EM 8403 • Revised August 2006
$3.50

Wood Preservation and Wood Products Treatment

Training Manual

G. Thomasson, J. Capizzi, F. Dost, J. Morrell, and D. Miller

Oregon State UNIVERSITY | Extension Service

Contents

Properties of wood 2
Wood-damaging pests..... 2
Wood-inhabiting fungi 3
Chemical stains 4
Insects..... 4
Marine borers 6
Controlling pests 6
Moisture control 6
Using naturally resistant wood 7
Chemical control 7
Protecting humans 8
Hazards to applicators..... 9
Protecting the applicator 10
Voluntary consumer awareness program 11
Protecting the environment 14
Groundwater pollution..... 15
Waste disposal..... 15
Storage and disposal of containers 15
Spills 15
Glossary..... 16
For more information..... 17
Table 1. Restricted-use pesticides 19
First aid ..... back cover

This publication was revised from a University of Georgia Cooperative Extension Service publication by Gary Thomasson, Extension entomologist, Washington State University, and the following from Oregon State University: Joseph Capizzi, Extension entomologist emeritus (deceased); Frank N. Dost, Extension toxicology and agricultural chemical specialist emeritus; Jeffrey J. Morrell, professor of wood science; and Donald J. Miller, professor of forest products emeritus.

Wood Preservation and Wood Products Treatment

Training Manual

Federal and state regulations establish standards that you must meet before you legally can use certain pesticides. Since November 1986, federal regulations administered by the Environmental Protection Agency (EPA) have restricted the sale and use of certain preservatives to ensure that only properly trained applicators, or people under their direct supervision, have access to them. Wood preservatives affected by these regulations are creosote, pentachlorophenol (penta), and inorganic arsenicals. Nearly 20 years later, the industry voluntarily withdrew registrations for the use of inorganic arsenicals for wood used in residential applications.

This publication is intended to help those preparing for the wood preservative pesticide licensing examinations administered by the state departments of agriculture in the Pacific Northwest.

Wood pesticides (preservatives) extend the life of wood products by protecting them from damage by insects, fungi, marine borers, and weather (Figure 1). Preservatives are applied depending on how and where the wood products will be used, the expected conditions of exposure to wood-destroying agents, and the cost per year of service life.

Crossties, poles, posts, and other wood products that contact the ground or are exposed to the weather must be protected with preservatives to ensure a reasonable service life. Other wood products not in contact with the ground may be treated as a precautionary measure even though they are not exposed to moisture and weather.

Long-term tests and experience show the levels of protection needed for various wood products and uses. These guidelines become industry-wide when they are accepted by the following groups:

- Groups that use the treated products
- Regulatory agencies
- Wood-preserving standards-writing organizations

Many standards and specifications exist to control the quality of treated wood and protect the purchaser. Federal and state specifications, requirements of the American Wood Preservers Association, and building codes are the most relevant regulations.

Figure 1. Wood products that are in contact with the ground or exposed to weather can be damaged by a variety of damaging insects (left), fungi (middle), and marine borers, as well as by the weather itself (right).

Properties of wood

A crosscut of most trees (Figure 2) shows a zone of lighter wood (sapwood) surrounding a core of darker colored wood (heartwood). Fast-growing trees usually have deeper sapwood than slow-growing trees.

Ninety percent of wood is made up of minute, hollow fibers oriented lengthwise along the tree stem. These fibers, 0.5 inch long (5 mm), are 100 times longer than wide. The tree transports water and nutrients vertically through these fibers, which also serve as a means of support.

The remaining 10 percent of the wood is composed of short, hollow, brick-shaped cells oriented from the bark toward the center of the tree as ribbons or rays of unequal height and length. These rays distribute food, manufactured in the leaves and transported down the inner bark, to the growing tissues between the bark and the wood (Figure 3).

Wood is composed of a complex mixture of substances, but the main constituent of all wood is a complex sugar (carbohydrate) called cellulose. This material serves as the primary source of energy and nutrition for many forms of life. People use this same source of energy, not as food but as heat, when they stoke up the wood stove or fireplace. It also is responsible for the remarkable strength of wood.

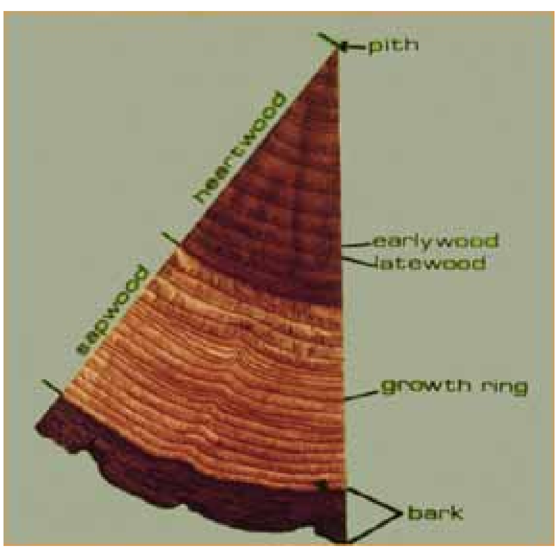

Figure 2. A crosscut of most trees shows that inside the bark there is a zone of lighter wood (sapwood) surrounding a core of darker colored wood (heartwood). Fast-growing trees usually have deeper sapwood than slow-growing trees.

Wood-damaging pests

People use wood for many applications. Under proper use conditions, wood can give centuries of good service; under unfavorable conditions, it can be damaged readily and destroyed by fungi, insects, and marine borers. These pests can attack in many ways, so wood must be protected to ensure maximum service life when used under conditions favorable to these pests.

In general, the conditions for decay include adequate oxygen, moisture

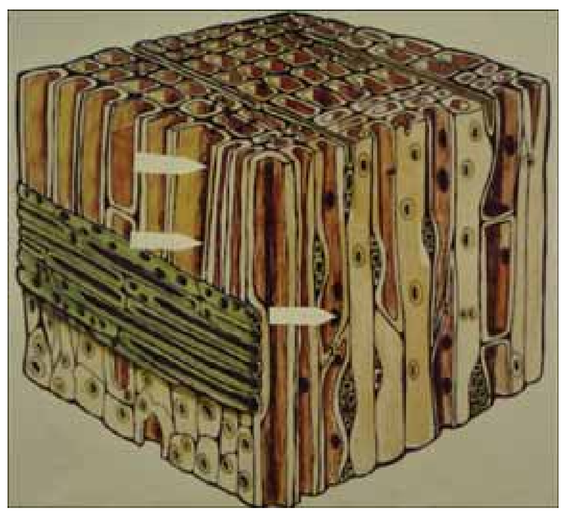

Figure 3. Ten percent of wood is composed of short, hollow, brick-shaped cells oriented from the bark toward the center of the tree as ribbons or rays of unequal height and length. These rays distribute food, manufactured in the leaves and transported down the inner bark, to the growing tissues between the bark and the wood.

(normally greater than 30 percent moisture content), temperature (41 to 104°F), and a food source (usually the wood). Limiting one or more of these factors is key to limiting degradation.

Wood-inhabiting fungi

Wood decay, mold, and most sapwood stains are caused by fungi. These organisms feed on living or dead wood and produce spores (microscopic seeds) that are distributed by wind, water, and insects. The spores can colonize moist wood during storage, processing, or use. All fungi that grow on wood have two basic requirements.

- Favorable temperature—usually between 50 and 90°F. Optimum temperature conditions generally are between 70 and 90°F. Wood usually is safe from decay at temperatures below 35 and above 100°F.
- Adequate moisture. Fungi will not attack dry wood (wood with a moisture content of 19 percent or less). Decay fungi require a wood moisture content of about 30 percent, the generally accepted fiber saturation point of wood. Thus, air-dried wood, usually with a moisture content not exceeding 19 percent, and kiln-dried wood with a moisture content of 15 percent or less, usually can be considered safe from fungal damage.

The many fungi that develop on or in wood can be divided into two major groups based on the damage they cause: wood-destroying fungi (decay fungi) and wood-staining fungi (sap-staining fungi and mold fungi).

Wood-destroying fungi

Both the sapwood and heartwood of most tree species are susceptible to decay, and unprotected sapwood of all trees deteriorates rapidly in warm, moist soil. Douglas-fir, western larch, western hemlock, and most other species also have nondurable heartwood. Heartwood of cedar, redwood, and a few other species is durable, lasting three to five times longer than nondurable woods.

Decay fungi may grow in the interior of the wood or appear on wood surfaces as fan-shaped patches of fine, threadlike, cottony growths or as rootlike shapes. The color of these growths ranges from white through light brown, bright yellow, or dark brown.

The spore-producing bodies may be mushrooms, shelflike brackets, or structures with a flattened, crustlike appearance. Fine, threadlike fungal strands grow throughout the wood and digest parts of it as food.

In time, the strength of wood is destroyed. For example, untreated poles or posts first rot in the sapwood just below the ground line, where moisture and temperature are most favorable for fungal growth. Once established, the fungal strands may extend several inches or more into the heartwood.

Decay stops when temperature or moisture conditions in the wood are unfavorable for fungal growth; however, decay will resume whenever conditions become favorable.

Wood-destroying fungi can be segregated into three major categories: brown rots, white rots, and soft rots.

Brown rot fungi break down the cellulose component of wood, leaving a brown residue of lignin. These fungi probably are the most important cause of decay of softwood species used in above-ground construction in this country.

Brown-rotted wood can be greatly weakened even before decay can be seen. The final stage of wood decay by the brown rots can be identified by the dark brown color of the wood, excessive wood shrinkage, cross-grain cracking, and the ease with which the dry wood substance can be crushed to powder (Figure 4, page 4).

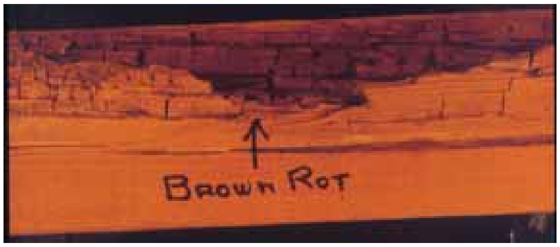

Figure 4. The final stage of wood decay by the brown rots can be identified by the dark brown color of the wood, excessive wood shrinkage, cross-grain cracking, and the ease with which the dry wood substance can be crushed to powder.

When dry, brown rot sometimes is called dry rot. This is an inaccurate term because wood will not decay when it is dry. One group of fungi called true dry rot fungi can produce rootlike rhizoids that draw moisture from soil into the wood. Fortunately, these fungi are rare in the western U.S.

White rot fungi break down both lignin and cellulose in wood and have a bleaching effect, which may make the damaged wood whiter than normal. These fungi are more common in hardwoods.

Soft rot fungi usually attack water-saturated wood, causing a gradual softening of wood from the surface inward. The damage done by these fungi resembles that caused by brown rot fungi. These fungi usually are not a problem except in wet locations, such as cooling towers.

Wood-staining fungi

The primary damage caused by these fungi is discoloration of the wood. They have little or no effect on its strength.

Sap-staining fungi penetrate and discolor sapwood, particularly among softwood species. Unlike staining by mold fungi, sapstain usually cannot be removed by brushing or planing. Sap-staining fungi may become established in the sapwood of standing trees, saw logs, lumber, and timber soon after it is cut and before it is dried adequately. Some of these fungi are carried to trees by beetles, thus infecting trees before they are cut.

Where appearance of the wood is important, sap-stained wood may be unfit for use.

Mold fungi first become noticeable as a green, yellow, brown, or black fuzzy or powdery surface growth on the wood. Freshly cut or seasoned stock, piled during warm, humid weather, may be noticeably discolored within a few days. Although brushing or planing will remove the stain, these fungi can increase the capacity of wood to absorb moisture, thereby increasing the likelihood of attack by decay fungi.

Molds also can colonize wood that becomes wet in a structure. The spores of some of these fungi are potential allergens, and some people are especially sensitive to them.

The best solution to mold colonization is to eliminate the moisture source. Small amounts of mold on a wood surface can be removed by washing with a dilute bleach solution. Higher levels of mold may require special remediation.

Chemical stains

Although they may resemble fungal blue or brown stain damage, chemical stains are not caused by fungi; rather, they are caused by chemical changes in the wood during processing or seasoning. For example, iron can react with chemicals in the wood called tannins to produce a black stain.

Chemical stains can downgrade lumber for some uses, but these stains usually can be prevented by rapidly drying the wood at relatively low temperatures during kiln drying, by limiting contact with iron, and by limiting storage of logs.

Insects

Several kinds of insects use living trees, logs, lumber, and finished wood products for food and shelter. The most important pests of wood and wood products include termites, carpenter ants, and various beetles.

Termites

Termites use wood for both food and shelter. Nationally, termites are the most destructive wood-destroying insect. Although they are not considered the number one wood pest insect in this area (carpenter ants hold that honor), termites account for a significant amount of structural damage in the Pacific Northwest.

Except when the reproductive termites swarm, termites are rarely seen outside the nest, making detection difficult. The presence of insect wings on a window sill can be an indicator of attack. Mud tubes over masonry walls are another sign.

The two major termite groups of concern in the Pacific Northwest are subterranean termites and dampwood termites.

Subterranean termites can attack any unprotected wood or wood product. They live in and obtain their moisture from the soil. Although subterranean termites prefer the soil environment, they will build mud tubes over exposed surfaces from the soil to a food source. Subterranean termites live in large colonies that continually tunnel through soil searching for wood. Construction debris under a house is an excellent point of entry for these insects.

Dampwood termites live in the wood on which they feed and rely on the wood as a source of water; consequently, these termites attack only wood with a high moisture content. Once established, they can extend their activities into sound, dry wood. Dampwood termite workers are easily distinguished from subterranean termites by their large size and the presence of soldiers with very large heads.

Carpenter ants

These are the most destructive insect pests of wood and wood structures in the Pacific Northwest (Figure 5). They usually live in stumps, trees, or logs, but will infest virtually any wood. They will even chew galleries in foam insulation because of its soft texture. These insects cannot use wood for food.

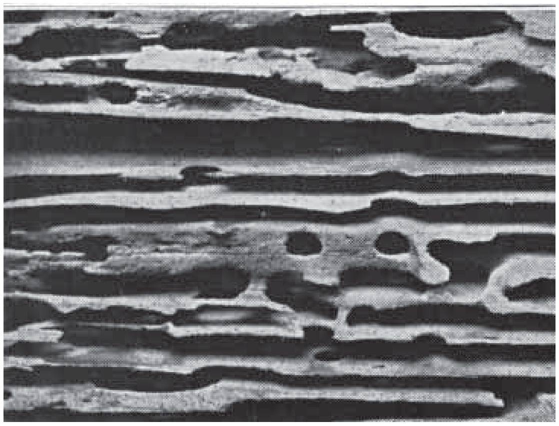

Figure 5. Carpenter ant damage.

Although carpenter ants often are confused with termites, there are several physical differences between these two groups of insects. For example, ants have elbowed antennae; termites do not. Ants have very narrow waists, but termite bodies are broad.

Carpenter ants often are seen outside the nest searching for food and water. Kitchens and bathrooms are the most common places to see workers. They also expel wood particles from their nest, and careful inspection can detect this debris.

Beetles

Powderpost or *Lyctus beetles* attack both freshly cut and seasoned hardwoods and softwoods. Adults lay eggs in the wood pores. Emerging larvae burrow through the wood, making tunnels packed with a fine powder. The Pacific powderpost beetle damages structures from California to Alaska, feeding mainly on well-seasoned wood.

Anobiid beetles attack softwoods in damp or poorly ventilated spaces beneath buildings. Small, round exit holes on the wood surface (⅛ inch in diameter) often

Figure 6. Wood used in docks and marine pilings should be treated to prevent damage by marine borers.

are the first sign of attack. These beetles are common in older barns, covered bridges, and coastal houses where the wood is slightly wetter than normal. Painting or sealing wood surfaces excludes beetles, but will not affect larvae already in the wood.

Roundhead and flatheaded borers infest live trees as well as recently felled or dead, standing softwood trees. They can cause considerable damage in rustic structures and some manufactured products. Some species live in wood as long as 40 years. Most species do not reinfest seasoned wood.

Marine borers

Submerged portions of pilings, wharf timbers, and wooden boats in brackish or salt water (Figure 6) are damaged extensively by a group of animals known collectively as "marine borers." Untreated timbers can be infested and destroyed by these organisms in less than a year. Major marine borers in the Northwest include species in the phylla Mollusca (related to clams and called "shipworms") and Crustacea (related to crabs and sowbugs and called "gribbles").

Shipworms drill tunnels in wood and line them with a thin, shell-like substance. The giant shipworm *Bankia setacea* and several species of *Teredo* (especially *Teredo navalis*) are the most common forms. Their attack is mostly internal, making detection difficult.

Gribbles (*Limnoria* spp.) mine the outer part of pilings and other marine structures. Attack takes place from the mud line to the upper tidal level. Gribbles are common in habitats all along the West Coast.

Controlling pests

Wood should be protected whenever it is used where it will be subject to pest attack. This protection can be achieved by controlling the wood moisture content, by using wood that is naturally resistant to pests, or by treating the wood with a chemical preservative.

Moisture control

Living trees and wood products range from about 10 percent to more than 200 percent moisture content (based on weight). Timber or logs stored for extended periods before processing can be protected from fungi and insects by submersion in pond water or by a continuous water spray. The water reduces the oxygen content and temperature of the logs to levels below those needed for pest development.

Much of the moisture in wood must be removed for most uses. Green lumber usually is seasoned or dried to do the following:

- Prevent development of stain and decay organisms
- Reduce insect damage
- Control wood shrinkage
- Reduce weight and increase strength
- Prepare wood for chemical preservative treatments

Figure 7. Cedar is naturally resistant to decay, but more expensive than many other woods.

The moisture content of wood usually is reduced either by air drying in a yard, shed, or predryer, or by drying in a kiln. The most efficient and widely used method is kiln drying because it offers better control of air movement, temperature, and drying rate than does air drying.

Although kiln drying is more expensive than air drying, it is much faster, and it provides better quality and more uniform drying. Furthermore, unless lumber is properly stacked and protected, air drying may result in surface cracking (checking), end cracking, warping, staining, and discoloration due to weathering. Kiln drying also eliminates most fungi and insects from the wood.

Even after being well seasoned, wood may again reach a moisture level favorable to pests, especially if exposed to rain or prolonged high humidity and favorable temperatures.

Most building designs seek to exclude moisture through the inclusion of gutters, steeply pitched roofs, wide roof overhangs, and coatings, and by avoiding direct soil contact.

Using naturally resistant wood

The sapwood of all native tree species and the heartwood of most species have low natural resistance to decay. However, the heartwood of some trees, such as cedar (Figure 7) and redwood, is quite resistant to decay. These species are resistant—but not immune—to attack by decay fungi and insects. Unfortunately, these naturally resistant woods usually are more expensive and are used only in special applications such as decks and decorative products. Naturally durable woods tend to perform best when used in situations where they are not in contact with the soil.

Chemical control

Any chemical that claims to be a biocide must be registered with the U.S. Environmental Protection Agency as well as with the state where it is sold. The effectiveness of preservative treatment depends on the chemical formulation selected, the method of application, the proportion of sapwood to heartwood, the moisture content of the wood, the amount of preservative retained, the depth of chemical penetration, and the distribution of the chemical in the wood.

Sapwood of most commercial lumber tree species accepts preservatives much better than heartwood, and softwood species generally can be treated more uniformly than hardwood species. Preservative treatment by pressure usually is required for wood exposed to high risk of attack by fungi, insects, or marine borers.

General-use pesticides

There are hundreds of pesticide products registered for application to wood and wood products in the Pacific Northwest. Most of these have been designated "general-use" pesticides. Exposure to such chemicals is considered less hazardous than exposure to "restricted-use" pesticides.

General-use pesticides commonly used by the wood preservation industry are copper naphthenate, copper 8 quinolinolate; 3-iodo propynyl butylcarbamate, zinc naphthenate, and sodium octaborate tetrahydrate. Unlike restricted-use preservatives, copper 8 quinolinolate has been approved for food-contact uses such as boxes, crates, pallets, and truck decking used during harvesting, storage, and transportation of food.

Restricted-use pesticides

Three groups of chemical wood preservatives have been designated "restricted-use" pesticides: creosote, pentachlorophenol (penta), and inorganic arsenicals. This designation includes the requirement that only those who are trained and licensed may purchase or use these preservatives.

Table 1 (pages 19–21) summarizes the advantages and disadvantages of these three pesticides.

Creosote is an oily liquid produced when coal is heated in the absence of air; it is the by-product of making coke from bituminous coal for the steel industry. This material usually is used as a preservative for railroad ties, large timbers, fence posts, poles, and pilings.

Pentachlorophenol (penta) is produced by chlorinating phenol under tightly controlled conditions that limit formation of other products. It is insoluble in water, so it generally is dissolved in petroleum or other organic solvents that will penetrate wood.

Penta is used to treat poles, crossarms, lumber, timber, and fence posts. It is not recommended for use in marine installations or close to plants, and it may not be used inside buildings except when the treated wood is sealed to limit volatilization. Penta no longer is available for the do-it-yourselfer.

Inorganic arsenicals consist of combinations of copper and arsenic. The most commonly used compounds are chromated copper arsenate (CCA) and ammoniacal copper zinc arsenate. These preservatives are water-soluble but, when applied to wood, they become fixed in the wood in an insoluble form. The copper provides protection against attack by fungi, and the arsenic prevents insect attack. These preservatives no longer are used for residential applications, but can be used for farm, highway, and marine applications.

Alkaline copper compounds use either amines or ammonia-based copper plus a secondary fungicide. Like CCA, these systems are water based, but they are less strongly fixed to the wood following treatment. Their primary benefits are the absence of chromium or arsenic. Amine copper azole and alkaline copper azole are the two most commonly used compounds. Both tend to be corrosive to steel, and either heavily galvanized or stainless steel is recommended for use with these products.

Protecting humans

Most chemicals used to protect wood from insects and decay must be toxic to be effective. The goal is to select chemicals and methods that will control pests without harming the applicator, the user, the public, pets, plants, or the environment.

The toxic effects of chemicals can be either acute (based on high-level, short-term exposure) or chronic (based on the cumulative effects of low-level, long-term exposure). Human exposure to preservatives can produce both acute and chronic toxicity. The Environmental Protection Agency's decision to classify creosote, pentachlorophenol, and inorganic arsenicals as restricted-use pesticides was based on potential human health hazards associated with long-term, low-level exposure or chronic toxicity. Table 1 lists the toxicity effects—acute and chronic—of the three restricted-use preservatives along with those of several commonly used alternatives.

EPA regulations include limitations on treating wood intended for certain uses, as well as on certain uses of treated wood. Not all limitations are the responsibility of commercial treaters, but all wood treaters should understand them. Table 1 includes a summary of these use limitations.

The EPA-approved labeling and mandatory Material Safety Data Sheets (MSDS) for wood preservatives are the primary sources of information about application methods, precautionary measures, emergency first aid, and disposal instructions.

The label is a legal document, and its provisions are enforced by state regulatory agencies. Therefore, make sure that labels for each formulated product used in a wood treatment operation are readily available; all responsible personnel should be thoroughly familiar with their contents.

Use pesticides safely!

- Wear protective clothing and safety devices as recommended on the label. Bathe or shower after each use.
- Read the pesticide label even if you have used the pesticide before. Follow closely the instructions on the label (and any other directions you have).
- Be cautious when you apply pesticides. Know your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

Hazards to applicators

All handlers of wood preservatives must know about potential hazards and necessary precautions when working with these chemicals. Those who apply the chemicals are at greatest risk of excessive exposure; those who use the wood are at far less risk. Therefore, it is especially important for those who apply preservatives and handle recently treated wood to minimize their exposure to these chemicals.

Exposure to wood preservatives can occur in a variety of ways: during mixing and handling the chemicals, entering pressure-treatment cylinders, working around preservative spraying or dipping operations, handling freshly treated wood, cleaning or repairing equipment, or disposing of wastes. Closed systems for handling the chemicals and mechanical systems for handling treated wood reduce potential exposure but do not eliminate the chance of accidental exposure for workers.

Like other pesticides, wood preservatives can enter the body through the mouth (oral), through the skin or eyes (dermal), or through inhalation (respiratory). Since most preservatives have a strong odor and taste, accidental ingestion of a dangerous amount of these chemicals is very unlikely. The more likely routes of exposure are through skin contact or by inhaling preservative vapors, dust, or other contaminated particles.

Human skin varies in thickness and other characteristics from one place to another on the body. The skin also varies in its ability to absorb chemicals. The eyes, eyelids, and groin area will absorb almost 100 percent of some chemicals, while the hand, especially the palm, will absorb less than 10 percent of the same chemicals. The addition of organic solvents will enhance the ability of any preservative to penetrate human skin.

Human lungs consist of a very large, membranous surface area well supplied with blood vessels. Any chemical vapor or minute liquid droplets taken into the lungs will be absorbed into the bloodstream very rapidly.

Protecting the applicator

Anyone working with wood preservatives is exposed to these chemicals to some extent, but the exposure can be minimized by following the directions on the preservative label and in Table 1 and by developing good work habits. It is the responsibility of the manager of any wood-preserving operation to ensure that proper handling procedures, protective clothing, and safety equipment are provided to workers in order to protect their health and conform to label instructions.

Personal hygiene

Basic, common-sense hygiene rules can reduce the risk of chronic exposure to wood preservatives significantly. For example:

- Wash hands often, especially before using the restroom, smoking, or eating.
- Don't drink, eat, or smoke in the work area. These activities increase the amount of preservative absorbed into the body.
- Remove gloves to handle paperwork, phones, or equipment that others may handle with unprotected hands.
- Launder protective clothing at the work site. If work clothes must be laundered at home, wash them separately from other laundry.

Protective equipment and clothing

The pesticide label will specify the type of personal protective equipment and clothing that should be worn when working with wood preservatives (Figure 8). Where skin contact is expected (for example, when handling freshly treated wood or manually opening pressure-treatment cylinders), the label will specify the use of impermeable gloves.

Figure 8. Pesticide handlers must wear appropriate protective clothing, as indicated on the product label.

Leather may protect hands from slivers, but leather gloves do not protect the wearer from wood preservatives! In fact, preservative-contaminated leather gloves will increase the amount of preservative absorbed into the body.

Individuals who enter pressure-treatment cylinders or other related equipment contaminated with wood-treatment solutions must wear protective equipment that is impervious to wood treatment solutions. Required equipment includes overalls, jacket, gloves, boots, and respirator. Respirators must be approved by the Mine Safety and Health Administration and the National Institute for Occupational Safety and Health (MSHA/NIOSH), and they must be properly fitted and maintained.

Special precautions

See Table 1 for special precautions for pentachlorophenol and arsenicals.

Material Safety Data Sheets (MSDS)

Material Safety Data Sheets (MSDS) are available from manufacturers and distributors of wood preservatives. Each MSDS provides information about toxicity, first aid, protective equipment, storage and handling precautions, disposal procedures, transportation, etc.

In Washington and Oregon, the Right to Know Law requires wood treaters to have an MSDS on file for each formulation they use.

Voluntary consumer awareness program

The treated wood industry has developed a voluntary Consumer Awareness Program (CAP) designed to inform consumers about proper uses of treated wood and precautionary measures to take when using such wood.

The treated wood industry has developed a model Consumer Information Sheet (CIS) containing use precautions and safe working practices for each restricted-use chemical preservative. The CIS is the main vehicle for conveying information about treated wood to consumers. Wood treaters assume primary responsibility for dissemination of the CIS to consumers. The CIS should be available from either the treating plant or the retailer. The following wording appears on the Consumer Information Sheets for the three restricted-use chemicals.

Wood pressure-treated with an inorganic arsenical

Consumer information—This wood has been preserved by pressure treatment with an EPA-registered pesticide containing inorganic arsenic to protect it from insect attack and decay. Wood treated with inorganic arsenic should be used only where such protection is important. Inorganic arsenic penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to inorganic arsenic may present certain hazards; therefore, the following precautions should be taken when handling treated wood, in determining where to use the wood, and in disposing of the treated wood.

Use site precautions—Wood pressure-treated with waterborne arsenical preservatives may be used inside residences as long as all sawdust and construction debris are cleaned up and disposed of after construction. Do not use treated wood under circumstances where preservatives may become a component of food or animal feed in such sites as structures or containers used to store silage or food.

Don't use treated wood for cutting boards or countertops. Only treated wood that is visibly clean and free of surface residue should be used in patios, decks, and walkways.

Don't use treated wood for construction of those portions of beehives that may come into contact with the honey. Treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

Handling precautions—Dispose of treated wood by ordinary trash collections or burial. Treated wood should not be burned in open fires, wood stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (for example, construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When power-sawing or machining, wear goggles to protect eyes. After working with the wood, and before eating, drinking, or using tobacco products, wash exposed body areas thoroughly. If preservatives or sawdust accumulate on clothes, launder before reuse.

Wood pressure-treated with creosote

Consumer information—This wood has been preserved by pressure treatment with an EPA-registered pesticide containing creosote to protect it from insect attack and decay. Wood treated with creosote should be used only where such protection is important.

Creosote penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to creosote may present certain hazards; therefore, the following precautions should be taken both when handling treated wood and in determining where to use the treated wood.

Use site precautions—Wood treated with creosote should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture) unless an effective sealer has been applied.

Creosote-treated wood should not be used in residential interiors. Creosote-treated wood in interiors of industrial buildings should be used only for components that are in ground contact and are subject to decay or insect infestation, and for wood block flooring. For such uses, two coats of appropriate sealer must be applied. Sealers may be applied at the installation site.

Wood treated with creosote should not be used in the interiors of farm buildings where the wood may be in direct contact with domestic animals or livestock that may crib (bite) or lick the wood. Creosote-treated wood may be used for building components that are in ground contact and are subject to decay or insect infestation; however, two coats of an effective sealer must be applied. Sealers may be applied at the installation site. Coal tar pitch and coal tar pitch emulsion are effective sealers for creosote-treated wood block flooring. Urethane, epoxy, and shellac are acceptable sealers for all creosote-treated wood.

Don't use treated wood for farrowing or brooding facilities. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed in structures or containers used for storing silage or food. Do not use treated wood for cutting boards or countertops. Only treated wood that is visibly clean and free of surface residues should be used for patios, decks, or walkways. Do not use treated wood for construction of those portions of beehives that may come in contact with honey.

Creosote-treated wood should not be used where it may come into direct or indirect contact with public drinking water or with drinking water for domestic animals or livestock, except for uses involving incidental contact such as docks and bridges.

Handling precautions—Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires, wood stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (for example, construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When power-sawing or machining, wear goggles to protect eyes.

Avoid frequent or prolonged skin contact with creosote-treated wood. When you handle the treated wood, wear long-sleeved shirts and long pants. Use gloves that are impervious to the preservative (for example, gloves that are vinyl coated). When you are power-sawing or machining, wear goggles to protect your eyes. After working with the wood, and before eating, drinking, or using tobacco products, wash exposed body areas thoroughly. If preservatives or sawdust accumulate on clothes, launder before reuse.

Wood pressure-treated with pentachlorophenol

Consumer information—This wood has been preserved by pressure treatment with an EPA-registered pesticide containing pentachlorophenol to protect it from insect attack and decay. Wood treated with pentachlorophenol should be used only where such protection is important.

Pentachlorophenol penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to pentachlorophenol may present certain hazards; therefore, the following precautions should be taken both when handling treated wood and in determining where to use the treated wood.

Use site precautions—Logs treated with pentachlorophenol are not to be used for log homes. Wood treated with pentachlorophenol should not be used where it will be in frequent or prolonged contact with bare skin (for example, chairs and other outdoor furniture), unless an effective sealer has been applied.

Pentachlorophenol-treated wood is not to be used in residential, industrial, or commercial interiors except for laminated beams or building components that are in ground contact and are subject to decay or insect infestations and where two coats of an appropriate sealer are applied. Sealers may be applied at the installation site.

Wood treated with pentachlorophenol is not to be used in the interiors of farm buildings where the wood may be in direct contact with domestic animals or livestock that may crib (bite) or lick the wood. In interiors of farm buildings, where domestic animals or livestock are unlikely to crib or lick the wood, pentachlorophenol-treated wood may be used for building components that are in ground contact and are subject to decay or insect infestation; however, two coats of an effective sealer must be applied. Sealers may be applied at the installation site. Urethane, shellac, latex epoxy enamel, and varnish are acceptable sealers for pentachlorophenol-treated wood.

Do not use pentachlorophenol-treated wood for farrowing or brooding facilities. Do not use treated wood under circumstances where the preservative may become a component of food or animal feed in structures or containers used for storing silage or food. Do not use treated wood for cutting boards or countertops. Only treated wood that is visibly clean and free of surface residues should be used for patios, decks, or walkways. Do not use treated wood for construction of those portions of beehives that may come into contact with the honey.

Pentachlorophenol-treated wood must not be used where it may come into direct or indirect contact with public drinking water or with drinking water for domestic animals or livestock, except for uses involving incidental contact such as docks and bridges.

Handling precautions—Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires, wood stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (for example, construction sites) may be burned only in commercial or industrial incinerators or boilers rated at 20 million BTU/hour or greater heat input or its equivalent in accordance with state and federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood. When you are power-sawing or machining, wear goggles to protect your eyes.

Avoid frequent or prolonged skin contact with pentachlorophenol-treated wood. When handling the treated wood, wear long-sleeved shirts and long pants. Use gloves that are impervious to the preservative (for example, gloves that are vinyl coated). When you are power-sawing or machining, wear goggles to protect your eyes. After working with the wood, and before eating, drinking, or using tobacco products, wash exposed body areas thoroughly. If oily preservatives or sawdust accumulate on clothes, launder before reuse.

Protecting the environment

It is not only people who can suffer from the careless use or disposal of wood preservatives—your community's environment also may suffer. Creosote, pentachlorophenol, and inorganic arsenicals must be toxic in order to kill or repel the fungi, insects, and marine borers that destroy wood. Unfortunately, these chemicals are not selective; they can harm nontarget organisms.

Contaminated runoff can pollute lakes, streams, and wetlands, thereby damaging habitat for fish and wildlife. Specifics vary, but penta, creosote, and inorganic arsenicals are all toxic to fish and other wildlife.

To reduce the chance of environmental contamination, proper protective measures must be an integral part of all your wood preservation operations.

Pentachlorophenol. This chemical is not uncommon in the aquatic environment and is extremely toxic to fish. Exposure to penta concentrations of only a few parts per billion can cause death within minutes for many species of salmon and trout.

Circumstantial evidence, including the identification of penta in rainwater, indicates that penta occasionally may be present in ambient air. Low levels of this compound have been detected in both wastewater and surface water.

The source of these residues often is unclear. However, it has been suggested that, in addition to direct contamination of water by penta, degradation of other organic compounds or chlorination of water may result in production of penta.

Penta is moderately persistent in the aquatic environment. It was reportedly detected in lake water and fish 6 months after an accidental spill.

Penta also is moderately persistent in the soil. Persistence reportedly ranges from 21 days to 5 years. Under most conditions, penta seldom persists in the soil longer than 9 months because soil microorganisms are capable of degrading it.

Since penta is not ordinarily applied to the soil, the likeliest source of soil contamination is the leaching or bleeding of the preservative from treated wood. As a result, low levels of penta may exist in the immediate vicinity of treated wood.

Significant accumulation of penta in plants and mammals is unlikely to occur because penta is not translocated in plants, and it is eliminated rapidly by mammals.

Arsenicals. Arsenicals have raised concern because of their potential to cause cancer, leading manufacturers to discontinue the use of CCA for residential applications. While there is no direct link between CCA and arsenic risk, public concern remains high. Arsenate, the form present in aerobic soils, is bound tightly to soil components and is unavailable for plant uptake or leaching.

Copper is relatively benign to humans, but it is highly toxic to aquatic organisms. Concerns about aquatic effects have led to calls for banning the use of copper-based systems in aquatic applications, but the data on possible effects remain ambiguous.

Creosote. There are no recorded reports of wild or domestic animals being injured by creosote. The amount of creosote that enters the environment as a liquid is relatively small. The fate of creosote in the environment is not known, but most of its components are biodegraded quickly. The primary concern with creosote is the presence of polycyclic aromatic hydrocarbons (PAHs). Some of these compounds are carcinogenic, and there have been efforts to limit PAHs in creosote.

Groundwater pollution

Use of wood preservatives has been cited as a source of pollution in surface and groundwater in many parts of this country. Testing has documented contamination in public and private wells at levels exceeding health advisories. In some cases, sources of contamination are obvious—for example, spills or illegal discharge of chemicals into ditches, storm drains, or sewers. However, groundwater typically is affected by contamination of the overlying soil. Such contamination usually is the result of applying preservatives to soil, spills, overflow from tanks or holding ponds, and improper disposal. Another less obvious source is the uncontained drippings from freshly treated wood.

In many communities, groundwater is the only source of drinking water. When groundwater becomes contaminated with any chemical, cleanup, where possible, is very difficult and costly.

Waste disposal

Some treating plants discharge wastes into approved municipal sewer systems for processing with municipal wastes. Many plants use closed chemical and wastewater recovery systems to contain wastes that could be harmful. Recovered solutions can be reused. If they are contaminated, they can be filtered to remove solid wastes. Liquid waste materials can be diverted to settling tanks or lined ponds.

Use door sumps under pressure-chamber doors and hard-surfaced drainage areas. Any excess chemicals that drip or are rinsed from freshly treated material thus are channeled into the waste or recovery system. It also is important to contain runoff from areas where toxic chemicals are used in order to protect stored logs, poles, or lumber before processing or during seasoning.

Treating vessels and drip pads must be covered to reduce the risk of rainwater runoff, and plants must routinely monitor stormwater runoff to ensure that contaminated water does not leave the site.

Storage and disposal of containers

Store chemicals in a dry, well-ventilated, locked area. Keep them in well-sealed containers whenever possible. Protect liquid storage against tank rupture. Protect concrete vats against freezing, cracking, or spillage. Wherever spills, leaks, or flooding could occur, be sure that runoff will drain into a recovery or disposal system.

Thoroughly rinse containers and empty them into storage or treating tanks before disposal. Dispose of containers at an approved landfill or by other approved means. Be particularly careful not to contaminate streams or groundwater.

Be sure to read and follow the label requirements and the Material Safety Data Sheet (MSDS) for each preservative. If you are not sure how to store a product safely or dispose of the empty containers, contact the chemical supplier or your state agency that regulates storage and container disposal.

Spills

Cleanup procedures depend on the chemical involved. Treating-plant personnel should know what chemicals are being stored and used, and they should have a plan for handling spills. All workers who might be involved should know what help is available and whom to notify in case of a major spill.

Glossary

Definitions for some of the terms used in this manual were taken from *Wood as an Engineering Material, Wood Handbook*, USDA Agricultural Handbook 72, revised 1974.

Brown rot. A group of fungi that remove cellulose, leaving wood darkened and fractured.

Cellulose. The carbohydrate that is the principal constituent of wood and forms the framework of wood cells.

Check. A lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stresses in wood that occur during seasoning.

Decay. The decomposition of a wood substance by fungi.

Incipient decay. The early stage of decay that has not proceeded far enough to soften or otherwise perceptibly impair hardness of the wood. It usually is accompanied by a slight discoloration or bleaching of the wood.

Advanced (or typical) decay. The older stage of decay in which destruction is recognized readily because the wood has become punky, soft and spongy, stringy, ringshaked, pitted, or crumbly. Obvious discoloration or bleaching of the rotted wood often is apparent.

Dry rot. A term loosely applied to any dry, crumbly rot, but especially to that which, when in an advanced stage, permits the wood to be crushed easily to a dry powder. The term actually is a misnomer, since all fungi require considerable moisture for growth.

Green. Freshly sawn or undried wood that still contains tree sap. Wood that has become completely wet after immersion in water would not be considered green, but may be said to be in the "green condition."

Hardwoods. Generally, one of the botanical groups of trees that have broad leaves, in contrast to the conifers or softwoods. The term has no reference to the actual hardness of the wood.

Heartwood. The wood extending from the pit to the sapwood, the cells of which no longer participate in the life processes of the tree. Heartwood may contain phenolic compounds, gums, resins, and other materials that usually make it darker and more decay-resistant than sapwood.

Kiln. A chamber having controlled airflow, temperatures, and relative humidity for drying lumber, veneer, and other wood products.

Lignin. The second most abundant constituent of wood, located principally in the secondary wall and the middle lamella, which is the thin cementing layer between wood cells. Chemically, it is an irregular polymer of substituted propylphenol groups. (Thus, no simple chemical formula can be written for it.)

Millwork. Planed and patterned lumber for finish work in buildings, including items such as sashes, doors, cornices, panelwork, and other items of interior or exterior trim. Does not include flooring, ceiling, or siding.

Moisture content. The amount of water contained in wood, usually expressed as a percentage of the weight of the oven-dry wood.

Molds. A group of fungi distinguished by the pigmented spores they produce on the wood surface.

Oven-dry wood. Wood dried to a relatively constant weight in a ventilated oven at 101 to 105°C.

Preservative. Any substance that, for a reasonable length of time, is effective in preventing the development and action of wood-rotting fungi, borers of various kinds, and harmful insects that deteriorate wood.

Sapwood. The wood of pale color near the outside of a log, just under the bark. Under most conditions, sapwood is more susceptible to decay than heartwood, and usually it is more receptive to impregnation with preservatives and fire retardants.

Seasoning. Removing moisture from green wood to improve its serviceability.

Air dried. Dried by exposure to air in a yard or shed, without artificial heat.

Kiln dried. Dried in a kiln with the use of artificial heat.

Soft rot. A type of decay developing under very wet conditions (as in cooling towers and boat timbers) in the outer wood layers. It is caused by cellulose-destroying microfungi that attack the secondary cell walls but not the intercellular layer.

Softwoods. Generally, one of the botanical groups of trees that, in most cases, have needlelike or scalelike leaves, i.e., the conifers (also the wood produced by such trees). The term has no reference to the actual hardness of the wood.

Weathering. The mechanical or chemical disintegration and discoloration of the surface of wood caused by exposure to light, the action of dust and sand carried by wind, and the alternate shrinking and swelling of surface fibers with variations in temperature and moisture content caused by changing weather. Weathering doesn't include decay.

White rot. In wood, any decay or rot that attacks both the cellulose and lignin and produces a generally whitish residue, which may be spongy or stringy. Also may occur as pocket rot.

For more information

The publications listed below are intended to provide basic information essential to safe handling of pesticides and to prepare treaters for certification. Changes in pesticide registration and use require continuing study to keep up to date. Proceedings, standards, and other publications of the American Wood Preservers Association provide current information. Other trade publications may also prove helpful.

Fuller, B. et al. *The Analysis of Existing Wood Preserving Techniques and Possible Alternatives*. Metrek Division/The Mitre Corporation, developed under contract with the U.S. Environmental Protection Agency, June 1977.

Graham, Robert D. and Guy C. Helsing. *Wood Pole Maintenance Manual: Inspection and Supplemental Treatment of Douglas-fir and Western Redcedar Poles*. FRL Research Bulletin 24. Oregon State University, February 1979.

Gjovik, Lee Jr. and Roy B. Baechler. *Selection, Production, Procurement and Use of Preservative-treated Wood, Supplementing Federal Specification TT-W-571*. General Technical Report FPL-15. USDA Forest Service, 1977.

Handling Precautions for Penta and Santobrite. Technical Bulletin No. O/PS-3. Monsanto Co., Organic Chemical Division, St. Louis, MO.

Hunt, George M. and George A. Garratt. *Wood Preservation*, 3rd edition. McGraw-Hill, New York, 1953.

Koch, Peter. *Utilization of the Southern Pines*. USDA Agriculture Handbook No. 420, August 1972. Provides information on wood-destroying organisms and the treating process.

Konasewich, D.E. et al. *Chlorophenate Wood Protection*. British Columbia Ministry of Environment, Wood Protection Task Force, 1983.

Maclean, J.D. *Preservative Treatment of Wood by Pressure Methods*. USDA Agriculture Handbook No. 40. December 1952. Reprinted with corrections September 1960.

Morrell, Jeffrey, Guy C. Helsing, and Robert D. Graham. *Marine Wood Maintenance Manual: A Guide for Proper Use of Douglas-fir in Marine Exposures*. FRL Research Bulletin 48, Oregon State University, October 1984.

Nicholas, Darrel D., editor, with assistance of Wesley E. Loose. *Wood Deterioration and Its Prevention by Preservative Treatment*, two volumes. Syracuse University Press, Syracuse, NY, 1973.

Safe Handling Guide to Sapstain Control Chemicals. Western Wood Products Association, Portland, OR, 1982.

Wood as an Engineering Material, Chapters 17–19 of USDA Agriculture Handbook No. 72, revised 1974.

Wood Preservation: Applicators Manual. Western Wood Products Association, Portland, OR.

Table 1. Restricted-use pesticides: creosote, pentachlorophenol, and inorganic arsenicals. Advantages, disadvantages, toxic effects (acute and chronic), special precautions, and limits on use.

Pesticide	Advantages	Disadvantages	Acute toxic effects	Chronic toxic effects	Special precautions	Limits on use
Creosote	• Toxic to fungi, insects, and marine borers • Insoluble in water • Ease of handling and application	• Dark color • Strong odor • Leaves oily, unpaintable surface • Tends to bleed or exude from wood surface • Cannot be used in homes or other living areas because of toxic fumes	• Skin irritation, burns, or dermatitis • Vapors irritating to eyes and respiratory tract • Ingestion can cause nausea and abdominal distress	• Laboratory animal studies indicate it is a carcinogen (cancer-causing agent) • Has been associated with skin cancer in some occupationally exposed workers • Bacteria and laboratory animal studies indicate that it is a mutagen (causes gene defects)		• Cannot be applied indoors, nor can it be used where it might contaminate food, feed, drinking water, or irrigation water • Cannot be applied to wood intended for use in interiors, except for those support structures that are in contact with the soil in barns, stables, and similar sites, and that are subject to decay or insect infestation. Two coats of a sealer must be applied to such support structures.
Pentachlorophenol (penta)	• Toxic to fungi and insects • Can be dissolved in oils having a wide range of viscosity, vapor pressure, and color • Low solubility • Can be glued, depending on diluent or carrier • Easy to handle and use	• Can leave oily, unpaintable surface, depending on carrier used • Not suitable for use in homes or other living areas • Toxic and irritating to plants, animals, and people	• Irritating to eyes, skin, and respiratory tract • Ingestion or excessive dermal or inhalation exposure can lead to fever, headache, weakness, dizziness, nausea, and profuse sweating • Prolonged high exposure levels can lead to acnelike skin condition or other skin disorders; may cause damage to the liver, kidneys, and nervous system	• Considered a teratogen because it causes birth defects in laboratory animals • A dioxin contaminant in penta has been shown to cause cancer in laboratory animals, although it is not the most toxic of the dioxins	• When emptying or mixing prilled, powdered, or flaked formulations of this chemical, you must use a closed system • When spraying penta, you must operate the spray apparatus to minimize visible mist, and the apparatus must be free of leaks. When you observe spray mist in the work zone, workers must wear approved goggles and clothing impervious to the preservative formulation (including overalls, jacket, gloves, boots, and head covering).	• Cannot be applied indoors, nor can it be used where it might contaminate food, feed, drinking water, or irrigation water • Cannot be applied to wood intended for use indoors, except for support structures that are in contact with the soil in barns, stables, and similar sites, and that are subject to decay or insect infestation. In these instances, a sealer must be applied to the wood. • It is prohibited to apply pentachlorophenol to logs used in the construction of log homes

Table 1. Restricted-use pesticides: creosote, pentachlorophenol, and inorganic arsenicals. Advantages, disadvantages, toxic effects (acute and chronic), special precautions, and limits on use.

Pesticide	Advantages	Disadvantages	Acute toxic effects	Chronic toxic effects	Special precautions	Limits on use
Inorganic arsenicals	• Toxic to fungi, insects, and most marine borers • Produces no smell or vapors • Suitable for use indoors • Suitable for use near growing plants • Treated surface can be painted	• Unless redried after treatment, wood is subject to warping and cracking • Does not protect wood from excessive weathering	• Exposure to high concentrations can cause nausea, headache, diarrhea, and abdominal pain (if ingested); extreme symptoms can progress • Prolonged exposure can produce persistent headaches, abdominal distress, salivation, low-grade fever, and upper respiratory irritation • Long-term, high exposure can cause liver damage, loss of hair and fingernails, anemia, and skin disorders	• Bacteria and laboratory animal studies indicate that it causes genetic defects • Shown to be associated with cancer in people who either drink water or breathe air contaminated with arsenic	• If the level of ambient arsenic in the work zone is unknown, or if the level exceeds 10 micrograms per cubic meter of air averaged over an 8-hour work day, all exposed workers are required to wear approved respirators • Processes used to apply inorganic arsenical formulations shall leave no visible surface deposits on the wood. Small, isolated, or infrequent spots of chemical on otherwise clean wood are allowed.	• Not permitted for residential uses
Amine copper	• Toxic to fungi, insects, and most marine borers	• Unless redried after treatment, wood is subject to warping and cracking • Can be corrosive; use galvanized steel fasteners			• Processes used to apply inorganic arsenical formulations shall leave no visible surface deposits on the wood. Small, isolated, or infrequent spots of chemical on otherwise clean wood are allowed.	None

Table 1. Restricted-use pesticides: creosote, pentachlorophenol, and inorganic arsenicals. Advantages, disadvantages, toxic effects (acute and chronic), special precautions, and limits on use.

Pesticide	Advantages	Disadvantages	Acute toxic effects	Chronic toxic effects	Special precautions	Limits on use
Copper naphthenate	• Toxic to fungi, insects, and some marine borers • Suitable for use indoors • Not restricted use	• Oil deposits on surface • Wood cannot be painted • Odor of solvent				None
Borates	• Toxic to most fungi and insects • Produces no smell or vapors • Suitable for use indoors • Suitable for use near growing plants • Treated surface can be painted	• Unless redried after treatment, wood is subject to warping and cracking • Does not protect wood from excessive weathering • Chemical not fixed and can leach when wetted				• Only permitted for protected (nonwetting) uses

First aid

Since accidents do happen, first aid information on the chemical(s) in use must be readily available. The product label provides basic first aid directions, as do Material Safety Data Sheets supplied by chemical manufacturers (see page 10). Take the following steps if accidental exposure to wood preservatives occurs.

- **Skin contact:** Remove contaminated clothing in contact with the skin and immediately wash the affected skin areas with mild soap and water. Do not irritate the skin with vigorous scrubbing. If you notice skin inflammation later, consult a physician.
- **Eye exposure:** Immediately flush the eyes with running water. Lift the upper and lower eyelids for complete irrigation and continue for 15 minutes. Then see a physician.
- **Inhalation:** Move the victim to fresh air and apply artificial respiration as needed. Get medical help immediately!
- **Accidental ingestion:** Seek immediate medical attention! *Also*:

  If creosote or penta is swallowed—and if the person is conscious—give one or two glasses of water, induce vomiting, and then administer 2 tablespoons of USP Drug Grade activated charcoal in water. Never attempt to administer anything orally or induce vomiting if the victim is unaware or unconscious.

  If an arsenical chemical is swallowed, the victim should drink large quantities of water or milk. Get professional medical help immediately!

Acute toxicity symptoms for all three preservatives usually are noticed soon after exposure and usually are treatable if first aid is administered quickly.

This publication was produced and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914. Extension work is a cooperative program of Oregon State University, the U.S. Department of Agriculture, and Oregon counties.

Published September 1989. Revised August 2006.