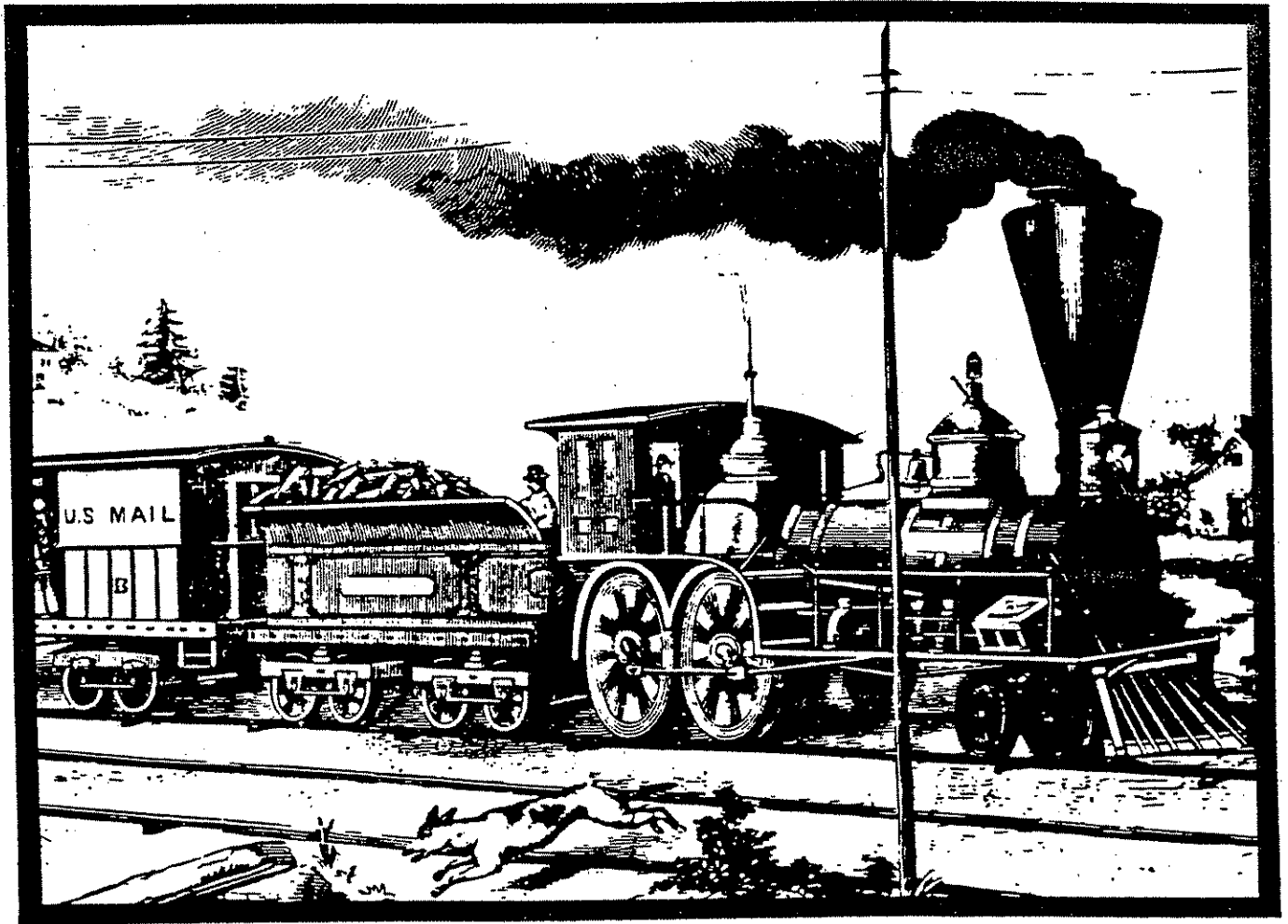


THE PRESERVATION OF WOOD



PROTECTION FROM WOOD-DESTROYING ORGANISMS

I. Introduction

Throughout history the strength, natural beauty and comparative abundance of wood, and the fact that it is a renewable resource, have made it a desirable material for structures, furniture, tools and objects of art. Chemically, wood is composed of complex carbohydrates (cellulose and hemi-cellulose which are composed of simple sugars); lignin, a complex macromolecule composed largely of phenolic compounds; extractives (resins, tannins, pigments, essential oils, fats, waxes, gums, starch) and mineral matter.

With such a varied assortment of chemicals, and given favorable environmental conditions, one would expect wood to be attractive to decomposing organisms, and indeed this is so. Wood can be attacked by insects, marine borers, fungi and bacteria. The economic importance of these attackers varies with environmental conditions as well as practical considerations. Nature has its own methods of preserving wood in the variations among species of trees and between the sapwood and heartwood regions within a given tree. Sapwood, located next to the growing cambium layer just under the bark, represents the living part of the tree and is less resistant to attack than is the heartwood. The inner heartwood near the center of the tree is less resistant than the outer layers of the heartwood, which contain chemicals such as phenols that act as natural preservatives.

Older, slow-growing trees from virgin stands of timber generally contained higher concentrations of those natural preservatives than do younger faster-growing replacement trees; hence, older structures tended to be more durable than wood structures built in modern times. In essence, the treatment of wood with chemical preservatives extends and supplements the natural preservatives and is in some measure a need brought about by modern living and population

pressures, as is the use of other types of pesticides to protect food and fiber crops.

"Resistance" is a relative term. Under no circumstances does high natural resistance mean total immunity. All woods are to some degree susceptible to attack by wood-destroying organisms; some are just less susceptible, i.e., more resistant, than others. Domestic woods have been grouped according to heartwood decay resistance by the USDA Forest Service. These groupings are reprinted in the following table.

Table 1.--Grouping of some domestic woods according to heartwood decay

Resistant or very resistant	Moderately resistant	Slightly or nonresistant
Baldcypress (old growth) ¹	Baldcypress (young growth) ¹	Alder
Catalpa	Douglas-fir	Ashes
Cedars	Honeylocust	Basswood
Cherry, black	Larch, western	Beech
Cypress, Arizona	Oak, swamp	Birches
Junipers	chestnut	Buckeye
Locust, black ²	Pine, eastern	Butternut
Mesquite	white ¹	Cottonwood
Mulberry, red ²	Southern pine:	Elms
Oak:	Longleaf ¹	Hackberry
Bur	Slash ¹	Hemlocks
Chestnut	Tamarack	Hickories
Gambel		Magnolia
Oregon white		Maples
Post		Oak (red and black species)
White		Pines
Osage orange ²		(other than longleaf, slash, and eastern white)
Redwood		Poplars
Sassafras		Spruces
Walnut, black		Sweetgum
Yew, Pacific ²		True firs (western and eastern)
		Willows
		Yellow-poplar

¹The southern and eastern pines and baldcypress are now largely second growth with a large proportion of sapwood. Consequently, substantial quantities of heartwood lumber of these species are not available.

²These woods have exceptionally high decay resistance.

Ref.: USDA Wood Handbook, Agriculture Handbook No. 72.

II. Preparation of Wood for Treatment

Structurally, wood is made up of cells of various sizes and shapes. In softwoods (generally conifers), long thin cells lie parallel to the vertical axis of the tree trunk; other cells lie across the trunk. In hardwood trees (generally deciduous) the organization of the cells is more complex. In the growing tree, the cells serve to store water, food reserves and extractives. Free water is inside the cells and bound water is held in the cell walls. Green wood as it comes from the forest contains a large amount of water. The high moisture content not only makes the wood attractive to wood-destroying organisms but also renders it less able to absorb liquid wood preservative chemicals in quantities sufficient to protect it from those organisms. If wood is treated wet, further drying after treatment can result in surface checking and end cracking at that time. Except in specialized situations involving unpeeled or green material, green wood should be peeled and either seasoned or similarly conditioned before the preservative is applied.

The moisture content (MC) of wood is usually expressed as a percentage of the weight of the wood after it has been oven-dried at about 216 degrees Fahrenheit. To calculate MC, wood must be weighed accurately before and after drying. The MC calculation formula is:

$$\% \text{ MC} = \frac{\text{weight of wood wet) - (weight of wood dry)}{\text{weight of wood dry}} \times 100$$

or

$$\% \text{ MC} = \frac{\text{weight of water}}{\text{weight of wood dry}} \times 100$$

Thus, if fresh wood contains a large amount of water and the oven dried weight is less than half of the wet weight, the MC is a figure greater than 100%. The moisture content of fresh wood from living trees can range from 30% to more than 200%.

Drying in itself offers some protection against wood-decaying organisms. Decay-producing fungi do little damage in wood that has a moisture content under 20% and do the most serious damage at MC's above 30%, up to the point of saturation, which is too wet for favorable fungal growth.

Peeling. Except in special situations, all the bark should be peeled off of round or slabbed wood products to enable the wood to dry quickly enough to avoid decay and insect damage and to allow the preservative to penetrate the wood satisfactorily. Bark obstructs penetration. Machines are available for peeling round timbers.

Air-drying. Air-drying is a widely used, effective and inexpensive method of conditioning. It may, however, be difficult under warm, wet climatic conditions. Wood can absorb moisture from rain or from air that is excessively humid. Wood should be dried as quickly as possible; the time will vary, depending on climate, location and condition of the seasoning yard, methods of piling, season of the year, and size and species of the timbers. Air-drying yards and sheds should be located on well-drained sites with good air circulation. The premises should be kept free of weeds, debris and rotted wood which may serve to retain moisture or as sources of fungal infection or insect infestation. The wood should be inspected often for such damage, and handled carefully to prevent mechanical damage.

Kiln drying. Kiln drying offers better control of air movement, temperature and drying rate than does air drying. It is also more expensive and quicker, and is used for materials of substantial value.

Conditioning Green Wood for Pressure Treatment. Besides drying, other conditioning methods can be used to condition green wood for pressure treatment. 1). In the steaming and vacuum process, green wood is first steamed in a cylinder or retort, then subjected to a vacuum that removes the water in the

wood by evaporation, after which the water is replaced by preservative applied under pressure. 2). In the Boulton process, creosote is introduced into a treatment cylinder at the same time that water is being removed under a vacuum. This process is carried out at a lower temperature than the steaming and vacuum process and is safer for some species of wood. 3). In vapor drying, green wood is exposed to an organic chemical such as xylene, which gradually vaporizes and removes the water.

Incising. A series of narrow holes or slits are made in the wood about 1/2 to 3/4 inch deep to allow better penetration of preservatives.

Cutting and Framing. Cutting, shaping, or boring the wood for its intended use before preservatives are applied can prevent exposure of untreated surfaces that result if these processes are done after treatment.

III. Methods of Applying Wood Preservatives

The two major types of wood preservative treatment are pressure and non-pressure methods.

Pressure. In pressure treatment, wood is treated by placing it in an air-tight steel cylinder and immersing it in a preservative under pressure to drive the preservative into the wood. Two variations are employed, the full cell and the empty cell processes.

The full cell process provides for maximum retention of the preservative. This is accomplished by applying a preliminary vacuum to wood in the cylinder to remove as much air as possible from the cells of the wood, so that it will accept more liquid preservative, which is then heated and admitted to the cylinder without adding air. Pressure is then applied until the required amount of preservative is retained by the wood.

The empty-cell process obtains deep penetration with a relatively low retention of preservative. The wood in the cylinder is first subjected to air

under pressure. Then the preservative is forced into the cylinder and air escapes into an equalizer tank at a rate that keeps pressure in the cylinder constant. When the cylinder is filled with preservative the pressure is elevated until the required amount of preservative has entered the wood.

Pressure treatment has several advantages over the non-pressure processes. They are: 1) deeper and more uniform penetration

2) better control over retention

3) wood can be pre-conditioned in the treatment chamber

4) increased speed and reliability

5) more easily controlled and regulated

The effectiveness of a wood preservative depends to a large extent on the two factors penetration and retention. The depth of penetration depends on the tree species, the proportion of sapwood to heartwood and the treatment process used. The sapwood of most species is fairly easily penetrated when well-dried and pressure treated; heartwood is more variable.

Even with the proper preservative penetration, good protection cannot be achieved unless enough preservative stays in the wood. Retention is measured in pounds per cubic foot (lbs./cu.ft.) of wood. For example, the minimum retention of creosote for lumber used in coastal (salt) waters is 25 lbs./cu. ft. (AWPA C-2), while for similar wood products in fresh water only 10 lbs. of creosote/ cu. ft. is required. By contrast, water soluble salt preservatives only require retentions of 0.2 lbs. to 2.25 lbs./cu. ft. depending on use.

Non-pressure processes include superficial applications such as brushing, spraying, pouring and dipping; cold soaking, steeping, hot and cold bath (thermal process); diffusion, vacuum process, and preservative pads or bandages. These processes differ widely in the penetrations and retentions of preservative attained. Generally speaking, pressure treatment gives better protection than

non-pressure; however, the latter may be satisfactory where pressure treatment is impractical, or in situations where less protection is required.

Brushing, spraying, and pouring are generally done on cut or machined surfaces of previously treated wood. Penetration of preservative into wood is superficial, resulting mostly from capillary action. Creosote or other oil-borne materials and water borne salts can be used. They should be applied at a temperature warm to permit as much penetration as the process allows; enough liquid should be used to cover the wood surface thoroughly, and care is taken to fill checks and depressions in the wood. Rough lumber may require 10 gallons of liquid per 1000 square feet of surface; finished lumber, less. A second application, made after the first has dried is desirable. Wood thus treated and used in contact with soil may be protected for one to five years.

Dipping consists of immersing wood in a preservative solution for a time period ranging from several seconds to several minutes. It allows better penetration into checks and cracks of wood but is unsatisfactory for uses subject to abrasion. It gives little protection against termites and is not recommended for wood used in contact with the ground, but only for such uses as window frames.

Cold soaking well-seasoned wood for a period of 2 to 7 days in a vat containing a low-viscosity oil-borne preservative is simple and relatively inexpensive. It is considered to give more protection than dipping.

Steeping for several days in a tank full of water-borne preservative can be done on either green or seasoned wood. Penetrations and retentions vary depending on the types of wood and conditions.

Thermal process treatment consists of immersing wood alternately in separate tanks containing heated and cold preservative, either oil- or water-borne (or in one tank which is first heated than allowed to cool). During the

hot bath, air in the wood expands and some is forced out, and the heat improves penetration of preservatives. In the cold bath, air in the wood contracts, creating a partial vacuum and atmospheric pressure forces more preservative into the wood. Temperature is critical; only preservatives that can safely be heated should be used in the thermal process.

In the double diffusion process, green or partially seasoned wood is soaked first in one water-borne preservative, then in another. The two chemicals diffuse into the wood and then react to form a combination that is highly resistant to leaching. The process converts leachable preservatives into stable ones.

In the vacuum process, wood is enclosed in an airtight container and air is removed from the wood with a vacuum pump. The preservative is then added without additional pressure or re-entry of air. A slight pressure is created which drives preservative into the wood.

Preservative pads or bandages constitute on-site treatment of wood previously treated which is nearing the end of its protection time, e.g., utility poles. The soil around the pole is removed and the preservative (oil- or water-borne or paste) is applied to the surface, injected or placed into drilled holes in the wood. The treated area is then wrapped ("bandaged") with heavy duty water-resistant paper or plastic film to contain the preservative at the site of application.

Sapstain prevention is a temporary treatment applied quickly to newly filled green wood, preferably within 24 hours after sawing. This is usually done at the sawmill by carrying the logs through a tank of treated solution to prevent growth of sapstain fungi which can attack cut wood quickly.

ORGANISMS THAT DEGRADE WOOD

Wood is subject to attack and degradation by fungi, insects, and marine borers. The organisms attack in a variety of ways, some utilizing wood substance for food, some for food and shelter, and others using it only for shelter. Wood treaters, in order to properly prescribe treatments and to assure proper performance of their treated products, must recognize and understand the nature of these wood attacking organisms.

Wood Destroying Fungi

Wood decay is caused by minute plants called fungi. These plants consist of microscopic threads called hyphae that are only visible to the naked eye when many of them occur together. The fruiting bodies (deadwood conks, mushrooms) of fungi from which their reproductive spores are distributed are easy to see. Some fungi merely discolor wood, but decay fungi can change the physical and chemical properties of wood, thus reducing the strength of the wood.

The many fungi that develop on or in wood can be divided into two major groups depending on the damage they cause:

- wood-destroying fungi (decay fungi),

- wood-staining fungi (sapstain fungi, mold fungi).

All fungi produce spores (analogous to tiny seeds), which are distributed by wind and water. The spores can infect moist wood during processing and use.

Fungi have certain basic requirements for growth on wood. They need:

- Food source - Wood substance (cellulose, hemicellulose, lignin).

Chemically treated wood is not a food source.

- Favorable temperature - usually ranging between 50° and 90° F.

The optimum is about 70° to 85° F. Wood is basically safe from decay at temperatures below 35° F and above 100° F.

- Adequate moisture - Fungi will not attack dry wood (i.e. moisture content

of 19% or less). Decay fungi require a wood moisture content (M.C.) of about 30% (the generally accepted fiber saturation point of wood). Thus, air dried wood, usually with a M.C. not exceeding 19% and kiln dried wood with a M.C. of 15% or less may be considered safe from fungal damage.

Adequate Oxygen - Fungi cannot live in water-saturated wood.

The sapwood and heartwood of the most tree species are susceptible to decay. Decay fungi may grow in the interior of the wood or appear on wood surfaces as fan-shaped patches of fine, threadlike, cottony growth or as rootlike shapes. The color of these growths may range from white through light brown, bright yellow, and dark brown. The spore-producing bodies may be mushrooms, shelf-like brackets, or structures with a flattened, crustlike appearance. Fine, threadlike fungal strands grow throughout the wood and digest parts of the wood as food. In time, the strength and other properties of the wood are destroyed.

Once decay has started in a piece of wood, the rate and extent of deterioration depends on the duration of favorable conditions for fungal growth. Decay will stop when the temperature of the wood is either too low or too high or when the moisture content is drier than the fungi's requirements. However, decay can resume when the temperature and moisture content become favorable again. Early decay sometimes is accompanied by discoloration and may be confused with stains caused by other fungi or by chemicals. Early decay is more easily noted on freshly exposed surfaces of unseasoned wood than on wood that has been exposed to and discolored by the weather.

Wood decay fungi can be grouped into three major categories:

brown rot (Poria monticola, Serpula lacrymans),

white rot (Phellinus megaloporus, Poria contigua), and

soft rot (Chaetomium globosum).

Brown rot - Fungi which cause brown rot are able to break down primarily the cellulose component of wood for food, leaving a brown residue of lignin. Brown-rotted wood can be greatly weakened even before decay can be seen. The final stage of wood decay by the brown rots can be identified by:

- the dark brown color of the wood,
- excessive shrinkage,
- cross-grain cracking, and
- the ease with which the dry wood substance can be crushed to a brown powder.

Brown-rot fungi are probably the most important cause of decay of softwoods used in above-ground construction in the United States. Brown rot decayed wood, when dry, is sometimes called "dry rot." This is a poor term, because wood must have moisture and will not decay when it is dry.

A few fungi that can decay relatively dry wood have water-conducting strands that are able to carry water from damp soil to wood in lumber piles or buildings. These fungi can decay wood that otherwise would be too dry for decay to occur. They sometimes are called the "dry rot fungi" or "water-conducting fungi."

White Rot - White-rot fungi, which break down both lignin and cellulose, have a bleaching effect which may make the damaged wood appear whiter than normal. Affected wood exhibits normal shrinkage and usually does not collapse or crack across the grain as with brown rot damage. It loses its strength gradually until it becomes spongy to the touch. White rot fungi

usually attack hardwood, but several species also decay softwoods.

Soft Rot - Soft rot fungi usually attack green (water-saturated) wood, causing a gradual shallow softening from the surface inward that resembles brown rot. The affected wood surface darkens and this superficial layer, up to 3-4 mm deep, becomes very soft, thus the name soft rot for this type of decay.

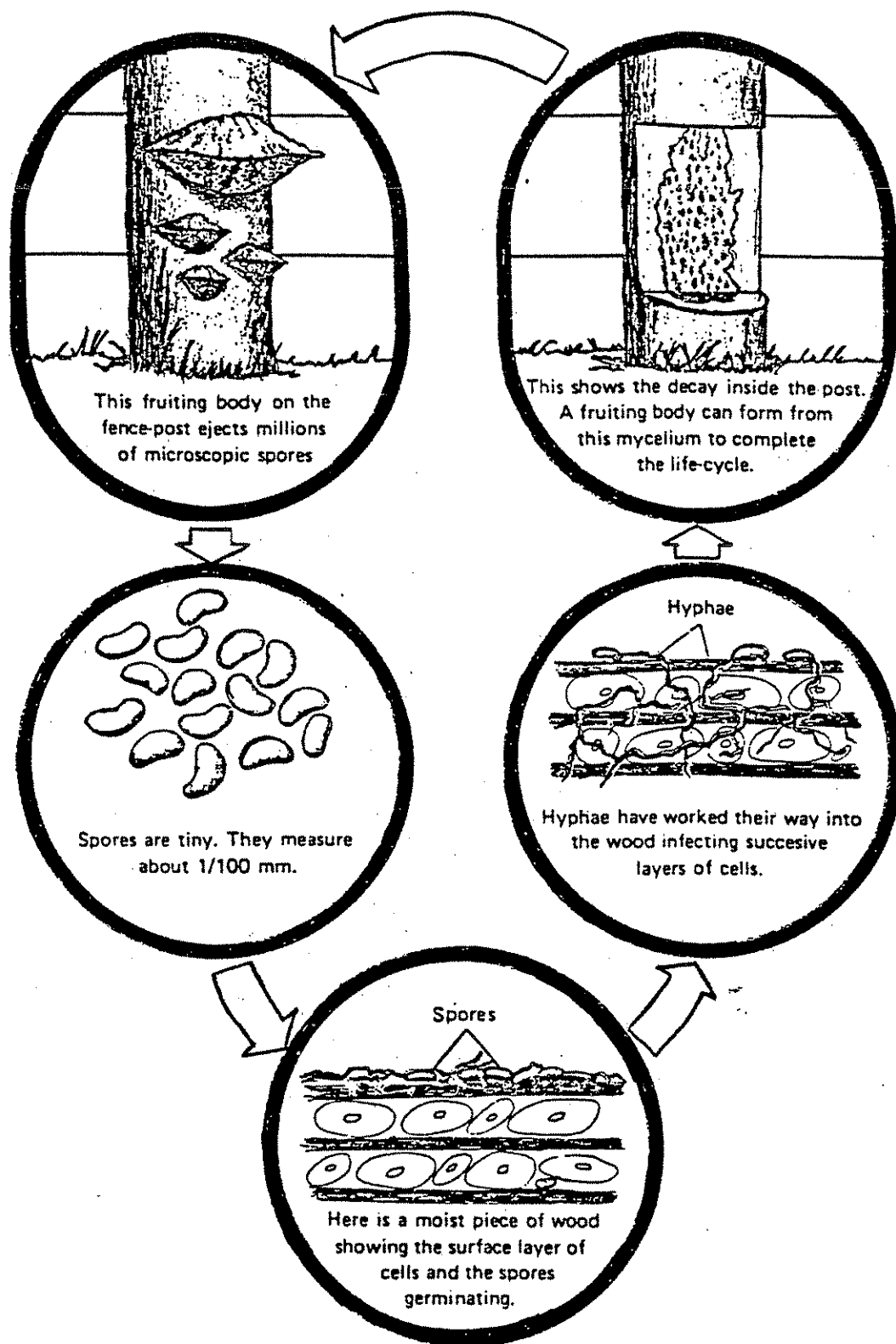
Wood-Staining Fungi

Sapstaining fungi (Ceratostomella sp., Diplodia sp.) - These fungi penetrate and discolor sapwood. Typical sapstain, unlike staining by mold fungi, cannot be removed by brushing or planing. Sapstain fungi may become established in the sapwood of standing trees, sawlogs, lumber and timber soon after they are cut and before they can be adequately dried. Strength of the wood is little affected, but the wood may not be fit for use where appearance is important (such as siding, trim, furniture and exterior mill work that is to be clear-finished).

Sapstaining fungi include several different fungus types. Some of the most common are called blue stain. They commonly produce a bluish, thread-like fungus growth deep within the wood, giving it a bluish color. The blue color may completely cover the sapwood, or it may be visible as specks, streaks, or patches in varying shades of blue.

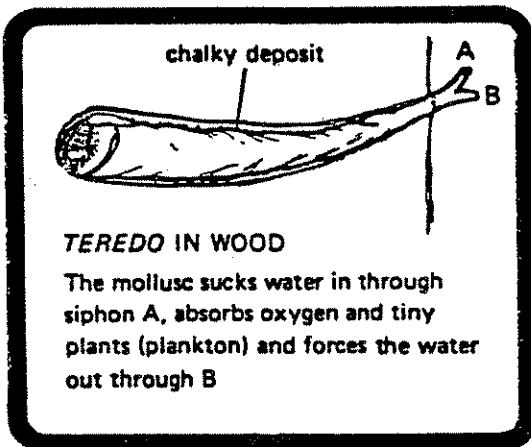
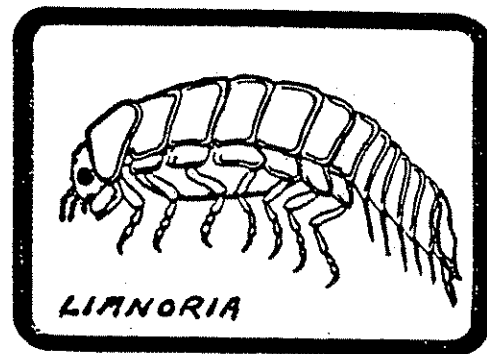
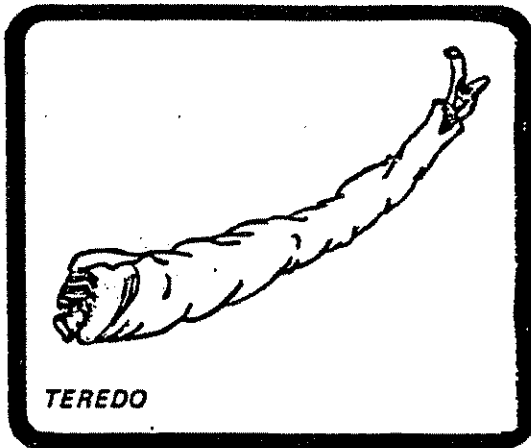
Blue stains are not the only sapstaining fungi which may infect wood. The color of the stain depends on the kind of fungus and the species and moisture content of the wood. Thus, there may be shades of yellow, orange, purple, or red stains.

Mold fungi (Fusarium sp., Penicillium sp.) - These fungi first become noticeable as green, yellow, brown or black fuzzy or powdery growths on the wood surface. The colored spores they produce can usually be brushed, washed, or surfaced off. On open-pored hardwoods, however, the surface molds may cause



Picture 3.1 Life cycle of a wood-rotting fungus

Courtesy of the University of Georgia Cooperative Extension Service.



MARINE ORGANISMS

stains too deep to be easily removed. Freshly cut or seasoned stock, piled during warm, humid weather, may be noticeably discolored with mold in less than a week's time. Molds do not reduce wood strength, however, they can increase the capacity of wood to absorb moisture, thus increasing the possibility of attack by decay fungi.

Chemical Stains - Chemical stains may resemble blue or brown stains, but are not caused by fungi. These stains result from chemical changes in the wood of both softwoods and hardwoods. Staining usually occurs in logs or in lumber during seasoning, and may be confused with a brown sapstain caused by fungi. The most important chemical stains are the brown stains that can downgrade lumber for some uses. They usually can be prevented by rapid air drying or using relatively low temperatures during kiln drying.

Marine Organisms

Wood placed in the sea near the shore-line is at risk from a variety of small animal organisms and a few fungi which can tolerate salt water. Shipworms, pholads and crustacean borers are the most common and destructive marine organisms.

Shipworms - Shipworms, the most destructive of the marine borers, are mollusks that are wormlike in form. They include several species of Teredo and several species of Bankia. In early life they are minute, free-swimming organisms. They lodge on wood, develop a new form, and bury themselves. A pair of boring shells on the head grows rapidly in size as the boring progresses. The tail part, or siphon, remains at the entrance. Thus, the shipworm grows in length and breadth within the wood but remains a prisoner in its burrow, which it lines with a chalky shell-like deposit. It lives on wood borings and organic matter extracted from the sea water which continuously passes through its body. The entrance holes remain relatively small so that the interior of the wood may

be completely honeycombed internally without showing much damage on the surface.

Pholads are another group of mollusks that resemble clams, being encased in a double shell. Like shipworms, they enter the wood when very small and grow larger as they burrow within. The major group are Martesia species. The pholads appear to be confined to the waters around Florida and the Gulf of Mexico.

Crustacean Borers. - In contrast to shipworms, these creatures erode timbers from the outside. They are small, shelled animals related to shrimp. Both the larvae and adults are mobile and can move from one source of wood to another. By chewing the surfaces of timbers, very large numbers wear the wood away. The wood surface becomes riddled with tunnels separated by very thin walls which are worn away by wave action so that the wood is gradually worn thin by combined action of the borers and water.

The most common type of crustacean borer is Limnoria which occurs around all U.S. coasts. Sphaeroma species are larger than Limnoria and resemble sowbugs. They are widely distributed but less plentiful and do less damage than Limnoria.

Severe damage is caused when large colonies of Limnoria attack unprotected wood in the sea. Eggs develop in a brood pouch on the underside of the female body. Each brood contains 5 to 15 eggs. Young are released into the parent burrow and begin boring at once. The adults are about 1/3 mm long; their burrows less than 1/5 mm wide. In warm months mature animals often migrate to fresh wood.

Treatment - No wood is immune to marine borer attack. The heartwood of some foreign species such as greenheart has shown resistance. Heavily-treated pines are suitable for marine use. Tests in marine waters have shown that creosote offers better protection against pholads than CCA preservatives, while

treatment with CCA protects wood better against certain crustaceans. For this reason, where coastal structures must have long lives, and where both wood-boring mollusks and crustaceans are present, it is common to specify CCA treatment followed by reseasoning and then re-treatment with creosote. This double protection is the best form of chemical preservation presently available, especially where pholads are present.

Other methods to prevent attack by marine borers have included wrapping of piles with plastic material in an attempt to suffocate the organisms. This can be successful so long as the barrier is not damaged.

WOOD-DESTROYING INSECTS

Termites

The stages in the life cycle of a termite are: the egg, the nymph, and the adult.

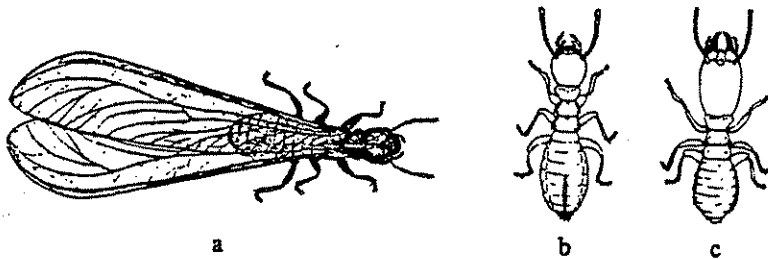
Termites are social insects having colonies in which there is a division of labor between different types of individuals. Nearly all species have reproductive and soldier castes, and many have a worker caste. If a worker caste is lacking, the nymphs handle the nest building and food gathering activities. The workers are responsible for damage done to wooden structures. Within the reproductive caste are the winged primary reproductives which emerge from the colony during the warmer months of the year to disperse and form new colonies.

SUBTERRANEAN TERMITES:

These pests are so named because the colony is usually located below ground with the workers attacking wood above ground.

The white, soft-bodied workers eat the soft grain of wood, leaving a thin shell outside and the ligneous portion in layers. Subterranean termites use bits of soil and excrement to build shelter tubes and to close up breaks in the surface of infested wood.

If "swarmer" (reproductive) termites have not been seen, the presence of a colony can be determined by probing wood near the foundation or soil or by observing earthen "shelter tubes" on foundation walls or wood. These are the only termites commonly found in Kentucky.



Subterranean Termite: a, winged reproductive; b, worker; c, soldier.

Termites must have wood for food and usually need soil for moisture. Wood in contact with soil is ideal for termite development. Termites occasionally become established without soil contact when a leaky roof or pipe provides moisture. Infestations may become established under concrete slabs, garage floors, patios, and dirt filled porches. Termites may then enter the building through structural wood or foundation walls adjacent to the slab. In houses built partly or completely on slabs, termites enter through expansion joints, cracks, and utility openings.

Breaking the connection between wood and the soil is essential in termite control. This may be done with either a chemical or mechanical barrier.

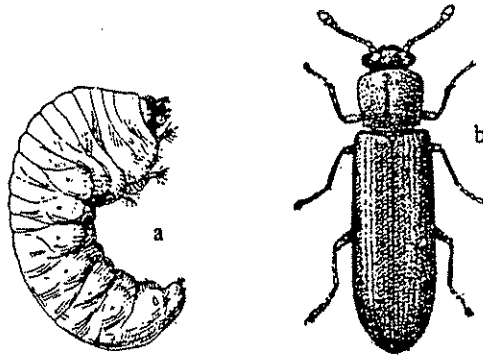
Ants

Ants are social insects that live in colonies located in and around homes and other structures. Ants enter buildings seeking sweet or fatty substances in kitchens, pantries, store rooms or warehouses. They may also be pests in lawns or gardens.

Ants characteristically have "elbowed" antennae and the body regions are distinctly defined by narrow constrictions. All ants have chewing mouthparts. Ants range in size from less than 1/16 inch long up to 1/2 inch long.

Powder-Post Beetles

There are several kinds of powder-post beetles. The most common are *Lyctid powder-post beetles* and *Anobiid powder-post beetles*. The adults are small (about 1/3 inch long) and usually reddish-brown to nearly black.



Lyctid Powder-Post Beetle: a, larva; b, adult.

The stages in the life cycle of powder-post beetles are: the egg, the larva, the pupa, and the adult.

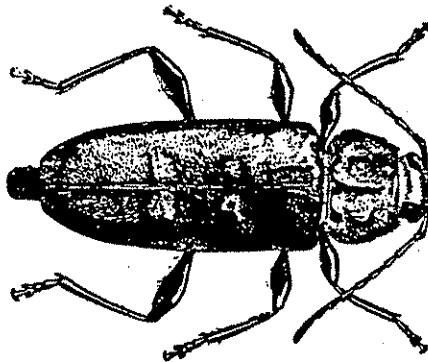
Small "shot hole" exit openings in wooden surfaces are a sign of infestation. Slight jarring of the wood causes a fine powder to sift from these holes. When the wood is cut or broken, the interior reveals galleries filled with a finely-packed powder which is produced by the feeding of grub-like larvae. Joists, subflooring, hardwood flooring, sills, plates, and interior trim are the parts of buildings most frequently attacked. Furniture and other wood products also may be damaged.

Long-Horned Beetles

Long-horned beetles are large (1/2 to 3 inches long) and brightly colored. They have long, thin antennae which may be longer than the body. Eggs are usually laid on unseasoned, rough-sawed timbers or logs. The larvae, called round-headed borers, feed in the wood. They bore large, oval holes as they move through wood.

The stages in the life cycle of the long-horned beetle are: the egg, the larva, the pupa, and the adult.

The only species that requires control in structures is the old-house borer. The adult is about 3/4 inch long, grayish-brown to black, and has two white patches on the wing covers. Its galleries have distinctive ripples on the interior surface. The old-house borer usually damages only pine sapwood.



Old House Borer

For control, infested timbers must be drilled and pressure-treated to force the insecticide throughout the gallery system. Fumigation under a tarpaulin may sometimes be required.

Table 1. Biological characteristics of wood-destroying beetles.

Group	Exit hole		Destructive stage	Length of life cycle	Types of frass
	Diameter	Shape			
Lyctidae (powder-post beetles)	1/32 to 1/16 inch	Round	Larvae	3 months to 1 year	Flour or talc-like; readily powders out of exit holes and cracks.
Anobiidae (deathwatch beetles)	1/16 to 1/8 inch	Round	Larvae	1 to 3 years	Fine to coarse; pellet-shaped; usually a gritty quality. Loose in tunnels; little at exit holes.
Bostrichidae (false powder-post beetles)	1/8 to 3/8 inch	Round	Larvae and adult	Usually 1 year	Fine to coarse; tightly packed; tends to stick together.
Curculionidae (weevils, snout beetles)	1/32 to 1/16 inch	Round	Larvae and adult	Varies with species	Powdery or granular dusts packed in irregular tunnels.
Buprestidae (flatheaded borers)	1/32 to 1/2 inch	Oval	Larvae	1 to 30 years	None at exit holes; coarse powder in tunnels.
Oedemeridae (wharf borer)	1/4 inch	Round		Approximately 1 year	Shredded and moist.
Cerambycidae (roundheaded borers)					
1. old house borer	1/4 inch	Oval	Larvae	1 to 32 years (normally 3 to 10)	Tunnels filled with powdery dust often formed in pellets.
2. flat oak borer	1/16 to 1/12 inch	Slightly oval	Larvae	1 to several years	Tunnels packed with fine flourlike dust and granules.
3. other roundheaded borers	1/8 to 1/2 inch	Round	Larvae	Variable	Coarse and fibery in tunnels.
Scolytidae (bark beetles)	Less than 1/16 inch	Round	Adult and larvae	2 months to 1 year or more	Little or none at exit holes. Very little or none in tunnels.

Table 2. Attack sites of wood-destroying beetles.

	Timbers attacked						Wood stage attack			Adult emergence sites and damage in buildings				Reinfestation
	Unseasoned	Seasoned	Softwood	Hardwood	Sap wood	Heart wood	Living trees	Dying trees or recently felled logs	Seasoned lumber and wood products	Woodwork and/or flooring	Structural timbers	Furniture, tool handles, etc.	Firewood	
Powder-post beetles		x		x	x				x	x	x	x	x	yes
Deathwatch beetles		x	x	x	x	x		x	x	x	x	x	*	yes
False powder-post beetles	x	x	x	x	x			x	x	x	x	x	x	rarely
Snout beetles	x	x	x		x	x	x	x	x	x	x		x	yes
Flatheaded borers	x	*	x	x	x	x	x	x	*	x	x	*	x	no
Wharf borer		x	x	x	x	x								yes
Roundheaded borers														
1. Old house borer		x	x		x				x	x	x			yes
2. Flat oak borer		x		x	x	x			x	x				no
3. Other roundheaded borers	x		x	x	x	x	x	x	x	x	x	*	x	no
Bark beetles	x	**	x	x	x	x	x	x	*		x	x	x	no

*Possible

**Rarely

REFERENCES:

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Wood Handbook. Wood as an Engineering Material. 1974. Agriculture Handbook no. 72. USDA Forest Service.

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Wood Preservation and Wood Products Treatment. 1986. Georgia Cooperative Extension Service.

The Preservation of Wood. A Self Study Program for Wood Treaters. Georgia Cooperative Extension Service.

Wood Deterioration and its Prevention by Preservative Treatments. Volume 1. Degradation and Protection of Wood. D.D. Nicholas (ED). Syracuse Univ. Press, New York. 1973.

WOOD PRESERVATIVES

Federal and State regulations establish general and categorical standards that must be met before you can legally use restricted use pesticides. Your state will provide information which should be followed to help you meet the general standards.

In order to obtain a registration for a pesticide under the Federal Insecticide, Fungicide, and Rodenticide Act, an applicant for registration must demonstrate that the pesticide satisfies the statutory standard for registration. That standard requires, among other things, that the pesticide perform its intended function without causing unreasonable adverse effects on man or the environment. "Unreasonable" takes into account the economic, social and environmental costs and benefits of the use of any pesticide.

The burden of proving that a pesticide satisfies the registration standard is on the proponents of registration and continues as long as the registration remains in effect. Under the Act, the EPA may cancel the registration of a pesticide or require modification or the terms and conditions of registration whenever it is determined that the pesticide causes unreasonable adverse effects. The Agency conducted a special review to facilitate the identification of pesticide uses which may not satisfy the standard for registration and to provide an informal procedure to gather and evaluate information about the risks and benefits of these uses.

The Environmental Protection Agency has listed the three wood preservatives, creosote, pentachlorophenol and inorganic arsenicals, as "restricted use pesticides." Their reasoning for this action is stated in the following paragraph which is quoted directly from the Federal Register.

"For creosote, the RPAR was issued on the basis of oncogenicity and mutagenicity. The Agency's bases for issuance of an RPAR for the inorganic arsenicals pesticides were oncogenicity, mutagenicity and reproductive or fetotoxic effects. For pentachlorophenol, the RPAR was issued on the basis of teratogenicity and fetotoxicity." For more information refer to your labels and MSDS sheets.

After carefully evaluating the risks to public health posed by these wood preservative chemicals (creosote, pentachlorophenol and inorganic arsenicals) along with the significant economic benefits resulting from their use, the Agency determined that the use of the three wood preservative chemicals in accordance with certain modifications would pose no unreasonable adverse effects to man or the environment.

The modifications referred to above are included in this manual. This manual also contains important information to help prepare workers to become certified to apply preservative or stain-controlling chemicals to wood at treating plants or sawmills. Although this manual is applicable

throughout the U.S., it was prepared specifically for the Pacific Northwest. If information important in your state is not included, the state agency regulating training and certification of wood preservative applicators in your area may be able to provide additional materials needed for study. The chemical company that supplies your chemicals may also assist you. Specifically, this manual provides information designed to foster better understanding of the various chemicals used for the protection and preservation of wood, to promote safer working conditions and procedures, and to protect workers and the environment.

It has been estimated that fully 10 percent of the timber cut each year in the United States is used to replace wood that has failed in service, often due to fungal, insect, or marine borer attack. Judicious use of chemicals for preserving or temporarily protecting wood can substantially increase service life, thereby significantly reducing wood losses and helping to conserve timber resources. Substitution of alternate structural materials for pressure-treated wood currently used would cost the U.S. economy 4.5 to 6.3 billion dollars each year while forcing us to use more of our nonrenewable resources. Similarly, failure to use anti-sapstain chemicals could cause unprotected, high-quality lumber to lose as much as half its value during processing and shipment. Thus, if we are to fully utilize our timber resource, some application of chemicals for extending the useful life or protecting wood at certain states is necessary.

Wood preservatives extend the life of wood products by protecting them from damage by insects, fungi, marine borers, fire and weather. Preservative solutions fall into two general classes: petroleum base, such as creosote and petroleum solutions of pentachlorophenol (penta); and water solutions of metal preservatives such as Chromated Copper Arsenate (CCA), Ammoniacal Copper Arsenate (ACA) and Ammoniacal Copper Zinc Arsenate (ACZA) and pentachlorophenate salts. Water solutions of pentachlorophenate salts have been widely used for sapstain control. Non-penta alternatives are also available. Preservative solutions may be applied by pressure or non-pressure dips or sprays that provide short-term protection. Treating applications are specifically made to protect the product under conditions to which it will be exposed. Thermal and pressure treatment is used when long-term protection is desired.

GENERAL

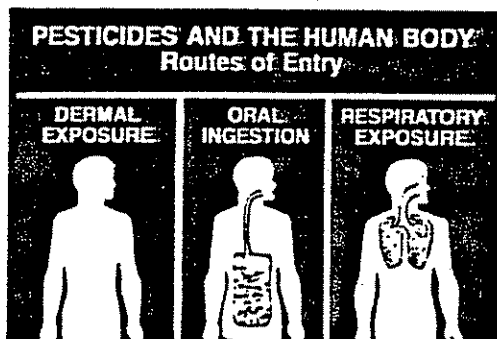
PROTECTING HUMAN HEALTH

Chemicals used to protect wood from insects and decay are necessarily toxic in order to be effective. The goal is to select chemicals and methods that will control the pests without harming human health and the environment.

Hazards to Applicators

All handlers of wood preservatives need to know the risks in working with preservatives, and necessary precautions to minimize these risks. Most of the risk associated with wood preservatives comes from personal exposure during their application process. Commonly used wood preservatives are toxic. Some can irritate and burn the skin, eyes, nose and throat and cause dizziness and muscle spasms. Excessive contact, particularly with some concentrates, can cause short-term, long-term, or permanently damaging effects.

Wood preservatives, like other pesticides, can enter the body in three ways:



Generally, preservative chemicals used in commercial pressure treating plants are received, transferred, mixed, stored and applied in closed systems. However, occasional leaks *can present sources of human exposure*. Handling of freshly treated wood is highly mechanized; thus, potential dermal (skin, including eyes and groin) exposure of employees is usually minimal except for maintenance and utility (cleanup) jobs. It should be noted that absorption of wood preservatives in the groin area is rapid, especially oil-based preservatives. Some inhalation of pentachlorophenol and creosote vapors may occur, especially in plants that use thermal treatment systems or in operations where wood is treated in open tanks.

Many wood preservatives have a strong odor and taste, so it is very unlikely that a person would swallow a dangerous amount. Constant, careless and accidental dermal or respiratory exposure, however, can cause short or even long-term health effects.

Work Practices and Protective Clothing

Protective clothing requirements will be specified on the product label attached to the container. It is imperative that the label requirements on these preservatives be strictly adhered to.

Posting Documentation and Technical Data

Certain documentation is available on site when wood treating chemicals are used, such as:

"Material Safety Data Sheets" (MSDS), available for each treating compound as shown in included examples.

Proper labels on each shipping container, including directions for use, a listing of active ingredients, warnings, the EPA registration number and other related information supplied by the vendor on shipping container, as shown in included examples.

Technical data sheets, available from manufacturer and/or vendor.

Toxicity data, available from the manufacturer.

CHEMICALS

There are a number of commonly used EPA-registered chemical compounds marketed to preserve wood. All compounds should, for practical reasons, be thought of as having toxic properties and should be treated accordingly.

Prior to the publication of this manual, the EPA chose to classify three of the wood treating chemicals as restricted use: Creosote, Inorganic Arsenicals and Pentachlorophenol. The following deals specifically with these three wood preservatives.

CREOSOTE

Creosote is a complex mixture of organic chemical products of fractional distillation of coal tar. Coal tar is a by-product of coking of bituminous coal. Creosote is used alone or in combination with coal tar or petroleum as a wood preservative.

Creosote is a restricted use pesticide and is to be used only by certified applicators or by persons under their direct supervision and only for those uses covered by the certified applicator's certification.

Hazard and Toxicity Information

- Can cause skin irritation.
- Vapors and fumes are irritating to eyes and respiratory tract.
- Skin may become sensitive to sunlight.
- Prolonged and repeated exposure may lead to dermatitis (folliculitis).
- Poor personal hygiene exposure practices or not wearing personal protective equipment could lead to chronic health effects.

Exposure Information

Routes of exposure are:

- Dermal
- Ingestion
- Inhalation

Exposure situations include:

- Manually opening pressure treatment cylinder doors.
- Entering tanks or cylinders which are contaminated with treating solutions.
- Handling freshly treated wood where skin contact is expected.

Protective Clothing, Equipment and Procedures

- Applicators must wear gloves impervious to the wood treatment formulation in all situations where skin contact with creosote is expected.
- Individuals who manually open cylinder doors must always wear protective equipment.

NOTE: The term "respirators" means properly fitting, well maintained, half-mask canister or cartridge respirators which are MSHA/NIOSH-approved for polynuclear aromatics and organic vapors as shown in included examples.

- Individuals who enter pressure treatment cylinders and other related equipment that is contaminated with the wood treatment formulation (e.g., cylinders that are in operation or are not free of the treatment formulation) must wear protective clothing, including overalls, jacket, gloves and boots, impervious to the wood treatment formulation and a respirator.
- Spray applicators must wear protective clothing, including overalls, jacket, gloves, boots and head covering, impervious to the wood treatment formulation, and a respirator and goggles when spraying.
- Individuals who enter, clean or repair vats, tanks or other related equipment that are contaminated with the wood treatment formulation (e.g., tanks that are in operation or are not free of the treatment formulation) must wear protective clothing, including overalls, jacket, gloves and boots, impervious to the wood treatment formulation, and goggles and a respirator.
- Examples of acceptable materials for protective clothing (e.g., gloves, overalls, jackets and boots) required during application and handling of creosote are covered as shown in included examples.
- Protective clothing must be changed when it shows signs of contamination. Applicators must leave protective clothing and workshoes or boots and equipment at the plant. Worn-out protective clothing and workshoes or boots must be left at the plant and properly disposed of and/or laundered.
- Applicators must not eat, drink, or use tobacco products during those parts of the application process that may expose them to the wood treatment formulation (such as manually opening/closing cylinder doors, moving trams out of cylinders, mixing chemicals or handling freshly treated wood.)
- Wash thoroughly after skin contact, and before eating, drinking, use of tobacco products, or using restrooms.

First Aid

- For inhalation exposure, remove person to fresh air. If not breathing, give artificial resuscitation.
- If breathing is difficult, administer oxygen.

- In case of skin contact, remove with waterless hand cleaners or soap and water. Avoid cleaning solvents. Contact may make skin sensitive to sunlight. Treat symptomatically.
- For eye contact, flush eyes immediately with large amounts of water for at least 15 minutes.
- If ingested, immediately seek medical aid. Do not induce vomiting. Give 1 glass of milk or 1 to 2 oz. (30 to 60G) of activated charcoal in water to victim as tolerated. Do not attempt to give anything by mouth to an unconscious person.

Disposal

Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. Wastes must be disposed of according to label and local regulations. Do not contaminate water or soil by disposal.

PENTACHLOROPHENOL

Penta is a widely used wood preservative normally carried in a petroleum solvent. Lesser quantities of penta are converted to sodium or potassium salts and carried in a water solvent for sapstain control and other uses.

Pentachlorophenol is a restricted use pesticide and is to be used only by certified applicators or by persons under their direct supervision and only for those uses covered by the certified applicator's certification.

Hazard and Toxicity Information

- Irritating to the eyes, skin and respiratory tract.
- Ingestion of penta solutions, inhalation of concentrated vapors or prolonged or repeated skin contact may lead to headache, weakness, dizziness, nausea, coordination loss, profuse sweating, elevated body temperature and convulsions.
- Inhalation and skin contact at continued high levels may cause damage to liver, kidney and skin and could be fatal in extreme cases.
- Poor personal hygiene exposure practices or not wearing personal protective equipment could lead to chronic health effects.
- The EPA has determined that pentachlorophenol can produce defects in the offspring of laboratory animals. Exposure to pentachlorophenol during pregnancy should be avoided.

Exposure Information

- Routes of exposure are:

- Dermal contact
- Ingestion
- Inhalation

• Exposure situations include:

- Manual emptying and mixing operations.
- Repair work on treating equipment.
- Manually opening pressure treatment cylinders.
- Entering work tanks or cylinders that have recently been in operation.
- Handling freshly treated wood where skin contact is expected.

Protective Clothing Equipment and Procedures

- Applicators must wear gloves impervious to the wood treatment formulation in all situations where skin contact is expected (handling freshly treated wood and manually opening cylinder doors).

NOTE: The term "respirators" means properly fitting, well-maintained, half-mask canister or cartridge respirators which are MSHA/NIOSH-approved for organic vapors and acid gases as shown in included examples.

- Individuals who manually open cylinder doors must wear personal protective equipment.
- Individuals who enter pressure treatment cylinders and other related equipment that are contaminated with wood treatment formulation (cylinders that are in operation or are not free of the treatment solution) must wear protective clothing, including overalls, jacket, gloves and boots, impervious to the wood treatment formulation and a respirator.
- For the spray method of application, spray apparatus must (1) be operated so as to minimize overspray (i.e., no visible mist) and (2) be free of leaks in the system. Should there be a visible mist, spray applicators in the zone in which the mist is visible must wear a respirator and protective clothing (including overalls, jacket, gloves, boots and head covering) impervious to the wood treatment formulation and goggles.
- Individuals who enter, clean, or repair vats, tanks or other related equipment that are contaminated with the treatment solution must wear a respirator. In addition, where skin contact is expected, these individuals must wear protective clothing (overalls, jackets, boots, gloves and head covering) impervious to the wood treatment formulation and goggles.

NOTE: For prilled, powdered or flaked formulations of pentachlorophenol: Until August 31, 1987, a closed emptying and mixing system must be used or protective clothing, including respirator, gloves, long-sleeved shirt and long pants or disposable coveralls, must be worn when emptying and mixing prilled, powdered or flaked formulations of pentachlorophenol. After September 1, 1987 a closed system must be used when emptying and mixing such formulations of pentachlorophenol.

- Examples of acceptable materials for protective clothing required during application and handling of pentachlorophenol are covered as shown in included examples.

- Protective clothing must be changed when it shows signs of contamination. Applicators must leave all protective clothing, workshoes or boots, and equipment at the plant. Worn-out protective clothing, and workshoes or boots must be left at the plant and properly disposed of and/or laundered.

- Applicators must not eat, drink, or use tobacco products during those parts of the application process that may expose them to the wood treatment formulation (such as, manually opening/closing cylinder doors, moving trams out of cylinders, mixing chemicals, and handling freshly treated wood).

- Wash thoroughly after skin contact, and before eating, drinking, use of tobacco products, or using restrooms.

First Aid

- In case of skin contact, immediately flush with a deluge of water and remove contaminated clothing and shoes.
- For inhalation exposure, remove to fresh air. Apply artificial resuscitation if necessary.
- In case of skin contact, wash with plenty of soap and warm water.
- If ingested, first induce vomiting, then take 2 tablespoons of activated charcoal — (USP drug grade) in water. Never give anything by mouth or induce vomiting if the victim is not alert or is unconscious.
- Obtain immediate medical assistance.

Disposal

Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. Wastes must be disposed of according to label and local regulations. Do not contaminate water or soil by disposal.

INORGANIC ARSENICALS

A family of wood preserving chemicals containing pentavalent arsenic in combination with other inorganic compounds and metals such as chromium, copper and zinc. These compounds have been used as wood preservatives for over 45 years.

Inorganic arsenicals are restricted use pesticides and are to be used only by certified applicators or by persons under their direct supervision and only for those uses covered by the certified applicator's certification.

Hazard and Toxicity Information

- Prolonged extreme exposure to inorganic arsenic and arsenical compounds can cause nausea, chills and diarrhea.
- Concentrated forms may cause severe skin burns.
- May cause ulceration and perforation of nasal septum upon prolonged exposures to mist.
- Poor personal hygiene exposure practices or not wearing personal protective equipment could lead to chronic health effects.

Exposure Information

- Routes of exposure are:
 - Dermal contact
 - Ingestion
 - Inhalation
- Exposure situations include:
 - Manual emptying and mixing.
 - Entering work tanks or pressure treatment cylinders recently in operation.
 - Handling of freshly treated wood.

Protective Clothing and Equipment

- Applicators must wear gloves impervious to the wood treatment formulation in all situations where skin contact is expected (handling freshly treated wood and manually opening cylinder doors).
- Individuals who enter pressure treatment cylinders and other related equipment that is contaminated with the wood treatment solution (cylinders that are in operation or are not free of the treatment solution) must wear protective clothing, including overalls, jacket, gloves, and boots, impervious to the wood treatment formulation.
- Examples of acceptable materials for protective clothing (e.g., gloves, overalls, jackets and boots) required during application and handling of inorganic arsenicals are covered as shown in included examples.
- Individuals in the work area of an arsenical wood treatment plant must wear properly fitting, well-maintained high efficiency filter respirators, MSHA-/NIOSH-approved for inorganic arsenic, if the level of inorganic arsenic in the plant is unknown or exceeds 10 micrograms per cubic meter of air (10 ug/m³) averaged over an 8-hour work period as shown in included examples.
- Protective clothing must be changed or laundered when it shows signs of contamination. Applicators must leave protective clothing and workshoes or boots and equipment at the plant. Worn-out protective clothing and workshoes or boots must be left at the plant and disposed of in accordance with state and federal regulations.

- In working with powder formulations of inorganic arsenicals a closed emptying and mixing system must be used. A closed system is defined as any containment which prevents the release of subject chemicals into the surrounding external environment, except the release of incidental amounts of chemical during equipment loading and periodic clean-out or maintenance operations shall not be deemed a breach of containment.
- Processes used to apply inorganic arsenical formulations shall leave no visible surface deposits on the wood. Small isolated or infrequent spots of chemical on otherwise clean wood shall be allowed.
- Applicators must not eat, drink, or use tobacco products during those parts of the application process that may expose them to the wood treatment formulation (manually opening/closing cylinder doors, moving trams out of cylinders, mixing chemicals, and handling freshly treated wood).
- Wash thoroughly after skin contact, and before eating, drinking, use of tobacco products, or using restrooms.

First Aid

- In case of skin contact, immediately flush with water and remove contaminated clothing and shoes.
- For inhalation exposure, remove to fresh air. Apply artificial resuscitation, if necessary.
- If ingested, immediately seek medical aid. Do not induce vomiting. Give 1 glass of milk or 1 to 2 oz. (30 to 60G) of activated charcoal in water to victim as tolerated. Do not attempt to give anything by mouth to an unconscious person.

Disposal

Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. Wastes must be disposed of according to label and local regulations. Do not contaminate water, or soil by disposal.

ACCEPTABLE GLOVE MATERIALS

I. CREOSOTE

- A. Polyvinyl acetate (PVA)
- B. Polyvinyl chloride (PVC)
- C. Neoprene
- D. NBR (Buna-N)

II. PENTACHLOROPHENOL

- A. Polyvinyl Acetate (PVA)
- B. Polyvinyl chloride (PVC)
- C. Neoprene
- D. NBR (Buna-N)
- E. Nitrile

III. INORGANIC ARSENICALS

- A. Vinyl
- B. Polyvinyl chloride (PVC)
- C. Neoprene
- D. NBR (Buna-N)
- E. Rubber
- F. Polyethylene

ACCEPTABLE MATERIAL FOR OTHER PROTECTIVE EQUIPMENT

I. CREOSOTE

- A. Neoprene
- B. Polyvinyl Acetate (PVA)
- C. Polyvinyl Chloride (PVC)
- D. NBR (Buna-N)

II. PENTACHLOROPHENOL

- A. Neoprene (for entering cylinders).
- B. Plastic-coated disposable coverall impervious to dust (for dust protection).
- C. Tightly woven natural or synthetic fiber clothing (cotton or polyester), full body covering (for working around treating plant).

III. INORGANIC ARSENICALS

- A. Vinyl
- B. Polyvinyl chloride (PVC)
- C. Neoprene
- D. NBR (Buna-N)
- E. Rubber
- F. Polyethylene

ACCEPTABLE RESPIRATORS

I. CREOSOTE

- A. MSHA/NIOSH approved cartridge type respirator that gives protection against organic vapors and polynuclear aromatics.**

II. PENTACHLOROPHENOL

- A. MSHA/NIOSH approved organic vapor and acid gas respirator.**
- B. MSHA/NIOSH self-contained breathing apparatus with full face piece (supplied air).**

III. INORGANIC ARSENICALS

- A. MSHA/NIOSH approved half-mask supplied air respirator.**
- B. Properly fitted, well-maintained, high efficiency filtered respirators approved for inorganic arsenic.**

ILLUSTRATION OF A MATERIAL SAFETY DATA SHEET (MSDS) ON CREOSOTE

The following is a sample. The one shown is very complete. Other MSDS's may not show the same detail. However, the general format will be the same. The reader should be very familiar with sections A, B, C, D and E. He or she should know that Sections F, G, H, I, J and K exist for further information, particularly in emergencies.

The sections included are:

- A. General Information: This section shows the common and chemical name, the formula and the producer. The producer's address and phone number are also shown.
- B. First Aid Measures: This section is very important as it outlines the first aid measures that you should take in cases of excessive exposure. Note that an emergency phone number is also given.
- C. Hazards Information: This is another important section as it illustrates the hazards involved with this chemical. It is broken into two divisions:
 - 1. Fire and explosion hazards.
 - 2. Health hazards.
- D. Precautions/Procedures: This section shows what you can do or be prepared to do to protect against the hazards shown in Section C.
- E. Personal Protective Equipment: This section illustrates the personal clothing and equipment that an individual must use to protect himself or herself from the health hazards outlined in Section C.
- F. Physical Data: This section shows the physical properties of the chemical.
- G. Reactivity Data: This section illustrates how the chemical in question reacts to other chemicals and heat conditions.
- H. Hazardous Ingredients: This section lists the separate hazardous components of the chemical formulation. In the case of a complex mixture like creosote, a separate list is provided.
- I. Environmental: This section lists the environmental hazards and precautions that must be taken with this compound to avoid environmental damage. In all cases of proposed disposal note the warning that: **Disposer must comply with federal, state and local disposal or discharge laws.**
- J. References: This section shows where the producer got his technical information and where you can obtain more information if interested or in need.
- K. Additional Information: This section, as its name implies, provides any additional information that the chemical supplier feels will be useful to you in handling their product safely. In this particular case the supplier has provided a separate product safety sheet.



PRODUCT SAFETY DATA SHEET

CHEMICALS COMPANY

A. GENERAL INFORMATION

TRADE NAME (COMMON NAME OR SYNONYM) Creosote		☒ CAS NO. ☐ ALLIED PRODUCT CODE 61789-28-4	
CHEMICAL NAME 2, 3 and 4 ringed polynuclear aromatic hydrocarbons including some substituted compounds			
FORMULA Mixture of organic compounds		MOLECULAR WEIGHT 130-210	
COMPANY PLANT ADDRESS INC., STREET, CITY, STATE AND ZIP CODE ALLIED CORPORATION CHEMICAL SECTOR P.O. Box 1139R Morristown, N.J. 07960 Attention: Tar Products Department			
CONTACT Manager, Technical & Environmental Services		PHONE NUMBER 201-455-5611	ISSUED DATE August 1980
REVISED DATE			

B. FIRST AID MEASURES

INHALATION: Remove to fresh air. If not breathing, give artificial respiration; preferably mouth to mouth. If breathing is difficult, give oxygen. Call a physician.	EMERGENCY PHONE NUMBER 614-533-1030
SKIN CONTACT: Remove with waterless hand cleaners or soap and water. Avoid solvents.	
EYE CONTACT: Flush eyes immediately with large amounts of water or mineral oil for at least 15 minutes. Call a physician.	
INGESTION: First induce vomiting, then take 2 tablespoons of activated charcoal (drug grade) in water. Get immediate medical assistance.	

C. HAZARDS INFORMATION

FIRE AND EXPLOSION

FLASH POINT 70°C	AUTO IGNITION TEMPERATURE °C	FLAMMABLE LIMITS IN AIR (% BY VOL.) LOWER UPPER
☐ OPEN CUP ☒ CLOSED CUP		
UNUSUAL FIRE AND EXPLOSION HAZARDS Water/fog can control unconfined fires, but water may cause frothing or eruption in closed tanks. When heated to elevated temperatures, it emits lower molecular weight hydrocarbons		

HEALTH

INHALATION	Overexposure to vapor may result in irritation to respiratory tract. Prolonged exposure in significant excess of permissible air concentrations can result in acute toxic effects, such as respiratory difficulty, convulsions and possible cardiovascular collapse.
INGESTION	Irritation of the gastro intestinal tract followed by nausea and vomiting, abdominal discomfort, rapid pulse, etc. Cardiovascular collapse may occur. Fatal dose is approximately 0.1 g/kg of body weight.
SKIN	Contact with skin can result in irritation which when not washed off or when accentuated by sunlight, can result in minor burns.
EYES	Overexposure to product vapors can result in irritation. Eye contact with product will result in irritation, which in the absence of recommended first aid can result in minor burns to the eyes.
PERMISSIBLE CONCENTRATION: AIR (SEE SECTION J)	OSHA exposure limit - TWA 8 hours is 0.2 mg/m ³ (PPAH)
BIOLOGICAL	
UNUSUAL CHRONIC TOXICITY	

D. PRECAUTIONS/PROCEDURES

VENTILATION

Avoid breathing vapors, ventilate work area, wear respirator, goggles, or face shield.

NORMAL HANDLING

Wear clothing closed at the neck, long sleeves and non-porous type gloves.

STORAGE

Recommended temperature for storage is about 38°C (100°F)

PRECAUTIONARY LABEL ☐ ATTACHED ☒ NOT ATTACHED

SPILL OR LEAK

Avoid breathing vapors and contact with skin and eyes. Avoid sources of ignition (sparks or open flame). Contain the spill or leak with solids, such as sand, earth, etc., dispose of in approved landfill or burn in approved incinerator.

FIRE EXTINGUISHING AGENTS RECOMMENDED

Water/fog, carbon dioxide, foam, dry chemicals, sand, or steam.

SPECIAL FIRE FIGHTING PRECAUTIONS

Water/fog is recommended for the control of unconfined fires, but water may cause frothing or eruption in closed tank.

FIRE EXTINGUISHING AGENTS TO AVOID

See: Special Fire Fighting Precautions.

SPECIAL PRECAUTIONS/PROCEDURES

Self-contained respirator equipment and full protective clothing should be worn when fumes and/or smoke are present. A complete soap and water shower should be taken at the end of each working day. Scott Air-Pack should be available.

E. PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION

Use a NIOSH approved respirator with suitable organic vapor cartridge.

EYES AND FACE

Safety glasses, goggles or face shield.

HANDS, ARMS, AND BODY

Long-sleeved clothing closed at the neck and non-porous gloves. For exposed skin, use approved creams (e.g. Pro-Tek, Fend A-2, Safetecote Skin Protector No. 83734).

OTHER CLOTHING AND EQUIPMENT

A complete change of work clothes should be used each day if contaminated.

P. PHYSICAL DATA

MATERIAL IS (AT NORMAL CONDITIONS):		APPEARANCE AND ODOR	
☒ LIQUID ☐ SOLID ☐ GAS ☐ _____		Dark brown liquid with a penetrating smokey odor and a burning caustic taste.	
BOILING POINT	210-425 °C	SPECIFIC GRAVITY (H ₂ O = 1)	VAPOR DENSITY (AIR = 1)
MELTING POINT	°C	1.03 - 1.18	>1
SOLUBILITY IN WATER (% by weight)		PH	VAPOR PRESSURE (mm Hg at 20° C)
Insoluble			100°C - 80 mmHg 125°C - 225 mmHg 150°C - 370 mmHg
EVAPORATION RATE (Butyl Acetate = 1)		% VOLATILES BY VOLUME (At 20°C)	
<1			

G. REACTIVITY DATA

STABILITY ☐ UNSTABLE ☒ STABLE		CONDITIONS TO AVOID None known
INCOMPATIBILITY (MATERIALS TO AVOID) None known		
HAZARDOUS DECOMPOSITION PRODUCTS Material does not decompose		
HAZARDOUS POLYMERIZATION ☐ MAY OCCUR ☒ WILL NOT OCCUR		CONDITIONS TO AVOID "Open flame and intense heat."

H. HAZARDOUS INGREDIENTS (Mixtures Only)

[illegible]

I. ENVIRONMENTAL

DEGRADABILITY

Due to its low vapor pressure and extremely low evaporation rate, the volatility rate at 20°C is almost zero. Upon heating, at extremely high temperatures, hydrocarbons will be emitted and some degradation will take place.

OCTANOL WATER PARTITION COEFFICIENT

WASTE DISPOSAL METHODS*

Burial or incineration.

*DISPOSER MUST COMPLY WITH FEDERAL, STATE AND LOCAL DISPOSAL OR DISCHARGE LAWS.

J. REFERENCES

PERMISSIBLE CONCENTRATION REFERENCES

OSHA General Industry 29 CFR 1910. Coal Tar Pitch Volatiles (CTPV)

REGULATORY STANDARDS

NIOSH Criteria Document - Coal Tar Products
DOT CFR 49 Parts 100-199
USEPA 40 CFR 112

GENERAL

National Fire Protection Association, Fire Protection Hand Book,
NFPA 325 m, NFPA 491 m
Encyclopedia of Occupational Health and Safety, Vol. I, McGraw Hill

K. ADDITIONAL INFORMATION

See attached Technical Data Report (PC-7)
"Using Coal Tar Products With Safety"

THIS PRODUCT SAFETY DATA SHEET IS OFFERED SOLELY FOR YOUR INFORMATION, CONSIDERATION AND INVESTIGATION.

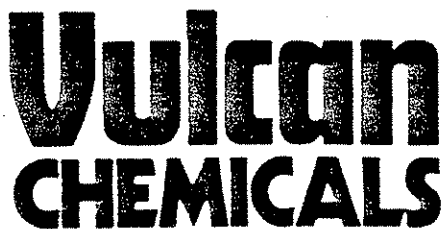
ALLIED CHEMICAL PROVIDES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, AND ASSUMES NO RESPONSIBILITY FOR THE ACCURACY OR COMPLETENESS OF THE DATA CONTAINED HEREIN.

ILLUSTRATION OF A MATERIAL SAFETY DATA SHEET (MSDS) ON PENTACHLOROPHENOL

The following is a sample. The one shown is very complete. Other MSDS's may not show the same detail. However, the general-format will be the same. The reader should be very familiar with sections I, through X.

The sections included are:

- Section I:** Identifies the product by chemical name, formulation and DOT I.D. #.
- Section II:** Product and Component Data. Names components in the product, the percentage of each one, and the CAS Registry # (CAS: Chemical Abstract Service), which will identify each component. Also the ACGIH TLV-TWA (ACGIH: American Conference of Governmental Industrial Hygienists) (TLV: Threshold Limit Value) (TWA: Time Weighted Average).
- Section III:** Physical Data. Tells weight, color, etc.
- Section IV:** Reactivity Data. Self-explanatory.
- Section V:** Fire & Explosion Hazards Data. Self-explanatory.
- Section VI:** Toxicity and First Aid. The most important section for workers. Study very carefully. Tells levels that are permissible, what can happen and what to do about it if it does happen.
- Section VII:** Personal Protection and Controls. Another very important section. Tells when and what protective equipment such as gloves, shields, clothes, etc., should be worn.
- Section VIII:** Storage and Handling Precautions. Tells of proper storage, and very important is how to handle contaminated clothing before reuse.
- Section IX:** Spill Leak and Disposal Practices. Management shall inform workers on how to handle spills, leaks and disposal of material.
- Section X:** Transportation. Employees will be informed of transportation practices by management.



MATERIAL SAFETY DATA SHEET

24 Hour Emergency Phone (316) 524-5751

 Division of Vulcan Materials Company P.O. Box 7689 • Birmingham, AL 35253-0689

I - IDENTIFICATION		
CHEMICAL NAME Pentachlorophenol	CHEMICAL FORMULA C₆Cl₅OH	MOLECULAR WEIGHT 266.32
TRADE NAME GLAZD® Penta, Block Penta		
SYNONYMS Penta, PCP		DOT IDENTIFICATION NO. NA 2020

II - PRODUCT AND COMPONENT DATA			
COMPONENT(S) CHEMICAL NAME	CAS REGISTRY NO	% (Approx)	ACGIH TLV-TWA
Pentachlorophenol	87-86-5	90	0.5 mg/m³
2, 3, 4, 6-Tetrachlorophenols	58-90-2	2	None
Hydroxypolychlorodibenzo Ethers		5	None

III - PHYSICAL DATA	
APPEARANCE AND ODOR	SPECIFIC GRAVITY
Light brown or tan flake or solid	Flake bulk density = 70 lbs/ft³
BOILING POINT	VAPOR DENSITY IN AIR (Air = 1)
310°C (Melting Point - 90°C)	N/A
VAPOR PRESSURE	% VOLATILE, BY VOLUME
N/A	0
EVAPORATION RATE	SOLUBILITY IN WATER
N/A	14 ppm @ 20°C

IV - REACTIVITY DATA	
STABILITY	CONDITIONS TO AVOID
Stable	None
INCOMPATIBILITY (Materials to avoid)	
Strong oxidizers and alkalis.	
HAZARDOUS DECOMPOSITION PRODUCTS	
Hydrogen chloride, chlorine, chlorinated hydrocarbons	
HAZARDOUS POLYMERIZATION	
None	

V - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) None	FLAMMABLE LIMITS IN AIR None
EXTINGUISHING AGENTS None	
UNUSUAL FIRE AND EXPLOSION HAZARDS Toxic gases are formed by thermal decomposition. Firefighters should wear self contained positive pressure breathing apparatus.	

VI - TOXICITY AND FIRST AID

EXPOSURE LIMITS (When exposure to this product and other chemicals is concurrent, the TLV must be defined in the workplace.)

ACGIH: 0.5 mg/m³ 8 hour TWA (Skin) No STEL
 OSHA: 0.5 mg/m³ 8 hour TWA (Skin)

Effects described in this section are believed not to occur if exposures are maintained at or below appropriate TLVs. Because of the wide variation in individual susceptibility, TLVs may not be applicable to all persons and those with medical conditions listed below.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE

Acute or chronic kidney or liver disease, asthma, bronchitis, chronic acne and other skin conditions, and disorders of the blood cells.

ACUTE TOXICITY Primary route(s) of exposure: ☒ Inhalation ☒ Skin Absorption ☐ Ingestion

Inhalation: Concentrations of 0.3 mg/m³ can cause nose irritation. Concentrations above 2 mg/m³ can cause irritation of upper respiratory tract with sneezing and coughing. Persons acclimated to pentachlorophenol can tolerate levels above 2 mg/m³. Symptoms of overexposure include rapid heart-beat and respiration, elevated temperature and blood pressure, muscular weakness, excessive sweating, dizziness and nausea. High concentrations can cause unconsciousness, convulsions and death generally from cardiac arrest.

Skin: Pentachlorophenol is readily absorbed through intact skin. Pentachlorophenol in solution can be readily absorbed through intact skin in toxic amounts, causing systemic poisoning and symptoms described in the Inhalation section. Pentachlorophenol on the skin can cause irritation.

Eyes: Pentachlorophenol causes irritation of the eyes at 1 mg/m³. If exposure is prolonged, slight transient corneal damage can occur.

Ingestion: Unlikely route of exposure. Single dose toxicity is high. Symptoms of ingestion are those described in the Inhalation section.

Note: Pentachlorophenol exposure by any route may result in the late development of a skin condition known as chloracne. (See Chronic Toxicity Section).

FIRST AID

Inhalation: Remove from exposure to fresh air. If breathing has stopped, administer artificial respiration. Call a physician.

Skin: Remove contaminated clothing and shoes. Wash thoroughly with soap and water. Wash contaminated clothing before reuse.

Eyes: Flush eyes immediately with water for at least 15 minutes. Contact a physician.

Ingestion: If conscious, induce vomiting. Contact physician or emergency medical facility immediately.

CHRONIC TOXICITY

Chronic overexposure to technical grade pentachlorophenol has caused liver and kidney toxic effects in experimental animals.

Carcinogenicity: Technical Grade Pentachlorophenol has been evaluated for possible cancer causing effects in laboratory animals. Rats exposed by ingestion to concentrations up to 30 mg/kg/day for 2 years and two strains of mice exposed by ingestion to concentrations up to 46.4 mg/kg/day did not show an increase incidence in tumors. Two strains of mice were also tested by having Technical Grade Pentachlorophenol subcutaneously injected. These mice did not show an increased incidence of tumors.

Pentachlorophenol is not listed on the IARC, NTP or OSHA carcinogen lists.

Reproductive Toxicity: Reproductive toxicity tests have been conducted to evaluate the potential adverse effects technical grade and purified pentachlorophenol may have on reproduction and offspring of laboratory animals. Both technical and purified pentachlorophenol have been found to be embro and fetotoxic to rats, but not to hamsters. Neither technical grade nor purified pentachlorophenol caused teratogenic (birth defects) effects, but did cause delays in normal fetal development.

Chloracne: In humans, the absorption of pentachlorophenol by any route may result in the development of the skin condition, chloracne. This usually appears as blackheads, whiteheads and yellow cysts over the temples and around the ears. In severe cases, involvement may be extensive. Mild cases may be similar in appearance to other forms of acne and to skin changes commonly seen with aging.

II. PERSONAL PROTECTION AND CONTROLS

RESPIRATORY PROTECTION

Where concentrations of pentachlorophenol are between 0.5 mg/m³ and 150.0 mg/m³ an approved organic vapor-dust filter type respirator is acceptable. Approved self-contained breathing apparatus or air line respirator, with full face piece, is required for concentrations above 150.0 mg/m³.

VENTILATION

Do not use in closed or confined space. Open doors and/or windows. Use ventilation to maintain exposure levels below 0.5 mg/m³.

SKIN PROTECTION

Wear PVC neoprene, or equivalent gloves and tightly woven clothing including long sleeve shirt when handling flake or solid penta. When mixing penta solutions, wear protective clothing, gloves and boots or shoes, which are suitable for the solvent being used.

EYE PROTECTION

Wear safety glasses. Contact lenses should not be worn. When mixing penta solutions, wear chemical goggles and/or face shield.

HYGIENE

Avoid contact with skin and breathing dust. Do not eat, drink, or smoke in work area. Wash hands prior to eating, drinking or using restroom. Change into uncontaminated clothing before leaving work premises. (Refer to Section VIII).

OTHER CONTROL MEASURES

To determine the exposure level(s), monitoring should be performed regularly. Safety shower and eye wash station should be available. Note: Protective equipment and clothing should be selected, used, and maintained according to applicable standards and regulations. For further information, contact the clothing or equipment manufacturer or the Vulcan Chemicals Technical Service

VIII - STORAGE AND HANDLING PRECAUTIONS

Store in properly labeled containers in dry, well ventilated area.

Thoroughly wash potentially contaminated clothing before reuse. Do not launder work clothes with other non-contaminated clothes and/or household laundry.

Contaminated clothing, boots or equipment should not be taken home.

IX - SPILL LEAK AND DISPOSAL PRACTICES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED

Ventilate spill area and avoid breathing dust or vapors. Clean up spilled material (wear protective equipment - See Section VII) and place in closed container for normal use if possible or proper disposal. Penta is toxic to fish and wildlife; do not allow to contaminate ground or surface waters.

WASTE DISPOSAL METHOD

Contaminated material must be disposed of in a permitted waste management facility. Consult Federal, State, or Local disposal authorities for approved procedures. Empty containers must also receive proper disposal.

X - TRANSPORTATION

DOT HAZARD CLASSIFICATION

ORM-E

PLACARD REQUIRED

None

LABEL REQUIRED

ORM-E. Label as required by OSHA Hazard Communication Rule, 29 CFR Part 1910.1200 (f), and any applicable state and local regulations.

For Further Information

Contact Vulcan Chemicals
Technical Service Department
P.O. Box 7689
Birmingham, AL 35253-0689
205/877-3459
8 AM to 5 PM Central Time
Monday Through Friday
For Emergency Information Call: 316/524-5751 (24 hours)

DATE OF PREPARATION

October 1, 1985

NOTICE: Vulcan Chemicals believes that the information contained on this Material Safety Data Sheet is accurate. The suggested procedures are based on experience as of the date of publication. They are not necessarily all-inclusive nor fully adequate in every circumstance. Also, the suggestions should not be confused with nor followed in violation of applicable laws, regulations, rules or insurance requirements.

NO WARRANTY, EXPRESS OR IMPLIED, OF MERCHANTABILITY, FITNESS OR OTHERWISE IS MADE.

ILLUSTRATION OF A MATERIAL SAFETY DATA SHEET (MSDS) ON INORGANIC ARSENICALS

- Section I:** Company name, trade name and synonyms.
- Section II:** Hazardous Ingredients
List all components of product and percentage makeup and TLV for all.
- Section III:** Physical Data
Boiling point, specific gravity, PH, etc.
- Section IV:** Fire and Explosion Data
Self-explanatory — water carrier will not burn.
- Section V:** Health Hazard Data
Very important section. Read thoroughly — lists TLV and emergency first aid procedures.
- Section VI:** Reactivity Data
Explains what can happen if it comes in contact with different products.
- Section VII:** Spill or Leak Procedures
Do not follow this section without checking with supervisors because of different laws in certain states.
- Section VIII:** Special Protection Information
Check closely for information about what type of clothing and protection devices to be worn.
- Section IX:** Special Precautions or Other Precautions
Self-explanatory.



MATERIAL SAFETY DATA SHEET

("essentially similar" to OSHA - 20)

RECEIVED
NOV 18 1985

PERMA POST PRODUCTS CO

Notice: The information herein is given in good faith but no warranty, express or implied, is made

SECTION I - PRODUCT IDENTIFICATION

MANUFACTURER'S NAME	OSMOSE WOOD PRESERVING CO. OF AMERICA, INC.	EMERGENCY TELEPHONE NO.	(404) 228-8434 (716) 882-5905
ADDRESS	1016 Everee Inn Road, Griffin, GA 30224 980 Ellicott Street, Buffalo, NY 14209	DATE FORM WRITTEN	7/1/84
TRADE NAME	Osmose® Brand Pressure Treated Wood	SYNONYMS	K-33® -C Brand CCA-C

SECTION II - HAZARDOUS INGREDIENTS

MATERIAL & COMPONENT	CAS NO.	0.25 pcf	0.4 pcf	0.6 pcf	1.0 pcf	2.5 pcf	TLV
		COMPONENT %*					
ARSENIC PENTOXIDE	1303-28-2	0.3	0.4	0.6	1.0	2.6	0.2 mg/m ³ As
COPPER OXIDE	1317-39-1	0.15	0.2	0.3	0.6	1.3	0.1 mg/m ³ As Cu
TRIVALENT CHROMIUM	1308-38-9	0.4	0.6	0.9	1.4	3.3	0.5 mg/m ³ As Cr
*Based on the applicable retention and a wood density of 32 pcf. These values may vary due to variability of treatment and the natural variability of wood.							
**Not subject to OSHA arsenic standard 29 CFR 1910.1018.							

SECTION III - PHYSICAL DATA

BOILING POINT, 760 MM HG	N.A.	MELTING POINT:	N.A.
SPECIFIC GRAVITY (H ₂ O = 1)	ESSENTIALLY THAT OF WOOD.	VAPOR PRESSURE:	N.A.
VAPOR DENSITY (AIR = 1)	N.A.	SOLUBILITY IN H ₂ O % BY WT:	HIGHLY INSOLUBLE
% VOLATILES BY VOL.	N.A.	EVAPORATION RATE (BUYLY ACETATE = 1):	N.A.
APPEARANCE AND ODOR	GREEN-YELLOW WOOD.	Ph (AS IS)	N.A.
		Ph (1% SOLN.)	N.A.

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (TEST METHOD)	N.A.	AUTOIGNITION TEMPERATURE	> 265°C
FLAMMABLE LIMITS IN AIR, % BY VOL.	LOWER	UPPER	
EXTINGUISHING MEDIA	☒ WATER FOG ☒ FOAM	☐ ALCOHOL FOAM ☒ CO ₂	☒ DRY CHEMICAL ☐ OTHER
SPECIAL FIRE FIGHTING PROCEDURES	TOXIC VAPORS FROM WOOD AND PRESERVATIVE MAY BE GIVEN OFF IN A FIRE. WEAR FULL PROTECTIVE EQUIPMENT AND SELF-CONTAINED AIR UNIT.		
UNUSUAL FIRE AND EXPLOSION HAZARD			

SECTION V – HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	SEE SECTION II.
EFFECTS OF OVEREXPOSURE	Wood dust may cause skin irritation and breathing difficulty. Dry Osmose® Brand Pressure Treated Wood has a low order to toxicity, therefore, the above reactions are unlikely. When machining any type of wood, a dust mask is recommended. FRESHLY TREATED "wet" wood presents a greater handling and machining risk; wear rubber gloves when handling and a dust mask or respirator when machining.
EMERGENCY AND FIRST AID PROCEDURES	
	WASH WITH SOAP AND WATER. FOR BREATHING, USE DUST MASK.
	(See Section VIII).

SECTION VI – REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	
INCOMPATIBILITY (Materials to avoid)			
HAZARDOUS DECOMPOSITION PRODUCTS THERMAL: Ash will contain free arsenic and chromium and may be toxic.			
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SECTION VII – SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED	
Maintain a clean workplace. Clean up scrap lumber and sawdust. Wear a dust mask when cleaning up sawdust.	
WASTE DISPOSAL METHOD Dispose in accordance with all Federal, State and Local laws.	
Dispose waste material in an approved landfill. DO NOT BURN: Ash may be toxic and a hazardous waste; combustion vapors may be toxic.	
(Industrial generators of waste: call Osmose.)	

SECTION VIII – SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type) When machining dry wood, a dust mask is recommended. For wet wood, a respirator may be required.		
VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (General) When machining.	OTHER
PROTECTIVE GLOVES - Rubber when handling wet wood. Leather to avoid splinters.		EYE PROTECTION To protect from sawdust.
OTHER PROTECTIVE EQUIPMENT As necessary to limit exposure when handling wet wood.		

SECTION IX – SPECIAL PRECAUTIONS OR OTHER PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING SEE LABEL: Use good personal hygiene, wash before eating and smoking. Specify only pressure treated wood treated with "oxide" CCA preservatives and free from excess surface deposits of preservatives. Avoid handling and machining of freshly treated "wet" wood unless specified safety precautions are observed.	
--	--

CREOSOTE OIL



Form C-8401-OH-82

ACTIVE INGREDIENT: Coal Tar Creosote 98½%

INERT INGREDIENTS 1½%

NET CONTENT GALLONS

(OVER)

(OVER)

ALLIED CHEMICAL
Allied Corporation
Morristown, New Jersey 07960

SAMPLE ONLY

KEEP OUT OF REACH OF CHILDREN
WARNING!

CAUSES IRRITATION (ACCENTUATED BY SUNLIGHT).
MAY CAUSE BURNS FROM PROLONGED CONTACT.
HARMFUL IF SWALLOWED, INHALED OR ABSORBED THROUGH SKIN.

Avoid contact with eyes, skin and clothing.

Avoid prolonged breathing of vapor.

Use only with adequate ventilation.

Wash thoroughly after handling.

Avoid sources of ignition.

FIRST AID: INHALATION: Remove to fresh air. If not breathing give artificial respiration (preferably mouth-to-mouth) or oxygen, as needed. Call a physician. **SKIN CONTACT:**

Avoid solvents. Use waterless hand cleaners or soap and water.

EYE CONTACT: Flush eyes immediately with plenty of water or mineral oil for at least 15 minutes. Call a physician.

INGESTION: First induce vomiting; then take 2 tablespoons of activated charcoal-USP (drug grade) in water. Get immediate medical assistance.

Form C-8401-OH-82

(OVER)

EPA REG. NO. 218-609
EPA EST. 218-OH-1

(OVER)

ALLIED CHEMICAL
Allied Corporation
Morristown, New Jersey 07960

PRECAUTIONARY STATEMENTS HAZARDS TO HUMANS AND DOMESTIC ANIMALS DANGER

May be fatal if inhaled, swallowed or absorbed through skin.

Do not breathe dust, vapors or mist.

Do not get either the dry material or solutions prepared from it in eyes, on skin or on clothing. May cause skin or eye irritation.

Keep well covered with clean clothing, (long sleeves, buttoned) gloves and shoes. Wear MSHA/NIOSH approved goggles and respiratory protection during handling. Wash thoroughly with soap and water after skin contact and before eating, drinking, use of tobacco products, or using restrooms. Protective clothing must be changed when it shows signs of contamination.

Do not use on picnic tables, children's playground structures or horticultural lumber. Do not use treated wood in structures to contain animal feed or agricultural produce. Products treated with or containing this chemical are not to be used in food packaging material or in areas where food is processed, handled or stored.

ENVIRONMENTAL HAZARDS

This product is toxic to fish and wildlife. Do not contaminate water, food or feed by storage, cleaning of equipment or disposal of wastes.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling. Vulcan Glazd® Penta is used for the preparation of fungicidal and insecticidal solutions. Recommended concentrations for such solutions vary according to the end uses and methods of applying solutions to get the desired biological control.

Each formulator is responsible for obtaining EPA registration for his end use product(s). For the preparation of wood preservation formulations and methods of applying them to wood, consult the current American Wood Preservers' Association Standards or contact Vulcan Chemicals.

Vulcan GLAZD® PENTA PENTACHLOROPHENOL ORM-E NA2020, RQ

TECHNICAL GRADE

For Manufacturing Purposes Only

ACTIVE INGREDIENTS	
Pentachlorophenol	96%
Other Chlorophenols	86%
and Related Compounds	10%
INERT INGREDIENTS	
	4%

DANGER POISON KEEP OUT OF REACH OF CHILDREN

STATEMENT OF PRACTICAL TREATMENT

- If swallowed - Call a physician or Poison Center immediately. If possible, vomiting should be induced under medical supervision. Drink one or two glasses of water and induce vomiting by touching the back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.
- If on skin - Wash immediately with soap and water. Wash thoroughly with soap and water after handling.
- If in eyes - Flush with water for at least fifteen minutes and contact a physician.

SEE SIDE PANEL FOR ADDITIONAL WARNINGS.

STORAGE AND DISPOSAL

STORAGE Glazd® Penta should be stored in a dry, well-ventilated secure area in proper containers. Do not store Penta solutions near sources of heat or near open flames. If package becomes ripped or punctured, apply tape to seal and prevent spillage. If a spill of dry product occurs, sweep up cautiously to avoid stirring up dust. Wear a respirator at all times. Do not store in an area where product can come into contact with foods, feeds or potable water.

PESTICIDE DISPOSAL Pesticide wastes are toxic. Improper disposal of excess pesticide, spray mixture or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA regional office for guidance.

CONTAINER DISPOSAL Completely empty bag or drum into application equipment. Then dispose of bag or drum in a sanitary landfill or by incineration, or, if allowed by State and local authorities, by burning. If burned stay out of smoke.

MEETS FEDERAL SPEC. TT-W-570a
MEETS AWPA SPEC. P-8
MEETS ASTM SPECIFICATION D 1272-56

NOTICE TO BUYER

Our recommendations for use of this product are based upon tests believed to be reliable. The use of this product being beyond the control of the manufacturer, no guarantee, expressed or implied, is made as to the effects of such or the results to be obtained if not used in accordance with directions or established safe practice. The buyer must assume all responsibility including injury or damage, resulting from its misuse as such, or in combination with other materials.

NET

lbs.

Vulcan Materials Company

CHEMICALS DIVISION / P. O. BOX 7689 • BIRMINGHAM, ALABAMA 35213

EPA Reg. No. 5382-16
EPA Est. No. 5302-KS-1

VAC: 3099
Rev 1/85

OSMOSE® K-33-C (50%)

WOOD PRESERVATIVE

(For Pressure Plant Use Only)

OSMOSE K-33-C IS DESIGNED FOR THE PRESSURE IMPREGNATION OF WOOD TO PROVIDE PROTECTION AGAINST DECAY, TERMITES AND MARINE BORERS. (LIMNORIA AND TEREDO).

DIRECTIONS FOR USE: TO BE USED IN ACCORDANCE WITH AWPA OR FEDERAL SPECIFICATIONS. REFER TO OSMOSE OPERATING MANUAL FOR SPECIFIC RECOMMENDATIONS.

ACTIVE INGREDIENTS

Arsenic Acid	17.00%	ARSENIC AS ELEMENTAL ARSENIC	11.00%
Copper Oxide	9.25%	WATER SOLUBLE ARSENIC AS ELEMENTAL	11.00%
Chromic Acid	23.75%		

INERT INGREDIENTS

Water	50.00%
	100.00%

NET CONTENTS: 55 Gallons (660 lbs.)



DANGER-POISON

DANGER KEEP OUT OF REACH OF CHILDREN

Poisonous if swallowed. May cause rash or external burns. Wear goggles or face shield and rubber gloves when loading. Do not get in eyes, on skin or on clothing. In case of contact flush skin or eyes with plenty of water. For eyes get medical attention. Wash thoroughly after using. Wash clothing before reuse. Do not breathe spray mist. All waste pesticide should be removed from the container and empty container decontaminated thoroughly before disposal in any other manner.

This product is toxic to fish and wildlife. Keep out of lakes, streams, or ponds. Do not contaminate water by cleaning of equipment, or disposal of wastes. Apply this product only as specified on this label.

PRACTICAL TREATMENT

If swallowed: Call a physician or Poison Control Center. Drink 1 or 2 glasses of water and induce vomiting by touching back of throat with finger. Do not induce vomiting or give anything by mouth to an unconscious person.

DIRECTIONS FOR DECONTAMINATION

Empty contents into mixing tank and flush container clean with 500 gallons of water which shall be reused for diluting treating solution.

Puncture and safely bury cleaned container.

Manufactured by

OSMOSE WOOD PRESERVING CO. OF AMERICA, INC.

880 Ellicott St. Buffalo NY 14208

EPA Est. 3008-TN-1

E. P. A. Reg. No. 3008-36

Laws and Regulations

Pesticide application has become more complex in recent years. The number of different kinds of pesticides available for use has increased greatly. Effects on wildlife and the environment are known to be important considerations in pesticide use. New highly poisonous pesticides require special equipment and safety measures. To help protect the public, the environment, and the applicator, new laws and regulations have been adopted.

FIFRA

A law passed by Congress in 1972 and substantially amended in 1974 and 1978 (called by its initials—FIFRA*) regulates the registration, manufacture, transportation, and use of pesticides. The law affects you, the applicator, in many ways. Most importantly, it provides that:

- all pesticides must be used only as directed on the label,
- all pesticide uses must be classified as "restricted" or "general",
- persons who buy or use restricted-use pesticides must be certified as competent pesticide applicators or must be directly supervised by a certified applicator,
- persons who do not obey the law will be subject to penalties (fines and jail terms).

Use Inconsistent With the Label

An applicator may not use any pesticide in a manner not permitted by the labeling. You must use the pesticide only on the plants, animals, or sites specified in the directions for use. You may not use higher dosages, higher concentrations, or more frequent applications. You must follow directions for use, safety, mixing, diluting, storage, and disposal—as well as restrictions on reentry and days to harvest, slaughter, and grazing.

The law **does** allow you to:

- apply a pesticide at any dosage, concentration, or frequency **less** than that listed on the labeling.

*Federal Insecticide, Fungicide, and Rodenticide Act, as amended. Original law regulating pesticides was enacted in 1947.

- apply a pesticide against any target pest not listed on the labeling if the application is to a crop, animal, or site that is listed.
- use any equipment or method of application which is not prohibited by the labeling.
- mix a pesticide or pesticides with a fertilizer if the mixture is not prohibited by the labeling.
- mix two or more pesticides, if all the dosages are at or below the recommended rate.

Classification of Pesticide Uses

Every use of every pesticide will be classified by the U. S. Environmental Protection Agency as either "general" or "restricted". Many times either all the uses of a particular formulation are classified as restricted or all of them are classified as general. Sometimes, however, certain uses of a formulation are restricted and other uses of the same product are not. In these cases the directions for use for the two classifications must be clearly separate from one another. Entirely different packaging and labeling often are used.

A pesticide (or some of its uses) will be classified as "general use" if it is not likely to harm humans or the environment when used as directed on the label.

A pesticide (or some of its uses) will be classified as "restricted use" if it could cause human injury or environmental damage unless it is applied by competent persons (certified applicators) who have shown their ability to use these pesticides safely and effectively.

Classification of pesticides and pesticide uses may be based on:

- the potential for poisoning of humans.
- the type of formulation.
- the way the pesticide is used.
- the place in which the pesticide is used.
- the potential for harm in the environment.

When a pesticide is restricted, the label will say "Restricted Use Pesticide" in a box on a prominent part of the front panel. When a pesticide is classified for general use, the words "General Classification" will appear immediately below the heading "Directions for Use."

NOTE: Although EPA has classified many pesticide products and uses, some pesticides have not yet been classified. Applicators should pay close attention to the signal words and human and environmental hazard statements on each product. The

absence of a "Restricted-Use Pesticide" statement does not mean that the product is not hazardous; it may simply mean that the pesticide has not yet been classified.

Certification of Applicators

Persons who are not certified pesticide applicators may not purchase or use restricted pesticides unless they are directly supervised by a certified applicator.

Certification requires training or testing for competency in the safe and effective handling and use of these pesticides.

Your state or a federal agency will conduct the training and or tests for certification. Your state may impose stricter standards than those required by FIFRA. The U.S. Environmental Protection Agency requires each state to maintain a program to assure that certified applicators have current certification. Check with your state to determine the requirements you need to meet.

Many adjoining states have developed agreements to allow certification in one state to be accepted in the nearby states or throughout a region. If you will be operating in more than one state, you should check with the proper authorities to determine whether separate training and or testing for certification is necessary for each state.

There are two types of certified pesticide applicators—private applicators and commercial applicators.

Private Applicators

Private applicators are persons who use or supervise the use of restricted-use pesticides in producing an agricultural commodity on property owned or rented by themselves or their employer, or on the property of another person with whom they trade services. Examples of private applicators are farmers, ranchers, floriculturists, and orchardists. Private applicators are trained and or tested in the safe use and handling of pesticides and pest control practices associated with agricultural operations.

Commercial Applicators

Commercial applicators are persons who use restricted-use pesticides for hire on property other than their own, and government workers (public operators) who apply pesticides in their jobs. Commercial applicators are trained and tested in the general areas of safe use and handling of pesticides

and then receive further training in one or more specific categories of application, including:

- agricultural pest control (plant or animal),
- forest pest control,
- ornamental and turf pest control,
- seed treatment,
- aquatic pest control,
- right-of-way pest control,
- industrial, institutional, structural, and health-related pest control,
- public health pest control,
- regulatory pest control,
- demonstration and research pest control.

Several states have different or additional categories for commercial applicators. These include, for example, aerial application, wood preservation, and use of antimicrobials.

You must determine which categories best fit your business needs. It is illegal to apply a restricted-use pesticide in a category in which you are not certified.

Penalties

If you violate the law or regulations enacted under FIFRA, you are subject to civil penalties. They can be as much as \$5,000 for each offense (\$1,000 for private applicators). Before EPA can fine you, you have the right to ask for a hearing in your own city or county. Some violations of the law may also subject you to criminal penalties. These can be as much as \$25,000 or one year in prison, or both, for commercial applicators; \$1,000 and or 30 days in prison for private applicators.

LAWS, REGULATIONS AND GUIDELINES

Laws

Pesticide use and application in Kentucky is governed by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as amended, and by Kentucky Revised Statutes (KRS) 217B, the Pesticide Use and Application Act of 1972, as amended. The law is administered by the Department of Agriculture, Frankfort, Kentucky.

Regulations - General Provisions

Department of Agriculture Relations KAR 31:005 sets forth the general provisions which apply with regard to definitions, compatibility, conflicting provisions, severability, record-keeping, storage and handling of restricted-use pesticides, supervisory requirements, certification denial, suspension, modification or revocation, and private applicators. Sections of this regulation are reprinted here:

Section 1. Definitions.

(5) "Certification" or "certified" means recognition by the Department that a person has demonstrated at least a minimum acceptable level of competence by examination or otherwise, and is authorized to use or supervise the use of restricted-use pesticides in the area of this certification.

(6) "Commercial applicator" means a certified applicator (whether or not the person is a private applicator with respect to some uses) who uses or supervises the use of any pesticide which is classified for restricted use for any purpose or on any property other than as provided by subsection (28). (see below).

(13) "Environment" means water, air, land, plants, man and other animals living therein, and the interrelationships which exist among them.

(14) "Faulty, careless or negligent manner" means any act or omission which has or may have a deleterious effect on any person or property or which any person recommending or applying pesticides knows or should know is unnecessary or will not effectively accomplish the end sought and also means any application or use of pesticides inconsistent with the standards established by this regulation.

(26) "Pesticide" means any substance or mixture of substances intended to prevent, destroy, control, repel, attract or mitigate any pest.

(27) "Practical knowledge" means the comprehension of and ability to see pertinent facts in dealing with specific problems and situations.

(28) "Private applicator" means a person certified to use or supervise the use of any pesticide which is classified for restricted-use for purposes of producing any agricultural commodity on property owned or rented by him or his employer or (if applied without compensation other than trading of personal services between producers of agricultural commodities) on the property of another person.

(41) "Under the direct supervision of" means the act or process whereby purchase, use or application of a pesticide is made by a competent person acting under the instructions and control of a certified applicator who is responsible for the actions of that person and who is available if and when needed, even though such certified applicator is not physically present at the time and place the pesticide is used or applied.

Section 7. Supervisory Requirements. When a person purchases, uses or applies restricted-use pesticides under the direct supervision of a person with certification, the availability of the person with certification shall be directly related to the hazard of the situation.

Section 5. Record-keeping Requirements.

(3) Commercial applicators. All commercial applicators who purchase, use or apply restricted-use pesticides shall maintain the following records:

- (a) Name and address of person requesting services;
- (b) Kind and amounts of pesticides applied;
- (c) Date of use or application;
- (d) Purpose of application;
- (e) Area of land treated, where applicable;
- (f) Crop or type of area treated;
- (g) Name of person with certification to purchase, use or apply restricted-use pesticides;
- (h) Pesticide dealer where restricted-use pesticides were purchased; and
- (i) Street address or site of use or application.

(4) Retention. All persons required to maintain records under subsection (3) of this section shall retain the records for a period of three (3) years from the date of use or application. Duplicate records need not be maintained. When a use or application of a restricted-use pesticide is made in the name of a person or business entity, then only one (1) set of records for each job or use need be maintained by that person or business entity, even though more than one (1) person may have made the use or application.

(5) Availability. Records required under this section shall be made available to the Department upon written request.

Regulations - Certification

Department of Agriculture Regulation KAR 31:015 establishes a system of certification for persons who purchase, use, or apply restricted-use pesticides pursuant to the Federal Insecticide, Fungicide, and Rodenticide Act of 1972, as amended.

Sections of this regulation that apply to Right-of-Way certification are reprinted here:

Section 1. Applicability. No person may purchase, use or apply restricted-use pesticides unless that person is certified in a category consistent with such purchase, use, or application, as provided in this regulation or is acting under the direct supervision of a person so certified.

Section 2. Certification. Certification under this regulation may be obtained from the Department in the following categories of restricted-use pesticide use or application:

(6) Right-of-way pest control. This category includes persons using or supervising the use of restricted-use pesticides in the maintenance of public roads, electric power-lines, pipelines, railway rights-of-way or other similar areas.

Section 3. General Requirements. To obtain certification, a person shall pay an application fee of twenty-five dollars (\$25), submit a completed application form specifying the category or categories in which certification is requested, and satisfactorily demonstrate competence in the use and handling of pesticides in those categories. Competency in the use and handling of pesticides shall be determined on the basis of written examinations, and, as appropriate, performance testing, based upon standards set forth below. Such examination and testing shall include the general standards applicable to all categories and the additional standards specifically identified for each category or subcategory in which a person desires to be certified.

Section 4. General Standards of Competency. All persons shall demonstrate practical knowledge of the principles and practices of pest control and safe use of pesticides, including standards for the supervision of noncertified persons as established by regulation.

Section 5. Specific Standards of Competency. In addition to meeting the requirements of Sections 3 and 4, persons requesting certification for a specific category must demonstrate competence related to that category as follows:

(6) Right-of-Way. Persons requesting right-of-way certification shall demonstrate practical knowledge of a wide variety of environments, since

rights-of-way can traverse many different terrains, including waterways. They shall demonstrate practical knowledge of problems of runoff, drift and excessive foliage destruction and the ability to recognize target organisms. They shall also demonstrate practical knowledge of the nature of herbicides and the need for containment of these pesticides within the right-of-way area, and the impact of their application activities upon the adjacent areas and communities.

Section 8. Certification Maintenance. To maintain certification, each person certified to purchase, use or apply restricted-use pesticides, other than a private applicator, shall in any five (5) year period, attend at least two (2) training programs approved by the Department in the use and application of pesticides, with the exception of seed treatment applicators who shall attend one (1) training course. Training received before the promulgation of these rules and regulations will be eligible for retroactive credit toward certification maintenance.

Section 9. Credentials.

(1) When a person meets all the requirements to obtain a license to do business under KRS 217B.010 to 217B.260 or under KRS 217B.500 to 217B.585, the Department shall issue that person a document signifying that the person is licensed to do business in the category for which a person qualifies.

(2) When a person meets all the requirements to obtain certification to purchase, use or apply restricted-use pesticides, then the Department shall issue that person a document signifying that the person is certified to purchase, use or apply restricted-use pesticides in the categories for which the person qualifies.

(3) When a person qualifies for certification incident to qualification for a license to do business, then the Department shall issue that person two (2) documents. One (1) document shall be the license to do business. The other document shall be the certification to purchase, use or apply restricted-use pesticides.

(4) A certification to purchase, use or apply restricted-use pesticides issued under this regulation is separate and distinct from any licenses to do business issued under KRS 217B.010 to 217B.260 or under 217B.500 to 217B.585. A certification may be granted or denied, or modified, suspended, or revoked independent of the grant or denial, modification, suspension, or revocation of any license to do business. In a like manner, any license to do business may be modified, suspended, or revoked independent of the grant or denial, modification, suspension, or revocation of any certification.

GLOSSARY

Absorption: The process by which a chemical is taken into plants, animals, or minerals. Compare with adsorption.

ACA: Abbreviation for Ammoniacal Cooper Arsenate.

ACGIH: American Conference of Governmental Industrial Hygienists.

ACZA: Ammoniacal Copper Zinc Arsenate.

Antidote: A practical treatment for poisoning, including first aid.

Aqueous: A term used to indicate the presence of water in a solution.

Arsenicals: Pesticides containing arsenic.

Carcinogen: Substance which causes cancer.

Carrier: The inert liquid or solid material added to an active ingredient to prepare a pesticide formulation.

CAS: Chemical Abstract Service.

CCA: Abbreviation for Chromated Copper Arsenate.

Chlorinated Hydrocarbon: A synthetic organic pesticide that contains chlorine, carbon and hydrogen. Same as organochlorine.

Chlorination: To treat or cause to combine with chlorine or a chlorine compound.

Closed Mixing System: Any containment which prevents release of the subject chemical into the surrounding environment. Note: The release of incidental amounts of chemical during equipment loading or periodic cleanout or maintenance operations shall not be deemed a breach of containment.

Concentration: The amount of active ingredient in a given volume or weight of formulation.

Contaminate: To make impure or to pollute.

Creosote: A distillate of coal tar produced by high temperature carbonization of coal.

Dermal: Of the skin; through or by the skin.

Dermal Toxicity: Ability of a chemical to cause injury when absorbed through the skin.

Diluent: Any liquid or solid material used to dilute or carry an active ingredient.

EPA: Environmental Protection Agency.

Fetotoxicity: Ability of chemical or agent to have harmful effects on a fetus, such as reduced litter size, lowered birth weight or reduced organ function.

Impermeable: Cannot be penetrated. Semipermeable means that some substances can pass through and others cannot.

LC50: The concentration of an active ingredient in air which is expected to cause death in 50 percent of the test animals so treated. A means of expressing the toxicity of a compound present in air as dust, mist, gas, or vapor. It is generally expressed as micrograms per liter as a dust or mist but in the case of a gas or vapor as parts per million (ppm).

LD50: The dose of an active ingredient taken by mouth or absorbed by the skin which is expected to cause death in 50 percent of the test animals so treated. If a chemical has an LD50 of 10 milligrams per kilogram (mg/kg), it is more toxic than one having an LD50 of 100 mg/kg.

MSHA: Mine Safety and Health Administration.

Mutagenic: Can produce genetic change.

Mutagenicity: Ability of chemical or agent to produce a genetic change. The change (mutation) may be passed on to the next generation.

NIOSH: National Institute for Occupational Safety and Health

Nonaqueous: Not relating to, or resembling water.

Oncogenicity: Ability of a chemical or agent to cause abnormal growth or tumor, either malignant or benign.

Oral: Of the mouth; through or by the mouth.

Oral Toxicity: Ability of a pesticide to cause injury when taken by mouth.

Organic Compounds: Chemicals that contain carbon.

Pentachlorophenol: (Penta) consists of pentachlorophenol and related chlorinated chemical compounds.

Permissible Exposure Level: (PEL). A specific time-weighted exposure level to an airborne contaminate.

Photosynthesis: Synthesis of chemical compounds with the aid of radiant energy and light.

RPAR: Rebuttable Presumption Against Registration.

Sapstain: A discoloration of the sapwood.

Solution: Mixture of one or more substances in another in which all ingredients are completely dissolved.

Solvent: A liquid which will dissolve a substance to form a solution.

Synthesis: The production of a substance by the union of chemical elements, groups or similar compounds, or by the degradation of a complex compound.

Teratogenicity: Ability of chemical or agent to cause abnormal development or malformation in a fetus.

Threshold Limit Value: (TLV). The level where first effects occur.

Toxic: Poisonous.

Trade Name: Same as brand name.

Time-Weighted Average: (TWA). An average exposure over a given work period determined by sampling.

Vapor Pressure: The property which caused a chemical to evaporate. The higher the vapor pressure, the more easily it will evaporate.

Viscosity: A property of liquids that determines whether they flow readily. Viscosity usually increases when temperature decreases.

Volatile: Evaporates at ordinary temperatures when exposed to air.

This publication was developed by an interdisciplinary committee with representation from:

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