PESTICIDE APPLICATION COMPENDIUM

3

Wood Preservation

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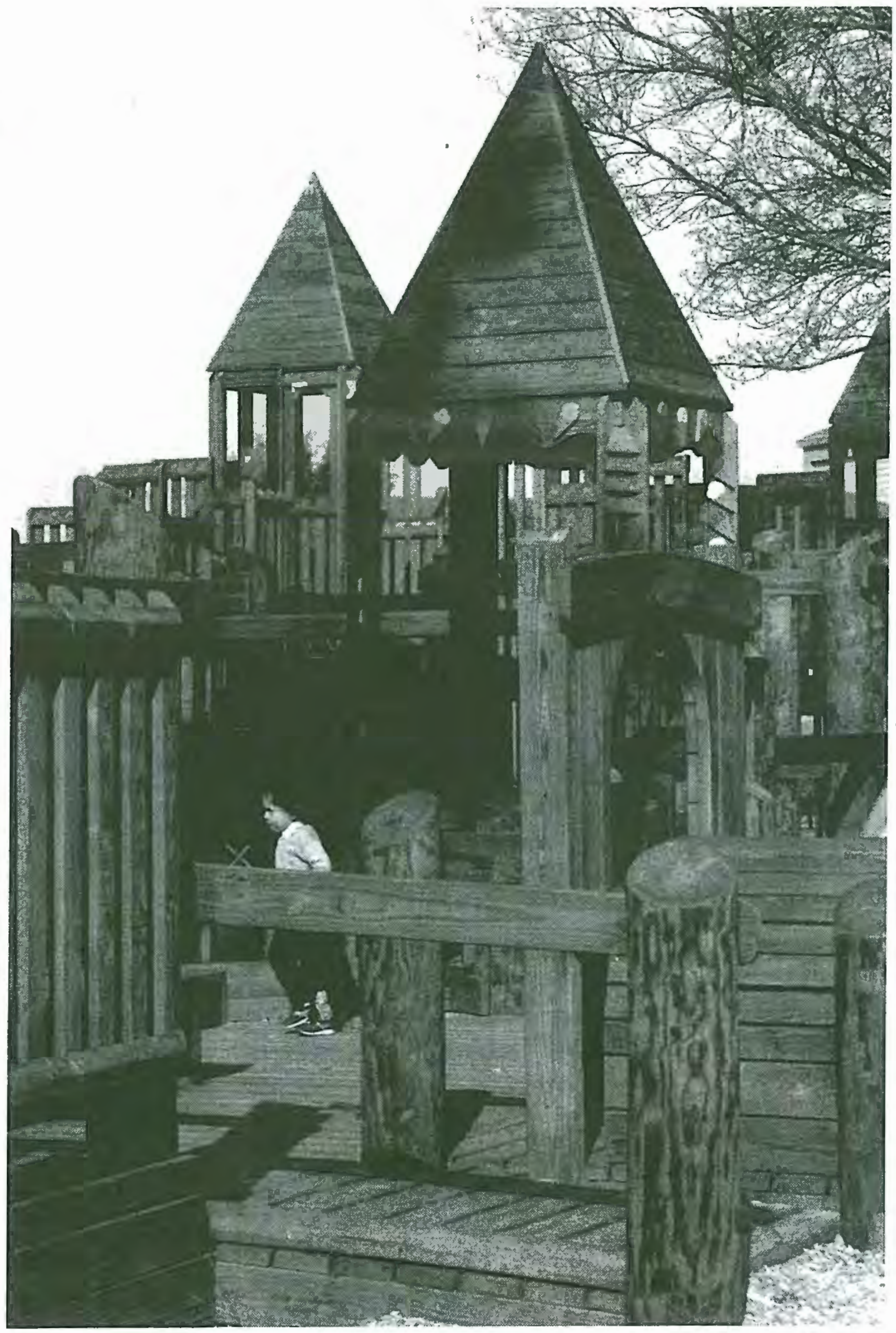


Over the centuries, wood has been an important primary construction material. Among the reasons why wood is widely used in structures are its ease of shaping and fastening, its great strength with respect to weight, and its low heat conductivity. Wood is available in many forms and sizes, and is often less expensive than other structural materials.

Wood is also used for railroad ties, utility poles, fencing, decks and piers, bridges, highway barriers and signs, forms and scaffolding, furniture, and many decorative purposes (Figure 1-1). Trailers and motor homes often get their structural strength from wood. Wood beams, rafters, and braces commonly provide support for tunnels and mine shafts.

For as long as wood has been used in construction, builders have sought ways to protect structures from wood-destroying pests and decay. The inventive Egyptians used oils to protect wood, and the ancient Greeks were among the first to note the rot-resistance of certain woods. The Romans combined these concepts, using species of resistant wood in combination with cedar oil to build their ships. More than 1,700 years later, the American victory in the war for independence was attributed in part to severe borer attacks and decay damage to the British fleet.

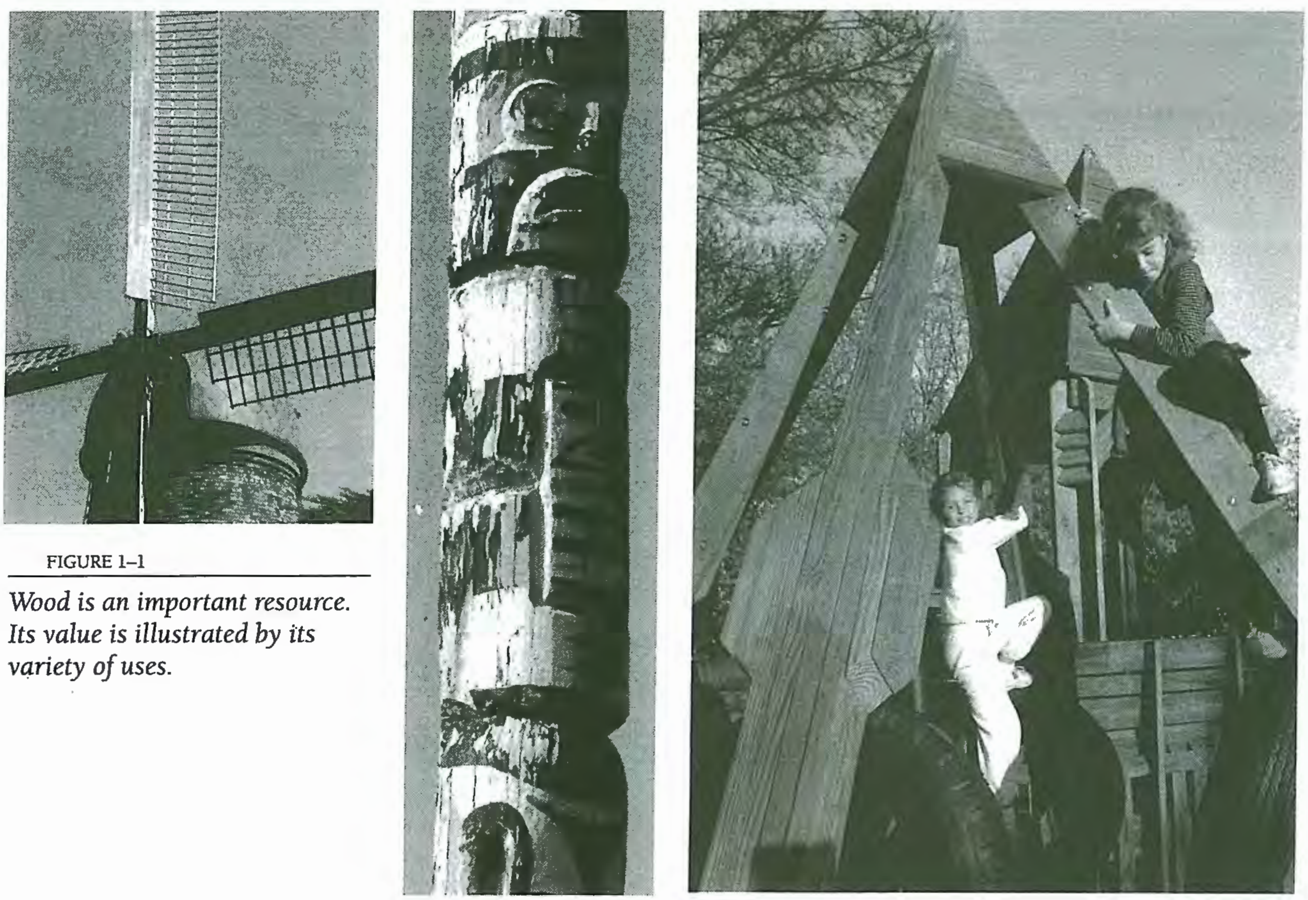


FIGURE 1–1

Wood is an important resource. Its value is illustrated by its variety of uses.

Pesticide Concerns

Pesticides have been and will continue to be the focus of a great deal of public attention. Many people have genuine concerns over the use of pesticides, while many others use them regularly to manage pest problems and find the risks acceptable.

Pesticide concerns arise from reported incidents where exposure has produced mild to severe illness (or death) in farmworkers, pesticide applicators, manufacturing plant workers, and even consumers of improperly treated products.

Injuries caused by some pesticides have included skin rashes, headache, nausea, and nervous system disorders. Long-term or chronic illnesses associated with or suspected of being caused by certain pesticides include cancer, birth defects, and other reproductive disorders. Pesticides have also been implicated in environmental problems such as groundwater contamination and wildlife injury.

The debate over the advisability of using pesticides will continue for many years. In the meantime, pesticide hazards must be reduced by proper handling and application techniques, accurate timing of applications, and by seeking and using alternate control methods whenever possible.

Some types of wood are naturally able to resist insect and fungus damage. No wood, however, is immune to physical or biological degradation.

Under suitable conditions, all wood species are susceptible to attack by a few insects, molluscs, fungi, bacteria, and vertebrates. Exposed wood is also affected by rain, wind, sunlight, and temperature extremes. These physical and biological agents are capable of weakening or totally destroying structural wood and diminishing the beauty and quality of wood used for other purposes.

Various methods, both chemical and nonchemical, are available to reduce the deterioration of wood by organisms and weather. Since the development in the 1800s of creosote, a coal tar derivative, chemical treatment of wood has dominated the effort to combat wood-destroying pests. Today, after more than a century of using a variety of extremely toxic chemicals to preserve wood, government review of these practices and industry realization that less toxic and more cost-efficient alternatives exist are beginning a new era of innovation in this field.

Refer to the *References* section at the back of this book for several sources of additional information on wood preservation.

THE RESPONSIBILITY IS YOURS

In November 1990, the United States Environmental Protection Agency (USEPA) proposed rule changes to the pesticide applicator certification program (Figure 1-2), expanding the categories of applicator licensing to more accurately reflect the particular areas of expertise that exist in the field. The new requirements form a comprehensive list of responsibilities and concerns that you—the certified wood preservative applicator—should recognize and implement routinely.

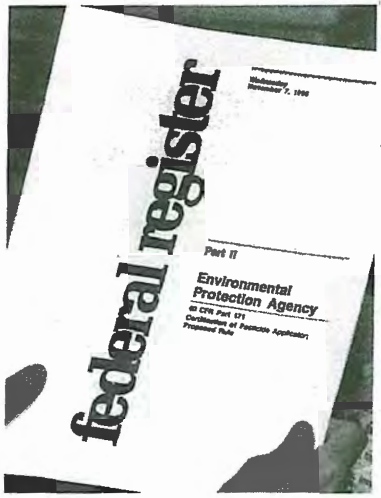


FIGURE 1–2

Pesticide applicator certification categories and standards are regulated by the United States and California Environmental Protection agencies. Changes have been proposed to the federal certification requirements. These include the Wood Preservation and Control of Wood-Destroying Organisms categories. The changes seek to expand the certification standards, while narrowing categories to better match the tasks performed by applicators.

Wood Preservation Categories

Under the Industrial, Institutional, and Structural Pest Control category, two major subcategories would include Control of Wood-Destroying Organisms (Excluding Fumigation) and Wood Preservation, both of which involve the regulation of wood preservatives.

The Control of Wood-Destroying Organisms subcategory would include "commercial applicators using or supervising the use of restricted-use pesticides to control structural wood destroying pests, and the handling and topical application and injection of wood preservatives, for operations such as groundline pole treatment, waterproofing, millwork cutoffs, or supplemental field treatment.

"Applicators shall demonstrate practical knowledge of structural wood-destroying organisms, such as beetles, termites, and fungi, and conditions conducive to infestation. They shall demonstrate knowledge and ability to select, calibrate, and use appropriate control procedures, including rodding and trenching, topical application of pesticides and local injection of specially labeled liquid or solid wood fumigants into infested wood, such as poles, pilings, and railroad crossties.

"Applicators shall demonstrate knowledge of the hazards involved with handling and use of these pesticides and the appropriate application equipment to be used."

The Wood Preservation subcategory would involve "commercial applicators using or supervising the use of restricted-use pesticides at treating plants and sawmills, for preservative treatment of wood by pressure, dipping, soaking, and diffusion processes to produce a commodity for sale and/or installation.

"Applicators shall demonstrate practical knowledge of conditions for which preservative treatment of wood is used. Applicators shall demonstrate a knowledge of the health and environmental hazards associated with wood treating procedures, and the need for informing purchasers of precautions for handling, use, and disposal of treated wood products. They shall demonstrate knowledge of all applicable treating and testing equipment."

General Certification Standards

The general certification standards for the wood preservative designations include an understanding of the following:

- labeling and label comprehension, including legal implications, warnings, symbols, and other information commonly appearing on pesticide labels (Figure 1-3);
- the meaning of the "Restricted Use" term;
- safety guidelines for pesticide use, including an understanding of the acute and chronic toxicity, exposure, and how risk is determined by exposure and specific pesticide hazard;
- environmental risk factors involving climate influences on pesticide drift and runoff, and how terrain, soil, and substrata influence contamination of surface and groundwater;
- recognition of sensitive areas and organisms affected by pesticide applications, drift, and runoff;
- protection of endangered and threatened species;
- methods of spill prevention and control;

- recognition of symptoms of acute toxicity and practical treatment;
- knowledge of precautions to prevent injury to applicators and other people in or near treated areas;
- the need for and use of personal protective equipment, worker warnings, and reentry restrictions;
- standards for proper transportation, storage, mixing, handling, application, and disposal of pesticides, including container disposal;
- principles of pest identification and biology, and recognition of the damage or problems caused by these pests;
- types of pesticides, formulations and adjuvants, factors affecting pesticide effectiveness, and selection of the correct formulation and application method for the site and pest;
- characteristics and uses of the equipment used for application, proper equipment care and maintenance, and selection of the appropriate equipment for the application and pest;
- calibration and calculation aptitude involving proper dilutions for mixing of concentrated formulations in accordance with label directions, determination of area and volume to be treated, and the amount of pesticide to be applied, as well as adjustment of application equipment to meet desired calculations for output of pesticide;
- comprehension of applicator-related federal and state laws and regulations, applicator responsibility for pesticide use consistent with label directions, supervision of noncertified employees assigned to handle a restricted use pesticide, and applicator liability and penalties.

PRECAUTIONARY STATEMENTS
Hazards to Humans and Domestic Animals

DANGER

Corrosive. Causes irreversible eye damage and skin burns. Do not get in eyes, on skin or on clothing. Wear goggles or face shield, protective clothing and rubber gloves.

Harmful if inhaled. Avoid breathing spray mist.

Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

ENVIRONMENTAL HAZARDS

This product is toxic to fish. Do not apply directly to water or wetlands. Do not contaminate water when disposing of equipment washwaters.

PHYSICAL AND CHEMICAL HAZARDS

Do not store near heat or open flame.

INGREDIENTS

ACTIVE INGREDIENT:
Copper Naphthenate........................45.4%*
INERT INGREDIENTS........................54.6%
*Equivalent to 5% metallic copper

Cunapsol-5 weighs approximately 8.75 lbs. per gallon

KEEP OUT OF REACH OF CHILDREN

DANGER

STATEMENT OF PRACTICAL TREATMENT

If in eyes: Hold eyelids open and flush with a steady, gentle stream of water for 15 minutes.

If on skin: Wash with plenty of soap and water. Get medical attention.

If swallowed: Drink promptly a large quantity of milk, egg white, gelatin solution, or if these are not available, large quantities of water. Avoid alcohol.

Note to Physician: Probable mucosal damage may contraindicate use of gastric lavage.

If inhaled: Remove victim to fresh air. If not breathing, give artificial respiration, preferably mouth to mouth. Get medical attention.

SEE RIGHT PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

DIRECTIONS FOR USE

It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

FIGURE 1–3

Label comprehension is critical to the safe and effective application of pesticides, including wood preservatives. The label provides such information as the active ingredient (here, copper naphthenate), signal word (DANGER), emergency exposure instructions (for eyes, skin, if swallowed or inhaled), and precautionary statements (to humans, animals, and the environment).

FIGURE 1–4

This manual, when used with Volume I of the Pesticide Application Compendium—The Safe and Effective Use of Pesticides, *will provide the information needed to prepare for the certification examination in the Wood Preservation category. In addition, use the* California Department of Pesticide Regulation Laws and Regulations Study Guide *to prepare for that section of the test.*

Adherence to these guidelines will ensure the quality of treatment administered to the wood product, the efficacy of the final product during its intended use, employee well-being and safety, consumer protection, community safeguarding, and environmental responsibility.

Important Note

The nature and scope of one's interaction with wood preservatives and treated wood products may be very different. Because the vast majority of wood preservatives in use today are restricted-use chemicals, each person using wood preservatives and treated wood products assumes the responsibility to use these products safely in accord with the specific label directions.

Because of the different types of contact individual applicators have with wood preservatives, this publication is divided into chapters that focus on the major ways applicators use these chemicals.

Chapter 2 focuses on general uses of wood preservatives by any applicator, with special emphasis on safety and the ways these products can be used most effectively.

Chapter 3 deals with the field application of restricted use chemicals; this does not include applicators working in a pressure treatment facility or those working in the re-treatment of wood utility poles.

Chapter 4 covers pressure treatment applications.

Chapter 5 discusses re-treatment of wood utility poles.

Finally, Chapter 6 details the various wood-destroying pests that create the need for wood preservatives and treated wood products.

While your work as a certified applicator of wood preservatives may find you working in one particular setting—as a pressure treater, for example—your certification examination will test your knowledge of all facets of wood preservation. For examination purposes, read all the information detailed here. It is all fair game for testing. Once you are certified, we hope you will continue to use this guide as a resource in your safe and effective application of wood preservatives.

This study guide, when combined with Volume 1 of the Pesticide Application Compendium—*The Safe and Effective Use of Pesticides* (Figure 1-4)—and the *California Department of Pesticide Regulation (CDPR) Laws and Regulations Study Guide*, will provide the necessary information you need to qualify in the Wood Preservation category of the CDPR Qualified Applicator Certificate or License Examinations.

2 Use Wood Preservatives With Care

Wood preservatives are a special class of pesticides. The same laws that control the use and disposal of all other types of pesticides also apply to wood preservatives. When you apply a wood preservative, you assume the legal responsibility for using it strictly in accordance with label instructions. You must also protect people who live or work in the treated area or around treated wood so they are not exposed to harmful residues.

Avoid using wood preservatives in ways that might damage property or injure nontarget animals or plants. Wood preservative use should in no way endanger the environment or cause contamination of groundwater, soil, air, or human and animal foods. Of equal importance, you must use wood preservatives carefully to prevent exposure to your own skin, eyes, and respiratory tract.

This chapter gives a brief introduction to the hazards associated with pesticides used for wood preservation. It also contains a discussion of safety precautions that must be observed to protect yourself and others.

HOW PRESERVATIVES CAN INJURE PEOPLE

Poisonous chemicals injure or kill people by interfering with biochemical and physiological functions. The nature and extent of injury depends on the toxicity of the chemical, as well as the dose (amount of material) that enters body tissues. The health and size of a person may also influence the severity of injury.

The ingredients of most wood preservatives are very potent, capable of causing poisoning at doses as small as a few drops or a few grams. Regardless of the specific potential hazard, anyone working with wood preservatives should avoid exposure by using suitable protective clothing (Table 2-1) and application techniques at all times. Anyone living or working around treated wood must be protected from exposure levels that will cause injury.

In 1978, the United States Environmental Protection Agency (USEPA) began a review of the three primary wood preservatives used in the treatment of lumber—creosote, inorganic arsenicals, and pentachlorophenol (penta). The review process continued through the 1980s, and complete resolution of the regulatory fate of these wood preservatives continued to be in doubt in 1991 as this training manual was being prepared for publication.

While an ultimate disposition or new recommendations by the USEPA may still be developed, both the federal government and the CDPR list creosote, pentachlorophenol, and inorganic arsenicals as restricted-use pesticides, requiring stringent training and handling guidelines for industrial and commercial applicators using these compounds. Scientific review, initiated as far back as the 1950s and continuing today, suggests that the restricted-use designation is appropriate. Consequently, careful handling of these compounds is essential.

Pentachlorophenol Poisoning: Two Case Histories

The following two case histories were reported by the Rocky Mountain Center for Occupational and Environmental Health in the *Journal of Occupational Medicine*, Volume 25, Number 7, July 1983:

Case I

The patient, a 33-year-old man, was admitted to an emergency room by ambulance. He had been found at home by his mother, who had noted that he was lethargic, perspiring excessively, and hyperventilating. While he did not complain of pain, he admitted to feeling very hot. At the hospital, his temperature reading was 105° F.

Cooling measures were begun to bring down the excessive temperature. Within 15 minutes, the patient suffered cardiac arrest, which was immediately followed by the onset of rigor mortis, preventing resuscitation efforts.

Autopsy revealed brain, heart, liver, and kidney involvement. Tissue concentrations of pentachlorophenol of 16 ppm (parts per million) in the blood, 8.2 ppm in the stomach, 29 ppm in the urine, 52 ppm in the liver, 639 ppm in the kidney, 116 ppm in the lung, and 1,126 ppm in the bile.

The patient had been employed for three weeks at a small wood preservative manufacturing facility. His duties involved crushing one-ton blocks of pentachlorophenol with a jackhammer. He performed this work in a small, poorly ventilated room. He was said to have been a hard worker, who often returned home from work covered with dust.

Case II

A 29-year-old man was admitted to a hospital in June 1980 for a fever of undetermined origin. He had experienced night sweats and fevers one month after beginning work at a wood preservative manufacturing plant. Following admission, the symptoms subsided. Chemical poisoning was suspected, but not confirmed. Upon discharge, the patient was dismissed from his employment.

A subsequent investigation be the Occupational Health and Safety Administration (OSHA) at the plant found three employees and a supervisor working there. One employee had just been released from the hospital following an episode of profuse perspiration, weakness, abdominal pain, nausea, and vomiting. He had been diagnosed as suffering penta poisoning.

During the investigation, wipe samples collected from the workplace revealed penta on the countertop in the lunch room and on the employees' drinking fountain.

Company records revealed that a former employee had been hospitalized with excessive perspiration and a temperature of 107° F, and had died within minutes of initiation of treatment. A sample from the area where he packaged 25-pound sacks of penta revealed a 4.59 mg/m^3 sample of penta, more than nine times the OSHA standard.

SYMPTOMS OF WOOD PRESERVATIVE POISONING

Certainly, the cases described in the "Pentachlorophenol Poisoning" sidebar, which occured in penta manufacturing facilities, are extreme examples of workplace negligence and mishandling of an extremely toxic compound. They are illustrative, however, of why penta and the other wood preservatives have been designated as restricted-use pesticides. In addition, they underscore the critical importance of careful handling, use, and disposal of

FIGURE 2–1

The age and body size of a person may influence their response to a given dose of a preservative. Children, older adults, and those persons of smaller stature may be affected by exposure at much lower rates than younger and middle-aged adults, or persons of larger stature.

preservative compounds. As documented case histories show, failure to use proper handling techniques have proved fatal.

Immediate symptoms of wood preservative poisoning are those observed soon after exposure—known as acute onset. Sometimes symptoms from exposure may not show up for weeks, months, or even years. These delayed onset symptoms can appear gradually or suddenly. They can be difficult to associate with their cause because of the lapse of time between exposure and observable effect.

Examples of delayed onset symptoms associated with high levels of exposure to wood preservatives include, among others, birth defects or cancer. Chemicals found to cause or suspected of causing such disorders often lose their federal registration, banning their use in the United States. If the evidence of health hazards warrants, the CDPR may prohibit the use of certain pesticides within the state, even though they still have a valid federal registration.

Some symptoms of wood preservative poisoning are similar to symptoms produced by many other chemicals. The type of symptoms may vary between chemical classes and may also be different within the same chemical class. The presence and severity of symptoms usually is proportional to the dosage entering the tissues of the exposed person.

Whenever the possibility of poisoning exists, consult a physician; be sure to give the physician a copy of the preservative label or supply the name of the preservative, the manufacturer, and the USEPA registration number. Diagnosis of a preservative-caused injury usually requires careful medical

PROTECTIVE CLOTHING AND EQUIPMENT REQUIREMENTS

A daily change of clean coveralls or clean outer clothing. Wear waterproof pants and jackets if there is any chance of becoming wet with spray. Disposable suits of Tyvek can be used in some, but not all situations. Uncoated Tyvek can be worn in place of coveralls or long sleeved shirt and pants. It will not take the place of waterproof outer clothing. Tyvek which has been coated with polyethylene can be worn in place of waterproof clothing in some situations, but not with organophosphate liquids. The solvents in these pesticides will break down the polyethylene coating. Saranex coated Tyvex suits can be used effectively with organophosphates. Neither uncoated or Saranex coated Tyvek adequately protect against chlorinated hydrocarbons such as methyoxychlor.

Waterproof apron made from rubber or synthetic material. Use for mixing liquids.

Waterproof boots or foot coverings made from rubber or synthetic material.

Faceshield. goggles, or full face respirator. Goggles with side shields or a full face respirator is required if handling or applying dusts, wettable powders, or granules or if being exposed to spray mist. Safety glasses with brow and temple protection may be worn if the label does not specify goggles or face shield.

Waterproof, unlined gloves made from rubber or synthetic material.

Waterproof, wide-brimmed hat with nonabsorbent headband, or a hood if wearing a waterproof plastic rainsuit with hood attached.

Cartridge type respirator approved for pesticide vapors unless label specifies another type of respirator such as a dust mask, canister type gas mask, or self-contained breathing apparatus.

TABLE 2–1

Protective Equipment and Clothing Guide.

SUMMARIZED LABEL STATEMENT *Toxicity Category*	MIXER-LOADER *I-II*	MIXER-LOADER *III*	APPLICATOR *I-II*	APPLICATOR *III***
Precautions should be taken to prevent exposure.	A B C F G H R *	A B C F G H	B C F G H R *	C F G H R *
Protective clothing or protective equipment is to be worn.	A B C F G H R *	B C F G H R *	B C F G H R *	C F G H R *
Clean clothing is to be worn.	C	C	C	C
Contact with clothing should be avoided.	A B C	B C	B C	C
Contact with shoes should be avoided.	B	B	B	B
Rubber boots or rubber foot coverings are to be worn.	B	B	B	B
Contact with skin should be avoided.	A B C F G H	B C F G H	B C F G H	C F G * H
A cap or hat is to be worn.	H	H	H	H
An apron is to be worn.	A	A		
Rubber gloves are to be worn.	G	G	G	G
Contact with eyes should be avoided	F	F	F	F
Goggles or faceshield is to be worn.	F	F	F	F
Avoid inhalation.	R	R	R *	R *
A respirator is to be worn.	R	R	R *	R *

*Use this equipment when there is a likelihood of exposure to spray mist, dust, or vapors.

**If the Category III pesticide application is being made in an enclosed area such as a greenhouse, or if the application consists of a concentrate spray of 100 gallons-per-acre or less in a grove, orchard, or vineyard, then use the protective equipment guidelines for Category I-II pesticides.

examination, laboratory tests, observation, and familiarity with a person's medical history.

Individuals commonly vary in their sensitivity to chemicals such as wood preservatives. Some people show no reaction to a dose that causes severe illness in others. A person's age and body size may influence their response to a given dose (Figure 2-1), thus infants and young children can be greatly affected by doses much smaller than those affecting young to middle-aged adults. Also, adult women may be affected by reproductive sensitivities that could potentially result in birth defects, miscarriage, or stillbirth.

Persons taking medications may be more susceptible to injury by chemical exposure. Respiratory diseases, alcoholism, and other illnesses may increase sensitivity to chemicals such as wood preservatives.

In most cases, preservatives that are applied in strict accordance with label instructions regarding application rates, reentry intervals, protective equipment requirements, aeration periods, and other listed procedures, generally do not leave unsafe levels of residues. However, persons coming in close contact with treated wood, without proper protection, may be exposed to harmful residues and could suffer ill effects.

Accidents during application or an improper application may result in a higher, and sometimes unsafe, exposure to applicators or persons working in the area.

APPLICATOR SAFETY

Avoid personal exposure to wood preservative chemicals by wearing required or recommended protective equipment. Table 2-1 gives examples of suitable protective equipment based on label recommendations. Maintain, clean, and store protective equipment carefully to keep it in good condition and to assure that it provides optimum protection.

FIGURE 2–2

The precautionary statement will tell you what protective clothing and equipment are required when using a preservative. Follow these requirements for your safety.

Depending on label requirements and potential for exposure, a cartridge respirator may be required when handling wood preservatives. Make sure the cartridge is approved for the preservative to be used.

Odor Problems. Many wood preservatives have odors detectable during and after application. Odors are usually strongest when wood preservatives are first applied. While it may or may not be harmful, a detectable odor may indicate the presence of potentially hazardous preservative vapors or fumes.

When working in a confined area, odors may become overpowering and objectionable. They can cause nausea or headache, initiate asthma or other breathing difficulties, or trigger other medical or anxiety-related symptoms. Label instructions often require use of protective equipment (Figure 2-2), such as respirators, when preservatives are used in confined settings. Some preservatives are not approved for use in an indoor or confined environment. If approved for such use, the preservative label precautions may require barring admittance of others or applicator readmittance to the treated area for a designated safe period of time.

Protecting People

Always apply wood preservatives in strict accordance with label instructions. Never use them in areas where people are living or working, unless they can be protected from exposure. This usually requires people to leave the area before an application begins and to remain away for a safe period of time after the application has been completed.

Provide information about the wood preservative application and be sure people understand what safety precautions you are taking. The type of information you need to provide includes the name of the material being used, what wood is being treated, poisoning symptoms, what to do if someone experiences such problems, where to get help, and how to get more information.

Protecting the Environment

By the end of 1989, there were 43 wood treatment plants on the "Superfund" National Priority List. Seven of these locations are in California. It is the goal of the applicator certification program to ensure the safe and sound handling and use of these beneficial, yet potentially harmful, pesticides through the actions of trained professionals. This proactive approach to dealing with potential hazards can result in safer working conditions for applicators, protection of the environment, and reduced costs to operators and society at large.

Unlike most other pesticides in use today, wood preservatives used at commercial treatment facilities are unique in that they are used continuously and intensively in a concentrated location on a year-round basis. Because this type of use—as opposed to a seasonal application of pesticide to a field crop, for example—can result in a huge buildup of both the chemicals themselves and their waste byproducts, it is imperative that certified applicators and those under their supervision take the proper steps in controlling the environmental fate of the preservative being used.

Both the preservatives and their wastes are regulated by the USEPA and other state and federal agencies as hazardous materials or hazardous wastes. Cleanup costs of hazardous wastes as a result of using penta, creosote, and inorganic arsenicals without proper containment devices have prompted many wood treatment companies to review alternatives. While copper naphthenate and copper-8-quinolinolate have been sparingly used due to higher costs and efficacy considerations, their use is increasing as the cost of cleaning up and disposing of hazardous wastes produced by penta, creosote, and the inorganic arsenicals continues to mount and prompts review of alternatives.

Burning Treated Wood

Two modern societal trends are impacting the use of preserved woods—the renewed interest in fireplaces and woodstoves as residential accessories, and the movement toward alternative methods of waste disposal. With regard to preserved woods, the bottom line is the same—do not burn treated wood or wood products.

Using a residential fireplace or woodstove as an incineration point for household waste has increased as landfills have been exhausted and social concerns for recycling and alternative waste disposal have come to the fore. In addition, escalating costs of cordwood for burning have prompted consumers to review alternatives. The result is that scrap wood has found its way into the family fireplace with increased frequency.

Scrap wood from chromated copper arsenical treated lumber, typically used in outdoor construction, releases toxic chrome and arsenic when burned. Wood treated with pentachlorophenol releases chlorine, which may form poisonous dioxins or furans.

While the burning of structural-grade plywood or composition board (e.g. particle board or hard board) has yet to be tested by the United States Environmental Protection Agency, there is concern that combustion of these products results in the release of aldehydes, a family of gases that includes the carcinogen formaldehyde.

Woodstoves and fireplaces are designed to burn untreated wood cleanly and efficiently. Scrap wood from preserved lumber should be disposed of in accordance with industry and regulatory standards, and never in the family fireplace or on-site scrap fire.

Treated wood should not be burned, especially in a household fireplace or woodstove. Refer to the consumer information sheet for scrap wood disposal instructions.

Integrated Pest Management

Integrated pest management (IPM) is an ecological approach to managing weeds, insects, vertebrates, fungi, and other pest organisms that often provides economical, long-term protection from pest damage. IPM has been shown to be very successful in commercial agricultural situations. The benefits of IPM are becoming more widely recognized in the management of urban pest problems.

Pests must be properly identified so aspects of their life cycle and developmental stages can be understood, and so their activity can be monitored (see Table 6-1). Conditions that promote or support the pest are identified so they can be either eliminated or suppressed.

Management methods are appropriate to the life cycle and development stages of the pest. Usually, two or more management methods are used. It is common for different methods to be used at other times or in different locations, rather than using the same method for the same pest at all times.

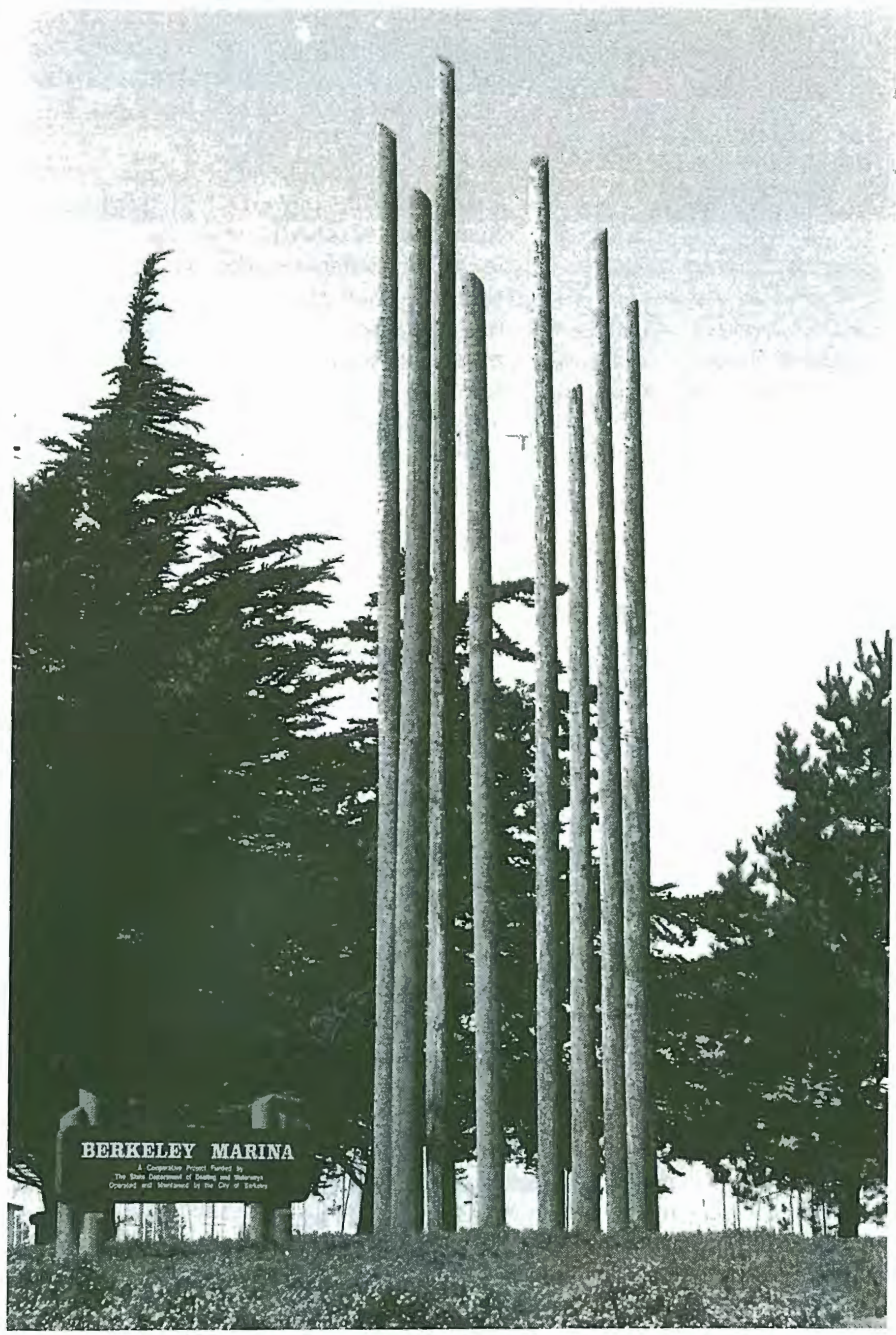
Control methods that might be used in an IPM program include exclusion, sanitation, modifying or eliminating habitats, biological control, and the selective use of pesticides.

Pesticides usually play an important role in an IPM program. However, pesticides are selected carefully and are nearly always combined with other control methods. The timing of the pesticide application is especially important. Pesticides are selected to be least disruptive to natural controls that may be present. Environmental concerns and human and animal safety are an utmost priority. Sometimes an emphasis is placed on spot treatment or reduced rates of the pesticide so that smaller quantities of pesticide need be applied.

An important component of an IPM program involves frequent evaluation of the control strategies and modification of the approach to keep pace with changes or anticipated changes in pest activities.

3

Preserving Wood: Field Applications



Field applications of wood preservatives include any treatment of wood not occurring at a commercial treatment facility. Examples of such treatments include on-site spraying or dipping of lumber at sawmills for sapstain control, treating fence poles on-site during installation, or spot brushing and spraying applications during or after construction of structures.

While pressure treatment of wood comprises the vast majority of wood preservative applications, the same concerns and regulations that apply to pressure treaters apply to field treatments by certified applicators. Although the setting may seem more casual, safe and effective practices are as important and necessary when handling wood preservatives in the field as they are at a pressure treatment facility.

When one begins to plan a pest management strategy for structural wood at a particular site, an issue that may get overlooked is whether the need for treated wood actually exists. Integrated pest management—the review and use of all available means of pest control, as opposed to a chemical-only solution—may result in a decision that treated wood is unnecessary or of marginal value. Given the restricted status of the prevailing wood preservatives, a status that means some hazard exists, an initial review of whether to use a wood preservative or treated lumber in an integrated pest management approach to a project is very important.

Historical use of wood preservatives dates back to ancient cultures, especially in the treatment of ships. Nevertheless, widespread use of wood preservatives is relatively new.

For centuries, untreated wood has had many uses that today find treated wood products as alternatives. While modern population and housing pressures have increased demand for lumber production, which has created a greater need and many new uses for treated wood, nonchemical options remain available that can reduce or eliminate the need for wood preservatives or treated lumber as a result of integrated pest management.

NONCHEMICAL WOOD PRESERVATION

Depending upon the situation, wood deterioration can be avoided or reduced by using various nonchemical methods. These include using the heartwood of resistant species, controlling moisture and temperature (Figure 3-1), protecting surfaces from weathering, using good building techniques, and installing mechanical barriers.

Resistant Species

The heartwood (Figure 3-2) of a few tree species has some natural resistance to insects and fungi. However, the only commonly available western tree species having resistant heartwood are cedars and redwood. The sapwood of all native tree species and the heartwood of most species are not naturally resistant to decay organisms. Even heartwood of cedar and redwood

FIGURE 3–1

Routine inspection of crawl spaces for pest infestation (example—shelter tubes of subterranean termites) or conditions that lure pests (such as excessive moisture) are important in early detection of structurally damaging pests. In addition, good building practices are critical to the well-being of structures. Here, extra crawl space vents have been added to reduce moisture accumulation that promotes decay.

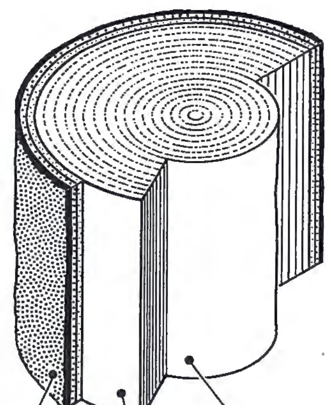


FIGURE 3–2

Heartwood forms the inner core of a tree. It is the most desired part for lumber. Heartwood is usually darker in color than the sapwood, which is located just beneath the bark. The heartwood of some trees—primarily cedar and redwood—has more resistance to pest infestation than other trees.

has only limited resistance to decay, although more so than most other wood species growing in the United States.

Natural resistance to decay or insects is usually provided by chemical compounds (extractives) produced by the tree. Most of these are deposited into cells of the wood tissue as the tissue is transformed from sapwood to heartwood during tree growth. Redwood and cedar contain higher percentages of these toxic extractives, many of them water-soluble, which retard insects and fungi to some degree.

In situations where there is a risk of exposure to wood-destroying organisms, damage can be reduced by selecting naturally resistant wood varieties. Fence posts and outdoor decking not in contact with soil are examples of these uses. However, protection offered by resistant wood is more variable than that of good quality, chemically treated wood. A combination of naturally resistant wood with other nonchemical or chemical protective methods often proves to be the most successful program in combatting wood-destroying pests.

Controlling Moisture and Temperature

Decay fungi and some wood-destroying insects have specific moisture requirements. Maintaining the wood moisture content outside of these limits can, in some cases, be an effective control measure. For example, decay fungi and most wood-destroying insects cannot survive in saturated wood. Also, decay fungi cannot survive in wood that has less than 20% moisture content.

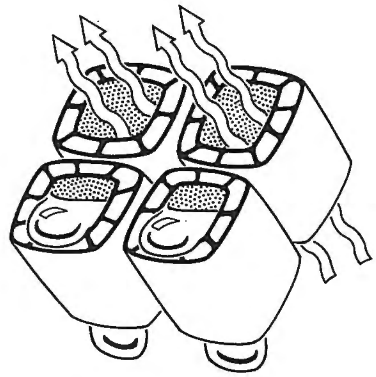


FIGURE 3–3

Wood can hold moisture as water vapor, free water, or "bound water." Bound water is adsorbed onto cell walls and held there by chemical attraction.

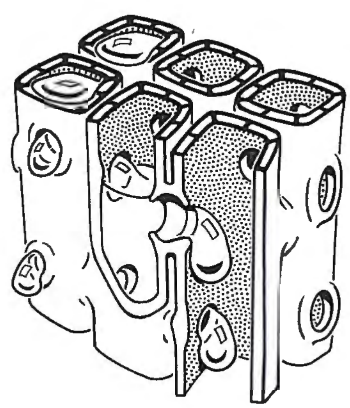


FIGURE 3–4

Water captured in wood cells can pass from cell to cell thru openings in the cell walls called "pits." Pits in heartwood are usually smaller than sapwood. Pits of certain trees are smaller than others. Smaller pits make water penetration more difficult.

Wood can hold moisture as water vapor, as free water, and as "bound" water (Figure 3-3). Bound water is adsorbed into the cell walls and held there by chemical attraction. It causes the walls to swell, which accounts for dimensional changes seen in wood when it becomes wet or when it dries. The maximum amount of water that can adsorb onto cell walls is the fiber saturation point—the approximate lowest moisture level for development of wood-attacking fungi.

Wood cells can hold free water. Free water passes to adjacent cells through openings in cell walls called pits (Figure 3-4). The species of tree influences the number and size of these pits, which in turn regulates the rate water can be absorbed. Pits in heartwood of some species may be sealed or plugged, making the cells more resistant to water uptake. For example, Douglas fir heartwood is very difficult to treat effectively with wood preservatives because of the blocked pits.

Liquids are drawn into cell cavities about 10 to 20 times more rapidly through end grain than from side grain surfaces. Cuts across the grain open many more cell cavities. Water that enters through exposed end grain surfaces penetrates more deeply and in greater quantity than water entering through the side grain. Because of this, brief exposures of end grain to water require a long drying-out period. Prolonged exposure can result in the wood holding sufficient water for a long enough period of time for the development of wood-destroying fungi.

Wood that is completely saturated with water does not decay because oxygen needed for fungal growth is absent. For this reason, logs awaiting processing into lumber are often kept under continual water spray. Saturating the wood lowers the temperature and reduces oxygen available for fungal growth.

Some fungi and bacteria that attack wood may not cause structural damage, but can increase the tendency for the wood to absorb water. Surface growth of these organisms can also hinder the re-drying of wetted wood creating favorable conditions for decay from other fungi.

Drying. During the process of manufacturing lumber, wood may be dried. Careful drying will minimize the warping and surface checking that often develop as wood dries. Approximately two-thirds of the potential shrinking of the lumber will take place during initial drying, rather than in service. Drying wood also reduces weight and facilitates better treatment with chemical preservatives.

Lumber can be air-dried or kiln-dried. Air-drying (Figure 3-5) requires stacking to allow good air circulation; this takes considerable space and time. Stacked wood must be protected to prevent weathering that would increase surface checking. Kiln-drying gives better control of air movement and speeds up drying time, achieving a more uniform dryness and less drying-related defects. The increased cost of kiln-drying is usually offset by the savings of time, space, labor, and reduction in shipping costs (due to less weight of the wood).

Storing lumber. Dried lumber is usually stored in a well-ventilated area protected from rainfall. When lumber is stored outdoors, stacks are usually covered, but never tightly covered with plastic as moisture condensation beneath the plastic can lead to mold, stain, and eventual decay. Lumber should be stacked in a way that allows good air circulation. Weeds must be kept from growing around storage areas to reduce moisture and improve air circulation. Storage areas should be kept free of debris that attracts termites or other pests.

FIGURE 3–5

Lumber thoroughly dried before use is less susceptible to warping, twisting, and shrinking. Incised lumber to be treated is stacked with stickers, small pieces of wood used to separate boards. Here, stickers are used between every third board to promote air-drying after treatment.

Using structural wood. To suppress deterioration of structural wood (Figure 3-6), certain conditions must be met when the wood is used. The most important factor is the use of good building practices. The structure should be designed so that untreated wood is protected from moisture and insects. Treated and untreated wood needs protection from direct contact with the soil, unless the wood is specifically treated for ground contact. The building design must include adequate ventilation that promotes air circulation.

Wood used in a structure may have enough moisture to support decay for several reasons: (1) it can be wet at the time of construction because of the use of green lumber or improper drying or storage; (2) it can pick up moisture from the soil or from rain due to faulty construction or improper sealing; (3) condensation of moisture inside the structure, due to improper ventilation, can wet the wood; or (4) leaking from plumbing or appliances can cause wetting.

Generally, green lumber used to build a structure does not decay because it will probably dry out before damage occurs. However, drying may cause dimensional changes and moisture may cause staining that could detract from the appearance of the finished structure. Faulty construction that permits untreated wood to come in contact with the soil, exposes unprotected cut ends to rainfall, or traps moisture at wood-to-wood or wood-to-metal connections will surely lead to decay. Poor ventilation and leaking water will also promote decay, since these conditions allow the wood to remain wet for prolonged periods.

Protecting Wood from Weathering

Weathering is the physical destruction of wood surfaces caused by repeated swelling and shrinking due to changes in moisture and temperature, ultraviolet light exposure, and wind and particulate abrasion

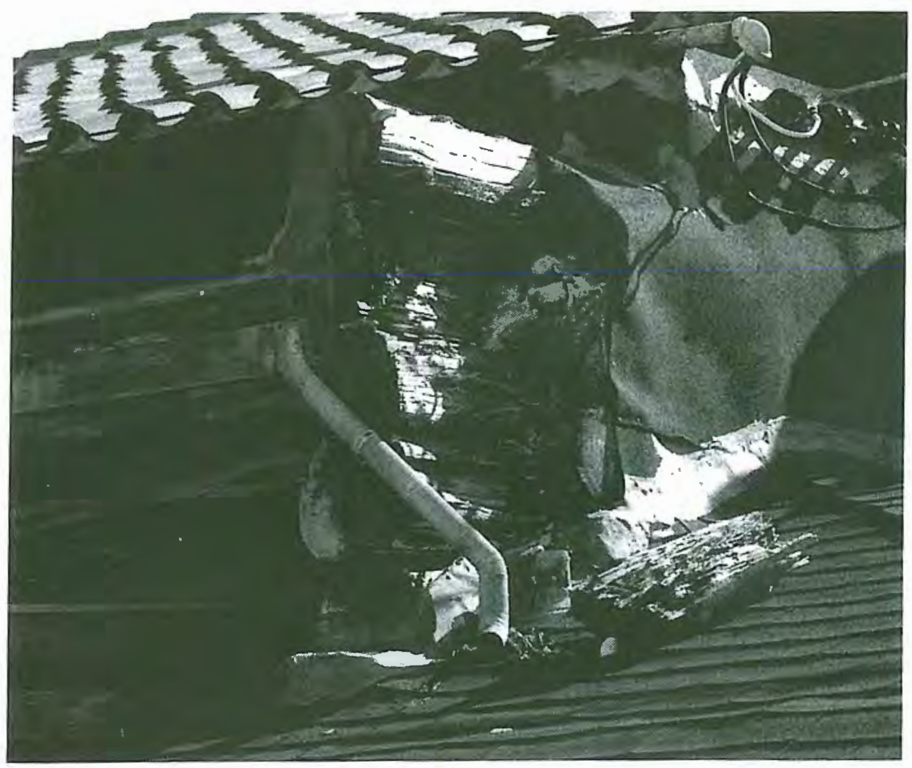


FIGURE 3–6

Good building practices are essential to the long life of a structure. Untreated wood should be protected from moisture and pests. This is especially true for important structural parts that become unsafe if damaged. Here, roof timbers of a log cabin are deteriorating from a combined attack by decay and termites.

The Pick Test

When monitoring structures for wood damage, a common practice is to use a sharpened implement such as an ice pick or screwdriver to probe wood where structural integrity is a concern. The tool is inserted approximately 1/8 inch into the wood, perpendicular to the grain, by pressing firmly. Lifting the wood grain by a lever action on the pick will indicate the integrity of the wood.

If the wood is sound, the splinter lifts out along the grain. If decay has diminished the soundness of the lumber, the resulting splinter is brittle and breaks across the grain in pieces.

Preserved woods often are relatively sound toward the outer shell of the lumber, where the preservative was absorbed most efficiently. Near the core of the lumber, where treatment was minimal or negligible, decay may be significant. Tapping on the wood with a mallet may also help locate hidden voids of decay within the lumber because decayed wood dampens the sound energy caused by the mallet resulting in a dull "thunk" sound.

(Figure 3-7). Weathering causes the surface to lose strength and crack and a deterioration of the surface fibers. Cyclical wetting and drying may cause surface checking. Checks on horizontal surfaces are avenues of deep water penetration that may lead to decay.

The weathering process can be slowed by applying a water repellent material and/or protective paint to exposed wood surfaces. Cracks and joints can be caulked as a method of keeping out moisture. Caulking, however, is not a substitute for good design and construction. Paint and other protective coatings must be reapplied whenever the surface becomes cracked or worn.

Using physical barriers. Physical barriers are sometimes used to protect exposed wood from vertebrate and insect damage. In some situations, moisture damage can also be retarded. Some types of physical barriers inhibit air circulation, however, and may increase moisture problems that lead to conditions ideal for fungal invasion and deterioration of the wood.

Examples of physical barriers include metal sheathing, wire screening, plastic sheeting, bricks, concrete, or sand troughs (Figure 3-8). Metal sheathing is commonly used to protect wood from damage by rats, mice, and birds.

FIGURE 3–7

Wood exposed to the elements is called "weathered." Weathering is common in barns, sheds, and fencing, especially where untreated wood is used. Weathering gives the wood a gray or black appearance that may make the wood look older than it really is.

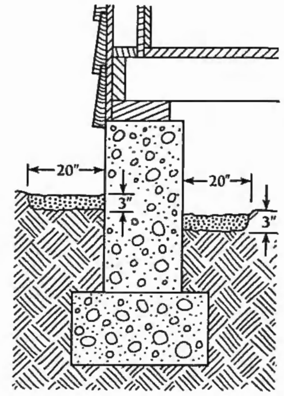


FIGURE 3–8

Physical barriers used in a structure can aid in repelling pest infestation. Here, a sand barrier along a crawl space interior wall is used to prevent invasion of western subterranean termites. The barriers are used instead of chemical treatments. In some cases, physical barriers can make using treated wood unnecessary.

Bricks or concrete can also protect wood from insect or vertebrate damage. Masonry absorbs moisture readily, however, so wood in contact with masonry that is subject to wetting should be treated with a preservative. Plastic polyethylene sheeting may be used as a temporary protection from moisture for wood surfaces or as a permanent moisture barrier when used with masonry. The use of plastic may increase condensation problems, however.

CHARACTERISTICS OF WOOD PRESERVATIVES

When the decision is made that chemically treated wood is needed, the primary concerns become what preservative, application method, and safety procedures are the correct choices for the project.

Wood preservatives are a category of pesticides applied to wood before damage occurs. Wood preservatives extend the life of wood by protecting it from insects, fungi, or marine borers. Preservatives offer some protection against weathering. To be suitable for most types of structural purposes, treated wood must last for the life of the structure.

The effectiveness of a wood preservative treatment depends on: (1) the chemical selected; (2) the depth of penetration of the preservative; and (3) the amount of preservative retained by the wood after treatment. Preservative retention, penetration, and distribution are influenced by the type of wood, how the wood is prepared, how the preservative is applied, and how the wood is handled after treatment.

Development of effective preservatives requires extensive testing and takes considerable time for performance evaluation. Manufacturers use accelerated exposure tests to help determine how well preservatives will protect wood over long periods of time. When developing a wood preservative, chemists look for the following qualities and conditions: (1) adequate toxicity to wood-destroying organisms; (2) good chemical stability promoting permanence, either through binding tightly or avoiding leaching; (3) ability to penetrate wood; (4) low hazards to people and the environment associated with handling and use; (5) lack of adverse affects, such as weakening, on treated wood; (6) little or no corrosiveness to application equipment or metal fasteners, such as screws and nails; and (7) ability to be economically produced.

An Alternative Wood Preservative

Most woods exposed to moisture over long periods of time show decay within 1 to 5 years unless they are protected. Problem areas for long-term exposure to moisture include:

- Mud sills or columns on concrete foundations that "wick" water up from damp soil;
- Siding, window frames, or decking exposed to the elements;
- Posts or footings buried in the ground;
- Rafters or other large dimension timbers in buildings prone to condensation;
- Architectural designs exposing large timbers to weathering.

Mud sills are a common use of treated wood in residential construction. Certain uses may be required by local building codes where wood comes in contact with soil or water "wicking" materials such as concrete.

Wood preservatives, especially those applied through pressure treatment, are usually recommended for such uses. Where pressure treated lumber is not available, dipping wood for 5 to 15 minutes in a preservative provides better protection than does application by brush. In fact, merely brushing wood preservative onto the side of lumber (along the grain) is rarely effective because the material cannot penetrate sufficiently. However, dipping or brushing the preservative onto the cut ends of lumber is worthwhile as cuts are more vulnerable to decay attack. Preservative dipped or brushed on the end grain can penetrate the 1/8- to 1/2-inch depth necessary to retard fungi.

Until recently, wood preservatives containing pentachlorophenol (penta), inorganic arsenicals, or creosote were widely recommended. The United States Environmental Protection Agency has moved to further restrict the use of these materials as potential health risks. In this light, alternative methods of protecting exposed wood have become more desirable.

A Nontoxic Water Repellent

The United States Department of Agriculture's Forest Products Laboratory (FPL) has determined that a simple water repellent made from varnish, paraffin wax, and mineral spirits can be as effective as conventional wood preservatives in some relatively low risk exposures. Tested on windows and sashes over 20 years in a high humidity climate, the FPL repellent was equal to penta preservative in staying power when applied to the wood before painting. Note the paint must be compatible with the repellent or adhesion problems will result. Without either treatment, the wood decayed in 6 years.

The FPL and commonly available commercial repellents can be used to protect decks, fences, siding, furniture and much more. Applying it to the cut end of the lumber is especially important to defeat the rapid uptake of moisture that leads to the early establishment of decay organisms.

In areas of high humidity and warm temperatures, the FPL repellent is not as effective. In these areas, where wood comes in contact with moist soil, researchers found that adding copper-8-quinolinolate improved the effectiveness of the water repellent. Copper-8 is the only preservative approved for use on picnic tables or other surfaces where food is served.

For further information on this alternative wood preservative, contact the United States Department of Agriculture Forest Products Laboratory, P.O. Box 5130, Madison, Wisconsin 53705.

It is an advantage for wood preservatives to be clean, colorless, odorless, and paintable. They should not cause more than minimal swelling of the wood. Table 3-1 describes the use characteristics of wood "treatments," from preservatives to finishes and paints.

A wood preservative must be toxic to insects, fungi, and/or marine borers to be effective. It must also be able to be absorbed and held by the wood so that it does not leach out into the environment.

APPLYING WOOD PRESERVATIVES IN THE FIELD

Methods of Field Application

The method of application usually affects the depth of penetration and the ultimate degree of protection. The type of application method selected may depend on conditions, such as where the wood is being used, the need for shaping the wood after preservation, the age and condition of the wood being protected, and whether the wood has already been put into use.

Brush application. The simplest way to apply a wood preservative in the field is to brush the liquid onto wood surfaces. This is usually the least

Applying Wood Preservatives

To apply wood preservatives correctly, you must make sure that the correct amount of active ingredient is applied to the area to be treated and that the preservative is confined just to that area. Here are some important things that you must do to properly apply wood preservatives:

- **Calibrate the application equipment accurately.**
- **Use the correct amount of active ingredient. Check the label for rates of application.**
- **Measure the area to be treated so that the correct quantity of preservative mixture can be prepared.**
- **Check the application site for hazards that might affect the safety of application. Hazards include electrical outlets and exposed wiring, and sources of ignition, such as flames or sparks. Applying preservatives in confined spaces or where improper ventilation exists should be avoided when possible; where necessary, proper respiratory equipment must be used.**
- **Make sure that the weather conditions are suitable for application. This includes temperature, humidity, and outdoor applications in the wind, fog, and rain. Some wood preservatives present greater hazards during periods of high heat.**
- **For liquid sprays, control the droplet size and spray pressure to prevent drift and to keep the spray on target.**
- **Do not apply wood preservatives in or near air conditioning or heating vents or ducts.**
- **Keep people and animals away from the area during application and until the treated area is safe to reenter.**

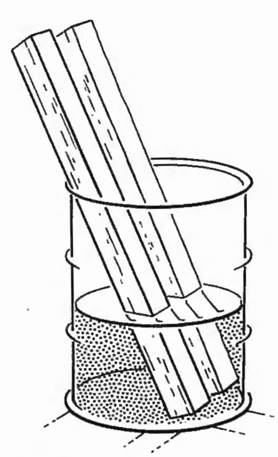


FIGURE 3–9

Dipping lumber is an example of a wood preservative field treatment. This method can be used to treat fence posts. Typically, only the portion of the post in soil contact needs treating. Dipping allows a more uniform and effective treatment than does brush-on applications.

FIGURE 3–10

When transporting preservatives classified as hazardous materials, specific placards such as these must be displayed on all four sides of the vehicle.

effective method because thorough coverage and penetration are difficult to achieve. Use this method of application only when other methods are not practical. Brush application can be used for treating or re-treating wood already in place or to protect freshly cut surfaces of previously treated wood.

Dipping. Dipping involves submerging wood to be protected into a container filled with liquid preservative. Fence posts, for example, are usually dipped before use (Figure 3-9); treatment is often confined to the section of post that will be buried in the soil. Dipping allows more uniform coverage of treated surfaces than can be obtained by brushing, especially if the wood contains splits or cracks. The depth of penetration is improved to an extent proportional to the length of time the wood is allowed to remain in the dipping tank. Penetration is also affected by the type of wood being treated and its moisture content. The higher the moisture content, the less effective the treatment.

Cold soaking. Cold soaking is a process that involves submerging wood in a tank of preservative for an extended period of time. This allows the wood to absorb preservative to a greater depth. Because cold soaking is slow, this method is not usually chosen as a commercial method of treating large quantities of wood.

Transporting Wood Preservatives

Wood preservatives must be carefully transported to prevent spills or accidents that might possibly injure people and animals, or damage the environment. A wood preservative spill on a roadway can result in serious problems, including contamination of surrounding soil, surface water, and possibly eventual leaching into the groundwater. Spills also endanger people and wildlife, and can damage vegetation.

Vehicles such as pickup trucks or vans are generally used to carry wood preservatives and application equipment to non-treatment facility work sites. Some of these pesticides are in original containers or service containers, while others are in a spray tank or application device.

No matter what form they are in or how they are contained, pesticides transported on public roads are classified by regulatory agencies as hazardous materials. Often, leftover or unused material is classified as a hazardous waste.

Classification as a hazardous waste greatly complicates the transportation, storage, and disposal of wood preservatives. Therefore, it is recommended that only the amount of preservative required for proper treatment be prepared and applied. Any excess is deemed waste and must be disposed of in accordance with regulations. Governmental agencies regulate hazardous material and hazardous waste transportation on public roads. Under certain conditions, a permit may be required to transport hazardous materials or wastes.

Transportation regulations also require that certain vehicles be equipped with placards indicating the class of hazardous material being carried (Figure 3-10). Vehicles may also be subject to California Highway Patrol inspection. See Table 3-2 for important agencies that should be contacted when transporting wood preservatives in a vehicle. Consult with the California Highway Patrol and the California Department of Transportation for information on regulations and permits. Failure to adhere to these regulations can result in stiff penalties and/or fines.

TABLE 3–1

Characteristics of Wood Treatments.

Finish	Initial Treatment	Appearance of Wood	Cost of Initial Treatment	Maintenance Procedure	Maintenance Period of Surface Finish	Maintenance Cost
Creosote-type preservatives	Pressure, hot and cold tank steeping	Grain visible, brown to black in color, fading slightly with age	Medium	Brush down to remove surface dirt	5-10 year only if original color is to be renewed; otherwise no maintenance required	Nil to low
	Brushing	Same as above	Low	Same as above	3-5 year	Low
Waterborne preservatives	Pressure	Grain visible, greenish in color, fading slightly with age	Medium	Brush down to remove surface dirt	None, unless stained, painted, or varnished as below	Nil, unless stains, varnishes or paints are used See below
	Diffusion plus paint	Grain and natural color obscured	Low to medium	Clean and repaint	7-10 year	Medium
Oilborne preservatives [1]	Pressure, steeping, dipping, brushing	Grain visible Color as desired	Low to medium	Brush down and reapply	2-3 year or when preferred	Medium
Water repellent [2]	One or two brush coats of clear material or, preferably, dip applied	Grain and natural color visible, becoming darker and rougher textured	Low	Clean and apply sufficient material	1-3 year or when preferred	Low to medium
Stains	One or two brush coats	Grain visible Color as desired	Low to medium	Clean and apply sufficient material	3-6 year or when preferred	Low to medium
Clear varnish	Four coats (minimum)	Grain and natural color unchanged if adequately maintained	High	Clean and stain bleached areas, and apply two more coats	2 year or when breakdown begins	High
Paint	Water repellent, prime, and two top coats	Grain and natural color obscured	Medium to high	Clean and apply top coat; or remove and repeat initial treatment if damaged	7-10 year[3]	Medium to high

[1] Pentachlorophenol, bis(tri-n-butylin oxide), copper naphthenate, copper-8-quinolinolate, and similar materials
[2] With or without added preservatives. Addition of preservative helps control mildew growth and gives better performance
[3] Using top-quality acrylic topcoats

During transport, keep undiluted wood preservatives in their original containers or in approved, labeled service containers. If a container has previously been opened, be sure it is tightly resealed before transporting.

Before transporting application equipment or service containers containing wood preservatives, these devices must be labeled with the name of the pesticide, the toxicity signal word from the original container (example: DANGER), and the name and address of the person or company responsible for the container. The label should also bear the statement "KEEP OUT OF THE REACH OF CHILDREN."

During transport, secure all pesticide containers and application equipment to avoid spills or container damage. Use sand bags, blocks, ropes, or straps to prevent movement. The vehicle should be equipped with an emergency spill control kit, including a supply of absorbent material, a special container for holding waste, and a quantity of uncontaminated water. If a spill occurs, no matter how small, clean it up immediately. Table 3-3 is a summary of a pesticide cleanup kit components.

Lock the area within the vehicle where wood preservatives and other pesticides are carried. Locking will keep children or unauthorized adults away from the preservatives and prevent possible injury. Store tanks containing diluted pesticides and other equipment containing pesticides in a locked area on the vehicle, separate from passengers. Stow these items securely to prevent spills.

Handling Wood After Treatment

All types of wood treatments penetrate only a short distance below the surface in most species. Wood below that point is not protected. Therefore, treated wood must be handled carefully to protect the treated surfaces. Rough handling can cause chipping, splintering, or cracking and expose untreated areas. Cutting, drilling, or shaping treated wood also exposes untreated surfaces (Figure 3-11).

To assure protection of the treated wood: (1) avoid rough treatment; (2) paint additional preservative onto any areas that have been damaged; (3) use pre-shaped wood whenever possible; and (4) apply preservative to surfaces that have been sawed, drilled, or shaped.

Treated wood may contain residues that could be harmful to plants, animals, or people coming in contact with it. Always wear impervious gloves while handling treated wood to protect your skin from the preservative and from splinters. When cutting, drilling, or shaping treated wood, wear goggles to keep sawdust from getting into your eyes. Also, wear a dust mask to prevent breathing sawdust.

Avoid using treated wood for constructing birdhouses, doghouses, or beehives (Figure 3-12). Do not allow scraps of treated wood to be used as firewood or for construction of items not requiring this type of lumber.

If treated wood is to be used by others, including consumers, complete information—typically in the form of a Material Safety Data Sheet (MSDS) or a Consumer Information Sheet—should be provided detailing the type of treatment, hazards of the material, and precautions to be observed. Table 3-4 is an example of the type of information that must be provided to users of treated wood.

If wood preservatives are not carefully applied, they may drift beyond the treatment site and become deposited as unacceptable residues on surfaces not intended to be treated. These residues can possibly endanger nontarget organisms. Residues from improper application or improper rinsing of equipment may also result in contamination of surface water or groundwater.

Preventing Unwanted Exposure

Do not apply a wood preservative in locations where residues can be carried into a well, stream, pond, or other water source. Never drain or wash application equipment where runoff into sewers, sumps, or drainage tiles can occur.

TABLE 3–2

Where to Get Information and Regulations on Transporting Pesticides.

FOR INTERSTATE MOVEMENT OF PESTICIDES:

U.S. Department of Transportation
Office of Motor Carrier Safety
Federal Building
801 I Street
Sacramento, CA 95812-1915
(916) 551-1300

or

U.S. Department of Transportation
San Francisco Regional Office
(415) 744-3088

FOR LOCAL INFORMATION: County Agricultural Commissioner's Office

FOR TRANSPORTATION OF PESTICIDES WITHIN THE STATE OF CALIFORNIA:

California Public Utilities Commission
Transportation Division
License Section
505 Van Ness Avenue
San Francisco, CA 94102
(415) 703-2063

California Highway Patrol
Hazardous Materials Section
444 N. Third Street, Suite 310
Sacramento, CA 95814
(916) 327-3310

...contact the California Highway Patrol Motor Carrier Safety Unit Supervisor at the nearest location below:

Northern Area:	2485 Sonoma Street Redding, CA 96001 (916) 225-2715
Sacramento Valley:	11336 Trade Center Drive P.O. Box 640, Rancho Cordova, CA 95741-0640 (916) 366-5185
Golden Gate:	1551 Benicia Road Vallejo, CA 94591 (707) 648-4180
Central Valley:	5179 North Gates Avenue Fresno, CA 93722 (209) 488-4329
Southern State:	437 North Vermont Avenue Los Angeles, CA 90004 (213) 644-1108
Border:	90330 Farnham Street San Diego, CA 92123 (619) 237-6811
Coastal Area:	4115 Broad Street, Suite B-10 San Luis Obispo, CA 93401 (805) 549-3261
Inland Area:	847 E. Brier Drive San Bernardino, CA 92408 (714) 383-4811

TABLE 3–3

Steps to Follow When Cleaning Up a Pesticide Spill.

CONTENTS OF A SPILL KIT

Protective Equipment
- Goggles
- Neoprene, nitrile, or rubber gloves
- Neoprene or rubber boots
- Waterproof coveralls
- Respirator

Barricade to Keep Area Clear
- Duct tape
- Barricade tape

Confinement Materials
- Spill control (Terrasorb)
- 10'x50' poly tarp
- Absorbent pillows

Clean Up Materials
- Whisk broom
- 16" squeegee
- Shovel
- Dust pan
- Poly bags
- Sealable drum
- Sponges

Decontamination Materials
- Bleach (optional)
- Lime, lye, soda ash (if recommended)
- Detergent
- Isopropyl alcohol (if recommended)

Miscellaneous
- Permanent marking pen to write name of pesticide, responsible party, and signal word on disposal container

Emergency Information

Office telephone number	
Fire department, CHP	911
Chemtrec	(800) 424-9300
County Agricultural Commissioner	

FIGURE 3–11

Cutting, shaping, or drilling can expose surfaces of wood that the preservative treatment failed to reach. This is especially true of exposed, untreated heartwood, seen here in a pier timber.

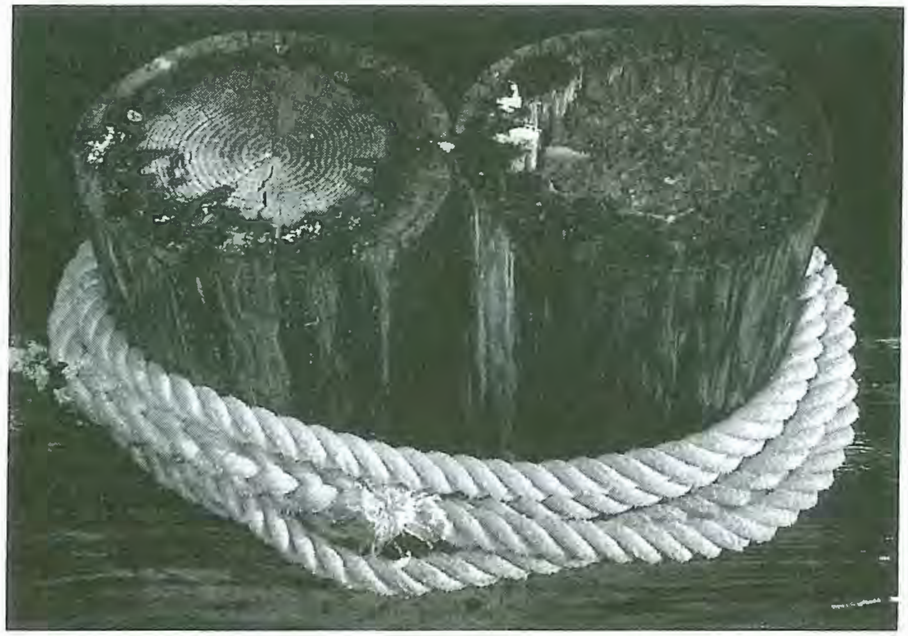


FIGURE 3–12

Use of treated wood is inappropriate for animal quarters, such as doghouses, lambing pens, and birdhouses. Animals may have a sensitivity to wood preservatives at lower doses than humans. "Cribbing" or chewing on wood by animals is another reason to avoid using treated wood. In addition, beehives should not be constructed of treated wood, since bees may be particularly sensitive to preservatives.

TABLE 3-4

Example of Information That Must Be Provided to Consumers Who Purchase Treated Wood. Suppliers of treated wood must provide written information to the consumer giving use site and handling precautions based on the hazards associated with the preservative used. The following is an example of a Consumer Information Sheet for Creosote Pressure Treated Wood.

Consumer Information Sheet

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 the treated wood and in determining where to use the treated wood.

Use Site Precautions for Creosote Pressure-Treated Wood

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 only be used for wood block flooring and industrial building components that are in ground contact and are subject to decay or insect infestation, and where two coats of an appropriate sealer are applied.

Wood treated with creosote should not be used in the interiors of farm buildings where there may be direct contact with domestic animals or livestock which may crib (bite) or lick the wood.

In interiors of farm buildings where domestic animals or livestock are unlikely to 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, and where two coats of an appropriate sealer are applied.

Do not use creosote-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. Examples of such sites would be structures or containers 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, and walkways.

Do not use treated wood for construction of those portion of beehives that may come into contact withe the honey.

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

Do not use creosote-treated wood where it may come into direct or indirect contact with drinking water for domestic animals or livestock, except for uses involving incidental contact such as docks and bridges.

Handling Precautions of Creosote Pressure-Treated Wood

Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves or fireplaces because toxic chemicals may be produced as part of the smoke and ashes. Large quantities of treated wood from commercial or industrial use (e.g., construction site) may be burned in commercial or industrial incinerators 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.

Avoid frequent or prolonged skin contact with creosote-treated wood. When handling the treated wood, wear tightly woven coveralls and use gloves impervious to chemicals (for example, gloves that are vinyl coated).

When power-sawing and machining, wear goggles to protect eyes from flying particles.

Wash exposed area thoroughly after skin contact, and before eating, drinking, or use of tobacco products.

If oily preservatives or sawdust accumulates on clothes, launder before reuse. Wash work clothes separately from other household clothing.

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.

Preservative storage areas should always be clearly posted by warning signs and always remain locked.

Storing Wood Preservatives

Store wood preservatives in their original, tightly closed containers. Whenever possible, wipe or wash residues off the outside of containers before they are put into storage, capturing the rinse water for disposal as a hazardous waste. Protect preservatives and their containers from extremes in temperature and from becoming wet.

A storage area should be a separate building, away from people, living areas, food, animal feed, and animals. The area must be well ventilated, well lighted, dry, and secure, with lockable doors and windows. Post signs near all primary entrances to warn others that the building contains preservatives.

Some wood preservatives may not store well for long periods of time. Extended storage, especially after temperature extremes, may cause chemical changes resulting in some products losing their effectiveness or others becoming more toxic. Moisture and air picked up during storage may alter the composition of some pesticides, especially those stored in unsealed containers. Solvents and petroleum-based chemicals can degrade some types of containers after a period of time.

Most chemicals should not be stored for longer than 2 years. Before they exceed their shelf life, use wood preservatives in an appropriate application or transport them to an approved disposal site.

Employee break rooms are no place for wood preservatives or preservative residues. Do not eat, drink, or smoke when handling wood preservatives. Wash thoroughly after using them, especially before eating, drinking, or using the toilet.

Handling Wood Preservatives

Undiluted wood preservatives in their original containers must be handled carefully. Wear rubber gloves and protective clothing, such as a waterproof apron, when handling these pesticides. Do not drop or throw containers or packages, as this may cause damage and leaks.

Check for contamination or leaks on all packages being handled, and do not let damaged packages or spilled preservative come in contact with your skin or clothing. If a container is damaged and leaking, the preservative should be transferred to another container and must be properly identified. When working around a leak, you may need to wear respiratory and eye protection—check the label for all precautions and required safety equipment. If there is any doubt, wear the maximum protection. Never walk through a spilled wood preservative.

Never leave containers unattended or stored in unlocked areas. Always keep wood preservatives and all other pesticides away from food, water, and sources of heat and fire. Never allow paper containers to get wet.

Do not eat, drink, or smoke while handling wood preservatives, other pesticides, or pesticide containers. Wash thoroughly before eating, drinking, smoking, or using the toilet, and again when you finish handling wood preservative containers.

Wood Preservative Disposal

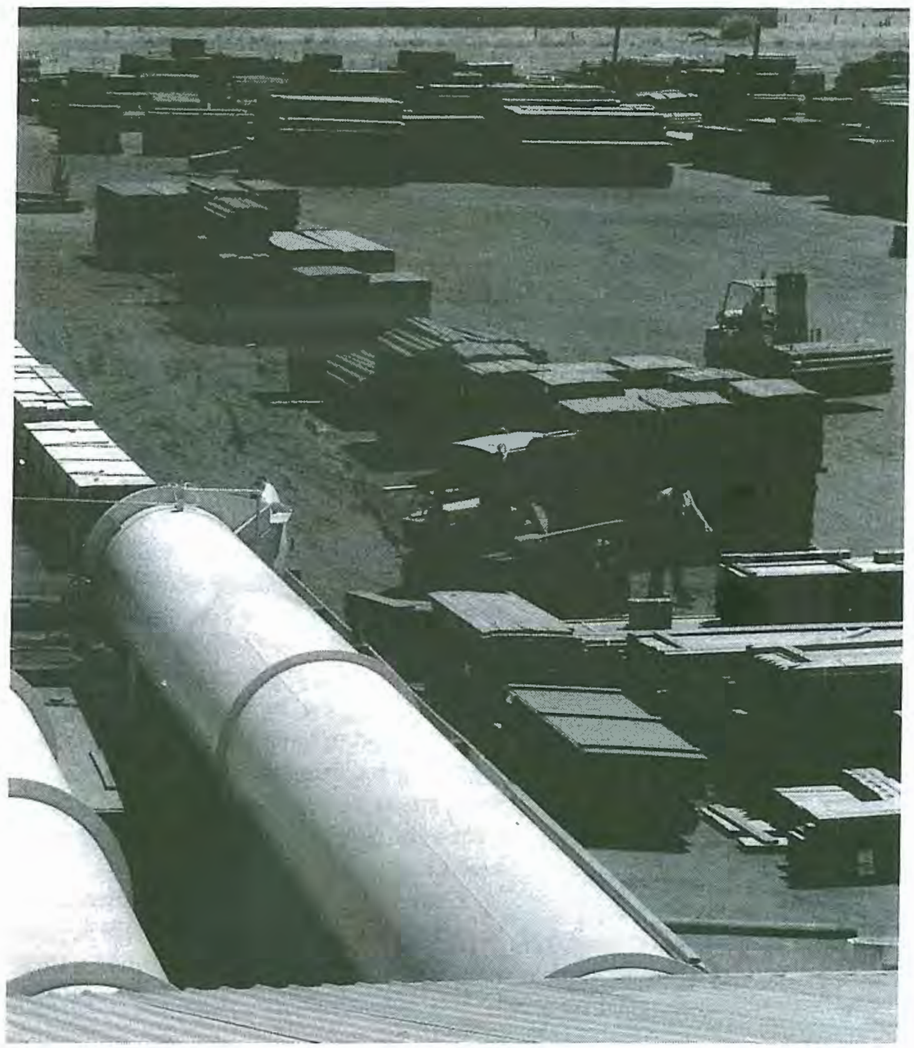
Leftover wood preservative mixtures are considered hazardous waste, unless they can legally be used at another site. Therefore, whenever possible, mix only the amount of preservative required for each job. Excess mixture must never be indiscriminately dumped; such dumping is a potential source of environmental and groundwater contamination and is illegal. Persons convicted of dumping are subject to large fines and jail terms.

Rinse water from the cleaning of application equipment, contaminated brushes and other application devices, obsolete dipping containers, and any other exposed implements needing to be disposed of are also hazardous waste and must be treated accordingly.

Hazardous materials, such as leftover preservative residues, must be transported to an approved Class 1 dump site. Preservative containers must be thoroughly rinsed via approved procedure before they can be disposed of in a Class 2 disposal site.

Check with the California Environmental Protection Agency, the Water Quality Control Board, and the local Agricultural Commissioner for methods of disposing of hazardous pesticide wastes and empty pesticide containers.

4 Commercial Treatment of Wood



Commercial treatment of wood comprises approximately one-third of all pesticides used in the United States annually. Roughly 330 million cubic feet of wood are treated each year to supply the nation with railroad ties, lumber, plywood, pilings, utility poles, fencing, and many other products.

While the three primary preservatives—inorganic arsenicals, creosote, and pentachlorophenol—carry "restricted use" status as a result of their potential hazards and human health risks, they comprise more than 90 percent of the wood preservatives in use today. According to the United States Department of Agriculture, there remain no practical chemical alternatives for these preservatives where the risk of wood-destroying organism attack is high.

TREATING WOOD PRODUCTS

Wood preservative chemicals fall into three general classes: creosote-type, oilborne, and waterborne preservatives.

Creosote-Type Preservatives

Creosote is an oily substance obtained from the distillation of wood tar, coal tar, or petroleum oil. Creosote preservatives include a large group of compounds and mixtures. In some formulations, creosote is combined with petroleum oils or pentachlorophenol to produce preservatives with specific characteristics.

Creosote preservatives are toxic to fungi, insects, and some marine borers. Creosotes, because they are oil-based, are not soluble in water. These preservatives are easy to handle and apply, readily available, economical to use, and long lasting once applied.

Depending on the way they are applied, creosote preservatives discolor treated wood to varying degrees, and may leave an oily, unpaintable surface (Figure 4-1). Treated surfaces have a tendency to bleed as the excess creosote oozes out of wood cells. However, creosote applied as an empty cell treatment (see the *Pressure Treatment* section later in this chapter) does not bleed and can be painted.

Creosote preservatives have a strong odor and give off toxic fumes, requiring their use only in outdoor locations. They are used primarily for protecting fence posts, railroad ties, utility poles, and saltwater marine docks and pilings against fungi, wood-boring insects, and marine borers (Figure 4-2).

Creosote is a restricted-use pesticide and a known carcinogen. The use and handling of creosote requires special training, certification, and strict adherence to label directions. The welfare of the applicator, people working or living in close proximity to the treatment site, consumers, and the environment must be considered when using this compound.

FIGURE 4–1

Creosote-treated poles have been widely used by utility companies for electric and telephone service. Here, poles of varied lengths await being put to use.

FIGURE 4–2

Saltwater marine piers and pilings have been a traditional use of creosote-treated timbers. Today, copper arsenical treated piers are used in increasing numbers because of the restricted status of creosote.

Health effects of creosote exposure. Short-term exposure to creosote may result in inflammation or even more severe injury of the eyes, skin, or respiratory tract. Symptoms of exposure include difficulty breathing, moderate to severe skin rash or blistering, eye irritation, headaches, dizziness, drowsiness, general weakness, lack of coordination, and/or loss of consciousness. Extreme exposure can be deadly.

Where in-plant safety requirements regarding protective clothing and lotions are in place and strictly followed, skin exposure to creosote is not a major problem. Because creosote causes a burning sensation on contact with skin, exposure is easily recognizable and normally results in instant removal through washing. Heightened skin reactivity to creosote has been observed in workers with light complexions.

Inhalation of creosote vapors may cause difficulty in breathing, dizziness, drowsiness, lack of coordination and/or loss of consciousness. Inhaling large amounts of creosote vapors can cause death.

As a result of both animal studies and human health studies, the USEPA has determined that chronic creosote exposure meets or exceeds the risk criteria relating to the development of tumors, and has been linked to skin cancer and malignant skin tumors.

Oilborne Preservatives

Oilborne preservatives contain specific toxic chemicals dissolved in a petroleum oil carrier and are not highly soluble in water. Examples include pentachlorophenol, copper naphthenate, and bis(tri-n-butyltin) oxide. Oilborne preservatives can be diluted with other oils to alter viscosity, vapor pressure, or color. The carrier solvent for these preservatives can be heavy oil or volatile solvents such as liquified petroleum gas, light hydrocarbon, or methylene chloride. The use of volatile solvents creates a relatively clean surface that can be glued or painted.

Creosote-treated wood will have a dark brown to black finish, at times even appearing to be applied with tar. Railroad ties and utility poles have been common uses of creosote.

What Is Creosote?

Creosote is a complex blend of organic chemicals produced during the distillation of coal tar. Coal tar is a byproduct of the coking process of bituminous coal, which can result at a variety of temperature ranges. In the United States, the coal tar fractions with boiling points between 150° and 270° C, consisting primarily of coal tar naphtha, methylnaphthalenes and dimethylnaphthalenes, are the basic component of most commercial-grade creosote. Several of the fractions, selected for their specific physical characteristics, are used alone or diluted with coal tar or petroleum oil for commercial treating uses.

Because of its complex chemical composition of some 200 primary constituents and several thousand lesser components, and because of its batch-to-batch variation in composition, creosote is traditionally described by its physical properties. Three grades of creosote, based on these properties, are recognized in the wood treatment industry—creosote for land and freshwater use, brush or spray applications, and a creosote-coal tar blend for marine use.

The oldest of the major wood preservatives, creosote was used extensively on ship timbers prior to 1800. The first pressure-vacuum application of creosote was patented in the early 1800s. The first pressure-treating plant was built in Mississippi around 1870 to treat railroad ties. The importance of creosote as a crosstie preservative was evidenced by its accounting for one-third of the pressure-treated wood production in the United States as late as the 1980s.

Creosote-coal tar solutions, used primarily in the eastern United States on railroad ties, reduce the tendency of wood to split in service, are cheaper than straight creosote, and have a lesser tendency to bleed to the surface than straight creosote. In the central and western United States, creosote-petroleum oil solutions are more frequently used, but are generally believed to be less effective in preventing attack by wood-destroying organisms. Cost, freight, and availability are the primary considerations in choosing a creosote blend.

Approximately 98 percent of the creosote used today is applied through pressure treatment. As a result, workers in treatment facilities are at greatest risk of exposure to the toxic effects of creosote.

A frequently used oilborne preservative is the chlorinated hydrocarbon pentachlorophenol (penta). Penta was the dominant preservative in use prior to the popularity of the inorganic arsenicals. It is still commonly applied to utility poles and roadway structures. The use of penta is highly regulated because of its potential to cause serious health problems.

Pentachlorophenol is a restricted-use pesticide suspected of causing reproductive defects and cancer on the basis of animal studies. Death from extreme exposure to penta and chronic health problems from recurring exposure have been reported in humans. The use and handling of penta requires special training and certification, and should be accomplished with strict adherence to label directions. The welfare of the applicator, people working and living in close proximity to the treatment site, and the environment must be considered when using this compound.

Health effects of pentachlorophenol exposure. Penta poisoning can be evidenced by the rapid onset of a variety of symptoms. These may include:

- profuse perspiration
- abnormally high temperature
- inordinately fast heartbeat
- irregularly brisk or deep breathing
- generalized weakness
- nausea and/or vomiting
- abdominal pain
- anorexia (loss of appetite)
- headaches
- severe unquenchable thirst
- pain in the extremities
- progressive coma

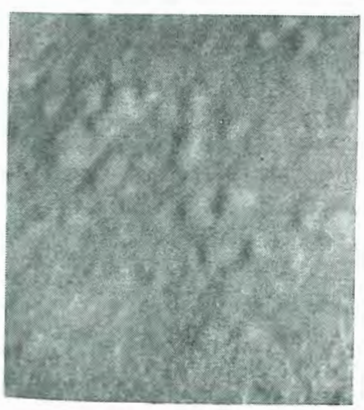


FIGURE 4–3

Pentachlorophenol is a chlorinated hydrocarbon wood preservative. Chronic exposure to penta can result in a variety of human health effects, including serious skin irritation and rashes, as above. Other body parts affected by penta are the eyes, sinuses, lungs, and nerves.

If you have been in contact with penta and begin to show early signs of any of the above symptoms, seek treatment immediately. Death from penta poisoning, characterized by the rapid onset of rigor mortis, has been observed within hours of these symptoms commencing.

Chronic exposure to penta has been associated with inflammation of the eyes (conjunctivitis), sinus (sinusitis), lungs (bronchitis), nerves (polyneuritis), and skin (dermatitis or chloracne) (Figure 4-3). Treatment of chronic conditions typically involves removing the affected person from further exposure.

A correlation has been observed between hot weather and incidence of penta reactivity. Exposure should be limited when temperatures are high.

The USEPA has determined that products containing penta meet or exceed the risk criteria for birth defects, miscarriages, or stillbirths in mammal tests. Research prior to 1988 concluded penta did not cause cancer. Based on data from a 1988 National Toxicology Program study, however, the USEPA reclassified penta from a Class D carcinogen (inadequate animal data) to a Class B carcinogen (probable human carcinogen). Studies on humans by the Canadian department of agriculture concluded that mixed exposures to chlorophenols, dioxins, and pesticides contaminated with these chemcials increases the risk of three types of cancer: soft tissue sarcoma, Hodgkin's lymphoma, and lymphoma (non-Hodgkin's).

Other chlorinated hydrocarbons, copper naphthenate, and copper–8–quinolinolate (Figure 4-4) are also formulated as oilborne preservatives, but appear not to present the health hazards associated with penta. These materials protect treated wood against fungi, termites, and wood-boring beetles. The chloronated hydrocarbon, oilborne preservatives (including penta) are not effective against marine borers.

Wood treated with a preservative in a heavy oil carrier has an oily, unpaintable surface, although colorants in the preservative may impart an attractive appearance. Preservatives in light oil or volatile solvents can be painted. Oilborne preservatives also give off toxic fumes, so they cannot be used in homes, other living areas, enclosed workplaces, animal enclosures, or storage areas. Oilborne preservatives are toxic to plants and, except for copper-8-quinolinolate, may be irritating or toxic to people and animals.

Waterborne Preservatives

Waterborne preservatives contain toxic chemicals dissolved in water that may form insoluble compounds when the water evaporates. These are generally combinations of the salts of zinc, chromium, copper, arsenic, and other metals.

Waterborne preservatives do not present the fire or explosion hazards sometimes associated with the application of oilborne preservatives. They leave the surface of treated wood clean and paintable, with no disagreeable odor or toxic fumes.

What Is Penta?

Penta is a chlorophenol, created by chemically combining phenol, a derivative of highly toxic benzene, and free chlorine. The chlorine gas is bubbled through the phenol until five (penta-) chlorine (chloro-) atoms have bonded to each phenol molecule to create pentachlorophenol. During this process, impurities are created, compounding the toxicity of penta. These byproducts include hexachlorobenzene, a known carcinogen; several chlorinated dioxins, some of the most hazardous toxins known to science; and dibenzofurans.

Developed in the 1930s, penta was mixed with oil or solvents to create a popular and effective preservative, quickly surpassing creosote as the treatment of choice in combatting wood pests for a majority of uses. Its ability to kill a broad spectrum of living organisms won it acceptance for use as an agricultural pesticide, paint preservative, hospital disinfectant, leather tanning component, and a slimicide for cooling towers and paper mills, in addition to its domination as a wood preservative.

After more than 50 years of use, penta's effect on living organisms began to be questioned. A laundry detergent containing penta used in a hospital nursery as a disinfectant was linked to the deaths of several newborns and serious health defects of several other infants. Illnesses among persons living in log homes treated with penta and homes finished with penta-based paint were also reported. Serious concerns about the safety of penta have diminished its once-lengthy list of uses; its current status is solely that of a wood preservative for outdoor use.

As a significant contaminant of soil, surface water, and groundwater, particularly around sawmills and treatment facilities, today penta residues are ubiquitous in the environment. As an organochlorine, penta bioaccumulates in the food chain. In a 1978 U.S. Health and Nutritional Examination Survey, penta was found in 85 percent of human urine sampled.

FIGURE 4-4

Copper-8-quinolinolate is an oil-borne preservative used to protect against fungal, termite, and wood-boring beetle infestations.

Suitable for use indoors in living and working areas, waterborne preservatives may require sealing. Those registered for use in California resist leaching when used outdoors, making them suitable to protect posts and other wooden structures that contact soil. Waterborne preservatives protect wood from fungi and insects, and some may be used for protection against marine borers.

Wood treated with waterborne preservatives has some protection from weathering. However, a waterproof sealer or suitable paint will assist in prolonging the useful life of the lumber. Wood treated with waterborne preservatives may be in swollen demension after treatment. To minimize demensional changes during service, treated lumber should be dried at the treatment site or before it is used.

Wood preservatives containing inorganic arsenicals are restricted-use pesticides and are known carcinogens. They are suspected of causing reproductive defects based on animal studies. The use and handling of inorganic arsenicals requires the same diligence and heightened standard of care as penta, creosote, and other restricted-use pesticides in order to maintain the welfare of the applicator, people working or living near the treatment site, and the environment.

Health Effects of Inorganic Arsenical Exposure. Short-term exposure to the inorganic arsenicals can cause irritation or inflammation of the nose, throat, bronchial tubes, and lungs. Skin exposure may result in irritation, leading to ulceration when the concentration is high enough. Contact with the eyes can result in severe damage.

Long-term exposure to arsenical preservatives may result in ulceration and perforation of the nasal septum, respiratory irritation resembling asthma, and liver damage resulting in jaundice. Exposure to airborne inorganic arsenic may cause lung cancer.

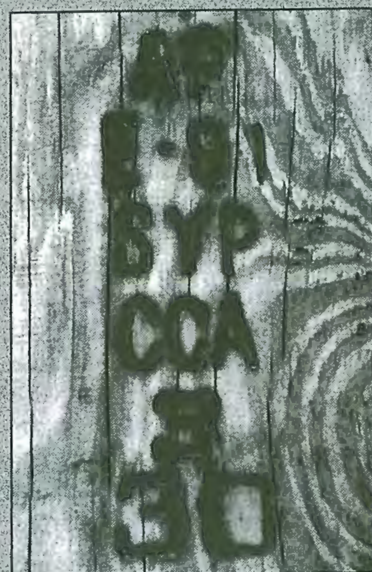
The USEPA has determined that pesticide products containing inorganic arsenicals meet or exceed the risk criteria relating to tumor development (based on human studies), genetic mutations, birth defects, miscarriages, or stillbirths.

PREPARING WOOD FOR TREATMENT

Several steps may be needed to prepare wood for treatment with a preservative. These preparations ensure that the preservative penetrates well, while providing complete coverage and uniform protection. The steps involved may include peeling, seasoning and drying, shaping, and incising.

What Are Inorganic Arsenicals?

Waterborne arsenical salt treatments in the preservation of wood have increased dramatically since the introduction of chromated copper arsenate (CCA), especially since the introduction of Type C (CCA-C) in 1968. CCA-C is a mixture of metallic salts—34 percent arsenic pentoxide, 47.5 percent chromic acid, and 18.5 percent cupric oxide.



Copper arsenical treated poles are a common construction material, especially in coastal buildings. Here, this building near a marina uses CCA treated timbers for external support.

Developed through an effort to standardize formulations for the American Wood Preserver's Association Book of Standards, CCA-C has become the favored arsenical formulation in the preservative market due to its ability to be more tightly retained to wood than the other arsenical formulations. The development of CCA-C followed fluor chrome arsenic phenol (FCAP, 1918), ammoniacal copper arsenate (ACA, 1938), and chromated copper arsenate Types A and B (1938 and 1947, respectively) into the wood preservative market. Two other waterborne salts, chromated zinc chloride (CZC) and acid copper chromate (ACC), have also been used as preservatives. CCA-C has outstripped almost all of these compounds in effectiveness, leaching resistance, and lack of complicating characteristics, such as harsh vapors.

In the early 1980s, in response to growing regulatory concerns over the arsenic content of arsenical preservatives, research was undertaken to reevaluate ACA as an alternative. This review resulted in the addition of zinc oxide to the compound as a replacement for 50 percent of the arsenic oxide used in ACA. The result was ammoniacal copper zinc arsenate (ACZA). ACZA has increased in popularity and use, especially on difficult to treat Douglas fir. ACZA has shown improvement over ACA in the areas of service life, leach resistence, lower corrosion rates, treatment color, and reduced arsenic content. ACZA is also mildly fire retardant.

Due to their cleanliness, durability, and comparative safety characteristics, arsenical formulations have found wide application in lumber, plywood, fence poles, utility poles, recreational equipment, and decks. In marine settings, where arsenicals were previously used in combination with creosote, arsenical-only treatments are a growing trend.

It is the wide range of applications, as well as their clean, paintable, and insoluble characteristics, that have seen the use of CCA and the newer ACZA grow significantly during a time when the use of pentachlorophenol and creosote declined. Reasons given for this comparative and rapid growth include increased acceptance resulting from good performance; a decline in the availability of naturally durable woods; and a greater need for longer service life.

Other Organic Metal Wood Preservatives

While most wood products are treated with one of the three primary wood preservatives—inorganic arsenicals, creosote, or pentachlorophenol—there are other chemical solutions available for the treatment of wood. The list of alternative preservatives includes:

- copper-8-quinolinolate
- copper naphthenate
- bis (tri-n-butyltin) oxide
- acid copper chromate
- chromated zinc chloride
- sodium octyborate

While each of these compounds is approved by the American Wood Preserver's Association and registered by the United States Environmental Protection Agency for the purpose of treating wood, economic and practical constraints have limited their use. Today, these preservatives comprise a minority share of the wood treatment market.

Copper-8-quinolinolate is the only wood preservative approved for picnic tables and other surfaces where food is served.

COPPER-8-QUINOLINOLATE (Copper-8). Copper-8 is the only wood preservative approved for use on food service items, such as picnic tables. Generally formulated in a mineral spirits carrier, this light petroleum-based preservative is also available in a water-based formulation. Due to its copper component, application of copper-8 leaves a light brownish-green color to the wood, which fades over time. Generally, copper-8 is not used in pressure treatment retorts because it corrodes steel.

When wood is pressure-treated with copper-8 in a light petroleum carrier, it has an expected useful life of 7-8 years, when in direct contact with the ground. Formulations in a heavy petroleum solvent provide protection equivalent to wood treated with pentachlorophenol. With penta requiring an active ingredient level of 5 percent, copper-8 has been determined to be 2.5 times more effective than penta in a 2 percent, heavy solvent formulation, based on laboratory analyses performed by the United States Department of Agriculture (USDA) during its biological and economic assessment of the wood preservatives industry. However, because copper-8 is corrosive to iron and steel, this compound has limited applications to field settings.

COPPER NAPHTHENATE (CuNap). Like copper-8, CuNap is commonly a petroleum-based preservative, found in either heavy or light solvent formulations. CuNap is dark green, very thick, and has a disagreeable odor, resulting in a tacky, aromatic, dark green treated surface.Unlike copper-8, CuNap is noncorrosive and therefore can be used in wood treatment equipment made of steel. However, CuNap becomes unstable in the presence of moisture, requiring that wood be dried prior to treatment. This additional step in the treatment process prevents the widespread use of CuNap in commercial treatment facilities.

Bis (TRI-N-BUTYLTIN) OXIDE (TBTO). TBTO is an oil-soluble chemical typically formulated as an oilborne preservative. Stable in solution, it can be used in a commercial treatment setting, providing a clean treatment surface on the wood.

Field tests have shown TBTO to be ineffective in protecting wood having contact with the ground. This is likely due to chemical changes it undergoes once applied to wood. TBTO breaks down into dibutyltin oxide, a less effective fungicide and insecticide. The USDA study indicated that a concentration of at least 2 percent was required to overcome this problem.

ACID COPPER CHROMATE (ACC). A waterborne preservative that results in a dark green treated surface due to its copper and chromium constituents, ACC is satisfactory for use in commercial treatment equipment. Due to its lack of arsenic, however, ACC is ineffective against copper-tolerant organisms. As a result, while the USDA rates ACC as a "fairly good" wood preservative, it cautions against its use in ground contact settings that could involve high replacement costs or risk to human life. In these settings, arsenic-based preservatives—especially CCA—are more effective.

CHROMATED ZINC CHLORIDE (CZC). CZC matches the physical properties and characteristics described for ACC—waterborne, stable in solution, dark green treated surface—and is available for use in commercial treatment settings, even though it is slightly corrosive to steel. However, CZC leaches when the treated wood is exposed to water. Consequently, CZC is recommended for "less demanding above-ground applications."

SODIUM OCTYBORATE. Borax-based preservatives have been used for decades in many countries, including Australia, New Zealand, many European nations, and Canada. While toxic to insects and fungi that attack wood, borates embody far fewer human health risks than conventional preservatives. Borates are water-soluble and offer far greater wood penetration than penta, the arsenical salts, or creosote, and do not require pressure treatment. Easily applied when mixed with glycols, borates do not alter the color or the dimensional integrity of the treated wood.

Borates have the disadvantage of leaching when in contact with water. New products are being developed, however, to combat this negative characteristic.

The Wapama, a logging ship built entirely of Douglas fir just after the turn of the century, has been treated with borax preservative in an attempt to stop a severe decay problem. Part of the National Maritime Museum fleet of the National Park Service in San Francisco, severe decay forced the Wapama from the water in the early 1980s. Although out of water, treatment was still necessary to prevent decay progress. The white U.S. Borax tanks on the dock were part of the system used to pump borax solution to sprayers set up in the hull of the ship. The system used landscape irrigation spray tips to apply the solution. Solution runoff was captured and recycled. As the damage near the ship name indicates, the spread of the decay was not limited to the below water portion of the hull. Two other National Park Service vessels are slated for borax treatment.

FIGURE 4–5

A peeling or debarking machine is used at most lumber mills to prepare logs as poles, posts, piers, or pilings. Treated wood also needs to have the bark removed. The bark prevents effective preservative penetration.

Peeling. Peeling refers to the removal of bark from logs that will be used for poles or posts (Figure 4-5). Bark forms a nearly impervious barrier to liquids, preventing adequate penetration of a wood preservative. Bark can also harbor wood-boring insects or keep in moisture, encouraging decay. Logs with bark intact are difficult to dry and season.

Seasoning and drying. Seasoning involves stacking poles or shaped lumber so that it is exposed to air and loses water uniformly. Sometimes wood is stacked in kilns where heated air is circulated to speed up the drying and make it more uniform (Figure 4-6).

Adequately dried wood absorbs more preservative and surface checks formed during drying also will be thoroughly treated.

Shaping. Whenever possible, wood that is to be treated with a preservative should be precut to its final specifications (Figure 4-7). This includes drilling holes or making notches. Surfaces that have been cut or drilled after treatment no longer have a protective coating and become susceptible to wood-destroying organisms. Shaping is usually performed on utility poles and some decking and pilings before preservative treatments.

Incising. Incising involves making many small holes or cuts in the surface of lumber to provide entry points and allow deeper penetration of the preservative (Figure 4-8). Industry standards and the Uniform Building Code require that all western wood species, except ponderosa pine, be incised before treatment.

Transporting Preservatives to Treatment Facilities

Wood preservatives, depending upon their particular characteristics, are transported to the treatment facility in a variety of methods. Often, the greatest opportunity for exposure is when the transported preservatives are unloaded for storage.

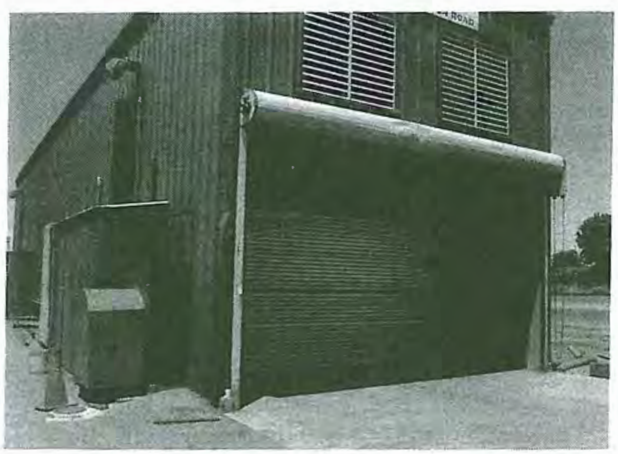


FIGURE 4–6

A kiln dryer, as seen here, is used to speed up drying by circulating heated air around stacked and stickered lumber.

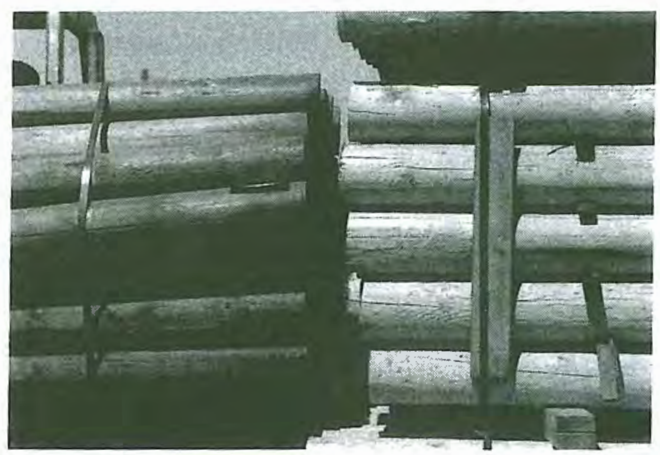


FIGURE 4–7

Treated wood should be in its final size whenever possible to prevent exposure of untreated surfaces by cutting or drilling. Here, chromated copper arsenical treated posts, cut to final size (left), are stacked next to the same untreated stock.

FIGURE 4–8

Incising involves cutting small holes or scoring along the surface of lumber. These holes are used to aid penetration of preservatives deeper into the wood. Commercial treatment facilities use an automated incising machine (as seen here) to score the wood. Incised wood is easy to tell from nonincised. Even with holes, incised wood can provide an attractive finished product.

Penta is typically shipped by delivery truck in solid blocks, bulk powder, and bagged powder. In these forms, transportation is generally neither difficult or hazardous. However, proper protective clothing is required.

Creosote is shipped via railroad tank car or tanker truck, and transferred to treatment plant storage facilities through a closed system.

The arsenic compounds are typically shipped in paste or powder form in drums or pails. When shipped in liquid form, a tanker is used. Chromated copper arsenate, Type C, is classified by the U.S. Department of Transportation as a Class B Poison-Corrosive under the Hazardous Transport Act.

COMMERCIAL APPLICATION METHODS

Wood preservatives may be applied in several different ways. The vast majority of wood preservative use in the United States occurs at pressure treatment facilities. The most common application method is pressure treatment, although vacuum and hot and cold bath treatments are also used at a few locations. The hot and cold process is routinely used to treat the butt sections of utility poles.

The method of application usually affects the depth of penetration and the ultimate degree of protection. The type of application method selected may depend on conditions such as where the wood is being used, the need for shaping the wood after preservation, age and condition of the wood being protected, and whether the wood has already been put into use.

Hot and cold bath treatment. The hot and cold bath treatment, also known as the thermal process, is more effective than brushing or cold soaking in increasing preservative penetration. Heating reduces the viscosity of an oil-based preservative, while removing some of the air and moisture trapped in the wood cell structure.

In the thermal process, prepared wood is first placed in a tank filled with heated preservative. After a period of time, the hot preservative is quickly replaced with cold preservative. This rapid drop in temperature creates a partial vacuum within the wood cells, which causes preservative to be drawn into the wood. The degree of absorption depends to a great extent on the amount of temperature difference between the hot and cold liquids.

FIGURE 4–9

Pressure treatment is the most common and effective method of applying wood preservatives. Here, stacked and stickered lumber is pushed into the pressure treatment chamber or "retort."

Pressure treatment. Pressure treatment of wood is probably the most common and effective commercial way of applying preservatives (Figure 4-9). Many types of pressure treatment are used, depending on the kind of preservative being applied, species of wood being treated, and the ultimate use of the wood.

Wood to be pressure treated is placed in a heavy steel cylinder. Preservative is pumped in and air pressure is increased to force the preservative into the wood.

In some pressure treatment methods (full-cell type) a vacuum is applied before introducing the preservative. This helps to evacuate air and moisture from wood cells. The process often involves alternating pressure with vacuum for several cycles. Vacuum may be applied again at the end of the treatment to remove surface residues.

At a pressure treatment facility, wood is pressure treated to facilitate absorption of the preservative. Vapors from the process are condensed and piped to a separator to reclaim free oils and unused preservative prior to treatment, disposal, and/or recycling of wastewater. Both the separation and wastewater treatment processes produce sludges containing high concentrations of hazardous, toxic compounds. These byproducts must be handled in accord with label directions and disposed of under the guidance of USEPA regulations and state law.

Treated wood, fresh from the pressure chamber or soaking tank, is stacked in the lumberyard of the facility for drying (Figure 4-10). Excess preservative dripping from the treated wood should be contained in collection basins. Collection basins prevent preservatives from accumulating in the soil underneath the facility or from being carried off site through runoff of rainwater. The certified applicator can protect the soil, nearby bodies of water, and groundwater at or near treatment facilities by monitoring residue collection to prevent runoff of preservatives (Figure 4-11).

FIGURE 4–10

Pressure-treated lumber fresh from the retort will be stacked in the yard for drying. Excess preservative dripping from the lumber is caught in a collection basin. Collected preservative is recycled or captured for removal to a proper hazardous waste disposal site.

Variables in pressure treatment of wood include the temperature of the preservative, the amount of pressure (and vacuum, if used) applied, and the length of time pressure or vacuum is held. Pressure treatment can be a full-cell process or an empty-cell process.

In the full-cell process, the aim is to fill the cell cavities of the treated wood with preservative. This is usually the preferred method when applying water-soluble preservatives.

The empty-cell process applies preservative to cell walls, leaving the cell cavities filled with air. This method is used with creosote and oil-based preservatives to prevent bleeding after application and to reduce the amount of preservative required for protection.

Temperature, pressure, vacuum, and timing are controlled to achieve either a full-cell or empty-cell condition.

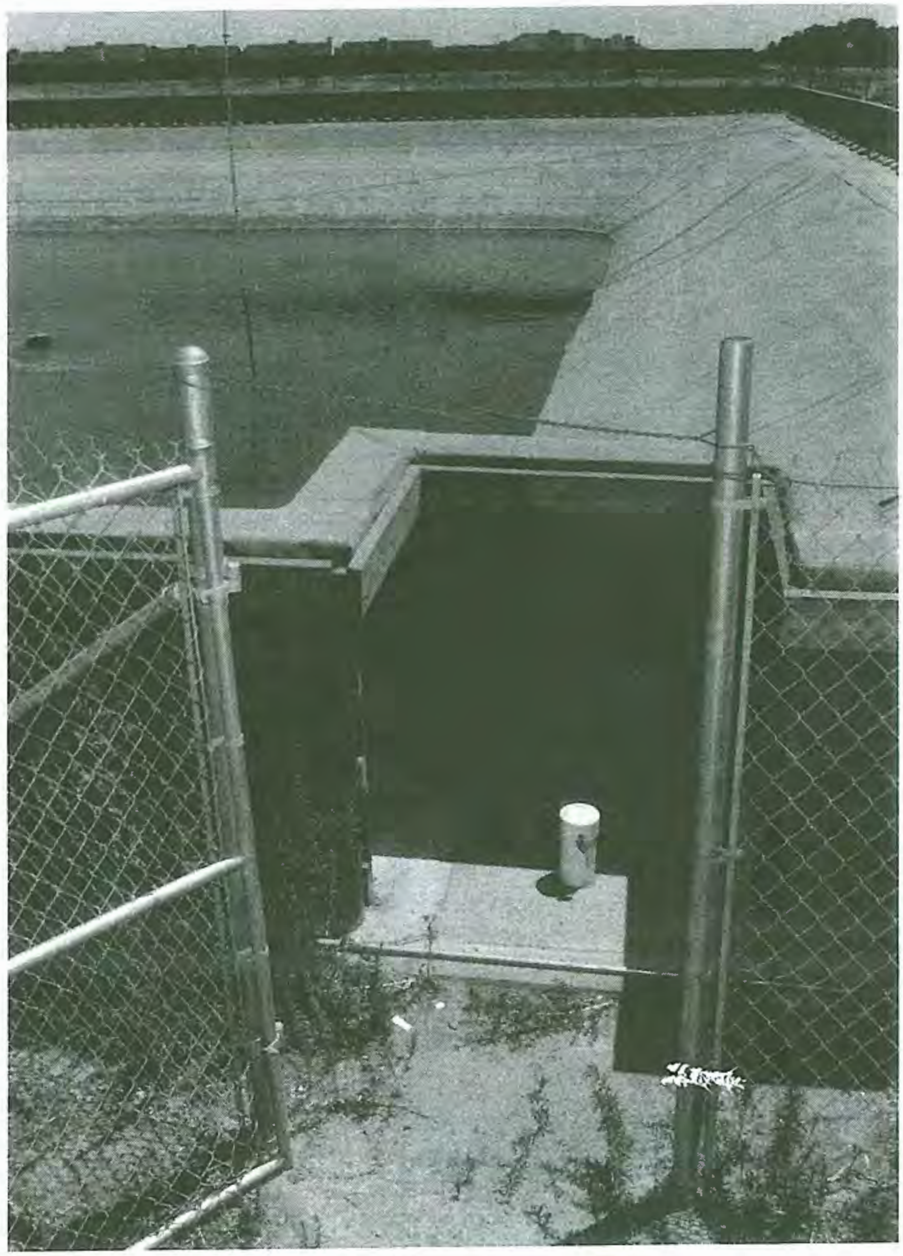


FIGURE 4–11

Applicators working at a commercial treatment facility can minimize soil and groundwater contamination through use of a residue collection and recycling system like the one seen here. In the foreground is one of nearly two dozen monitoring wells at this treatment facility used for early detection of leaching. This preventative approach to pollution is ultimately cost-effective and environmentally sound.

Mixing Wood Preservatives

Wood preservatives must be properly mixed to ensure that the correct amount of active ingredient is thoroughly incorporated into a measured amount of water or other solvent. Techniques for mixing wood preservatives are the same for large and small volumes.

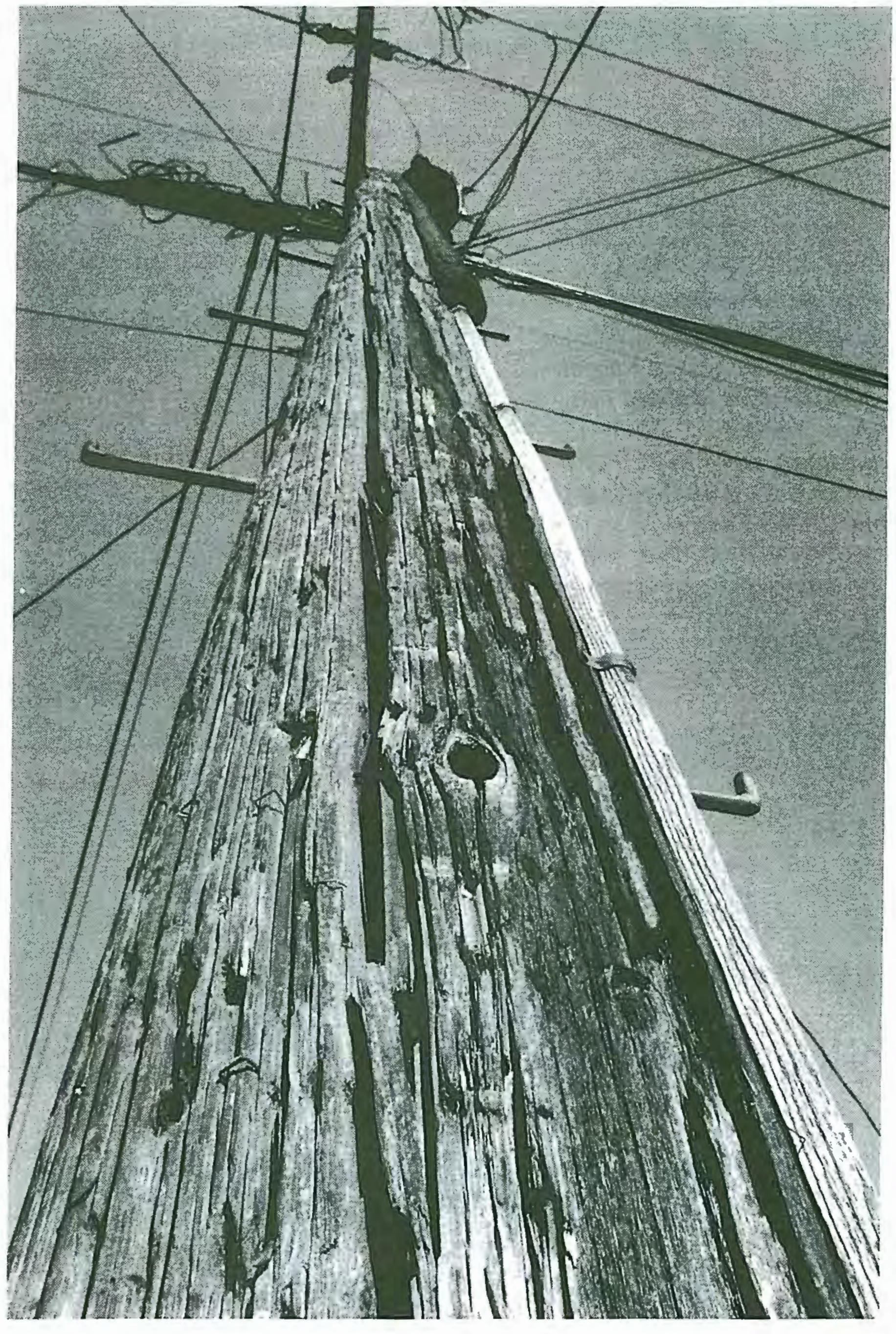
Before beginning, read the mixing directions on labels of all materials you will be using and decide on the proper order that those chemicals should be added to the application system to be used.

General rules for mixing wood preservatives and other pesticides include:

- Determine what protective clothing and equipment is required for mixing by checking the preservative label.
- Before adding chemicals into the application system, check for leaks in the tank and hoses. Make sure the equipment is clean and operating properly.
- Use only clean water or other solvent in the application system.
- Measure pesticides carefully, accurately, and safely to be certain that the correct amount of pesticide is put into the application system.
- When mixing more than one type of formulation, add the materials in the following order:
  1. Wettable powders
  2. Flowables and dry-flowables
  3. Water-soluble concentrates
  4. Emulsifiable concentrates

Emergency equipment should be in working order and available during wood preservative handling, especially at mixing and loading sites. At commercial treatment facilities, where exposure possibility is low due to closed systems being used to mix chemicals, the greatest potential for worker exposure often exists at the loading dock or mixing site. As a precaution, this facility has a personnel shower and eye wash in place. Both devices are critical in emergency exposure abatement.

5 Re-treating Standing Wood Utility Poles



Millions of wood utility poles are in use in the United States. This quantity of poles represents a significant investment to utility companies and others (Figure 5-1). Depending on the type of pole and the location where it is used, re-treatment may be required every 8 to 12 years to protect them from wood-decaying organisms. Normally, utility poles require major attention or replacement after 20 to 25 years of service.

Wood utility poles are subject to weathering, insect attack, and decay organisms, no matter where in the country they are used. However, decay organisms are most severe in areas with high rainfall and high average temperatures. Figure 5-2 is a map of "decay severity zones" in the United States. External damage from rough handling or other causes may speed up decay problems of wood utility poles in all areas of the country.

Alternative materials for utility poles, as well as the increased use of underground cables, have only slightly decreased the number of wood utility poles used today. Alternative materials primarily include metal and concrete, and some experimentation into hardened plastic has been undertaken. Treated wood remains the standard, however.

Re-treating standing wood utility poles lowers costs to utility companies by extending the useful life of poles, in turn reducing the drain on forest resources. Maintaining and re-treating poles increases safety to utility company workers and the public, while improving utility company service.

FIGURE 5–1

Treated poles comprise a significant investment to utility companies. Pole service life expectancy, depending on local environment, generally ranges from 20 to 40 years.

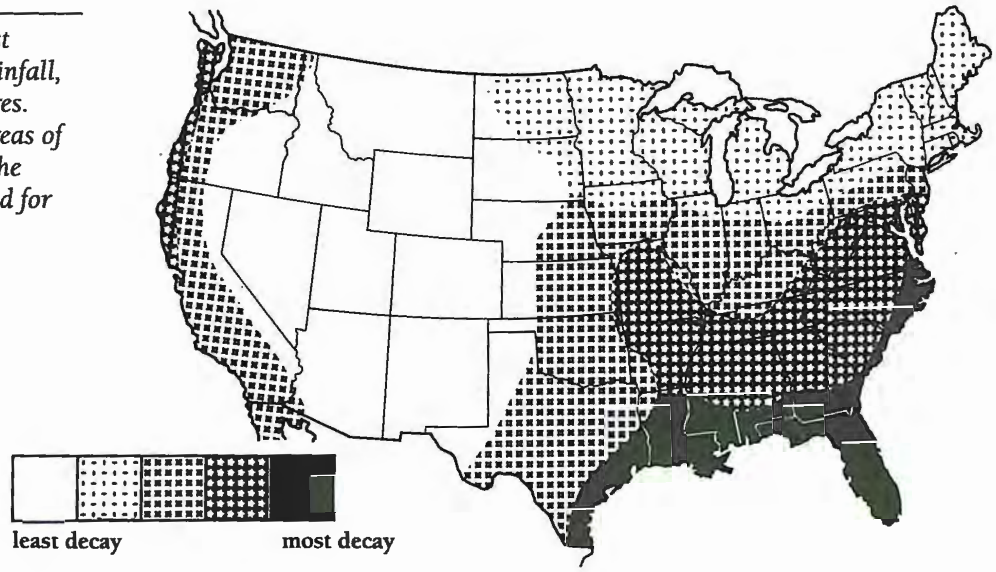


FIGURE 5–2

Decay organisms are most severe in areas of high rainfall, humidity, and temperatures. This map indicates the areas of the United States where the environment is most suited for decay problems.

TYPES OF POLES

Utility poles are usually one of two basic types—thick sapwood poles or thin sapwood poles. Each type has characteristic patterns of deterioration, making it suitable for specific uses.

Thick sapwood poles are made from southern yellow pine and ponderosa pine trees, which grow fast and straight. About 85 percent of the utility poles used in the United States are made from southern yellow pine. Because this species is mostly sapwood, it can be readily penetrated by preservative.

Thin sapwood poles are usually made from Douglas fir or cedar, all of which are typically allowed to grow larger than southern yellow pine. Poles in lengths of 60 feet or greater can be made from these tree species. Because these poles contain a greater amount of heartwood, they are often more difficult to treat.

The cross section of a pole can be divided into the core, the inner two-thirds of the diameter of the pole at the ground line, and the shell, the outer one-third of the diameter at the ground line (Figure 5-3). The ground line is a point 6 feet from the butt end of a pole, although this may not be the actual ground line of an installed pole (Figure 5-4).

The shell of a utility pole must have a minimum of 2 inches of sound wood, since 90 percent or more of the pole strength comes from the shell. Re-treatment of standing utility poles concentrates on protecting the shell. Fumigation is also used to prevent heart rot. The shell may be entirely sapwood, typically the case with southern yellow pine poles, or a combination of sapwood and heartwood, common in Douglas fir poles.

Utility poles are generally buried from 4 to 10 feet into the ground, depending on the type of pole, environmental considerations, and local soil conditions. Once in place, the section from 3 inches above the soil surface to 12 to 18 inches below ground level is most vulnerable to fungi and wood-boring insects.

Moisture drawn from the soil provides a suitable environment in this area of the pole for fungal invasion and growth. Lack of oxygen and decreased temperatures at soil depths greater than 18 inches prevent attack from fungi and wood-boring insects.

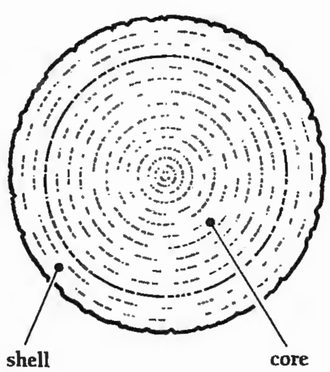


FIGURE 5–3

A tree can be divided into the core—the inner two-thirds, and the shell—the outer one-third. The shell is where preservative absorption is the greatest.

FIGURE 5–4

The ground line of a utility pole is the point six feet from the butt end of the pole. This may not be the actual point where the ground rises on the pole once installed. The lower part of the pole, from the butt end to the ground line, will typically receive additional treatment to guard against decay organisms and other wood-destroying pests in the soil.

FIGURE 5–5

Eventually, even a well-serviced, treated pole will succumb to weathering and wood-destroying organisms. It is not uncommon for the pole to decay from the inside out, leaving only a hollow shell to support the pole. It will need to be replaced or it will give way, as this pole finally did.

Moisture and temperature fluctuation between seasons contributes to splitting of the shell, which may allow entry of decay organisms and additional moisture deep enough to reach the untreated core. Sometimes new poles may be predisposed to breakdown due to the presence of moisture and decay organisms before the initial preservative treatment.

Preservatives in contact with the top 18 inches of the soil are leached more rapidly than elsewhere due to high moisture conditions and moisture fluctuations. Biological activity contributes to the breakdown of preservatives; volatilization can also take place. After a number of years, the lowered concentration of preservative in this part of the pole allows decay organisms to attack (Figure 5-5). Before this occurs, the pole must be re-treated to bring the level of preservative above the threshold. Re-treatment may add as much as 10 to 15 years to the life of the pole.

INSPECTION

Periodic inspection of utility poles is an important part of the re-treatment program, helping spot problems before serious damage can occur. Inspection will reveal one of the following conditions: (1) the pole is unsound and needs replacing; (2) the pole is sound with no evidence of decay—it may be re-treated or no action is necessary, depending on the age of the pole, environmental conditions, and economic considerations; or (3) some damage is found—the pole must be repaired and re-treated.

RE-TREATMENT

To treat a standing utility pole (Figure 5-6), first excavate the soil around the pole to a depth of 18 inches. Expose the outer surface of the pole by cleaning with a wire brush or other device. Using a mallet, tap around the circumference of the pole every few inches from about 1 foot below ground level to about 8 feet above ground level. Listen to the sound made by this tapping. Poles in good condition produce a sharp, solid sound, while decayed areas respond with a dull thud or hollow sound. Mark areas that sound suspicious so these can be checked by drilling.

Check for internal voids or decay areas within the core of the pole at the critical ground level, either by drilling holes into the core or by using a coring device. Also sample any areas that sounded suspicious when tapped with a mallet. Be sure to plug all holes after finishing this procedure, using tight-fitting, treated wooden dowels. Where internal voids are found, inject them with a suitable liquid preservative (check the label of the preservative for appropriate uses).

If signs of decay are detected without voids being present, inject the core with a liquid fumigant. Liquid fumigants will volatilize inside the core, and fumigant molecules can move as far as 2 to 4 feet within the wood.

Scrape away decay down to sound wood on the surface of the pole, disposing of the scrapings as a hazardous waste. Be sure to check the remaining thickness of the shell to see that it is still within the recommended range. If the shell thickness is inadequate, the pole must be replaced.

Poles that do not need replacing should be treated with a preservative. Apply preservatives with a long-handled brush, then cover the area with a polyethylene sheet. Refill the hole around the base of the pole. Poles that have been re-treated are usually tagged, and the re-treatment is indicated on a pole record.

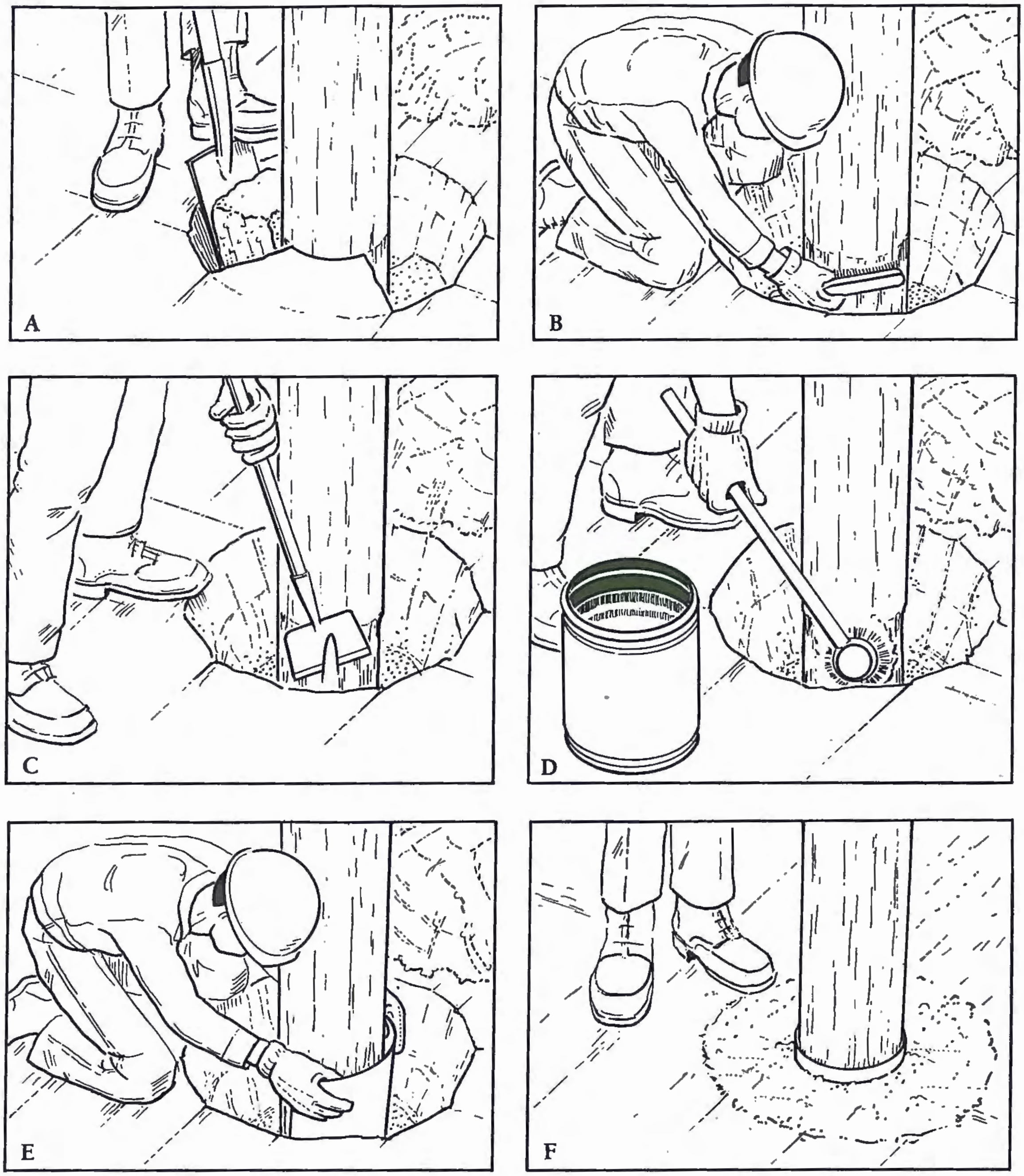


FIGURE 5–6

Follow these steps for inspecting and retreating utility poles. 1) Observe above-ground portion of pole and check for cracks, splits, and other defects. 2) Excavate soil around base of pole to a depth of 18 inches. Remove loose dirt from pole with a wire brush. 3) Using a mallet, make soundings of the pole from below ground level to about 8 feet above the ground line. Sound all the way around the circumference of the pole, listening for hollow sound of voids in wood. 4) Drill to the center of the pole. Look for the presence of internal voids or early signs of decay (such as darkening or softening of the wood). Measure the thickness of the shell. Measure amount of decay if any is found. Plug and seal the hole. 5) Shave away any external decay down to sound wood. Measure amount of sound wood remaining. 6) Apply a thin layer of paste preservative or paint to the excavated part of the pole and cover with plastic film. Be sure to thoroughly fill cracks or splits with preservative. 7) Backfill the excavation. 8) If internal decay is present, but pole still has a serviceable life, apply a preservative. If voids are present, apply a fumigant in a liquid form through drilled holes; fill holes with treated wood plugs. If early decay is discovered in solid cores, inject fumigant preservatives through drilled holes. Fumigant will diffuse from 2 to 4 feet. 9) Record results of inspection and retreatment and attach a date tag to the pole.

6 Wood-Destroying Pests

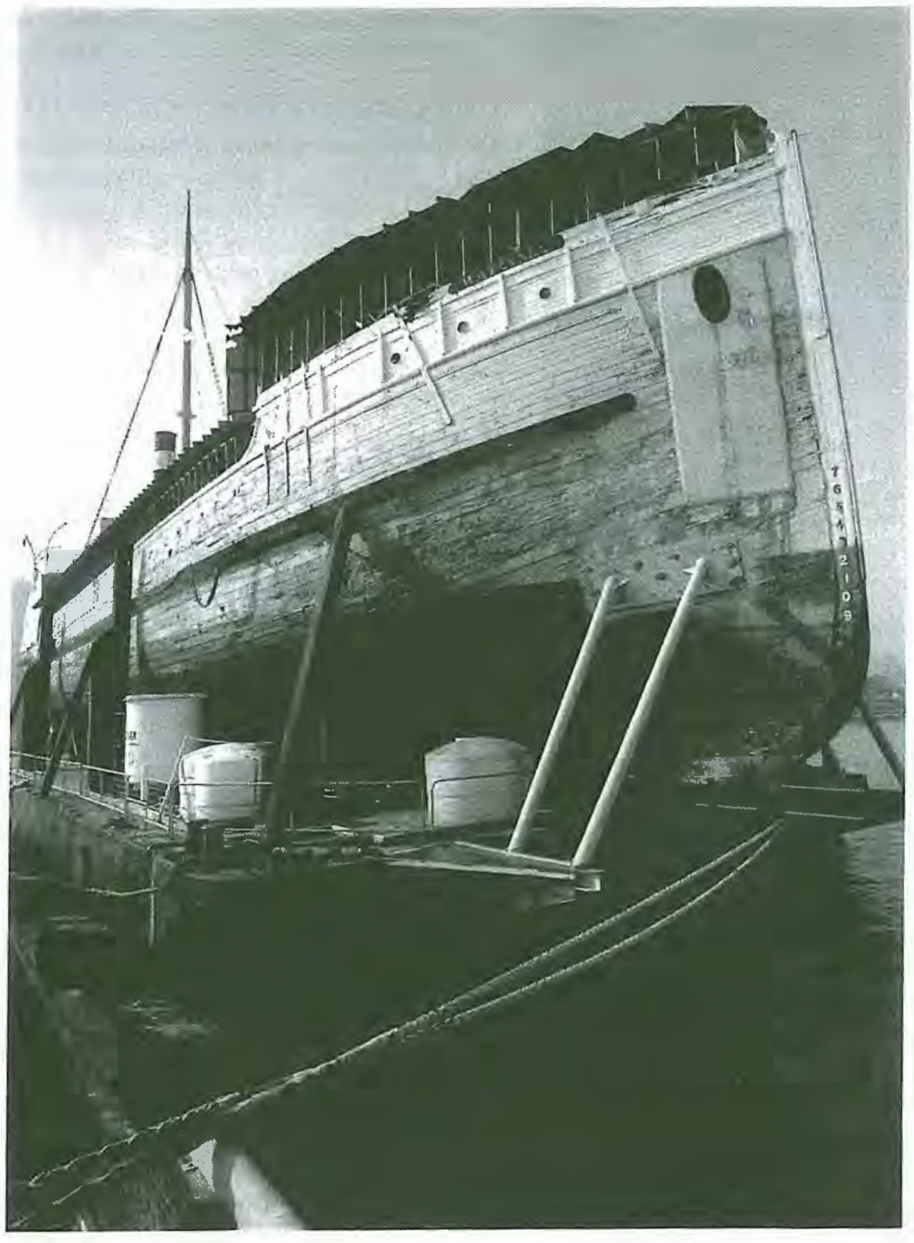


FIGURE 6–1

Moist conditions are ideal for decay organisms. They are responsible for more damage to wood and wood structures than termites and wood-boring beetles combined. Here, a treated sign post is used to combat moisture produced by the nearby drainage ditch.

An integrated pest management program addressing the challenges posed by wood-destroying pests includes a variety of control methods. These include modifying habitats, excluding pests from wood structures, and incorporating pest management ideals in the original construction planning. One of the first considerations possible—especially where structural wood will be exposed to the elements, used in foundations, or otherwise come in contact with soil—is the use of treated or preserved wood.

Wood that cannot be kept free of moisture is at risk, especially from fungi, and must be protected. More damage is caused to structures by wood decay than by termites and wood-boring beetles combined. Moist conditions suitable for most termite infestations are also ideal for wood decay organisms (Figure 6-1). While painting and sealing wood enhances useful life, chemical treatment of structural wood is the most successful and economical method of protecting wood subject to regular moisture contact.

Wood-destroying pests include certain fungi, termites, wood-boring beetles, carpenter ants, carpenter bees, and marine borers. These are important economic pests because they damage or destroy structural wood—the wood used in homes, apartments, offices, and warehouses—as well as decorative wood, piers and pilings, posts, furniture, and sometimes plastics. At least 1 percent of the housing units in the United States require treatment each year for control of termites; building owners spend nearly $2 billion yearly for termite control or repair of damage. Damage from wood-rot fungi, wood-boring beetles, carpenter bees, and carpenter ants greatly increases these losses.

This chapter provides descriptions of some of the common pests that destroy wood. Understanding the habits of these pests can aid in developing control programs and preventive measures designed to reduce damage. Monitoring and control guidelines for these pests are included in Volume 2 of the Pesticide Application Compendium—*Residential, Industrial, and Institutional Pest Control*, and summarized here in Table 6-1.

TERMITES

Termites belong to the insect order Isoptera. These are primitive insects believed to be closely related to cockroaches, probably sharing a common ancestor. Cockroaches, however, are classified in a different insect order. Like cockroaches and other primitive insects, termites do not undergo complete metamorphosis. Young, known as nymphs, are fed and groomed during part of their development by other members of the colony.

Termites have the most highly developed insect social structure, living in large colonies in the soil or in chambers carved in dead or, sometimes, living wood (Figure 6-2). Colonies are composed of castes, specialized forms of individuals that include soldiers, reproductives, and, in some species, workers. Unlike social bees and wasps, each caste is made up of members of both sexes.

TABLE 6-1

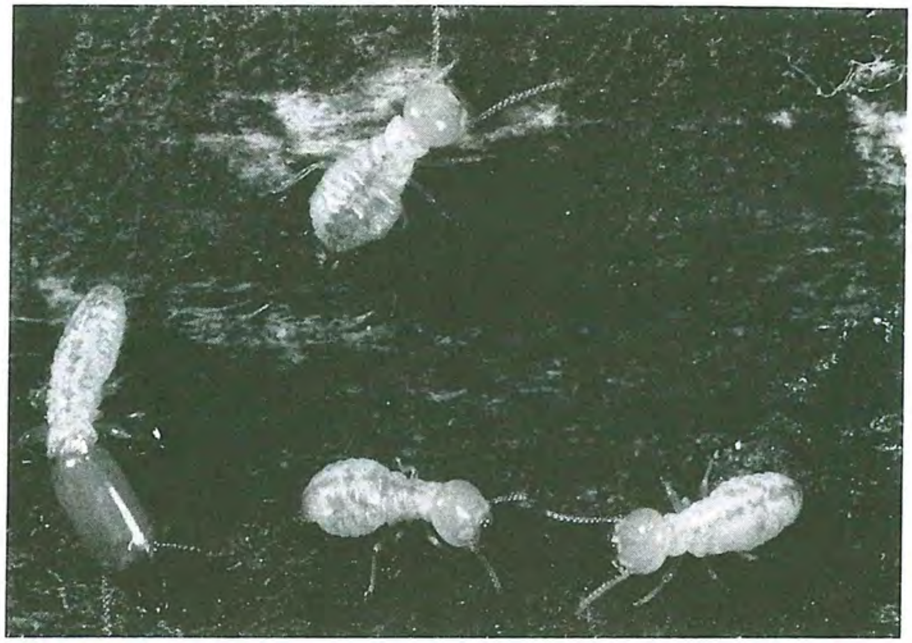
Type of Damage Description	Causal Agent	Damage	
		Begins	Ends
PIN HOLES			
Holes 1/100–1/4 inch in diameter, usually circular			
A. Tunnels open			
1. Holes 1/50–1/8 in. (0.5–3mm) in diameter, usually centered in dark streak or ring in surrounding wood	Ambrosia beetles	In living trees and unseasoned logs and lumber	During seasoning
2. Holes variable sizes; surrounding wood rarely dark stained; tunnels lined with wood-colored substance	Timber worms	In living trees and unseasoned logs	Before seasoning
B. Tunnels packed with usually fine sawdust			
1. Exit holes 1/32–1/16 in. (.08–1.6 mm) in diameter; in sapwood of large-pored hardwoods; loose floury sawdust in tunnels.	Powderpost beetles	During or after seasoning	Reinfestation continues until sapwood destroyed
2. Exit holes 1/16–1/8 in. (1.6–3 mm) in diameter; primarily in sapwood, rarely in heartwood; tunnels loosely packed with fine sawdust and elongate pellets	Deathwatch beetles	Usually after wood in use (in buildings)	Reinfestation continues; progress of damage very slow
3. Exit holes 3/32–9/32 in. (2.5–7 mm) in diameter; primarily sapwood of hardwoods, minor in softwoods; sawdust in tunnels fine to coarse and lightly packed	False powder-post beetles	Before seasoning or if wood is rewetted	During seasoning or redrying
4. Exit holes 1/16–1/12 in. (1.6–2mm) in diameter; in slightly damp or decayed wood; very fine sawdust or pellets tightly packed in tunnels	Wood-boring weevils	In slightly damp wood in use	Reinfestation continues while wood is damp
GRUB HOLES			
Exit holes 1/8–1/2 in. (3–13 mm) in diameter, circular or oval			
A. Exit holes 1/8–1/2 in. (3–13 mm) in diameter; circular; mostly in sapwood; tunnels with coarse to fibrous sawdust or it may be absent	Roundheaded borers (beetles)	In living trees and unseasoned logs and lumber	When adults emerge from seasoned wood or when wood kiln dried
B. Exit holes 1/8–1/2 in. (3–13 mm) in width; mostly oval; in sapwood and heartwood; sawdust tightly packed in tunnels	Flatheaded borers (beetles)	In living trees and unseasoned logs and lumber	When adults emerge from seasoned wood or when wood kiln dried

Table 6-1, continued

Type of Damage Description	Causal Agent	Damage	
		Begins	Ends
C. Exit holes 1/4 in. (6mm) in diameter; circular; in sapwood of softwoods, primarily pine; tunnels tightly packed with coarse sawdust, often in decay-softened wood	Old house borers (a round-headed borer)	During or after seasoning	Reinfestation continues in seasoned wood in use
D. Exit holes perfectly circular, 1/16–1/4 in. (4–6 mm) in diameter; primarily in softwoods; tunnels tightly packed with coarse sawdust, often in decay-softened wood	Wood-wasps	In dying trees or fresh logs	When adults emerge from seasoned wood, usually in use or when wood kiln dried
E. Nest entry hole and tunnel perfectly circular 1/2 in. (13 mm) in diameter; in soft softwoods structures	Carpenter bees	In structural timbers, siding, etc.	Nesting reoccurs annually in spring at same and nearby locations
NETWORK OF GALLERIES			
Systems of interconnected tunels and chambers			
A. Walls look polished; spaces completely clean of debris	Carpenter ants	Usually in damp, partly decayed, or soft-textured wood in use	Colony persists unless prolonged drying of wood occurs
B. Walls usually speckled with mud spots; some chambers may be filled with "clay"	Subterranean termites	In wood structures	Colony persists
C. Chambers contain pellets; areas may be walled-off by dark membrane	Drywood termites (occasionally dampwood termites)	In wood structures	Colony persists
Pitch pocket	Various insects	In living trees	In tree
Black check	Grubs of various insects	In living trees	In tree
Pith fleck	Fly maggots or adult weevils	In living trees	In tree
Gum spot	Grubs of various insects	In living trees	In tree

FIGURE 6–2

Western subterranean termites, Reticulitermes hesperus.



Soldiers have greatly enlarged heads and mandibles, which they use to defend their colonies. Workers, the most numerous caste in colonies of many termite species, are responsible for constructing living chambers and tunnels, and foraging for food. They also groom and feed one another and other colony members.

Other termite species, such as the drywood termites, are believed to be more primitive; they do not have a worker caste, so these functions are carried out by immature soldiers. Workers of the more advanced species probably evolved from this soldier caste. Reproductives are long-lived queens and kings, which are winged during their early adult life but lose their wings after dispersing from their original colony.

Significant communication among colony members takes place by means of messenger chemicals called pheromones. Individuals produce pheromones to mark trails, which are followed by other colony members. Hormones excreted into feces regulate the development of individuals that consume these materials while grooming, and are responsible for caste determination and suppression of reproductive functions.

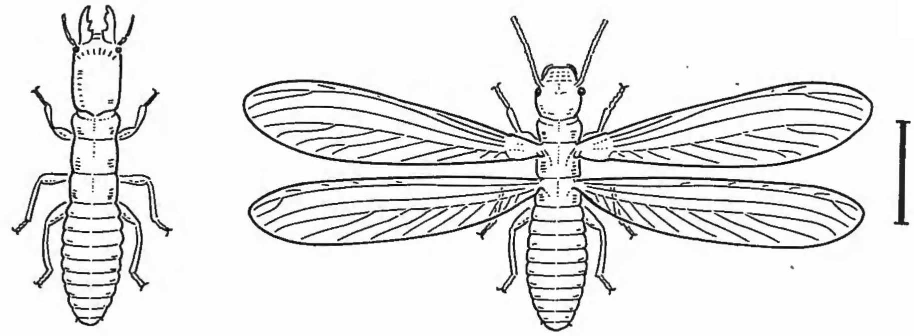
Most species of termites have protozoa in their intestines that convert wood cellulose into sugar, allowing termites to feed on wood or paper. Newly hatched nymphs and freshly molted individuals do not have these protozoa, but obtain them by ingesting excrement of other members of the colony.

Termites are long-lived and successful insects. Their success is probably due to exploitation of a large, almost unlimited supply of food and the hidden, obscure places they inhabit, protected from enemies and environmental extremes.

Termite pests in California include the drywood termites, the dampwood termites, and the subterranean termite. These pests cause serious damage to wooden structures and posts, and may also attack stored food, household furniture, and even plastics.

FIGURE 6–3

Western drywood termite, Incisitermes minor.



Western Drywood Termite
Incisitermes minor

Desert Drywood Termite
Marginitermes hubbardi

Drywood termites (Figure 6-3) are believed to be a more primitive species than other termites because they do not have a worker caste; nymphs destined to be soldiers assume this role. Drywood termites remain entirely above ground and do not connect their nests to the soil. They have low external moisture requirements resulting from efficient recycling of metabolic water, which allows them to tolerate dry conditions for prolonged periods.

Although colonies are small, they are long-lived and may exist for decades. An established colony contains several thousand individuals, compared to millions of individuals found in colonies of some other species. Colonies grow slowly and may have only 20 members after the first year.

Drywood termites are the most typical termite in southern California, but also occur along most coastal regions, the central valley, and southern desert.

Drywood termites infest dry, undecayed wood. This includes structural lumber, as well as dead limbs of native, shade, and orchard trees, utility poles, posts, and lumber in storage. From these areas, winged reproductives seasonally migrate to nearby buildings and other structures.

Mating and dispersal flights take place on sunny days during fall months. Usually, mated pairs enter buildings through attic vents, roof shingles, or openings around doors and windows. In hot, dry locations, they enter through foundation vents.

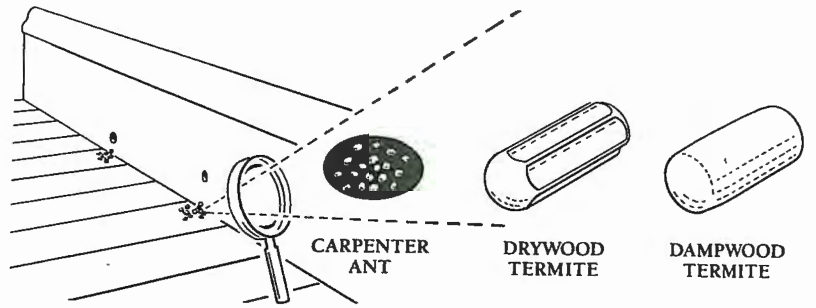
An infestation begins when the mated pair finds suitable wood and constructs a small chamber, which they enter and seal. Soon afterward, the female begins egg laying. Newly hatched nymphs start enlarging the nest.

Although colonies are commonly established in roof structures and attics, the substructure of a building may be invaded by mated pairs entering through foundation vents. Occasionally they are found in wooden boxes, crates, or furniture; because colonies are small and hard to see, they can be easily transported to other locations.

A sign of drywood termite infestation is the appearance of piles of fecal pellets coming from openings in infested wood. These openings are known as kickouts. Workers bore open kickouts and push accumulated debris out of the tunnels and galleries. Fecal pellets have a distinctive appearance, helping to distinguish drywood termites from subterranean or dampwood termites. Pellets are elongate with rounded ends, about 5/16 inch long, and have six flattened or roundly depressed surfaces separated by six longitudinal ridges (Figure 6-4).

FIGURE 6-4

The sawdust produced by carpenter ants is very different from the frass produced by termites.



Another sign of infestation is swarms of winged reproductives suddenly appearing in a building during warm fall days. Winged adults of western drywood termites are about 1/2 inch long. They are dark brown with smoky black wings, reddish brown head and thorax, and black wing veins. These insects are noticeably larger than subterranean termites. Winged forms of the desert drywood termite are pale. Soldiers of this species have a clublike third antennal segment nearly as long as all the succeeding segments combined, which easily distinguishes them from other species.

Western Subterranean Termite
Reticulitermes hesperus

Arid Land Subterranean Termite
Reticulitermes tibialis

Desert Subterranean Termite
Heterotermes aureus

The western subterranean termite (Figure 6-5) is likely the most destructive of all termites found in California. This is due to (1) the large number of individuals in a colony, (2) their habit of nesting in the soil, (3) the difficulty in detecting and controlling them, and (4) occurrence of much of their damage in foundation and structural support wood.

The arid land subterranean termite is commonly found in mountain and desert regions of California. In some areas of the San Joaquin Valley, both subterranean species occupy the same territory. *R. tibialis*, however, is better able to withstand more arid conditions, and is considered a much more aggressive fighter than *R. hesperus*.

Subterranean colonies include reproductive, worker, and soldier castes. Reproductive winged forms of subterranean termites are dark brown to brownish black, with brownish gray wings. They are about 3/16 to 1/4 inch long, excluding wings. Soldiers have white bodies with pale yellow heads.

FIGURE 6-5

The western subterranean termite, Reticulitermes hesperus, *is the most destructive of the termites found in California.*

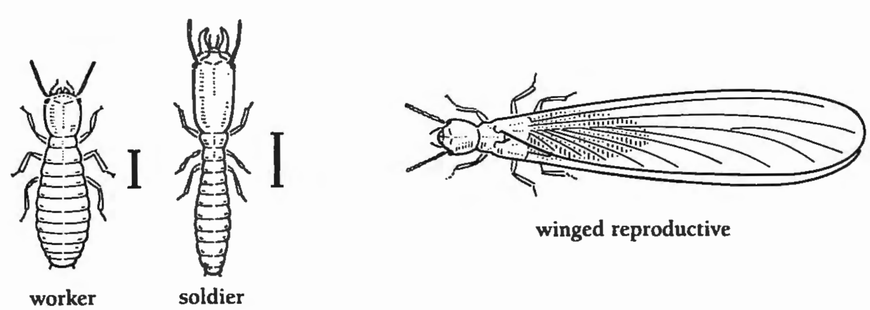
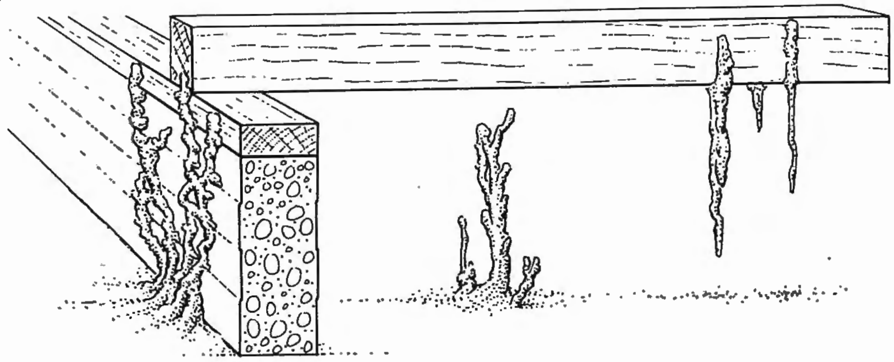


FIGURE 6–6

Subterranean termites construct four types of tubes or tunnels. Working tubes (left) are constructed from nests in the soil to wooden structures, and may travel up concrete or stone foundations. Swarming tubes are extensions of the working tubes. Exploratory and migratory tubes (center) arise from the soil but do not connect to wood structures. Drop tubes (right and below) extend from wooden structures back to the soil, and are typically comprised of more sawdust than the other types of tubes.



Their heads are long, narrow, and large, without eyes. Workers are slightly smaller than reproductives, wingless, and have a shorter head than soldiers; they are colored similar to soldiers.

Subterranean termites require moist environments. During dry periods, workers must periodically return to the soil to replenish their body moisture. To satisfy this need, they usually nest in or near the soil and maintain some connection with the soil through tunnels in wood or through construction of shelter tubes.

Four types of shelter tubes are made by subterranean termites (Figure 6-6). Working tubes are constructed out of soil that the termites bind with liquid fecal material and an excreted gluelike substance. These tubes connect nests located in the soil to wooden substructures, providing safe travel for workers by protecting them from natural enemies.

Exploratory or migratory tubes also arise from the soil, but do not usually connect to wooden structures above, as they are likely uncompleted working tubes, abandoned after workers were unable to locate a food source.

Suspended or drop tubes develop from wooden substructures and travel down to the soil. They are lighter in color than working and migratory tubes because they contain more wood particles. After establishing tunnels in wooden structures, workers construct drop tubes to make additional return routes to the nest or to humid soil.

Swarming tubes are specialized shelter tubes used as nest exit routes by reproductives during swarming flights. These tubes arise from the soil and may extend a considerable distance up onto wooden structures.

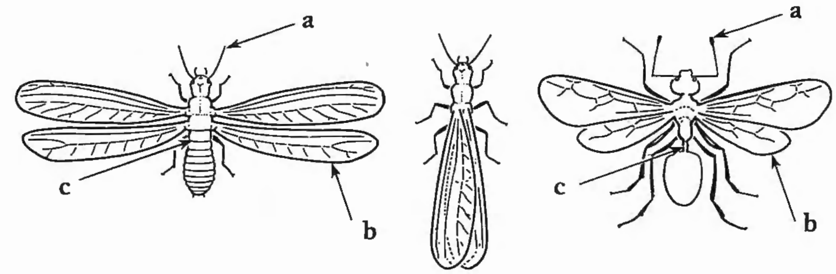
Signs of infestation include swarming of winged forms shortly after late fall and early winter rains. Swarming sometimes extends into spring due to late spring rains. People sometimes confuse winged termites with winged ants, but closer examination easily reveals the differences (Figure 6-7): the hind wings of termites are nearly as long as the forewings, whereas winged ants have much shorter hind wings, and the termite abdomen is broadly joined to the thorax, whereas winged ants have a very thin waist joining the abdomen to the thorax.

Western subterranean termites feed along the soft parts of wood and usually do not cross harder grains. This species produces liquid fecal material rather than dry pellets, so tunnels are characteristically stained by the liquid feces. Darkening or blistering of wooden members is another indication of an infestation; wood in damaged areas is typically thin and easily punctured with a knife or screwdriver.

In the southeastern part of California and well into Arizona, an extremely destructive species, *Heterotermes aureus*, accounts for considerable eco-

FIGURE 6–7

Winged termites are distinguished from winged ants by their straighter antennae (a), longer hind wings (b), and the broad connection of their abdomen to their thorax (c).



nomic loss, for which the *Reticulitermes* species often receive blame. The general appearance and method of attack of the desert subterranean termite, similar to the more common subterranean termite species, are the primary sources of this confusion. The soldiers are difficult to distinguish from *Reticulitermes*, although their mandibles are more slender and slightly longer than the latter. The adult reproductives are distinguished by their color, which is much paler than *Reticulitermes*.

Pacific Dampwood Termite
Zootermopsis angusticollis

Nevada Dampwood Termite
Zootermopsis nevadensis

Desert Dampwood Termite
Paraneotermes simplicicornis

Like drywood species, dampwood termites are a primitive group. They do not have a social organization as highly structured as the subterranean termites. These species have only two distinct castes, the reproductives and the soldiers (Figure 6-8), with nymphs performing the tasks of the worker caste.

Dampwood termites nest in wood buried in the ground, although contact with the ground is unnecessary when infested wood is high in moisture. These termites sometimes attack decaying wood. Sound wood in both dead and living trees is attacked by dampwood termites; they usually gain entry through the roots.

Because of their high moisture requirements, dampwood termites most often are found in cool, humid areas along the coast and are typical pests of beach houses. The Nevada dampwood termite, however, occurs in the higher, drier mountainous areas of the Sierra, where it is an occasional pest of mountain cabins and other forest structures. It also occurs along the northern California coast.

All species of dampwood termites produce distinctive fecal pellets that can be used for their identification (see Figure 6-4). Dampwood termite pellets are rounded at both ends, elongate, but lack clear longitudinal ridges; flattened sides are noticeable. Pellets are expelled through kickouts, although in damper areas they clump together and remain stored in unused tunnels.

Dampwood termites are the largest of the termites occurring in California. Winged reproductives are nearly an inch long and are dark brown with brown wings. Typically swarming between July and October, it is not unusual to see winged reproductives at other times of the year. Soldiers have a flattened brown or yellowish brown head with elongated black or dark brown mandibles. Nymphs are cream-colored and have a characteristic spotted abdominal pattern caused by food in their intestines.

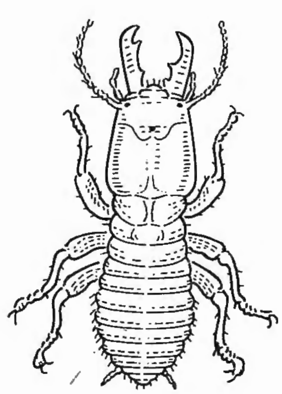


FIGURE 6-8

Pacific dampwood termite, Zootermopsis angusticollis.

Nevada dampwood termites are slightly smaller and darker; reproductives are about 3/4 inch long.

The desert dampwood termite, *Paraneotermes simplicicornis*, was initially labeled as a drywood termite, due to the similarity of its infestation in the wood. The desert dampwood, however, differs from the drywood termites in that colonizing pairs cannot enter wood above the ground as do drywoods, requiring wood that is partly or entirely buried for entry (a true dampwood trait). *P. simplicicornis* differs from subterranean termites in that it does not build covered shelter tubes to reach wood above ground. This species is a common cause of damage to untreated poles and posts.

WOOD-DESTROYING FUNGI

Wood decay is a serious problem in buildings (Figure 6-9), often closely associated with termite infestations and occasionally confused with termite damage. More damage is caused to structures by wood decay than by termites and wood-boring beetles combined. Moist conditions suitable for dampwood and subterranean termite infestations are also ideal for wood decay organisms.

Structural wood gets its strength from the compact arrangement of once-living cells that are tightly bound together by rigid cell walls. Wood decay fungi penetrate and destroy cell walls by dissolving them with enzymes. Cell walls and contents of cells are used by fungal organisms for food. Wood attacked by the brown rot type of decay fungi is soft and crumbly, and breaks into many small square or rectangular pieces, usually denoted by a dark brownish discoloration. This is the major form of decay found in structural wood. A condition called dry rot results from wood decay fungi. The name is inappropriate because moisture levels must be high at some time to support the growth of the fungus causing the rot, but a few "water conducting" fungi can transport moisture from soil contact and attach to otherwise dry wood.

Fungi reproduce and spread by transport of hyphal fragments (the filaments that comprise the "body" of the fungi) or by producing large quantities of spores, seedlike structures that develop into new fungal organisms (Figure 6-10). Wood in contact with soil or rotting wood will be infected by growing hyphae. Spores are small and easily carried through the air, even on slight air currents. Spores can also be dispersed by free water, such as rainfall or irrigation, or by insects.

Resistant to temperature extremes, some spores can withstand long periods of time without moisture. When temperature and moisture conditions become adequate, however, spores develop into fungal organisms. Wood must have a regular moisture content of at least the fiber saturation point (25 to 30 percent) before it can support fungal growth. Maintaining low levels of moisture in wood is the most effective control method for minimizing wood decay.

Wood Rot

Only a few species of decay or rot fungi infest structural wood, although several other types of fungi may be associated with them. Wood decay organisms include brown-rot fungi, water-conducting or dry-rot fungi (which also produce brown rot), and white-rot fungi. White rots can be distinguished by the bleached appearance of the attacked wood. Soft rot, a type of degradation caused by non-decay fungi and resembling superficial brown rot, is found in very wet situations and causes a gradual softening from the surface inward. Soft rot may also degrade wood otherwise treated sufficiently to protect it from decay organisms. The brown-rot and water-conducting rot organisms are typically responsible for most structural damage; both of these impart a characteristic brown color to infected wood.

Water-conducting organisms are different because they produce long, fibrous water-carrying structures called rhizomorphs. These rootlike structures enable fungal organisms to invade drier wood far from a moisture source.

Mildews, Blue-Stain Fungi, and Slime Molds

Mildews, blue-stain fungi, and slime molds are associated with wood decay fungi (Figure 6-11). Mildews cause discoloration of wood, but do not themselves cause structural damage. Mildew stains can usually be removed by sanding or scrubbing.

Blue-stain fungi produce a blue stain in sapwood that cannot be removed. Slime molds appear like drops of egg white on damp surfaces at certain times, while at other times resembling brightly colored mushrooms. Because they feed on spores and bacteria, slime molds are important indicators of conditions suitable for the growth and development of wood decay fungi, yet they do not cause wood damage.

Mildews and blue-stain fungi are also indicators of conditions that promote the growth of decay fungi.

FIGURE 6–9

Wood decay is a serious problem in buildings, often closely associated with termite infestations. Decay can be confused with termite damage. Inspection and maintenance of exposed wood structures is important to preventing decay.

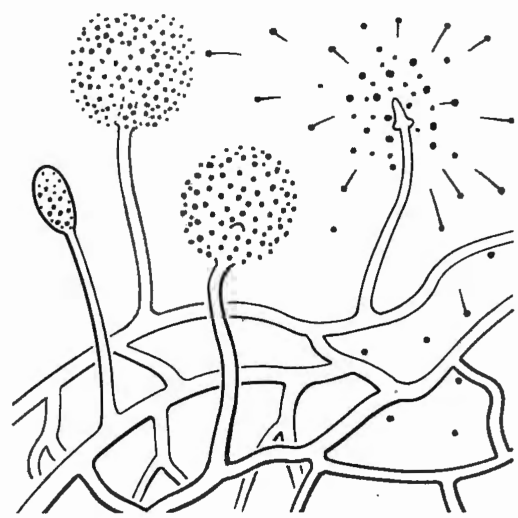
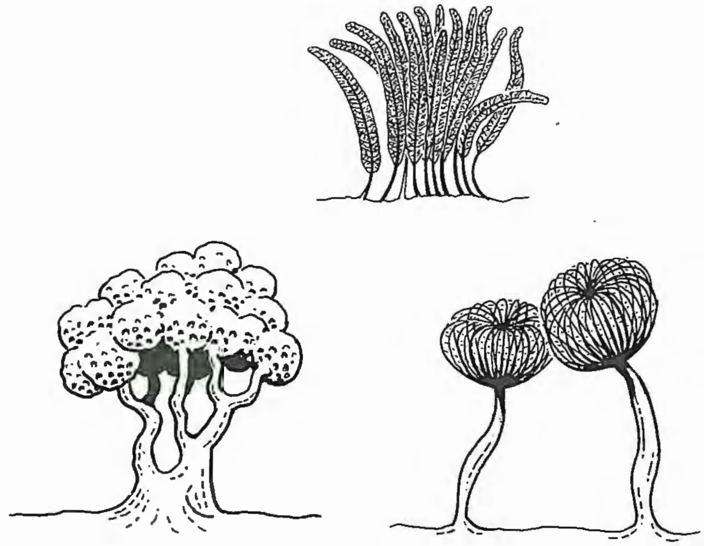


FIGURE 6–10

Examples of the varied structure of fungus hyphal fragments and spores.

FIGURE 6–11

Examples of mold structures, which cause discoloration but no structural damage to wood. Presence of molds, however, can indicate conditions that promote wood decay.



WOOD-DESTROYING ANTS AND BEES

Carpenter ants and carpenter bees occasionally cause damage to structures and require control.

Carpenter Ants
***Camponotus* spp.**

Several species of carpenter ants (Figure 6-12) are capable of damaging wood in buildings and other structures. These cause problems mainly in rural mountainous and forested areas, although they may also invade buildings in urban locations.

Carpenter ants are easily distinguished from other species of ants by their large size, up to 1/2 inch long. Most species are dark, often black, with a single node on the pedicel. Carpenter ants cannot sting, but if handled can inflict a painful bite with their powerful jaws. Some emit a noxious excretion of formic acid when disturbed.

Carpenter ants feed on dead and living insects, aphid and scale honeydew, and juices of ripe fruit. Entering buildings in search of food or water, these ants may construct nests containing several thousand individuals somewhere within the building. Nests constructed indoors may be satellite colonies of a larger nest located outside near the building, usually in trees.

Insect growth regulators are the only materials found to successfully kill entire nests.

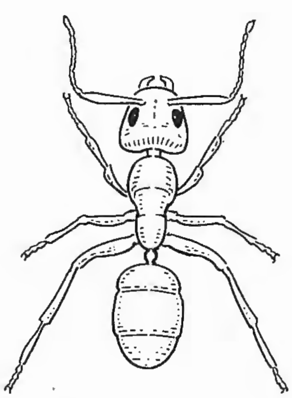


FIGURE 6–12

Carpenter ant, Camponotus spp. *Carpenter ant infestations, while much more rare than termites, are difficult and expensive to treat.*

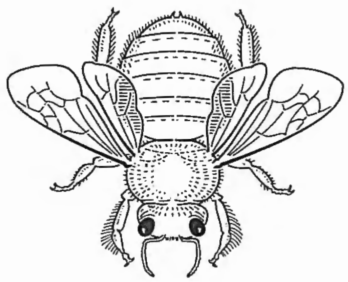


FIGURE 6–13

Carpenter bee, Xylocopa *spp.*

Although ants do not eat wood, they bore into wood to make their nests, which consist of extensive networks of galleries usually begun in areas soft from decay. Indoor carpenter ant nests are bored into wood parts of the building, sometimes causing serious structural damage. They also nest in wall voids, hollow doors, cracks and crevices, furniture, and termite galleries.

Infestations can occur in new buildings when land clearing in the area disturbs existing native colonies. In the wild, carpenter ants nest in the soil, beneath rocks, and in living and dead trees and tree stumps.

Carpenter Bees
Xylocopa spp.

Most carpenter bees are large and robust insects resembling bumble bees (Figure 6-13). They are usually about 1 inch long and colored metallic blue black with green or purplish reflections. They differ from bumble bees by having a shiny, hairless abdomen. Males of some species are lighter, ranging into golden or buff hues.

The presence of carpenter bees around buildings and wooden structures can be annoying or even frightening, although males cannot sting and females rarely attack. However, these bees cause damage to wooden structures by boring into timbers and siding to prepare nests. Sound, undecayed wood without paint or bark is usually selected for nests; carpenter bees frequently attack southern yellow pine, white pine, redwood, cedar, and cypress. They avoid most harder woods.

Nests usually consist of tunnels 1/2 inch in diameter and 6 to 10 inches deep, partitioned into several chambers, each containing an egg and a supply of food. Carpenter bees may use old tunnels for their nests, and sometimes enlarge these; several bees may use a common entry hole connecting to different tunnels. Over a period of time, tunnels may extend as far as 10 feet into wood timbers, weakening structural wood and leaving unsightly holes and stains on building surfaces. Tunnels are vacated after the brood's larval and pupal stages, remaining empty throughout the rest of the year.

WOOD-BORING BEETLES

Wood-boring beetle larvae feed on wood and wood products; adults emerge from larval feeding chambers through round, oblong, or D-shaped exit holes. Adults of some species also bore holes into plaster, plastic, and soft metals. Many species of wood-boring beetles, especially those in the family Buprestidae (flatheaded or metallic wood borers) or the family Cerambycidae (which include the longhorned beetles and roundheaded wood borers), infest living trees but do not reinfest lumber or wood products. Three families of beetles have species of wood borers that invade and damage structural and decorative wood and furniture. These families are the Lyctidae, Anobiidae, and Bostrichidae.

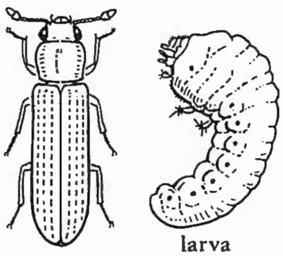


FIGURE 6–14

Powderpost beetle, Lyctus *spp.*

Powderpost Beetles
Family Lyctidae

Beetles in the family Lyctidae are known as powderpost beetles (Figure 6-14). They are so named because larvae leave a fine, dustlike powdered frass in their galleries that occasionally falls out of exit holes into small piles on floors or other surfaces. This powdered frass distinguishes powderpost beetles from the other typical wood-boring beetles.

Lyctids attack hardwood species and bamboo products, apparently because these woods have pores into which they can oviposit. Softwoods do not have such pores. Also, the starch content in softwoods is nutritionally low for these beetles. Lyctids most often attack oak, ash, hickory, mahogany, and walnut.

Adult lyctids range from 1/8 to 1/3 inch in length, depending on species, and are usually brownish to reddish. They have a life cycle ranging from 3 months to over 1 year, depending on temperature, humidity, and the nutritional quality of the wood.

Infestations may occur if beetles or larvae are brought into a building in furniture or firewood. Sometimes the only sign of infestation may be the tiny, round exit holes made by emerging adult beetles. Once they emerge, the winged adult beetles spread to other wood surfaces where they deposit eggs onto unfinished surfaces or in cracks or other openings.

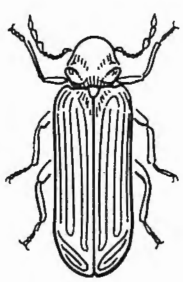


FIGURE 6–15

Deathwatch beetle, family Anobiidae.

Deathwatch Beetles
Family Anobiidae

Wood-boring beetles in the family Anobiidae are known as deathwatch beetles (Figure 6-15). Adults communicate with each other and probably locate mates by tapping their heads against wood, usually at night. (Deathwatch beetles supposedly acquired this name from people who have heard the tapping while sitting up with a sick or dying person during the night.)

Adult anobiids are 1/16 to 1/4 inch in length and reddish to dark brown. Adults lay eggs in crevices or small openings or pores in unfinished wood. Two years may be required to complete each generation.

Larvae of deathwatch beetles fill their galleries with small pellets of frass—smaller than the pellets produced by drywood termites—which distinguish them from other wood borers. None of the other boring beetles produces pelletized frass.

Deathwatch beetles are found primarily in soft woods, including girders, beams, foundation timbers (especially in areas with high moisture), and some types of furniture. Some species attack books. This beetle is typically found in old wood and may be associated with wood that is partially decayed.

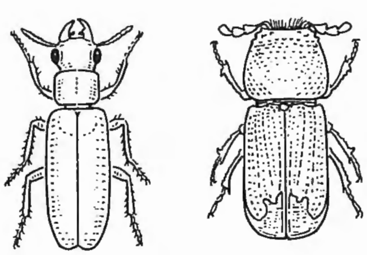


FIGURE 6–16

False powderpost beetles, family Bostrichidae (left). Leadcable borer, Scobicia declivis.

False Powderpost Beetles
Family Bostrichidae

Wood-boring beetles in the family Bostrichidae (Figure 6-16) are sometimes known as false powderpost beetles. Larvae tightly pack their galleries with frass that has the consistency of coarse powder; this coarse texture distinguishes them from true powderpost beetles and deathwatch beetles.

Adults are about 1/4 inch long, mostly dark brown or black, sometimes with reddish mouthparts, legs, and antennae. Some species are large, adults reaching 1 1/2 to 2 inches in length. Adult beetles have a humpback appearance, so their head is not visible when viewed from above. This characteristic is also seen in some other wood-boring beetles.

Females bore a tunnel, or egg gallery, into wood or other materials, then deposit their eggs in pores or cracks within the tunnel. In buildings, the false powderpost beetles infest floors, furniture, hardwood paneling, and other wood materials.

Adults of some species bore through soft metal, such as lead and silver, as well as plaster and other nonwood materials, searching for sites to deposit eggs or for protection from weather extremes. This gives rise to the common name "leadcable borer" given to one species because of its habit of boring into the metal covering of suspended telephone wires.

Refer to Volume 2 of the Pesticide Application Compendium—*Residential, Industrial, and Institutional Pest Control*—for a detailed discussion of these wood-destroying pests.

Other Wood-Boring Beetles

Several other species of beetles are considered wood-borers, and are occasionally found as structural pests. These include the families Buprestidae (flatheaded and metallic wood borers), Cerambycidae (roundheaded wood-borers and longhorned beetles), Scolytidae (bark and engraver beetles), Curculionidae (wood-boring weevils and snout beetles), and Platypodidae (ambrosia beetles). These beetles are considered to be greater pests of forests and timber, however, and with some minor exceptions are generally not considered reinfesters of lumber and structures.

MARINE BORERS

Wood exposed to seawater or brackish (Figure 6-17) waters is subject to damage or destruction by two types of marine borers: molluscan borers, related to oysters and clams; and crustacean borers, relatives of lobsters and crabs.

FIGURE 6–17

Steel-hulled ships were an important development in control of marine borer damage to ocean-going vessels. Victory over the British in the American Revolution was attributed in part to severe marine borer attacks and decay damage to the British fleet.

Molluscan Borers (Bivalves)

European Shipworm
Teredo navalis

Northwest Shipworm
Bankia setacea

Molluscan borers are related to and resemble clams. They occur along the coasts of the Gulf of Mexico and the Pacific Ocean in the contiguous United States, and the Hawaiian coasts. Along the Pacific coast, they are wormlike, commonly called shipworms.

Shipworms hatch from eggs into free-swimming larvae that search for suitable wood, into which they make a small entrance hole. Once inside, shipworms enlarge the hole into a chamber where they remain throughout their life. They feed on wood from within the chamber and on minute organic particles and plankton. Large infestations of these molluscan borers severely weaken or destroy pilings, wooden boats, docks, and other wooden objects (Figure 6-18).

FIGURE 6–18

Molluscan borer damage, as seen here, can severely weaken or destroy wooden structures in contact with seawater or brackish water.

FIGURE 6–19

Prolonged attack by crustacean borers and erosion can give piers an hourglass shape.

Crustacean Borers (Isopods)

Gribble
Limnoria lignorum
Limnoria quadripunctata
Limnoria tripunctata

Crustacean borers, which are related to garden pillbugs, are distinctly different from molluscan borers in appearance and habits, as well as the damage they cause to wood. They do not become imprisoned inside the wood they invade. They make narrow galleries that seldom extend very far below the surface.

Under conditions of heavy infestation, the outer shell of the attacked wood becomes thoroughly honeycombed. This layer is gradually eroded due to wave action and the battering of floating debris, exposing new wood to attack. The location of attack is usually limited to an area on pilings between mid-tide and low-tide levels. Prolonged attack and erosion give pilings a characteristic hourglass shape (Figure 6-19). Eventually, enough wood is removed to make the wooden structure useless.

Protection against marine borers is achieved by using properly treated wood. Creosote has proved to be a highly effective material for protecting pilings, docks, and other wooden structures in coastal or brackish waters. Compounds containing creosote prolong the useful life of wooden structures to 15 to 30 years. Without treatment, wooden structures may be destroyed within 6 months to a few years. Metal and concrete barriers used in the intertidal zone have been an effective control method.

Special paints are used to protect wooden boats from borer damage and to repel other crustaceans. See the Pesticide Application Compendium volume *Antifouling Paint Practices* for additional information on this subject.

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Glossary

Defined below are some of the terms used in this manual. Definitions were taken mainly from *Wood Handbook: Wood as an Engineering Material*, USDA Agricultural Handbook No. 72, revised 1974.

air-dried. seasoned or dried by exposure to air in a yard or shed, without artificial heat.

American lumber standards. provisions for softwood lumber dealing with recognized classifications, nomenclature, basic grades, sizes, description, measurements, tally, shipping provisions, grademaking, and inspection of lumber. These standards serve as a guide in the preparation or revision of the grading rules of the various lumber manufacturers' associations. A purchaser must, however, make use of association rules because the basic standards are not commercial rules.

bloom. crystals formed on the surface of treated wood by exudation and evaporation of the solvent in preservation solutions.

blue stain. a blue or gray discoloration of the sapwood caused by the growth of certain dark-colored fungi on the surface and in the interior of the wood; made possible by the same conditions that favor the growth of other fungi.

brown rot. any wood decay in which the attack concentrates on the cellulose and associated carbohydrates rather than on the lignin, producing a light to dark brown friable residue—hence loosely termed "dry rot." An advanced stage where the wood splits along rectangular planes is termed "cubical rot."

brown stain. a rich brown to deep chocolate-brown discoloration of the sapwood of some pines caused by a fungus that acts much like the blue-stain fungi.

cambium. a thin layer of tissue between the bark and wood that repeatedly subdivides to form new wood and bark cells.

cellulose. the carbohydrate that is the principal constituent of wood, which forms the framework of the wood cells.

check. a lengthwise separation of the wood that usually extends across the rings of annual growth and commonly results from stress in wood during seasoning.

chemical brown stain. a chemical discoloration of wood that sometimes occurs during the air drying or kiln drying of several species, apparently the result of the concentration and modification of extractives.

collapse. the flattening of single cells or rows of cells in heartwood during the drying or pressure treatment of wood. Often characterized by a caved-in or corrugated appearance of the wood surface.

creosote. a pungent, oily liquid distilled from wood tar or coal tar, commonly used as a wood preservative. Placed on the Environmental Protection Agency list of "Restricted Use" chemicals in 1984.

curing time. the period of time an assembly of lumber is subjected to heat or pressure, or both, to cure a preservative. Also called "setting time."

decay. the decomposition of wood substance by fungi. In advanced (or typical) decay, the wood has become punky, soft and spongy, stringy, ringshaked, pitted, or crumbly. Decided discoloration or bleaching of the rotted wood is often apparent. In incipient decay, the decay has not proceeded far enough to soften or otherwise perceptibly impair the hardness of the wood. It is usually accompanied by a slight discoloration or bleaching.

density. the mass of wood substance enclosed within a unit volume. It is variously expressed as pounds per cubic foot, kilograms per cubic meter, or grams per cubic centimeter at a specified moisture content.

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

empty-cell process. any process for impregnating wood with preservatives or chemicals in which air, imprisoned in the wood under pressure, expands when pressure is released to drive out part of the injected preservative or chemical. The distinguishing characteristic of the empty-cell process is that no vacuum is drawn before applying the preservative. The aim is to obtain good preservation distribution in the wood and leave the cell cavities only partially filled.

full-cell process. any process for impregnating wood with preservatives or chemicals in which a vacuum is drawn to remove air from the wood before admitting the preservative. This favors heavy adsorption and retention of preservative in the treated portion.

green. freshly sawed 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.

heart rot. any rot characteristically confined to the heartwood. It generally originates in the living tree.

heartwood. the wood extending from the pith 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 air flow, temperature, and relative humidity for drying lumber, veneer, and other wood products.

kiln-dried. dried in a kiln with the use of artificial heat.

lignin. the second most abundant constituent of wood, located principally in the secondary wall and the middle lamella—the thin cementing layer between wood cells.

modified wood. wood processed by chemical treatment, compression, or other means (with or without heat) to impart properties quite different from those of the original wood.

moisture content. the amount of water contained in the wood, usually expressed as a percentage of the weight of the oven-dried wood.

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

pentachlorophenol. a powder produced by chlorinating phenol and used as a wood preservative. In 1984, placed on the Environmental Protection Agency list of "Restricted Use" chemicals for use as a wood preservative.

pocket rot. advanced decay that appears in the form of a hole or pocket, usually surrounded by apparently sound wood.

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.

pressure process. any process of treating wood in a closed container whereby the preservative is forced into the wood under pressures greater than one atmosphere. Pressure is generally preceded or followed by vacuum, as in vacuum-pressure and empty-cell processes respectively; or high and low pressures may be alternated, as in the full-cell and alternating-pressure processes.

rot. see **decay.**

sapwood, the wood of pale color near the outside of a timber and just under the bark. Under most conditions, the 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.

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

softwoods. generally, one of the botanical groups of trees that in most cases have needlelike or scalelike leaves—the conifers; also the wood produced by such trees. The term has no reference to the actual hardness of the wood.

stain. a discoloration in wood that may be caused by such diverse agencies as microorganisms, metal, or chemicals. The term also applies to materials used to impart color to wood.

stickers. strips or boards used to separate the layers of stacked lumber, thus improving air circulation.

sticker stain. a brown or blue stain that develops in seasoning lumber where it has been in contact with the stickers.

water repellent. a liquid that penetrates wood, which, after drying, retards changes in moisture content and dimensions without adversely altering the desirable properties of wood.

water-repellent preservative. a water repellent containing a preservative that, after application to wood and drying, accomplishes the dual purpose of imparting resistance to attack by fungi or insects, while also retarding changes in moisture content.

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 the wind, and the alternate shrinking and swelling of the surface fibers with the continual variation in temperature and moisture content brought by changes in the weather. Weathering does not include decay.

white rot. any wood decay attacking both the cellulose and lignin, while producing a generally whitish residue that may be spongy or stringy rot, or occur as pocket rot.

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