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Safe Use of Preservatives and Preservative-Treated Wood at Home and on the Farm: A Guide for the Pacific Northwest

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Notice

Wood preservatives and pesticides are toxic chemicals that can cause health risks to humans and livestock—if they are handled or used improperly. These chemicals can enter the body three ways: by mouth, by skin contact, and by breathing the fumes. Use common sense to minimize contact with any toxic chemicals. Recommendations for using wood preservatives safely include:

1. READ THE LABEL, and follow the prescribed safety precautions and application methods.

2. When handling treated wood or treatment solutions, wear gloves, overalls, and boots that are impervious to the wood preservative. Wear goggles to protect against accidental splashing.

3. Avoid prolonged exposure to vapors when working around solutions or freshly treated wood.

4. When spraying preservatives, wear impervious clothing and goggles. Use a respirator when you are in the zone of visible spray.

5. Dispose or launder contaminated clothing. Do not wash it with other clothing because you may contaminate the entire load.

6. Wash exposed skin (face and hands) thoroughly after handling treated wood or chemicals, as well as before using restrooms, eating, drinking, smoking or chewing tobacco, or chewing gum.

7. Never burn treated wood scraps or sawdust because this can release toxic chemicals.

8. Never use chemicals near streams, lakes, or other bodies of water. If possible, use chemicals only on a cement pad with a drain trap to prevent leaching of run-off chemicals into soil. Contact the state Department of Environmental Quality for information on disposal of leftover chemicals, treated wood scraps, and chemical-soaked sawdust.

Several specific recommendations for the use of pentachlorophenol, creosote, and inorganic arsenicals are outlined in Appendix C.

Contents

Summary

Wood can provide long service under a wide range of conditions. But in the mild, rainy climate of the Pacific Northwest, wood can be attacked by decay fungi, insects, or other organisms, particularly if it is in contact with the soil. To insure its long life in such an environment, it should be protected by chemical preservatives.

This bulletin describes a wide array of wood preservatives to help the reader be knowledgeable when buying commercially treated wood as well as in applying these chemicals.

Commercial treatment of wood by pressure processes always results in better performance than home treatment. The preservative chemical is absorbed to a deeper depth, and the distribution is more uniform. When wood is already available, however, treating it at home may be more convenient and less expensive than buying it. Several methods of treating wood with preservatives at home are therefore described.

Anyone handling and using wood preservatives should be extremely careful. Always read and follow the directions on the label. Avoid spilling any chemical on the skin, splashing it in the eyes, or breathing the vapors. Applicators who plan to use creosote, pentachlorophenol, or chemicals containing inorganic arsenicals are required by law to become state-certified.

All leftover wood preservatives and preservative-treated wood must be disposed of according to the recommendations of the state Department of Environmental Quality.

Deterioration of wood used in an outdoor environment

Because of its unique molecular combination of lignin, cellulose, and hemicellulose, wood is a remarkably durable, structural material with numerous uses. In spite of this durability, wood will degrade when used under adverse conditions. The mild, rainy climate of much of the Pacific Northwest can provide a favorable environment for decay fungi, termites, carpenter ants, and other organisms that attack wood. Fence posts and wood structures may need special protection to prevent any degradation over the years. Such degradation can markedly shorten the useful life of wood products.

Damage to wood from either nonliving or living agents often appears similar; however, certain visible, tell-tale signs can aid the careful observer in identifying the cause of deterioration.

Physical agents of deterioration

Heavy loads or chafing, heat, strong chemicals, corrosion, and ultraviolet light affect wood in different ways. Mechanical damage often occurs where wood is repeatedly stressed, causing an apparent disintegration and breakage along the growth rings (Figure 1A). Temperature or chemical damage generally darkens the wood and can be confused with attack by organisms. Corrosion generally occurs where iron-containing fasteners contact moisture. As the metal corrodes, ions are released that gradually soften and degrade the nearby wood. Galvanized or non-iron-containing hardware is less apt to cause corrosion.

Ultraviolet light is probably the most common physical agent of degradation. UV light degrades the lignin in the outer layer of wood, causing dark wood to lighten and light wood to darken (Figure 1B). Although damage from UV light is usually not a severe problem, in certain cases when it is combined with water erosion, weakened layers of wood can peel off. Fresh wood is then exposed to light, and the deterioration is accelerated.

Changes in wood pH, the presence of surface deposits, the lack of biological agents, or the environment in which the wood is used are additional clues that will help an observer determine if the damage has a physical cause.

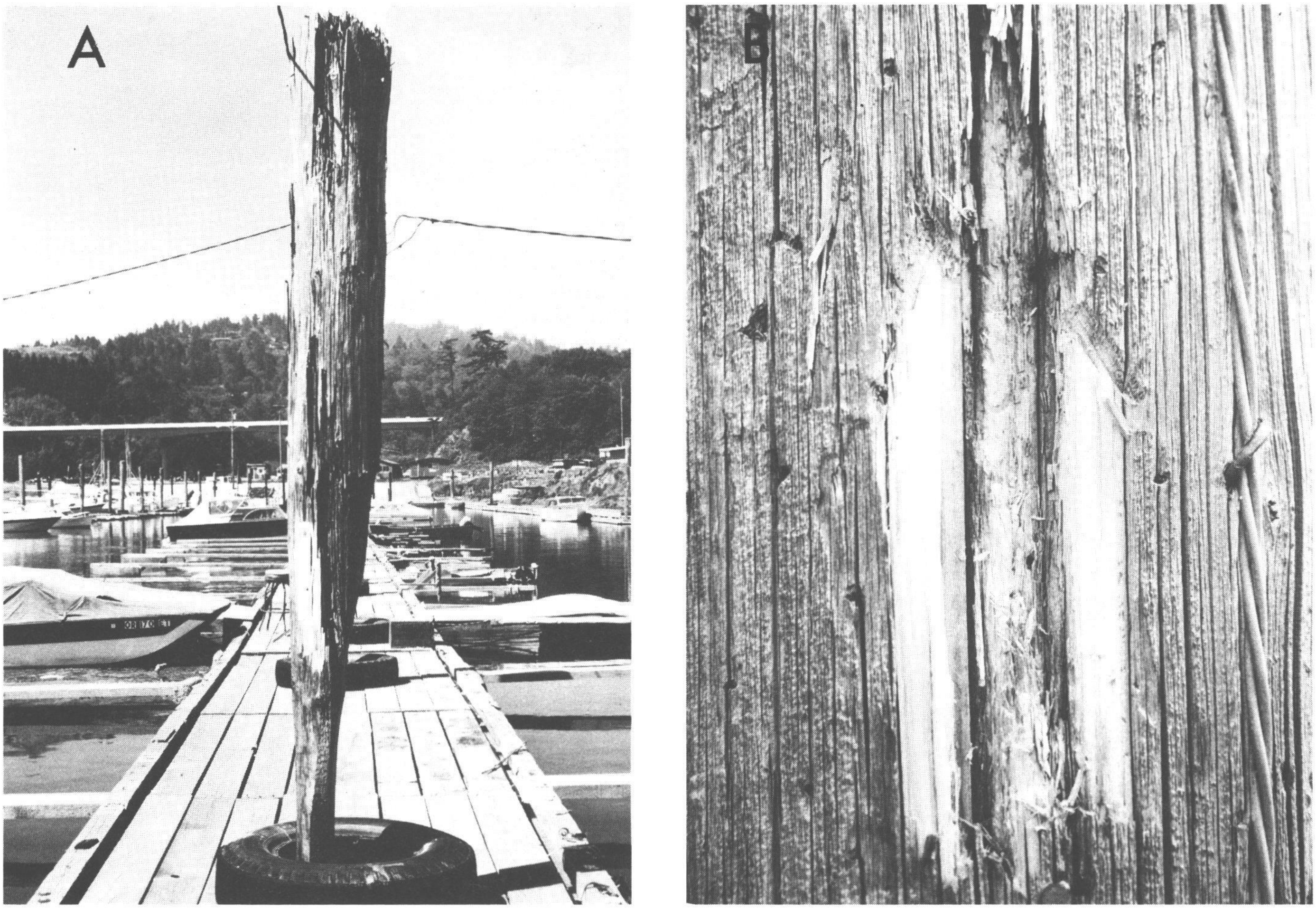

FIGURE 1.

EXAMPLES OF DETERIORATION BY NONLIVING AGENTS: (A) MECHANICAL DAMAGE OF A MARINE PILE CAUSED BY MOVEMENT OF THE SURROUNDING DOCK; (B) EXPOSURE TO ULTRAVIOLET LIGHT HAS DARKENED AND WEAKENED THE OUTER SURFACE OF THIS WOOD. INNER WOOD (EXPOSED AT CENTER) RETAINS ITS NORMAL COLOR.

Living agents of deterioration

Algae, bacteria, fungi, insects, and marine borers are major biological agents of wood degradation. Of these, the latter three cause the most physical damage to wood; they will be discussed here. To survive, all living agents of decay must have each of the following basic requirements; oxygen, favorable temperature, available water, and food. It is generally not practical to limit oxygen or temperature; however, certain designs can keep moisture from entering wood. Where moisture control is not practical, wood can be chemically treated, thereby eliminating the food source.

Fungi

Fungi are simple, "plant-like" organisms that lack chlorophyll. Therefore, they must obtain their food by microscopic, rootlike filaments that penetrate wood tissue and absorb its energy-rich chemicals. The fungi that colonize wood can cause surface mold, staining, or wood deterioration. Surface molds generally utilize the readily available sugars on the wood surface and do not affect wood properties (Figure 2A). These fungi will mar the surface appearance of wood, but most can be brushed off. Stain fungi attack the ray cells deep in the wood, causing discoloration of the sapwood (Figure 2B). Although stain fungi do not seriously affect wood strength, they can

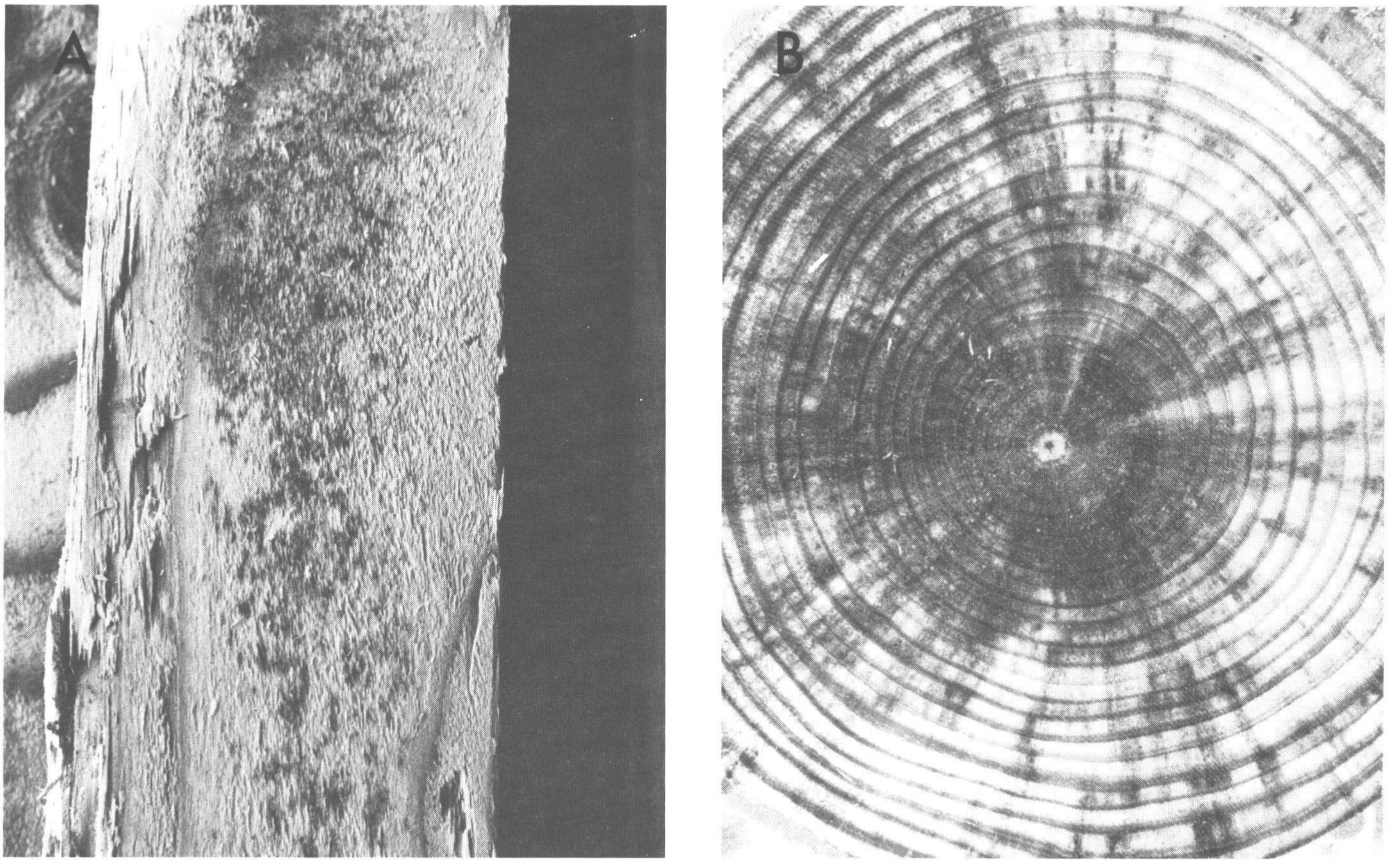

FIGURE 2.

A: MOLDS CAN MAR THE SURFACE APPEARANCE OF WOOD. B: STAIN FUNGI CAUSE DEEPER DISCOLORATION.

reduce toughness. They cause serious problems in species such as southern pine with a high percentage of sapwood, but they do not affect western species with narrow sapwood so severely. Attack by these fungi can be prevented by drying the wood as soon as it is cut or by dipping it in fungicides shortly after sawing. Stain fungi increase permeability to liquids and can improve preservative retention.

Although mold and stain fungi can disfigure the wood, the decay fungi cause more substantial damage. There are three types of decay fungi: white rots, brown rots, and soft rots. Each can be distinguished by the appearance of the damaged wood. White rot fungi bleach or whiten the wood and use all three of its components--the lignin, cellulose, and hemicellulose (Figure 3A). These fungi ultimately can cause weight losses up to 97 percent. Brown rot fungi utilize only the cellulose and hemicellulose, leaving the wood brown and cracked in appearance (Figure 3B). Brown rot fungi generally cause substantial strength losses at the very early stages of decay, when the damage is not visible to the naked eye. Both white rot and brown rot fungi are members of the class Basidiomycete, which also includes many common edible mushrooms.

A more recently discovered group of fungi, classified as Ascomycetes and Fungi Imperfecti, are the soft rots. They cause a unique type of cavity damage near the wood surface in areas where the wood either is continually wet or contains high levels of nutrients (Figure 3C). Although the wood near the surface deteriorates slowly, its strength decreases as its dimensions are reduced.

In most cases, careful design and construction of wood structures with preservative-treated wood can prevent or minimize attack by these fungi.

Insects

In addition to fungi, insects such as beetles, termites, and carpenter ants attack wood. Many beetles lay their eggs on freshly cut trees that still retain their bark. When the larvae emerge, they feed on the wood. Removing the bark as soon as possible or spraying logs with water are two methods to prevent this attack. Other species of beetles attack dry wood in service. These include members of the Buprestidae (the golden buprestid, *Buprestis aurulenta*, is the most common in the Pacific Northwest) and the Lyctidae (powderpost beetles). The larvae of these insects can cause substantial internal damage to wood; only minimal signs of attack show up on the surface. Often the insects are detected only after the adults have bored to the surface to leave the wood. Buprestids are usually associated with fungal decay, and the 3/4-inch-long adults leave oval exit holes 1/2 inch wide (Figure 4). Powderpost beetles leave a mixture of sawdust and droppings (frass) near their exit holes, and the surface of the wood often has a "shothole" appearance (Figure 5). These flat, dark-brown beetles less than 1/4 inch long may be found in the home, hidden in hardwood furniture or paneling. Dipping or coating wood with a preservative can only prevent damage by these beetles. More involved procedures, such as fumigation, are required to control beetles that already infest the wood.

Although beetles can seriously degrade wood, termites and carpenter ants cause extensive

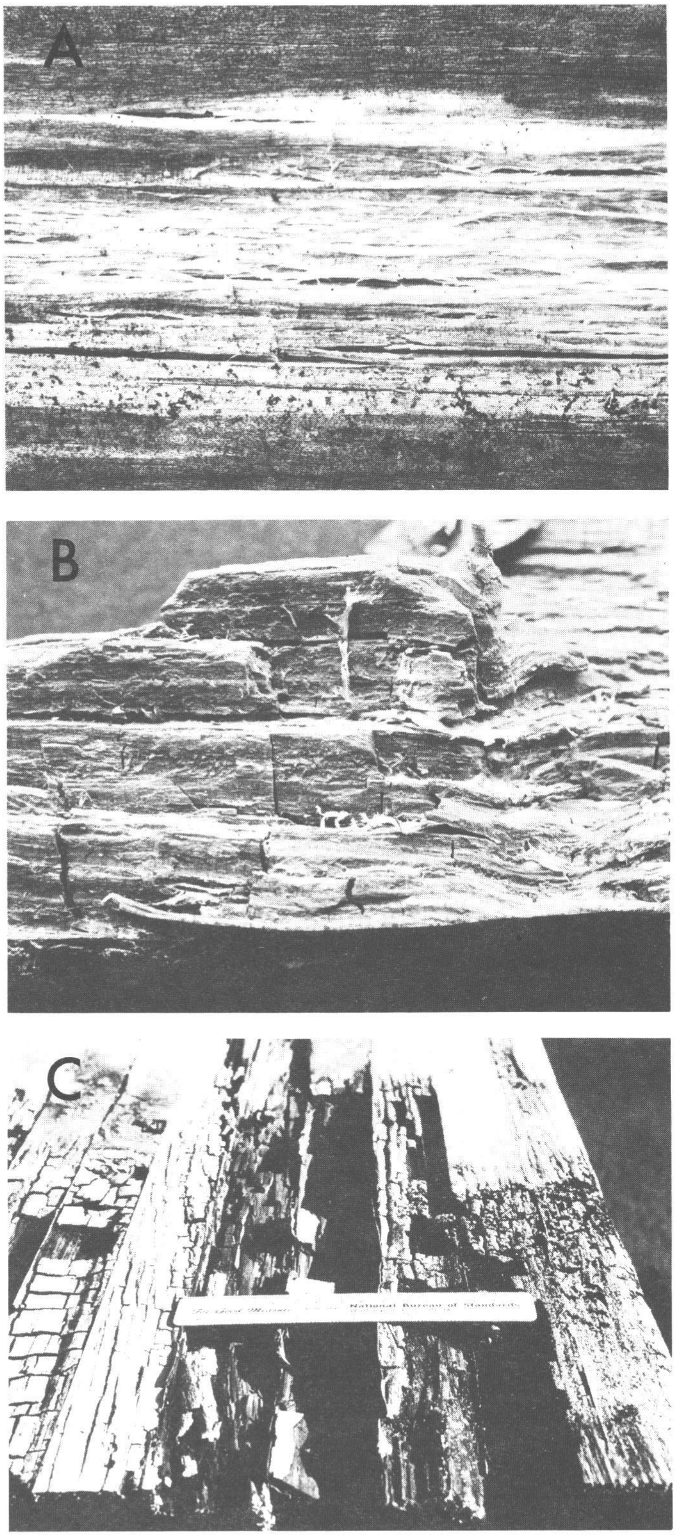

FIGURE 3.

DECAY FUNGI ARE CLASSIFIED, BASED ON THEIR APPEARANCE, AS (A) WHITE ROT, (B) BROWN ROT, OR (C) SOFT ROT.

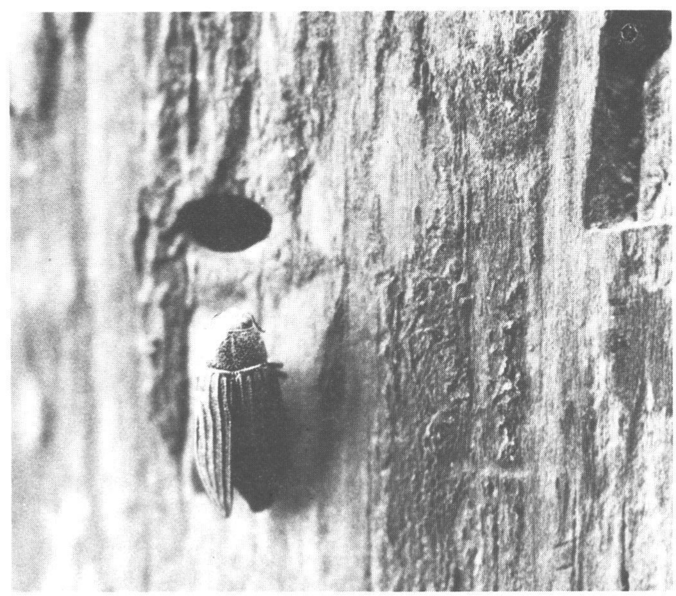

FIGURE 4.

IRIDESCENT GREEN OR GOLD BUPRESTID BEETLES ARE OFTEN ASSOCIATED WITH SIGNIFICANT INTERNAL DECAY AND MAY BE DETECTED BY THE OVAL-SHAPED, 1/2-INCH-WIDE EXIT HOLES THAT ARE MADE BY THE ADULTS.

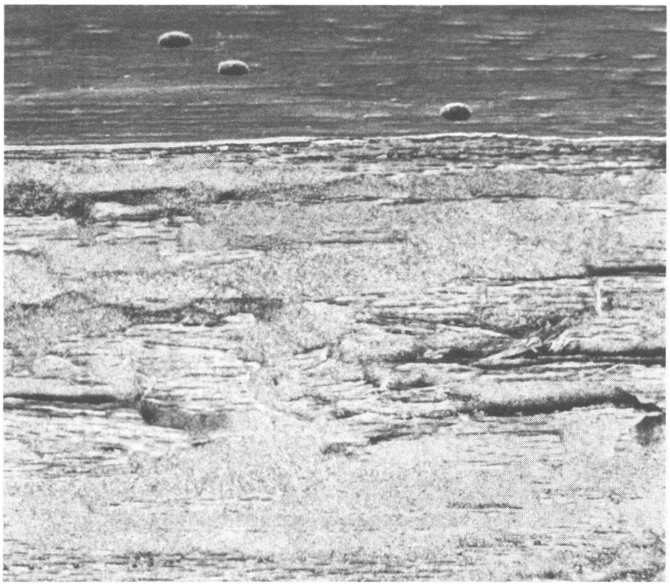

FIGURE 5.

AFTER THE LARVAE OF POWDERPOST BEETLES FED ON THIS WOOD, THEY PUPATED BELOW THE SURFACE. THE MATURE, ADULT BEETLES THEN CHEWED THEIR WAY THROUGH THE REMAINING WOOD, LEAVING SMALL EXIT HOLES ABOUT 1/16 INCH IN DIAMETER.

structural damage. Both termites and carpenter ants bore networks of tunnels throughout the wood, choosing the more open, porous tissue. Generally, the tunnels bored by termites contain frass; however, the ones produced by carpenter ants are clean. Because termites feed on the wood, they remain hidden inside. Therefore, damage from these insects is frequently not discovered until the wood fails. Carpenter ants only live in the wood, and these dark-colored insects can be seen foraging for food near their nests. The ants, which have constricted waists, may be as long as 3/4 inch (Figure 6). Piles of sawdust at the base of a structure indicate that these ants are present. Carpenter ants generally attack moist wood, and they may be a problem in homes with crawl spaces. To reduce an ant infestation, solve any moisture problems and remove the affected wood. Even then, the services of an experienced exterminator may be needed.

Like carpenter ants, termites are social insects whose caste system includes workers, soldiers, and reproductives (queens and kings) (Figure 7). Termite workers look very different from ants. Creamy-colored, their bodies have a fairly uniform width, but vary in length from about 1/4 to 3/4 inch, depending on the species. Although there are many species of termites worldwide, only two types are common to the Pacific Northwest: the subterranean termite *(Reticulotermes flavipes)* and the dampwood termite *(Zootermopsis augusticolus)*. Each attacks moist wood, especially if it is in contact with the ground. These insects are difficult to detect. One sign of termites is swarm-

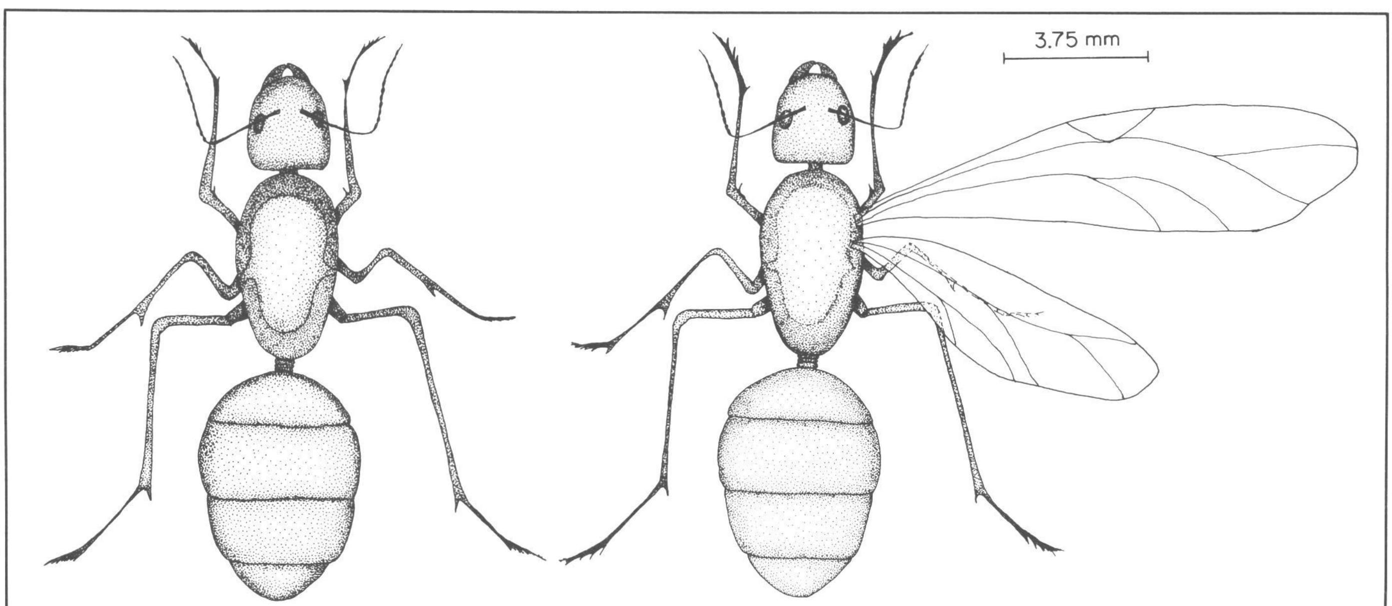

FIGURE 6.

WINGLESS AND WINGED FORMS OF THE CARPENTER ANT. NOTE THE "PINCHED-IN" WAIST AND "ELBOWED" ANTENNAE.

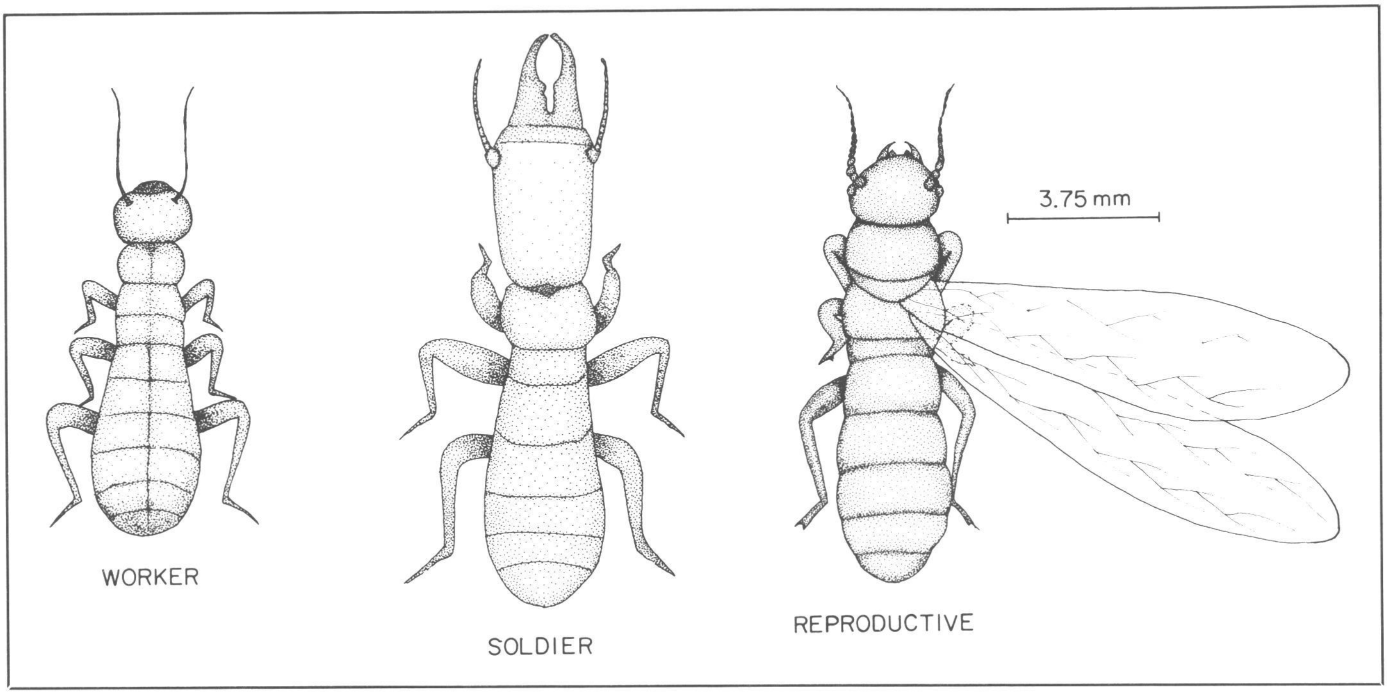

FIGURE 7.

A TERMITE COLONY INCLUDES NUMEROUS WORKERS THAT BURROW IN WOOD FOR FOOD AND SHELTER, SOLDIERS THAT PROTECT THE COLONY FROM OTHER INSECTS, AND A SINGLE, EGG-LAYING QUEEN.

ing of winged reproductives. If subterranean termites are present, the mud shelter tubes that they build from the soil to the untreated wood above may also be visible.

The risk of termite attack can be minimized by keeping untreated wood away from the ground, disposing of wood scraps near buildings, and using preservative-treated wood where termites could be a problem. Call a professional exterminator if termite damage is suspected.

Marine borers

Wood exposed to brackish or salt water can be attacked by marine borers. Two major groups of marine borers are found along the West Coast: the shipworms (Figure 8) and the gribbles (Limnorans) (Figure 9). Shipworms are worm-like mollusks that tunnel inside wood and grow 1 to 3 feet long. They can cause substantial damage to piling and timbers (Figure 10). Gribbles are mobile crustaceans that attack the wood surface. As they tunnel, they weaken that surface, which is worn away by wave action. Eventually, piles attacked by gribbles take on an hourglass shape around the tide line.

In the Pacific Northwest, gribble and shipworm damage can be prevented by treating the wood with creosote, ammoniacal copper zinc arsenate, or chromated copper arsenate. Although these restricted-use preservatives can only be used by certified appliers, the use of wood products

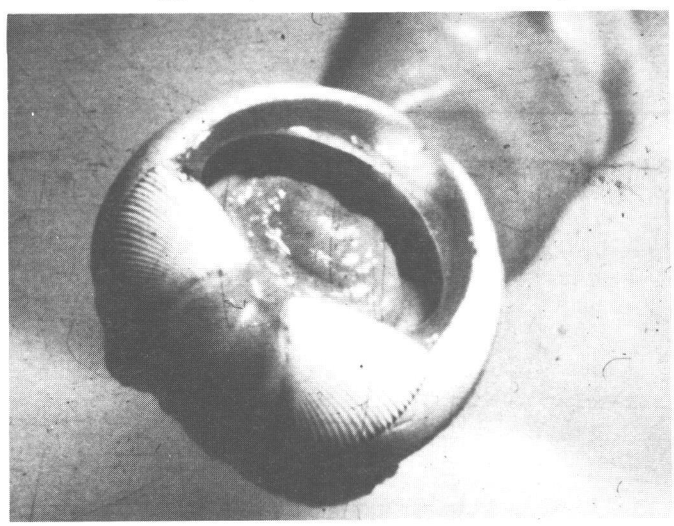

FIGURE 8.

THE HEAD OF A SHIPWORM HAS A PAIR OF RASPING SHELLS THAT HELP IN BORING TUNNELS THROUGH WOOD IN MARINE WATER.

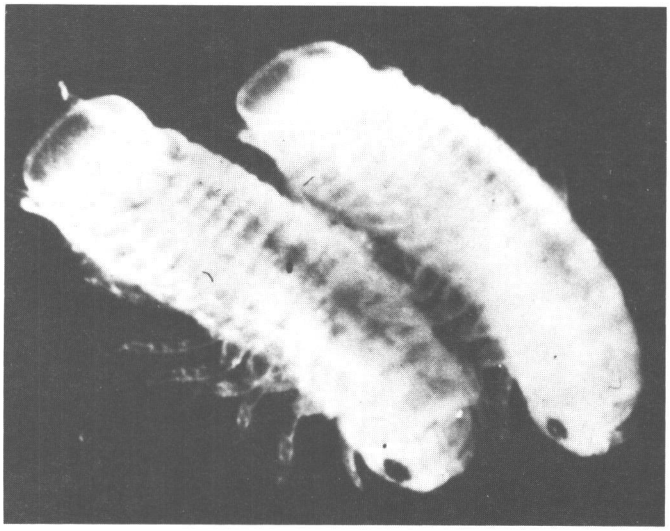

FIGURE 9.

GRIBBLES ARE SMALL, MOBILE, MARINE CRUSTACEANS THAT FEED ON OR BORE INTO THE OUTER SURFACE OF A PILE.

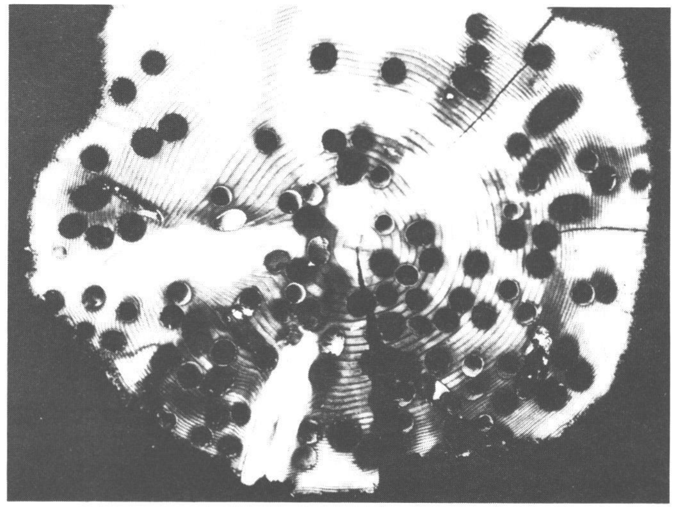

FIGURE 10.

WOOD CROSS SECTION WITH NUMEROUS SHIPWORM TUNNELS IN THE INTERNAL PORTION OF THE WOOD. THE SURFACE OF THIS PILE WAS ALSO ATTACKED BY GRIBBLES.

treated commercially with the chemicals is not restricted. Pilings and timbers can also be sealed within a plastic or cement barrier. But if that preservative-treated layer of wood or the barrier is damaged, marine borers will enter to attack the untreated wood.

Wood protection

Wood is a unique material whose cellular structure allows preservative treatment to be effective. In a sense, wood cells resemble a bundle of straws. These microscopic "straws" provide support for the tree while water and nutrients travel through them. When a tree is cross-cut, several distinct zones of cells are visible. These include the outer bark, inner bark, sapwood, heartwood, and pith (Figure 11).

The outer bark provides a protective cover, the inner bark distributes sugars produced by the leaves, and the sapwood conducts moisture and soil nutrients from the roots to the leaves. During each growing season, a tree produces a growth ring of new sapwood. Large, thin-walled cells (earlywood) are formed first, and then smaller, thick-walled cells (latewood). As the tree ages, the sapwood of most species gradually dies, forming heartwood. In some species, the dying cells produce extremely toxic extractives that impart durability to the heartwood. Good examples of such species are western redcedar and western juniper (Table 1), as well as American chestnut. Although heartwood of some species provides resistance to degradation, sapwood of all species has little decay resistance.

Because sapwood is normally much easier than heartwood to penetrate with liquids, home treatments are mostly limited to protecting the surface of sapwood. It is important for applicators of preservatives to think of wood cells as straws, which absorb liquids much easier along their lengths than across their diameters. This difference in the cellular structure of wood can affect treatability. For instance, when posts are soaked in a preservative solution, the chemicals are taken up more quickly along the lengths of the posts, just as water is absorbed by a living tree. Different wood species vary in treatability, also. For example, ponderosa pine sapwood treats more easily than Douglas-fir sapwood. (Although, in some instances, the sapwood of Intermountain Douglas-fir, which is grown east of the Cascades, is extremely difficult to penetrate.)

Treatment of heartwood generally requires forcing chemical into the wood at a pressure above 50 pounds per square inch. Even then, the preservative may only penetrate a half inch or less.

Treatability can also be affected by bark that blocks preservative flow and by excess moisture

FIGURE 11.

A TREE CONSISTS OF OUTER BARK, INNER BARK, SAPWOOD, HEARTWOOD, AND PITH. NOTE THE DIFFERENCES BETWEEN THE THICKNESSES OF THE SAPWOOD LAYERS OF THE TWO CROSS SECTIONS SHOWN.

TABLE 1.

AVERAGE AGE AT FAILURE OF TREATED AND UNTREATED POSTS IN COMPLETED SERIES (ALL POSTS FAILED) AND IN SERIES REMAINING IN TEST IN 1985.

Treatment and species[a]	Series No.	Average age at failure (yr): Completed series[b]	Average age at failure (yr): Series in test[c]
	UNTREATED POSTS[d]		
Indigenous species			
Western juniper, some split posts	30		30+
Pacific yew	13	25	—
Western redcedar, split	10,11	23	—
Port Orford cedar, split	21	20	—
Oregon white oak, split	19	18	—
Exotic species			
Osage-orange, some split posts	32	—	52 (no failure)
Black locust, some split posts	40	—	30+
Redwood, square	58	21	—
Alaska cedar, split	46	19	—

TABLE 1 (continued)

Treatment and species[a]	Series No.	Average age at failure (yr) Completed series[b]	Series in test[c]
		PRESERVATIVE-TREATED POSTS	
Pressure treatment			
Creosote and creosote solutions			
Douglas-fir	7,23	--	56 (no failure)
Douglas-fir, square, incised	51,52,53	--	46 (no failure)
Chemonite			
West coast hemlock, square	44	--	50+
Douglas-fir, square	45	--	47
Tanalith			
West coast hemlock, square	41	--	50+
Douglas-fir, square	42	--	45
Boliden salts			
Douglas-fir	96	--	40
Douglas-fir, square	98	--	32
Cold-soak treatment			
Pentachlorophenol-oil solution			
Lodgepole pine, incised	86	--	50+
Oregon maple, incised	83	--	50+
Black cottonwood, incised	68	--	41
Douglas-fir, incised, long soak	94	--	39
Douglas-fir, incised	64	--	30
Creosote			
Douglas-fir, incised, long soak	95	--	44
Black cottonwood, incised	87	--	41
Lodgepole pine, incised	85	--	36
Douglas-fir, incised, long soak	88	--	36
Copper naphthenate (1% Cu)			
Douglas-fir, incised, long soak	93	--	30
Hot-cold soak treatment			
Creosote			
Douglas-fir, square	54	--	45[e]
Black cottonwood, split	27	22[e]	--
Creosote and crankcase oil			
Douglas-fir	18	18[e]	--
Double-diffusion treatment			
4% sodium fluoride; 6% copper sulfate			
Douglas-fir	101	--	27[e]
5% zinc sulfate + 0.7% arsenic acid; 6% sodium chromate			
Lodgepole pine	104	--	24[e]
Diffusion			
Osmosalts slurry			
Douglas-fir	75	--	40

[a] Posts are round and peeled unless otherwise noted.
[b] Average life in tests where all posts have failed.
[c] Not all posts have failed. Average life is estimated by a method reported by MacLean in "Percentage Renewal and Average Service Life of Railway Ties," Report R886, Forest Products Laboratory, U.S. Department of Agriculture, Madison, Wis.
[d] Posts are mostly or entirely heartwood.
[e] Untreated or poorly treated tops have decayed.

in the wood. Although some preservatives can be injected into freshly cut trees, most chemicals perform best when applied to dry wood. Drying insures uniform penetration and retention of the treating solution. In round stock, however, complete drying not only takes considerable time, but it can make wood "too" dry for adequate penetration. Therefore, for practical purposes, wood to be treated with preservatives only needs to be dried to a moisture content of less than 20-25 percent, even though checks will probably continue to develop afterwards.

Where treatability is a problem, preservative penetration can be improved by mechanical preparation of the wood. Such mechanical preparation can improve the performance of a commercially treated product. Generally, these methods, which include incising, through-drilling, and kerfing, cannot be carried out easily at home or on the farm.

Incising, a process that involves using special tools to cut numerous small slits in the wood, increases the amount of end-grain exposed to the preservative (Figure 12). Because end-grain is more easily penetrated, solution uptake increases. Incising is required by treating standards for lumber of all western wood species except ponderosa pine and is commonly used on Douglas-fir and hem-fir timbers, piles, and poles.

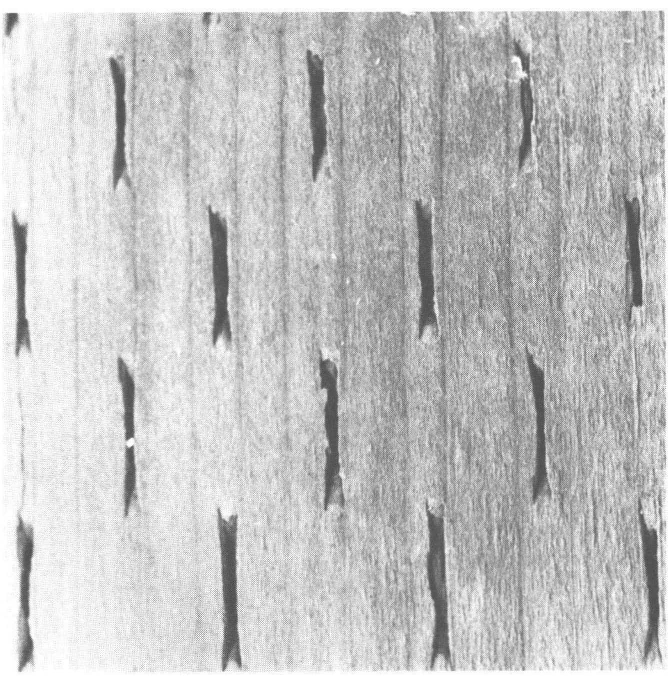

FIGURE 12.

INCISING (SHORT, DEEP CUTS IN THE OUTER LAYER OF THE WOOD) CAN BE USED TO INCREASE THE SURFACE AREA EXPOSED TO THE TREATING SOLUTION, THEREBY INCREASING PRESERVATIVE RETENTION AND PENETRATION.

Through-drilling involves drilling a series of small-diameter holes at a slight angle through a pole or timber so as to treat some of the internal heartwood (Figure 13). It is probably most effective combined with pressure treatments to protect an area exposed to ground contact. But it may also help in nonpressure treatments.

Kerfing involves sawing a cut to the center of a timber or pole along its length before treatment (Figure 14). As wood dries after treatment, it often checks beyond the zone of preservative protection, allowing decay fungi to penetrate into the untreated wood. Kerfing acts to relieve drying stress and reduce checking. Since the kerf is, in essence, a treated check, the timber is less likely to decay.

The presence of knots, decay, wet wood, and other defects can also affect treatment. Most of these problems can be minimized by careful material selection before treatment. Where possible, select wood that is straight-grained, defect-free, and not too rapidly grown (no greater than 5 to 6 rings per inch).

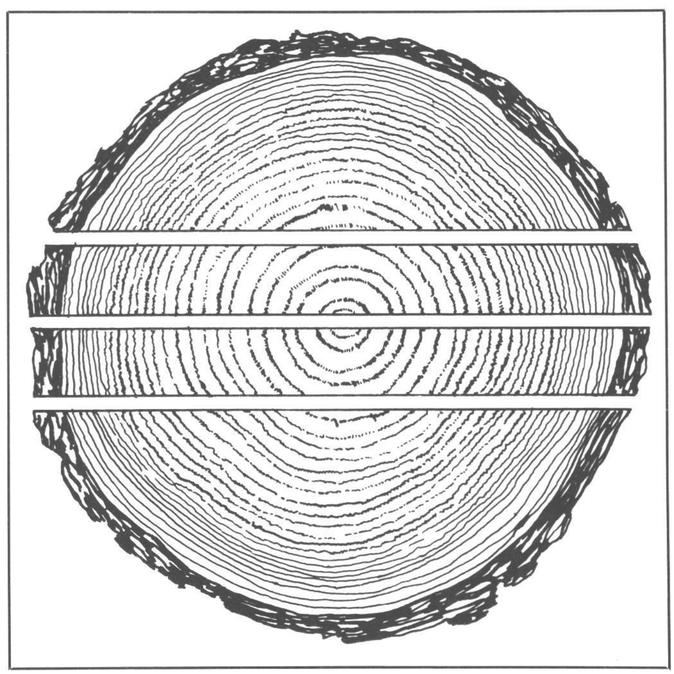

FIGURE 13.

THROUGH-DRILLING IN HIGH-RISK AREAS LIKE THE GROUNDLINE ZONE OF POLES CAN HELP IMPROVE PROTECTION.

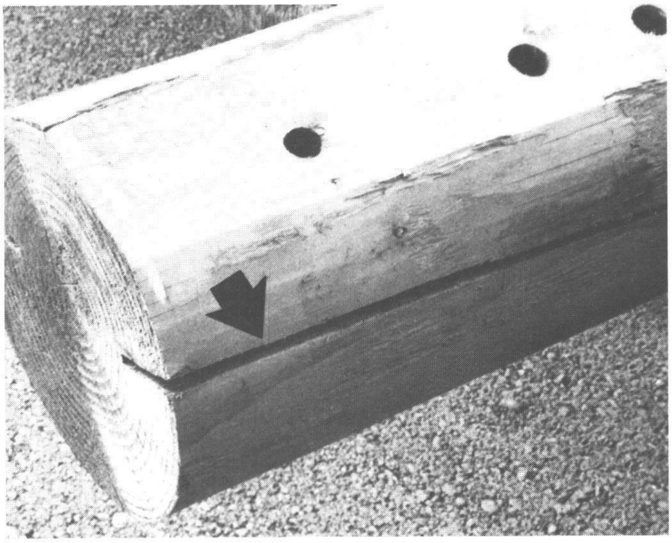

FIGURE 14.

SAW-KERFING TO THE CENTER OF ROUNDWOOD OR LARGE TIMBERS CAN REDUCE THE DEVELOPMENT OF DEEP CHECKS.

Preservative solutions

A variety of preservatives are available for wood protection, and these can be simply classified as oil- or waterborne chemicals. Oilborne chemicals include creosote, pentachlorophenol, copper naphthenate, copper-8-quinolinolate, and tributyltinoxide. Waterborne chemicals include inorganic arsenicals such as chromated copper arsenate, ammoniacal copper arsenate, and ammoniacal copper zinc arsenate; as well as sodium fluoride, sodium chromate, or sodium chloride, which can be used in a double-treatment process with copper sulfate. Two chemicals, zinc naphthenate and 3-iodopropynylbutyl carbamate, can be either oil- or waterborne.

Each chemical has particular characteristics that make it useful for certain applications. Creosote, pentachlorophenol, and those chemicals containing inorganic arsenicals are restricted-use preservatives, and are available only to those who have successfully completed an exam on the safe use of these toxic chemicals. Oregon residents desiring to become certified pesticide applicators should contact the Plant Division, Oregon Department of Agriculture, Salem, OR 97310. Suggestions for protective clothing and equipment when working with these preservatives are presented in Appendix C. Copper naphthenate, zinc naphthenate, copper-8-quinolinolate, tributyltinoxide, 3-iodopropynylbutyl carbamate, sodium fluoride, sodium chromate, sodium chloride, and copper sulfate can be purchased over the counter.

Oilborne preservatives

Preservative chemicals that are oily liquids or soluble in oil have been used for years to treat wood successfully. Applied correctly, they can help considerably to extend the service life of wood.

Creosote

Creosote is a complex, chemical substance that forms when coal is destructively distilled to produce coke for steel production. Although it is prepared according to a series of industry specifications, creosote contains over 200 different compounds, and individual batches tend to vary in the levels of each fraction. As a preservative, creosote has a long record of excellent service life. It is extensively used to protect railroad ties, marine piling, and electric utility poles.

Recently, creosote was classified as a restricted-use pesticide, and those using this chemical must be licensed with the appropriate state regulatory agency. Creosote-treated wood should not be used indoors or where risk of human or livestock contact is high. The tender growth of plants may be damaged by touching or being near wood treated with this preservative. Therefore, avoid using creosote-treated wood for greenhouse benches, raised-bed supports, or planters.

Creosote can be blended with oil to reduce solution costs; however, the effectiveness of treatment will decline because toxicity will decrease. Because it may cause hyperkeratosis in cattle, used crankcase oil should not be mixed with creosote and applied to wood with which animals come in contact.

Pentachlorophenol

Pentachlorophenol, a more recently developed chemical that is synthesized by chlorinating phenol, is another restricted-use preservative and pesticide. Users of this chemical, as well as creosote, must pass an exam and be licensed by the state regulatory agency. "Penta" is toxic, and wood treated with this chemical should not be used inside inhabited buildings or where animals can come in contact with it. Penta is also toxic to plants and should not be used in planters or greenhouse benches.

Penta is a broad-spectrum biocide that provides excellent protection against insects and decay fungi, but has little effect on marine borers. It is used to protect poles, timbers, and lumber in many environments. Although recently the total amount of pentachlorophenol used has declined, over 3.75 million gallons of 5-percent penta in light oil are applied annually to protect existing wood structures. Penta is generally diluted in aromatic oils, but mineral spirits, diesel oil, and liquified petroleum gas have also been used. Each of these solvents can influence effectiveness, but penta remains one of our most important wood preservatives.

Although dioxin contaminants have been found in commercially prepared penta, they are less toxic than those found in other pesticides. Dioxins are a group of chemicals that include several highly toxic forms. The EPA has recently placed limits on the amount of dioxin permitted in penta, and this restriction should minimize potential hazards.

Copper naphthenate and zinc naphthenate

Another oilborne wood preservative is copper naphthenate, which is currently being presented as an alternative to penta. The naphthenic acid for this chemical is derived from petroleum. Long-term tests of copper naphthenate indicate that it will perform well in pressure-treated wood. However, its effectiveness for brush-on or dip treatments is less documented. Generally, 1-percent copper naphthenate is used to treat wood aboveground in temperate regions; however, stronger solutions (2-percent copper) are advisable for wood in ground contact. Wood initially treated with copper naphthenate is green, but this color fades to brown after the wood is exposed to sunlight. Plants growing in greenhouse benches treated 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.

A similar, oil- or waterborne chemical, zinc naphthenate, is a colorless compound that is a less effective preservative and should not be used where wood is in contact with soil. Neither copper naphthenate nor zinc naphthenate is a restricted-use pesticide, and both are available over the counter for home use.

Other protective chemicals

In addition to the above-mentioned chemicals, several other formulations are used in specialized markets. However, the recent desire for safer chemicals, as well as a concern for protecting the natural environment, has stimulated interest in preservatives such as tributyltinoxide (TBTO), 3-iodopropynylbutyl carbamate (IPBC), and copper-8-quinolinolate. TBTO is a colorless, oilborne chemical that is extensively used in Europe. In the U.S., this biocide is an ingredient in many different brands of paint. TBTO will degrade in sunlight, and is not effective in ground contact at the concentrations presently available.

More recently, IPBC in oil or waterborne formulations has been used to protect wood out of ground contact. Like zinc naphthenate, IPBC is colorless. A quick survey of wood preservatives on the shelves at several home repair centers reveals that zinc naphthenate, IPBC, and TBTO are the most commonly used chemicals for the do-it-yourself market.

Copper-8-quinolinolate is also colorless and can be brushed onto wood to obtain a clean, paintable surface. This chemical is the only formulation registered with the Federal Food and Drug Administration for application on wood that is in direct contact with food. Therefore, copper-8 can be used to protect such items as fruit and vegetable containers, planters for edible crops, and picnic tables.

Like TBTO, copper-8 at currently registered levels is less effective than 5-percent penta and would probably need to be used at a 1.8-percent copper level. It is generally not used to protect wood in ground contact.

Waterborne preservatives

Although oilborne chemicals have advantages for penetrating and stabilizing wood, certain waterborne chemicals become strongly bound to the wood and resist leaching and volatilization. This stability makes wood products treated with these chemicals far safer to use in areas where direct human or animal contact occurs.

The most widely used waterborne preservatives are chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), and ammoniacal copper zinc arsenate (ACZA). All of these restricted-use chemicals are used to pressure-treat wood commercially. They are not generally available for treatment of wood at home. These formulations have the advantage of forming strong, leach-resistant complexes with the wood. Both CCA and ACA color the wood green, but this coloration can be masked in CCA treatments with pigments to produce a naturally colored brown wood. In addition, wood treated with these chemicals can be painted. ACA- and CCA-treated wood is recommended for uses where human or livestock contact is likely to occur, but not for areas where direct food contact is likely. Zinc naphthenate and 3-iodopropynylbutyl carbamate, discussed previously under oilborne preservatives, are also available as waterborne formulations.

As mentioned earlier, certain waterborne chemicals can be used in double treatments to form insoluble preservatives in sapwood. Chemicals used in these procedures include sodium fluoride, then copper sulfate; sodium chromate, then copper sulfate; or sodium chloride, then copper sulfate. All of these chemicals may be purchased from chemical supply houses. These double-treatment processes allow wood to be treated in the green condition, but the treatments are generally less uniform than those produced by pressure treatment of dry wood.

Treatment methods

Pressure and nonpressure methods are used to apply preservatives to wood. Generally, wood that is pressure-treated commercially has superior performance to wood treated at home.

Commercial processes

Either of two commercial processes is effective. During pressure treatment, sawn timber or roundwood is placed in a sealed cylinder. Pressure and temperature are closely controlled so that the wood is heated, and sometimes dried, before it is impregnated with a preservative chemical. In some cases where high levels of chemicals are desired, a short vacuum is drawn prior to the pressure period to remove air from the wood. During thermal treatment, which is used for western redcedar and lodgepole pine poles, air-seasoned or kiln-dried wood is immersed in hot oil (190–220°F) for several hours, and then immersed in a cooler solution of oil (160–180°F). In this process, a small vacuum builds up in the wood cells, and preservative is drawn in.

Wood is pressure-treated according to the standards of the American Wood Preservers' Association. These standards list the treatment conditions, preservative penetration, and preservative retention necessary for maximum performance. Compared to nonpressure methods, pressure treatment generally results in more uniform distribution of the preservative chemical.

Home treatments

The quality and performance of wood treated at home with preservatives often will not equal that of pressure-treated wood. Treatments will be less uniform and some early failures will occur. Sometimes, however, if wood is already available, treating it at home is more convenient and less expensive than buying commercially treated wood.

Preservatives applied at home usually penetrate some of the sapwood, but provide little protection to the less permeable heartwood. For this reason, nonpressure methods are best for round posts where the treated sapwood can form a protective, unbroken barrier against fungi and insects. Dry, split posts from species with durable heartwoods also appear to benefit from soaking their bases in preservative. Posts of nondurable species exposed in dry areas in eastern Oregon can also benefit from butt treatment. Full-length treatment, however, is recommended for wood exposed in western Oregon or any other wet areas.

To make home treatment of posts, poles, and timbers more effective, do the following first: Completely remove the bark by hand or machine; season the wood adequately (1 to 3 months in summer, longer for winter); incise it to improve penetration; and drill any holes for attachments. Then proceed with the treatment process.

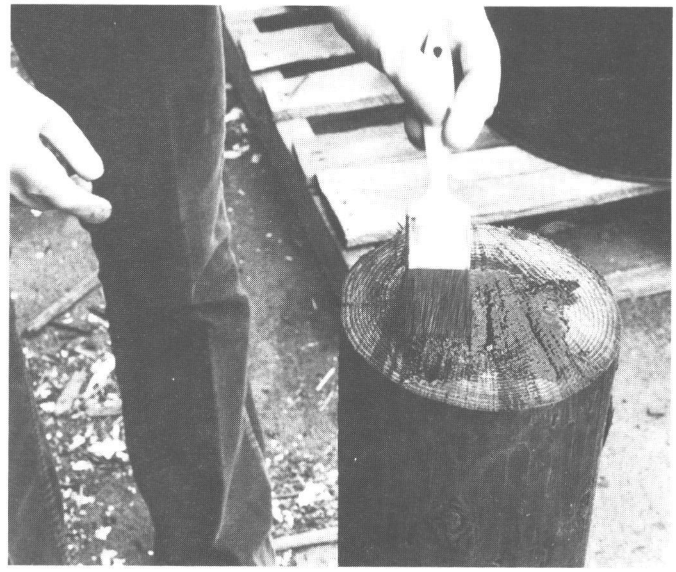

FIGURE 15.

WHEN BRUSHING PRESERVATIVE ON THIS SURFACE, BE CERTAIN TO FLOOD SOLUTION OVER THE WOOD TO FILL EVERY CRACK OR HOLE IN THE SURFACE.

Brushing

Brushing is often the simplest way to apply preservative to wood already installed in structures. Although wood will not absorb much preservative solution when it is merely brushed on, such an application can still be beneficial. Best results have been obtained with oil-type preservatives applied to dry wood, to wood aboveground that is protected from weathering, and to 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 (Figure 15). Every crack and hole should be flooded with preservative solution. Brushing should only be used to protect wood aboveground. It will not protect wood in soil, or in fresh or marine water.

Dipping

Momentary immersion of dried wood in a preservative requires more solution than a brush-on treatment, but it provides better coverage. This process can be used to treat window frames, doors, and siding with a preservative and water-repellent solution before they are painted. As with brushing, dipping wood in oily preservatives is most effective on the end-grain of dry wood used aboveground.

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

Like brushing, dipping is recommended only to protect wood that will be used aboveground, and not in fresh or marine water.

Soaking

Soaking incised posts in diesel oil containing 5-percent pentachlorophenol has proven effective for some wood species (Table 2). Pentachlorophenol is now a restricted-use chemical, but other oilborne chemicals such as a copper naphthenate or copper-8-quinolinolate can be substituted, even though they will provide slightly less protection. 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 they were removed from the ground 9 years after treatment. Similar, untreated posts were decaying after the same period of time. These and other results indicate that, for best service, nondurable wood posts should be treated full-length, and durable heartwood posts that contain little or no sapwood may be butt-treated.

To treat a wood post or pole, immerse it completely in the preservative solution or first soak one end and then the other. The second procedure permits soaking the butts and tops of posts and

TABLE 2.

PERFORMANCE OF ROUND POSTS SOAKED IN A 5-PERCENT SOLUTION OF PENTACHLOROPHENOL IN DIESEL OIL.[a]

Species[b]	Years in test	Soaking time (hr)		Percentage of posts remaining (1985)	Average age of failed posts (yr)
		Butt	Top		
Cottonwood, black	37	6	1	56	28
Douglas-fir	37	48	6	12	29
Douglas-fir	35	144	48	56	30
Maple, bigleaf	36	24	2	84	19
Pine, lodgepole	35	43	24	88	30

[a] Round posts are preferable for this method of preservation because they contain the most sapwood, the most treatable part of the wood.
[b] Twenty-five posts of each species were peeled, incised, and dried before being soaked.

poles for different lengths of time, thus controlling the amount of preservative absorbed. Large timbers, however, are usually too unwieldy for the ends to be treated this way.

Ordinary 55-gallon drums make excellent tanks for treating small lots of posts. A drum will hold about 9 upright posts 6 inches in diameter or 18 posts 4 inches in diameter. About 20 gallons of preservative are required to raise the liquid level to 30 inches when a drum is filled with posts. For treating long material, weld two or more drums together lengthwise and set in a horizontal position on supports. Cut away an area of the top to create a long trough. Posts can be conveniently laid in the trough for treatment. To prevent contamination of the surrounding area with chemical, keep the dipping area away from water sources and livestock. If you expect to treat material over a long time period, it is advisable to construct a cement drip pad to keep the chemical contained in a small area.

The rate that sapwood absorbs a preservative chemical varies, so periodically evaluate the soaking process by boring a hole through the treated wood at a point above the intended groundline or by splitting a treated piece. This latter method of penetration measurement is more accurate. Failure to test the amount of absorption could result in less effective treatment. Try to achieve results like those shown in Figure 16 for posts soaked 48 or more hours. Because penetration near deep cracks gives a false impression of overall good treatment, be

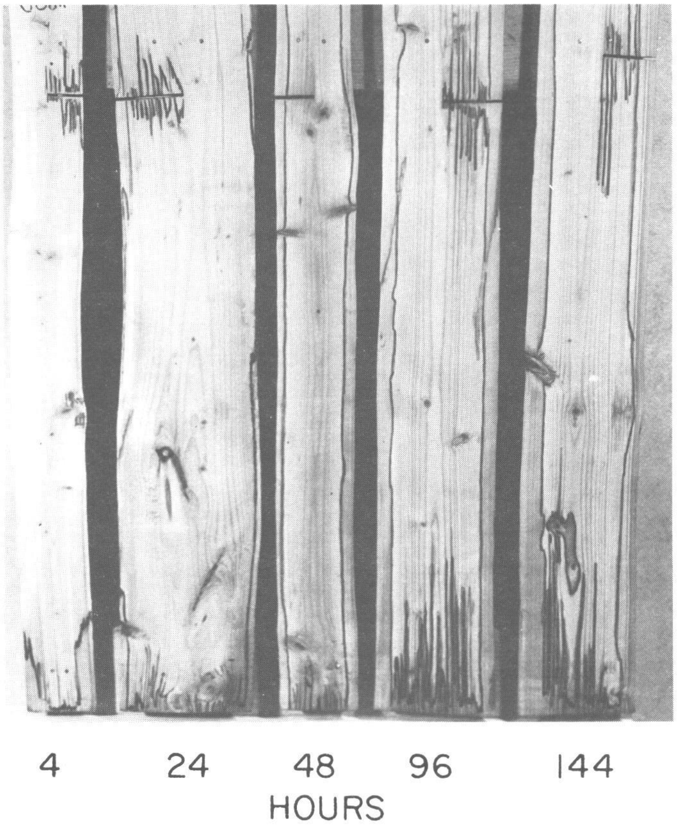

FIGURE 16.

EXAMPLES OF PRESERVATIVE PENETRATION IN POSTS SOAKED FOR 4, 24, 48, 96, OR 144 HOURS. COMPLETE TREATMENT OF SAPWOOD WAS ACHIEVED AFTER 48 HOURS.

sure to examine wood away from these zones. Test holes should be flooded with preservative and plugged with a tightly fitting dowel that has been soaked in preservative solution.

For best results with oil-type preservatives, follow the suggestions below:

1. Dry wood for 1 to 3 months in the summer, or until deep checking stops.

2. Incise the groundline zone of woods that are difficult to treat such as Douglas-fir and ponderosa pine.

3. Use the proper concentration of preservative in the solution. Do not skimp or overapply because either action may reduce treatment effectiveness.

4. Keep the treating tanks covered to prevent accumulation of rain water in the bottom of tanks. Install a cement drip pad if you plan continued treatment.

5. Check treatment results.

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

7. Dispose of unused chemical according to label requirements. (See Appendix A for more specific recommendations.)

Double diffusion

In the double-diffusion process, freshly cut and peeled round material is placed first in a water-soluble preservative solution for 2 to 3 days, rinsed with water, then placed in a second different water solution for 2 to 3 days. The treated material is closely piled and covered for 3 to 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 the material is recommended when this process is used. This method is more completely described by R.H. Baechler in his report, "How to Treat Fence Posts by Double-Diffusion," listed under Treating Methods in Appendix B.

Results from the double-diffusion method have been variable--sometimes satisfactory, but also sometimes inadequate--for treating posts of pine, Douglas-fir, and some hardwoods. Treatments with sodium chloride followed by copper sulfate have been more successful than treatments with copper sulfate and then sodium chromate. Neither of the double-diffusion treatments is as satisfactory as soaking dry wood in pentachlorophenol or copper naphthenate. The speed with which freshly cut and peeled material can be treated by double diffusion without drying, however, may be attractive.

The copper sulfate solution should be placed in wood or nonferrous containers because steel drums will quickly corrode and leak. The chemical must be added as needed to keep each treating solution at the proper concentration (Baechler, see Treating Methods, Appendix B).

Insuring the long life of preservative-treated wood

Although preservative-treated wood will prolong the useful life of a structure, any break in the protective "shell" can provide an opening for decay fungi and insects to enter. This is a particular problem with western wood species that have low percentages of treatable sapwood.

Commonly, deep checks will develop in large wood members that have not been completely seasoned before they were treated with preservatives. These checks extend past the preservative-treated "shell" into untreated wood. Because it is generally not feasible to season these members completely to in-service levels before preservative treatment, the checks frequently develop as the wood dries in service.

In addition to seasoning checks, any cutting or drilling that penetrates beyond the treated "shell" can also act as a point of entry for decay agents. Where possible, it is always best to make bore holes and cuts before preservative treatment; however, this is not always feasible.

Therefore, in all these instances, apply a remedial chemical (for example, copper naphthenate in oil) to any openings as soon as possible. Like brush treatments, these applications will not penetrate into the wood to any depth, but they do provide a barrier to decay agents. Almost any of the chemicals suggested in the preservative section can be used for this procedure.

Appendix A: Waste disposal

In the process of treating, a certain amount of chemical solution will be left over or small quantities of chips or sawdust containing solution will remain. At present, the Oregon Department of Environmental Quality has classified this material as a hazardous waste and requires that all such waste be disposed of in an approved hazardous waste landfill. This ruling currently applies to creosote, pentachlorophenol, and the inorganic arsenicals, but it is expected that this ruling will be extended to include most of the major wood preservatives.

The disposal of wood treated with wood preservatives is less clearcut. Generally, all attempts should be made to reuse treated wood. Appropriate uses include landscape timbers and parking barriers. Do not burn preservative-treated wood because it releases toxic vapors. If the treated material is to be discarded, the DEQ requires that a leach test be performed to insure that the waste will not result in aquatic toxicity. For more information on this test and for the most up-to-date rules on the handling of chemical waste, Oregon residents should call the Oregon Department of Environmental Quality. Residents of other states should contact the appropriate state regulatory agency before treating wood with chemicals.

Appendix B: References

The following references are listed alphabetically by author under eight topics or categories: wood, seasoning, decay and stain fungi, insects, preservation, specifications, buildings, and treating methods. Because some sources have issued more than one reference, these sources are listed and numbered below. If applicable, corresponding numbers appear at the left of the citations.

Sources

1. Superintendent of Documents
   U.S. Government Printing Office
   Washington, DC 20402

2. Forest Research Laboratory
   College of Forestry
   Oregon State University
   Corvallis, Oregon 97331

3. Extension Service
   Oregon State University
   Corvallis, Oregon 97331

4. U.S. Forest Products Laboratory
   One Gifford Pinchot Drive
   Madison, Wisconsin 53705-2398

5. Forestry Media Center
   College of Forestry
   Oregon State University
   Corvallis, Oregon 97331

Wood

5 KRAHMER, R.L. Undated. Wood structure. Slide-tape package 564: 114 slides, 35 minutes. Forestry Media Center, Oregon State University, Corvallis, Oregon 97331.

4 LASSEN, L.E., and E.A. OKKONEN. 1969. Sapwood thickness of Douglas-fir and five other western woods. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. Research Paper 124. 16 p.

MEYER, R.W., and R.M. KELLOGG, Editors. 1982. Structural Uses of Wood in Adverse Environments. Van Nostrand Reinhold, New York. 510 p.

PANSHIN, A.J., and C. deZEEUW. 1970. Textbook of Wood Technology. 3rd edition. McGraw-Hill, 8171 Redwood Highway, Novato, California 94947. 705 p.

1 U.S. FOREST PRODUCTS LABORATORY. 1974. Wood Handbook: Wood as an Engineering Material. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Agriculture Handbook 72. 421 p.

WESTERN WOOD PRODUCTS ASSOCIATION. 1973. Western Wood Use Book. 1500 Yeon Building, Portland, Oregon 97204. 316 p.

Seasoning

5 ESPENAS, L.D., and R.D. GRAHAM. Undated. How wood dries. Slide-tape package 565: 76 slides, 30 minutes. Forestry Media Center, Oregon State University, Corvallis, Oregon 97331.

4 JAMES, W.L. 1975. Electric moisture meters for wood. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. General Technical Report FPL-6. 27 p.

1 REITZ, R.C., and R.H. PAGE. 1971. Air Drying of Lumber: A Guide to Industry Practices. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Agriculture Handbook 402. 110 p.

Decay and stain fungi

BOYCE, J.H. 1961. Forest Pathology. McGraw-Hill, New York. 600 p.

4 DUNCAN, C.G., and F.F. LOMBARD. 1965. Fungi associated with principal decay of wood products in the United States. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. Research Paper W0-4. 31 p.

3 HELSING, G.G., and R.D. GRAHAM. 1981. Control of wood rot in waterfront structures. Oregon State University Extension Service, Sea Grant Marine Advisory Program, Corvallis, Oregon 97331. Publication SG-55. 8 p.

1 U.S. DEPARTMENT OF AGRICULTURE. 1986. Wood decay in houses: how to prevent and control it. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Home and Garden Bulletin No. 73. 25 p.

1 VERRALL, A.F. 1956. Building decay associated with rain seepage. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Forest Service Technical Bulletin 1356. 58 p.

Insects

3 EVERY, R.W., and J.A. RUDINSKY. 1972. The golden Buprestid--a wood boring beetle. Oregon State University Extension Service, Corvallis, Oregon 97331. Extension Circular 713. 4 p.

1 FURNISS, R.L., and V.M. CAROLIN. 1977. Western Forest Insects. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Miscellaneous Publication 1339. 654 p.

3 GOULDING, R.L., and J. CAPIZZI. 1971. Carpenter ant control. Oregon State University Extension Service, Corvallis, Oregon 97331. Extension Circular 700. 5 p.

1 JOHNSTON, H.R., and L.H. WILLIAMS. 1973. Controlling wood destroying beetles in buildings and furniture. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Leaflet 558. 8 p.

Preservation

AMBURGEY, T.L. 1971. Annotated Bibliography on Prevention and Control of Decay in Wood Structures. USDA Forest Service, Southern Forest Experiment Station, P.O. Box 2008, Gulfport, Mississippi 39503. 123 p.

BARNES, H.M. 1986. Zinc naphthenate pressure treatment of pine logs for log homes. Forest Products Journal 36(11/12):63-68.

BEST, C.W., and G.E. MARTIN. 1969. Deep treatment of Douglas-fir poles. Proceedings, American Wood Preservers' Association 65:223-226.

BLEW, J.O., Jr. 1961. Results of preservative treatment of Douglas-fir from different areas. Proceedings, American Wood Preservers' Association 57:200-212.

5 GRAHAM, R.D. Undated. Pressure wood preserving processes. Slide-tape package 567: 119 slides, 24 minutes. Forestry Media Center, Oregon State University, Corvallis, Oregon 97331.

5 GRAHAM, R.D. Undated. Wood preservation microcourse. Slide-tape package 593: 80 slides, 22 minutes. Forestry Media Center, Oregon State University, Corvallis, Oregon 97331.

5 GRAHAM, R.D. Undated. Wood preservation minicourse. Slide-tape package 578: 144 slides, 50 minutes. Forestry Media Center, Oregon State University, Corvallis, Oregon 97331.

GRAHAM, R.D., and E.M. ESTEP. 1966. Effect of incising and saw kerfs on checking of pressure-treated Douglas-fir spar crossarms. Proceedings, American Wood Preservers' Association 62:155-158.

GRAHAM, R.D., D.J. MILLER, and R.H. KUNESH. 1969. Pressure treatment and strength of deeply perforated Pacific coast Douglas-fir poles. Proceedings, American Wood Preservers' Association 65:234-241.

HELSING, G.G., and R.D. GRAHAM. 1976. Saw kerfs reduce checking and prevent internal decay in pressure-treated Douglas-fir poles. Holzforschung 30:184-186.

KILBORN, K. 1971. A guide to establishing a pressure-treating plant for small sawed and round wood products in Colorado. Department of Forest and Wood Sciences, Colorado State University, Fort Collins, Colorado 80521. 50 p.

5 LIN, R.T., D.J. MILLER, and R.D. GRAHAM. Undated. Penetration of liquids into wood. Slide-tape package 566: 80 slides, 20 minutes. Forestry Media Center, Oregon State University, Corvallis, Oregon 97331.

1 MacLEAN, J.D. 1953. Preservative Treatment of Wood by Pressure Methods. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Agriculture Handbook 40. 160 p.

2 MILLER, D.J. 1986. Performance of several western species as roof shingles with and without on-site preservative treatments. Forest Products Journal 36(6):61–66.

2 MILLER, D.J. 1986. Service life of treated and untreated fence posts: 1985 post-farm report. Forest Research Laboratory, Oregon State University, Corvallis, Oregon 97331. Research Paper 48. 27 p.

MILLER, D.J., and R.D. GRAHAM. 1963. Treatability of Douglas-fir from the western United States. Proceedings, American Wood Preservers' Association 59:218–222.

NICHOLAS, D.D., Editor. 1973. Wood Deterioration and Its Prevention by Preservative Treatments. Syracuse University Press, Syracuse, New York 13210. 402 p. (2 volumes).

ROFF, J.W., R.S. SMITH, A.J. CSERJESI, and P.A. COOPER. 1975. Protection and preservation of wood in service: questions and answers. Forintek, Montreal Road, Ottawa, Ontario, Canada K1A 0W5. Informational Report VP-X-145. 42 p.

4 ROWELL, R.M., J.M. BLACK, L.R. GJOVIK, and W.C. FEIST. 1977. Protecting log cabins from decay. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. General Technical Report FPL-11. 11 p.

Specifications

AMERICAN WOOD PRESERVERS' ASSOCIATION. Current edition. Book of Standards. P.O. Box 849, Stevensville, Maryland 20666.

4 GJOVIK, L.R., and R.H. BAECHLER. 1977. Selection, production, procurement, and use of preservative treated wood: supplemental federal specification TT-W-571. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. General Technical Report FPL-15. 37 p.

1 U.S. GENERAL SERVICES ADMINISTRATION. Latest revision. Wood preservation: treating practices. Federal specification TT-W-571.

Buildings

2 GRAHAM, R.D. 1978. Useful information for the home owner and builder. Forest Research Laboratory, Oregon State University, Corvallis, Oregon 97331. 7 p.

2 LATTIN, J.A., Editor. 1978. Protect your home against decay and insects. Forest Research Laboratory, Oregon State University, Corvallis, Oregon 97331.

Treating methods

4 BAECHLER, R.H. 1961. How to treat fence posts by double diffusion. 3rd edition, revised. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. Report 1955. 5 p.

4 BLEW, J.O. 1961. Treating wood by the cold-soaking method. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. Report 1445. 10 p.

4 BLEW, J.O., and F.J. CHAMPION. 1967. Preservative treatment of fence posts and farm timbers. U.S. Forest Products Laboratory, Madison, Wisconsin 53705. USDA Farmers Bulletin 2049. 33 p.

COLLEARY, M.H., and H.P. SEDZIAK. 1962. The preservative treatment of fence posts by non-pressure processes. Forest Products Research Branch, Department of Forestry, Ottawa, Ontario, Canada. Bulletin 107. 24 p.

ROSS, C.R., and R.D. GRAHAM. 1962. Salt treatments for green posts and poles. Oregon State University Extension Service, Corvallis, Oregon 97331. Extension Circular 556. 6 p.

4 U.S. FOREST PRODUCTS LABORATORY. 1959. Preservation of timber by the steeping process. Madison, Wisconsin 53705. Report 621. 12 p.

1 VERRALL, A.F. 1965. Preserving wood by brush, dip, and short-soak methods. Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. USDA Technical Bulletin 1334. 50 p.

WOHLETZ, E., and V. RAVENSCROFT. 1948. Cold-soak wood preservation. University of Idaho, Moscow, Idaho. 47 p.

Appendix C: Personal protection when applying restricted-use preservatives

Preservative	Recommended protective clothing and equipment			Symptoms of overexposure		
	Gloves	Clothing	Respirators	Over a prolonged time	Skin contact	Vapors
Creosote	Polyvinyl acetate, polyvinyl chloride, neoprene, BUNA-N (NBR)	Neoprene, polyvinyl acetate, polyvinyl chloride, NBR (BUNA-N)	MSHA/NIOSH-approved cartridge-type respirator for organic vapors	Dermatitis	Skin becomes light-sensitive	Irritating
Pentachlorophenol	Polyvinyl acetate, polyvinyl chloride, neoprene, NBR (BUNA-N), nitrile	Neoprene, plastic-coated disposable coveralls, tightly-woven fabric (cotton or polyester)	MSHA/NIOSH-approved organic vapor and gas respirator. MSHA/NIOSH self-contained breathing apparatus with full-face piece	Headache, weakness, dizziness, nausea, coordination loss, profuse sweating, elevated body temperature.	Liver, kidney, and skin damage.	Irritating
Inorganic arsenicals	Vinyl, polyvinyl chloride, neoprene, NBR (BUNA-N), rubber, polyethylene	Vinyl, polyvinyl chloride, neoprene, NBR (BUNA-N), rubber, polyethylene	MSHA/NIOSH-approved half-mask or supplied-air respirator. Properly fitted, well-maintained, high-efficiency filtered respirators for inorganic arsenic	Nausea, chills, diarrhea.	Burns.	Ulcers of nasal septum.

First aid			
Skin contact	Eyes	Vapors	Ingestion
Wash with soap and water or waterless soap. Do not use solvents.	Flush with water for at least 15 minutes. Consult a physician.	Move victim to fresh air.	Do NOT induce vomiting. Give 1 glass of milk or 1 to 2 ounces of activated charcoal in water. Do not give if victim is unconscious. Call a doctor.
Wash with soap and warm water. Remove contaminated clothing.	Flush with water for at least 15 minutes. Consult a physician.	Move victim to fresh air.	Induce vomiting, then take 2 tablespoons of activated charcoal in water. Never induce vomiting or attempt to force an unconscious person to drink. Call a doctor.
Flush with water. Remove contaminated clothes.	Flush with water for at least 15 minutes. Consult a physician.	Move victim to fresh air.	Do NOT induce vomiting. Give 1 glass of milk or 1 to 2 ounces of activated charcoal in water. Do not give if victim is unconscious. Call a doctor.

Morrell, J.J., R.D. Graham, and D.J. Miller. 1988. SAFE USE OF PRESERVATIVES AND PRESERVATIVE-TREATED WOOD AT HOME AND ON THE FARM: A GUIDE FOR THE PACIFIC NORTHWEST. Forest Research Laboratory, Oregon State University, Corvallis. Special Publication 15. 21 p.

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