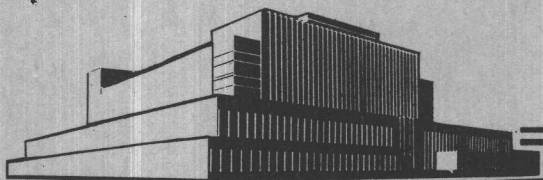


THE PRESERVATIVE TREATMENT AND STAINING OF SHINGLES

Original report dated 1930

Revised October 1960

No. 761



FOREST PRODUCTS LABORATORY

MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

In Cooperation with the University of Wisconsin

THE PRESERVATIVE TREATMENT AND STAINING OF SHINGLES¹

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Types of Wood Shingles

Most of the wood shingles used at the present time for roofs and walls of buildings are of western redcedar. Redwood, baldcypress, and eastern white-cedar find use to a smaller extent. The heartwood of these species is resistant to decay. Experience proves that good quality, all heartwood shingles of these woods give good service without preservative treatment when installed by ordinary methods. It is important, however, that the shingles be entirely of heartwood because sapwood is not resistant to decay. Edge-grain shingles are much better than flat-grain shingles because they warp much less and withstand weathering better. Commercial western redcedar, cypress, and redwood shingles of the No. 1 grade promulgated by the U.S. Department of Commerce are all heartwood and all edge-grain. For lasting service, the shingles should be properly laid and nailed with corrosion-resistant nails. The thickest standard-grade shingles (4/2) have butts one-half inch thick and will last longer and give better service than those with butts 0.4 inch (5/2) or 0.45 inch (5/2-1/4) thick.

Roofs are more severely exposed to weathering and decay than are walls. Only the No. 1 grade shingles are ordinarily recommended for roofs of permanent buildings. Shingles of lower grade may be suitable for walls if it is more important to minimize cost than to obtain the best appearance. On walls, however, shingles may be laid with as much as 7-1/2 inches instead of a maximum of 5 inches exposed to the weather, and wider shingles may be used on walls than on roofs. These practices increase the tendency for shingles to curl as a result of weathering. Moreover, a moderate amount of curling that might be unobjectionable on a roof is unacceptable on walls, when the best appearance is desired. For best appearance, therefore, shingles of No. 1 grade should be used for walls as well as for roofs. Shingles of lower grade may be used for temporary buildings, for the lower layers when shingles are laid in double courses, and for walls when it is not necessary to maintain the best appearance.

Roofs should have sufficient pitch to make rain water drain off rapidly and to prevent water from melting snow from backing up under the shingles. Roof sheathing may be laid tight or with open joints. Tight sheathing affords better insulation against heat and cold. Open sheathing provides better opportunity for the escape of air-borne moisture entering through leaks. No actual evidence is available to show that the method of laying the sheathing has a noticeable effect on the durability of the roof.

Painting of Shingles

Where desired, it is entirely practicable to let shingles of the species named weather naturally without any surface treatment. In a few months the original color of the wood changes to a pleasing gray that blends harmoniously with many color schemes. For

¹Original report dated 1930.

²Maintained at Madison, Wis., in cooperation with the University of Wisconsin.
Report No. 761 (revised)

shingled side walls as a rule, and very often for shingled roofs, surface treatment to provide color is desired. Good shingle stains generally offer the most satisfactory and economical means of providing color. Stains provide color without gloss and without entirely concealing the grain and texture of the wood, a combination of conditions usually very appropriate for the rough, sawed surfaces of wood shingles. The most satisfactory shingle stains are highly colored, such as brown, green, red, or yellow. It is not possible to make a white stain because stains do not entirely hide the color of the underlying surface. There are light gray stains but they are not so durable as paints. For that reason it is common practice, when white or a pale color is desired, to paint shingle side walls. Ordinary house paint may be used for the purpose; two coats of it are required for the first painting, one coat for repainting unless the previous coating has very largely worn away. Glossy paint, however, is seldom considered suitable for rough surfaces. The low-luster house paints are to be preferred. Many paint manufacturers supply so called "shingle and shake" paints made specially for such use.

When shingles are to be painted, the first coat of paint is best applied before the shingles are laid, so that the backs and butts as well as the faces are well coated. The paint may be applied by dipping the shingles to at least two-thirds of their length in the paint and then standing them vertically until the paint has dried. If the backs are not so painted, rain water seeping under the shingles may cause more curling than would otherwise take place and the paint near the butts and edges of cedar or redwood shingles may be discolored by water-soluble dyes extracted from the wood. The finish coat may be applied by brushing or spraying after the shingles have been laid, but care should be taken to see that the exposed butt ends are well coated with the finish paint. Good paint coatings on shingle walls usually should last about 5 years, after which the paint should be renewed, again seeing that butt ends of shingles are well painted.

Painting is not recommended for shingle roofs. Because of the sloping position of shingles on a roof, more water penetrates beneath shingles and it stays there longer than is the case on side walls. Moreover, painting or repainting after the shingles have been erected tends to build little dams of paint across the bottom of the gaps between shingles, which on roofs adds to the amount of water backed up under the shingles while the paint coating on the exposed wood surfaces retards the rate of subsequent drying out of the moisture. Painting shingle roofs, therefore, tends to increase cupping and the changes for decay to set in. Stains are not subject to these disadvantages and may properly be used on shingle roofs.

Staining of Shingles

Commercial wood shingles can be purchased already stained, or they can be bought unstained and stained on the job. The commercially stained shingles have the advantage of convenience and may prove to be more uniformly and durably stained, but at times requirements of availability, grade of shingles, special color, or price may make it desirable to buy unstained shingles and stain them on the job. Staining on the job is done to best advantage by dipping the shingles one by one at least two-thirds of their length in the shingle stain and standing them up nearly vertically to drain and dry. It is also practicable, as far as decorative effect is concerned, to apply stains by brush or spray gun after the shingles are laid. Stains even though they contain preservatives, applied to a completed roof can have little effect on decay resistance for they do not reach the hidden surfaces between the shingles where decay is most likely to develop.

Shingle stains can be purchased in ready-mixed form or they can be mixed on the job from the necessary ingredients. Some commercial shingle stains contain coal-tar creosote in addition to other ingredients, for the purpose of imparting protection

against decay. If the shingles are entirely heartwood of cedar, cypress, or redwood there is little need of toxic chemicals in the stain. On the other hand, shingles containing sapwood or of species not resistant to decay require more effective treatment than superficial application of creosote stains, if good durability is to be assured, at least when they are used for roofs. There is, however, no objection to the use of coal-tar creosote in stains for durable woods provided that it does not displace more necessary ingredients, such as linseed oil, and provided further that there is no thought of painting the shingles at some subsequent date with white or light-colored paint. Coal-tar creosote remaining in shingles may discolor paint even several years after the creosote stain was applied.

The most important ingredients of shingle stains are linseed oil and pigments of suitable color. For stains to be mixed on the job the pigments should be bought in the form of colors ground in linseed oil, which are obtainable from nearly all retail paint dealers. Pure colors of highest quality only should be used. They should contain no "inert" or "extending" pigments, such as china clay, barium sulfate, silica, or magnesium silicate. The higher cost per pound of the pure colors is more than offset by the smaller amount that need be used and the greater durability of the stain. For good durability the liquid part of the stain should be at least one-third and may well be two-thirds linseed oil. The remainder of the liquid may be volatile thinner such as turpentine or mineral spirits, coal-tar creosote, or a mixture of volatile thinner and creosote. Ordinary coal-tar creosote as used for wood preserving has a brown color that makes it unsuitable for stains of bright colors. For that reason makers of "creosote shingle stains" often use a light-colored, relatively volatile fraction of creosote that makes stains of bright color; but it is doubtful whether such "creosote" stains retain effectiveness against decay very long. Used automobile crankcase oil, sometimes suggested for use in home-mixed stains, has none of the toxic properties of creosote, but usually shares with creosote the disadvantage of dark color. Crank-case oil can be used to replace some of the volatile thinner in shingle stains of dark color, but no advantage other than a trifling saving in cost can be obtained thereby. Crank-case oil must not be used as a substitute for any of the linseed oil.

The amount of color-in-oil to be mixed with the liquid varies with the nature and quality of the colors and must be determined by trial. The following formulas for guidance, which are from the "Handbook on Painting" by the National Lead Company, give the amounts of colors in oil required for each gallon of the liquid mixture to produce some of the more common colors:

Gray
12-1/2 pounds white lead
touch of lampblack

Deep red brown
1 pint Indian red

Bright red
1 pint Venetian red

Permanent green
3/4 pint chromium oxide

Fairly permanent green
1-1/2 pints medium chrome green

Golden brown
1/4 pint raw Italian sienna
3/4 pint burnt Turkey umber

Seal brown
1 pint raw Turkey umber

Deep brown

1 pint burnt Turkey umber

Shingle stains are sometimes used on bevel siding. For the most attractive results it is best to attach siding that is to be stained with the sawed side rather than the planed side exposed to the weather.

Stains, particularly those of the deeper colors, last even longer than good house paints, especially when applied on rough surfaces such as the split or sawed surfaces of shingles. Good stains should last at least 5 years on shingle roofs and at least 8 years on shingle walls or the sawed side of bevel siding. The stains, however, will eventually wear out and must then be renewed if the original color is to be restored. Fresh stain can be applied by brushing or spraying; it should again last at least as long as the first staining did.

The shingle stains described in this report contain enough durable pigment to make them long-lasting. They agree closely with common usage of long standing and with Federal Specification TT-S-706 for "Stain; Opaque, Wood, Exterior, Oil." In recent years, the Forest Products Laboratory's natural finish for such surfaces as wood siding has become widely used. It is described in Forest Products Laboratory Report No. 2096 and in interim Federal Specification TT-S-00708 (AGR-FS) entitled, "Stain; Semi-Transparent, Wood, Exterior, Oil." The FPL natural finish contains less pigment than the shingle stains described in this report in order to let the grain pattern of the wood show more clearly. This result, however, is achieved only at an appreciable sacrifice in durability. The FPL natural finish may be used in place of the older shingle stains on shingle side walls if desired, provided the shorter life of the finish is acceptable. For shingle roofs, which are more severely exposed to the weather than side walls, the more richly pigmented shingle stains are recommended.

Painting Over Stained Shingles

After stain has worn out on shingle walls it is often practicable to paint them if paint is desired instead of fresh stain. If the original stain, however, contained creosote there may be question whether it will discolor white or light-colored paint. The tendency for creosote to discolor paint gradually diminishes during exposure to the weather, especially if the creosote was applied superficially by dipping, brushing, or spraying. After 4 or 5 years, such creosote-stained shingles can often be painted satisfactorily but there is a problem of determining whether that stage has been reached. The best way to tell is to try painting a few shingles, preferably on an inconspicuous part of the house and on the area that receives least sunshine. If the paint remains free from discoloration for as much as 2 weeks, it is safe to paint all of the shingles. An additional test on a few shingles may be made by applying one coat of aluminum house paint followed by two coats of white or light-colored paint. Sometimes aluminum paint will prevent discoloration where ordinary house paint will be discolored.

Curling of Shingles

Exposure to the weather tends to make shingles curl, although with commercial shingles of best quality the amount of curling should be unimportant. Cedar, cypress, and redwood usually curl less than most other woods. With any wood, there is less curling of edge-grain than of flat-grain shingles and less curling the thicker and narrower the shingles and the shorter the length exposed to the weather. Curling is especially marked in dry climates or in spells of very dry weather. Ordinary staining of shingles probably has little effect on their curling, though the thorough treatment of sapwood shingles with creosote or with water-repellent preservative, discussed farther on in this report, probably reduces curling appreciably. On walls,

painted shingles, if well primed on the backs before laying and if the paint coating is well maintained, curl less than similar unpainted shingles.

In some parts of the United States it is believed that superficial application of creosote, of linseed oil, or even of spent crank-case oil will keep shingles from curling. Thorough treatment of sapwood shingles with any of the oils mentioned probably would delay curling for a long time, especially if further applications of the oil were made every few years for maintenance. At the Forest Products Laboratory it is doubted, however, that superficial application of any of these oils to heartwood shingles of cedar, cypress, or redwood materially reduces curling.

Once serious curling has taken place, no material is known that can be applied to straighten the shingles out again. Some improvement can be effected by face nailing the badly curled shingles, allowing the shingles to split as the wider ones will, but the large nail heads will be left showing.

Treatment for Shingles of Less Desirable Woods

Where building materials are purchased from the customary retail channels, it is rarely advisable to consider anything but the heartwood of durable species for shingles to be used on roofs. For walls, shingles of cheaper grade may be used because there is little chance of decay, though the cheaper shingles cannot be expected to lie so flat and maintain so good an appearance as the better ones will do. In rural communities, however, it sometimes proves desirable to build with locally grown woods, none of which may provide naturally durable shingles. Shingles of the less desirable woods may be expected to curl more and present somewhat less satisfactory appearance than shingles of the best woods; for that reason, shingles of the inferior woods probably should not be more than 6 inches wide and should not be made less than one-half inch thick at the butts. It is usually sufficient to dip such shingles for walls in suitable wood preservative or in stains that contain coal-tar creosote, but for roofs more adequate preservative treatment is necessary. Impregnation of the shingles by pressure treatment is not practicable unless there is a treating plant within reach, but many woods can be given a reasonably thorough treatment by the hot-and-cold bath method, with equipment that can be easily improvised. For such treatment, sapwood shingles are preferable to heartwood because sapwood takes treatment more readily. The shingles should be in an air-dry condition before treatment, because green or wet shingles will not absorb enough preservative in the hot-and-cold bath method.

The hot-and-cold bath method of treatment requires two tanks for creosote or stain, one of which is equipped for heating the liquid. The best method of heating is with steam coils, because there is then little danger of setting the oil afire and the temperature can be maintained more uniformly. Fairly light galvanized iron tanks with joints riveted and soldered will do if the heating is done with steam coils. Unless the tank for the hot bath is to be used for treatment of fence posts or other timbers also, it need be only large enough for the immersion of a single bundle of shingles. If more than a few bundles of shingles are to be treated at one time, the cold bath should have capacity for at least four bundles, because they may have to remain in the cold bath as much as four times as long as they do in the hot bath. There must be some arrangement for submerging the shingles and separating them from each other so that the stain can gain uniform contact with the surfaces and color them evenly. The best way to accomplish this is to open the bundles and put the shingles in screen-wire baskets of suitable design. It is best to have the shingles stand on the butt ends in the treating baths, particularly in baths containing pigments. Such baths must also be stirred frequently to keep the pigments in suspension.

In commercial shingle-staining operations, special staining machines are in use in which the shingles can be stained with suitable stains without opening the bundles.

It is doubtful whether these machines could be used with some of the stains to be described, but in any event they would hardly be available at places where the use of shingles that require preservative treatment can be recommended.

Experiments at the Forest Products Laboratory by the procedures described in the following paragraphs resulted in reasonably satisfactory penetration and retention of coal-tar creosote and good staining of sapwood shingles of ponderosa pine. The stained shingles were exposed to the weather on a test fence at Madison, Wis., from February 1935 to September 1938. The stained shingles retained their colors well during the test period, but the appearance was somewhat marred by a certain amount of exudation of creosote during hot weather in July and August of 1935. Although the performance in that respect was inferior to that of commercially stained cedar shingles, it was considered reasonably acceptable. The sapwood shingles did retain an overall bright appearance of the chosen color and at the same time they contained enough preservative to ensure reasonably long life. The mottled effect caused by exuded creosote was not considered seriously unattractive for shingle roofs.

Cleaner colors and freedom from the mottled effect undoubtedly can be achieved by substituting for coal-tar creosote a more modern oil-borne preservative of lighter color, namely, pentachlorophenol in No. 2 fuel oil. This preservative solution should contain 5 percent by weight of pentachlorophenol. Its effectiveness against decay is well established. For use by the hot-and-cold bath method, the pentachlorophenol preservative must be made with a high-boiling solvent such as fuel oil; preservatives made with more readily volatile solvents such as mineral spirits are unsuitable.

In the treatments made by the Forest Products Laboratory, the hot bath consisted of coal-tar creosote of the kind generally used for commercial impregnation treatments of railway crossties and telegraph poles. The shingles were submerged in the hot bath at 212° F.² for 1/2 hour, after which they were quickly submerged in stain at room temperature for 2 hours. They were then stood on the butt ends to drain and to permit the stain to dry.

The stains were made from colors-in-oil, boiled linseed oil, and mineral spirits. The colors-in-oil had the following composition:

Iron oxide red	72.5 percent,	linseed oil	27.5 percent	by weight			
Iron oxide yellow	56.2	"	"	"	43.8	"	"
Ferrite yellow	60.5	"	"	"	39.5	"	"
Vandyke brown	66.6	"	"	"	33.4	"	"
Chrome green	80.0	"	"	"	20.0	"	"

The iron oxide red, iron oxide yellow, and ferrite yellow were all pure, manufactured iron oxide pigments containing more than 95 percent iron oxide by weight. The chrome green was so-called C.P. green consisting entirely of chrome yellow and Prussian blue with no extending pigments. The Vandyke brown was a natural earth pigment.

The five stains used in the experiments had the following composition:

1. Chrome green in oil	1.5 pounds
Boiled linseed oil	.67 gallon
Mineral spirits	.33 gallon

²Shingle stains containing oils of low flash point such as mineral spirits cannot safely be heated in open tanks and should therefore be used only in the cold bath at room temperatures.

2.	Iron oxide red in oil	1.5 pounds
	Boiled linseed oil	.67 gallon
	Mineral spirits	.33 gallon
3.	Vandyke brown in oil	1.5 pounds
	Boiled linseed oil	.67 gallon
	Mineral spirits	.33 gallon
4.	Ferrite yellow in oil	1.5 pounds
	Boiled linseed oil	.67 gallon
	Mineral spirits	.33 gallon
5.	Iron oxide yellow in oil	1.0 pound
	Boiled linseed oil	.67 gallon
	Mineral spirits	.33 gallon

These stains do not dry rapidly, but inasmuch as a stain is more or less absorbed by the wood, rather than a coating over the wood, rapid drying is not usually necessary. The shingles can be handled and laid without undue inconvenience before the linseed oil is thoroughly dry. Drying probably can be hastened somewhat by adding one-half pint of liquid paint drier to the above formulas.

For dark brown stains it is practicable to substitute creosote for the mineral spirits in the above formulas and thereby increase the amount of creosote retained by the shingles. On the other hand, if a brown color is desired it is possible to omit pigments altogether, in which event the cold bath consists of exactly the same creosote used for the hot bath. Such treatment with creosote alone is safer than any of the stains suggested where maximum preservation against decay is more important than bright colored shingles.

Detailed description of hot and cold bath treatment and other nonpressure treatments will be found in Farmers' Bulletin 2049, "Preservative Treatment of Fence Posts and Farm Timbers," which may be obtained from the Forest Products Laboratory, Madison 5, Wis., on request.

SUBJECT LISTS OF PUBLICATIONS ISSUED BY THE
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The following are obtainable free on request from the Director, Forest Products Laboratory, Madison 5, Wisconsin:

List of publications on
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List of publications on
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List of publications on
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List of publications on
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Partial list of publications
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Note: Since Forest Products Laboratory publications are so varied in subject, no single list is issued. Instead a list is made up for each Laboratory division. Twice a year, December 31 and June 30, a list is made up showing new reports for the previous six months. This is the only item sent regularly to the Laboratory's mailing list. Anyone who has asked for and received the proper subject lists and who has had his name placed on the mailing list can keep up to date on Forest Products Laboratory publications. Each subject list carries descriptions of all other subject lists.