CONTROL OF DECAY AND SAP STAIN IN LOGS AND GREEN LUMBER

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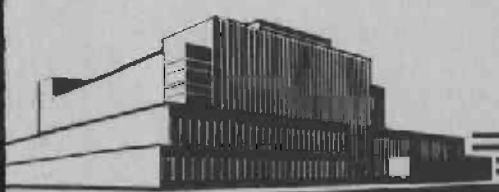

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FOREST SERVICE
In Cooperation with the University of Wisconsin

CONTROL OF DECAY AND SAP STAIN IN LOGS AND GREEN LUMBER

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Decay (variously known as rot, doze, or dote) and sap stain are prominent sources of waste or degrade in stored logs and in lumber on the seasoning yard during mild weather. These forms of damage generally can be controlled by the comparatively simple and inexpensive ways described here.

Damage Caused by Decay and Sap Stain Fungi

Decay and sap stain are caused by minute, thread-like organisms known as fungi. These grow deep into the wood and use portions of it for their food. The sap-stain fungi are essentially limited to sapwood but decay fungi can attack both heartwood and sapwood of most woods. The decay fungi also consume parts of the wood that give it most of its strength; consequently, they can cause severe weakening of the wood. The sap-stain fungi chiefly attack other parts and cause objectionable discoloration but ordinarily do not affect strength seriously. With heavy staining, however, the toughness of the wood -- or its capacity to withstand shock -- may be excessively reduced for some uses.

There is always the additional possibility that the stain may be accompanied by early decay, hidden by the stain but, nevertheless, present in a damaging amount. Such an association is common because the conditions that favor the stain fungi also favor those that cause decay.

It is important to note also that (in structures exposed to the weather) stained lumber is more subject than bright lumber to decay. Staining considerably increases the absorptiveness of wood and so causes it to soak up rain water more readily than the unstained lumber.

A particularly objectionable form of sap stain is commonly known as interior stain. Stock with interior stain may be perfectly bright on the outside and

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

pass for top-grade material, but when it is surfaced the underlying wood shows a discoloration. As a result, manufacturing or marketing costs are involved that might have been avoided if this degrading factor had been known earlier. Interior stain differs from ordinary sap stain only in that it is not apparent on the surface as well as in the interior of the lumber; the causal fungi are the same. Interior stain occurs when lumber becomes infected by stain fungi but very shortly thereafter will no longer support development of the fungi at and near the surface because of the rapid development of unfavorable conditions near the outside. As a result, the fungi in the outer zone do not have time to acquire their normal dark color that is responsible for the wood discoloration; however, deeper in the lumber -- where the wood has not been affected by external conditions -- the fungi are able to continue their growth as long as adequate moisture remains.

Unfavorable surface conditions that lead to interior stain may come about through a period of rapid drying or they may be produced by surface treatment with a chemical solution. The infection that ultimately develops into interior stain occurs in the lumber soon after sawing or in some cases it may take place in the log shortly before it is sawed.

Mold is the third kind of fungus damage to wood. It consists mainly of unsightly surface growths of the fungi and is sometimes troublesome on green lumber and other wood products. Molds do not discolor wood as deeply as does sap stain but occasionally, particularly in hardwoods, the discoloration may penetrate far enough into the wood to be visible after the stock is surfaced. Mold, like sap stain, is essentially limited to the sapwood. Its effect on wood strength and absorptivity also is similar to that of sap stain. Because of its lesser importance, it will not be considered further here. Fortunately, the three kinds of fungi responsible for decay, sap stain, and mold can all be controlled by the same means.

Basic Aims of Control Measures

Control measures are designed to eliminate one or more of four things needed by the fungi for their growth. These things are suitable temperature, air (oxygen), water, and the normal nutritional quality of the wood.

Temperatures that favor the growth of wood-attacking fungi are similar to those needed by the green plants. If logs are stored or seasoned in the yard when temperatures are below about 50° F., little trouble will ordinarily be experienced from fungi. In some regions, sprinkling of log piles apparently lowers temperatures around the wood sufficiently to cause worthwhile retardation of decay and sap stain.

Wetting the logs has an additional fungus-retarding effect in that it limits movement of air into the logs. Both effects combine to give a large degree of protection. This can be accomplished by completely submerging logs in water, as in pond storage. For lumber, limiting the air in wood usually is impractical as a protective measure.

Need of the fungi for water can be used in a number of ways to protect lumber. Wood with less than 20 percent moisture is immune to decay and sap stain. Therefore, if the drying of green stock can be made to progress rapidly enough, this alone will often give adequate protection. That is why special piling methods such as end racking or extra-wide spacing of boards sometimes may be of value in addition to shortening the time required to get stock dry enough for shipping. It follows that if the wood is not allowed to become infected beforehand, kiln drying insures sound, bright lumber.

Where it is not practicable to make the temperature, air supply, or water content of the wood sufficiently unfavorable for their growth, the fungi can be controlled in most situations of log storage or lumber seasoning by applying a toxic solution to the surfaces of the green product. This solution acts as a chemical barrier and prevents the fungi from entering the wood. Since only the surface is affected, however, such treatment does not give permanent protection.

Control of Decay and Stain in Logs

Rapid Conversion

Where winters are relatively cold, attack by fungi is slowed to negligible amounts if logs are cut and decked between October and the following spring. In the Gulf States, however, stain and decay are not stopped completely during this period; some loss is likely if logs are stored for longer than 3 or 4 months. During summer storage everywhere, losses can be severe unless precautions are taken to avoid them (fig. 1).

The most effective method of holding losses to a minimum in mild weather is to convert the logs into lumber or other products within a week or two after the trees are felled. With saw logs and other large round products, decking in the open or under other conditions that hasten drying has little value in preventing fungus damage. Furthermore, rapid drying may result in excessive loss from end checking.

Wet Storage

When it is impracticable to utilize logs promptly, it is sometimes possible to store them in ponds, lakes, or fresh-water inlets. This is a regular practice at some sawmills. Fungus attack is prevented except for occasional infections in the parts of the logs that are out of the water. Prolonged submersion has no adverse effect on the wood except in apparently rare situations where the iron content of the water is unusually large; in the presence of excessive iron, many woods gradually acquire a grayish color because of a reaction between their tannin constituents and the iron.

Decay and stain in logs that float high in the water are commonly the result of infection carried through the bark by beetles as they attack the logs. These forms of damage can be controlled for several weeks by spraying the exposed part of the log with an insecticidal solution.

Where conditions do not permit storage in water, or where decking is a preferred manner of storage, comparable protection can be provided to at least certain timber species by sprinkling the decks with water. The beneficial effect of sprinkling has been specifically observed with western pines, Engelmann spruce, and Douglas-fir,[2] and with western hemlock and northern hardwoods. It remains to be determined what can be accomplished by sprinkling logs of southern woods. The wetting system should be in continuous operation in periods when there is risk of serious decay and sap stain. With such species as birches, maples, and sweetgum, which have a tight, relatively fungus-proof bark, it seems most important to wet the log ends. Present evidence indicates that where decks are placed close together the log ends can still be adequately reached by making the decks no more than 12 to 15 feet high and by wetting them at the top, letting the water trickle and drift (in mist form) down between decks. This method of course also gets the sides of the logs wet; thus, it has the potential advantage, over strictly end wetting, of cooling the wood.

In the case of wood species that develop loose bark readily or that have bark that is easily penetrated by fungi (for example, beech and black oak), it would be essential to wet the sides as well as the ends of the logs. But it has not yet been determined whether even this complete wetting would be suitably effective on such species.

Cyclic or rotating sprinkler heads of the irrigation type seem to deliver water to a given surface frequently enough if the heads are spaced with due regard to their rated covering areas.

Chemical Treatment

Suitability for Different Woods.--Chemical spray treatments are available that will prevent serious losses from decay and stain for many months in logs of a number of timber species. These treatments can be supplemented when necessary by an end coating to minimize log checking. Woods that have been successfully protected by this method are, in the South, sweetgum, oaks of undetermined species, yellow-poplar, magnolia, elm, hickory, sycamore, black locust, and pine and, in the North, white and yellow birch and hard and soft maples. The method has also been effective on western pines.

However, chemical treatment apparently will not give adequate protection to all woods. For example, it has proved ineffective in tests on beech and black oak in the North. Where an untried species is being considered for chemical protection, the safest thing is to make limited tests before treating it extensively.

Treating Procedure

Handling the Complication of Beetle Attack.--If it is likely that the logs will be free of serious attack by bark or wood-boring beetles during the periods of

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[2] Stout, Albert W. Water Sprinkling Protects Decked Logs. Western Pine Association Research Note No. 2.114, 6 pp. 1957.

storage, it is necessary to spray only the ends and such debarked areas as can practicably be reached. But if a beetle attack is possible, both sides and ends must be treated and the spray should contain a mixture of chemicals that will control both fungi and insects. Beetle infestations are not only damaging in themselves, but they limit the value of the preservative treatment by carrying the decay and stain fungi into the logs. In the South, beetle attacks are so unpredictable that it is safest to include measures against them at all times. With northern hardwoods, above approximately the 44th parallel, an insecticide usually is not needed in the spray because beetle attack on these woods is often slight.

A hand-operated garden sprayer can be used to spray logs before they are decked, or for logs in the deck if only the ends are to be covered. A power sprayer will be needed for decked logs that are to be treated on both sides and ends. A hydraulic type developing 200 pounds per square inch has been found suitable (fig. 2). The spray gun should be adjustable so it can deliver a wide spray over the outer surfaces of the deck and a narrow spray that will drive into the interior of the deck. Whatever the kind of sprayer, the aim should be to cover all required surfaces and to get them dripping wet.

In warm weather it is well to spray on the day the logs are cut or, at latest, on the following day. This will generally require the logs to be treated in the woods or at a ramp. In cool or cold weather, treating can often be delayed until the logs are hauled and decked. This has considerable advantage in reducing labor cost, especially if the sides are to be treated and a power sprayer is available. There is evidence that cold winter temperatures in the North will permit treatment to be delayed without particular danger until as late as April; where winters are milder, a few days' delay may be all that can be tolerated. Frozen logs can be successfully sprayed if an oil-type solution is used and there are no iced-over areas on the log ends.

To maintain effectively the protective barrier of chemical at the ends of the logs through long periods of storage, seasoning checks must be prevented or covered. Seasoning checks act as channels through which fungus infection can occur despite the best possible spray treatment of the surface. Therefore, with logs that are to be held long enough in mild weather to entail risk of end checking, or in the North with winter-cut logs that have already end checked and are to be carried into warm weather, an end coating is needed after the spray treatment (fig. 3).

For the end coating, a heavy asphalt preparation known to the trade as a cutback has proved highly suitable. Asphalt cutbacks are readily available since they are extensively used in roofing construction and for moisture-excluding coatings on cement and metal surfaces. The product should be viscous enough so that it does not "sag" excessively and leave a thin coating. As a general guide, the coating should be thick enough when dry to hide small irregularities on the end surface made by the saw. To accomplish this it may be necessary to use a heavier material in summer than in winter, for example something with a consistency for light trowling rather than brushing. It is important that the coating extend to the edge of the bark.

A fast and effective way of applying the coating is to spread it with the palm of the hand, using an oil-resistant rubber (neoprene) glove for protection. If desired, a power rig presumably could be used to apply the coating to decked logs.

A brief summary of general recommendations for protecting logs by chemical treatment, according to region, kind of wood, need for insect control, and need for including an end coating, is given in table 1. Insofar as is known, measures suitable for protecting logs in the South should be generally applicable to tropical situations also. In the Tropics it may be necessary to repeat the spraying for insect control every 2 or 3 months, especially on smooth-bark logs.

Chemicals for Log Treatment.--Solutions suitable for spraying logs that need protection against fungi but not insects are listed in table 2. All but one are made up with water as the carrier for the treating chemicals and, except for a higher concentration, most of the chemicals are the same as are used on lumber. The oil solution of pentachlorophenol should be used when the temperature of the air or the wood is below freezing or where a combination of insecticide and fungicide is wanted. The pentachlorophenol can be diluted in a variety of oils, but No. 2 fuel oil is recommended if the insecticide be added.

Commercial products from which the water solutions listed in table 2 or similar ones can be made are, in alphabetical order: Diprite, Dowicide G, Lignasan, Melsan, Napclor, Noxtane, Permatox 10S, Santobrite, Santobrite S, and Timber San. Pentachlorophenol is sold under various trade names and can be obtained from the suppliers of most of the other products.

Suppliers are: Chapman Chemical Company, Memphis, Tenn., (Dowicide G, Napclor, and Permatox 10S); E. I. du Pont de Nemours and Company, Wilmington, Del., (Lignasan and Melsan); Monsanto Chemical Company, St. Louis, Mo., (Santobrite); R. T. Vanderbilt Company, New York 17, N. Y., (Diprite and Santobrite S); Timber Products Chemical Company, Minneapolis, Minn., (Timber San); and Wood Treating Chemicals Company, St. Louis, Mo., (Noxtane).

The recommended insecticide is benzene hexachloride. This can be readily incorporated in the pentachlorophenol solution; moreover, when it is applied in oil rather than as a suspension or emulsion in water, it tends to give longer protection under the more severe conditions of exposure. This is true, for example, with logs that are to be floated. It is important in spraying with the oil solution that the bark be dry.

Benzene hexachloride can be obtained in a form known as an emulsifiable concentrate, which is especially appropriate for use on logs. The concentrate is the easiest form from which to disperse benzene hexachloride in oil. It can be obtained with 11 percent gamma content (the active ingredient) from some of the suppliers of the aforementioned fungus-inhibiting products and often from local suppliers of agricultural or pest-control chemicals. Amounts of benzene hexachloride to incorporate in the pentachlorophenol solution are shown in table 3. It may be noted that two amounts are indicated for use on pine logs; the choice depends on whether pinhole borers (ambrosia beetles) are among the beetles to

be controlled. For any repeat spraying with insecticide, the same amounts would be added to the fuel oil without the pentachlorophenol.

Cost of Treating Logs.--The cost of treating logs, exclusive of labor, will depend on the cost of the spraying solution, whether it is applied to individual logs or to the logs after decking, and whether an end coating is applied. Approximate costs of chemicals for various treatments are given in table 4.

The indicated costs per 1,000 board-feet are proportional to the cost per gallon of chemical and therefore can be recomputed to fit any significant change in price of material. The amount of spray solution needed when treating individual logs with a hand spray was considered, from experimental data, to be 2 gallons per 100 square feet of treated surface. The amount of end coating needed was similarly determined to be about 1 gallon per 100 square feet. With power spraying of logs in the deck, Johnston's data[3] indicate that about 1 gallon of solution would be needed per 100 square feet. The cost per gallon of ready-to-use treating materials was figured as 5 cents for the solutions of waterborne fungicides, 25 cents for the pentachlorophenol solution (including 15 cents for the carrier oil), 36 cents for the mixture of pentachlorophenol and benzene hexachloride (3-1/2-pound concentration), and 50 cents for the end coating. Costs shown for treatments incorporating benzene hexachloride are based on the use of 3-1/2 pounds of gamma isomer per 100 gallons of solution. Where half this amount is used, as with pine logs not subject to pinhole borers, the costs will be about 15 percent less.

Chemical Control of Decay and Stain in Lumber

Methods

The surest means of preventing fungus attack on freshly cut lumber is to kiln dry the lumber promptly. Rapid air seasoning cannot be relied on in some sections of the country during the damper periods of the summer. Moreover, it is not feasible with some species because of their tendency to check.

The alternative to quick drying is to dip or, as some large mills prefer, spray the stock. Economical chemical surface treatments for lumber have been developed that make it possible to use conventional air seasoning without the usual risk of decay, stain, and mold (figs. 4 and 5). Even in the arid Southwest, where drying conditions are especially good, lumber is sometimes dipped so that boards can be piled closer together to reduce losses from checking. Surface-treated lumber is, of course, protected only temporarily.

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[3] Johnston, H. R. Control of Insects Attacking Green Logs and Lumber. Southern Lumberman, Vol. 184, No. 2307, pp. 37-39, 1952.

At most mills, the freshly cut lumber is treated by passing it through a dipping vat (fig. 6) containing the chemical in water solution. Mills that prefer to treat by spraying must use special care to see that all surfaces of the stock are thoroughly covered, and this virtually requires mechanical equipment. At the larger sawmills the dipping vat is placed at some convenient point in the sorting table so that the stock can be passed through the vat mechanically on the green chain (fig. 6, B and C). Overhead rolls are generally used to force the boards into the solution. At some smaller mills the dipping vat is located separately from the sawmill proper and the green chain has its own source of power. Such an arrangement is common where the lumber is dipped at a concentration yard.

At small portable and semiportable mills the stock is commonly dipped by hand, the work being done by one or two men. One man can regularly dip no more than about 5,000 feet of 1-inch lumber in a day. With power available and a mill output of as much as about 15,000 board-feet per day, it is advisable to consider the use of a mechanical vat because of the great saving in labor cost. A simple portable mechanical vat may be constructed. Hand-dipping vats need be little more than sturdy wooden troughs of sufficient size to accommodate the largest boards; sloping sideboards on such a vat will permit draining of excess solution from the lumber and also will prevent waste of solution from splashing (fig. 6, A). Suggestions for constructing both hand-operated and mechanical dipping vats may be obtained from companies that supply anti-stain chemicals.

A variation on the hand-dipping vat has been encountered that minimizes the need for the operators to get their hands in the treating solution. As shown in figure 7, the vat is placed alongside the rolls and immediately beyond the the trimsaw. The trimsaw operator tips the boards to be dipped onto the inclined skids. The slope and length of the 1-1/2-inch pipe skids are such that the weight of the boards being tipped off the rolls pushes the other ones through the liquid to the discharging side. Normally, excess liquid drains off the board and back into the tank as the board emerges and before it drops to the skids at the discharging side. This equipment permits dipping about 2,000 board-feet per hour.

Green timbers and the larger dimension materials are usually sprayed by passing the stock on a roller conveyor through a spray box that is fitted with perforated pipes or special nozzles (fig. 6, D). Runoff solution is recovered and flows or is pumped back into a storage tank. At small mills, large items may be treated with a hand-operated sprayer, sprinkling can, broom, or brush. Any of these devices is adequate so long as all surfaces are completely wetted.

Occasionally someone is interested in dipping entire packages of lumber. This, of course, requires an extra-large tank and facilities for moving the packages into and out of the tank. The method of dipping is effective enough, provided all board surfaces are wetted and the strength of the dipping solution is adequate for the drying conditions. With package piling, drying conditions are sometimes less favorable than with ordinary flat piling. Package interiors should be inspected regularly to ascertain that complete wetting is being obtained.

Solutions for Lumber Treatment

Chemicals most widely used for controlling decay, sap stain, and mold in lumber during seasoning are the same water-soluble products as listed for treating logs, but the concentrations do not have to be as great (commonly only about one third as much as noted for logs). In addition, borax at the rate of about 30 pounds per 100 gallons of water can be used effectively on hardwood lumber, but not on pine. The concentrations for normal use on stock to be air seasoned should never be less than those recommended by the suppliers. In fact, they can often be advantageously increased, especially on stock thicker than 2 inches or in damp weather. In this respect, needs will vary somewhat with the product used, since the concentrations recommended for some do not provide as large a margin of safety as for others.

In dipping hardwoods that have a relatively high tannin content, such as oak, the boards tend to acquire a bluish-black chemical stain. This stain results from a combination of iron in the treating solution with the wood tannins. It is most likely to occur in vats built of steel, but it can also be troublesome in wood vats when the green chain passes through them. The stain can be prevented by making the dipping solution alkaline. This can be done by using one of the treating products that have a substantial amount of borax or by adding soda ash to one of the other chemicals. If a wood vat is used, 2 pounds of soda ash per 100 gallons of dipping solution will usually be enough; if the vat is built of steel, 4 pounds may be needed.

Controlling Both Fungi and Pinhole Borers

Pinhole borers (ambrosia beetles) not only attack logs, but they may also attack lumber of hardwood species while it is drying. These attacks can be prevented by adding emulsifiable benzene hexachloride to a dipping solution that contains any of the chemicals listed in table 4. The concentration should be 10 ounces (or slightly more in wet weather) of gamma isomer per 100 gallons of solution. An equivalent amount of the emulsifiable concentrate previously noted for use on logs would be 5 pounds 11 ounces.

Special Points for Most Effective Treating

Stain-Free Logs.--It is desirable that the logs be bright and free from infection at the time they are converted into lumber. The chemical affects only the surface layers of the wood; consequently, infection that originates in the log may continue to spread in the interior of the sawed products.

Prompt Treatment.--For best protection during warm weather, lumber should be dipped the day it is sawed or, at latest, the following day. Greater delays give infections a chance to go deeper into the wood than the chemical and cause interior stain (fig. 8). A common cause of interior stain is bulk piling of the stock for too long a time before it is kiln dried or before it is dipped. Excessive delay in dipping is particularly apt to occur where the stock is taken to a concentration yard for treating and seasoning.

During cool weather, delays of longer than two days may do no harm; the maximum delay that can be safely tolerated with particular climatic conditions, however, can be determined only by experience. If excessive delay is unavoidable, dipping may still be worthwhile in controlling the slower-growing decay fungi. In such cases more rapid seasoning is also advisable.

Mixing Tank.--A special tank of known capacity, which at small mills need consist of nothing more than a barrel, is necessary to obtain accurate proportions of chemical and water. Do not dissolve the chemical in the dipping vat; it will not dissolve immediately and there will be a time in which the solution is not up to proper strength. Moreover, the quantity of water in a dipping vat usually cannot be estimated very reliably.

Maintenance of Solution Strength.--Besides starting with the right strength of treating solution, it also is important that this strength be maintained by protecting the solution against dilution from rain.

Thorough Treatment.--The dipping vat should be so constructed and equipped that all stock passing through it will be completely immersed. Complete surface wetting is all that is necessary. The solution should never be allowed to become so low that if the stock bunches occasionally the top boards will go through wholly or partially untreated.

Stock that is being sprayed should be handled with extra care to insure that none of the surface remains untreated. The spray nozzles must be kept open, and it is usually necessary to have considerable spray pressure in order that the splashing liquid will cover portions of the stock not directly hit by the outcoming streams. When timbers are sized after treatment, they should be resprayed.

Proper Piling.--Ordinary chemical treatment will protect lumber very well under a variety of drying conditions, but it is neither intended nor designed to give consistently good protection despite poor handling or seasoning practices. Dipping or spraying should be accompanied by the best practicable seasoning conditions. Factors for good rates of air seasoning are generally known and so need only be mentioned here. They include:

Use of sloped (1 inch per foot) and elevated pile covers.

Pile foundations, elevated enough to favor circulation of air downward through the pile.

Spacing of boards to facilitate vertical movement of air in the pile.

Use of narrow, dry stickers (infection of lumber by old stickers can be avoided by occasionally dipping the sticks in solutions described for log treatment).

Treating Before or After Dressing Green Lumber

It should be kept in mind that if lumber is dressed while it is still green, the advantage of dipping is lost. The chemicals do not penetrate the wood far and so are largely removed with the shavings. If green lumber is to be surfaced within about 2 days after it is sawed, it can be dipped or sprayed as it comes from the planer, instead of before it is surfaced. If, however, the weather is warm and the green stock is surfaced more than about 2 days after it is sawed, the best course is to treat it directly after sawing and again after dressing. The 2-day delay in treating is the maximum that generally should be allowed with pine lumber in warm weather; longer delays, as determined by experience, can be tolerated with certain woods, and with all woods in cold weather. If the delay is too long, interior stain will develop.

Protection of Timbers and Bulk-Piled Green Lumber

Timbers dry at a comparatively slow rate when piled on sticks and practically not at all if bulk piled. Similarly, green lumber undergoes negligible drying when bulk piled. Consequently, timbers and lumber temporarily bulked in front of the dry kiln, or lumber that is shipped green -- as is commonly the case with western woods -- is dependent on the chemical treatment alone for protection against fungus infection. Moreover, the period of needed protection exists as long as the stock remains surface green.

Timbers and lumber to be bulk piled, therefore, often may be treated to advantage with solutions having materially greater strengths than those required for lumber that is to be placed on the seasoning yard. Dipped fir, spruce, and hemlock have been bulk piled experimentally in the Pacific Northwest for several months without apparent damage, whereas undipped boards in the same piles incurred heavy decay infection. In similar but shorter tests, southern pine and hardwoods were protected during bulk storage by dipping.

The usual strength of dipping solution generally will be adequate on stock of 8/4 thickness or less, when periods of warm-weather bulk piling will not exceed 6 to 8 weeks for western woods other than pine, or 2 weeks for southern and western pines. For best assurance of protection through long periods in bulk piles or for large timbers, a solution as strong as 1-1/2 to 2 times the usual concentration is advisable. For sawed timbers, the benefits from surface treating are less certain and the double-strength solution should be used.

Cost of Treating Lumber

The cost of chemical for dipping or spraying lumber will vary with the thickness of the stock. With 4/4 lumber and a minimum waste of solution, the outlay for chemical will be about 25-30 cents per thousand board-feet treated. The cost for thicker stock similarly handled will be less. For example, with 8/4 stock it would be about 15 cents per thousand.

Safety Tips on Handling of Treating Chemicals

In the dry form, all of the fungicidal products mentioned here may cause burns if allowed to remain on the skin. However, no more than ordinary care is needed to avoid this. In solution at the recommended treating concentration, some of the products also may irritate the skin of susceptible persons. The difficulty is most prevalent in connection with log spraying and with dipping by hand. As the chemicals are all poisonous internally, it is especially important to see that they do not enter the nose or mouth. The most essential precautions are:

1. Carefully follow the recommendations of the manufacturer or distributor in the use of a particular product.

2. Avoid breathing fumes or dusts from the chemicals.

3. Protect the workmen, who do hand dipping or who handle stock that is dripping wet with treating solution, with rubber gauntlets and waterproof aprons. The gauntlets should be washed free of chemical at the end of each working period. Cotton gloves alone are not enough protection, because the solutions dry and become concentrated in their fabric. In connection with hand dipping, hooks for handling lumber are helpful where it is practicable to use them.

4. Wash skin and clothing with soap after each exposure.

5. Watch for workmen who may be allergic to the treating solution and shift the more sensitive ones to jobs away from the hazard.

6. While spraying logs and lumber, use particular care to keep the chemical away from workers' faces.

Removal of Discoloration from Stained Wood

Sap stain can be removed from the surface of the affected wood by applying a suitable bleaching agent, but the treatment may have to be so severe that an objectionable amount of natural color is also eliminated. If the stain is not too heavy, it can be removed or reduced in intensity by the hydrogen peroxide method or possibly with a laundry bleach of a 5 percent sodium hypochlorite solution.[4]

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[4]Downs, Leslie E. Bleaching Wood. Forest Products Laboratory Report No. 1705, 10 pp. 1956.

Chemical Control of Fungus Damage in Other Green Wood Products

The measures described for the control of fungi in logs and lumber have been found applicable to other forest products. Chemical dips are used to protect products that are to be air seasoned, such as veneer, staves, hoops and shingles. The use of a product, such as for food containers, should be considered in determining whether such treatments can be safely and profitably used. Wood recently treated with the chemicals should not be used in direct contact with food that is to be eaten without peeling. There probably is no particular danger, however, if dipped or sprayed wood is allowed to weather in the open for a few weeks before it is used in a food container. The odor of some of the chemicals may be imparted to foods, but this possibility also diminishes as the wood weathers.

Temporary Nature of Fungus Control by Surface Treating

Applications of chemicals to the surface of green stock provide no permanent protection. Preservative treatment is effective for long periods only when considerably more chemical goes into the wood and deeper penetrations are obtained than is accomplished by dipping or spraying. Consequently, to protect wood in service additional treating is needed that will provide chemicals and penetrations adequate for the purpose. Protection beyond the seasoning period is not needed so long as the wood remains air dry (moisture content about 20 percent or less). But seasoned wood again becomes susceptible to fungus attack when it is wet.

Table 1.--Recommendations for chemical treatment to protect stored logs against decay and sap stain

Kind of log and region of storage	Treatment for storage in mild or warm weather[1]	
	Up to 7 weeks	7 weeks to an entire season
Pine		
South	B	B or D[3]
North	A or B[2]	B or D[3]
Hardwoods		
South	B	B or D[3]
North	A	C

[1]Treatment A -- spray log ends with a treating solution listed in table 2.
Treatment B -- spray both ends and sides of logs with a solution combining fungicide and insecticide (see table 3).
Treatment C -- Treatment A followed by coating the log ends with a heavy asphalt cutback.
Treatment D -- Treatment B followed by coating the log ends with a heavy asphalt cutback.

[2]Treatment B may not be needed in the cooler portions of spring and fall, if wood-attacking insects are inactive.

[3]Use treatment D if end checks are present or expected, so that the treated end surfaces will be an unbroken fungus barrier.

Table 2.--Types of solution used for treating logs to prevent decay and sap stain

Primary chemicals	Commonly used amounts per 100 gallons of water or oil
FOR WATER SOLUTIONS[1]	
Sodium pentachlorophenate	21 pounds
Sodium pentachlorophenate plus borax (also soda ash in some cases)	30 pounds
Sodium pentachlorophenate plus ethyl mercuric phosphate	12 pounds
Ethyl mercuric phosphate	6 pounds
FOR OIL SOLUTIONS[2]	
Pentachlorophenol	
1:5 concentrate	10 gallons
1:10 concentrate	5 gallons

[1] See text for names of specific products.

[2] An oil-borne chemical is needed in freezing weather or where a combination of fungicide and insecticide (see tables 1 and 3) is to be used.

Table 3.--Amounts of benzene hexachloride insecticide to be added to the pentachlorophenol solution to protect logs against both fungi and insects[1]

Kind of wood and insects to be controlled	Amount of gamma isomer needed	Corresponding amount of emulsifiable concentrate (with 11 percent gamma isomer) needed
	Pounds	Pounds
Hardwoods		
Pinhole and larger wood borers	3-1/2	32
Pine		
Insects as above, also bark beetles	3-1/2	32
All but pinhole borers	1-3/4	16

[1] Amounts and form of benzene hexachloride suggested by H. R. Johnston, Division of Forest Insect Research, Southern Forest Experiment Station.

Table 4.--Approximate cost of chemicals for treating 1,000 board-feet of 14- to 16-inch logs[1]

Treating procedure and material applied	Cost	Treating procedure and material applied	Cost
	Dollars		Dollars
Ends of individual logs treated, using a hand-operated spray, with:		Both ends and sides of individual logs treated, using a hand-operated spray with:	
Waterborne fungicides	0.02	Pentachlorophenol and benzene hexachloride	3.60
Waterborne fungicides and end coating	.12	Pentachlorophenol and benzene hexachloride and end coating	3.70
Pentachlorophenol	.10		
Pentachlorophenol and end coating	.20	Logs sprayed on ends and sides while decked, using a power spray, with:	
		Pentachlorophenol and benzene hexachloride	1.80
		Pentachlorophenol and benzene hexachloride and end coating	1.90

[1]See text for bases of cost computations.

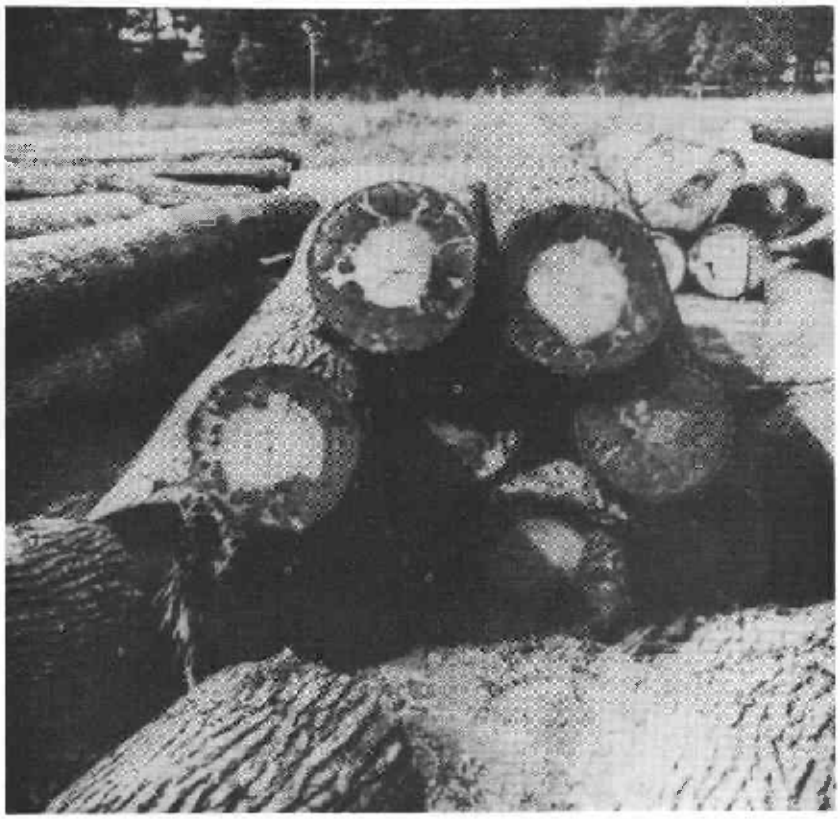

Figure 1.--Sweetgum logs with heavy sap stain at the ends. With conditions favorable for staining, end stain may appear within 10 days and the discoloration may penetrate into the log as rapidly as 1 foot per month.

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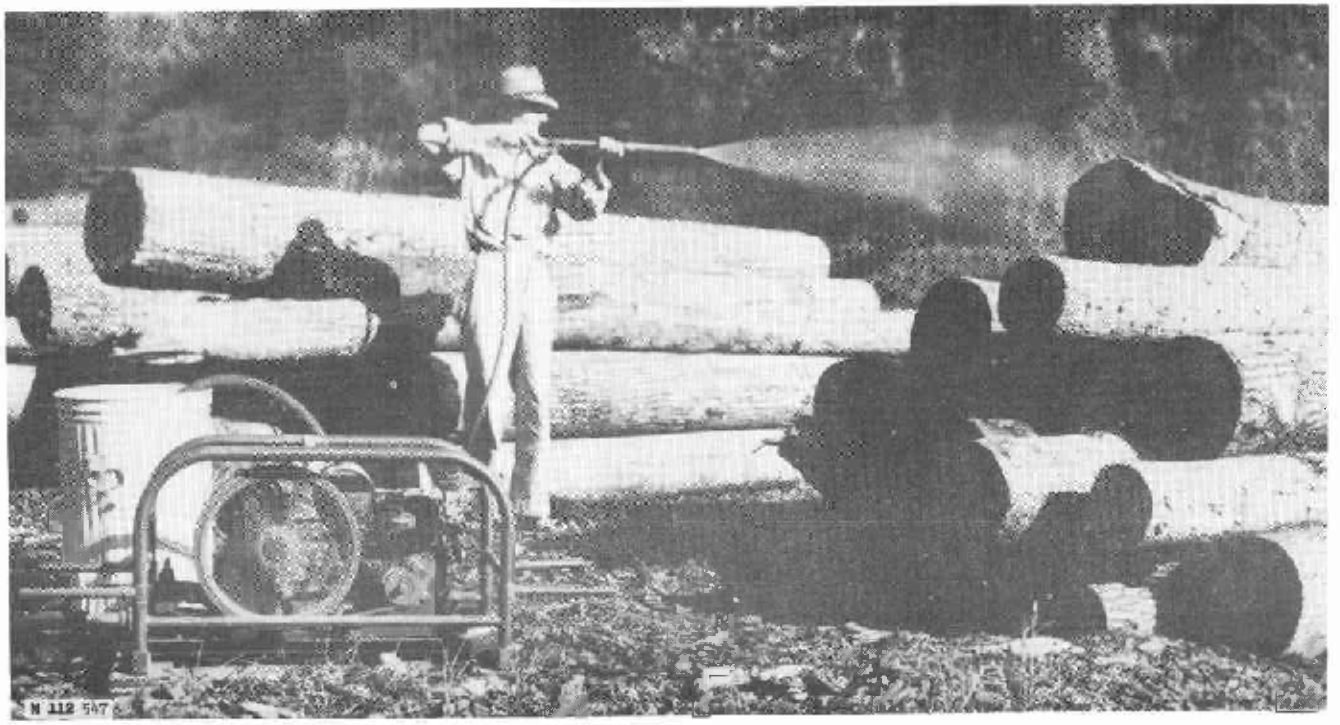

Figure 2.--Spraying logs in the deck with a hydraulic outfit. Coverage of the entire log surface is necessary where insect attack as well as fungus damage is to be controlled. A hand-operated garden sprayer is suitable for spraying the entire surface of logs individually or just the ends of decked logs.

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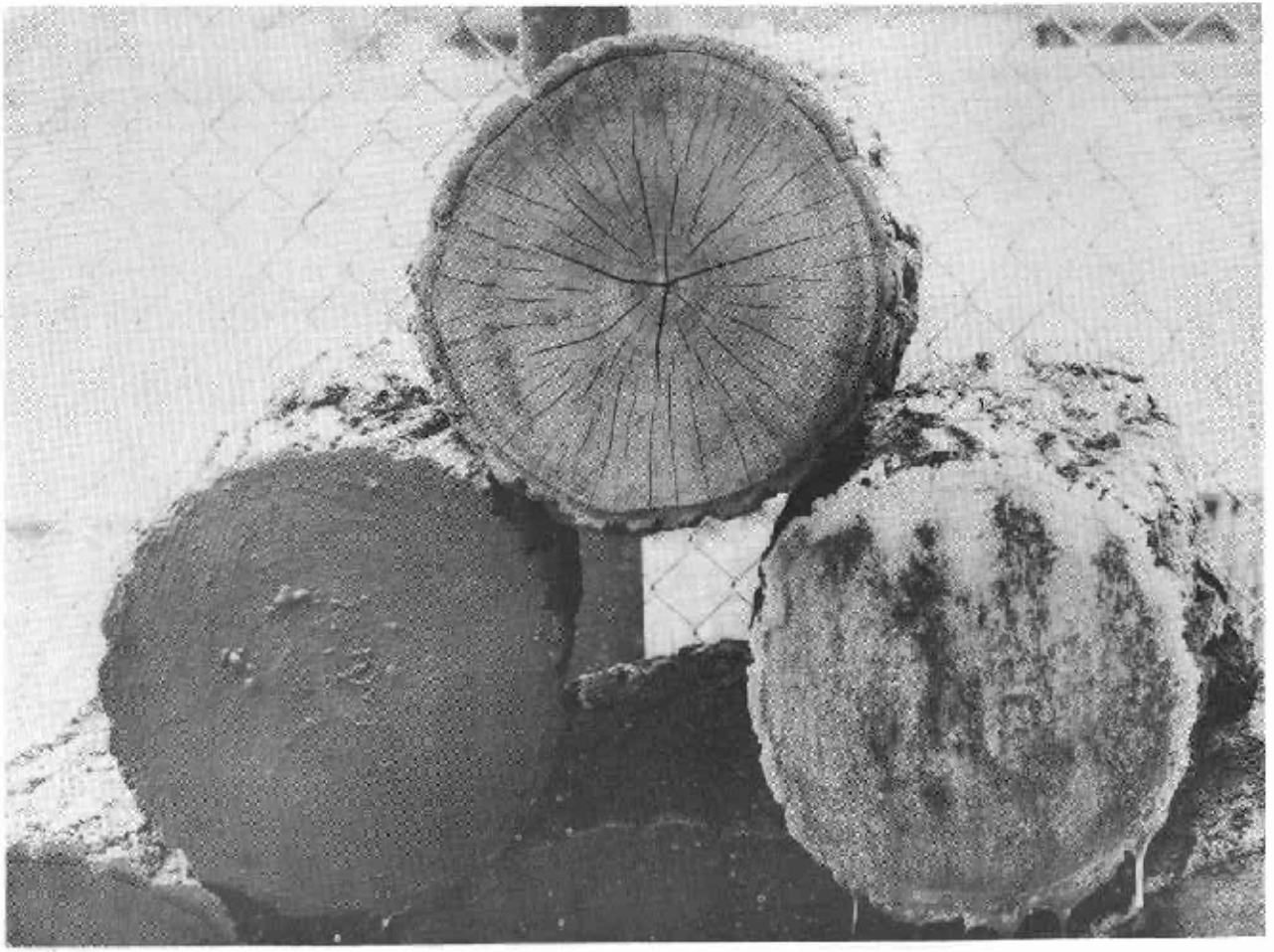

Figure 3.--Oak logs 8 months after they were cut and the ends treated with preservative. The lower 2 logs were also end coated. A good end coating is needed in addition to the spray treatment if the logs are of a species in which seasoning checks are likely to form during any considerable part of the storage period in warm weather. The spray treatment becomes of little value once the barrier of surface-treated wood is ruptured by seasoning checks (upper log).

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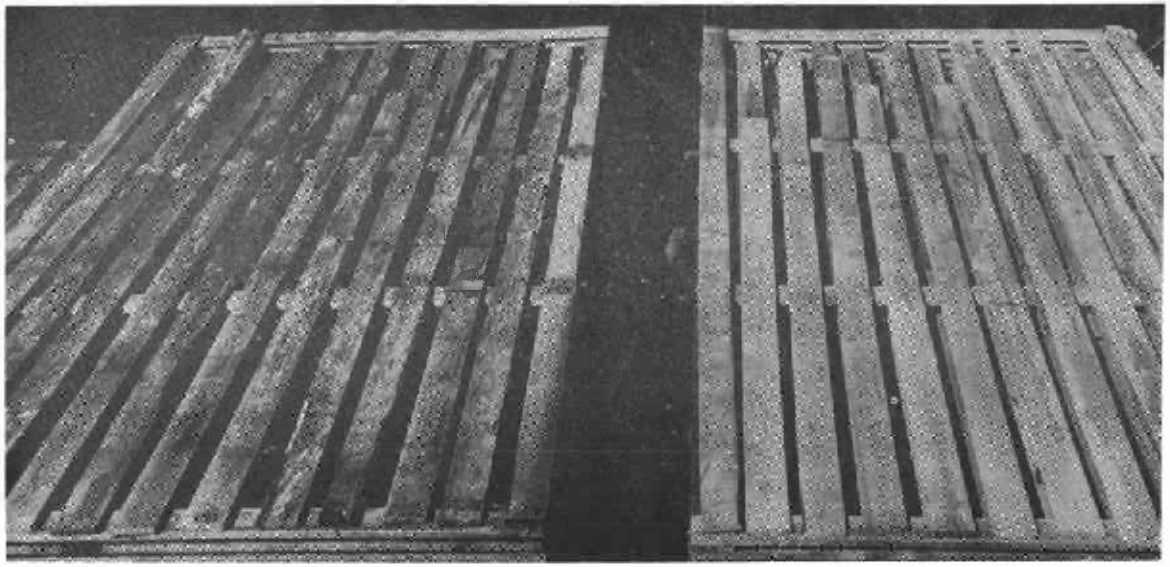

Figure 4.--Untreated (left) and dip-treated southern pine lumber at the end of 90 days on the air-seasoning yard. The untreated stock has both blue stain and early decay.

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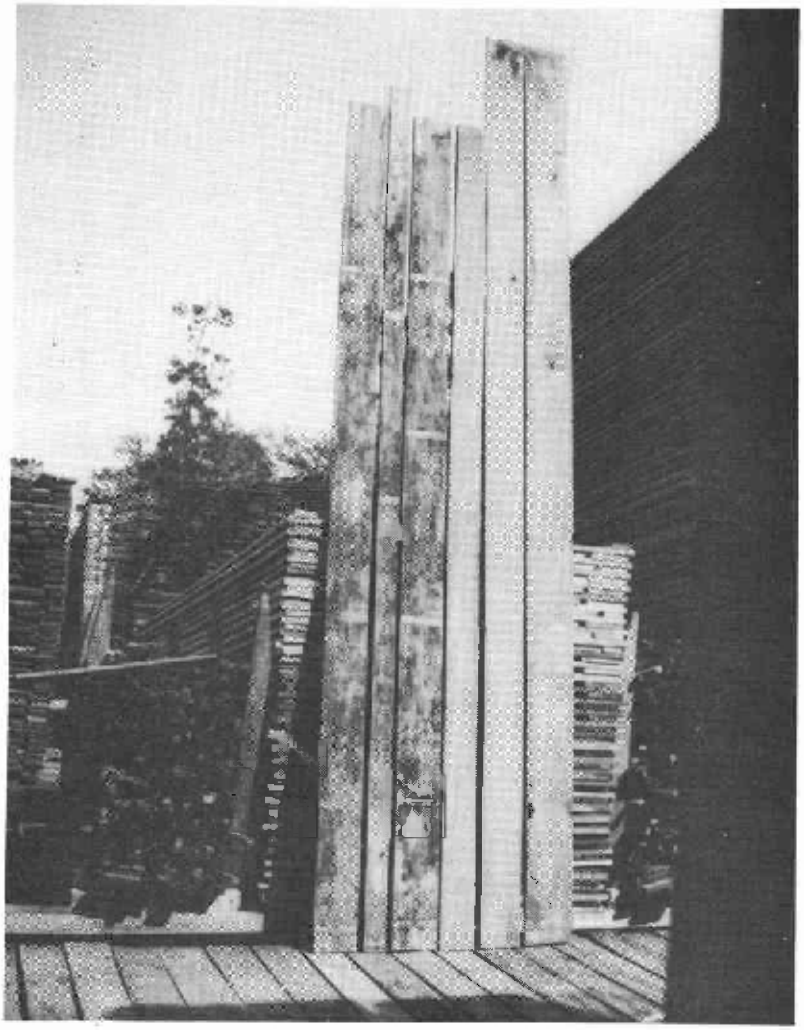

Figure 5.--Untreated (left) and dip-treated sweetgum lumber after 120 days on the seasoning yard.

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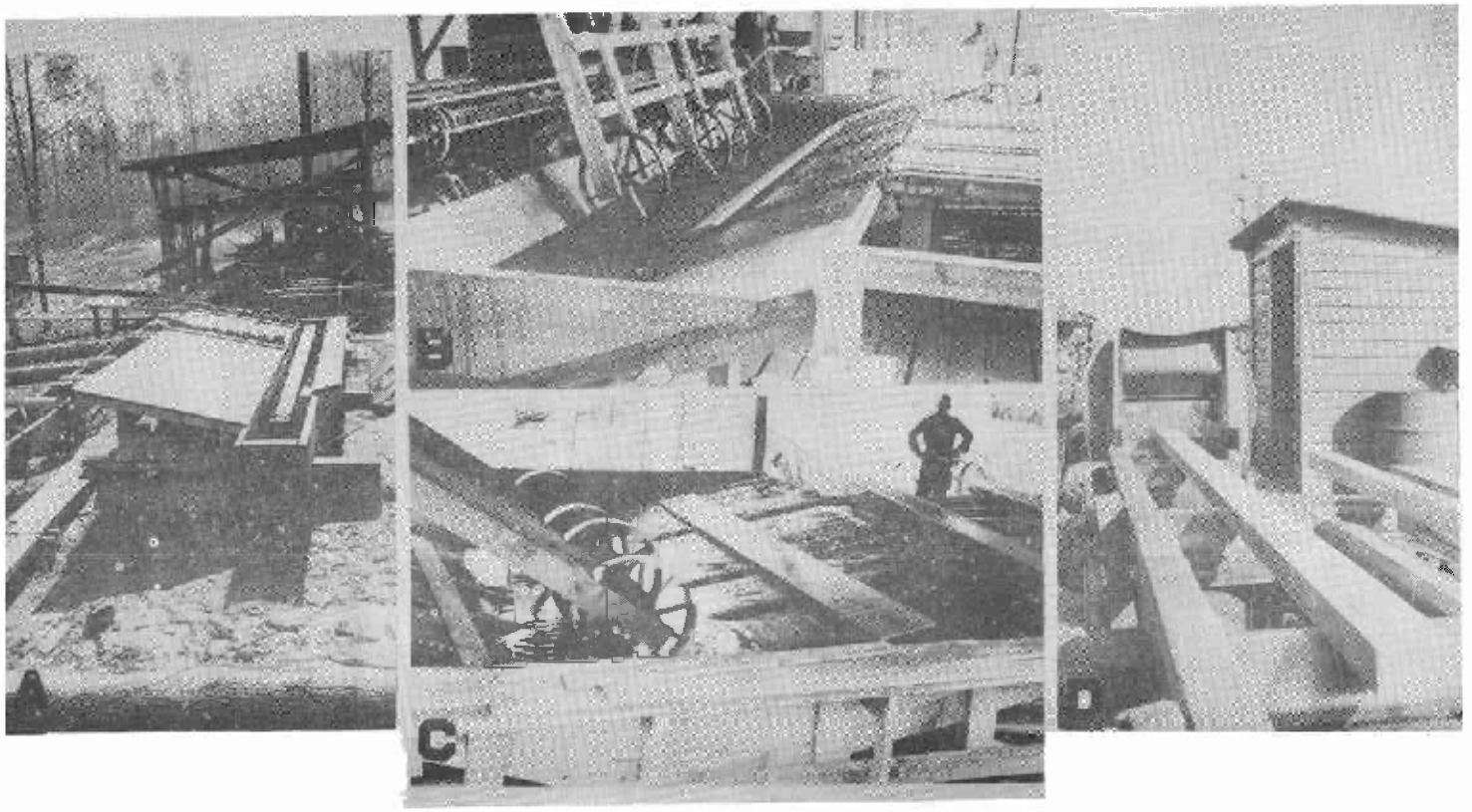

Figure 6.--Lumber and timber treating equipment. A, Well-designed hand dipping vat. Commendable features are the splash board and ample drain apron; cleats on the drain apron hold the boards partly on edge, to hasten draining. B and C, Mechanical dipping vats of simple design suited to semi-portable and large mills. The suspended wheels submerge the lumber as it passes through on the green chain. D, Common type of mechanical spray timber.

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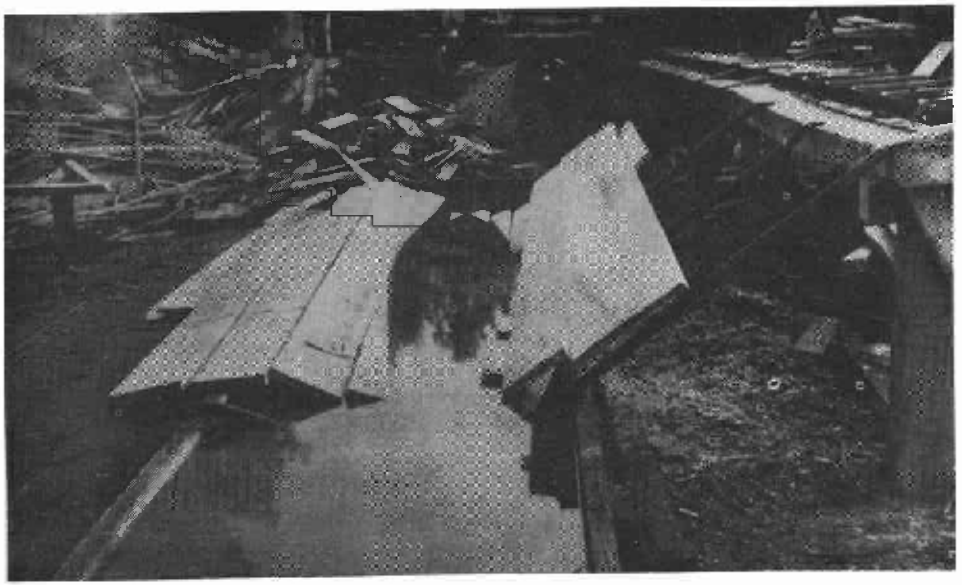

Figure 7.--Dipping vat in which the lumber is carried through the treating solution by gravity. This scheme reduces the need for the vat operators to put their hands in the solution. To function properly, the drop from the roller bed to the vat should be at least 3 feet, and the slope of the pipe should be gradual as it leaves the vat.

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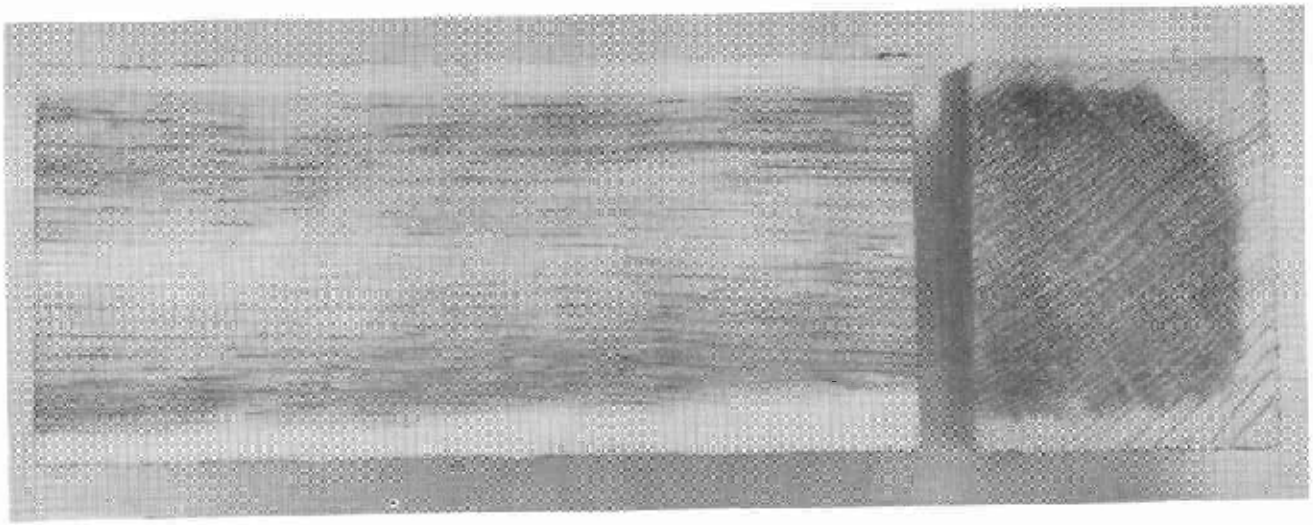

Figure 8.--Interior sap stain in a section of 6/4 white pine lumber. Where lumber is bright on the surface but stained inside, it is evident that conditions were initially suitable for infection but later, because of chemical treatment or accelerated drying, conditions became unfavorable for further fungus growth in the outer portion of the stock. The stain fungus, therefore, was able to develop sufficiently to cause discoloration only on the interior.

ZM 39166 F

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List of publications on Chemistry of Wood and Derived Products

List of publications on Fungus Defects in Forest Products and Decay in Trees

List of publications on Glue, Glued Products, and Veneer

List of publications on Growth, Structure, and Identification of Wood

List of publications on Mechanical Properties and Structural Uses of Wood and Wood Products

Partial list of publications for Architects, Builders, Engineers, and Retail Lumbermen

List of publications on Fire Protection

List of publications on Logging, Milling, and Utilization of Timber Products

List of publications on Pulp and Paper

List of publications on Seasoning of Wood

List of publications on Structural Sandwich, Plastic Laminates, and Wood-Base Aircraft Components

List of publications on Wood Finishing

List of publications on Wood Preservation

Partial list of publications for Furniture Manufacturers, Woodworkers and Teachers of Woodshop Practice

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