



U.S. DEPARTMENT OF AGRICULTURE • FOREST SERVICE  
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In Cooperation with the University of Wisconsin



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RESEARCH NOTE  
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## MOISTURE CONTENT OF WOOD IN USE<sup>1</sup>

Forest Products Laboratory, <sup>2</sup> Forest Service  
U.S. Department of Agriculture

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### Summary

The moisture content of wood will change with changes in the conditions under which it is used. To give best service, the wood should be installed at a moisture content close to the midpoint between the high and low values it will usually attain in use. This report presents recommendations that will enable the user to select the preferable moisture content for wood used under various conditions.

### Introduction

Wood products shrink as they dry and swell as they absorb moisture, either liquid or vapor, from the atmosphere. Unless these changes in dimension are kept to a minimum, they may result in unsatisfactory service of wood products and structures,

Fortunately, most of the difficulties caused by moisture can be practically eliminated by drying the wood--to the moisture content best suited for the intended use--before the wood is put into service. The optimum moisture content will be midway between the extreme values that the wood is likely to reach.

If the wood is too wet when it is put into place, it will eventually dry to a moisture content approximating that of the conditions under which it is used. This drying in place will be accompanied by shrinkage.

In a house, this shrinkage may cause loosening of fastenings and settling of the building with resulting plaster cracks, drywall nail popping, and unsightly openings around trim and moldings. Excessive shrinking of studs, sheathing, and siding decreases the weathertightness of walls, loosens fastenings, and may reduce the mechanical stiffness of walls.

If wood is dried too far below the average moisture content it will reach in use, swelling may cause drawers, windows, and doors to stick.

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<sup>1</sup>Revision of Forest Products Laboratory report 1655, of the same title, originally written in 1947 by E. C. Peck.

<sup>2</sup>Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

In furniture, woodwork, flooring, sash and doors, cabinets, and other products, swelling and shrinking may split, crack, or warp the part: open joints and loosen nails and other fastenings; cause gluelines to fail; and mar the finish of the product.

Shrinkage and swelling may also cause difficulties in heavy construction, such as mills, docks, trestles, and bridges. Generally, however, the effects of such shrinkage and swelling are provided for in the design and maintenance of such structures.

This report summarizes information and recommendations that will help the wood user select the correct moisture content.

### Green Lumber and Timber

Green lumber, dimension, and timber are best used under conditions where the wood is maintained at a high moisture content or where shrinkage and defects caused by drying in place have been considered in the design of the structure.

It may be feasible, for example, to use green timber for piling that is submerged in water or for large members of wood boats.

Large timbers that would require an exceedingly long and mild seasoning period to dry without serious seasoning defects are generally used green and allowed to season in place. Such timbers are used in construction of bridges, trestles, and mill buildings where shrinkage, splits, checks, and other drying defects have been considered in the design of the structure. Also, at present, many large timbers are fabricated from several laminations of dried 1-inch or 2-inch lumber bonded together. The dried laminations permit the producer to control final moisture content quite accurately, and this minimizes many of the moisture content problems associated with the use of green timbers.

The greatest difficulty connected with the use of green, untreated lumber and timber is decay, particularly at joints and contact points.

### Air-Dried Lumber and Dimension

In most parts of the country, the minimum moisture content that can be generally obtained in air drying is about 12 to 15 percent. Most air-dried material is usually closer to 20 percent moisture content when used.

Air-dried lumber is suitable for items that are not ordinarily subjected to the artificial heat and dehumidification of buildings or where appreciable shrinkage can be tolerated. All types of out-buildings, such as sheds and barns, can usually be safely constructed of air-dried lumber. Air-dried lumber is also satisfactory for products used outdoors, such as boxes and crates, parts of agricultural implements, and truck and trailer bodies.

### Kiln-Dried Lumber and Dimension

Kiln-dried lumber or air-dried lumber that has received additional drying in a heated room is recommended for all uses that require a moisture content below about 12 percent. In most parts of the United States this will include practically all interior woodwork, such as flooring, trim, furniture, stairway stock, panels, and cabinet work that is used inside heated buildings.

Figures 1 and 2 show how the moisture content of interior woodwork is related to outdoor temperature and relative humidity. In air-conditioned homes, the values would probably be slightly higher for houses that have cooling systems only and slightly lower for houses that combine dehumidification and cooling.

Table 1, which is based on the data in figures 1 and 2, presents recommendations for the moisture content of interior and exterior woodwork for use in each of three areas in the United States. Figure 3 presents similar data in graphic form. Each of the three areas shown (fig. 3) has its own requirements with respect to the moisture content to which wood should be seasoned for use as interior and exterior woodwork. Lumber seasoned for use in New Orleans, for example, would not be suitable for use in Minneapolis: a door manufactured in Wisconsin of kiln-dried lumber would probably undergo troublesome swelling and warping if it were shipped to the relatively humid conditions of Galveston, Texas.

Although the values in the tables and figures are averages first developed in the 1930's, their accuracy and workability have been verified by numerous investigations since then. They provide a sound basis for selecting the correct moisture content of wood for use under the various conditions.

If recommendations given in table 1 and in the following paragraphs are observed, most difficulties connected with the use of improperly seasoned lumber will be eliminated.

### Plywood, Particleboard, and Hardboard

Plywood, particleboard, hardboard, and other more extensively processed wood products undergo a significant change in hygroscopicity during manufacture. Frequently the desired equilibrium moisture content of such materials is not known. In such cases, the material should be conditioned to approximate equilibrium with the proper relative humidity shown in figure 3. It is not desirable to condition such products to the same moisture content as lumber.

### Recommendations

1. Use lumber that is dried to a moisture content close to the midpoint between the high and low values the wood will attain in service. Table 1 and figure 3 show the recommended moisture content values for wood used in interior and exterior parts of heated buildings. The values for exterior sheathing and trim will also apply to lumber used outdoors and in unheated buildings.

2. If it is not known beforehand in what locality a product will be used, the wood should be dried to a moisture content of about 8 percent, which is close to the average of the values preferred for the arid and damp regions.

3. In most of the United States, practically all interior woodwork, such as trim, flooring, panels, and cabinet work, should be kiln dried. Material for furniture, cabinets, case goods, musical instruments, tool handles, turning stock, and sporting goods should be kiln dried to an average moisture content between 5 and 8 percent.

4. Air-dried lumber is suitable for items that are not ordinarily subjected to artificial heat or for use in structures in which some shrinkage can be tolerated.

5. Green lumber should be limited to uses where it is maintained at a high moisture content or where shrinkage has been considered in the design of the structure. When green lumber is used, precautions should be taken to prevent decay.

6. Plywood, particleboard, hardboard, insulation board, and other wood products that undergo more extensive processing operations should be conditioned to equilibrium with the relative humidities shown in figure 3.

Table 1 -- Recommended moisture content values for various wood items  
at time of installation

Use of wood	Moisture content for--					
	Most areas of United States		Dry southwestern area <sup>1</sup>		Damp, warm coastal areas <sup>1</sup>	
	Average <sup>2</sup>	Individual pieces	Average <sup>2</sup>	Individual pieces	Average <sup>2</sup>	Individual pieces
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
<u>Interior:</u>						
Woodwork, flooring						
Furniture, wood trim	8	6-10	6	4-9	11	8-13
Laminated timbers						
<u>Exterior:</u>						
Siding, wood trim						
Framing, sheathing	12	9-14	9	7-12	12	9-14
Laminated timbers						

<sup>1</sup>For limiting range, see figure 3.

<sup>2</sup>To obtain a realistic average, test at least 10 pct. of each item. If the amount of a given item is small, several tests should be made. For example, in an ordinary dwelling having about 60 floor joists, at least 10 tests should be made on joists selected at random.

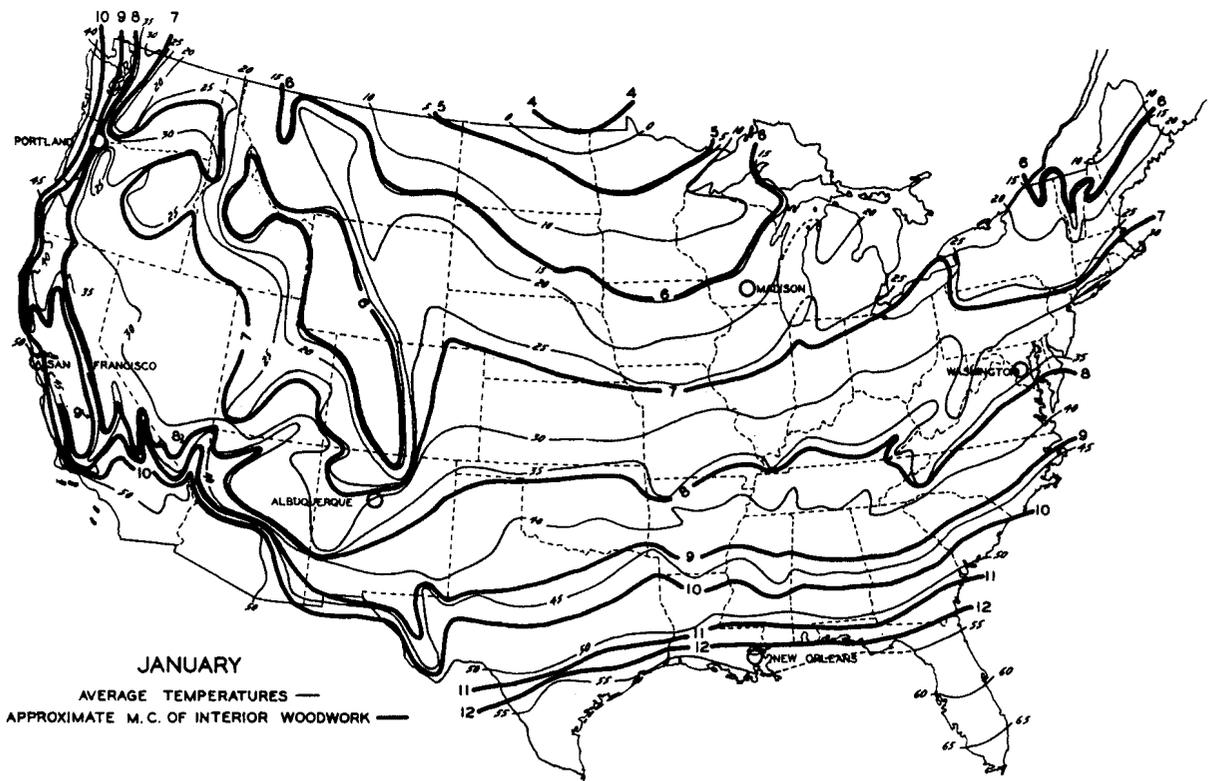


Figure 1.--Relation of moisture content of interior woodwork to outdoor temperature of various areas of the United States in January. M 16876F

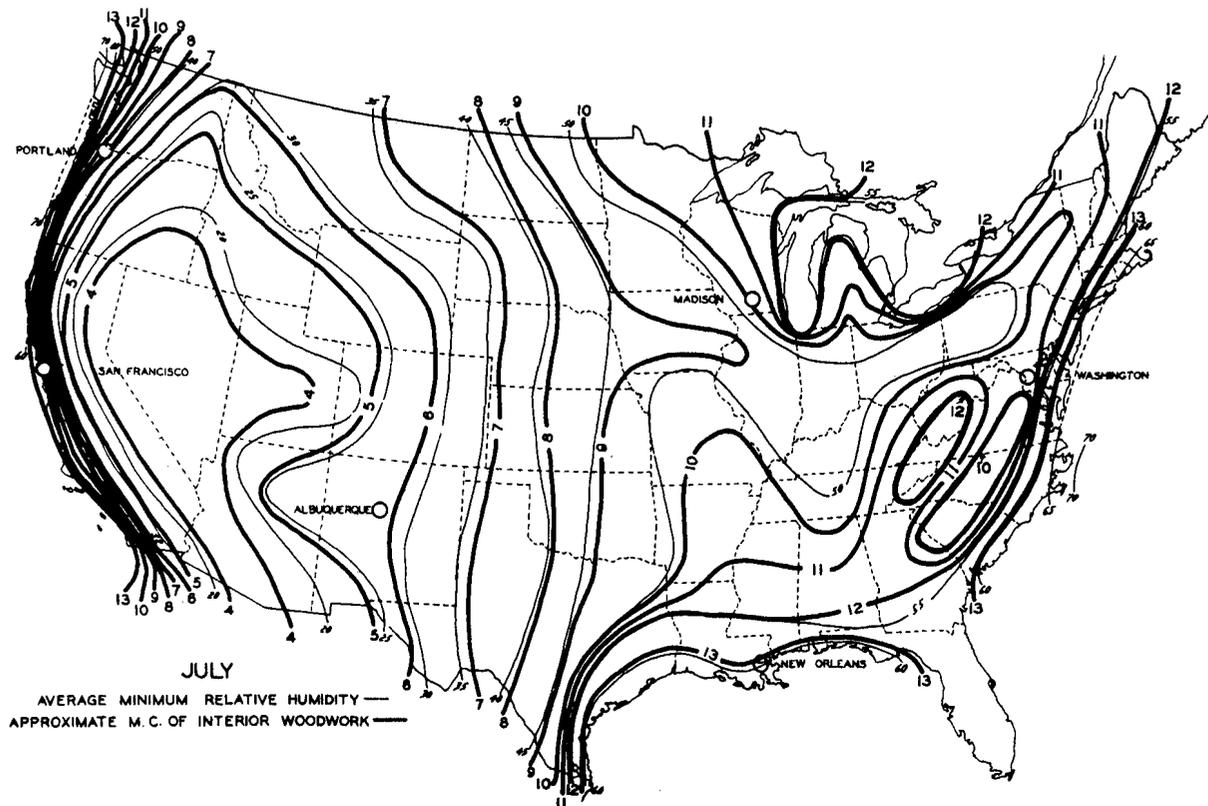


Figure 2.--Relation of moisture content of interior woodwork to outdoor relative humidity of various areas of the United States in July. ZM 16877F

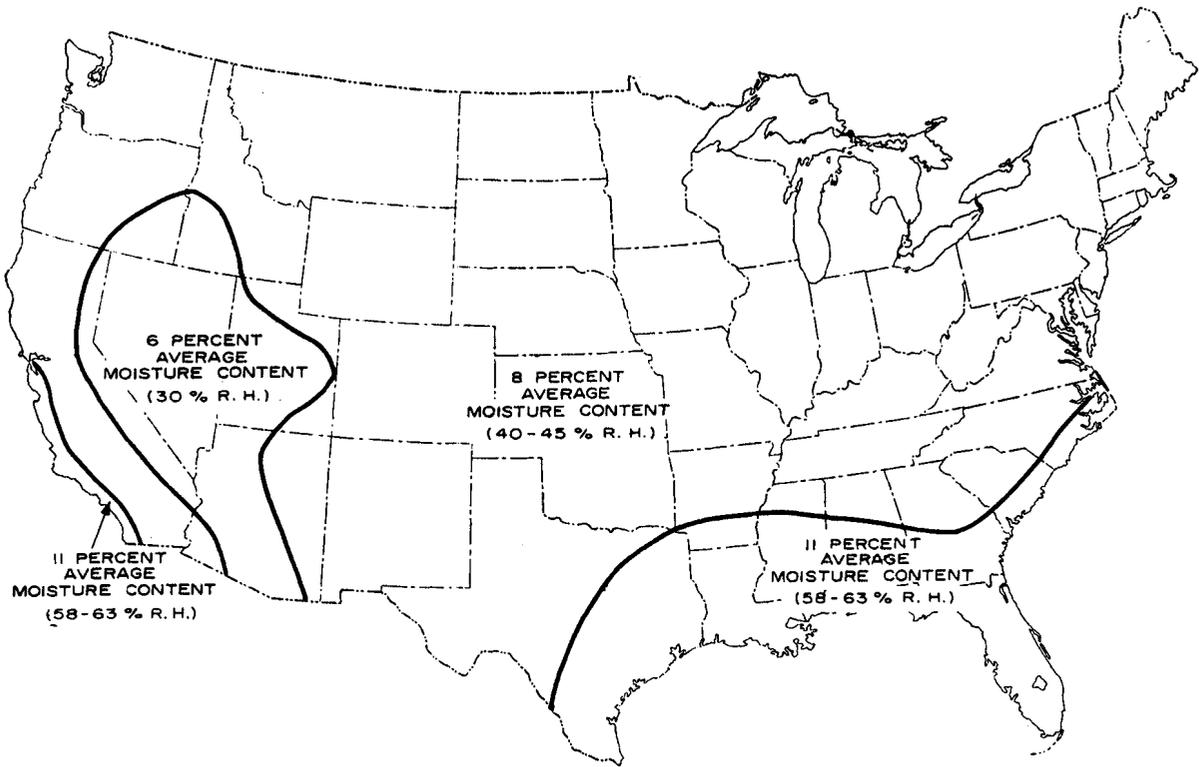


Figure 3.--Recommended moisture content averages for interior-finishing woodwork for use in various parts of the United States.

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