 20° F that the wood is above 70° F. Also, wood treated with preservatives or fire retardants will give inaccurate meter readings. Readings are likely to be high, but by how much is difficult to predict.

Radio-frequency type. The dielectric properties of wood, in particular the radio-frequency power absorption, depend upon the moisture content of the wood. Moisture meters of the radio-frequency type are based on this principle. An electrode is used that radiates low-power radio waves into the wood, and a sensitive meter indicates the relative rate of power absorption by the wood. This type of meter can be calibrated to read moisture content directly for one species of wood, or it can be calibrated in units that can be converted to moisture content values for various species by consulting calibration tables. The radio-frequency power absorption of wood varies smoothly and is easily measured over a range of moisture content from zero to near the fiber saturation point. Readings are, however, appreciably affected by density of the wood. Presumably the species correction provides for the density effect, but the density of an individual sample may be different than the average for the species. Still, the average moisture content of a load of lumber can be obtained with reasonable accuracy if a large enough sample is checked. Depth of penetration of the radio-frequency field is about 1/8 inch for veneer electrodes, about 3/4 inch for lumber electrodes, and about 2 inches for thick-material electrodes. Readings made on material more than two or three times as thick as the field penetration may be subject to a large error because they could fail to detect a high moisture content near the middle of the piece.

> Note: Superficial moisture from rain or dew will interfere with accurate moisture measurement with this type of meter. Inaccurate readings will also result when the meter is used on wood treated with preservatives or fire retardants.

CHAPTER 11. HANDLING OF LUMBER

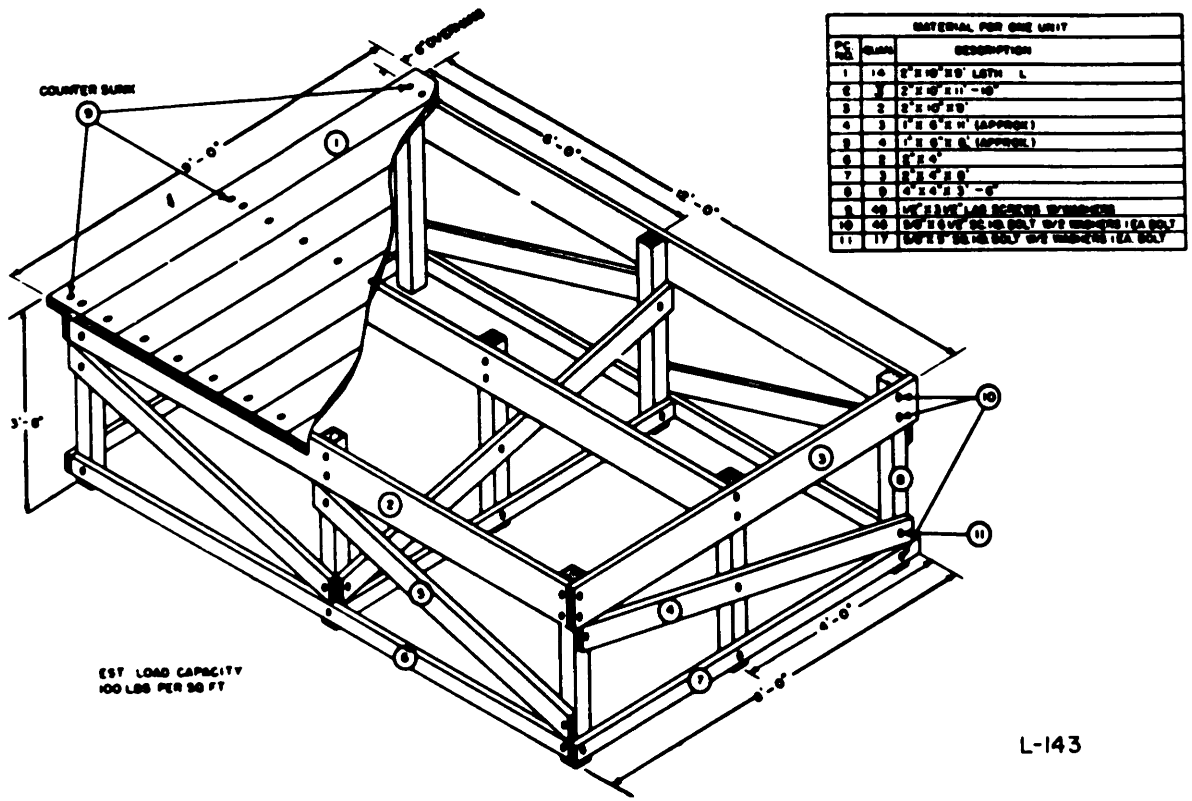
GENERAL

The advances made in the mechanized handling of lumber have to a great extent changed storage and handling methods. The development of handling equipment, such as forklift and straddle trucks or carriers, that can be used to pile, unpile, and transport lumber has brought about revolutionary changes in storage and handling practices; the most notable being the handling of lumber in packages. Regardless of whether lumber is handled by mechanized equipment or by manual labor, the objectives of handling are unchanged. The objectives are to load, transport, unload, pile, and unpile lumber economically and without damage. Lumber is received hand-loaded in boxcars and protected trucks or in strapped packages loaded on open-top gondolas, flatcars, barges, or trucks, in accordance with MIL-L-14362. In the past, the objective of most activities has been to unload the carrier as quickly as possible, the overall handling cost per board foot usually being considered secondary to the unloading of the carrier. Therefore, boxcar shipments of lumber were often double handled to speed unloading. Methods have been designed to eliminate double handling of lumber, to develop permanent packages, and to unload boxcars in less time than was possible under past methods. These methods will permit the building of packages of lumber at the freight car door, which will eliminate rehandling prior to storage. Unit-type packages described in MIL-L-14362 can be used; although unit sizes given therein can be modified to fit requirements of the receiver for handling and storage of accepted lumber.

Carrier Unloading

Place a platform, constructed as shown in Figure 58 in front of the doorway of the car to be unloaded. A platform may be placed on one or both sides of the car to facilitate unloading, sorting, and distribution of lumber to the buttboards, which are convenient aids for piling lumber in packages. The buttboards should be placed strategically around the unloading platforms in such a manner that, as the packages are completed, they may be picked up by straddle or forklift truck and transported to storage yard or point of use. Standing on the platform, the car man can work with greater confidence and safety, gain more leverage, and acquire more dexterity in unloading operations.

As soon as the car is unloaded sufficiently, one or two men, as required, should be stationed inside the car. Once the men enter the car, they should measure and mark on the inside wall of the car each 2 foot interval for a distance equal to the length of the longest board anticipated. Utilizing these marks, they can segregate the lumber by length and width. As the lumber is segregated, it is passed to the man on the platform by the man in the car, who calls out necessary information such as length, width, and species, to assist the man on the platform to determine on which buttboard the lumber should be placed.



MATERIAL FOR ONE UNIT		
PC NO.	QUAN	DESCRIPTION
1	14	2" X 10" X 9' LGTH L
2	2	2" X 10" X 11'-10"
3	2	2" X 10" X 8'
4	3	1" X 6" X 11' (APPROX)
5	4	1" X 6" X 8' (APPROX)
6	2	2" X 4"
7	3	2" X 4" X 8'
8	9	4" X 4" X 3'-6"
9	40	1/2" X 3 1/2" LAG SCREWS W/WASHERS
10	40	5/8" X 6 1/2" SQ HD BOLT W/2 WASHERS 1 EA BOLT
11	17	5/8" X 5" SQ HD BOLT W/2 WASHERS 1 EA BOLT

FIGURE 58. Construction of platform used to unload lumber from boxcars.

X-3860

Unloading a boxcar of loose lumber takes longer and requires a larger crew than unloading a shipment of packages from a flatcar or gondola. Packaged shipments are unloaded by forklift truck (Figure 59) or by crane in a short time. If the packages on flatcars or in gondolas are improperly staked and strapped so that they shift in transit, then the economies inherent in this type of shipment may be lost.

The greatest savings in unloading and handling costs occur with lumber that is properly dried. A strapped package of dry lumber can be moved from the car directly into storage. If the lumber is not properly dried, the solid packages must be broken and rebuilt into stickered packages for drying or storing, thus increasing handling costs. Requirements that lumber be shipped in the form of solid-piled strapped packages may limit the number of suppliers and involve premium charges for the building of the packages at the mills. Such charges might be sufficient to wipe out the savings in unloading and handling costs.

The same handling costs factors apply to lumber shipped by motor truck.

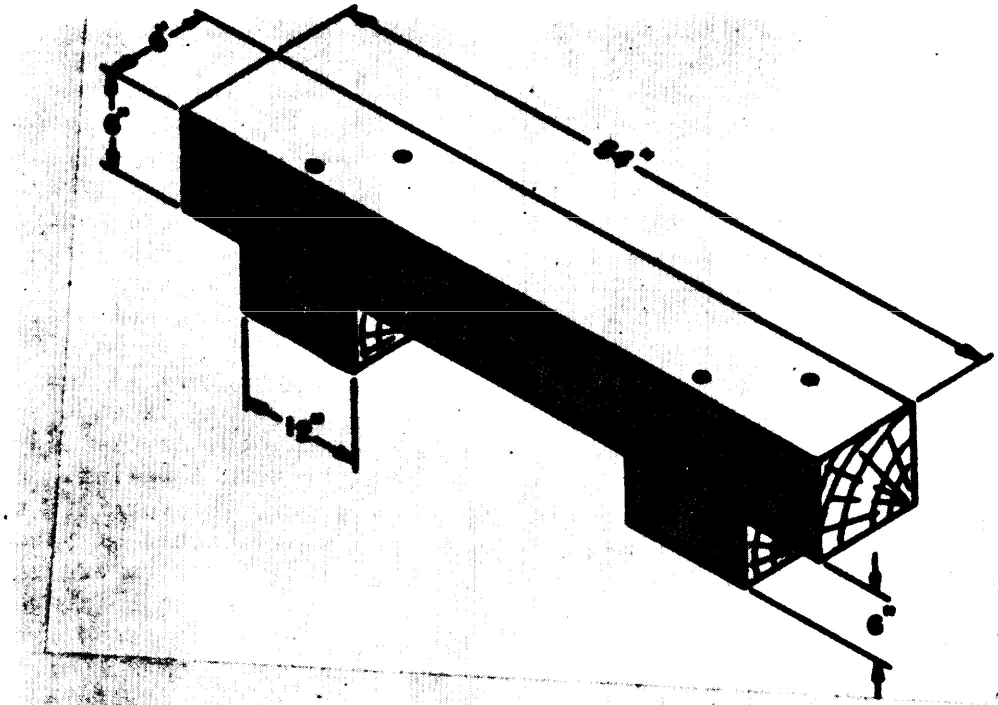
The success of any lumber-handling system is dependent on the individuals working with it. It is recommended strongly that the personnel assigned to lumber handling be interested in it and have an attitude favorable toward it. Lumber handling requires skill and dexerity; tricks of the trade are learned only through self-application and experience; therefore, once lumber handlers are developed, it will prove profitable to assign them permanently to the lumber section.

The method of unloading lumber received on gondolas, flatcars, or flatbed trucks will be dictated by the way the vehicle is loaded. Most lumber received by gondola or flatcar is packaged and loaded so that the packages can be lifted from the car by the use of railroad or mobile crane, or in the case of flatcars or flatbed trucks by forklift truck. Lumber unloaded in this manner should be placed on bolsters (Figure 60A) for pickup and transportation to point of use by straddle or forklift trucks. If the lumber in the packages is at a moisture content that is suitable for storage, the packages may be moved directly into storage. When the lumber in the packages does not meet requirements for storage because of moisture content, or the packages have been improperly made, the packages must be rebuilt before being placed in storage.

Unpackaged lumber on gondolas, flatcars, or trucks should be unloaded and . prepared for storage in the same manner as lumber received in boxcars.

FIGURE 59. Forklift truck removing strapped solid-piled package of dry lumber from flatcar.

X-3861



A. Diagram of bolster for use with 57-inch straddle truck.

B. Straddle truck picking up a load of packaged lumber. L-146

FIGURE 60. Straddle truck and bolster.

X-3862

Handling Equipment

Straddle trucks. Although many uses have been developed for the straddle truck (Figure 60B) its major purpose is to transfer lumber from unloading to storage areas or from storage areas to the point of use. This vehicle is considerably faster and more efficient than the forklift truck and can be operated in more restricted areas. The straddle truck efficiently transports lumber through narrow storage aisles or over highways, because the loads are carried lengthwise. Where lumber-storage operations are sufficiently large to warrant utilizing both forklift and straddle trucks, the straddle truck is used for transporting and the forklift truck for unloading, piling, and unpiling.

Forklift trucks. The principal uses for the forklift truck in lumber-storage areas are to pile and unpile packages of lumber in normal receipt and issue procedures. It is also used to unload lumber from motor trucks and railroad flatcars when the packages are properly loaded for such handling. After removing the package of lumber from the truck or car, the forklift truck can deliver it to the storage area, load it on automotive trucks or place it on bolsters for pickup by straddle truck. Where forklift trucks are used exclusively for transporting, packages must be assembled on bolsters consisting of short pieces of timber generally about 4 by 4 inches in cross section.

Sorting platform, buttboards, sticker guide. The sorting platform should be constructed according to the specifications shown in Figure 58.

The buttboards should be constructed according to the specifications shown in Figure 61. The 4- by 4-inch members used for the base should be of oak. The base should be nailed together with sixteen-penny spirally grooved, screw-type nails. Metal corners or angle irons will help to reinforce the base and are essential if Douglas fir or other softwood is substituted for oak.

The sticker guide, used in conjunction with the buttboard, is an essential unit of equipment for building packages of lumber. The proper spacing and vertical alinement of the stickers will have a decided bearing on the prevention of drying defects in the stored product (Figure 62). The principles of snickering set forth elsewhere in this section should be followed.

Bolsters for straddle trucks should be constructed according to the specifications in Figure 60A, except that the width of the straddle truck in use will determine the bolster length. Fork-lift trucks do not require special bolsters but merely pieces of 4- by 4-inch or 6-inch timbers of suitable length. The bolsters should be made from straight-grained wood of the denser hardwood or softwood species, such as oak, Douglas-fir, or southern yellow pine. As the lumber is placed in storage, the empty bolsters are picked up and stacked for return to the car side for further use, by straddle or forklift truck. The bolsters are made into plies by placing two or more bolsters in position for picking up, and solid piling the others across them. Successive layers of bolsters are cross piled for stability during transport.

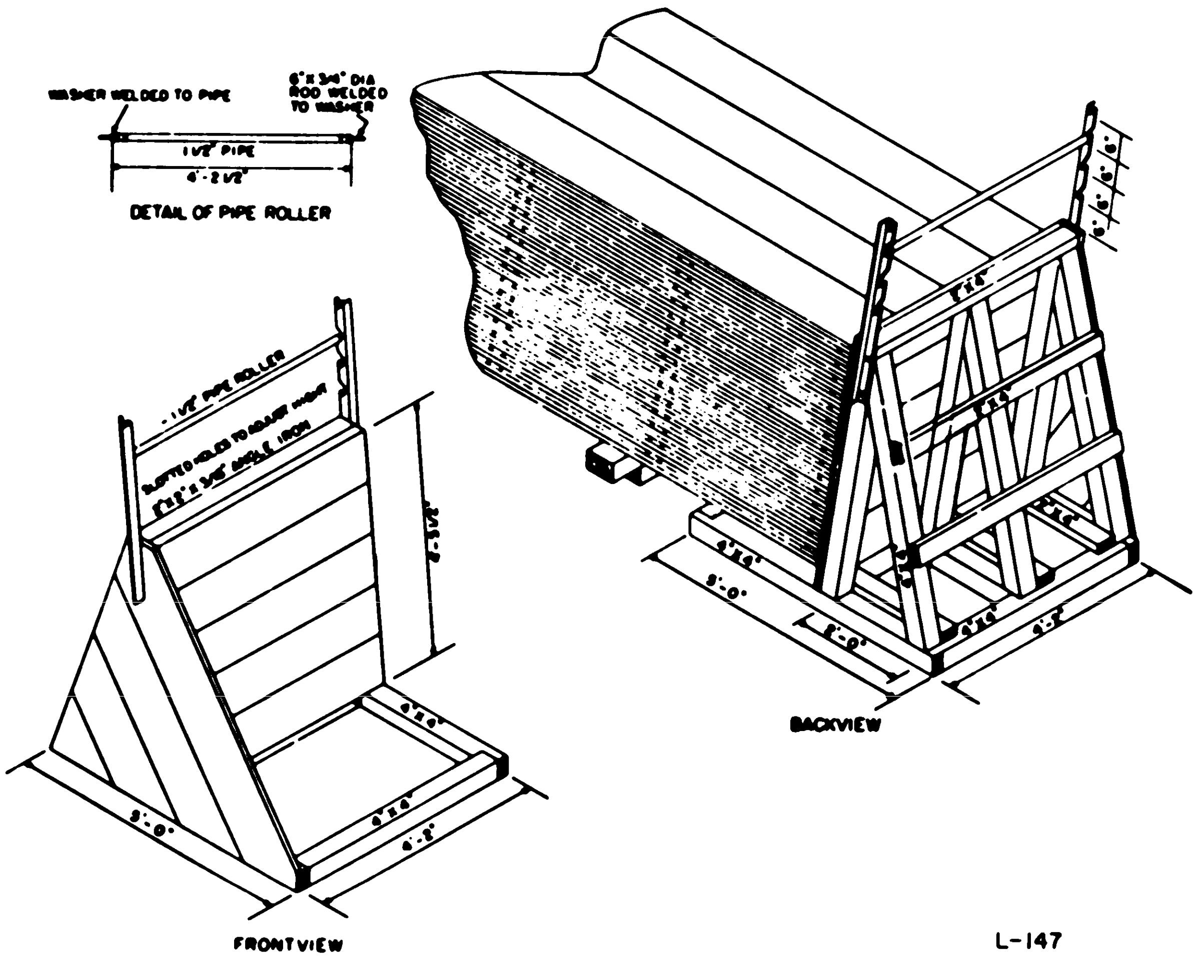


FIGURE 61. Construction details of a buttboard.

X-3863

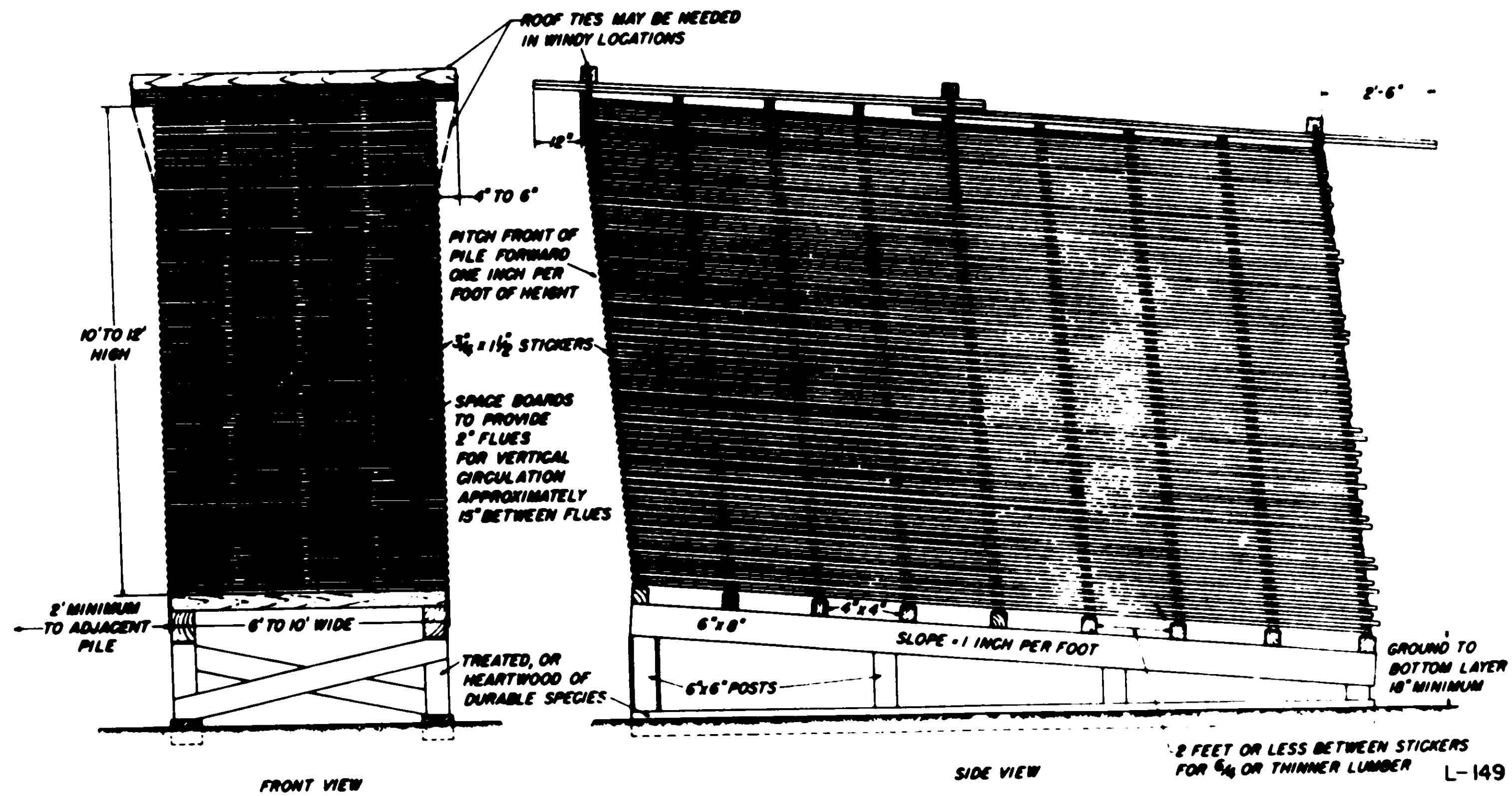


FIGURE 62. Essential features of a pile of hardwood lumber stacked for air seasoning.

X-3864

CHAPTER 120 STORAGE OF LUMBER

GENERAL

The objective of lumber storage is to maintain the lumber at or bring it to a moisture content suitable for its end use with a minimum of deterioration. Adequate protection of lumber in storage will help prevent attack by fungi, insects, and changes in moisture content that will result in checking, warping, and stain in lumber, making it unsuitable for the intended use. The condition of lumber being placed in storage, with respect to moisture content and possible fungus infestation, has an important bearing on the subsequent keeping qualities of the lumber. Decay fungi and subterranean termites infecting wood are retarded or stopped in their activity when the moisture content of the wood is lower than 20 percent; however, drywood termites, powder-post beetles, and other wood borers can develop successfully in well dried wood. Lumber that is treated with a preservative resists infestation. If lumber is infested with decay while drying, the fungus will continue to live in the dormant state for months or years after the wood dries and resume activity if and when moisture content again becomes high enough. A key, then, to prevention of deterioration during long storage is to eliminate infestation during drying and keep the wood dry in storage.

For this reason, all lumber must be checked thoroughly for moisture content and fungus infestation before storage. The preparation for storage and the type of storage will be based upon the results of these checks. It is important, especially when the lumber is received in packages, to choose packages from different parts of each shipment and disassemble them for examination. Unless this procedure is followed, the condition of the lumber inside the package cannot be ascertained. Lumber presents unique problems in storage, and proper piling procedures are necessary to provide adequate air circulation to prevent deterioration of the lumber.

The Storage Yard

The best location for the storage yard is on high ground that is level, well-drained, and remote from water bodies or wind-obstructing objects, such as tall trees or buildings. A low site is likely to be sheltered from the full sweep of the winds and to be damp, conditions that may retard drying and expose the lumber to stain and decay. A storage yard that is paved, or covered with cinders, gravel, shells or crushed stone, will be free from vegetation which obstructs the movement of air over the ground surface and beneath the lumber piles. Crude oil, salt, or other weed killer may also be applied for this purpose.

The actual layout is controlled by the size and shape of the available area. In yards where lumber is hand-piled the alleys are usually 16- to 20-feet wide; in yards where lumber is machine-piled the alleys are 24-to 30-feet wide. Piles of lumber are arranged to form pathways or alleys which not only serve as routes for transporting lumber, but permit movement of air through the yard and help to prevent the spread of fire. Hand stacked lumber piles are usually at right angles to the alleys. Piles built by crane may be either parallel or at right angles to the alleys. Piles built by forklift truck are necessarily parallel to the alleys. The direction of the main alleys - those from which the piles are built or taken down - is generally established by the nature of the available yard site. Drying of the yard after rainstorms or melting of snow is facilitated by running the main alleys north and south. Piles along the main alleys running east and west, shade the wet ground on the south side of the alleys and increase drying time.

Lumber Piles

Whether lumber should be placed in solid or open piles for drying or storing depends on its moisture content when it is received, its intended use, and the length of time it is to be stored.

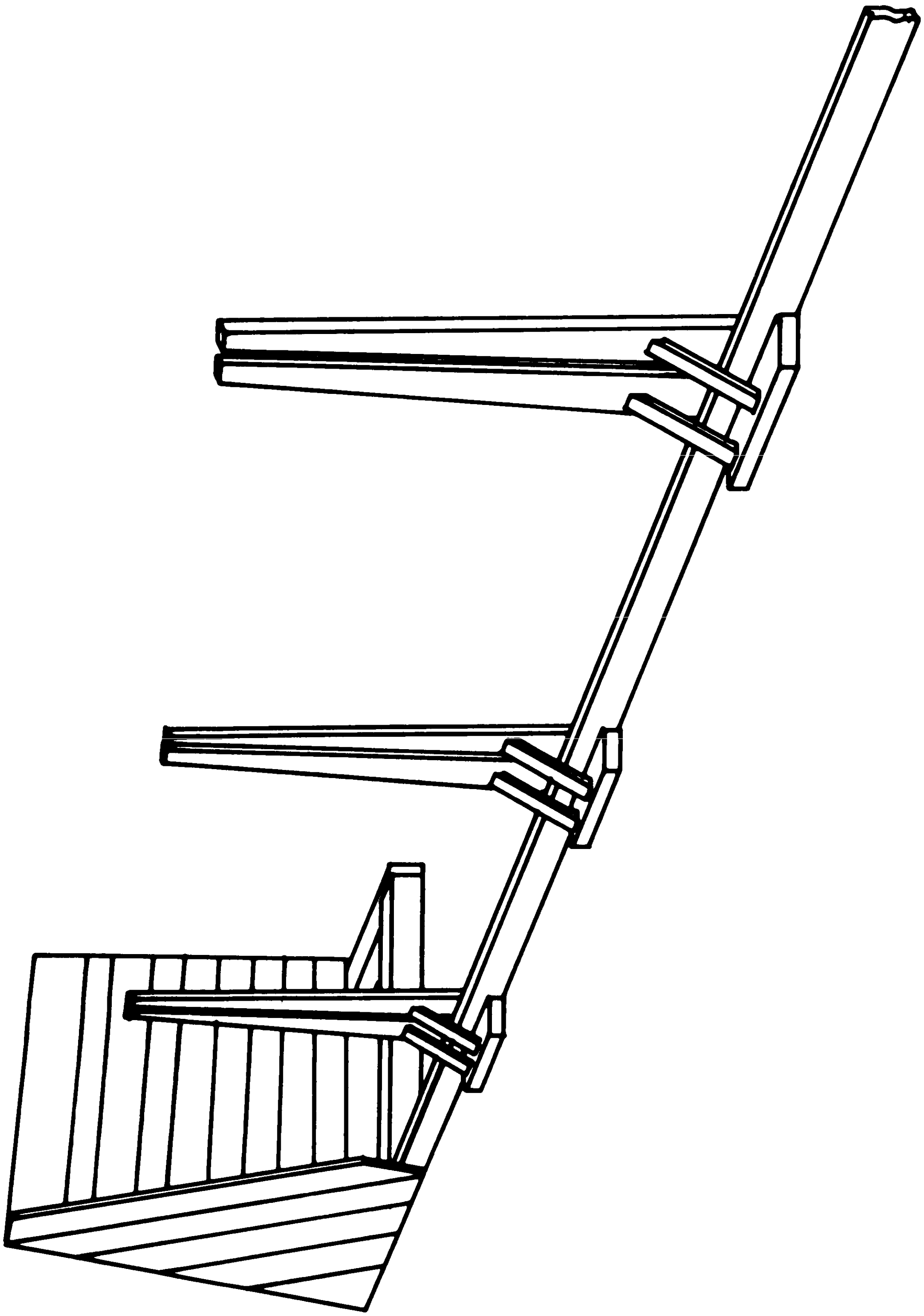
Lumber at a moisture content of 20 percent or more that is to be held for more than a week or two, particularly in warm weather, should be piled with stickers. Such lumber is likely to deteriorate if held long in a solid pile. Mold and stain usually develop first, and while these may not spoil the lumber, they may conceal decay and obscure stenciled or other identification marks.

If the end use requires a moisture content below that of the lumber at the time of receipt, the lumber should be piled on stickers, so that it will dry before use. During the favorable drying season, in most parts of the United States, lumber properly piled outdoors can be dried to a moisture content of 12 to 15 percent.

Lumber in storage should not contact the ground; therefore, some type of pile foundation is essential. The type needed will vary with different methods of piling. Good foundations, however, are mechanically strong and resistant to decay. They are high enough off the ground to allow air that has circulated through stickered lumber piles to escape from below the pile.

A typical foundation for a handstacked pile is shown in Figure 63. Foundation posts are made of concrete, masonary, preservative-treated wood of any species, or untreated heartwood of decay-resistant species. Wood posts should be 6 to 8 inches in diameter if round, or about 6 inches square. Posts used to support stringers should be placed about 5 feet apart length-wise of the pile and not more than 6 feet apart across the pile.

Posts may be set into the ground below the frost line or they may bear on preservative-treated sills laid on the ground. The foundation should slope about 1 inch per foot of length from front to rear, with the rear posts sufficiently high to keep the under side of the boards in the first course at least 18 inches above the ground. Unless the posts are set into the ground, the foundation should be braced against lateral tipping.



L-148

FIGURE 63. Sticker guides used for building a stickered pile of lumber.

X-3865

Foundation stringers, which run the length of the pile, may be steel I-beams, railroad rails, concrete, or timbers. Timbers should be about 6 by 8's, set on edge and treated with a preservative. Stringers are spaced generally not more than 6 feet apart. The stringers carry the cross beams, which are placed directly under the tiers of stickers in the pile. Usually at least three cross beams are needed, one at each end and one under the center of the pile.

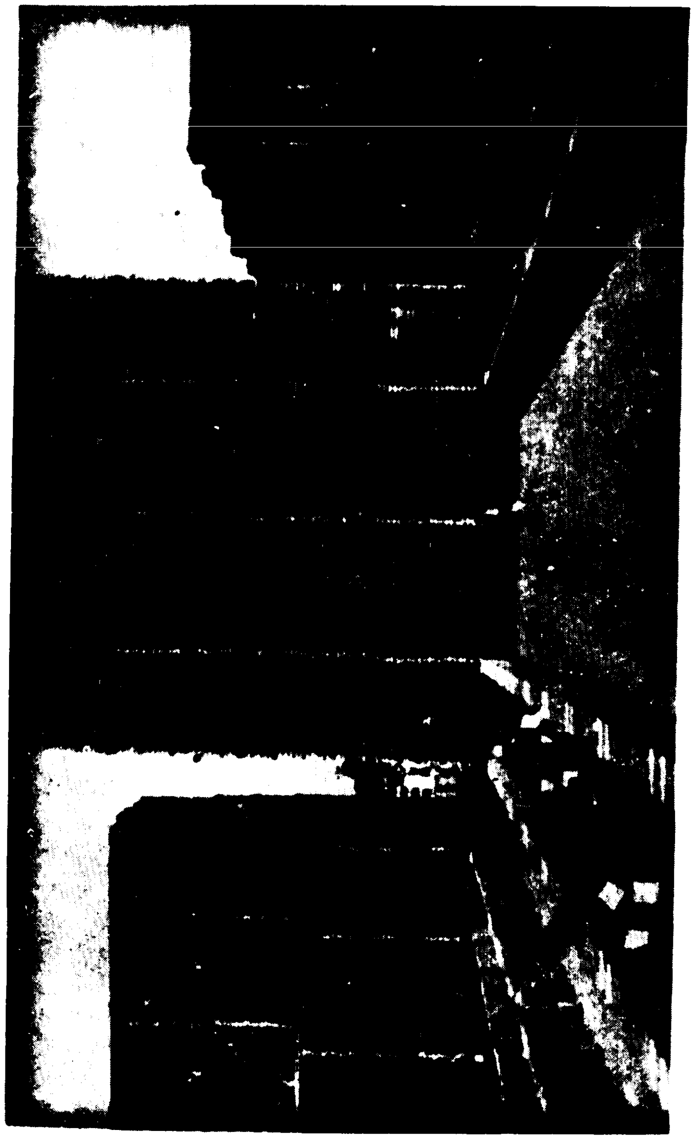
In hand-stacked piles, boards can be spaced 1 to 6 inches apart to form vertical flues for air movement. The sum of the widths of the flues should equal about 20 percent of the width of the pile for best drying.

Foundations for packaged lumber are usually level and lower than those for hand-stacked piles, especially if for piles built with forklift trucks (Figure 64). The type of foundation needed varies with climatic conditions and the kind of yard surface. In a dry climate, 4 by 4 wood bolsters may serve the purpose if the yard is paved. In most regions, however, foundations at least l-foot high are needed to permit adequate air circulation underneath the piles during damp weather. These, of course, are too high to be cleared by forklift trucks, and for this reason passageways 8- to 9-feet wide must be provided between the foundation timbers. As piles are built, timbers are laid in place to support the central portions of the piles. These should be alined under tiers of stickers. Portable foundations made of treated wood blocks allow flexible yard layout where requirements change frequently enough to warrant the added labor of handling them.

Solid piles. A solid pile is suitable for dry lumber because the pieces lie directly on one another, thus greatly retarding air circulation and consequent absorption of moisture. Solid piles are not recommended for lumber with more than 20 percent moisture content because stain and decay develop rapidly and drying is prevented. The height of a hand-stacked pile is generally limited to about 15 feet unless lumber-elevating devices are used. When lumber is machine-piled, the height limit is about 30 feet. Piles that are much higher may tip over, or their tremendous weight may crush the lower parts. Moreover, such high piles are likely to result in too much variation in moisture content from top to bottom. Each solid package of lumber is bound with round steel galvanized wire or flat steel strapping. The binding will keep the package intact during handling, transporting, and piling operations by straddle carriers or forklift trucks.

If cranes or forklift trucks are used, bolsters at least 3-inches thick are placed between the packages in order that the forks or slings of the machines can be inserted between the packages.

The foundations for solid piles can be similar to foundations for stickered piles (Figure 63), or they can consist of two or three cross beams only. Where two cross beams are used, they should be located roughly at the first and third quarters along the length of the pile.



L-150

FIGURE 64. Foundations for piles of packaged lumber built with forklift trucks.

X-3866

Open (stickered) piles. All lumber at a moisture content above 20 percent should be open-piled on stickers. The construction of a stickered pile is considerable more complex than that of a solid pile (see Figure 63). Good mechanical support is essential, and the pile must be built so that air can circulate around all the boards. For good drying and convenience in handling, a maximum pile height of 12 feet above the foundation and a width of 6 to 8 feet is recommended.

Stickers may be made from any species, but preferable from heartwood because sapwood may harbor stain organisms. Stickers for softwoods are often 1 by 4's, those for hardwood 1 by 2’s or narrower. Stickers should be dressed to a uniform thickness.

Stickers should be thoroughly air dried or kiln dried to reduce the danger of blue stain, decay, and checking in lumber.

The number position of the stickers have an important effect on warping. Lumber of a species that is prone to warp needs more stickers than lumber of other species; thin lumber needs more stickers than thick lumber; and high-grade lumber should be piled with more stickers than lowgrade lumber.

Stickers act as ties to hold the pile together, separate the courses of lumber, improve air circulation and restrain warping by holding the boards flat. They should be alined above the cross beams of the pile foundation.

Softwoods, which generally warp less than hardwoods, require fewer stickers to prevent sagging and warping, but these should be wide enough to provide bearing surfaces sufficient to avoid crushing. Most commonly, four or five are used per layer for 16-foot softwood lumber. Stickers for hardwood lumber are usually spaced 16 inches to 2 feet apart.

Vertical alinement of stickers should follow the pitch of the pile, with the front tier projecting out enough to protect the ends of boards in the course beneath. If the stickers are not alined, the weight will not be directly transmitted from one to another, and the boards may sag and warp. Sticker guides suitable for use in hand stacking are an effective means of alining stickers.

It is highly important that the long boards be placed in the outer parts of stickered piles. Wherever possible, boards of the same thickness and length should be piled together. This assures better piles and less warping, and facilitates handling and supply operations. Overhanging ends of lumber should be avoided at the back of the pile.

Packaged lumber. Special short stickers are needed in packaged lumber, because of the narrowness of the package. Stickers for packages are generally made from nominal l-inch stock, although thinner ones are suitable in dry regions. They are usually 1-1/2- or 2-inches wide. The number and spacing of the stickers in packages are about the same as for hand-stacked piles. Packages of lumber should be built in stacking racks or jigs equipped with buttboards and sticker guides. The use of sticker guides is usually essential in the building of packages to assure good sticker alinement and uniform spacing. Otherwise, piles consisting of several packages cannot be properly supported. Figure 64 shows good alinement of stickers and bolsters in package piles.

It is advantageous to band or strap stickered packages of lumber to prevent damage during handling and piling. The wire or flat steel strapping should be placed directly over tiers of stickers. The number of bands placed on a package is optional, but there should be at least two, one at or near each end of the package.

Pile Roofs. A roof is needed to minimize checking, splitting, warping, stain, mold, and decay in lumber. A good pile roof (Figures 63 and 65) will shield the boards in the top courses and the sides and ends of the upper part of the pile from direct sunshine. A good pile roof will also protect the lumber from water. The roof should be raised several inches above the topcourse of lumber to permit movement of air across the top course of lumber.

Panels made by nailing boards to cross pieces are sometimes used for pile roofs. To provide pitch, the cross pieces should be of graduated height. Pane 1 roofs can be designed to pitch from end to end or from middle toward both ends. The boards in panel roofs are often placed edge to edge, with narrow boards or battens nailed over the joints. Panels of this sort are more commonly used on piles containing narrow packages or stickered packages. A single-length panel or two overlapping panels can be used to cover the pile. Panel roofs can be handled manually or with a crane or forklift truck; they are placed on the top package before it is lifted onto the pile.

Building paper or roll roofing can be combined with boards to form a pile roof. The boards in this type of roof should be laid in a single layer edge to edge. If two lengths of boards are needed, their ends may be butted together over a central cross piece. Since this type of roof is water-tight, the pitch can be less than in a type composed only of boards. The building paper or roll roofing can be lapped like shingles or run lengthwise of the pile. Pieces of wood should be laid on the roofing lengthwise of the pile to keep it in place. Roofing or building paper of good quality can be reused. Boards and roll roofing can be combined in a panel type of roof. When used in this fashion, the roll roofing should last for a number of years.

FIGURE 65. Portable roofs for piles of packaged lumber.

X-3867

Corrugated aluminum or galvanized steel makes a good pile roof. The sheets can be fastened to a wood framework to form roof panels handled by machine. The sheets are laid like shingles and are either nailed to the frame or held down by wood cross pieces and springs.

Roofs for hand-stacked piles. For hand-stacked piles, the slope of the roof generally equals that of the pile, about 1 inch per foot of length.

To lay a double-layer, two-section roof of loose boards on a hand-stacked pile, two cross pieces about 4-inches wide, 6-inches thick, and l-foot longer than the width of the pile are placed on the top course of lumber at the center and the rear end; or directly over the center-most and rear tiers of stickers. On these the rear section of the roof is laid. For a 16-foot-long pile, a layer of boards at least n-feet long is laid on the pieces, their ends projecting about 2-1/2 feet back beyond the rear cross piece and about 6 inches forward beyond the center cross piece. A second layer of boards is laid to cover the cracks between boards in the first layer. The front section of the roof is made from boards at least 9-1/2-feet long, laid in like manner and projecting well over the front of the pile. At the center of the pile, the boards of the front roof section overlap the boards of the rear section by 1 foot or more. In order to obtain the proper roof pitch, the cross piece at the front of the pile or above the first tier of stickers should raise the roof about 8 inches above the top course of lumber. To prevent the roof from being blown off by wind, tie pieces of 2 by 4's are laid crosswise over the roof at the front, middle, and rear of the pile and fastened by wires or springs to the pile about 10 courses below the top (Figure 63).

Roofs for packaged piles. Piles consisting of packages either solid or stickered, may likewise be roofed with double layers of boards. Since package piles are often horizontal, it is harder to provide sufficient pitch to the roof than with sloped hand-stacked piles. To obtain a roof pitch of l-to-12 in a 16-foot pile, a roof of a double layer of boards would have to be elevated 18 inches at one end for a single-section roof and 20 inches for a double-section roof if the other end were elevated 2 inches. To raise one end of the roof to these heights above the pile is not practical. Board roofs on horizontal piles can instead be elevated in the middle and made to pitch towards each end. This requires a two-section roof with an elevation of only 10 inches at the middle, if each end is supported 2 inches above the pile, to secure a roof pitch of l-in-12.

Indoor Storage

Open sheds. An open shed may be likened to a storage yard with a roof. Open sheds that provide adequate protection are excellent for the storage of all lumber except kiln-dried material. Lumber that is received green or inadequately dried can be air dried in an open shed. The atmospheric conditions within an open shed are similar to those found outdoors and if the outdoor air is circulated within the piles, the lumber will dry much as it does in an outdoor pile. Piles in an open shed are much like piles in the storage yard, but since the shed roof will protect the piles from rain and snow, they need not be roofed, sloped, or pitched. Consequently, the pile foundations can be level.

With wide sheds and hand stacking, it is necessary to have one or more aisles running through the shed. If the piles are built with a forklift truck, the rows of piles may run from one side of the shed to the other. The spaces occupied by the rows must be free from supporting columns or posts. Cranes operating within open storage sheds are generally of the monorail or bridge type. With crane piling, the piles can be arranged in any desired fashion within reach of the cranes.

Closed sheds. Closed sheds are used primarily for the storage of well-seasoned lumber, plywood, and other stock destined for high grade uses. The object during storage is to prevent regain of moisture by the dry stock. As a consequence, lumber and other items should be piled solid, with only sufficient strips or separators to make stable piles or to designate quantities, grades, or items.

Closed sheds should be provided with floors, preferably concrete, asphalt, wood block, or planking. Loose surfacing is less satisfactory. Ventilation should be provided by adjustable openings in the roof and walls. In wet, cool weather the ventilators should be kept shut.

Forklift trucks require aisles at least 24-feet wide between rows of piles for turning with a 16-foot load. When the material is piled by hand, the aisles can be narrower. If the shed is equipped with an overhead bridge crane, the piles can be arranged in any way that leaves room between piles for access to them, and for enough air circulation to keep the temperature within the shed as nearly uniform as possible. Adequate spacing is 1 to 2 feet between hand-stacked piles, and 2 feet between rows and 1 foot between piles for machine-stacked package piles.

Pile foundations in a closed shed should be high enough to permit air to circulate beneath the piles. Stagnant air underneath the piles is likely to be cooler and damper than the air in the rest of the shed, hence may increase the moisture content of the wood in the lower parts of the pile. If the floor is earthen or is surfaced with some loose material, the foundation should elevate the pile about 1 foot; if the floor is paved, a clearance of about 6 inches is sufficient.

If forklift trucks are used and the timber foundations are more than 6-inches high, an operating space must be provided. A removable center timber can be used within this space, as with outdoor piles.

Unheated sheds. The temperature within a closed shed is usually somewhat higher than that outdoors, because of heat from the sun. Consequently, the mean relative humidity within the shed will be somewhat lower than that of the outdoor air, provided no considerable amount of evaporation of moisture from the wood or ground occurs. Therefore, wood can be held at a lower moisture content when stored inside an unheated shed than when it is stored outdoors.

An earthen floor in a shed, particularly if the shed stands on a low, damp site, can upset the moisture conditions within the shed. For this reason, closed sheds should be located on dry, well-drained sites. A paved surface with good drainage will help assure a dry floor.

Heated sheds. A closed shed maintains lumber and other items for high grade end use at a low moisture content more efficiently if it is heated under certain conditions. Heat is most useful during the seasons when the outdoor air is cold and damp because it maintains a low relative humidity within the shed and consequently keeps the wood at a low moisture content.

A closed storage shed can be heated by warm air furnaces, steam coils, radiators, or unit heaters as long as lumber piles are shielded against direct blast of hot air. The heating system need not have a large capacity, since only enough heat usually is required to raise the shed temperature 10° to 20° F above the outdoor temperature, with a minimum of 32° F to prevent freezing of heating pipes and sprinkler systems. The heating system should be arranged so that the temperature throughout the shed is uniform, and may involve the use of fans to attain desired uniformity. High rates of air circulation are not required.

The heat supply can be controlled manually or automatically. Various types of control devices are available. A simple general rule is to maintain the shed temperature of 10° F above the outdoor temperature to maintain wood at 10 percent moisture content, and 20° F above the outdoor temperature to maintain it at 7 percent. This rule applies roughly to winter conditions in the northern part of the United States.

When lumber is stored in solid piles, only the exposed wood quickly reaches equilibrium with the atmosphere of the shed. It may be months before the wood in the interior of the pile reaches that moisture content.

Storage of Specific Products

Plywood. Because of the conditions of its manufacture, plywood can generally be assumed to be dry when received. It should therefore be stored in a closed shed. For long storage in winter or the rainy season, a heated storage building is recommended.

Plywood is commonly solid piled. Under humid conditions, there is some tendency for edges to swell because of exposed end grain, and this swelling causes dishing, especially in the upper panels of high piles. Dishing can be minimized by placing stickers in the pile at intervals. Enough stickers should be used so that plywood will not bend between them. Dry 1 inch strips are suitable for snickering plywood. Plywood reusable concrete forms should be stacked flat on dry, level platforms after use. Wet faces should be separated with stickers to permit drying. If unused for long periods, forms should be stored indoors after being cleaned and dried. Before reuse, the faces should be oiled with standard wood form oil or pale oil. Newly cut edges should be sealed with an appropriate edge-sealing compound.

Timbers. The storage of timbers differs from that of lumber in that moisture content itself is not of major concern. The objectives in timber storage are to prevent serious deterioration and at the same time accomplish slight drying. Timbers held in open air storage are subject to checking, splitting, and warping. They are also subject to decay. Checking, splitting, and warping are associated with shrinkage stresses generated by the drying of the outer portions. Decay can result where infection takes place in those portions of timbers that are exposed to moisture and air. In large timbers, end checks may occur that are likely to develop into splits that may extend a considerable distance along the length of the timber. Surface checks are generally of minor importance except where they develop into the relatively large cracks that are likely to occur in boxed-heart timbers. Timbers sometimes crook, bow, and twist, but cupping, a form of warping that is common in boards, is not important in timbers.

Timbers may decay in storage because of fungi that were in the living tree, or infection may start during the storage period. Decay may start on the surfaces of timbers in solid piles because surface drying is retarded; or in surface checks or splits into which rain or snow water penetrates.

Timbers stored in piles outdoors are usually exposed to sunshine and wetting because it is impractical to provide roofs. Timbers stored outdoors should be end-coated for protection from end checking. If the coating is applied before end checking has started, it will greatly retard the drying from the end grain that causes checking and splitting. The various types of antisplitting irons that are used commonly on railroad ties may be used on timbers to prevent the opening up of splits that may develop from end checks.

Timbers stored outdoors should be piled so that the air has access to all faces. The timbers in each layer, or course, should be placed several inches apart, and the courses should be separated by 2 by 4’s. The stickers should be in good vertical alinement directly above the cross supports of the foundations, and should be spaced 6 to 10 feet apart. Pile foundations should slope, and the pile of timbers should be built with a forward pitch much like hand-stacked piles of boards or dimension lumber (Figure 63).

Timbers stored in an open shed are subjected to practically the same atmospheric conditions as timbers stored outdoors, but they are protected from sunshine and wetting by the roof of the shed. Piles are level rather than sloped and pitched.

Timbers are generally handled and stacked piece by piece rather than in packages. Timbers may be transported by straddle carrier or forklift truck and stacked generally by crane.

Poles, piles, ties. Several methods of storage are commonly used for poles, piles and ties. The following paragraphs are intended primarily for air seasoning of green material without preservative treatment. In general, items treated with preservatives should be close piled and protected from the sun by a cover to prevent them from checking. Checks may expose untreated wood to infection by decay fungi and attack by insects. Partially treated material, such as butt-treated poles, needs the same type of storage as untreated material.

Poles and piles. The foundations of piles for poles should be of the pier-and-beam type and should support the first layer of poles at least 18 inches above the ground. The foundations, if wood, should be constructed of the heartwood of decay-resistant species, such as cypress, cedar, and redwood, or of pressure-treated timbers of any species. Concrete piers also are satisfactory.

The crib piling method is used in localities where the decay hazard is not high. The poles are piled parallel to one another and, for the most part, in contact with one another, as shown in Figure 66. Crosspieces 4 to 6 inches in diameter are placed as stickers to separate the pile by groups of six layers each.

In the crosshatch method of piling poles, the poles in adjacent layers are placed at right angles as shown in Figure 67A in which the number of poles in each layer is about the same. In another method, alternate layers of poles may also be separated by two tiers of poles as stickers. The more open piling, as compared with the close piling in Figures 66, and 67B permits a more rapid drying rate with less chance that stain and decay will develop. On the other hand, if it is desired primarily to reduce checking rather than stain and decay, the crib or crosshatch method may be preferable.

Piles are handled like poles.

Ties. The lowest level of railroad ties should be piled on preservative-treated stringers a foot or more above the ground, to avoid slow drying and decay (Figure 67B).

In Figure 67B the crossties are solid piled by the so-called 11-by-11 method. The ties in each layer are at right angles to those in adjacent layers. With this method, surface checking is not so likely to occur, because of the relatively slow drying resulting from very slow air circulation through the pile. This method can be used only in a dry climate where there is practically no danger of decay.

Another type of pile, known as the 8-by-1 form is shown in Figure 68. Because of the more open character of this pile, more rapid drying may occur, with increased checking and less decay. Special stickers to separate the layers of crossties have been used in exceptional cases and permit piling more ties in a given space.

FIGURE [illegible]. Crib method of piling poles.

X-3066

A. Crosshatch method of piling poles with same number of poles in each layer.

B. Railroad ties solid piled by 11-by-11 method-11 ties in each layer. L-153

FIGURE 67. Other methods of piling.

X-3869

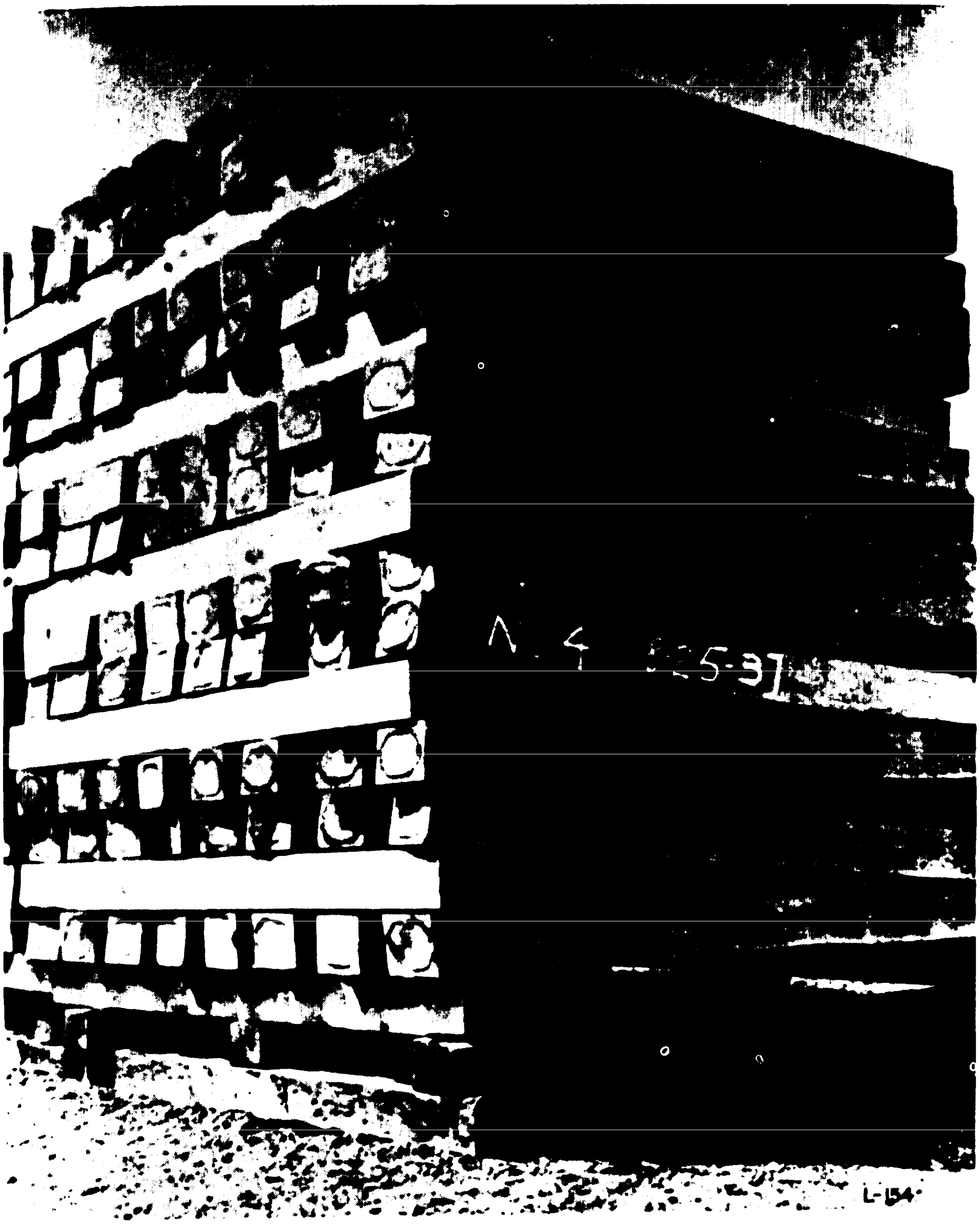


FIGURE 68. Railroad ties piled 8-by-1 method.

X-3870

CHAPTER 13. WOOD PRESERVATION

GENERAL

Wood preservation is the art of protecting wood or wood products from the action of destructive agents. The principal agents destructive to wood are fungi that cause rot, insects such as termites and marine borers, and fire. In preserving wood , chemicals are applied to protect it from these agents. The value or extent of the protection provided will vary with the kind and quality of the chemicals or preservatives used, the retention (pounds of chemical per cubic foot of wood) of the chemical used, and the depth of penetration of the chemicals in wood. This penetration is influenced by the method of applying them, as well as by the species and sapwood content of the product treated. Federal Specification TT-W-571, "Wood Preservation: Treating Practices," stipulates the preservatives and minimum retentions to be used for various wood products for different use requirements involving decay, termites, and marine borers ; it also sets forth specific requirements as to depth of penetration of the preservative. This specification should be used whenever a high degree of protection is required, particularly for wood used in contact with the ground and for wood of low decay resistance, which is likely to absorb moisture and remain damp for long periods. Such products as crossties, fence posts, piles, and poles are examples of wood used in contact with the ground. Lumber and plywood in structures exposed to the weather, such as flat decks of loading platforms, piers, and boardwalks, and in outdoor steps, often rots within 5 to 6 years in warm, moist areas of the United States unless treated with preservatives or consisting of heartwood of a decay-resistant species. Military Specification MIL-L-19140 covers the fire-retardant treatment for lumber and plywood . This specification should be referred to when lumber, plywood, and timbers require protective treatment from fire.

Types of preservatives. Preservatives used for protection are of two types: (1) oils or oil-borne materials and (2) water-borne materials.

Oil preservatives. Oil preservatives are resistant to leaching action of water, and their use should be specific when maximum protection is required, particularly for wood that will be used in contact with the ground or water. Where cleanliness, freedom from odor, and paintability of the treated wood are important, however, preservative oils are often objectionable. Selected volatile petroleum oils containing preservatives such as pentachlorophenol will sometimes meet such requirements, provided the petroleum oil has been removed from the wood after treatment. The preservative oils coal-tar creosote and creosote-coal tar solution are recommended for wood marine structures that require maximum service. Federal Specification TT-W-571 should be referred to for recommendations as to preservatives and retentions for the treatment of such specific products as railroad ties, poles, posts, piles, lumber, plywood, and timbers.

Water-repellent preservatives, consisting of a preservative such as pentachlorophenol or copper naphthenate, together with small amounts of resin and paraffin, in a volatile petroleum solvent, are used principally for superficial application to millwork products, such as window sash and wood containers. Preservatives of this type may also be used in pressure treatments under TT-W-571 for wood not to be used in contact with the ground or water and where water repellency, cleanliness, or paintability is required. Water repellents retard moisture changes but do not prevent them. Consequently, they have questionable value for the treatment of wood that is continuously exposed to moisture. Water-repellent preservatives applied by superficial methods like brushing and dipping provide only limited protection from decay and insects, but are useful in the control of surface stains and molds.

The water-repellent components of these preservatives sometimes interfere with satisfactory gluing of wood and may interfere with paints used on ships and boats. In such cases preservatives (pentachlorophenol or copper naphthenate) as covered by MIL-W-18142, "Wood Preservative Solutions, Oil Borne, Ship and Boat Use," should be called for. Federal Specification TT-W-572, "Wood Preservative: Water-Repellent ," should be referred to for products to be treated with preservatives of this type. Composition A (pentachlorophenol) of this specification does not appreciably discolor the wood. Composition B (copper naphthenate) imparts a green color to the wood. Listed in TT-W-572 are the requirements on paintability when the preservative is applied by dipping and similar methods. When the preservative is applied by pressure impregnation, however, special conditioning methods must be used to remove residual preservative solvents before the lumber is paintable. The supplier should be permitted to select the conditioning method, but should also have the sole responsibility for furnishing a suitably paintable product without objectionably discoloring, checking, or otherwise degrading the lumber.

Water-borne preservatives. Water-borne preservatives are dissolved in water and applied to wood in a water solution. Since the wood absorbs large amounts of water during treatment, it must be redried (after treatment) to meet moisture requirements for use. Water absorption involves swelling and other dimensional changes. Special care must be taken in handling and drying after treatment to avoid degradation through checking and warping.

Water-borne preservatives have proven to be effective, along with oil preservatives, under severe exposure conditions such as contact with soil or water and for important above-ground structures exposed to severe weather conditions. Heavy treatments of 2-1/2 pounds per cubic feet (PcF) of the preservative are effective in some marine waters. A lesser amount of the water-borne salts in combination with creosote (dual-treatment) is also effective in marine waters. Water-borne preservatives are also specified where cleanliness and paintability of the lumber is of prime consideration. Water-borne preservatives are not used for railroad ties because the oil type preservatives, in addition to affording protection against decay, also retards weathering and checking. Only preservatives listed in the Federal Specifications should be specified and used by Government activities.

Methods of treatment.

Pressure methods. Treatment of wood by pressure involves placing it in steel cylinders or retorts (see Figure 69) and impregnating it with the preservative at high pressures (usually from 50 to 250 pounds per square inch). Preservative retention is controlled by varying the pressure of the air in the cylinder and around the wood before the preservative enters and covers the wood. High preservative retentions are obtained by subjecting the wood to a vacuum before it is impregnated with the preservative under pressure. Lower retentions can be obtained by having the initial air in the cylinder at or above atmospheric pressure. The best control over preservative penetrations and retentions is assured through pressure treatment. However Federal Specification TT-W-571 does permit non-pressure full length treatment by the hot-and-cold bath process for Western Red Cedar and Alaska Yellow Cedar poles. This same treatment is allowed for the treatment of incised pole butts of these same two species and also Northern White Cedar.

For improved quality of marine piles, TT-W-571 requires that preservative retentions be determined by assay or by the extraction of preservative from borings taken from the piles after treatment. For poles and other products where American Wood-Preservers' Association Standards permit retentions to be determined either by gage or by assay, the assay method shall be used for Government purchases.

In ordering pressure-treated wood products, any special requirements - cleanliness, paintability, or moisture content - should be noted.

Non-pressure methods. Non-pressure methods for preservative application include: brushing, dipping and spraying. Since the effectiveness of non-pressure treatment cannot usually be expected to equal that of standard pressure treatment, non-pressure treatment cannot be used as an alternate in bid proposals calling for pressure treatment except as noted above. Nonpressure methods are described in the chapter on wood preservation in the Wood Handbook U.S. Department of Agriculture Handbook No. 72. The following methods are those which requisitioners are most likely to be concerned with, in order of protective value.

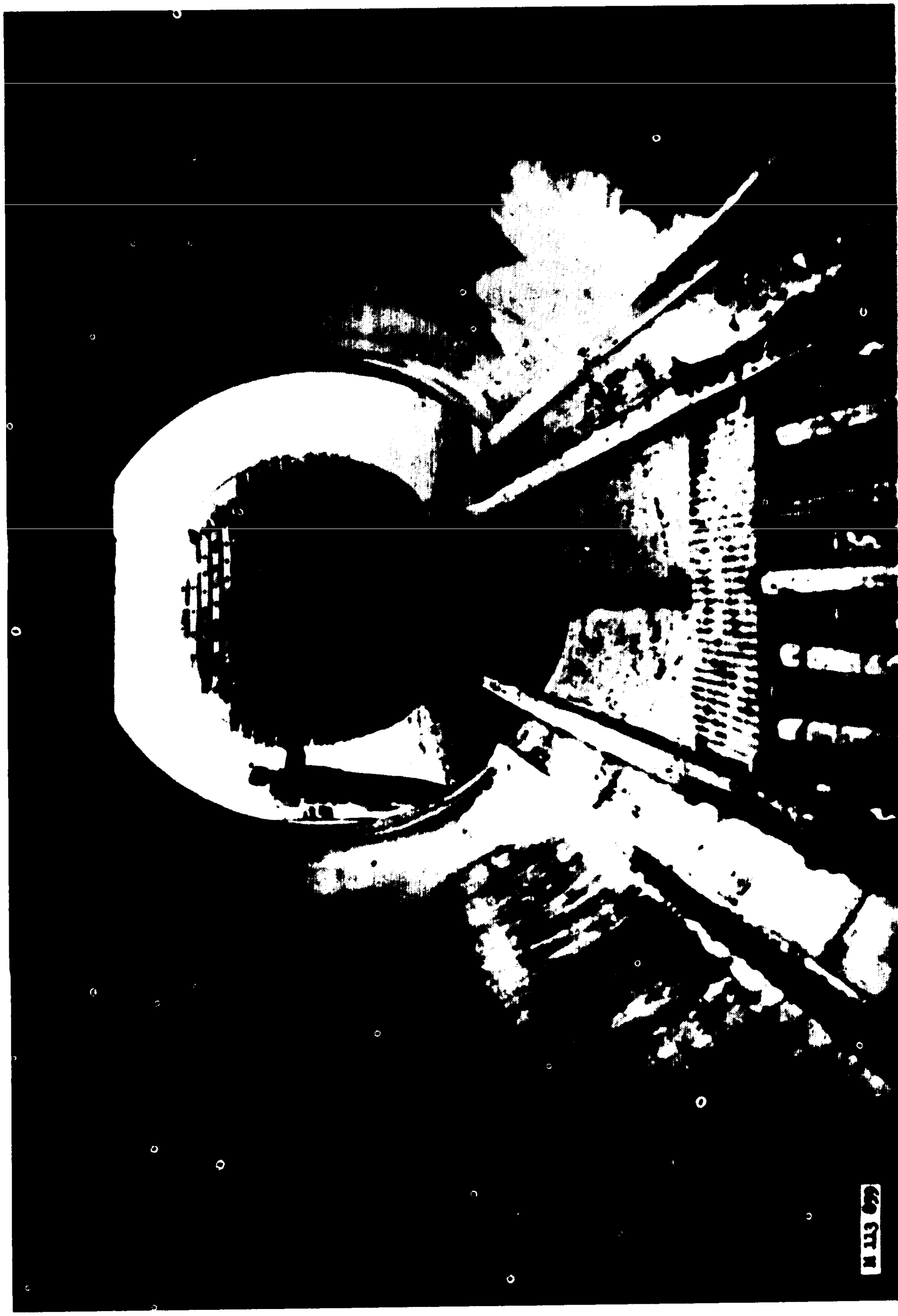


FIGURE 69. Treating cylinder at wood-preserving plant.

X-3871

Hot-and-cold bath method. The hot-and-cold bath process, including various modifications, is commonly used commercially for the treatment of products such as poles and lumber (see Figure 70). With proper application to selected species, its results may compare favorably with those of pressure treatment.

The usual hot-and-cold bath treatment consists of two operations, a heating bath in the preservative oil, and a cold or cooling bath. The time and temperature of the hot and cold baths vary with different wood products, sizes, seasoning conditions, sapwood thicknesses, and preservatives.

Adaptations of the hot-and-cold bath process are in commercial use for preservatives that must not be heated. These include steam or air, instead of a preservative, as a heating medium. A combination of steaming and vacuum is also substituted for the heating bath in one commercial process before the cold bath in the preservative.

Vacuum treatments. Two types of vacuum treatments are in commercial use. The first involves a low vacuum equivalent to 2 or 3 inches of mercury, a short soaking period, and a high vacuum (27 to 28 inches of mercury) to recover preservative. This treatment is used to apply water-repellent preservatives to window sash and millwork and results in limited penetration and low preservative retentions similar to those obtained by dipping for a few minutes. The treatment has the advantage over dipping in that surplus oil on the wood surface is removed, and the time between treatment and glazing or finishing of millwork is substantially reduced. The second type of vacuum treatment is used in applying preservative oils and water-borne preservatives to items such as construction lumber and fence posts. Treating conditions can be varied for material of different sizes and species but usually involve a high initial vacuum (up to 28 inches of mercury), a long soaking period, and a recovery vacuum. The penetrations and retentions of preservative obtained can compare favorably with those resulting from hot-and-cold bath treatments.

Cold soaking. Cold soaking involves prolonged (several hours or days) in unheated preservative oil of low viscosity, such as 5 percent pentachlorophenol in domestic fuel oil. Soaking periods of 24 to 48 hours furnish good penetration in seasoned sapwood of most pines. Heartwood and sapwood of most other woods are treated less satisfactorily than pine sapwood and consequently will not receive as much protection from this treatment.

Surface treatments. Surface treatments, such as brushing, spraying, or brief dipping, result in shallow penetration and low retention of the preservative, and therefore provide only limited protection of the wood. Oils are usually used. Dipping is frequently used for millwork.

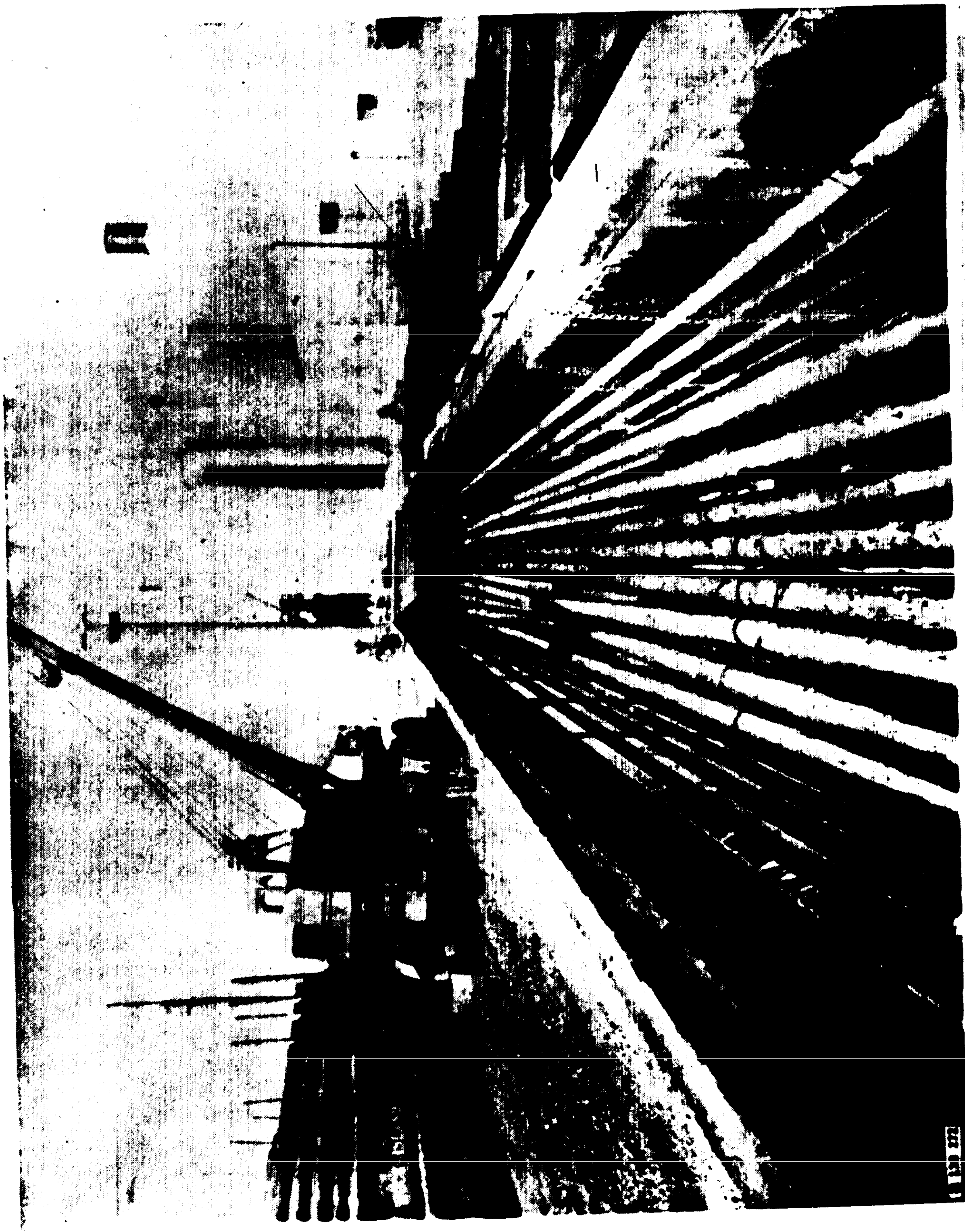


FIGURE 70. Hot-and-cold bath treatment of utility and building poles.

X-3872

Preparation of Wood for Treatment

All cutting, framing, and drilling should be completed before treatment. Numerous early failures of poles, piles, and other treated timbers can be attributed to cutting or boring operations after treatment. Cutting after treatment exposes unpenetrated wood to attack by destructive agents. When the wood must of necessity be cut or bored after treatment, the exposed surfaces should be liberally coated with a preservative, preferably a preservative oil or one heavy application of a suitable bodied preservative composition containing 10 percent of pentachlorophenol, to minimize the danger of infection. American Wood-Preservers' Association Standard M4 contains instructions for protecting cuts and holes made in pressure-treated wood.

Lumber and timbers to be treated by nonpressure methods should be thoroughly air seasoned before treatment. Best results can usually be expected in pressure treatment with water-borne preservatives if the wood is seasoned to a moisture content of less than 30 percent before treatment.

Peeling round or slabbed products is necessary to enable the wood to dry quickly enough to avoid decay and insect damage and to permit the preservative to penetrate satisfactorily (see Figure 71). (Processes in which a preservative is forced or permitted to diffuse through green wood lengthwise do not require peeling of the timber).

When wood is treated with water-borne preservatives by certain diffusion methods, high moisture content may be permitted. For treatment by other methods, drying before treatment is essential. Drying the material permits adequate penetration and distribution of the preservative and reduces the risk of checking that would expose unpenetrated wood after treatment.

Air drying, despite the greater time, labor, and storage space required, is a widely used method of conditioning and is generally the cheapest and most effective, even for pressure treatment. Kiln drying has the important advantage of quickly reducing moisture content and thereby reducing transportation charges.

Methods for conditioning green wood products for pressure treatment are described in the Wood Handbook, U.S Department of Agriculture Handbook No. 72.

Woods that are resistant to penetration by preservatives, such as Douglas fir, western larch, western hemlock, redwood, and pines predominantly of heartwood, are often incised before treatment to permit deeper and more uniform penetration (see Figure 72).

Treatment of Plywood and Laminated Wood

Exterior or boat-hull grades of plywood can be pressure treated with the preservatives and retentions recommended in TT-W-571 or in MIL-P-19550 for plywood ordered by the Navy for boats. Specification MIL-L-19140 contains requirements for fire-retardant treatment of plywood for use in boats. Laminated timbers may also be pressure treated, although large curved laminated timbers are often too large for pressure-treating cylinders. In such a case the recommended procedure is to pressure treat the lumber before laminating. Standard C28 of the American Wood-Preservers' Association covers the pressure treatment of laminated timbers and of lumber for laminating.

FIGURE 71. Machine peeling of poles.

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FIGURE 72. Deep incising permits better penetration of preservative.

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CHAPTER 140 SELECTION OF LUMBER GRADES BY USE

GENERAL

The end use criteria presented in this section by narrative and in table form will be useful for determining the proper grades of lumber and other wood products that will serve a specific purpose. It is incumbent on all users to give proper consideration to this information in order to make full use of a valuable resource. In this regard, the proper selection of lumber in combination with a good preservative treatment will increase the useful life of the lumber by many years. The initial cost for the treatment will be greatly offset by the resulting reduction in maintenance and repair costs.

The tables show lumber grouped by species and assigned grade. The Federal Supply Catalog Identification List 5500-IL will also show similar grouping with National Stock Numbers (NSNs) established for the various sizes of lumber that can be supplied for any of the species in a grouping. The grade listings for the end uses shown in this Handbook and the IL are advisory and are not to be construed as mandatory for use where higher grades are deemed necessary for a specific application. In general, the uses specified for any of the species and grades in a group agree with the uses cited in each of the lumber grading rules that apply to those species. However, the groups are not intended to reflect any comparability between species with respect to physical or mechanical properties. Even when physical and mechanical properties must be considered, more than one species will be cited. poles, piles, and crossarms are representative of this type of requirement and several species have been proven to be comparable.

The use of the tables is based on the assumption that an installation is equipped to use the low grades listed, thus gaining the benefit of the lower prices that will exist for these grades. Requisitioners can also anticipate that those species that are produced within their geographic area will be supplied. When requirements are limited by requisitioners to species from other producing areas, the cost will generally be higher, especially if the quantity is less than carload or truck load lots. This is one reason why the restriction of species should be carefully considered before requisitions are submitted. Another very important reason is that the Defense Acquisition Regulations (DARs) contain specific instructions to procurement activities regarding restrictive data that will result in noncompetitive procurements. In effect, any requisitions for lumber that are restricted to a single species, even if a National Stock Number (NSN) has been established for that species, must be supported with justification as to why other comparable species cannot be used.

The information contained in the other sections of this handbook, together with a careful analysis of the information presented in the following paragraphs will result in the best and most economical use of an essential resource.

The initials shown under the heading “Association Grading Rules” in the use tables represent the grading rules writing agencies. The full names of the agencies are shown in Appendix A, and in Chapter 4

Container lumber

Table XXI lists the species that can be used in the grades indicated for construction of wood boxes and crates described by PPP-B-601, PPP-B-621, MIL-C-104, MIL-C-52950 and MIL-C-3774. The box and crate specifications require that quality of lumber components conform to MIL-STD-731, which has no direct relationship to commercial grading rules. Pieces meeting the requirements of MIL-STD-731 may be cut from lower quality commercially graded lumber. The maximum allowable moisture content is 19 percent. Pallets conforming to NN-P-71 and MIL-P-15011 shall be fabricated from lumber meeting the requirements of MIL-STD-731 in a manner similar to that for boxes and crates.

Dunnage

For heavy blocking, timber sizes 5 by 5 and larger are used in Timber grades as listed in Table XXII. For bracing and light blocking, lumber less than 5-inches thick is listed in Table XXII under the grades for dimension lumber. Rules promulgated by the Association of American Railroads for loading of open-top cars restrict blocking and bracing lumber to certain species only. When hardwood is specified, the the following species are acceptable: Oak (red and white) , ash (white), birch (yellow and sweet), beech, elm (American and slippery), hickory (true), maple (hard, sugar, and black), sweetgum, and black cherry. Acceptable softwoods are: Eastern, and Sitka spruce, Douglas fir, western larch, tamarack, western hemlock and southern pine. No such restriction of species is placed on blocking and bracing for closed cars, and all species listed in Table XXII are acceptable. Lumber at any stage of seasoning may be used for blocking and bracing.

Lower grades of lumber could, and should, be used for dunnage when conditions allow. These lower grades are grade No. 3 for lumber that is nominal 2 to 4-inches thick and 6-inches and wider; utility grade for nominal 2 to 4-inches thick and 2 to 4-inches wide; and, for all sizes, the lowest grade available which is economy grade. Grade No. 3 Timbers (5-inches thick by 5-inches wide and larger) should be used for very rough dunnage. NSNs do not exist for No. 3 Timber or the economy grade of dimension lumber. The one exception is NSN 5510-00-272-7753 which has been established for economy grade lumber that is nominal 2-inches thick by 4-inches wide and wider, with any degree or surfacing, 19 percent moisture content, and furnished in random lengths. Requisitions could designate specific widths when using this NSN by submitting exception data.

TABLE XXI. Lumber grades for nailed wood boxes and crates.

Species	Recommended grade[1]	Association grading rules
SOFTWOODS		
Cypress	No. 2 Common	NHLA
Cedar:		
Northern white	No. 3 Common	NELMA
Western red	No. 3 Common	WWPA
Western red	Standard	WCLIB
Fir:		
Douglas	Standard	WCLIB
Douglas	No. 3 Common	WWPA
Balsam	No. 1 Common	NELMA, NHPMA
Hemlock:		
Eastern	No. 3 Common	NHPMA, NELMA
Mountain	Standard	WCLIB
Mountain	No. 3 Common	WWPA
Hem-Fir	Standard	WCLIB
Hem-Fir	No. 3 Common	WWPA
Larch, western	No. 3 Common	WWPA
Pine:		
Idaho white	Standard	WWPA
Lodgepole	No. 3 Common	WWPA
Eastern white	No. 3 Common	NHPMA
Norway	No. 3 Common	NHPMA
Ponderosa	No. 3 Common	WWPA
Southern	No. 2 Boards	SPIB
Sugar	No. 3 Common	WWPA
Eastern white	Standard	NELMA
Norway	Standard	NELMA
Jack	No. 3 Common	NELMA, NHPMA
Pitch	No. 3 Common	NELMA
Redwood	Construction Common	RIS
Spruce:		
Engelmann	No. 3 Common	WWPA
Eastern	No. 3 Common	NHPMA, NELMA
Sitka	Standard	WCLIB
Hardwoods	No. 2 construction boards	NHLA

1 The grades listed do not necessarily reflect comparability of species, and are not so recognized in the industry. Requisitioning agencies should exercise judgement in specifying the grade appropriate to the end use.

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TABLE XXII. Species and grades for car blocking and bracing.

Species	Recommended grade[1]		Association grading rules
	Heavy car blocking Timbers	Car bracing Dimension lumber[2]	
Softwoods:			
Cypress	No. 2 Common Timbers	No. 1 Dimension	NHLA
Fir:			
Douglas	No. 2	No. 2	WWPA
Douglas	Standard timbers	No. 2	WCLIB
Hemlock:			
Hem-Fir	No. 2	No. 2	WWPA
Hem-Fir	Standard timbers	No. 2	WCLIB
Eastern	No. 2	No. 2	NELMA, NHPMA
Larch, western	No. 2	No. 2	WWPA
Pine:			
Lodgepole	No. 2	No. 2	WWPA
Ponderosa	No. 2	No. 2	WWPA
Southern	No. 2	No. 2	SPIB
Redwood	No. 2 Str	No. 2	RIS
Spruce:			
Engelmann	No. 2	No. 2	WWPA
Eastern	No. 2 timbers	No. 2	NELMA, NHPMA
Sitka	Standard timbers	No. 2	WCLIB
Hardwoods	Common timbers	No. 2 dimension	NHLA

1 The grades listed do not necessarily reflect comparability of species and are not so recognized in the industry. Requisitioning agencies should exercise judgment in specifying the grade appropriate to the end use.

2 With the exception of Cypress and Hardwoods, the grades listed for dimension lumber are for structural joists and planks (2 to 4 inches thick - 6 inches and wider). If requirements are for lumber 2 to 4 inches wide, specify Standard Grade in lieu of No. 2 grade.

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Cross arms

Crossarms are used to support and to space telephone and electric wires on wood poles. There are seven types of crossarms listed in the dimension table shown in MIL-C-12436. This table shows the thicknesses, widths, and length of the various crossarms, under each type, together with size and spacing details for pin holes, center holes, and brace bolt holes. This same information is repeated in 5500-IL. The table will show an asterisk (*) in the column for pin hole size for some crossarms. In those cases the requisitioner will be required to designate the desired pin hole diameter for the available sizes shown in the data at the end of the table that is in the specification and 5500-IL. Manufacturing and identification marking requirements are detailed in MIL-C-12436. Each crossarm is required to be marked to show the source of the crossarm and the preservative treatment. With the exception of two Type III crossarms, all the crossarms listed in the dimension table in MIL-C-12436 have NSNs assigned. Attention is again directed to the preceding discussion of the asterisk and the requirement for the requisitioner to designate pin hole size when the asterisk appears. Crossarms are constructed from Douglas fir or southern pine only. The crossarms are made from dense lumber and are surfaced on all four sides to the thickness and widths shown in the table in MIL-C-12436 and the 5500-IL. The top edges have a 3/8 inch - 30 to 45 degree bevel. When required and specified, the top center of the crossarm shall not be beveled. The top edges may also be rounded on a 3/8 inch radius in lieu of the 3/8 inch bevel. The holes that may be bored in the crossarm are described in detail with the sketch in the 5500-IL and Figure 1 in MIL-C-12436.

Unless specifically deleted by the requisitioner, all crossarms will be preservative treated with coal-tar creosote or pentachlorophenol specified in MIL-C-12436. Crossarms shall have a moisture content of 22 percent or less prior to treatment. All splintering around drilled holes shall be removed to comply with “good workmanship” requirements and must be removed prior to treatment.

When any variations are required in the standard crossarms shown in the 5500-IL, or if special crossarms are required, a sketch or drawing should be prepared to describe the required item. The sketch shown in the 5500-IL should be used as a pattern with all the requirements for sizes clearly documented.

Moulding

Moulding can be considered as lumber of specific architectural design that is used, primarily, to give a finished appearance to both interior rooms and exterior surfaces. Mouldings also have functional uses such as door stops, hand rails and door jambs. The mouldings listed in 5500-IL are softwoods, unfinished and suitable for natural or clear finish. All the mouldings cited in the commercial publications mentioned below are softwoods and unfinished. The industry establishes an N grade for moulding that will receive a natural finish and a P grade for moulding that will be painted. The P grade can be finger jointed or edge-glued lumber and can have some stain.

The multitude of patterns for moulding and the variations of sizes for the patterns makes it mandatory that each pattern and size be identified by symbols or numbers. For example, there are over 18 different patterns for door and window stops but when the different sizes for these 18 patterns are considered there are over 120 different stops that can be ordered. It is for this reason that a specific pattern and size for that pattern is identified by letters and numbers or by a number only.

The various patterns and sizes of patterns are identified in the following sources among others: WWMMP Catalog, “WP/Series Moulding Patterns” and 1975 Supplement; and in the SPIB publications, “Standard Wood Mouldings, 7000 Series,” and “8000 Series Moulding Book.” These publications provide a sure method of communication between the requisitioner and the buying activity, and requisitioners are encouraged to obtain the publications and order by using the assigned pattern number. Reference to such general terms as “Ranch House Casing” does not describe the pattern and size required and is meaningless to the buying activity.

It would be impractical to assign NSNs to all the various patterns and size moulding because much of this would not be used by the military. NSNs have been established for some of the common patterns and sizes of window and door stops, quarter round, cove, etc. These are listed in the 5500-IL. If the desired pattern and size is not assigned an NSN, the order should be placed as a non-NSN giving the name and number designation shown in one of the reference publications. If the P grade (paint grade) can be used, this should be specified in order to realize a possible cost advantage.

A combined water-repellent and preservative treatment as specified in TT-W-572, “Wood Preservative: Water-Repellent” should always be considered for exterior moulding that will be painted. Such treatments provide a moderate degree of resistance to shrinking and swelling and to fungi attack when the treated moulding is exposed intermittently to rain wetting. This is a nonpressure treatment. Requirements for pressure treatments of moulding are difficult to satisfy unless the quantity required is large enough to make up a single load for treatment.

Piles

Piles are intended to support structures by bearing upon sound supporting soil. Type I piles are intended for temporary use. Type II piles are intended for any permanent construction or any use in any environment where insects or decay represent a hazard to the pile. Piles should be requisitioned in accordance with MM-P-371.

The current ASTM D 25 contains two tables specifying tip and butt circumferences for wood piles with lengths from 20 through 120 feet in increments of 10 feet. These tables classify piles on the basis of loading-carrying capacity and assign the designation of “Friction Piles” or “End-Bearing Piles.” The previous ASTM D 25 classified piles on the basis of intended use and designated the piles as Class A, B, or C. The lengths ranged from under 30 feet to 90 feet and over with 2 foot increments from 16 to 40 feet and 5 foot increments for lengths over 40 feet. This resulted in lengths with 5 foot increments being assigned National Stock Numbers and these lengths are still listed in the 5500-IL. When these piles are ordered, the tip and butt circumferences for the former Class A and B piles will be in accordance with the circumferences specified for Friction Piles. The tip and butt circumferences for the former Class C piles will be in accordance with the circumferences specified for End-Bearing Piles.

Piles are processed as either unpeeled, rough peeled, or clean peeled. Unpeeled piles will have no bark removed; rough peeled piles will require the removal of all outer bark; and cleaned peeled piles shall have all outer bark removed and not less than 80 percent of the inner bark that will be well distributed over the surface of the pile. Specific limitations and requirements for trimming, straightness, knots, splits, etc., are detailed in ASTM D 25. Identification marking is required for each pile and these details are in MM-P-371.

Not all the lengths shown in the tables in ASTM D 25 have NSNs assigned. Those lengths with NSNs are the more common sizes and will satisfy most normal requirements. The piles assigned NSNs are all clean peeled and preservative treated. The type of full length treatment and treating materials have been established based upon exposure conditions in coastal waters, fresh waters, or soil. These service conditions and the type of treatment required are outlined in TT-W-571. The 5500-IL specifies the same service conditions, and requisitioners should study the IL carefully to select the proper NSN that is grouped under each of the service conditions. Further information on NSN assignments is noted in the preceding information on sizes.

Requisitioners may have requirements for tip and butt sizes that are more in line with those sizes that were formerly assigned to the old Class A, B, and C designations. when requisitions are submitted for these piles, the desired tip and butt circumferences should be specified rather than reference to any classes. Also, any special heading requirements at the butt end should be clearly detailed in the requisition.

Poles

Poles are intended for use as supports for communications or electric transmission lines. Poles should be requisitioned in accordance with MM-P-371, which supplements ANSI 05.1 with specific requirements for military applications.

Tables specifying tip and butt circumferences for wood poles of specific lengths and species are contained in ANSI 05.1. The established tip and butt circumferences for each pole length will vary and these various circumferences are identified by classes. Example: A 20 foot, Class 3, Douglas fir or southern pine pole will provide a minimum circumference of 23 inches at the top and 27 inches at 6 feet from the butt. Each of the other class designations for the same length will provide a difference in circumferences. MM-P-371 provides this information for lengths of poles not covered by ANSI 05.1.

The requirements for manufacturing and identification marking are detailed in MM-P-371 and ANSI 05.1.

Not all lengths and classes of wood poles have NSNs assigned, but, the majority of the lengths and classes listed in ANSI 05.1 are cataloged in 5500-IL. Poles ordered by NSN will be either mortised or slab gained for two standard crossarms; bored for two 5/8 inch crossarm bolts spaced 24 inches apart with the center of the top hole 10-1/4 inches from the peak of the roof; and, the roof will be 15 degrees one-way, or flat. All poles will be treated full length with coal-tar creosote, pentachlorophenol, or waterborne salts as cited in TT-W-571.

Poles are ordered for uses that may not require gaining, boring, or treatment. Requisitioners must be careful to cite any exceptions to the normal requirements when a non-standard use exists and poles are ordered by NSN.

Doors

The main door designs used by the military are:

(1) Flush interior and exterior doors constructed with hardwood veneer face panels:

(2) Sash doors constructed of fir, hemlock, or pine panels and provided with windows (lights);

(3) Interior panel doors constructed of fir, hemlock, or pine; and

(4) Screen or combination storm and screen doors constructed of fir, hemlock, and pine.

Sitka spruce is also authorized by Standard FHDA/7-79 to be used along with Douglas fir and western hemlock. Pine doors may be constructed of ponderosa pine, white pine, or sugar pine. With very few exceptions, all doors procured for military use are standard commercial designs and sizes as specified in the commercial standards cited in paragraph 2. Federal Specification LLL-D-581 describes the requirements for exterior and interior wood doors.

Flush doors are constructed with a solid core or hollow core. The solid core will have the space between the two faces completely filled with wood blocks or a rigid panel. The hollow core consists of wood, wood derivatives, or other acceptable material that is spaced so as to support the two faces of the door. Detailed requirements for stiles, rails, cores, and veneers for flush doors are presented in the Standard ANSI/NWMA I.S-1 Series. The doors are also available with plastic faces or hardboard faces. The hardwood veneer doors are supplied as premium, good, and sound grades. Premium grade requires the highest quality of veneer and near perfect matching at the joints when more than one piece of veneer is used in the face. Requisitioners should avoid specifying this grade unless the ultimate in appearance is necessary. Good grade is the normal grade for natural finishes and sound grade when paint is to be applied. Flush doors are available with louvers and lights (glass). There are no number designations to identify flush doors and requisitioners must be specific on size of the door and the size and spacing of louvers and lights.

The details involving the construction of these doors are well outlined in Standard FHDA/7-79 and Standard ANSI/NWMA I.S. 5-73. The sizes for these doors are specified in the standards with each door style or design identified by a number. Each standard has a different numbering system and this will result in two numbers that apply to the same door design. The species of wood used in the construction will be dependent on the number designation that is used. The species are described under the above description for the doors. One standard may show door styles not listed in the other standard. If a design in FHDA 7-79 is required but ponderosa pine is desired in lieu of Douglas fir, the requisitioner should cite Standard FHDA/7-79 and specify the required species. Door manufacturers will process such orders. In all cases, the requisitioner should cite a design number, along with the door size, to assure that the correct door will be received.

The NSNs that are in existence for doors have been in existence for many years and will not always refer to a design number. Also, some descriptions will detail the sizes for stiles and rails which should be disregarded by the requisitioner because these sizes are not standard in the industry. Careful examination of the descriptions in the 5500-IL should be made prior to selecting an NSN. If any doubt exists the requisitioner should process the requirement as a non-NSN item using the guidelines above for describing the door. Every effort should be made to order the present day designs. Old designs require special milling and this increases the cost.

A water repellent preservative treatment is required for exterior doors manufactured in accordance with ANSI/NWMA I.S. 5-73. No such requirement exists in Standard FHDA/7-79 and should be specified by the requisitioner when required. This also applies when interior designs are specified for exterior use. Interior doors that will be exposed to high humidity conditions in use should also be considered for a water repellent preservative treatment by the requisitioner.

Dimension Lumber

Light framing. Dimension lumber for light framing is 2 to 4 inches nominal thickness and 2 to 4 inches nominal width except hardwoods will have nominal widths through 12-inches wide. Light framing lumber is used for general construction where stress rated lumber is not required. It is used for sills, plates, bracing, partitions, and other uses involved in new building, repair, and maintenance. Other end use guides will specify this lumber for other applications such as containers and dunnage.

A maximum of 19 percent moisture content is allowed for lumber 2-inches thick. Any stage of seasoning is allowed for lumber above 2-inches through 4-inches thick.

Table XXIII describes the species of wood and the grades of lumber which may be used for light framing.

Structural joists and planks. Dimension lumber for structural joists and planks is 2 to 4 inches nominal thickness and 5 inches and wider nominal width. The grades specified in this end use guide will provide lumber with established strength values required for such applications as joists, decking, heavy framing and forms, rafters, piers, wharves, and similar heavy construction. Allowable unit stresses for the species listed in Table XXIV are contained in the National Design Specification for Stress-Grade Lumber and its Fastenings, and in the Association Grading Rules for Softwood Lumber.

A maximum of 19 percent moisture content is allowed for lumber 2-inches thick, and any stage of seasoning is allowed for lumber above 2-inches through 4-inches thick.

Table XXIV describes the species of wood and the grades of lumber to be used for structural joists and planks.

Structural light framing. Dimension lumber for structural light framing is 2 to 4 inches nominal thickness and 2 to 4 inches nominal width. The grades specified in this end use guide will provide lumber with established strength values required for such applications as trusses, concrete wall forms or other heavy forms, scaffold bracing, bracing for piers and wharves, or any application where high bending strength is required for heavy duty construction. Allowable unit stresses for structural lumber are contained in the National Design Specification for Stress-Grade lumber and its Fastenings and in the Association Grading Rules for Softwood Lumber. A maximum of 19 percent moisture content is allowed.

Table XXV describes the species of wood and the grades of lumber to be used for structural light framing.

TABLE XXIII. Species and grades for light framing.

Species	Recommended Grade[1, 2]				
	Temporary Construction	Low Cost Construction	General Construction	High Quality Construction	Association Grading Rules
Softwoods:					
Cedar:					
Northern white	Economy	Utility	Standard	Construction	NELMA
Western red	Economy	Utility	Standard	Construction	WWPA, WCLIB
Cypress	No. 4 Common	No. 3 Common	No. 2 Common	No. 1 Common	NHLA
Fir:					
Douglas	Economy	Utility	Standard	Construction	WWPA, WCLIB
Balsam		Utility	Standard	Construction	NELMA, NHPMA
Hemlock:					
Eastern		Utility	Standard	Construction	NELMA, NHPMA
Mountain	Economy	Utility	Standard	Construction	WWPA, WCLIB
Hem-Fir	Economy	Utility	Standard	Construction	WWPA, WCLIB
Larch, western	Economy	Utility	Standard	Construction	WWPA
Pine:					
Idaho white	Economy	Utility	Standard	Construction	WWPA
Lodgepole	Economy	Utility	Standard	Construction	WWPA
Eastern white		Utility	Standard	Construction	NELMA, NHPMA
Norway		Utility	Standard	Construction	NELMA, NHPMA
Ponderosa	Economy	Utility	Standard	Construction	WWPA
Southern	Economy	Utility	Standard	Construction	SPIB
Sugar	Economy	Utility	Standard	Construction	WWPA
Jack		Utility	Standard	Construction	NELMA, NHPMA
Pitch		Utility	Standard	Construction	NELMA
Redwood	Economy	Utility	Standard	Construction	RIS
Spruce:					
Engelmann	Economy	Utility	Standard	Construction	WWPA
Eastern	Economy	Utility	Standard	Construction	NELMA, NHPMA
Sitka	Economy	Utility	Standard	Construction	WCLIB
Hardwoods			No. 2 Dimension	No. 1 Dimension	NHLA

1 The grades listed do not necessarily reflect comparability of species and are not so recognized in the industry. Requisitioning agencies should exercise judgment in specifying the grade appropriate to the end use.

2a A separate Stud Grade has been established for softwood lumber used in load bearing walls. The NSN for the stud will provide a nominal 2 X 4, 8 feet long, surfaced 4 sides, with a 19% moisture content. Any of the softwood species listed above may be supplied under the Stud Grade.

2b Effective June, 1976, the National Grading Rule Committee approved a revision to the National Grading Rule to include 5 and 6 inch nominal widths in the Stud Grade to allow outer walls to be deeper to take thicker insulation. No NSN will be established for these sizes until a requirement exists in the Government.

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TABLE XXIV. Species and grades for structural joists and planks.

Species	Recommended Grade[1]				
	Low Cost Heavy Construction	General Heavy Construction	High Quality Heavy Construction	Highest Quality Heavy Construction	Association Grading Rule
Softwoods:					
Cedar:					
Northern White	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA
Western red --	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WCLIB, WWPA
Fir:					
Douglas ------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WCLIB, WWPA
Balsam -------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Hemlock:					
Eastern ------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Mountain -----	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WCLIB, WWPA
Hem-Fir ------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WCLIB, WWPA
Larch, Western	No. 3	No. 2	No. 1	Select Structural	WWPA
Pine:					
Idaho white --	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WWPA
Lodgepole ----	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WWPA
Eastern white-	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Norway -------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Ponderosa ----	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WWPA
Southern -----	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WWPA
Sugar --------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Jack ---------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Pitch --------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA
Redwood --------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	RIS
Spruce:					
Engelmann ----	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WWPA
Eastern ------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	NELMA, NHPMA
Sitka --------	No. 3 --------	No. 2 -------	No. 1 ------------	Select Structural	WCLIB

1 The grades listed do not necessarily reflect comparability of species and are not so recognized in the industry. Requisitioning agencies should exercise judgment in specifying the grade appropriate to the end use.

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TABLE XXV. Species and grades for structural light framing.

Species	Recommended Grade[1]				
	Low Cost Structural Framing	General Structural Framing	High Strength and Appearance	High Strength and Appearance	Association Grading Rule
Softwoods:					
Cedar:					
Northern white	No. 3	No. 2	No. 1	Select Structural	NELMA
Western red	No. 3	No. 2	No. 1	Select Structural	WCLIB, WWPA
Fir:					
Douglas	No. 3	No. 2	No. 1	Select Structural	WCLIB, WWPA
Balsam	No. 3	No. 2	No. 1	Select Structural	NELMA, NHPMA
Hemlock:					
Eastern	No. 3	No. 2	No. 1	Select Structural	NELMA, NHPMA
Mountain	No. 3	No. 2	No. 1	Select Structural	WCLIB, WWPA
Hem-Fir	No. 3	No. 2	No. 1	Select Structural	WCLIB, WWPA
Larch, western	No. 3	No. 2	No. 1	Select Structural	WWPA
Pine:					
Idaho white	No. 3	No. 2	No. 1	Select Structural	WWPA
Lodgepole	No. 3	No. 2	No. 1	Select Structural	WWPA
Eastern white	No. 3	No. 2	No. 1	Select Structural	NELMA, NHPMA
Norway	No. 3	No. 2	No. 1	Select Structural	NELMA, NHPMA
Ponderosa	No. 3	No. 2	No. 1	Select Structural	WWPA
Southern	No. 3	No. 2	No. 1	Select Structural	SPIB
Sugar	No. 3	No. 2	No. 1	Select Structural	WWPA
Jack	No. 3	No. 2	No. 1	Select Structural	NELMA, NHPMA
Pitch	No. 3	No. 2	No. 1	Select Structural	NELMA
Redwood	No. 3	No. 2	No. 1	Select Structural	RIS
Spruce:					
Engelmann	No. 3	No. 2	No. 1	Select Structural	WWPA
Eastern	No. 3	No. 2	No. 1	Select Structural	NELMA, NHPMA
Sitka	No. 3	No. 2	No. 1	Select Structural	WCLIB

1. The grades listed do not necessarily reflect comparability of species and are not so recognized in the industry. Requisitioning agencies should excercise judgment in specifying the grade appropriate to the end use.

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Select and Finish Lumber

Select and finish lumber is available in the nominal sizes established for boards and dimension lumber by Voluntary Product Standard PS 20, American Softwood Lumber Standard.

Some association, such as WWPA and NH & PMA designate thickness in multiples of quarter inches such as 4/4, 5/4, etc. These grades are cataloged in 5500-IL under the nominal sizes of the American Softwood Lumber Standards and requisitioners must specify if quarter sizes are required in lieu of nominal sizes. Quarter sizes provide thicker lumber. 5500-IL lists NSNs for C and D Select/Finish in the board size; B and Better and C and D Select/Finish in 2-inch thick lumber; and, C Select/Finish for 3- and 4-inch thick lumber. A limited number of NSNs have been established for the more common sizes and this has proven to be adequate to meet the requirements of military activities. Select and finish lumber is used for cabinet work, door and window casing, and other interior and exterior trim. Although this lumber has relatively few defects, it should not be considered where strength characteristics are essential. Stress rated lumber is required for those applications.

A maximum of 15 percent moisture content is allowed for lumber that is a nominal 2 inches and less in thickness. A maximum of 19 percent moisture content is allowed for lumber that is over 2 and not greater than 4-inches in nominal thickness.

Table XXVI describes the species of wood and the grades of lumber which may be used for select and finish lumber.

Timbers

Timbers are 5-inches and larger in both thickness and width. On the basis of size, there are two classifications of timbers recognized in the softwood industry, as follows:

(a) Beams and stringers - 5-inches and thicker with the width not more than 2-inches greater than the thickness.

(b) Post and timbers - 5-inches and thicker with the width not more than 2-inches greater than the thickness.

Stress values have been established for Select Structural and No. 1 grades for all the species shown in this end use guide. Stress values have also been established for Dense Select Structural and Dense No. 1 Douglas fir; No. 2 and No. 3 Structural Redwood; No. 1 and No. 2 Dense Stress Rated southern pine and Dense Structural 65 southern pine. Allowable unit stresses for structural lumber are contained in the National Design Specification for Stress-Grade Lumber and its Fastenings and in the Association Grading Rules for Softwood Lumber. Timbers are used for heavy construction such as posts, columns, trusses, bulkheads, drydocks, keel blocks, beams, stringers, shoring, and dunnage.

TABLE XXVI. Species and grades for select and finish lumber.

Species	Recommended Grade[1]			
	Quality Finish	High Quality and Appearance	Highest Quality and Appearance	Association Grading Rule
Softwoods:				
Cedar:				
Northern white	D-Select	C-Select		NELMA
Western red	D-Select/Prime Fin	C-Select/Superior Fin	B & BTR	WWPA
Western red	B-Finish	A-Finish	B & BTR INDUS. CLEAR	WCLIB
Fir:				
Douglas	D-Finish	C & BTR Finish	B & BTR INDUSTRIAL	WCLIB
Douglas	D-Select/Prime Fin	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Balsam	D-Select	C-Select		NELMA
Balsam	D-Select	C & BTR Select		NHPMA
Hemlock:				
Eastern	D-Select	C-Select		NELMA
Eastern	D-Select	C & BTR Select		NHPMA
Hem-Fir	D-Finish	C & BTR Finish	B & BTR Industrial	WCLIB
Hem-Fir	D-Select/Prime Fin	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Larch, western	D-Select/Prime Fin	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Pine:				
Idaho white	Quality	Choice	Supreme	WWPA
Lodgepole	D-Select/Prime Fin	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Eastern white	D-Select	C & BTR Select		NELMA
Eastern white	D-Select	C & BTR Select		NHPMA
Norway	D-Select	C & BTR Select		NELMA
Norway	D-Select	C & BTR Select		NHPMA
Ponderosa	D-Select	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Southern	D-Finish	C-Finish	B & B Finish	SPIB
Sugar	D-Select	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Jack	D-Select	C-Select		NELMA
Jack	D-Select	C & BTR Select		NHPMA
Pitch	D-Select	C-Select		NELMA
Pitch	D-Select	C & BTR Select		NHPMA
Redwood		Clear	Clear All Heart	RIS
Spruce:				
Engelmann	D-Select/Prime Fin	C-Select/Superior Fin	B & BTR/1&2 Clear	WWPA
Eastern	D-Select	C-Select		NELMA
Eastern	D-Select	C & BTR Select		NHPMA
Sitka	D-Finish	C & BTR Finish	B & BTR Industrial	WCLIB

1. The grades listed do not necessarily reflect comparability of species and are not so recognized in the industry. Requisitioning agencies should excercise judgment in specifying the grade appropriate to the end use.

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Any stage of seasoning is allowed.

Table XXVII describes the species of wood and the grades of lumber which may be used for timbers.

Plywood

Standard panel sizes are 3-, 4- and 5-feet wide with lengths ranging from 5 to 12 feet in one foot increments. The most commonly available sizes are 4-feet wide by 8- or 10-feet long. Standard nominal thicknesses of sanded panels range from 1/4 inch to 1-1/4 inches and greater in 1/8 inch increments, and, for unsanded panels, from 5/16 inch to 1-1/4 inches in increments of 1/8 inch for thicknesses over 3/8 inch. Not all combinations of panel sizes, thicknesses, and grades are covered by NSNs but those most common for Department of Defense use are listed in 5500-IL. These uses are presented in a general manner in this end use guide and the grades cited do have NSNs assigned.

A maximum of 18 percent moisture content is allowed when the plywood is shipped from the mills.

Table XXVIII describes the grades of softwood plywood to be used for various purposes.

TABLE XXVII. Species and grades for timbers.

Species	Recommended Grade[1]				
	Lower Grade Requirements[2]	Good Serviceability	High Strength Heavy Construction	Highest Strength and Appearance	Association Grading Rule
Softwoods:					
Cedar:					
Northern white		No. 2	No. 1	Select Structural	NELMA
Western red	Utility	Standard	No. 1 Structural	Select Structural	WCLIB
Western red	No. 3	No. 2	No. 1	Select Structural	WWPA
Fir:					
Douglas	Utility	Standard	No. 1 Structural	Select Structural	WCLIB
Douglas	No. 3	No. 2	No. 1	Select Structural	WWPA
Balsam	No. 3 (NHPMA Only)	No. 2	No. 1	Select Structural	NELMA, NHPMA
Hemlock:					
Eastern	No. 3 (NHPMA Only)	No. 2	No. 1	Select Structural	NELMA, NHPMA
Hem-Fir	Utility	Standard	No. 1 Structural	Select Structural	WCLIB
Hem-Fir	No. 3	No. 2	No. 1	Select Structural	WWPA
Larch, western	No. 3	No. 2	No. 1	Select Structural	WWPA
Pine:					
Idaho white	No. 3	No. 2	No. 1	Select Structural	WWPA
Lodgepole	No. 3	No. 2	No. 1	Select Structural	WWPA
Eastern white	No. 3 (NHPMA Only)	No. 2	No. 1	Select Structural	NELMA, NHPMA
Norway	No. 3 (NHPMA Only)	No. 2	No. 1	Select Structural	NELMA, NHPMA
Ponderosa	No. 3	No. 2	No. 1	Select Structural	WWPA
Southern	No. 2 Timbers	No. 2 SR	No. 1 SR	No. 1 Dense SR	SPIB
Sugar	No. 3	No. 2	No. 1	Select Structural	WWPA
Jack	No. 3 (NHPMA Only)	No. 2	No. 1	Select Structural	NELMA, NHPMA
Pitch		No. 2	No. 1	Select Structural	NELMA
Redwood	No. 3 Structural	No. 2 Structural	No. 1 Structural	Select Structural	RIS
Spruce:					
Engelmann	No. 3	No. 2	No. 1	Select Structural	WWPA
Eastern	No. 3 (NHPMA Only)	No. 2	No. 1	Select Structural	NELMA, NHPMA
Sitka	Utility	Standard	No. 1 Structural	Select Structural	WCLIB

1. The grades listed do not necessarily reflect comparability of species and are not so recognized in the industry. Requisitioning agencies should exercise judgment in specifying the grade appropriate to the end use.

2. Although NSNs have not been established for Utility and No. 3 grades, this may be ordered as a Non-NSN item and should always be considered for use when stress rating is not a factor.

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TABLE XXVIII. Grades and uses for softwood plywood.

Uses	Recommended Grades[1, 2]											
	A-A INT	A-B INT	A-B EXT	A-C EXT	A-D INT	B-B EXT	B-C EXT	B-D INT	C-C EXT	C-D INT	CDX (4)	B-B HDO
Appearance of both sides important. Cabinets, signs, built-ins.	X											
Appearance of one side important and other side with a good surface for painting. Signs, cabinets, partitions, fences.		X	X									
Appearance of only one side important. Exterior structures, gable ends, bulletin boards.				X								
Only one side will show. Wall paneling, ceiling, displays, partitions.					X							
Concrete forms. Will be mill oiled and sanded two sides. Not to be used as a B-B EXT utility panel for which no NSN exists.						X						
Good face for paintability and a substitute for A-C EXT when painting is required.							X					
Good face for paintability and a substitute for A-D INT when painting is required.								X				
Outside construction, pallets, crates, subflooring, siding, roof decking.									X			
Wall and roof sheathing, subflooring, general interior construction, pallets.										X		
Provided with exterior glue. Roof sheathing, target ranges, subflooring, general exterior construction where appearance is not essential and containers.											X	
Abrasion resistant surface for signs, counter and table tops, cabinets. Exterior glue and a hard semi-opaque resin-fiber overlay.												X
Treated plywood for use in coastal waters, freshwaters, ground contact and above ground (Fed Spec TT-W-571).			X	X			X		X		X	

1. Grades of softwood plywood are based on defects that are, or are not present in the veneers used for faces and backs. The higher the grade (A-A) the more costly will be the sheet. Requisitioners should study this end use guide when ordering plywood to determine the proper grade for the intended use. Exterior (EXT) plywood will also be more costly than interior (INT) plywood because of the waterproof glueline that is an essential element in the construction of the sheet.

2. Federal Specification NN-P-530, Plywood, Flat Panel, covers both softwood and hardwood plywood but references product standards for details of construction and grades. These are Department of Commerce Voluntary Product Standards PS-1 for Softwood and PS-51 for Hardwood. No end use guide has been prepared for hardwood because it is principally for decorative and interior use. Some NSNs are in IL 5500 for birch and mahogany plywood.

3. Exterior plywood should always be used for all permanent outdoor applications or when wet, moist or high humidity conditions will be constantly encountered indoors. Interior plywood will be appropriate for dry conditions of use.

4. Grade CDX signifies that the sheet is a C-D interior made for exterior application by being constructed with a waterproof glueline.

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Custodians:
Army - ME
Air Force - 99

Review activities:
Army - MD
DLA - CS

User activities:
Army - CE
Navy - MC

Preparing activity:
Army - ME

Project 5500-0002

APPENDIX A.

REFERENCED DOCUMENTS

This appendix contains all referenced documents, both Government and non-Government. In all cases, the latest issue of a given document should be consulted for revisions or changes.

GOVERNMENT DOCUMENTS

SPECIFICATIONS

FEDERAL

MM-P-371	- Piles and Poles, Wood.
NN-P-71	- Pallets, Material Handling, Wood, Stringer Construction, 2-way and 4-way, (Partial).
NN-P-530	- Plywood, Flat Panel.
TT-W-571	- Wood Preservative, Treating Practices.
TT-W-572	- Wood-preservative, Water-repellent.
MMM-A-181	- Adhesive, Phenol, Resorcinol, or Melamine Base.
PPP-B-601	- Boxes, Wood, Cleated-Plywood.
PPP-B-621	- Boxes, Wood, Nailed and Lock-Corner.

MILITARY

MIL-C-104	- Crates, Wood; Lumber and Plywood Sheathed, Nailed and Bolted.
MIL-W-2038	- Wood Laminates, Douglas-Fir (for Ship and Boat Use).
MIL-C-3774	- Crates, Wood; Open, 12,000 - and 16,000-pound capacity.
MIL-P-6070	- Plywood and Veneer Aircraft Flat Panel.
MIL-P-8053	- Plywood, Metal-Faced.
MIL-C-12436	- Crossarms, Wood.
MIL-L-14362	- Lumber: Unitizing and Loading of.
MIL-P-15011	- Pallets, Material Handling, Wood, Post Construction, 4-way Entry.
MIL-W-15154	- Wood Laminates, Oak (for Ship and Boat Use).
MIL-P-18066	- Plywood, Ship and Boat Construction.
MIL-W-18142	- Wood Preservative Solutions, Oil-Soluble, Ship and Boat Use.
MIL-L-19140	- Lumber and Plywood, Fire-Retardant Treated.
MIL-P-19550	- Preservative Treatment, Plywood.
MIL-W-24126	- Wood Laminates, Southern Pine (for Ship and Boat Use).
MIL-C-52950	- Crates, Wood, Open and Covered.

STANDARDS

MILITARY

MIL-STD-731 - Quality of Wood Members for Containers and Pallets.

FEDERAL SUPPLY CATALOG

Identification Lists.

C5500-IL - Lumber, Millwork, Plywood, and Veneer.

(Copies of Government Documents required by contractors in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

COMMERCIAL DOCUMENTS

AMERICAN INSTITUTE OF TIMBER CONSTRUCTION (AITC)

AITC-117 - Standard Specification for Structural Glued-Laminated Timber of Softwood Species.
AITC-119 - Standard Specifications for Hardwood Glued-Laminated Timber.
AITC-120 - Standard Specifications for Structural Glued-Laminated Timber using "E" Rated and Visually Graded Lumber of Douglas Fir, Southern Pine, Hem-Fir, and Lodgepole pine.
AITC-200 - Inspection Manual.
Timber Construction Manual.

(Application for copies should be addressed to the American Institute of Timber Construction, 333 West Hampden Avenue, Englewood, CO 80110.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI 05.1 - Specifications and Dimensions for Wood Poles.

(Application for copies should be addressed to the American National Standards Institute, Inc., 1430 Broadway, New York, NY 10016.)

AMERICAN WOOD PRESERVERS ASSOCIATION (AWPA)

AWPA Al - Analysis of Creosote and Oil-Type Preservatives.
AWPA A8 - Qualitative Recovery of Creosote or Creosote-Coal Tar Solution from Freshly Treated Piles, Poles, or Timber (Squeeze Method).
AWPA Cl - All Timber Products - Preservative Treatment, by Pressure Processes.
AWPA C2 - Lumber, Timbers, Bridge Ties, and Mine Ties, Pressure Treatment.
AWPA C3 - Piles, Pressure Treatment.
AWPA C4 - Poles, Pressure Treatment.
AWPA C5 - Posts, Pressure Treatment.
AWPA C6 - Crossties and Switch Ties, Pressure Treatment.

AWPA C7 - Incised (Red White and Alaska Yellow Cedar) Pole Butts, Thermal Treatment.
AWPA C8 - Western Red Cedar and Alaska Yellow Cedar, Poles-Preservative Treatment by the Full-Length Thermal Process.
AWPA C14 - Wood for Highway Construction-Preservative Treatment by Pressure Processes.
AWPA C16 - Wood Used on Farms-Preservative Treatment by Pressure Processes.
AWPA C18 - Pressure Treated Material in Marine Construction.
AWPA C23 - Round Poles and Posts used in Building Construction-Preservative Treatment by Pressure Processes.
AWPA C28 - Preservative Treatment of Structural Glued Laminated Members and Laminations Before Gluing of Southern Pine and Pacific Coast Douglas Fir, Hemfir, and Western Hemlock Pressure Processes.
AWPA Ml - Purchase of Treated Wood Products.
AWPA M2 - Inspection of Treated Timber Products.
AWPA M4 - Care of Preservative-Treated Wood Products.
AWPA P8 - Oil-Borne Preservatives.
AWPA P9 - Solvents for Organic Preservative Systems.

(Application for copies should be addressed to the American Wood Preservers Association, 7735 Old Georgetown Road, Bethesda, MD 20014.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 25 - Round Timber Piles.
ASTM D 245 - Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber.
ASTM D 1272 - Pentachlorphenol.
ASTM D 2555 - Establishing Clear Wood Strength Values.

(Application for copies should be made to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

CALIFORNIA REDWOOD ASSOCIATION (CRA)

Data Sheet 2B1-2, Redwood Lumber Grades and Uses, Patterns or Redwood Lumber.

(Applications for copies should be addressed to California Redwood Association, One Lombard Street, San Francisco, California 94111.)

FIR AND HEMLOCK DOOR ASSOCIATION (FHDA)

FHDA 7-79 - Standard for Douglas Fir, Western Hemlock, and Sitka Spruce Doors and Blinds.

(Application for copies should be addressed to the Fir and Hemlock Door Association, Yeon Building, Portland, OR 97204.)

HARDWOOD DIMENSION MANUFACTURERS ASSOCIATION (HDMA)

HDMA Rules for Measurement and Inspection of :

Hardwood Dimension Parts.
Hardwood Interior Trim and Mouldings.
Hardwood Stair Treads and Risers.

(Application for copies should be addressed to the Hardwood Dimension Manufacturers Association, 3813 Hillsboro Road, Nashville, TN 37215.)

HARDWOOD PLYWOOD MANUFACTURERS ASSOCIATION (HPMA)

HPMA Design Guide HP-SG-71 Structural Design Guide for Hardwood Plywood.

(Application for copies should be addressed to Hardwood Plywood Manufacturers Association, 1825 Faraday Drive, Reston, VA 22090.)

HOUSING AND URBAN DEVELOPMENT DEPARTMENT (HUD)

HUD 4900.1 - Minimum Property Standards for One and Two Family Dwellings.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

MAPLE FLOORING MANUFACTURERS ASSOCIATION (MFMA)

MFMA - Hard Maple Flooring - Standard Specifications and Official Grading Rules.

(Applications for copies should be addressed to the Maple Flooring Manufacturers Association, 2400 E. Devon Avenue, Des Plaines, IL 60018.)

MOUNTAIN PRESS PUBLISHING COMPANY

Wood Technology in Design of Structures (Hoyle, R.J. Jr. 1972)

(Application for copies should be addressed to the Mountain Press Publishing Company, Missoula, Montana 59801.)

NATIONAL BUREAU OF STANDARDS (NBS)

PS-1 - Construction and Industrial Plywood.
PS-20 - American Softwood Lumber Standard.
PS-51 - Hardwood and Decorative Plywood.
PS-56 - Structural Glued Laminated Timber.

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

NORTHERN HARDWOOD AND PINE MANUFACTURERS ASSOCIATION (NHPMA)

NHPMA - Grading Rules for Eastern White Pine, Norway Pine, Jack Pine, Eastern Spruce, Balsam Fir, Eastern Hemlock and Tamarack.

(Application for copies should be addressed to the Northern Hardwood and Pine Manufacturers Association, Suite 207 Northern Building, Green Bay, WI 54301.)

REDWOOD INSPECTION SERVICE (RIS)

Standard Specifications for Grades of California Redwood Lumber.

(Application for copies should be addressed to Redwood Inspection Service, One Lombard Street, San Francisco, CA 94111.)

SOUTHERN PINE INSPECTION BUREAU (SPIB)

Standard Wood Mouldings, 7000 and 8000 Series.
Standard Grading Rules.

(Application for copies should be addressed to Southern Pine Inspection Bureau, P.O. Box 846, Pensacola, FL 32594.)

UNITED STATES FOREST PRODUCTS LABORATORY

Selection, Production, Procurement and Use of Preservative - Treated Wood, Supplementing Federal Specification TT-W-571 (General Technical Report FLP-15).
Wood Handbook; Agriculture Handbook 72.
Timber Resources for Americas Future (Forest Resource Report No. 14).

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

WEST COAST LUMBER INSPECTION BUREAU (WCLB)

Standard Grading Rules for West Coast Lumber No. 16.

(Application for copies should be addressed to the West Coast Lumber Inspection Bureau, Portland, Oregon. 97223.)

NATIONAL FOREST PRODUCTS ASSOCIATION (NFPA)

NFPA - Technical Report No. 3, Comparative Fire Test of Timber and Steel Beams.
National Design Specification for Stress-Grade Lumber and Its Fastenings.

(Application for copies should be addressed to the National Forest Products Association, 1619 Massachusetts Avenue NW, Washington, DC 20036.)

NATIONAL HARDWOOD LUMBER ASSOCIATION (NHLA)

NHLA - Rules for the Measurement and Inspection of Hardwood and Cypress Lumber.

(Application for copies should be addressed to the National Hardwood Lumber Association, P.O. Box 34518, Memphis, TN 38134.)

NATIONAL OAK FLOORING MANUFACTURERS ASSOCIATION (NOFMA)

NOFMA - Specification Manual and Grading Rules.

(Application for copies should be addressed to the National Oak Flooring Manufacturers Association, 804 Sterick Building, Memphis, TN 38103.)

NATIONAL WOODWORK MANUFACTURERS ASSOCIATION (NWMA)

NWMA - Industry Standard I.S.Z Series for Wood Flush Doors.
ANSI/NWMA I.S. 5-73 - Industry Standard for Ponderosa Pine Doors.
NWMA I.S. 2-73 - Industry Standard for Wood Window Units.

(Application for copies should be addressed to the National Woodwork Manufacturers Association, 400 West Madison Street, Chicago, IL 60606.)

NORTHEASTERN LUMBER MANUFACTURERS ASSOCIATION, INC. (NEIMA)

NEIMA - Standard Grading Rules for Northeastern Lumber.

(Application for copies should be addressed to the Northeastern Lumber Manufacturers Association, Inc., 4 Fundy Road, Falmouth, Maine 04105.)

WESTERN WOOD MOLDING AND MILLWORK PRODUCERS (WWMMP)

WWMMP - WP/Series Moulding Patterns.

(Application for copies should be addressed to Western Wood Moulding and Millwork Producers, P.0. Box 25278, Portland, OR 97225.)

WESTERN WOOD PRODUCTS ASSOCIATION (WWPA)

Grading Rules for Western Lumber. Product Use Manual. Western Wood Species Book, Vol. 1, Dimension Lumber.

(Application for copies should be addressed to the Western Wood Products Association, 1500 Yeon Building, Portland, OR 97204.)

APPENDIX B.

DEFINITIONS

Adhesive. A substance capable of holding materials together by surface attachment. It is a general term and includes cements, mucilage, and paste, as well as glue.

Air-dried. (See seasoning.)

Alinement. The course or location of elements of design or construction in relation to a determined line.

Allowable property. The value of a property normally published for design use. Allowable properties are identified with grade descriptions and standards, reflect the orthotropic structure of wood, and anticipate certain end uses.

American lumber standards. American lumber standards embody provisions for softwood lumber dealing with recognized classifications, nomenclatures basic grades, sizes, description, measurements, tally, shipping provisions, grademarking, and inspection of lumber. The primary purpose of these standards is to serve as a guide in the preparation or revision of the grading rules of the various lumber manufacturers' associations A purchaser must, however, make use of association rules as the basic standards are not in themselves commercial rules.

Annual growth ring. The layer of wood growth put on a tree during a single growing season. In the temperate zone, the annual growth rings of many species (e.g., oaks, and pines) are readily distinguished because of differences in the cells formed during the early and late parts of the season. In some temperate zone species (black gum and sweetgum) and many tropical species, annual growth rings are not easily recognized.

Balanced construction. A construction such that the forces induced by uniformly distributed changes in moisture content will not cause warping. Symmetrical construction of plywood in which the grain direction of each ply is perpendicular to that of adjacent plies is balanced construction.

Bark. Outer layer of a tree, consisting of the inner bark, or thin, inner, living portion (phloem), and the outer bark, or corky layer, composed of dry, dead tissue.

Bark pocket. An opening between annual growth rings that contains bark. Bark pockets appear as dark streaks on radial surfaces and as rounded areas on tangential surfaces.

Bastard sawn. Lumber (primarily hardwoods) in which the annual rings make angles of 30 degrees to 60 degrees with the surface of the piece.

Beam. A structural member supporting a load applied transversely to it.

Beams and stringers. Large pieces (nominal dimensions 5 by 8 inches and up) of rectangular cross section graded with respect to their strength in bending when loaded on the narrow face.

Bending, steam. The process of forming curved wood members by steaming or boiling the wood and bending it to a form.

Bent wood. (See bending, steam.)

Bird peck. A small hole or patch of distorted grain resulting from birds pecking through the growing cells in the tree. In shape, bird peck usually resembles a carpet tack with the point toward the bark; bird peck is usually accompanied by discoloration extending for considerable distance along the grain and to a much lesser extent across the grain.

Birdseye. Small localized areas in wood with the fibers indented and otherwise contorted to form few to many small circular or elliptical figures remotely resembling birds' eyes on the tangential surface. Sometimes found in sugar maple and used for decorative purposes; rare in other hardwood species.

Blemish. Anything, not necessarily a defect, marring the appearance of wood.

Bloom. Crystals formed on the surface of treated wood by exudation and evaporation of the solvent in preservative solutions.

Blue stain. (See Stain.)

Board. (See Lumber.)

Board foot. A unit of measurement of lumber represented by a board l-foot long, 12-inches wide, and l-inch thick, or its cubic equivalent. In practice, the board foot calculation for lumber 1 inch or more in thickness is based on its nominal thickness and width and the length. Lumber with a nominal thickness of less than 1 inch is calculated as 1 inch.

Bole. The main stem of a tree of substantial diameter - roughly, capable of yielding sawtimber, veneer logs, or large poles. Seedlings, saplings, and small-diameter trees have stems, not boles.

Bolt. (1) A short section of a tree trunk; (2) in veneer production, a short log of a length suitable for peeling in a lathe.

Bow. That distortion of a board in which the face is convex or concave longitudinally.

Box. A rigid container having closed faces which completely enclose the contents.

Box beam. A built-up beam with solid wood flanges and plywood or wood-base panel product webs.

Boxed heart. The term used when the pith falls entirely within the four faces of a piece of wood anywhere in its length. Also called boxed pith.

Brashness. A condition that causes some pieces of wood to be relatively low in shock resistance for the species and, when broken in bending, to fail abruptly without splintering at comparatively small deflections.

Breaking radius. The limiting radius of curvature to which wood or plywood can be bent without breaking.

Bridging. Small wood members that are inserted in a diagonal position between the floor joists in order to stabilize the joists and to distribute concentrated loads to more than one joist.

Broad-leaved trees. (See Hardwoods.)

Brown rot. In wood, any decay in which the attack concentrates on the cellulose and associated carbohydrates rather than on the lignin, producing a light to dark brown friable residue - hence loosely termed “dry rot”. An advanced stage where the wood splits along rectangular planes, in shrinking, is termed “cubical rot”.

Brown stain. (See Stain.)

Built-up timbers. As assembly made by joining layers of lumber together with mechanical fastenings so that the grain of all laminations is essentially parallel.

Burl. A large wartlike outgrowth on a tree which contains the dark piths of a large number of buds which rarely develop. In lumber or veneer, burls result in a localized severe distortion of the grain generally rounded in outline.

Butt joint. (See Joint.)

Cambium. A thin layer of tissue between the bark and wood that repeatedly subdivides to form new wood and bark cells.

Casehardening. A condition of stress and set in dry lumber characterized by compressive stress in the outer layers and tensile stress in the center or core.

Cell. A general term for the structural units of plant tissue, including wood fibers, vessel members, and other elements of diverse structure and function.

Cellulose. The carbohydrate that is the principal constituent of wood and forms the framework of the wood cells.

Check. A lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses set up in wood during seasoning.

Chemical brown stain. (See Stain.)

Close grained. (See Grain.)

Coarse grain. (See Grain.)

Cold-press plywood. (See Plywood.)

Collapse. The flattening of single cells or rows of cells in heartwood during the drying or pressure treatment of wood. Often characterized by a caved-in or corrugated appearance of the wood surface.

Collar beam. A tie connecting roof rafters at a level usually considerably above the top wall plate.

Column. 1. In architecture: A vertical supporting member, circular or rectangular in section, usually consisting of a base, shaft, and capital. 2. In engineering: A vertical structural compression member, which supports loads acting in the direction of its longitudinal axis.

Compartment kiln. (See Kiln.)

Compression failure. Deformation of the wood fibers resulting from excessive compression along the grain either in direct end compression or in bending. It may develop in standing trees due to bending by wind or snow or to internal longitudinal stresses developed in growth, or it may result from stresses imposed after the tree is cut. In surfaced lumber compression failures may appear as fine wrinkles across the face of the piece.

Compression wood. Wood formed on the lower side of branches and inclined trunks of softwood trees. Compression wood is identified by its relatively wide annual rings, usually eccentric, relatively large amount of summerwood, sometimes more than 50 percent of the width of the annual rings in which it occurs, and its lack of demarcation between springwood and summerwood in the same annual rings. Compression wood shrinks excessively lengthwise, as compared with normal wood.

Conifer. (See Softwoods.)

Cooperage. Containers consisting of two round heads and a body composed of staves held together with hoops, such as barrels and kegs.

(a) Slack cooperage. Cooperage used as containers for dry, semidry, or solid products. The staves are usually not closely fitted and are held together with beaded steel, wire, or wood hoops.

(b) Tight cooperage. Cooperage used as containers for liquids, semi-solids, and heavy solids. Staves are well fitted and held tightly with cooperage grade steel hoops.

Core stock. A solid or discontinuous center ply used in panel-type glued structures (such as furniture panels and solid or hollowcore doors).

Crate. A rigid shipping container of framed construction assembled with nails or bolts. Crates may be open or completely enclosed.

Crook. That distortion of a board in which the edge is convex or concave longitudinally.

Crossband. To place the grain of layers of wood at right angles in order to minimize shrinking and swelling; also, in plywood of three or more plies, a layer of veneer whose grain direction is at right angles to that of the face plies.

Cross break. A separation of the wood cells across the grain. Such breaks may be due to internal stress resulting from unequal longitudinal shrinkage or to external forces.

Cross grain. (See Grain.)

cup. A distortion of a board in which the face is convex or concave transversely.

Cure. To change the properties of an adhesive by chemical reaction (which may be condensation, polymerization, or vulcanization) and thereby develop maximum strength. Generally accomplished by the action of heat or a catalyst, with or without pressure.

Curly grain. (See Grain.)

Cut stock. A term for softwood stock comparable to dimension stock in hardwoods. (See Dimension stock.)

Cuttings. In hardwoods, a portion of a board or plank having the quality required by a specific grade or for a particular use. Obtained from a board by crosscutting or ripping.

Decay. The decomposition of wood substance by fungi. The term "rot", "doze", and “dote” are synonyumuos with “decay”.

(a) Advanced (or typical) decay. The older stage of decay in which the destruction is readily recognized because the wood has become punky, soft and spongy, stringy, ringshaked, pitted, or crumbly. Decided discoloration or bleaching of the rotted wood is often apparent.

(b) Incipient decay. The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching of the wood.

Defect. Any irregularity occurring in or on wood that may lower its strength.

Delamination. The separation of layers in a laminate through failure within the adhesive or at the bond between the adhesive and the laminae.

Density. The mass of a body per unit volume. When expressed in the metric system, it is numerically equal to the specific gravity of the same substance.

Density rules. A procedure for segregating wood according to density, based on percentage of latewood and number of growth rings per inch of radius.

Dew point. The temperature at which water vapor in the atmosphere begins to deposit as a liquid.

Diagonal grain. (See Grain.)

Dimension. (See Lumber.)

Dimension stock. A term largely superseded by the term "hardwood dimension lumber". It is hardwood stock processed to a specified thickness, width, and length, or multiples thereof. According to specification it may be solid or glued up, rough or surfaced, semifabricated or completely fabricated.

Dimensional stabilization. Special treatment of wood to reduce the swelling and shrinking that is caused by changes in its moisture content with changes in relative humidity.

Dote. (See decay.)

Doze. (See decay)

Dressed lumber. (See lumber.)

Dry-bulb temperature. The temperature of air as indicated by a standard thermometer. (See Psychrometer.)

Dry rot. A term loosely applied to many types of decay but especially to that which, when in an advanced stage, permits the wood to be easily crushed to a dry powder. The term is actually a misnomer for any decay, since all fungi require considerable moisture for growth.

Dry wall. Interior covering material, such as gypsum board, hardboard, or plywood, which is applied in large sheets or panels.

Durability. A general term for permanence or resistance to deterioration. Frequently used to refer to the degree of resistance of a species of wood to attack by wood-destroying fungi under conditions that favor such attack. In this connection the term "decay resistance" is more specific.

Earlywood. The portion of the annual growth ring that is formed during the early part of the growing season. It is usually less dense and weaker mechanically than latewood.

Edge grain. (See Grain.)

Edge joint. (See Joint.)

Empty-cell process. Any process for impregnating wood with preservatives or chemicals in which air, imprisoned in the wood under pressure, expands when pressure is released to drive out part of the injected preservative or chemical. The distinguishing characteristic of the empty-cell process is that no vacuum is drawn before applying the preservative. The aim is to obtain good preservative distribution in the wood and leave the cell cavities only partially filled.

Encased knot. (See Knot.)

End grain. (See Grain.)

End joint. (See Joint.)

Equilibrium moisture content. The moisture content at which wood neither gains nor loses moisture when surrounded by air at a given relative humidity and temperature.

Exterior plywood. (See Plywood.)

Extractives. Substances in wood, not an integral part of the cellular structure, that can be removed by solution in hot or cold water, ether, benzene, or other solvents that do not react chemically with wood components.

Factory and shop lumber. (See Lumber.)

Fiber. A wood fiber is a comparatively long (one-twenty-fifth or less to one-third inch), narrow, tapering cell closed at both ends.

Fiber saturation point. The stage in the drying or wetting of wood at which the cell walls are saturated and the cell cavities free from water. It applies to an individual cell or group of cells, not to whole boards. It is usually taken as approximately 30 percent moisture content, based on ovendry weight.

Fiberboard. A broad generic term inclusive of sheet materials of widely varying densities manufactured of refined or partially refined wood (or other vegetables) fibers. Bonding agents and other materials may be added to increase strength, resistance to moisture, fire, or decay, or to improve some other property.

Fibril. A threadlike component of cell walls, visible under a light microscope.

Fiddleback. (See Grain.)

Figure. The pattern produced in a wood surface by annual growth rings, rays, knots, deviations from regular grain such as interlocked and wavy grain, and irregular coloration.

Fine grain. (See Grain.)

Finger joint. (See Joint.)

Finish (Finishing). Wood products such as doors, stairs, and other fine work required to complete a building, especially the interior. Also, coatings of paint, varnish, lacquer, wax, etc., applied to wood surfaces to protect and enhance their durability or appearance.

Fire retardant. A chemical or preparation of chemicals used to reduce flammability or to retard spread of a fire over the surface.

Flat grain. (See Grain.)

Flat-sawn. (See Grain, flat.)

Flecks. (See rays, wood.)

Flitch. A portion of a log sawn on two or more faces - commonly on opposite faces, leaving two waney edges. When intended for resawing into lumber, it is resawn parallel to its original wide faces. Or, it may be sliced or sawn into veneer, in which case the resulting sheets of veneer laid together in the sequence of cutting are called a flitch. The term is loosely used.

Foundation. The supporting portion of a structure below the first-floor construction, or grade, including the footings.

Framing. Lumber used for the structural member of a building, such as studs and joists; also of wood crates.

Full-cell process. Any process for impregnating wood with preservatives or chemicals in which a vacuum is drawn to remove air from the wood before admitting the preservative. This favors heavy adsorption and retention of preservative in the treated portions.

Girder. A large or principal beam of wood or steel used to support concentrated loads at isolated points along its length.

Grade. The designation of the quality of a manufactured piece of wood or of logs l

Grain. The direction, size, arrangement, appearance, or quality of the fibers in wood or lumber. To have a specific meaning the term must be qualified.

(a) Close-grained wood. Wood with narrow, inconspicuous annual rings. The term is sometimes used to designate wood having small and closely spaced pores, but in this sense the term “fine textured” is more often used.

(b) Coarse-grained wood. Wood with wide conspicuous annual rings in which there is considerable difference between springwood and summerwood. The term is sometimes used to designate wood with large pores, such as oak, ash, chestnut, and walnut, but in this sense the term “coarse textured” is more often used.

(c) Cross-grained wood. Wood in which the fibers deviate from a line parallel to the sides of the piece. Cross grain may be either diagonal or spiral grain or a combination of the two.

(d) Curly-grained wood. Wood in which the fibers are distorted so that they have a curled appearance, as in "birdseye" wood. The areas showing curly grain may vary up to several inches in diameter.

(e) Diagonal-grained wood. Wood in which the annual rings are at an angle with the axis of a piece as a result of sawing at an angle with the bark of the tree or log. A form of cross-grain.

(f) Edge-grained lumber. Lumber that has been sawed so that the wide surfaces extend approximately at right angles to the annual growth rings. Lumber is considered edge grained when the rings form an angle of 45 degrees to 90 degrees with the wide surface of the piece.

(g) End-grained wood. The grain as seen on a cut made at a right angle to the direction of the fibers (e.g., on a cross section of a tree).

(h) Fiddleback-grained wood. Figure produced by a type of fine wavy grain found, for example, in species of maple, such wood being traditionally used for the backs of violins.

(i) Fine-grained wood. (See Close-grained wood.)

(j) Flat-grained wood. Lumber that has been sawed parallel to the pith and approximately tangent to the growth rings. Lumber is considered flat grained when the annual growth rings make an angle of less than 45 degrees with the wide surface of the piece.

(k) Interlocked-grained wood. Grain in which the fibers put on for several years may slope in a right-handed direction, and then for a number of years the slope reverses to a left-handed direction, and later changes back to a right-handed pitch, and so on. Such wood is exceedingly difficult to split radially, though tangentially it may split fairly easily.

(1) Open-grained wood. Common classification for woods with large pores, such as oak, ash, chestnut, and walnut. Also known as "coarse textured".

(m) Plainsawed lumber. Another term for flat-grained lumber.

(n) Quartersawed lumber. Another term for edge-grained lumber.

(o) Side-grained wood. Another term for flat-grained lumber.

(p) Slash-grained wood. Another term for flat-grained lumber.

(q) Spiral-grained wood. Wood in which the fibers take a spiral course about the trunk of a tree instead of the normal vertical course. The spiral may extend in a right-handed or left-handed direction around the tree trunk. Spiral grain is a form of cross grain.

(r) Straight-grained wood. Wood in which the fibers run parallel to the axis of a piece.

(s) Vertical-grained lumber. Another term for edge-grained lumber.

(t) Wavy-grained wood. Wood in which the fibers collectively take the form of waves or undulations.

Green. Freshly sawed or undried wood. Wood that has become completely wet after immersion in water would not be considered green, but may be said to be in the "green condition".

Growth ring. (Annual growth ring.)

Hardboard. A generic term for a panel manufactured primarily from interfelted ligno-cellulosic fibers (usually wood), consolidated under heat and pressure in a hot press to a density of 31 pounds per cubic foot or greater, and to which other materials may have been added during manufacture to improve certain properties.

Hardness. A property of wood that enables it to resist indentation.

Hardwoods. Generally one of the botanical groups of trees that have broad leaves in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood.

Header. A beam placed perpendicular to joists and into which joists are framed in framing for a chimney, stairway, or other opening, (Compare Trimmer); also describes the end crossmembers on the base of a wood crate.

Heart, Heartwood. The wood, extending from the pith to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may be infiltrated with gums, resins, and other materials which usually make it darker and more decay-resistant than sapwood.

Hollow-core construction. A panel construction with faces of plywood, hardboard, or similar material bonded to a framed-core assembly of wood lattice, paperboard rings, or the like, which support the facing at spaced intervals.

Honeycombing. Checks, often not visible at the surface, that occur in the interior of a piece, usually along the wood rays.

Increment borer. An augerlike instrument with a hollow bit and an extractor, used to extract thin radial cylinders of wood from trees to determine age and growth rate. Also used in wood preservation to determine the depth of penetration of a preservative.

Intergrown knot. (See Knot.)

Interlocked-grained wood. (See Grain.)

Joint. The junction of two pieces of wood or veneer.

(a) Butt joint. An end joint formed by abutting the squared ends of two pieces.

(b) Edge joint. The place where two pieces of wood are joined together edge to edge, commonly by gluing. The joints may be made by gluing two squared edges as in a plain edge joint or by using machined joints of various kinds, such as tongued-and-grooved joints.

(c) End joint. The place where two pieces of wood are joined together end to end, commonly by scarf or finger jointing.

(d) Finger joint. An end joint made up of several meshing wedges or fingers of wood bonded together with an adhesive. Fingers are sloped and may be cut parallel to either the wide or edge faces of the piece.

(e) Lap joint. A joint made by placing one member partly over another and bonding the overlapped portions.

(f) Scarf joint. An end joint formed by joining with glue the ends of two pieces that have been tapered or beveled to form sloping plane surfaces, usually to a feather edge, and with the same slope of the plane with respect to the length in both pieces. In some cases, a step or hook may be machined into the scarf to facilitate alinement of the two ends, in which case the plane is discontinuous and the joint is known as a stepped or hooked scarf joint.

(g) Starved joint. A glue joint that is poorly bonded because an insufficient quantity of glue remained in the joint.

Joint efficiency or factor. The strength of a joint expressed as a percentage of the strength of clear straight-grained material.

Joist. One of a series of parallel beams used to support floor and ceiling loads, and supported in turn by larger beams, girders, or bearing walls.

Joist and Plank. Pieces (nominal dimensions 2 to 4 inches in thickness by 4 inches and wider) of rectangular cross section graded with respect to their strength in bending when loaded either on the narrow face as joist or on the wide face as plank.

Kiln. A chamber having controlled air-flow, temperature, and relative humidity, for drying lumber, veneer, and other wood products.

(a) Compartment kiln. A kiln in which the total charge of lumber is dried as a single unit. It is designed so that, at any given time, the temperature and relative humidity are essentially uniform throughout the kiln. The temperature is increased as drying progresses, and the relative humidity is adjusted to the needs of the lumber.

(b) Progressive kiln. A kiln in which the total charge of lumber is not dried as a single unit but as several units, such as kiln truckloads, that move progressively through the kiln. The kiln is designed so that the temperature is lower and the relative humidity higher at the end where the lumber enters than at the discharge end.

Kiln dried. (See Seasoning.)

Knot. That portion of a branch or limb which has been surrounded by subsequent growth of the stem. The shape of the knot as it appears on a cut surface depends on the angle of the cut relative to the long axis of the knot.

(a) Encased knot. A knot whose rings of annual growth are not intergrown with those of the surrounding wood.

(b) Intergrown knot. A knot whose rings of annual growth are completely intergrown with those of the surrounding wood.

(c) Loose knot. A knot that is not held firmly in place by growth or position and that cannot be relied upon to remain in place.

(d) Pin knot. A knot that is not more than 1/2 inch in diameter.

(e) Sound knot. A knot that is solid across its face, at least as hard as the surrounding wood, and shows no indication of decay.

(f) Spike knot. A knot cut approximately parallel to its long axis so that the exposed section is definitely elongated.

Laminated wood. An assembly made by bonding layers of veneer or lumber with an adhesive so that the grain of all laminations is essentially parallel.

(a) Horizontally laminated wood. Laminated wood in which the laminations are so arranged that the wider dimension of each lamination is approximately perpendicular to the direction of load.

(b) Vertically laminated wood. Laminated wood in which the laminations are so arranged that the wider dimension of each lamination is approximately parallel to the direction of load.

Lap joint. (See Joint.)

Latewood. The portion of the annual growth ring that is formed after the earlywood formation has ceased. It is usually denser and stronger mechanically than earlywood.

Lath. A building material of wood, metal, gypsum or insulation board, that is fastened to the frame of a building to act as a plaster base.

Lignin. A principal constituent of wood, second in abundance to cellulose. It incrusts the cell walls and cements the cells together.

Loads.

(a) Dead load. The weight of all permanent stationary construction included in a structure.

(b) Live load. The total of all moving and variable loads that may be placed upon a structure.

Loose knot. (See Knot.)

Lumber. The product of the saw and planing mill not further manufactured than by sawing, resawing, passing lengthwise through a standard planing machine, crosscutting to length, and matching.

(a) Boards. Lumber that is nominally less than 2-inches thick and 2 or more inches wide. Boards less than 6-inches wide are sometimes called strips.

(b) Dimension. Lumber with a nominal thickness of from 2 up to but not including 5 inches and a nominal width of 2 inches or more.

(c) Dressed size. The dimensions of lumber after being surfaced with a planing machine. The dressed size is usually 1/2 to 3/4 inch less than the nominal or rough size. A 2- by 4-inch stud, for example, actually measures about 1-1/2 by 3-1/2 inches.

(d) Factory and shop lumber. Lumber intended to be cut up for use in further manufacture. It is graded on the basis of the percentage of the area that will produce a limited number of cuttings of a specified minimum size and quality.

(e) Matched lumber. Lumber that is edge dressed and shaped to make a close tongued-and-grooved joint at the edges or ends when laid edge to edge or end to end.

(f) Nominal size. As applied to timber or lumber, the size by which it is known and sold in the market; often differs from the actual size. (See also, Dressed size.)

(g) Patterned lumber. Lumber that is shaped to a pattern or to a moulded form in addition to being dressed, matched, or shiplapped, or any combination of these workings.

(h) Rough lumber. Lumber which has not been dressed (surfaced) but which has been sawed, edged, and trimmed.

(i) Shiplapped lumber. Lumber that is edge dressed to make a lapped joint.

(j) Shipping-dry lumber. Lumber that is partially dried to prevent stain and mold during transit.

(k) Side lumber. A board from the outer portion of the log - ordinarily one produced when squaring off a log for a tie or timber.

(l) Structural lumber. Lumber that is intended for use where allowable properties are required. The grading of structural lumber is based on the strength of the piece as related to anticipated uses.

(m) Surfaced lumber. Lumber that is dressed by running it through a planer.

(n) Timbers. Lumber that is nominally 5 or more inches in least dimension. Timbers may be used as beams, stringers, posts, caps, sills, griders, purlins, etc.

(o) Yard lumber. A little-used term for lumber of all sizes and patterns that is intended for general building purposes having no design property requirements.

Manufacturing defects. Includes all defects or blemishes that are produced in manufacturing, such as chipped grain, loosened grain, raised grain, torn grain, skips in dressing, hit and miss (series of surfaced areas with skips between them), variation in sawing, miscut lumber, machine burn, machine gouge, mismatching, and insufficient tongue or groove.

Matched lumber. (See Lumber.)

Millwork. Planed and patterned lumber for finish work in buildings, including such items as sash, doors, cornices, panelwork and other items of interior or exterior trim. Does not include flooring, or siding.

Mineral streak. An olive to greenish-black or brown discoloration of undetermined cause in hardwoods.

Modified wood. Wood processed by chemical treatment, compression, or other means (with or without heat) to impart properties quite different from those of the original wood.

Moisture content. The amount of water contained in the wood, usually expressed as a percentage of the weight of the ovendry wood.

Moulded plywood. (See Plywood.)

Moulding. A wood strip having a curved or projecting surface, used for decorative purposes.

Mortise. A slot cut into a board, plank, or timber, usually edgewise, to receive the tenon of another board, plank, or timber to form a joint.

Nominal-size lumber. (See Lumber.)

Old growth. Timber in or from a mature, naturally established forest. When the trees have grown during most if not all of their individual lives in active competition with their companions for sunlight and moisture, this timber is usually straight and relatively free of knots.

Open-grained wood. (See Coarse-grained wood.)

Ovendry wood. Wood dried to a relatively constant weight in a ventilated oven at 101° to 105° C.

Pallet. A low wood or metal platform on which material can be stacked to facilitate mechanical handling, moving, and storage.

Parenchyma. Short cells having simple pits and functioning primarily in the metabolism and storage of plant food materials. They remain alive longer than the tracheids, fibers, and vessel segments, sometimes for many years. Two kinds of parenchyma cells are recognized - those in vertical strands, known more specifically as axial parenchyma, and those in horizontal series in the rays, known as ray parenchyma.

Particleboard. A generic term for a panel manufactured from lignocellulosic materials - commonly wood - essentially in the form of particles (as distinct from fibers). These materials are bonded together with synthetic resin or other suitable binder, under heat and pressure, by a process wherein the interparticle bonds are created wholly by the added binder.

Partition. A wall that subdivides spaces within any story of a building

(a) Bearing partition. A partition which supports any vertical load in addition to its own weight.

(b) Fire partition. A partition designed to restrict the spread of fire, or to provide an area of refuge.

(c) Nonbearing partition. A partition extending from floor to ceiling which supports no load other than its own weight.

Patterned lumber. (See Lumber.)

Peck. Pockets or areas of disintegrated wood caused by advanced stages of localized decay in the living tree. It is usually associated with cypress and incense cedar. There is no further development of peck once the lumber is seasoned.

Peel. To convert a log into veneer by rotary cutting.

Phloem. The tissues of the inner bark, characterized by the presence of sieve tubes and serving for the transport of elaborate foodstuffs.

Pile. A long, heavy timber, round or square cut, that is driven deep into the ground to provide a secure foundation for structures built on soft, wet, or submerged sites; e.g., landing stages, bridge abutments.

Pin-knot. (See Knot.)

Pitch pocket. An opening extending parallel to the annual growth rings and containing, or that has contained, pitch, either solid or liquid.

Pitch streaks. A well-defined accumulation of pitch in a more or less regular streak in the wood of certain conifers.

Pith. The small, soft core occurring near the center of a tree trunk, branch, twig, or log.

Pith fleck. A narrow streak, resembling pith on the surface of a piece; usually brownish, up to several inches in length; resulting from burrowing of larvae in the growing tissues of the tree.

Plainsawed. (See Grain.)

Planing mill products. Products worked to pattern, such as flooring, ceiling, and siding.

Plank. A broad board, usually more than l-inch thick, laid with its wide dimension horizontal and used as a bearing surface.

Plasticizing wood. Softening wood by hot water, steam, or chemical treatment to increase its moldability.

Plate.

(a) A horizontal structural member placed on a wall or supported on posts, studs, or corbels to carry the trusses of a roof or to carry the rafters directly.

(b) A shoe or base member, as of a partition or other frame.

(c) A small, relatively flat member placed on or in a wall to support girders, rafters, and other framing.

(d) A nonstructural protective unit, such as a push-plate or kick-plate.

Plywood. A composite panel or board made up of cross-banded layers of veneer only or of veneer in combination with a core of lumber or of particleboard and with all components bonded together with an adhesive. . Generally the grain direction of each layer is at right angles to that of adjoining layers; an odd number of layers are used.

(a) Cold-pressed plywood. Refers to interior-type plywood manufactured in a press without external applications of heat.

(b) Exterior plywood. A general term for plywood bonded with a type of adhesive that by systematic tests and service records has proved highly resistant to weather; micro-organisms; cold, hot, and boiling water; steam; and dry heat.

(c) Moulded plywood. plywood that is glued to the desired shape either between curved forms or more commonly by fluid pressure applied with flexible bags or blankets (bag moulding) or other means.

(d) Postformed plywood. The product formed when flat plywood is reshaped into a curve configuration by steaming or plasticizing agents.

Pocket rot. Advanced decay which appears in the form of a hole, pocket, or area of soft rot usually surrounded by apparently sound wood.

Pore. (See Vessel.)

Porous woods. Hardwoods having vessels or pores large enough to be seen readily without magnification.

Postformed plywood. (See Plywood.)

Posts and timbers. Pieces of square or approximately square cross section, 5 by 5 inches or larger in nominal dimensions graded primarily for use as posts or columns but adapted to miscellaneous uses in which strength in bending is not especially important.

Preservative. Any substance that, for a reasonable length of time, is effective in preventing the development and action of wood-rotting fungi, borers of various kinds, and harmful insects that deteriorate wood.

Pressure process. Any process of treating wood in a closed container whereby the preservative or fire retardant is forced into the wood under pressures greater than 1 atmosphere. Pressure is generally preceded or followed by vacuum, as in the vacuum-pressure and empty cell processes respectively, or they may alternate, as in the full cell and alternating-pressure processes.

Progressive kiln. (See Kiln.)

Psychrometer. An instrument for measuring the amount of water vapor in the atmosphere. It has both a dry-bulb and wet-bulb thermometer. The bulb of the wet-bulb thermometer is kept moistened and is, therefore, cooled by evaporation to a temperature lower than that shown by the dry-bulb thermometer. Because evaporation is greater in dry air, the difference between the two thermometer readings will be greater when the air is dry than when it is moist.

Purlin. A horizontal member usually laid at right angles to main rafters or trusses of a roof to support elements of the roof framing.

Quarter-sawed. (See Grain.)

Rabbet. A rectangular longitudinal groove cut in the edge of a board or other piece of material.

Radial. Coincident with a radius from the axis of the tree or log to the circumference.

Rafter. One of a series of structural members of a roof designed to support roof loads. The rafters of a flat roof are sometimes called roof joists.

Rafter types.

(a) Hip rafter. A rafter which forms the intersection of an external roof angle.

(b) Jack rafter. A rafter which spans the distance from a wall plate to a hip or from a valley to a ridge.

(c) Valley rafter. A rafter which forms the intersection of an internal roof angle.

Raised grain. A roughened condition of the surface of dressed lumber in which the hard summerwood is raised above the softer springwood but not torn loose from it.

Rate of growth. The rate at which a tree has laid on wood, measured radially in the trunk or in lumber cut from the trunk. The unit of measure in use is the number of annual growth rings per inch.

Rays, wood. Strips of cells extending radially within a tree and varying in height from a few cells in some species to 4 or more inches in oak. The rays serve primarily to store food and transport it horizontally in the tree. On quartersawed oak, the rays form a conspicuous figure, sometimes referred to as flecks.

Relative humidity. Ratio of the amount of water vapor present in the air to that which the air would hold at saturation at the same temperature. It is usually considered on the basis of the weight of the vapor but, for accuracy, should be considered on the basis of vapor pressures.

Resilience. The property whereby a strained body gives up its stored energy on the removal of the deforming force.

Resin. Flammable, water-soluble, vegetable substances secreted by certain plants or trees, and characterizing the wood of many coniferous species. The term is also applied to synthetic organic products related to the natural resins.

Resin ducts. Intercellular passages that contain and transmit resinous materials. On a cut surface, they are usually inconspicuous. They may extend vertically parallel to the axis of the tree or at right angles to the axis and parallel to the rays.

Retention by assay. The determination of preservative retention in a specific zone of treated wood by extraction or analysis of specified samples.

Ring failure. A separation of the wood during seasoning, occurring along the grain and parallel to the growth rings. (Also, see Shake.)

Ring-porous woods. A group of hardwoods in which the pores are comparatively large at the beginning of each annual ring and decrease in size more or less abruptly toward the outer portion of the ring, thus forming a distinct inner zone of pores, known as the earlywood, and an outer zone with smaller pores, known as the latewood.

Ring shake. (See Shake.)

Rip. To cut lengthwise, parallel to the grain.

Roof. The entire construction used to close in the top of a building.

Roof hip. The sloping line at the junction of two roof surfaces where an external angle greater than 180 degrees is formed.

Roof ridge. The horizontal line at the junction of the top edges of two roof surfaces where an external angle greater than 180 degrees is formed.

Roof types.

(a) Flat roof. A roof which is flat or one which is pitched only enough to provide for drainage. (Compare roof types; pitched roof.)

(b) Gabled roof. A ridge roof which terminates in a gable.

(c) Hip (or hipped) roof. (1) In general, a roof which has one or more hips. (2) A roof which has four sloping sides that meet at four hips, or at four hips and a ridge.

(d) Pitched roof. A roof which has one or more sloping surfaces pitched at angles greater than necessary for drainage. (Compare roof types; flat roof.)

(e) Ridge roof. A roof which has one or more ridges.

Rot. (See Decay.)

Rotary-cut veneer. (See Veneer.)

Rough lumber. (See Lumber.)

Sap. All the fluids in a tree, special secretions and excretions such as gum, excepted.

Sapwood. The layers of wood next to the bark, usually lighter in color than the heartwood, one-half inch to 3 or more inches wide that are actively involved in the life processes of the tree. Under most conditions sapwood is more susceptible to decay than heartwood; as a rule, it is more permeable to liquids than heartwood. Sapwood is not essentially weaker or stronger than heartwood of the same species.

Saw kerf. (1) Grooves or notches made in cutting with a saw; (2) that portion of a log, timber, or other piece of wood removed by the saw in parting the material into two pieces.

Sawed veneer. (See Veneer.)

Scarf joint. (See Joint.)

Schedule, kiln drying. A prescribed series of dry- and wet-bulb temperatures and air velocities used in drying a kiln charge of lumber or other wood products.

Seasoning. Removing moisture from green wood to improve its serviceability.

(a) Air-dried. Dried by exposure to air in a yard or shed, without artificial heat.

(b) Kiln-dried. Dried in a kiln with the use of artificial heat.

Second growth. Timber that has grown after the removal, whether by cutting, fire, wind, or other agency, of all or a large part of the previous stand.

Shake. A separation along the grain, the greater part of which occurs between the rings of annual growth. Usually considered to have occurred in the standing tree or during felling.

Shakes. In construction, shakes are a type of shingle usually hand cleft from a bolt and used for roofing or weatherboarding.

Shear. A condition of stress or strain where parallel planes slide relative to one another.

Sheathing. The structural covering, usually of boards, building fiberboards, or plywood, placed over exterior studding or rafters of a structure.

Sheathing paper. A building material used in wall and roof construction as a protection against the passage of air and sometimes moisture.

Shiplapped lumber. (See Lumber.)

Shipping-dry lumber. (See Lumber.)

Side-grained wood. (See Grain.)

Side lumber. (See Lumber.)

Sill.

(a) The lowest member of the frame of a structure, usually horizontal, resting on the foundation and supporting the uprights of the frame.

(b) That member forming the lower side of an opening, as door sill, window sill, etc.

Slash grain. (See Grain.)

Sliced veneer. (See Veneer.)

Softwoods. Generally, one of the botanical groups of trees that in most cases have needlelike or scalelike 1eaves ; the conifers, also the wood produced by such trees. The term has no reference to the actual hardness of the wood.

Sound knot. (See Knot.)

Span. The distance between structural supports such as walls, columns, piers, beams, girders, and trusses.

Specific gravity. As applied to wood, the ratio of the ovendry weight of a sample to the weight of a volume of water equal to the volume of the sample at a specified moisture content (green, air-dry, or ovendry).

Spike knot. (See Knot.)

Spiral grain. (See Grain.)

Split. A lengthwise separation of the wood due to the tearing apart of the wood cells.

Springwood. (See Earlywood.)

Stain. A discoloration in wood that may be caused by such diverse agencies as micro-organisms, metal, or chemicals. The term also applies to materials used to impart color to wood.

(a) Blue stain. A bluish or grayish discoloration of the sapwood caused by the growth of certain dark-colored fungi on the surface and in the interior of the wood; made possible by the same conditions that favor the growth of other fungi.

(b) Brown stain. A rich brown to deep chocolate-brown discoloration of the sapwood of some pines caused by a fungus that acts much like the blue-stain fungi.

(c) Chemical brown stain. A chemical discoloration of wood, which sometimes occurs during the air-drying or kiln-drying of several species, apparently caused by the concentration and modification of extractives.

(d) Sap stain. (See Blue stain.)

(e) Sticker stain. A brown or blue stain that develops in seasoning lumber where it has been in contact with the stickers.

Starved joint. (See Joint.)

Stickers. Strips or boards used to separate the layers of lumber in a pile and thus improve air circulation.

Straight grained. (See Grain.)

Strength. The term in its broader sense embraces collectively all the properties of wood which enable it to resist different forces or loads. In its more restricted sense, strength may apply to any one of the mechanical properties, in which event the name of the property under consideration should be stated, thus strength in compression parallel to the grain, strength in bending, hardness, etc.

Stressed-skin construction. A construction in which panels are separated from one another by a central partition of spaced strips with the whole assembly bonded so that it acts as a unit when loaded.

Stringer. A timber or other support for cross members in floors or ceilings. In stairs, the support on which the stair treads rest.

Structural lumber. (See Lumber.)

Structural timber. Pieces of wood of relatively large size in which strength is the controlling element in their selection and use. Trestle timbers (stringers, caps, posts, sills, bracing, bridge ties, guard rails): car timbers (car framing, including upper framing, car sills); framing for buildings (posts, sills, girders, framing joists); ship timbers (ship timbers, ship decking); and crossarms for poles are examples of structural timbers.

Summerwood. (See latewood.)

Surfaced lumber. (See Lumber.)

Tangential. Strictly, coincident with a tangent at the circumference of a tree or log, or parallel to such a tangent. In practice, however, it often means roughly coincident with a growth ring.

Tension wood. An abnormal form of wood found in the upper side of the bole and branches of leaning trees of some hardwood species and characterized by the presence of gelatinous fibers and excessive longitudinal shrinkage. Tens ion wood fibers hold together tenaciously so that sawed surfaces usually have projected fibers, and planed surfaces often are torn or have raised grain. Tension wood may cause warping.

Texture. A term often used interchangeably with grain. It refers to the finer structure of the wood (See Grain) rather than the annual rings.

Thermoplastic glues and resins. Glues and resins that are capable of being repeatedly softened by heat and hardened by cooling.

Thermosetting glues and resins. Glues and resins that are cured with heat but do not soften when subsequently subjected to high temperatures.

Timbers. Lumber 5 inches or larger in least dimension (see Lumber).

Tracheid. The elongated cells that constitute the greater part of the structure of the softwoods (frequently referred to as fibers) which are present in some hardwoods.

Trim. The finish materials in a building, such as mouldings applied around openings, (window trim, door trim) or at the floor and ceiling of rooms (baseboard, cornice, picture moulding).

Trimmer. A beam or joist into which a header is framed in framing for a chimney, stairway, or other opening. (Compare Header.)

Truss. An assembly of members, such as beams, bars, rods, and the like, so combined as to form a rigid framework. All members are interconnected to form triangles.

Twist. A distortion caused by the turning or winding of the edges of a board so that the four corners of any face are no longer in the same plane.

Tyloses. Masses of parenchyma cells appearing somewhat like froth in the pores of some hardwoods, notably the white oaks and black locust. Tyloses are formed by the extension of the cell wall of the living cells surrounding vessels of hardwood.

Veneer. Thin sheets of wood.

(a) Rotary-cut veneer. Veneer cut in a continuous strip by rotating a log against the edge of a knife in a lathe.

(b) Sawed veneer. Veneer produced by sawing.

(c) Sliced veneer. Veneer that is sliced off by moving a log, bolt, or flitch against a large knife.

Vertical grain. (See Grain.)

Vessels. Wood cells of comparatively large diameter which have open ends and are set one above the other forming continuous tubes. The openings of the vessels on the surface of a piece of wood are usually referred to as pores.

Virgin growth. The original growth of mature trees.

Walls.

(a) Bearing wall. A wall which supports any vertical load in addition to its own weight.

(b) Curtain wall. A nonbearing wall between columns or piers which is not supported by girders or beams.

(c) Exterior wall. Any outside wall or vertical enclosure of a building other than a party or common wall.

(d) Foundation wall. Any bearing wall or pier below the first-floor construction.

(e) Nonbearing wall. A wall which supports no vertical load other than its own weight.

Wallboard. Wood pulp, gypsum, or similar materials made into large rigid sheets that may be fastened to the frame of a building to provide a surface finish.

Wane. Bark, or lack of wood or bark, from any cause, on edge or corner of a piece.

Warp. Any variation from a true or plane surface. Warp includes bow, crook, cup, and twist, or any combination thereof.

Wavy-grained wood. (See Grain.)

Weathering. The mechanical or chemical disintegration and discoloration of the surface of wood that is caused by exposure to light, the action of dust and sand carried by winds, and the alternate shrinking and swelling of the surface fibers that come with the continual variation in moisture content brought by changes in the weather. Weathering does not include decay.

Wet-bulb temperature. The temperature indicated by the wet-bulb thermometer of a psychrometer.

White-rot. In wood, any decay attacking both the cellulose and the lignin, producing a generally whitish residue that may be spongy or stringy rot, or occur as pocket rot.

Wood preservative. (See Preservative.)

Workability. The degree of ease and smoothness of cut obtainable with hand or machine tools.

Working of wood. Change in the dimensions of a piece of wood with change in moisture content.

Yard brown stain. (See Stain, chemical brown.)

Yard lumber. (See Lumber.)

APPENDIX C.

ABBREVIATIONS

These abbreviations are commonly used for softwood lumber, although all of them are not necessarily applicable to all species. Additional abbreviations which are applicable to a particular region or species may be included in approved grading rules. Abbreviations are commonly used in the forms indicated, but variations such as the use of upper- and lower-case type, and the use or omission of periods and other forms of punctuation are optional.

AD	Air-dried
ADF	After deducting freight
ALS	American Lumber Standards
AV or AVG	Average
Bd	Board
Bd. ft.	Board foot or feet
Bd1	Bundle
Bev	Beveled
B/L	Bill of lading
BM	Board Measure
Btr	Better
B&B or B&Btr	B and better
B&S	Beams and stringers
CB1S	Center bead one side
CB2S	Center bead two sides
CF	Cost and freight
CG2E	Center groove two edges
CIF	Cost , insurance, and freight
CIFE	Cost, insurance, freight and exchange
Clg	Ceiling
Clr	Clear
CM	Center matched
Com	Common
CS	Caulking seam
Csg	Casing
Cu. Ft.	Cubic foot or feet
CV1S	Center Vee one side
CV2S	Center Vee two sides
D&H	Dressed and headed
D&M	Dressed and matched
DB. Clg.	Double-beaded ceiling (E&CB1S)
DB. Part	Double-beaded partition (E&CB2S)
DET	Double end trimmed
Dim	Dimension
Dkg	Decking
D/S or D/Sdg	Drop siding
EB1S	Edge bead one side
EB2S	Edge bead two sides
E&CB1S	Edge and center bead one side
E&CB2S	Edge and center bead two sides

E&CV1S	Edge and center Vee one side
E&CV2S	Edge and center Vee two sides
EE	Eased edges
EG	Edge (vertical) grain
EM	End matched
EV1S	Edge Vee one side
EV2S	Edge Vee two sides
Fac	Factory
FAS	Free alongside (named vessel)
FBM	Foot or feet board measure
FG	Flat (slash) grain
Flg	Flooring
FOB	Free on board (named point)
FOHC	Free of heart center or centers
FOK	Free of knots
Frt	Freight
Ft	Foot or feet
GM	Grade marked
G/R or G/Rfg	Grooved roofing
HB	Hollow back
H&M	Hit-and-miss
H or M	Hit-or-miss
Hrt	Heart
Hrt CC	Heart cubical content
Hrt FA	Heart facial area
Hrt G	Heart girth
IN.	Inch or inches
J&P	Joists and planks
KD	Kiln-dried
Lbr	Lumber
LCL	Less than carload
LFT or Lin. Ft	Linear foot or feet
Lgr	Longer
Lgth	Length
Lin	Linear
Lng	Lining
M	Thousand
MBM	Thousand (feet) board measure
MC	Moisture content
Merch	Merchantable
Mldg	Moulding
No.	Number
N1E	Nosed one edge
N2E	Nosed two edges
Og	Ogee
Ord	Order
Par	Paragraph
Part	Partition
Pat	Pattern
Pc	Piece

Pcs	Pieces
PE	Plain end
PO	Purchase order
P&T	Post and timbers
Reg	Regular
Res	Resawed or resawn
Rfg	Roofing
Rgh	Rough
R/L	Random lengths
R/W	Random widths
R/W&L	Random widths and lengths
Sdg	Siding
Se1	Select
S&E	Side and Edge (surfaced on)
SE Sdg	Square edge siding
SE & S	Square edge and sound
S/L or S/LAP	Shiplap
SL&C	Shipper's load and count
SM, or Std. M	Standard matched
Specs	Specifications
Std	Standard
Stpg	Stepping
Str. or Struc	Structural
S1E	Surfaced one edge
S1S	Surfaced one side
S1S1E	Surfaced one side and one edge
S1S2E	Surfaced one side and two edges
S2E	Surfaced two edges
S2S	Surfaced two sides
S2S1E	Surfaced two sides and one edge
S2S&CM	Surfaced two sides and center matched
S2S&SM	Surfaced two sides and standard matched
S4S	Surfaced four sides
S4S&CS	Surfaced four sides and caulking seam
T&G	Tongued and grooved
VG	Vertical grain
Wdr.	Wider
WT	Weight

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TABLES

FIGURES

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