Preservation of Wood
FOR HOME AND FARM

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Forest Products Research
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PROGRAM AND PURPOSE

The Forest Research Laboratory of the School of Forestry combines a well-equipped laboratory with a staff of forest and wood scientists in a program designed to improve the forest resource and promote full utilization of forest products. The extensive research done by the Laboratory is supported by the forest industry and by state and federal funds.

The current report results from studies in forest products, where wood scientists and technologists, chemists, and engineers are concerned with properties, processing, utilization, and marketing of wood and of timber by-products.

The PROGRAM of research includes
- identifying and developing chemicals from wood,
- improving pulping of wood and wood residues,
- investigating and improving manufacturing techniques,
- extending life of wood by treating,
- developing better methods of seasoning wood for higher quality and reduced costs,
- cooperating with forest scientists to determine effects of growing conditions on wood properties, and
- evaluating engineering properties of wood and wood-based materials and structures.

The PURPOSE of research on forest products is to expand markets, create new jobs, and bring more dollar returns, thus advancing the interests of forestry and forest industries, by

> developing products from residues and timber now wasted, and
> improving treatment and design of present wood products.
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<td>21</td>
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</tbody>
</table>

The cover picture is from a watercolor painting of a landscape near Lakeview, Oregon, by Rodney C. Gould.
SUMMARY

Wood provides long service under a wide range of conditions. Construction practices that keep wood dry, and preservative treatments that protect it, add to its useful life.

Warm, moist conditions favor attack by decay fungi and insects, but even dry wood may be attacked by termites. Preservative treatments prevent such attack. Other treatments protect from fire or slow the absorption of water to prevent swelling.

Preparation of wood for preservative treatment is important for success. Bark must be removed; wood for most treatments should be air-dried; in some woods, incising (small holes made in the wood) should be done to aid penetration of preservative; and all notches or bored holes for attachments should be made before treatment to prevent later exposure of untreated wood.

The most satisfactory treatments involve heat and pressure or heat alone to impregnate wood with preservatives to meet nationally approved standards. Wood can be treated at home by several methods, with the choice depending on purposes for which the wood is intended. In general, however, the simpler the treatment the less its effectiveness.

Persons handling freshly treated wood should avoid getting preservative on the skin or should wash it off at once. Animals usually are not harmed by contact with treated wood, but tender plants may be damaged by fumes from solvents used with oil-type preservatives.
INTRODUCTION

Information is assembled here to help home and farm owners improve the serviceability of wood products. Good construction practices and use of wood treated to resist unfavorable conditions can prevent losses from deterioration.

Wood is a versatile structural material under many conditions of service. Sound construction practices that keep wood dry add to satisfactory service, and preservative treatments to protect the wood from decay fungi, insects, fire, and moisture further lengthen its useful life (Figure 1). The differences between woods in structure, durability, and treatability increase their versatility; knowledge of these differences is essential for selecting the treatment that will assure maximum serviceability. Understanding of wood and of organisms that contribute to its deterioration is as important as knowledge of the technique of wood preservation.

This publication will briefly describe these organisms, the principles involved in preservation of wood, and the methods of treatment suitable for western woods. Detailed information on wood and wood preservation as well as information on construction of farm buildings, condensation control in buildings, and exterior finishes for wood can be found in references listed.
WHY WOOD DETERIORATES

Wood can outlast the useful life of structures into which it is built. A dry or cold environment retards its deterioration, as do conditions that exclude air—as when wood is submerged in fresh water or buried deep in the ground.

Warm, damp conditions favor growth of organisms that use wood for shelter or food. For example, inadequate drainage, improper flashing around openings, poor ventilation, and venting warm moist air (as from clothes dryers) into crawl space create conditions that encourage decay of wood in buildings. Decayed wood is more susceptible than

Figure 1. Belowground portion of one of 50 posts that were pressure treated with creosote and installed in 1929. Remaining posts are in excellent condition. Their long service can be attributed to a combination of thorough seasoning and treatment with a suitable preservative.
sound wood to attack by termites and carpenter ants. Even dry wood may be attacked by some termites.

Decay fungi are simple plants having microscopic rootlike filaments that penetrate into, and feed on, wood. Decay fungi eventually reduce wood to either a soft whitish or easily crumbled brown mass. Fungi germinate from microscopic spores shed from conks, mushrooms, and similar growths.

Termites (Figure 2) live in colonies and burrow into wood to obtain food and shelter. During late summer and early fall along the Pacific coast, winged termites emerge for short flights, then burrow into earth or wood to form new colonies. Termite control is discussed in References 17, 21, and 22.

Carpenter ants (Figure 3) live in colonies and burrow into wood for shelter though not for food. Piles of sawdust at the base of structures frequently indicate their presence. They are less serious pests than decay or termites but can do extensive damage. Ants have constricted waists that make them distinguishable from termites, whose
bodies are of more uniform width, but ants, too, swarm during the summer months. Reference 18 discusses control of carpenter ants.

Sapwood of all species and heartwood of many species are attacked by decay, termites, and carpenter ants. On the other hand, heartwood of the cedars, junipers, redwood, and some other species is durable. "Durable" means an average life of about 15 years; "nondurable" means an average life of about 5 years.

Life of fence posts of many western woods in contact with top soil are listed in Table 1. Factors that influence serviceability of wood are discussed in Reference 7.
TREATABILITY OF WOOD

The stem of a tree, when cross cut, usually shows distinct zones (Figure 4), which include, in order of their occurrence toward the center of the tree, outer bark, inner bark, sapwood, heartwood, and pith.

The outer bark serves as a protective covering; the thin inner bark distributes food from the leaves to growing parts of the tree. The sapwood conducts sap and its soil nutrients upward to the leaves for conversion into food. The wood of young trees may be composed entirely of sapwood. The heartwood, which was once sapwood, is composed of dead cells. In living trees, sapwood is generally lighter colored and wetter than heartwood.

Sapwood is much easier to treat than is heartwood; hence treatments that can be done at home are mostly limited to sapwood. Water-soluble chemicals will penetrate the sapwood of freshly felled trees, but wood should be dried before being treated with oily preservatives.

Figure 4. Cross sections of two small Douglas fir trees grown near each other in Polk County, Oregon. Note the difference between thicknesses of light-colored sapwood of the two sections. Sapwood of all species is not naturally durable; usually, however, sapwood is much easier to treat with preservatives than is the heartwood core of the tree.
<table>
<thead>
<tr>
<th>Wood</th>
<th>Description of post</th>
<th>Amount of heartwood</th>
<th>Average girth, ground level</th>
<th>Life^2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Inches</td>
<td>Years</td>
</tr>
<tr>
<td><strong>Durable heartwood species</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Cedar, Alaska</td>
<td>Split</td>
<td>All</td>
<td>18</td>
<td>18</td>
</tr>
<tr>
<td>Cedar, incense</td>
<td>Split</td>
<td>All</td>
<td>20</td>
<td>14</td>
</tr>
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<td>24</td>
<td>20</td>
</tr>
<tr>
<td>Cedar, western red</td>
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<td>All</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
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<td>1/2</td>
<td>23</td>
<td>27</td>
</tr>
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<td>Mostly</td>
<td>19</td>
<td>No failures at 32 yr</td>
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<td>Redwood</td>
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<td>All</td>
<td>16</td>
<td>23</td>
</tr>
<tr>
<td>Yew, Pacific</td>
<td>Round</td>
<td>Mostly</td>
<td>16</td>
<td>28</td>
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<td></td>
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<td>3</td>
</tr>
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<td>5</td>
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<td></td>
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<td>6</td>
</tr>
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<td></td>
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<td>16</td>
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<tr>
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<td>Condition</td>
<td>Content</td>
<td>Wear</td>
<td>Life</td>
</tr>
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<td>--------------------</td>
<td>-------------</td>
<td>------</td>
<td>----------</td>
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<td>16</td>
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<td>21</td>
<td>6</td>
</tr>
<tr>
<td>Maple, bigleaf</td>
<td>Split</td>
<td>3/4</td>
<td>20</td>
<td>7</td>
</tr>
<tr>
<td>Pine, lodgepole</td>
<td>Round</td>
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<td>4</td>
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<td>Pine, ponderosa</td>
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<td>6</td>
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<td>Pine, sugar</td>
<td>Square</td>
<td>All</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Pine, western white</td>
<td>Square</td>
<td>All</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Spruce, Sitka</td>
<td>Square</td>
<td>All</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Tanoak</td>
<td>Round</td>
<td>None</td>
<td>12</td>
<td>4</td>
</tr>
</tbody>
</table>

1. The useful natural life of the post depends on the durability and amount of heartwood in a post.

2. In the tests, post life ends when the post can be broken off by a sharp tug sideways. Posts were not used in a fence.
Figure 5. Incising tools and sections cut from incised posts. Incisions help penetration of preservative solutions into wood, and numerous small incisions do this job more satisfactorily than larger but fewer incisions (right). Incising tools can be made in a machine shop.

which are not absorbed by wet wood. Sapwood of different species varies slightly in treatability. For example, sapwood of pine treats more easily than sapwood of Douglas fir. Treatment of heartwood usually requires a commercial process with pressures above 50 pounds to a square inch.

In general, wood is easier to treat along the grain (up and down the tree) than toward the pith or around the growth rings, though some sapwoods, principally of pines, can be treated by movement of preservative toward the pith.

Treatability of most woods can be improved by making many spaced incisions in surfaces to be treated (Figure 5). Incisions let preservative penetrate through glazed sap, strips of bark, and other surface conditions that may retard penetration.
Preservatives include chemicals that are toxic to attacking organisms, water repellents that delay absorption of moisture, and fire retardants.

**Toxic chemicals**

Toxic preservatives are oil or water soluble, or are themselves oily liquids such as creosote. Chemicals that are soluble in oil include pentachlorophenol and copper naphthenate.

Creosote has a long record of good service. Freshly treated wood ranges from dark brown to black and has a pungent odor. The dark color may fade, and the odor disappears with time. Painting of creosote-treated wood should be delayed 1-3 years; then a prime coat of aluminum paint should be applied. Creosote may be mixed with an equal quantity of petroleum oil to reduce cost of the solution, but toxicity of the mixture will be less than expected. For example, a 50-50 mixture would be less than half as toxic as the original creosote.

Oil-borne preservatives include pentachlorophenol in a 5 percent solution and copper naphthenate in a solution containing the equivalent of 2 percent copper metal. Pentachlorophenol for home use is usually sold as a concentrate to be diluted by any of a wide range of solvents from mineral spirits to heavy petroleum. Copper naphthenate, which imparts a green color to wood, usually is sold dissolved in mineral spirits. Cleanliness, color, and paintability of treated wood depend on characteristics of the oils. Costs of solutions can be reduced by use of concentrates diluted to proper strength.

Water-borne preservatives react in wood to form toxic chemicals that are not readily leached from wood. Wood treated with these preservatives is clean and paintable when dry and may be light green, brown, or natural in color.

**CAUTION!** Although ordinary exposure to treated wood is not harmful to animals or man, the chemicals used are poisonous and should be handled with care. Manufacturers' directions for use should be followed carefully.

**Water repellents**

Mixtures of waxes and resins dissolved in light solvents, such as mineral spirits, will slow the rate of moisture absorption and reduce
swelling of wood; oil-borne preservatives may be included in some mixtures. Windows and doors made of wood treated with water repellent are not apt to swell and stick. Treatment of siding with water repellent may reduce blistering of paint.

Fire retardants

Wood impregnated by pressure processes with combinations of ammonium phosphate and sulfate, borax and boric acid, zinc chloride, and sodium bichromate in water solution is fire resistant and is paintable when dry. Exterior use of wood treated with fire retardant is not recommended because water will leach the chemical from the wood. New fire-retardant treatments are being developed for exterior use.
PRESERVATIVE TREATMENTS

Commercially treated wood, which has a long record of good service, might be available at a local retail lumberyard or treating plant. Sometimes, however, as when the wood is already on hand, treating it at home is more convenient and less expensive. Home treatments, when properly applied, can be expected to lengthen the service of wood, but some early failures may occur, and home treatment should not be expected to equal the uniformity and quality of commercial treatments.

Commercial processes

Commercially treated wood has been treated according to specifications designed to assure good performance.

Pressure process. Wood is placed in a sealed vessel in which pressure and temperature are closely controlled to heat and sometimes to dry the wood before impregnating it with preservative. Pressures of more than 50 pounds to the square inch are maintained during impregnation. Both sawed and round wood products are pressure treated with different preservatives for different conditions of service.

Some test groups of pressure-treated Douglas fir and western hemlock posts at Corvallis have lasted 26-35 years without failure; lives of other pressure-treated groups of the same species are estimated to range from 20 to 40 years.

Thermal process. Air-seasoned or kiln-dried wood products are placed in an open or covered vessel, conditioned by heating and then cooled in an oil-type preservative; a final heating period reduces bleeding of preservative from the wood. Poles may be treated full length or to a foot above the depth they will be set in the ground.

Availability of commercially treated wood. Information on use, availability, and cost of treated material may be obtained from local treating plants listed in the telephone directory under "Poles" and "Lumber Treating" or from the following sources:

Pressure process, American Wood Preservers Institute
700 Yeon Building
Portland, Oregon 97204
(See Reference 5 for Western Wood Preservers Institute)

Western Red and Northern White Cedar Association
Box 2786
New Brighton, Minnesota 55366
Home treatments

Preservatives applied by simple home-treatment methods, usually penetrate and protect sapwood better than heartwood. These methods are best suited to treatment of round posts, or similar wood products where the treated sapwood forms an encircling barrier against rot and insects. Dry posts split from durable cedar heartwood also have appeared to benefit from having the butts soaked in preservative. Posts of nondurable wood used in dry areas of eastern Oregon may be adequately protected by butt treatment, but full-length treatment is recommended for western Oregon or for any doubtful conditions of service.

The following treatments are suggested for preservation of western woods. These and other treating processes are described in greater detail in References 9 through 16.

Brushing. Wood does not absorb much preservative solution when it is merely brushed on. Nevertheless, brushing is often the simplest way to apply preservative to wood already installed in structures and can be beneficial, though its limitations must be recognized. Best results have been obtained with oil-type preservatives applied to dry wood, wood aboveground which is protected from weathering, and joints or exposed end grain. At least two applications should be flooded by brush over the wood, the second one after the first has dried. Every crack and hole should be flooded.

Dipping. Momentary immersion of dried wood in a preservative requires more solution but provides more complete coverage than can be assured by brushing. This process can be used to treat window frames, doors, and siding with a preservative and water repellent solution before painting. Both dipping and brushing with oily preservatives yield best results on end grain of dry wood used aboveground.

Dipping freshly cut wood in water-soluble preservatives will protect green lumber from stain fungi and insects during drying and shipping but is not regarded as a preservative treatment.

Soaking. Soaking incised posts in diesel oil containing 5 percent pentachlorophenol is proving effective for some kinds of wood, as shown in Table 2. Split cedar posts treated by soaking the butts for 48 hours in creosote or in a 5 percent solution of pentachlorophenol in diesel oil were in excellent condition when removed from the ground after 9 years; untreated posts were decaying. These and other results indicate that,
Table 2. Performance of Round Posts Soaked in a 5 Percent Solution of Pentachlorophenol in Diesel Oil.\(^1\) Twenty-five Posts of Each Species Were Tested. They Were Peeled, Incised, and Dried Before Being Soaked.

<table>
<thead>
<tr>
<th>Species</th>
<th>Years in test</th>
<th>Soaking time</th>
<th>Years to first failure</th>
<th>Percentage of posts remaining (1965)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Butt Hours</td>
<td>Top Hours</td>
<td></td>
</tr>
<tr>
<td>Cottonwood, black</td>
<td>17</td>
<td>6</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Douglas fir</td>
<td>17</td>
<td>2</td>
<td>2</td>
<td>322</td>
</tr>
<tr>
<td>Douglas fir</td>
<td>17</td>
<td>48</td>
<td>6</td>
<td>100</td>
</tr>
<tr>
<td>Douglas fir</td>
<td>15</td>
<td>144</td>
<td>48</td>
<td>100</td>
</tr>
<tr>
<td>Maple, bigleaf</td>
<td>16</td>
<td>24</td>
<td>2</td>
<td>92</td>
</tr>
<tr>
<td>Pine, lodgepole</td>
<td>15</td>
<td>43</td>
<td>24</td>
<td>100</td>
</tr>
</tbody>
</table>

\(^1\) Round posts are preferable for this method of preservation because they contain the most sapwood, the most treatable part of the wood.

\(^2\) Estimated average life for this species is 16 years. Predictions for other species cannot be made until at least 20 percent of them have failed.

for best service, posts of nondurable wood should be treated full length; posts that are of durable heartwood and contain little or no sapwood may be butt-treated.

Wood can be treated by immersing it completely or by immersing one end, then reversing the ends. The second procedure permits soaking the butts and tops of posts and poles for different lengths of time, thus controlling the amount of preservative absorbed. Large timbers, however, are usually too unwieldy for the second procedure.

Ordinary 55-gallon drums make excellent tanks for treating small lots of posts. A drum will hold about nine posts 6 inches in diameter and twice as many with a diameter of 4 inches; it will require about 20 gallons of preservative to raise the liquid level to 30 inches when filled with posts. For treating long material, two or more drums can be welded together lengthwise and buried in the ground to a convenient working level.

Treating time may vary. Penetration of preservative into sapwood during soaking should be tested periodically to achieve results like those obtained in posts soaked 48 or more hours, as shown in Figure 6. Depth of penetration can be tested by boring a hole through
treated wood above the ground line or by splitting a treated piece. The second method is more accurate. Addition of creosote to a pentachlorophenol solution makes depth of penetration more easily seen. Deep penetration near deep cracks gives a false impression of overall good treatment. Test holes should be flooded with preservative and plugged.

From the amount of preservative absorbed by a tankload of well-treated posts, one can estimate the progress of later treatments of similar material.

The consequences of failure to test results of treatment could be absorption of too much or too little preservative. The following precautions should be taken to assure best results with oil-type preservatives.

1. Dry wood for 1-3 summer months, or until cracking stops.

Figure 6. Round, dry posts of Douglas fir were soaked in unheated oily preservative for different periods of time, then split in half to show depth of penetration at the ends. In the photograph, the penetration of preservative is shown by vertical black lines. Nearly complete treatment of sapwood was obtained by soaking for 48 hours and longer. Penetration of heartwood was erratic.
2. Incise the ground-line zone of woods that are difficult to treat or that absorb excessive amounts of preservative through end grain.

3. Use the proper concentration of preservative in the solution.

4. Keep the treating tanks under cover to prevent accumulation of water in the bottom of tanks.

5. Check treatment results.

6. Wear protective clothing and keep fire away from treating area.

**Hot-cold bath (thermal process).** Retention of preservative is usually greater from the hot-cold bath than from soaking. Dry wood is immersed in a hot oil-type preservative (200-235°F) for about 6 hours and allowed to cool in the preservative or transferred quickly to a bath of cool preservative (90-150°F) to continue soaking for 2 hours or longer. A final short hot bath (not over 230°F) will remove excess oil from the surface of the wood. Treatment results should be tested to guide in determining the duration of each bath. Precautions should be taken to avoid fire when the preservative is heated by exposed flame.

**Double diffusion.** Freshly cut and peeled round material is placed in a water solution of sodium fluoride for 2-3 days, rinsed with water, then placed in a water solution of copper sulfate for 2-3 days. The treated material is closely piled and covered for 3-4 weeks to permit the chemicals to spread through the wood, where they react to form a preservative that resists leaching. Full-length treatment of all material is desirable.

Results from the double-diffusion method (described in Reference 9) have been variable--sometimes satisfactory but sometimes inadequate--for treating posts of pine, Douglas fir, and some hardwoods. Treatments with copper sulfate followed by sodium chromate have been less successful than treatments with sodium chloride and copper sulfate and not so satisfactory as soaking dry wood in pentachlorophenol. The speed with which freshly cut and peeled material can be treated, however, (without waiting for it to dry) may be attractive.

The copper sulfate solution should be placed in wood or nonferrous containers; steel drums will quickly corrode and leak. Chemical must be added as needed to keep the treating solution at the proper concentration (Reference 9).
PREPARATION OF MATERIAL FOR TREATMENT

Success in preservation of wood depends largely on its moisture content at time of treatment. Wood should be well dried so that seasoning cracks do not develop after treatment to expose the untreated core, or it should be deeply penetrated so that decay of the untreated core will not weaken the product. The care with which material is prepared will help greatly in achieving satisfactory results from home treatments.

Peeling

Remove bark from all wood for most treating methods. Bark resists penetration by preservative solutions and favors decay and insect attack by keeping wood moist. Trees peel most easily immediately after felling during the spring and early summer; a barking spud, tire iron, or shovel with a flat or concave cutting edge will remove bark. A drawknife or other sharp cutting tool may be necessary to "clean peel" wood during the fall and winter when the bark is "tight."

Mechanical peelers can be constructed or purchased at costs up to several thousand dollars. In one type, chains flail the bark off, others tumble posts, and many have rotating knives to cut off the bark. A mechanical peeler may not be economical for one farm or home but might be purchased and used cooperatively.

Seasoning

Wood should be thoroughly air-dried before treating with oily preservatives. Material to be seasoned should be loosely cross-piled on decay-free supports to permit air circulation; supports should be at least 18 inches high. Rate of drying can be speeded by increasing the spacing between pieces. Although warm summer months are best for seasoning, wet wood will continue to dry slowly during winter months if stored under cover with good air circulation.

Posts and small poles can be dried in 1-3 summer months. Some woods, such as lodgepole pine, form a resinous glaze after peeling, and eliminating this surface condition may require either incising or seasoning through one winter exposed to the weather.

Incising

Incisions aid penetration of preservative solution into side grain of timbers. Many small incisions, staggered to prevent serious loss of strength, usually provide more uniform penetration than do a few large incisions. They can be made with a drill, axe, or saw, but more evenly spaced incisions can be made more quickly with an incising hammer.
(Figure 5). It should have sharp teeth capable of making incisions about 1/2 inch deep and less than 1 inch apart.

Incisions in the sapwood of round posts should extend a foot above and below ground to assure preservative treatment where it is needed most. Dry sapwood of lodgepole pine is exceptionally penetrable (Table 1) and may not need incising unless it is glazed with dried sap.

Framing

All cuts or holes to be made in wood for later fitting or fastening in frames should be made before treatment to prevent exposure of unprotected wood after treatment. Openings made through treated wood should be flooded with preservative.
HANDLING AND USE OF TREATED WOOD

Persons handling freshly treated wood should wear gloves and other protective clothing to prevent preservative from touching the skin. Preservative on the skin should be washed off at once.

Livestock normally are not harmed by contact with treated wood. Young pigs have been injured by wood that had been freshly treated with oil-type preservatives. Covering the floor with straw eliminated this hazard.

Although tender growth of plants may be damaged by touching or being near oil-type preservatives, plants are not likely to suffer from treated wood that has weathered for a few years, unless preservative has continued to bleed from the wood. Plants growing in greenhouse benches treated with leach-resistant, waterborne preservatives or with a solution of copper naphthenate in mineral spirits have suffered no visible damage. Copper naphthenate itself apparently is not injurious to plants, but fumes from many of its commonly used solvents are harmful, especially in confined places where ventilation is poor.

Wood treated with water-borne preservatives may be painted as soon as it dries. Before painting wood treated with oil-type preservatives, a delay of 1 year and a prime coat of aluminum paint usually are necessary.
REFERENCES

Unless otherwise noted, these publications are free and may be obtained by writing to the address indicated.

General


Wood Preservation


5. Membership Directory of Western Wood Preservers Institute. (Where to buy preservatively pressure-treated wood.) American Wood Preservers Institute, Yeon Building, Portland, Ore. 97204.

Serviceability


Treating methods


Stain, decay, and insect attack


**Buildings**


24. Plan Folders and Instruction Sheets Published by the Douglas Fir Plywood Association (lists plans for 23 different farm structures). American Plywood Association, 1119 A St., Tacoma, Wash. 98401.


**Moisture condensation problems**


Exterior finishes


34. Forest Products Laboratory Natural Finish. (A durable homemade finish.) 1964. Research Note FPL-046., U. S. Forest Products Laboratory, Madison, Wis. 53705.

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