The moisture content of a wood product will fluctuate in accordance with 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 moisture content values it will attain in use. This report presents data and recommendations that will enable the user to select the correct moisture content for wood used under various conditions.

Wood, as do most fibrous materials, shrinks as it dries and swells as it absorbs moisture, either in the form of free water or in the form of vapor from the atmosphere. Unless these changes in dimension are kept to a minimum, they may cause difficulties that will result in unsatisfactory service and expensive repair and maintenance of wood products and structures.

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, uneven floors, and unsightly openings around trim and moldings. Shrinking of studs, sheathing, and siding decreases the weathertightness of walls, loosens fastenings, and reduces the mechanical strength and stiffness of walls.

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

1Maintained 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 glue lines 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, in which it is customary to use green or partially seasoned timbers and other large structural members. Generally, however, the effects of such shrinkage and swelling are provided for in the design and maintenance of such 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 a value midway between the extreme values that the wood will reach in service.

Wood that is seasoned to a moisture content in harmony with service conditions will have most of its shrinkage before it is installed. The inherent tendency of the wood to check, warp, and become distorted in cross section will also be satisfied before the rough lumber is cut, dressed, and shaped to form the final product. The final product, therefore, should undergo the changes in moisture content caused by the fluctuating conditions of service without checking, warping, or distortion.

The U. S. Forest Products Laboratory has made intensive tests and investigations to determine the correct moisture content for wood products used in various sections of the country. This report summarizes the information gathered in these tests and presents data and recommendations that will help the wood user select the correct moisture content for his particular purpose.

**Green Lumber and Timber**

Green lumber and timber have limited uses, usually 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 commonly 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.
The greatest hazard connected with the use of green, untreated lumber and timber is decay, particularly at joints and contact points.

### Air-Dried Lumber

In most parts of the country, the minimum moisture content that can be generally obtained in air drying is about 12 to 15 percent.

Air-dried lumber is suitable for items that are not ordinarily subjected to the artificial heat of buildings or where appreciable shrinkage can be tolerated. All types of outbuildings, such as sheds and barns, can usually be safely constructed of air-dried lumber.

Air-dried lumber is often used for framing members, such as joists and studs, and for the subflooring and sheathing of heated buildings. For such uses, however, it is recommended that the lumber be installed at a moisture content below that usually attained in air drying, because air-dried lumber will usually shrink in service in heated buildings. This shrinkage may result in plaster cracks and other difficulties. Joists and studs are sometimes installed in the green condition, but this practice is not recommended because difficulties resulting from shrinkage are sometimes severe.

Air-dried lumber is also satisfactory for boxes and crates, parts of agricultural implements, and wagon, truck, and trailer bodies. Lumber and small structural items that go into the hulls of boats and ships and material for silos and most types of tanks should be thoroughly air dried.

Poles, cross ties, and timbers that are to receive preservative treatment should be partially air dried, and stock for steam bending should be partially if not thoroughly air dried.

### Kiln-Dried Lumber

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.

Table 1 gives the average moisture content of interior woodwork in dwellings in representative cities throughout the United States. These data are supplemented by figures 1 and 2, which 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 system only, and slightly lower for houses that combine dehumidification and cooling.

Table 2, which is based on the data in table 1 and 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 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, and 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, their accuracy and workability have been verified by numerous tests and investigations. They provide a sound basis for selecting the correct moisture content of wood for use under the various conditions.

If the recommendations given in table 3 and in the following paragraphs are observed, most of the difficulties connected with the use of improperly seasoned wood will be eliminated.

Repetitions

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 2 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.

Rept. No. 1655 -4-
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.
Table 1.--Estimated average moisture content of the principal interior woodwork in 13 widely separated cities during January and July

<table>
<thead>
<tr>
<th>City</th>
<th>Moisture content of interior woodwork</th>
<th>City</th>
<th>Moisture content of interior woodwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>City</td>
<td>July</td>
<td>January</td>
<td>City</td>
</tr>
<tr>
<td>Atlanta, Ga.</td>
<td>11.5</td>
<td>8.5</td>
<td>New York, N. Y.</td>
</tr>
<tr>
<td>Albuquerque, N. Mex.</td>
<td>6.0</td>
<td>7.0</td>
<td>Portland, Oreg.</td>
</tr>
<tr>
<td>Boston, Mass.</td>
<td>13.0</td>
<td>7.0</td>
<td>Salt Lake City, Utah</td>
</tr>
<tr>
<td>Dallas, Tex.</td>
<td>9.0</td>
<td>9.0</td>
<td>San Francisco, Calif.</td>
</tr>
<tr>
<td>Duluth, Minn.</td>
<td>10.5</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>Madison, Wis.</td>
<td>10.0</td>
<td>6.0</td>
<td>Seattle, Wash.</td>
</tr>
<tr>
<td>New Orleans, La.</td>
<td>13.5</td>
<td>12.5</td>
<td>Washington, D. C.</td>
</tr>
</tbody>
</table>
Table 2.--Recommended moisture content values for various wood items at time of installation

<table>
<thead>
<tr>
<th>Use of lumber</th>
<th>Moisture content (percentage of weight of oven dry wood) for --</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry southwestern</td>
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<tr>
<td></td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Percent</td>
</tr>
<tr>
<td>Interior finish woodwork and softwood flooring</td>
<td>6</td>
</tr>
<tr>
<td>Hardwood flooring</td>
<td>6</td>
</tr>
<tr>
<td>Siding, exterior trim, sheathing, and framing</td>
<td>9</td>
</tr>
</tbody>
</table>

¹ For limiting range, see figure 3.
² In general, the moisture content averages have less significance than the range in moisture content permitted in individual pieces. If the moisture content values of all the pieces in a lot fall within the prescribed range, the entire lot will be satisfactory as to moisture content, no matter what its average moisture content may be.

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.

Rept. No. 1655
Figure 1.—Relation of moisture content of interior woodwork to outdoor temperature of various areas of the United States in January.
Figure 2.--Relation of moisture content of interior woodwork to outdoor relative humidity of various areas of the United States in July.