AD-A123 089 COMPARISON OF WOOD PRESERVATIVES IN STAKE TESTS (1981 PROGRESS REPORT)(U) FOREST PRODUCTS LAB MADISON WI L R GJOVIK ET AL. DEC 81 FSRN-FPL-02 1/1

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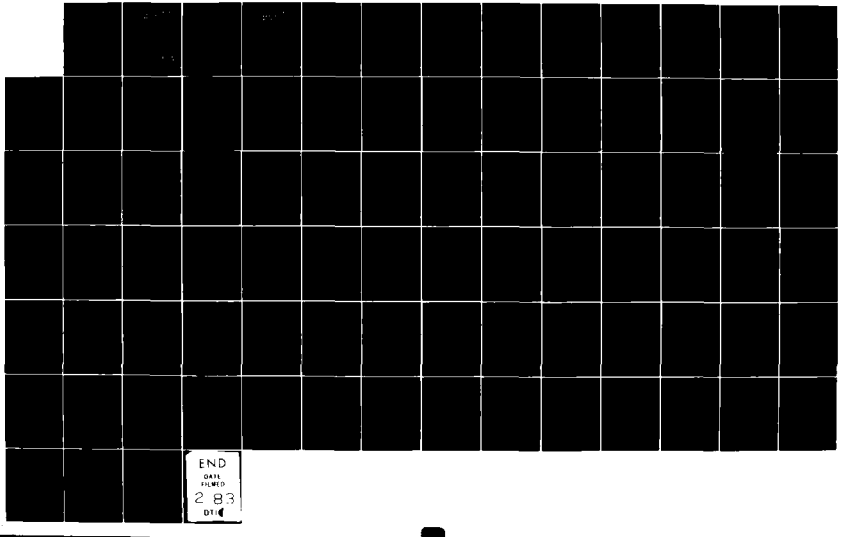

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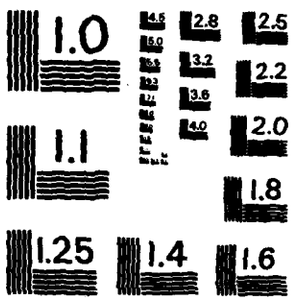

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United States
Department of
Agriculture

Forest Service

Forest
Products
Laboratory

Research
Note
FPL-02

Comparison of Wood Preservatives in Stake Tests

(1981 Progress Report)

Abstract

This report covers test stake results primarily from southern pine sapwood 2 by 4 by 18 inches in size, treated by pressure and nonpressure processes, and installed by the Forest Products Laboratory and cooperators in our decay and termite exposure sites at various times since 1938 at Saucier, Miss., Madison, Wis., Bogalusa, La., Lake Charles, La., Jacksonville, Fla., and the Canal Zone, Panama. Also included in the tests at Saucier, Miss., are smaller pine stakes and those of treated and untreated plywood, particleboard, modified woods, laminated paper plastic, pine infected with Trichoderma mold, plus other selected species such as oak, Douglas-fir, and Engelmann spruce.

Southern pine untreated control stakes have had an average life of about 1 year in the Canal Zone, 1.8 to 3.6 years in Mississippi, Florida, and Louisiana, and about 6 years in Wisconsin. Superficial treatments by 3-minute dipping and brushing with preservatives such as coal-tar creosote and petroleum oils containing copper naphthenate, zinc napthenate, phenyl mercury oleate, and pentachlorophenol have added a few months to 4 years to the life of the untreated stakes. When appropriate retentions are used, the creosote, pentachlorophenol, and selected waterborne salt preservatives are giving excellent service.

United States
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Research
Note
FPL-02

December 1981

Comparison of Wood Preservatives in Stake Tests[2]

(1981 Progress Report)

By

L. R. Gjovik, Research Specialist Wood Preservation
and
D. I. Gutzmer, Physical Science Technician

INTRODUCTION

The results of an international termite exposure test[3/] have indicated that pine sapwood stakes 2 by 4 by 18 inches furnish an effective means for testing the protection provided against decay and termite attack by various wood preservatives. The Forest Products Laboratory during late 1938, in cooperation

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

2/ This note is a continuation of progress reports by the same title issued periodically from 1950 to 1962 as Forest Products Laboratory Report No. 1761 and as USDA Forest Service Research Note FPL-02 since 1963.

3/ Hunt, G. M., and Snyder, T. E. An International Termite Exposure Test. Proceedings of the American Wood-Preservers' Association, 1930, p. 318-334. Annual progress reports published in the above Proceedings each year from 1930 to 1949, again in 1952, 1956, and 1957 (final report).

with others, treated test stakes of southern pine sapwood with several preservatives for installation at the Harrison Experimental Forest at Saucier, Miss. Replicate sets were treated for installations at Madison, Wis., Bogalusa, La. Jacksonville, Fla., and the Canal Zone, Panama. Since 1938, additional preservatives have been added to these tests, principally at the Saucier, Miss., station. Also installed at that station, so their decay and termite resistance could be studied, were stakes of treated and untreated modified-wood products, such as plywood, impreg, compreg, staypak, papreg, laminated acetylated wood, cyanoethylated wood, that with thiamine destroyed, chemically modified wood, wood infected with Trichoderma mold, embedded fiberboard (western hemlock strands in portland cement), and particleboard.

In 1967 an installation including 11 standard wood preservatives was made in cooperation with the Wood Products Insect Laboratory, Gulfport, Miss., at Lake Charles, La., in an area infested by the destructive Formosan termite (Coptotermes formosanus), and for comparison at the Harrison Experimental Forest.

Stake tests are useful for screening out ineffective materials. They can be used to advantage as a means of further exploring the preservative properties of materials that show promise in laboratory toxicity tests. The limitations of these somewhat accelerated field tests must be recognized, however, by those who wish to make use of them. They should not be considered as a substitute for actual service tests on full-size products such as ties, poles, or posts. Furthermore, the results obtained in stake tests are applicable only under the set of conditions existing in the particular test. Factors such as exposure conditions, preservative retentions, preservative distribution, heartwood volume, and size (surface area in relation to total volume) all tend to influence the performance of treated wood. With small stakes, these factors are much different from those when treated products are used under actual service conditions.

This publication is a progress report on the condition of the modified-wood products and stakes, treated with the various preservatives and oils, at the time of the 1980 inspections. The tests at Panama were completed with the final inspection in January 1956. Those at Jacksonville were terminated in December 1960 and those at Bogalusa in December 1958. The tests in Wisconsin and Mississippi were completed with the final inspection in October and December 1963, respectively. The tests in Lake Charles were completed with the final inspection in December 1979. Progress reports showing the condition of the test stakes in 1947, and during the years 1949 to 1969, 1971, 1973, 1975, and 1977 were prepared previously.[2/,4/]

4/ Blew, J. O. Comparison of Wood Preservatives in Stake Tests. Proceedings of the American Wood-Preservers' Association, 1948, p. 88-119.

PRESERVATIVES AND MODIFIED-WOOD PRODUCTS TESTED

Table 1 lists preservatives and other products tested, and refers to existing preservative specifications in cases in which specifications had been issued. Table 1 also refers to tables 2 through 58 in this report, in which test data on the various materials appear. Formulations of treating solutions and descriptions of the various test materials are generally given in these tables. More complete information as to the source and composition of the various materials can, in most cases, be furnished upon request to the Forest Products Laboratory.

SELECTION AND TREATMENT OF STAKES

The stakes of modified-wood, with one or two exceptions, were 4 by 18 inches with variable thicknesses. The wood stakes were, for the most part, 2- by 4-inch (nominal) by 18-inch southern pine, uniformly seasoned, surfaced four sides, and selected, as far as possible, for freedom from heartwood, wane, objectionable knots, and other visible defects. Five installations included stakes of smaller size for comparison (tables 6, 35, 37, 42, 45, 54, 56, 57, and 58). The stakes, before treatment, were identified by a number, either stamped on the ends or marked with lumber crayon.

All preservative treatments were by pressure impregnation unless otherwise indicated in the tables. Waterborne preservatives, unless otherwise noted in the tables, were applied by the full-cell process, while preservative oils were applied by either empty-cell or full-cell methods, depending upon the retentions required. Complete penetration is desirable and is usually noted in the pressure treatment used. For this reason heartwood material was avoided in the southern pine stakes unless specially noted (tables 5 and 51). In most cases, preservative retentions were computed for individual stakes from the difference in weight before and after treatment. However individual retentions are not included in this report because of limited space. Surplus preservative was permitted to drain from the stakes before the final weights were taken. After past experience or exploratory treatments had indicated the correct treating schedule or the treating-solution concentration necessary to produce a desired preservative retention, twenty 2- by 4-inch stakes were treated for each test variable, from which 10 acceptable stakes were selected for installation. By discarding those stakes with retentions higher or lower than that desired, the 10 stakes selected by this procedure were usually found to have preservative retentions within 10 percent of that desired. The stakes not acceptable for the test provided material for checking preservative penetrations. For stakes treated in liquefied petroleum gas (tables 42 and 45) it was impracticable to follow this general procedure. The stakes installed were treated at a commercial plant during the presence of a Laboratory representative and retentions were determined from the analysis of either sections of test stakes or from extra matched stakes included for that purpose.

The test stakes were usually identified by a numbered metal tag nailed (riveted in the case of thin modified-wood products) to the wide face approximately 2 inches from the top of the stake.

INSTALLATION AND INSPECTION OF STAKES

The stakes at Madison, Wis., and Saucier, Miss., were installed in plots by the randomized-block method.[5/] The stakes were set in the ground in an upright position with about half of their length (9 in.) in the ground. The soil in the plot at the Harrison Experimental Forest, Saucier, Miss., is Norfolk fine sandy loam with a pH of 4.85. That area was cleared of trees, mostly scrub oak and gallberry with a few longleaf and slash pine, before the stakes were installed, and the ground cover is now mostly wire grass. The Madison, Wis., plot, until late 1956, was located in an area of clay loam soil partially shaded by various hardwood trees and sumac. In October 1956, it was necessary to move the stakes to a new test plot near Madison with similar soil but without overstory of trees or shrubs. The soil at Bogalusa, La., is sandy loam, and that at Jacksonville, Fla., is sandy. Both plots are partially shaded. The plot at Lake Charles, La., is located on an open area partially covered with broom sedge and marsh grass. The top 10 inches of soil is sandy with some streaks of clay, below which is a heavy muck and a high water table.

The 1970 and 1974 inspections at Lake Charles, La., and the final inspection of stakes installed at the Canal Zone during January 1956 were made by representatives of the Wood Products Insect Laboratory, Gulfport, Miss., and the Forest Products Laboratory. The final inspections of the stakes at Jacksonville and Bogalusa were made in 1960 and 1962, respectively, by representatives of the Chapman Chemical Company and the Forest Products Laboratory. The Madison and Saucier installations were inspected by representatives from the Forest Products Laboratory.

In these inspections, the stakes were removed individually, scraped off to facilitate inspection, examined, and then returned to their original place unless their condition indicated removal. Following the examination, the stakes were given a numerical and a letter rating according to decay and termite attack, as follows:

Decay	Termite attack
1, no decay	A, no attack
2, slightly soft or suspicious	B, nibbles or trails
3, partial or limited decay	C, limited attack (penetration)
4, bad decay	D, heavy attack
5, removed because of decay[6/]	E, removed because of termite attack[6/]

In tables 2 through 58, stakes listed as "Good" had an inspection rating of one of the following: 1A, 1B, 2A, or 2B. Stakes listed as "Serviceable but showing some decay" had one of the following inspection ratings: 3A, 3B, 4A, or 4B. Those listed as "Serviceable but showing some termite attack" were so classified on the basis of a field rating of: 1C, 2C, 1D, or 2D. Stakes

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5/ Fisher, R. A., and Yates, F. Statistical Tables for Agricultural and Medical Research. London. 99 p. 1938.

6/ 50 pct or more of cross section destroyed.

listed as "Serviceable but showing some decay and termite attack" were given one of the following ratings: 3C, 3D, 4C, or 4D. Under the foregoing system of classification, stakes showing limited and heavy decay, termite attack, or both are grouped together. Undue emphasis is often placed upon this classification, in which the stakes show some deterioration but are not necessarily in serious condition. In making comparisons between preservatives, therefore, only the stakes actually destroyed should be considered.

For stakes classified as "Destroyed by decay fungi and termites," both forms of deterioration must be rated at least with bad decay or heavy attack ("4" or "D") in the inspection. In other words, a stake rated in the inspection as 3E would be considered as destroyed by termites rather than by decay and termites, while one rated as 5C would be considered as destroyed by decay fungi. The system used in the tables for classifying the destroyed stakes therefore emphasizes the major factor of factors responsible for damage, but it ignores those that may have been noted but that have not seriously contributed to the destruction. In estimating service life prior to 100 percent removal of stakes it has been noted that the average life is approximately at the time when 60 percent of the stakes in a group have been removed.

The foregoing system of classification is considered well suited to the requirements of tests rated on the basis of visual examination. Such methods of examination do not appear to warrant the use of elaborate or precise methods of rating or classification.

Tables 2 through 58 show the condition of the test stakes at the most recent inspection. Table 59 is a summary of results obtained in Mississippi on 2- by 4-inch pine stakes treated with wood preservatives that are in general use.

SUMMARY OF RESULTS

The results of the tests thus far can be summarized as follows:

Southern Pine and Plywood Stakes

Untreated stakes.--The untreated 2- by 4-inch southern pine sapwood stakes have had an average life of approximately 1 year in the Canal Zone, Panama, 1.8 to 3.6 years at Saucier, Miss., Bogalusa, La., and Jacksonville, Fla., and 4 to 6 years at Madison, Wis. At Lake Charles, La., 90 percent of the untreated control stakes were destroyed by Formosan termites giving an average service life of 2.3 years. Untreated 3/4-inch pine sapwood stakes in Mississippi have had an average life of 1.4 to 2.1 years.

The untreated Douglas-fir plywood stakes installed at Saucier, Miss., have had an average life of about 1 to 4 years. Those glued with phenolic and urea-resin glues have lasted somewhat longer than those glued with casein glue, which have had an average life of 1 year. The stakes cut from Douglas-fir lumber and of thickness similar to that of the plywood have had an average life of slightly more than 2 years. Untreated plywood stakes of yellow birch, sweetgum, and tangile have had an average life of less than 2 years.

Untreated plywood stakes of Engelmann spruce heartwood have had an average life of 2.6 years and untreated Douglas-fir heartwood plywood stakes gave an average life of 3.2 years. Southern pine plywood stakes that contained about equal amounts of heartwood and sapwood have had an average life of 2.8 years.

Pressure-treated stakes.--In the newer installations and in those with the more effective preservatives only a limited number of stakes have thus far been removed, and the average life of stakes pressure treated with various preservatives cannot yet be determined. Estimates on average life were made for preservatives with significant failures at the time of the termination of several installations (see tables 2, 3, 4, 5, 8, 12, 18, 38, and 47). In the Canal Zone, stakes treated with several retentions of chromated zinc arsenate were destroyed during the 15-1/3 years of exposure. Stakes with 0.22 pound per cubic foot (pcf) (oxide basis) of the preservative had an average life of 9.2 years, while those with approximately 0.69 pcf (oxide basis) had an average life of 15.3 years. Stakes treated with chromated zinc arsenate to retentions of 0.22 pcf (oxide basis) to 0.70 pcf (oxide basis)had 70 to 100 percent failures in Wisconsin after 40 years, while in Mississippi failures have been noted only with the lower rentention (table 4; see similar comparison in table 20). This may be attributed to the presence of arsenic-tolerant fungi at the Wisconsin test area.

Stakes treated with retentions of from 0.30 pcf (oxide basis) to 0.63 pcf (oxide basis) of chromated zinc chloride lasted, on an average, about 5 to 7 years in Panama, 14 to 20 years in Mississippi, and 17 to 18 years in Wisconsin. In Panama, stakes treated with fluor chrome arsenate phenol with average retentions of 0.12 pcf (oxide basis) to 0.19 pcf (oxide basis) had an average life of about 3 to 6 years. With stakes treated to 0.37 pcf (oxide basis) the average life in Panama was 14 years. In Mississippi, stakes treated with 0.12, 0.19, and 0.37 pcf (oxide basis) of fluor chrome arsenate phenol had an average life of about 10, 18, and 24 years, respectively. Stakes in Wisconsin treated with similar retentions of that preservative had an average life of 14 to 16 years.

Of the waterborne preservatives in test (31 to 36 yrs in Mississippi), the formulations containing either copper and arsenic (ammoniacal copper arsenate, table 14) or copper, chromium, and arsenic (chromated copper arsenate, tables 15 and 20) are better performers with no failures with retentions of 0.29 pcf (oxide basis) or higher. Again the overall performance of the arsenic containing preservatives (table 20) is better in Mississippi than in Wisconsin.

Results thus far on installations of pentachlorophenol with similar retentions (approximately 0.2 pcf) and with different hydrocarbon solvents (tables 17, 42, and 45), show better performance with solutions containing the heavy solvents such as heavy gas oil, lube oil extract (table 17), No. 4 aromatic oil (table 22), and AWPA P9 heavy petroleum solvent (tables 42 and 45), than with volatile liquid petroleum gas (LPG) or light oils such as Stoddard solvent (mineral spirits) (tables 17 and 42). Preservatives such as rosin amine-D-pentachlorophenate (tables 22 and 23), tributyltin oxide (tables 36 and 41), and copper-8-quinolinolate (tables 38 and 43) also show better performance with the heavy petroleum solvent than with the light Stoddard solvent (mineral spirits). The above-mentioned heavy petroleum solvents have the following properties:

Petroleum oils	API gravity 60° F	Flash point (PMCC)	Viscosity SUS at 100° F	Penta solvency at 75° F	Distillation		
					IBP	50 percent	EP
		(°F)		(Pct)	(°F)	(°F)	(°F)
Heavy gas oil, No. 101	8.3	345	167.4	20-22	600	700	734
Lube oil extract	5.1	295	196.4	28-30	440	696	736
AWPA P9, heavy	23.8	225	38.4	15	480	538	647
No. 4 aromatic	6.8	230	72.6	10+	458	592	Cracked, (85 pct)

Coal-tar creosotes installed in Mississippi during 1940 and 1941 (tables 4, 5, and 6) have shown better performance than those installed in 1948 (tables 18 and 19). In the latter installation, 10 coal-tar creosotes with a retention of approximately 8 pcf showed only a few serviceable stakes after 20 years and the average life was determined or estimated at 14 to 21 years. Creosotes installed earlier showed only 20 to 100 percent failures in 39-1/2 to 40-1/2 years.

Stakes pressure treated with the fire-retarding formulation containing ammonium phosphate and ammonium sulfate lasted, on an average, only 2 to 3 years in Mississippi. With these ammonium salts plus borax and boric acid, the stakes installed in 1943 lasted on the average about 4 years. The fire-retarding formulation with borax and boric acid alone has provided protection against decay and termites for an average of about 6 years. The addition of zinc chloride and chromium compounds to combinations of boron and ammonium salts in fire retardants improves protection against decay fungi and termites.

Douglas-fir plywood stakes treated with 6 and 12 pcf of coal-tar creosote have performed somewhat better in Mississippi than those treated with 26 pcf of 1.1 percent or 2.25 percent pentachlorophenol in light solvent (table 8).

The results of stake tests in Mississippi show copper naphthenate is providing greater protection than zinc naphthenate with similar retentions.

Stakes pressure treated with various concentrations of phenyl mercury oleate in naphtha have lasted from 5 to 9 years in Mississippi. This chemical alone did not perform as well as did a proprietary product containing a water repellent.

Rosin amine-D-pentachlorophenate in Stoddard solvent is performing less satisfactorily than is pentachlorophenol with that solvent and similar retentions. Naval stores products such as rosin oil, oleo resin, and drop liquor concentrate with petroleum solvents appear to have limited value as preservatives but are improved by the addition of pentachlorophenol. Urea (table 10) has also shown limited protection. Stakes pressure treated with 5.8 pcf had an average life of 9.1 years in Mississippi. Other products showing limited preservative value in the retentions used are acrylonitrile (cyanoethylation), ammonium hydroxide (thiamine destruction), amyl phenyl acetate, capric acid, copper-8-quinolinolate (in Stoddard solvent), diamyl phenol, DDT, dodecyl amine, nickel stearate, and tributyltin oxide (in Stoddard solvent).

An indication of the influence of size of test stakes can be noted in table 6. With a coal-tar creosote retention of approximately 8 pcf, 1/2-inch-square stakes have been destroyed in 21-1/2 years with an average life of 17 years, 1- by 1-inch-square stakes have been destroyed in 39-1/2 years with an average life of 23.5 years, 1-1/2-inch-square stakes have been destroyed in 33-1/2 years with an average life of 26.6 years, and 2- by 4-inch stakes show 60 percent failure after 39-1/2 years.

Nonpressure-treated stakes.--Southern pine stakes and Douglas-fir plywood stakes treated by superficial applications, such as brushing and brief dipping in coal-tar creosote and solutions of pentachlorophenol, copper naphthenate, zinc naphthenate, and phenyl mercury oleate, have, in general, lasted 1 to 4 years longer than the untreated control stakes. However, stakes dipped for 15 minutes in coal-tar creosote had a life of about 8 years in Mississippi.

For the plywood stakes in which the veneer was treated by dipping or long soaking in the preservatives before gluing, the results have generally been more favorable than for plywood similarly treated after gluing. Stakes soaked 18 hours in solutions of pentachlorophenol or mixtures of chlorinated phenols have lasted 5 to 10 years in the Canal Zone. In the United States, the stakes soaked 18 hours in these solutions lasted 8 to 16 years. Douglas-fir plywood stakes treated by brushing, dipping, and 18-hour soaking in chloro-2-phenylphenol solution, however, have lasted only a few months longer than the untreated plywood control stakes. Douglas-fir plywood stakes treated by soaking 18 hours in pentachlorophenol solution had a life of 5 years, while those similarly treated with coal-tar creosote have an estimated average of 24 years.

Pine stakes treated by soaking in urea solution have lasted about 1 to 1-1/2 years longer than the control stakes in Mississippi, while those similarly treated with ureaformaldehyde solution have lasted about 3 to 4 years longer than the controls.

Pine stakes with higher retentions of copper chromate and with copper arsenate applied by double-diffusion have continued to perform well after 39 years in Mississippi. Failures thus far, however, are attributed to poor penetration of the preservative (table 9).

Modified-Wood Stakes

Plywood stakes impregnated with phenolic resin (impreg) and impregnated and compressed (compreg) have been considerably more resistant to decay and termite attack than untreated plywood of the same species. Plywood stakes with a low resin content had an average life of approximately 7 years and those with a high resin content lasted 12 years. In Douglas-fir plywood stakes with phenolic-resin-impregnated faces and untreated cores, an average life of about 3.5 years has been obtained, and s[illegible]ewhat bet[illegible]er results have been noted when the edges of the plywood have bee[illegible] with a phenolic-resin coating. Southern pine 2- by 4-inch stakes im[illegible]gnated with a low resin content had an average life of 12 years while those with a higher content of phenolic resin have lasted somewhat longer.

Laminated paper plastic made with phenolic resin has shown limited resistance to decay and termite attack, with the life of the stakes averaging about 6 to 8 years. Heat-stabilized birch and maple plywood (staypak) stakes have lasted

about 4 to 6 years. The staypak with veneer of 1/16-inch thickness has performed better than that with 1/8-inch veneer, presumably since the thinner veneer permits a better distribution of the phenolic-resin adhesive in the plywood.

Acetylated birch (laminated veneer) has had reasonably good resistance to decay and termite attack with an average life of 17.5 years in Mississippi. Deterioration is due primarily to decay fungi.

Untreated stakes of aspen particleboard installed in 1973 are now destroyed with an average life of 2.0 years. It is interesting to note that this material treated with chromated copper arsenate and fluor chrome arsenate phenol is showing less degradation than those stakes treated with pentachlorophenol in light solvents. Stakes treated to 0.22 pcf retention of penta gave an average life of 5.4 years (table 49).

Butylene oxide stakes treated to 17 to 22 percent weight gain had an average life of 4.2 years, and those treated to 37 to 40 percent weight gain are showing attack after 6 years. Approximately 50 percent of the butylene oxide stakes treated to 31 percent weight gain are showing attack after 2 years. Propylene oxide modified stakes are showing various degrees of degradation from 67 to 100 percent failure depending on the chemical loading (table 50).

Note

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife--if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Crankcase oils may contain chlorinated naphthalenes, which have been reported to contribute to "X-disease" (hyperkeratosis) in cattle. These oils are therefore not recommended for preservative treatment of wood with which cattle may come in contact.

Table 1.--Index to materials tested

Materials	Existing specification or AWPA reference	Table No.
Chemicals		
Acid copper chromate	Fed. Spec. TT-W-546; AWPA P5	15, 16, 46, 47
Acrylonitrile	--	36
Aldrin	--	41
Ammoniacal copper arsenate	Fed. Spec. TT-W-549; AWPA P5	14, 47, 51, 52,55
Ammoniacal copper borate	--	52
Ammonium hydroxide	--	36
Ammonium sulfate-phosphate	Navy Spec. 51C38	13
Amyl phenyl acetate	--	14
Basic zinc chloride	--	26
Basilit UA	--	30
Boliden salt S-25	--	24
Borax-boric acid	Navy Spec. 51C38	13
Capric acid	--	14
Chloro-2-phenylphenol	--	5, 8
Chromated copper arsenate	Fed. Spec. TT-W-550 Type I; AWPA P5; AWPA P5, Type A	15, 47
Chromated copper arsenate	Fed. Spec. TT-W-550 Type II; AWPA P5, Type B	20, 47
Chromated copper arsenate	Fed. Spec. TT-W-550 Type III; AWPA P5, Type C	48, 49, 51, 55, 57
Chromated copper fluoride (CFK)	--	58
Chromated zinc arsenate	Formerly in Fed. Spec. TT-W-538; AWPA P5	4, 24
Chromated zinc chloride	Fed. Spec. TT-W-551; AWPA P5	2, 16, 25, 35, 47
Chromated zinc chloride, copperized	Formerly in Fed. Spec. TT-W-562; AWPA P5	31
Chromated zinc chloride (FR)	AWPA P10, Type B	25
Copper arsenate	AWPA Proc. 1941; pp. 23-31	9
Copper chromate	AWPA Proc. 1941; pp. 23-31	9
Copper-chrome boron (CB)	U.S. Patent No. 3,007,844	46
Copper-chrome-phosphorus	--	48
Copper formate	--	34
Copper naphthenate	AWPA P8	7, 12, 16, 17, 29
Copper-8-quinolinolate	AWPA P8	38, 43, 54
Creosote, coal-tar	Fed. Spec. TT-C-645; AWPA P1	4, 5, 6, 8, 16, 17, 18, 19, 20, 31, 35, 47
Creosote, coal-tar (English)	--	18, 19
Creosote, coal-tar (low temperature)	--	28
Creosote, coal-tar (Texas lignite)	--	32
Creosote-coal tar solution	Fed. Spec. TT-C-650; AWPA P2	18, 47
Creosote-petroleum solution	Fed. Spec. TT-W-568	18, 47
Creosote toluene	--	6
Diamyl phenol	--	14
Dichloro-diphenyl-trichloroethane (DDT)	--	14
Dieldrin	--	41
Dodecyl amine	--	14
Drop-liquor concentrate	--	27
Fire retardants	--	53
Fire retardants	AWPA P10	25
Fluor chrome arsenate phenol	Fed. Spec. TT-W-535, Type A; AWPA P5	2, 33, 37, 47, 49
Fluor chrome arsenate phenol	Fed. Spec. TT-W-535, Type B; AWPA P5	47
Fuel oils	--	5, 17, 27

(Page 1 of 2)

Table 1.--*Index* to materials tested--continued

Materials	Existing specification or AWPA reference	Table No.
Chemicals--continued		
Heptadecyltrimethyltetra-hydropyrimidine (HTP)	--	44
KP (copper oxide and chlorophenol)	--	35
Lignite-tar extracts	--	39
Mercuric chloride	--	12
Minalith	AWPA P10, Type C	25
Nickel-chromium-arsenic salt	--	15
Nickel-sterate	--	14
Oleo resin	--	27
Paraffin	--	32
Pentachlorophenol	Fed. Spec. TT-W-570; AWPA P8	5, 8, 12, 16, 17, 22, 23, 27, 29, 31, 32, 33, 41, 42, 43, 45, 47, 49, 54
Petroleum oils (various types)	--	17, 18, 21, 23, 45
Phenyl mercury oleate	--	12
Pyresote	AWPA P10, Type D	25
Rosin amine D copper acetate complex	--	27
Rosin amine D pentachlorophenate	--	22, 23
Rosin oil	--	27
Sodium pentachlorophenate	--	2, 5
Sodium tetrachlorophenate	--	2
Toluene	--	6
Tributyltin oxide	--	36, 41
Urea	--	10
Zinc-arsenate-chromium salts	--	20
Zinc chloride	--	2, 4, 20, 26
Zinc naphthenate	--	7, 8
Modified woods, particleboard, plywood, and paper plastic		
Acetylated wood	--	14
Butylene oxide	U.S. Patent No. 3,985,921	50, 56
Cyanoethylated wood	--	36
Embedded fiberboard	--	40
Epichlorohydrin		50
Heat-stabilized wood (staypak)	--	11
Laminated paper plastic (papreg)	--	11
Impreg and compreg	--	3
Mold-infected wood	--	31
Particleboard	--	49
Plywood	--	3, 8, 16, 33, 51
Propylene oxide	U.S. Patent No. 3,985,921	50
Wood with thiamine destroyed	--	36

Table 2.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with chlorinated phenols and with fluor chrome arsenate phenol--Type A, zinc chloride, and chromated zinc chloride, after 15 to 25 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, September 1938; Bogalusa, La., December 1939; Jacksonville, Fla., January 1939; Harrison Experimental Forest, Saucier, Miss., December 1939; and Madison, Wis., November 1939

Preservative	Location	Retention of salts[a]			Number in test[b]	Condition of stakes late in 1963[c]								
						Good	Serviceable but showing some--			Destroyed by--			Total removed		Average life
		Minimum	Maximum	Average			Decay	*Termite* attack	Decay *and* termite attack	Decay fungi	Termite attack	Decay fungi *and* termite attack			
		Pcf				Pct							Number	Pct	Yr
Sodium pentachlorophenate	Canal	0.24	0.28	0.26	10	--	--	--	--	--	--	100	10	100	6.9
	La.	.24	.28	.26	10	--	--	--	--	10	--	90	10	100	9.2
	Fla.	.25	.28	.26	9	--	--	--	--	11	--	89	9	100	14.2
	Miss.	.24	.28	.26	10	--	--	--	--	10	20	70	10	100	11.9
	Wis.	.24	.28	.26	10	--	--	--	--	100	--	--	10	100	12.5
	Canal	.45	.54	.50	10	--	--	--	--	--	20	80	10	100	11.2
	La.	.45	.53	.49	10	--	--	--	--	30	--	70	10	100	10.7
	Fla.	.46	.55	.50	10	--	--	--	20	--	--	80	8	80	22.0[d]
	Miss.	.44	.54	.49	10	--	--	--	--	10	--	90	10	100	19.4
	Wis.	.44	.53	.49	10	--	--	--	--	100	--	--	10	100	16.4
	Canal	.69	.81	.75	10	--	--	--	--	10	20	70	10	100	11.7
	La.	.69	.85	.75	10	--	--	--	--	10	--	90	10	100	15.6
	Fla.	.68	.82	.74	10	--	--	--	40	10	--	50	6	60	22.0[d]
	Miss.	.69	.84	.76	10	--	--	--	--	40	--	60	10	100	21.6
	Wis.	.67	.81	.76	10	--	--	--	--	100	--	--	10	100	21.0
	Canal	.92	1.06	.98	10	--	--	--	--	--	10	90	10	100	14.3
	La.	.93	1.09	.99	10	--	--	--	--	10	--	90	10	100	16.2
	Fla.	.92	1.08	.98	10	--	--	--	60	10	--	30	4	40	--
	Miss.	.93	1.09	.97	10	--	--	--	--	20	--	80	10	100	25.0
	Wis.	.86	1.01	.90	10	--	--	--	--	100	--	--	10	100	23.4
Sodium tetrachlorophenate	Canal	.24	.27	.25	10	--	--	--	--	--	60	40	10	100	4.8
	La.	.23	.27	.25	10	--	--	--	--	20	--	80	10	100	8.1
	Fla.	.23	.28	.25	9	--	--	--	--	22	--	78	9	100	11.3
	Miss.	.23	.27	.25	10	--	--	--	--	--	10	90	10	100	10.7
	Wis.	.24	.27	.25	10	--	--	--	--	100	--	--	10	100	11.4
	Canal	0.47	0.56	0.51	10	--	--	--	--	--	20	80	10	100	9.9
	La.	.46	.55	.50	10	--	--	--	--	30	--	70	10	100	10.9
	Fla.	.47	.55	.51	10	--	--	--	--	--	--	100	10	100	15.3
	Miss.	.48	.58	.52	10	--	--	--	--	--	--	100	10	100	15.1
	Wis.	.47	.55	.50	10	--	--	--	--	100	--	--	10	100	14.5
	Canal	.70	.83	.76	10	--	--	--	--	--	--	100	10	100	13.1
	La.	.71	.83	.77	10	--	--	--	--	30	--	70	10	100	11.9
	Fla.	.68	.83	.76	9	--	--	--	--	--	11	89	9	100	16.7
	Miss.	.68	.82	.75	10	--	--	--	--	--	--	100	10	100	19.7
	Wis.	.67	.81	.75	9	--	--	--	--	100	--	--	9	100	16.7
Fluor chrome arsenate phenol--Type A	Canal	.18 (0.11)	.22 (0.14)	.20 (0.12)	10	--	--	--	--	--	100	--	10	100	2.9
	La.	.19 (.12)	.22 (.14)	.20 (.12)	10	--	--	--	--	50	--	50	10	100	9.6
	Fla.	.18 (.11)	.21 (.13)	.20 (.12)	10	--	--	--	--	50	--	50	10	100	13.9
	Miss.	.18 (.11)	.21 (.13)	.20 (.12)	10	--	--	--	--	10	50	40	10	100	10.2
	Wis.	.13 (.08)	.22 (.14)	.20 (.12)	10	--	--	--	--	100	--	--	10	100	13.8
	Canal	.28 (.17)	.33 (.20)	.30 (.19)	10	--	--	--	--	--	30	70	10	100	6.4
	La.	.28 (.17)	.32 (.20)	.30 (.19)	10	--	--	--	--	20	--	80	10	100	13.7
	Fla.	.29 (.18)	.32 (.20)	.30 (.19)	10	--	--	--	--	100	--	--	10	100	15.4
	Miss.	.29 (.18)	.32 (.20)	.30 (.19)	10	--	--	--	--	10	--	90	10	100	18.0
	Wis.	.27 (.17)	.30 (.19)	.28 (.17)	10	--	--	--	--	100	--	--	10	100	16.5
	Canal	.53 (.33)	.66 (.41)	.60 (.37)	10	--	--	--	--	40	--	60	10	100	14.2
	La.	.56 (.35)	.64 (.40)	.60 (.37)	10	--	--	--	--	50	--	50	10	100	15.6
	Fla.	.57 (.35)	.65 (.40)	.61 (.38)	10	--	--	--	--	100	--	--	10	100	17.3
	Miss.	.57 (.35)	.65 (.40)	.61 (.38)	10	--	--	--	--	60	--	40	10	100	24.1
	Wis.	.59 (.36)	.68 (.42)	.65 (.40)	10	--	--	--	--	100	--	--	10	100	16.0

(Page 1 of 2)

Table 2.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with chlorinated phenols and with fluor chrome arsenate phenol--Type A, zinc chloride, and chromated zinc chloride, after 15 to 25 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, September 1938; Bogalusa, La., December 1939; Jacksonville, Fla., January 1939; Harrison Experimental Forest, Saucier, Miss., December 1939; and Madison, Wis., November 1939--continued

Preservative	Location	Retention of salts[a]			Number in test[b]	Condition of stakes late in 1963[c]									
		Minimum	Maximum	Average		Good	Serviceable but showing some--			Destroyed by--			Total removed		Average life
							Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf				Pct							Number	Pct	Yr
Sodium pentachlorophenate and sodium chloride[e]	Canal	0.52	0.55	0.54	10	--	--	--	--	--	30	70	10	100	8.7
	La.	.46	.53	.49	10	--	--	--	--	--	--	100	10	100	13.3
	Fla.	.48	.54	.50	10	--	--	--	50	10	--	40	5	50	--
	Miss.	.46	.53	.49	10	--	--	--	--	--	--	100	10	100	16.3
	Wis.	.46	.53	.50	10	--	--	--	--	100	--	--	10	100	16.8
Zinc chloride	Canal	.44 (0.26)	.53 (0.32)	.47 (0.28)	10	--	--	--	--	--	30	70	10	100	3.9
	La.	.45 (.27)	.55 (.33)	.50 (.30)	10	--	--	--	--	30	--	70	10	100	8.1
	Fla.	.45 (.27)	.53 (.32)	.49 (.29)	10	--	--	--	--	20	--	80	10	100	12.9
	Miss.	.45 (.27)	.54 (.32)	.50 (.30)	10	--	--	--	--	40	--	60	10	100	15.4
	Wis.	.45 (.27)	.53 (.32)	.49 (.29)	10	--	--	--	--	100	--	--	10	100	18.2
	Canal	.70 (.42)	.82 (.49)	.76 (.45)	10	--	--	--	--	--	--	100	10	100	3.9
	La.	.70 (.42)	.78 (.47)	.74 (.44)	10	--	--	--	--	40	--	60	10	100	12.1
	Fla.	.71 (.42)	.82 (.49)	.75 (.45)	10	--	--	--	--	40	--	60	10	100	13.5
	Miss.	.70 (.42)	.79 (.47)	.74 (.44)	10	--	--	--	--	20	10	70	10	100	16.7
	Wis.	.65 (.39)	.87 (.52)	.75 (.45)	9	--	--	--	--	100	--	--	9	100	18.9
	Canal	.94 (.56)	1.08 (.64)	1.00 (.60)	10	--	--	--	--	--	40	60	10	100	4.0
	La.	.94 (.56)	1.08 (.64)	1.01 (.60)	10	--	--	--	--	70	--	30	10	100	11.6
	Fla.	.95 (.57)	1.08 (.64)	1.02 (.61)	10	--	--	--	--	20	--	80	10	100	15.4
	Miss.	.94 (.56)	1.07 (.64)	1.00 (.60)	10	--	--	--	--	10	--	90	10	100	17.3
	Wis.	.93 (.56)	1.13 (.68)	1.02 (.61)	10	--	--	--	--	100	--	--	10	100	19.0
	Canal	1.40 (.84)	1.62 (.97)	1.49 (.89)	10	--	--	--	--	--	10	90	10	100	7.3
	La.	1.44 (.86)	1.63 (.97)	1.52 (.91)	10	--	--	--	--	40	--	60	10	100	11.1
	Fla.	1.41 (.84)	1.62 (.97)	1.49 (.89)	10	--	--	--	--	20	--	80	10	100	15.7
	Miss.	1.43 (.85)	1.63 (.97)	1.52 (.91)	10	--	--	--	--	60	--	40	10	100	17.9
	Wis.	1.36 (.81)	1.74 (1.04)	1.59 (.94)	10	--	--	--	--	100	--	--	10	100	18.7
Chromated zinc chloride	Canal	0.45 (0.28)	0.55 (0.34)	0.49 (0.30)	10	--	--	--	--	--	--	100	10	100	4.9
	La.	.46 (.28)	.55 (.34)	.49 (.30)	10	--	--	--	--	40	10	50	10	100	8.6
	Fla.	.45 (.28)	.53 (.33)	.49 (.30)	8	--	--	--	--	25	--	75	8	100	14.3
	Miss.	.45 (.28)	.55 (.34)	.49 (.30)	10	--	--	--	--	30	10	60	10	100	14.2
	Wis.	.43 (.26)	.53 (.33)	.47 (.29)	10	--	--	--	--	100	--	--	10	100	16.9
	Canal	.70 (.43)	.81 (.50)	.76 (.47)	10	--	--	--	--	--	--	100	10	100	7.2
	La.	.70 (.43)	.80 (.49)	.76 (.47)	10	--	--	--	--	40	--	60	10	100	10.6
	Fla.	.73 (.45)	.81 (.50)	.77 (.47)	9	--	--	--	--	11	--	89	9	100	14.3
	Miss.	.72 (.44)	.81 (.50)	.76 (.47)	10	--	--	--	--	40	--	60	10	100	20.2
	Wis.	.70 (.43)	.86 (.53)	.80 (.49)	10	--	--	--	--	100	--	--	10	100	14.7
	Canal	.95 (.58)	1.11 (.68)	1.02 (.63)	10	--	--	--	--	10	--	90	10	100	6.6
	La.	.93 (.57)	1.07 (.66)	1.00 (.62)	10	--	--	--	--	40	--	60	10	100	11.9
	Fla.	.96 (.59)	1.09 (.67)	1.02 (.63)	10	--	--	--	10	20	--	70	9	90	17.0[d]
	Miss.	.96 (.59)	1.09 (.67)	1.02 (.63)	10	--	--	--	--	50	--	50	10	100	20.1
	Wis.	.89 (.55)	1.13 (.70)	1.02 (.63)	10	--	--	--	--	100	--	--	10	100	18.2
Untreated controls	Canal	--	--	--	10	--	--	--	--	--	100	--	10	100	0.7
	La.	--	--	--	10	--	--	--	--	20	20	60	10	100	2.9
	Fla.	--	--	--	10	--	--	--	--	--	10	90	10	100	2.8
	Miss.	--	--	--	10	--	--	--	--	--	60	40	10	100	2.9
	Wis.	--	--	--	10	--	--	--	--	100	--	--	10	100	5.7

[a] Retention values in parentheses are based on preservative oxides.

[b] 10 stakes were originally installed at each test station. This number has since been reduced either because of failure to locate the stakes at the time of the inspection or because of damage by fire.

[c] Final inspection at Canal Zone, January 1956; at Louisiana, December 1958; at Florida, December 1960; at Wisconsin, October 1963; and at Mississippi, December 1963.

[d] Estimate based on percentage of stakes remaining after final inspection.

[e] Retention values based on sodium pentachlorophenate only. Sodium chloride added was equal to 20 pct of weight of sodium pentachlorophenate in solution.

Table 4 --Condition of the plywood stakes and resin-impregnated stakes, set January 1940 on the Harrison Experimental Forest, Saucier, Miss., after about 27 years of service

Group No.	Stake No.	Treatment	Approximate average retention	Number in test	Condition of stakes January 1967						Total removed		Average life
					Good	Serviceable but showing some--		Destroyed by--					
						Decay	Termite attack and decay	Decay fungi	Termite attack	Termite attack and decay fungi			
			Pcf		Pct						Number	Pct	Yr
				PLYWOOD[a]									
1	1-1-40 to 1-10-40	Each ply impregnated with a 50 pct aqueous solution of phenolic resin, slowly dried, and cured for 1 day at 220° F. Bonded with phenolic-resin film.	10	8	--	--	--	38	--	62	8	100	12.4
2	2-1-40 to 2-10-40	Same as group 1 except that a 25 pct solution was used.	5	10	--	--	--	60	--	40	10	100	6.8
3	3-1-40 to 3-10-40	Face plies impregnated as in group 1 and bonded to an untreated core with phenolic-resin film.	10[b]	10	--	--	--	--	100	--	10[c]	100	3.3
4	4-1-40 to 4-10-40	Face plies impregnated as in group 2 and bonded to an untreated core with phenolic-resin film.	5[b]	10	--	--	--	--	100	--	10[c]	100	3.5
5	5-1-40 to 5-10-40	Same as group 2 except that edges of specimens were given a protective treatment by dipping in a phenolic resin containing 15 pct alcohol.	10[b]	10	--	--	--	30	70	--	10[c]	100	4.9
6	6-1-40 to 6-10-40	Same as group 5 except that edges were protected as in group 5.	5[b]	9	--	--	--	22	45	33	9[c]	100	9.3
7	7-1-40 to 7-10-40	Untreated plies bonded with phenolic-resin film.	--	10	--	--	--	--	70	30	10	100	1.9
8	8-1-40 to 8-10-40	Untreated plies bonded with hot-press urea resin.	--	10	--	--	--	--	70	30	10	100	1.9
9	9-1-40 to 9-10-40	Untreated plies bonded with casein glue (FPL formula 4B)	--	10	--	--	--	--	90	10	10[d]	100	1.0
10	10-1-40 to 10-10-40	Untreated plies (yellow birch) bonded with phenolic-resin film.	--	10	--	--	--	10	30	60	10	100	1.9
11	11-1-40 to 11-10-40	Untreated controls--solid wood (1/4 by 4 by 18 in.).	--	10	--	--	--	--	80	20	10	100	2.4
				STAKES (IMPREG)[e]									
12	12-1-40 to 12-10-40	Impregnated same as group 1.	10	10	--	10	10	50	--	30	8	80	19.5[f]
13	13-1-40 to 13-10-40	Impregnated same as group 2	5	10	--	--	--	50	--	50	10	100	11.7
14	14-1-40 to 14-10-40	Controls--untreated	--	10	--	--	--	--	20	80	10	100	2.7
				COMPRESSED PLYWOOD (COMPREG)[g]									
15	15-1-40 to 15-3-40	Douglas-fir--all plies impregnated as in group 1, dried and assembled without the use of glue on a hot press at 330° F and 1,000 pounds pressure per square inch.	10	3	100	--	--	--	--	--	--	--	--
	15-4-40 to 15-6-40	Yellow-poplar--all plies impregnated and compressed the same as for Douglas-fir.	10	3	--	--	--	33	--	67	3	100	19.5

[a] Specimens in groups 1 to 9 are 3-ply Douglas-fir; in group 10, yellow birch. They are 1/4 x 4 x 18 in. in size and made of 1/16-in. faces and a 1/8-in. core. Specimens in group 11 are solid Douglas-fir, 1/4 x 4 x 18 in. in size.

[b] Increase based on treated faces.

[c] Deterioration principally in cores.

[d] Some separation of plies had also occurred.

[e] Specimens are southern pine sapwood, 2 x 4 (nominal) x 18 in. in size.

[f] Based on estimated life of 2 remaining stakes.

[g] Specimens of both Douglas-fir and yellow-poplar made of 15-1/16-in. plies, compressed to a thickness of 3/8 in. Size of specimens 3/8 x 4 x 14 in.

NOTE--Stakes remaining after the 1952 inspection were taken up and reset in the same general area.

Table 4.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with chromated zinc arsenate (Boliden salts), zinc chloride, and coal-tar creosote after 15 to 40-1/2 years of service. Stakes placed in test at Madison, Wis., September 1940; Harrison Experimental Forest, Saucier, Miss., June 1940; and Barro Colorado Island, Canal Zone, September 1940

Preservative	Location	Average retention		Number in test	Condition of stakes December 1980[a]							Total removed		Average life
					Serviceable but showing some--				Destroyed by--					
		Oil	Dry salt[b]		Good	Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf			Pct							Number	Pct	Yr
Zinc chloride	Wis.	--	0.50 (.30)	10	--	--	--	--	100	--	--	10	100	14.8
	Miss.	--	.50 (.30)	10	--	--	--	--	60	--	40	10	100	14.2
	Canal	--	.49 (.29)	10	--	--	--	--	--	--	100	10	100	3.0
	Wis.	--	1.03 (.61)	10	--	--	--	--	100	--	--	10	100	19.8
	Miss.	--	1.02 (.61)	10	--	--	--	--	60	10	30	10	100	14.4
	Canal	--	1.01 (.60)	10	--	--	--	--	--	--	100	10	100	3.6
	Wis.	--	1.51 (.90)	10	--	--	--	--	100	--	--	10	100	22.3
	Miss.	--	1.51 (.90)	10	--	--	--	--	60	--	40	10	100	18.1
	Canal	--	1.49 (.89)	10	--	--	--	--	--	--	100	10	100	4.5
Chromated zinc arsenate (Boliden salts)[c]	Wis.	--	.33 (.22)	10	--	--	--	--	100	--	--	10	100	19.6
	Miss.	--	.33 (.22)	10	--	--	--	--	30	--	70	10	100	33.0
	Canal	--	.33 (.22)	10	--	--	--	--	--	--	100	10	100	9.2
	Wis.	--	.44 (.29)	10	--	--	--	--	100	--	--	10	100	26.5
	Miss.	--	.44 (.29)	9	--	--	--	22	11	--	67	7	78	--
	Canal	--	.44 (.29)	10	--	--	--	--	30	10	60	10	100	11.6
	Wis.	--	.60 (.40)	10	--	10	--	--	90	--	--	9	90	--
	Miss.	--	.58 (.38)	10	--	--	--	80	10	--	10	2	20	--
	Canal	--	.58 (.38)	10	--	--	--	--	60	40	--	10	100	14.6
	Wis.	--	.78 (.52)	10	--	10	--	--	90	--	--	9	90	--
	Miss.	--	.78 (.52)	10	--	--	--	100	--	--	--	--	--	--
	Canal	--	.78 (.52)	10	--	--	--	--	100	--	--	10	100	15.1
	Wis.	--	1.06 (.70)	10	--	30	--	--	70	--	--	7	70	--
	Miss.	--	1.06 (.70)	10	--	--	--	100	--	--	--	--	--	--
	Canal	--	1.05 (.69)	10	--	--	--	--	100	--	--	10	100	15.3
Coal-tar creosote	Wis.	4.3	--	10	--	20	--	--	80	--	--	8	80	--
	Miss.	4.2	--	10	--	--	--	--	60	--	40	10	100	17.8
	Canal	4.3	--	10	--	--	--	--	40	--	60	10	100	13.4
	Wis.	8.0	--	9	--	89	--	--	11	--	--	1	11	--
	Miss.	8.0	--	10	--	--	--	50	30	--	20	5	50	--
	Canal	8.0	--	10	--	60	--	10	30	--	--	3	30	19[d]
	Wis.	11.8	--	9	22	78	--	--	--	--	--	--	--	--
	Miss.	11.8	--	10	--	--	--	80	10	--	10	2	20	--
	Canal	11.8	--	10	--	60	--	--	40	--	--	4	40	18[d]
	Wis.	16.3	--	10	40	60	--	--	--	--	--	--	--	--
	Miss.	16.5	--	10	--	--	--	100	--	--	--	--	--	--
	Canal	16.5	--	10	--	90	--	10	--	--	--	--	--	--
	Wis.	1.8[e]	--	10	--	--	--	--	100	--	--	10	100	12.4
	Miss.	1.8[e]	--	10	--	--	--	--	10	30	60	10	100	7.7
	Canal	1.8[e]	--	10	--	--	--	--	--	80	20	10	100	4.8
	Wis.	.71[f]	--	10	--	--	--	--	100	--	--	10	100	8.4
	Miss.	.76[f]	--	10	--	--	--	--	--	50	50	10	100	4.2
	Canal	.76[f]	--	10	--	--	--	--	--	90	10	10	100	2.5
Untreated controls	Wis.	--	--	10	--	--	--	--	100	--	--	10	100	6.2
	Miss.	--	--	10	--	--	--	--	--	50	50	10	100	2.2
	Canal	--	--	10	--	--	--	--	--	90	10	10	100	1.1

[a] Final inspection at Canal Zone, January 1956.
[b] Retention values in parentheses are based on preservative oxides.
[c] Retention based upon total anhydrous salts: $ZnSO_4 + H_3AsO_4 + Na_2HAsO_4 + Na_2Cr_2O_7$.
[d] Estimate based upon percentage of stakes remaining after final inspection.
[e] 15-min dip at room temperature.
[f] Brush treatment, 2 coats.

Table 5.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with chlorinated phenols and coal-tar creosote, after 15 to 40 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, February 1941; Bogalusa, La., March 1941; Jacksonville, Fla., March 1941; and Harrison Experimental Forest, Saucier, Miss., February 1941

Preservative	Location	Retention of preservative[a]			Number in test[b]	Condition of stakes December 1980[c]							Total removed		Average life
						Good	Serviceable but showing some--			Destroyed by--					
		Minimum	Maximum	Average			Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf				Pct							Number	Pct	Yr
Sodium pentachlorophenate	Canal	0.23	0.27	0.25	10	--	--	--	--	--	60	40	10	100	6.4
	La.	.23	.26	.25	10	--	--	--	--	10	--	90	10	100	10.0
	Fla.	.23	.26	.25	9	--	--	--	--	--	--	100	9	100	14.5
	Miss.	.23	.26	.25	10	--	--	--	--	20	--	80	10	100	16.9
	Canal	.31	.34	.33	10	--	--	--	--	--	10	90	10	100	10.9
	La.	.31	.34	.33	10	--	--	--	--	--	--	100	10	100	10.4
	Fla.	.32	.34	.33	8	--	--	--	--	--	12	88	8	100	16.3
	Miss.	.31	.34	.33	10	--	--	--	--	20	--	80	10	100	19.5
	Canal	.47	.55	.51	10	--	--	--	--	--	20	80	10	100	12.9
	La.	.48	.54	.51	10	--	--	--	--	--	--	100	10	100	15.5
	Fla.	.47	.54	.50	10	--	--	--	50	--	--	50	5	50	21.0[d]
	Miss.	.47	.55	.51	10	--	--	--	--	10	--	90	10	100	21.3
	Canal	.73	.81	.77	10	--	--	--	--	50	20	30	10	100	14.3
	La.	.72	.82	.77	8	--	--	--	50	--	--	50	4	50	22.0[d]
	Fla.	.72	.83	.77	10	--	--	--	80	--	--	20	2	20	27.0[d]
	Miss.	.72	.83	.77	10	--	--	--	10	--	--	100	10	100	26.2
	Canal	.92	1.09	.99	10	--	--	--	--	70	--	30	10	100	14.2
	La.	.92	1.09	.99	7	--	--	--	57	--	--	43	3	43	23.0[d]
	Fla.	.91	1.10	.99	9	--	--	--	100	--	--	--	--	--	--
	Miss.	.93	1.08	.99	10	--	--	--	30	30	--	40	7	70	--
Sodium pentachlorophenate and sodium chromate; chemical ratio 3.24:1	Canal	.41	.47	.44	10	--	--	--	--	--	20	80	10	100	11.1
	La.	.41	.47	.44	10	--	--	--	--	--	--	100	10	100	15.6
	Fla.	.40	.47	.44	9	--	--	--	44	--	--	56	5	56	20.3[d]
	Miss.	.40	.47	.44	10	--	--	--	--	--	--	100	10	100	23.0
Sodium pentachlorophenate and borax; chemical ratio 1:0.76	Canal	.54	.62	.58	10	--	--	--	--	--	--	100	10	100	12.8
	La.	.54	.62	.58	9	--	--	--	--	11	--	89	9	100	11.4
	Fla.	.53	.62	.57	8	--	--	--	--	--	--	100	8	100	17.9
	Miss.	.54	.61	.58	10	--	--	--	--	20	--	80	10	100	21.0
1:2	Canal	.71	.80	.75	10	--	--	--	--	--	--	100	10	100	12.2
	La.	.71	.81	.75	10	--	--	--	--	10	--	90	10	100	9.9
	Fla.	.72	.82	.76	10	--	--	--	--	--	--	100	10	100	12.9
	Miss.	.71	.80	.75	10	--	--	--	--	--	--	100	10	100	18.8
1:1.52	Canal	.78	.88	.83	10	--	--	--	--	50	--	50	10	100	13.0
	La.	.77	.88	.83	10	--	--	--	--	30	--	70	10	100	10.0
	Fla.	.79	.86	.82	9	--	--	--	--	--	--	100	9	100	16.7
	Miss.	.79	.87	.83	10	--	--	--	--	--	--	100	10	100	18.9
1:3	Canal	.91	1.06	.98	10	--	--	--	--	--	--	100	10	100	11.5
	La.	.90	1.07	.98	10	--	--	--	--	10	--	90	10	100	9.0
	Fla.	.92	1.05	.98	10	--	--	--	--	--	--	100	10	100	13.2
	Miss.	.92	1.06	.98	10	--	--	--	--	10	--	90	10	100	16.1
1:2.27	Canal	1.00	1.19	1.09	10	--	--	--	--	--	--	100	10	100	12.7
	La.	1.01	1.16	1.09	10	--	--	--	--	20	--	80	10	100	9.9
	Fla.	1.01	1.18	1.09	10	--	--	--	--	--	--	100	10	100	15.6
	Miss.	1.01	1.18	1.09	10	--	--	--	--	--	--	100	10	100	18.6
1:1.50	Canal	1.17	1.32	1.25	10	--	--	--	--	10	--	90	10	100	12.8
	La.	1.17	1.32	1.25	10	--	--	--	--	--	--	100	10	100	14.6
	Fla	1.17	1.32	1.25	10	--	--	--	20	10	--	70	8	80	16.5[d]
	Miss.	1.17	1.33	1.25	10	--	--	--	--	10	10	80	10	100	20.9

Table 5.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with chlorinated phenols and coal-tar creosote, after 15 to 40 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, February 1941; Bogalusa, La., March 1941; Jacksonville, Fla., March 1941; and Harrison Experimental Forest, Saucier, Miss., February 1941--continued

Preservative	Location	Retention of preservative[a]			Number in test[b]	Condition of stakes December 1980[c]									
						Good	Serviceable but showing some--			Destroyed by--			Total removed		Average life
		Minimum	Maximum	Average			Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf				Pct							Number	Pct	Yr
5 pct pentachlorophenol in fuel oil[e]	Canal	4.0	5.4	4.7	10	--	--	--	--	40	--	60	10	100	13.0
	La.	4.0	5.4	4.8	10	--	--	--	--	--	--	100	10	100	16.6
	Fla.	4.0	5.6	4.8	10	--	--	--	40	--	--	60	6	60	20.0[d]
	Miss.	4.2	5.4	4.7	10	--	--	--	--	--	--	100	10	100	21.0
	Canal	8.6	10.5	9.6	10	--	--	--	--	30	--	70	10	100	14.4
	La.	8.4	10.9	9.6	7	--	--	--	57	--	--	43	3	43	23.0[d]
	Fla.	8.8	10.5	9.6	9	--	--	--	67	--	--	33	3	33	24.0[d]
	Miss.	8.6	10.5	9.6	10	--	--	--	--	10	--	90	10	100	27.2
	Canal	14.0	16.5	15.3	10	--	--	--	40	10	--	50	6	60	15.0[d]
	La.	14.2	16.3	15.3	7	--	--	--	100	--	--	--	--	--	--
	Fla.	14.2	16.3	15.3	10	--	--	--	100	--	--	--	--	--	--
	Miss.	14.0	16.3	15.3	10	--	--	--	70	20	--	10	3	30	--
	Canal	18.6	21.5	20.1	10	--	--	--	100	--	--	--	--	--	--
	La.	18.2	21.7	20.1	7	--	--	--	100	--	--	--	--	--	--
	Fla.	18.2	21.7	20.1	9	--	22	--	78	--	--	--	--	--	--
	Miss.	18.2	21.9	20.0	10	--	--	--	90	--	--	10	1	10	--
3 pct pentachlorophenol + 2 pct chloro-2-phenylphenol in fuel oil[e]	Canal	4.2	5.8	4.9	10	--	--	--	--	20	--	80	10	100	12.6
	La.	4.4	5.8	4.9	10	--	--	--	--	--	--	100	10	100	14.2
	Fla.	4.4	5.8	4.9	9	--	--	--	22	--	--	78	7	78	20.0[d]
	Miss.	4.2	5.8	4.9	10	--	--	--	--	--	--	100	10	100	19.2
	Canal	9.1	10.9	10.0	10	--	--	--	--	50	--	50	10	100	13.7
	La.	9.1	10.9	10.0	6	--	--	--	67	--	--	33	2	33	24.7[d]
	Fla.	8.9	11.0	10.0	8	--	--	--	75	--	--	25	2	25	25.3[d]
	Miss.	8.9	11.0	10.0	10	--	--	--	--	10	--	90	10	100	24.4
	Canal	14.2	16.3	15.4	10	--	--	--	10	10	--	80	9	90	12.0[d]
	La.	13.8	16.3	15.3	6	--	--	--	100	--	--	--	--	--	--
	Fla.	13.8	16.3	15.3	9	--	--	--	100	--	--	--	--	--	--
	Miss.	14.4	16.1	15.3	10	--	--	--	30	30	--	40	7	70	--
Coal-tar creosote, grade 1	Canal	3.5	6.7	4.7	10	--	--	--	10	90	--	--	9	90	12.0[d]
	La.	3.3	6.7	4.7	6	--	--	--	33	--	--	67	4	67	22.0[d]
	Fla.	3.3	6.5	4.7	9	--	--	--	33	33	--	34	6	67	19.0[d]
	Miss.	3.5	6.5	4.6	10	--	--	--	--	40	--	60	10	100	21.3
	Canal	8.4	11.6	10.0	10	--	60	--	20	10	--	10	2	20	20.0[d]
	La.	8.6	11.2	10.0	4	--	--	--	75	--	--	25	1	25	26.6[d]
	Fla.	8.6	11.4	10.0	10	--	--	--	90	10	--	--	1	10	--
	Miss.	8.4	11.4	10.0	10	--	--	--	30	40	--	30	7	70	--
	Canal	13.5	15.4	14.4	10	10	90	--	--	--	--	--	--	--	--
	La.	13.5	15.9	14.5	6	50	16	17	17	--	--	--	--	--	--
	Fla.	13.5	15.9	14.5	9	22	56	--	22	--	--	--	--	--	--
	Miss.	13.3	16.1	14.5	10	10	--	--	90	--	--	--	--	--	--
Fuel oil[e]	Canal	8.2	11.9	9.9	10	--	--	--	--	--	60	60	10	100	5.9
	La.	8.4	11.7	9.8	10	--	--	--	--	40	--	60	10	100	8.4
	Fla.	8.2	11.7	9.8	8	--	--	--	--	12	--	88	8	100	9.7
	Miss.	8.2	11.7	9.8	10	--	--	--	--	20	10	70	10	100	6.3
	Canal	18.2	21.0	19.4	10	--	--	--	--	--	30	70	10	100	7.8
	La.	18.2	21.4	19.4	10	--	--	--	--	50	--	50	10	100	11.9
	Fla.	18.2	21.4	19.4	9	--	--	--	--	--	--	100	9	100	12.4
	Miss.	18.0	21.9	19.4	10	--	--	--	--	30	10	60	10	100	9.1

(Page 2 of 3)

Table 5.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with chlorinated phenols and coal-tar creosote, after 15 to 40 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, February 1941; Bogalusa, La., March 1941; Jacksonville, Fla., March 1941; and Harrison Experimental Forest, Saucier, Miss., February 1941--continued

Preservative	Location	Retention of preservative[a]			Number in test[b]	Condition of stakes December 1980[c]							Total removed		Average life
						Good	Serviceable but showing some--			Destroyed by--					
							Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Minimum	Maximum	Average									Number	Pct	Yr
		Pcf				Pct									
5 pct pentachlorophenol in fuel oil[e] and naphtha: 3-minute dip	Canal	0.5	1.4	0.8	10	--	--	--	--	--	90	10	10	100	2.7
	La.	.5	1.2	.8	10	--	--	--	--	30	--	70	10	100	4.2
	Fla.	.5	1.2	.8	8	--	--	--	--	12	--	88	8	100	5.0
	Miss.	.5	1.2	.8	10	--	--	--	--	10	20	70	10	100	3.2
18-hour soaking	Canal	2.1	2.6	2.4	10	--	--	--	--	--	--	100	10	100	9.1
	La.	2.1	2.8	2.4	9	--	--	--	--	33	--	67	9	100	8.4
	Fla.	2.1	3.0	2.4	10	--	--	--	--	--	--	100	10	100	11.9
	Miss.	1.9	3.0	2.4	10	--	--	--	--	--	--	100	10	100	12.9
5 pct pentachlorophenol in soybean oil, naphtha and fuel oil:[e,f] 3-minute dip	Canal	.7	1.2	.9	10	--	--	--	--	--	100	--	10	100	3.3
	La.	.5	1.2	.9	10	--	--	--	--	50	--	50	10	100	4.0
	Fla.	.5	1.6	.9	7	--	--	--	--	--	14	86	7	100	5.4
	Miss.	.7	1.2	.9	10	--	--	--	--	--	60	40	10	100	4.9
18-hour soaking	Canal	2.3	3.7	2.8	10	--	--	--	--	--	--	100	10	100	10.4
	La.	2.1	3.9	2.8	10	--	--	--	--	30	--	70	10	100	7.6
	Fla.	2.3	3.2	2.7	10	--	--	--	--	--	--	100	10	100	12.2
	Miss.	2.3	3.5	2.8	10	--	--	--	--	--	--	100	10	100	16.3
18-hour soaking[g]	Canal	1.1	3.0	2.3	10	--	--	--	--	--	30	70	10	100	7.0
	La.	1.8	2.6	2.3	10	--	--	--	--	20	--	80	10	100	6.3
	Fla.	1.8	2.8	2.3	8	--	--	--	--	12	--	88	8	100	9.8
	Miss.	1.1	2.8	2.2	10	--	--	--	--	10	10	80	10	100	11.9
3 pct pentachlorophenol + 2 pct chloro-2-phenylphenol in naphtha and fuel oil:[e] 3-minute dip	Canal	.9	1.6	1.2	10	--	--	--	--	--	100	--	10	100	2.3
	La.	.9	1.6	1.2	10	--	--	--	--	40	--	60	10	100	4.1
	Fla.	.7	1.6	1.2	10	--	--	--	--	10	10	80	10	100	5.0
	Miss.	.5	1.8	1.2	10	--	--	--	--	20	20	60	10	100	5.1
18-hour soaking	Canal	2.5	4.0	3.1	10	--	--	--	--	--	10	90	10	100	9.0
	La.	2.5	4.0	3.1	10	--	--	--	--	10	--	90	10	100	7.2
	Fla.	2.3	3.9	3.1	8	--	--	--	--	12	--	88	8	100	10.8
	Miss.	2.6	4.4	3.1	10	--	--	--	--	--	--	100	10	100	14.8
3 pct pentachlorophenol + 2 pct chloro-2-phenylphenol in solvent of 80 pct mineral spirits and 20 pct moisture repellent: 3-minute dip	Canal	.5	.9	.8	10	--	--	--	--	--	90	10	10	100	1.6
	La.	.5	.9	.7	10	--	--	--	--	30	--	70	10	100	1.9
	Fla.	.5	.9	.8	10	--	--	--	--	20	10	70	10	100	2.5
	Miss.	.5	.9	.8	10	--	--	--	--	20	30	50	10	100	3.6
18-hour soaking	Canal	2.1	5.8	3.4	10	--	--	--	--	--	90	10	10	100	4.8
	La.	2.3	4.6	3.4	10	--	--	--	--	--	--	100	10	100	9.2
	Fla.	2.3	4.9	3.4	10	--	--	--	--	20	--	80	10	100	9.6
	Miss.	2.3	5.1	3.4	10	--	--	--	--	20	10	70	10	100	12.7
Untreated controls	Canal	--	--	--	10	--	--	--	--	--	100	--	10	100	1.2
	La.	--	--	--	10	--	--	--	--	50	20	30	10	100	2.2
	Fla.	--	--	--	10	--	--	--	--	10	20	70	10	100	1.8
	Miss.	--	--	--	10	--	--	--	--	40	30	30	10	100	2.3

[a] Based upon weight of dry chemical for sodium pentachlorophenate alone or mixed with other chemicals and on weight of solution for other treatments. Values for stakes originally installed.

[b] 10 stakes were originally installed in test. This number has since been reduced either because of failure to locate the stakes at the time of the inspection or because of damage by fire.

[c] Final inspection at Canal Zone, January 1956; at Jacksonville, December 1960; and at Bogalusa, December 1962.

[d] Estimate based upon percentage stakes remaining after final inspection.

[e] Purchased and reported earlier as No. 2 fuel oil but has since been found to have a distillation range lower than that for typical No. 2 fuel oils.

[f] Solvent contained 1 part soybean oil and 9 parts each of fuel oil and naphtha by volume.

[g] Specimens contained some heartwood.

Table 6.--Condition of southern pine stakes of different sizes, treated with coal-tar creosote, toluene, and creosote-toluene mixtures, after 39-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest Saucier, Miss., May 1941

Preservative	Size of stakes	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	In.	Pcf		Pct							Number	Pct	Yr
Coal-tar creosote	1/2 by 1/2 by 18	7.8	8	--	--	--	--	88	--	12	8	100	17.1
	1 by 1 by 18	8.0	10	--	--	--	--	40	--	60	10	100	23.5
	1-1/2 by 1-1/2 by 18	7.9	10	--	--	--	--	60	--	40	10	100	26.6
	2 by 4 (nominal) by 18	3.3	10	--	--	--	--	10	--	90	10	100	24.9
	2 by 4 (nominal) by 18	7.8	10	--	--	--	40	20	--	40	6	60	--
	2 by 4 (nominal) by 18	13.2	10	--	--	--	80	10	--	10	2	20	--
Toluene	2 by 4 (nominal) by 18	29.5	10	--	--	--	--	--	100	--	10	100	2.1
Coal-tar creosote: 11.25 pct by weight in toluene	2 by 4 (nominal) by 18	3.4[a]	10	--	--	--	--	30	--	70	10	100	19.1
25.2 pct by weight in toluene	2 by 4 (nominal) by 18	8.1[a]	10	--	--	--	80	10	--	10	2	20	--
39.0 pct by weight in toluene	2 by 4 (nominal) by 18	12.6[a]	10	10	--	--	90	--	--	--	--	--	--

[a] Creosote only.

Table 7.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper naphthenate and zinc naphthenate, after about 39 years of service. Stakes placed in test at Madison, Wis., October 1941, and on Harrison Experimental Forest, Saucier, Miss.. February 1942

Preservative	Treatment	Location	Average retention of solution	Number in test	Condition of stakes December 1980							Total removed		Average life
					Good	Serviceable but showing some--			Destroyed by--					
						Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
			Pcf		Pct							Number	Pct	Yr
Zinc naphthenate solution 17 pct (2 pct zinc metal)	Brush, one coat	Miss.	0.6	10	--	--	--	--	--	20	80	10	100	2.9
		Wis.	.5	10	--	--	--	--	100	--	--	10	100	6.4
	Dipped, 3 min	Miss.	1.0	10	--	--	--	--	--	40	60	10	100	2.2
		Wis.	.9[a]	10	--	--	--	--	100	--	--	10	100	7.7
1 pct (0.12 pct zinc metal)	Pressure	Miss.	9.9	10	--	--	--	--	50	--	50	10	100	11.2
		Wis.	9.7	10	--	--	--	--	100	--	--	10	100	18 9
2.5 pct (0.29 pct zinc metal)	Pressure	Miss.	10.3	10	--	--	--	--	50	--	50	10	100	15.0
		Wis.	9.8	10	--	--	--	--	100	--	--	10	100	21.9
5.0 pct (0.59 pct zinc metal)	Pressure	Miss.	10.2	10	--	--	--	--	60	--	40	10	100	13.5
		Wis.	10.3	10	--	--	--	--	100	--	--	10	100	22.6
7.5 pct (0.88 pct zinc metal)	Pressure	Miss.	10.4	10[b]	--	--	--	--	60	--	40	10	100	19.7
		Wis.	10.0	9[b]	--	22	--	--	78	--	--	7	78	--
Copper naphthenate solution 17.5 pct (2 pct copper metal)	Brush, one coat	Miss.	.5	10	--	--	--	--	20	40	40	10	100	3.7
		Wis.	.5	10	--	--	--	--	100	--	--	10	100	8.6
	Dipped, 3 min	Miss.	.7	10	--	--	--	--	--	40	60	10	100	5.2
		Wis.	.8	10	--	--	--	--	100	--	--	10	100	9.8
1 pct (0.11 pct copper metal)	Pressure	Miss.	10.3	10[b]	--	--	--	--	80	--	20	10	100	15.9
		Wis.	10.3	8[b]	--	--	--	--	100	--	--	8	100	25.5
2.5 pct (0.29 pct copper metal)	Pressure	Miss.	10.2	10[b]	--	--	--	--	40	--	60	10	100	21.8
		Wis.	9.6	7[b]	--	57	--	--	43	--	--	3	43	--
5.0 pct (0.57 pct copper metal)	Pressure	Miss.	10.6	10[b]	--	--	--	--	90	--	10	10	100	27.2
		Wis.	10.6	8[b]	--	38	--	--	62	--	--	5	62	--
7.5 pct (0.86 pct copper metal)	Pressure	Miss.	9.6	10[b]	--	--	--	30	60	--	10	7	70	--
		Wis.	9.8	8[b]	--	88	--	--	12	--	--	1	12	--
Untreated controls	--	Miss.	--	10	--	--	--	--	--	30	70	10	100	1.8
		Wis.	--	10	--	--	--	--	100	--	--	10	100	4.9

[a] Average retention based on 9 stakes.

[b] 10 stakes were originally installed. This number has been reduced for causes other than decay or insect attack.

Table 8.--Condition of treated five-ply exterior Douglas-fir plywood stakes (approximately 1/2 x 4 x 18 in.) at final inspection after approximately 22 years of exposure. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., in February 1942

Preservative	Treatment	Retention of preservative (average)	Number in test[a]	Condition of stakes December 1963									
				Good	Serviceable but showing some--			Destroyed by--			Total removed		Average life
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Coal-tar creosote	Brush, one coat	Oil 1.5	30	--	--	--	--	27	27	46	30	100	6.2
	Dipped, 3 min	Oil 1.9	30	--	--	--	--	17	20	63	30	100	9.5
	Soaked, 18 hr	Oil 5.6	30	--	6	--	47	27	--	20	14	47	24.0[b]
	Pressure	Oil 5.9	30	--	--	--	70	17	--	13	9	30	27.0[b]
	Pressure	Oil 12.3	29	27	38	7	28	--	--	--	--	--	--
Pentachlorophenol solution[c]													
5 pct	Brush, one coat	Solution 1.0	30	--	--	--	--	10	60	30	30[d]	100	2.8
	Dipped, 3 min	Solution 1.3	30	--	--	--	--	13	60	27	30	100	3.3
	Soaked, 18 hr	Solution 3.2	30	--	--	--	--	3	37	60	30	100	5.0
1.11 pct	Pressure	Solution 26.3	30	--	--	--	--	20	--	80	30[e]	100	11.1
2.25 pct	Pressure	Solution 26.3	30	--	--	--	23	10	7	60	23	77	19.0[b]
Zinc naphthenate solution[f]													
4.8 pct (0.55 pct zinc)	Brush, one coat	Solution .7	30	--	--	--	--	10	30	60	30	100	2.1
	Dipped, 3 min	Solution 1.1	30	--	--	--	--	10	57	33	30	100	2.0
	Soaked, 18 hr	Solution 3.0	30	--	--	--	--	14	43	43	30	100	2.9
1.11 pct (0.13 pct zinc)	Pressure	Solution 25.5	30	--	--	--	--	13	20	67	30	100	5.3
2.25 pct (0.25 pct zinc)	Pressure	Solution 25.6	30	--	--	--	--	13	7	80	30	100	10.7
Chloro-2-phenylphenol solution[f]													
5 pct	Brush, one coat	Solution .9	30	--	--	--	--	10	50	40	30	100	2.2
	Dipped, 3 min	Solution 1.1	30	--	--	--	--	20	50	30	30	100	2.4
	Soaked, 18 hr	Solution 2.9	30	--	--	--	--	13	60	27	30	100	2.5
Untreated controls	--	--	30	--	--	--	--	20	43	37	30[e]	100	1.8

[a] Of the 30 panels tested for each treatment there were 3 sets of 10 specimens. Each set was selected from material contributed by a different manufacturer.

[b] Estimate based on condition of stakes at final inspection.

[c] Solvent contained 1 part pine oil and 12 parts Stoddard-type solvent by volume.

[d] 2 stakes showed some delamination.

[e] 1 stake showed some delamination.

[f] Stoddard-type solvent used.

NOTE: The stakes remaining in test after the 1950 inspection were taken up and reset in the same general area.

Table 9.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper arsenate and copper chromate by the double-diffusion process, after about 39 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., February 1942

Treatment	Calculated retention of chemical[a,b]				Number in test	Condition of stakes December 1980						Total removed		Average life
							Serviceable but showing some--		Destroyed by--					
	Copper as $CuSO_4$	Chromium as Na_2CrO_4	Arsenic as Na_2HAsO_4	Total		Good	Decay	Termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf					Pct						Number	Pct	Yr
6-day soak in 10.6 pct copper sulfate solution plus:														
6-day soak in 9.8 pct sodium arsenate solution	0.66 (0.33)	--	0.59 (0.36)	1.25 (0.69)	10	100	--	--	--	--	--	--	--	--
12-day soak in 9.8 pct sodium arsenate solution	.66 (.33)	--	.75 (.46)	1.41 (.79)	10	100	--	--	--	--	--	--	--	--
12-day soak in 11.8 pct sodium chromate solution	.66 (.33)	2.58 (1.59)	--	3.24 (1.92)	10	100	--	--	--	--	--	--	--	--
3-day soak in 10.6 pct copper sulfate solution plus:														
6-day soak in 9.8 pct sodium arsenate solution	.88 (.44)	--	.55 (.34)	1.43 (.78)	10	100	--	--	--	--	--	--	--	--
6-day soak in 11.8 pct sodium chromate solution	.88 (.44)	1.57 (.97)	--	2.45 (1.41)	10	90	--	--	--	10	--	1	10	--
3-day soak in 5.3 pct copper sulfate solution plus:														
6-day soak in 4.9 pct sodium arsenate solution	.31 (.15)	--	.17 (.10)	.48 (.25)	10	100	--	--	--	--	--	--	--	--
6-day soak in 5.9 pct sodium chromate solution	.31 (.15)	.50 (.31)	--	.81 (.46)	10	50	--	--	30	--	20	5	50	--
Untreated controls	--	--	--	--	10	--	--	--	--	20	80	10	100	1.9

[a] Retentions based on chemical analyses made on 2 stakes treated in each charge with those placed in test.

[b] Retention values in parentheses are oxides (CuO - CrO_3 - As_2O_5).

Table 10.--Condition of urea-treated southern pine stakes (2 x 4 in. nominal x 18 in.) after about 11 to 16-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., February 1942 and December 1946, and at Madison, Wis., April 1942

Treatment	Location	Total retention of urea or solids[a]	Average retention of urea or solids[a]	Number in test	Condition of stakes late in 1958					Total removed		Average life
					Good	Serviceable but showing some decay	Destroyed by-- Decay fungi	Termite attack	Decay fungi and termite attack			
		Lb	Pcf		- - - - - - - - - - Pct - - - - - - - - - -					Number	Pct	Yr
INSTALLED 1942												
2 days' soaking[b]	Miss.	4.7	3.4	10	--	--	--	10	90	10	100	3.4
	Wis.	4.7	3.4	10	--	--	100	--	--	10	100	8.1
4 days' soaking[b]	Miss.	6.9	5.0	10	--	--	--	20	80	10	100	3.3
	Wis.	6.9	5.0	10	--	--	100	--	--	10	100	8.0
6 days' soaking[b]	Miss.	10.2	7.4	10	--	--	--	20	80	10	100	2.9
	Wis.	10.2	7.4	10	--	--	100	--	--	10	100	6.0
B_1[c] (thermosetting) 2 days' soaking	Miss.	9.9	7.1	10	--	--	--	20	80	10	100	4.5
	Wis.	9.9	7.1	10	--	--	100	--	--	10	100	12.5
B_1[c] (thermosetting) 4 days' soaking	Miss.	11.2	8.1	10	--	--	--	--	100	10	100	5.1
	Wis.	11.2	8.1	10	--	--	100	--	--	10	100	13.1
B_1[c] (thermosetting) 6 days' soaking	Miss.	11.7	8.4	10	--	--	--	10	90	10	100	5.6
	Wis.	11.7	8.4	10	--	--	100	--	--	10	100	15.2
Untreated controls	Miss.	--	--	10	--	--	--	20	80	10	100	1.8
	Wis.	--	--	10	--	--	100	--	--	10	100	4.8
INSTALLED 1946												
Urea resin, pressure[d]	Miss.	--	5.8	10	--	--	10	--	90	10	100	9.1

[a] Calculated total retention of urea or solids for 22 stakes.

[b] Treating solution made up to 1.15 parts of urea to 1.00 part of water by weight.

[c] Solution made up of 380 parts urea, 344 parts of 37 pct formaldehyde solution, 231 parts of water, 6 parts of sodium hydroxide, and 39 parts of borax by weight.

[d] Treated with buffered urea-formalin mix (2 to 1 formaldehyde-urea ratio) at a resin solids content of 30 pct.

Table 11.--Condition of high-strength laminated paper plastic (papreg) stakes (1/8 x 4 x 14 in.) and heat-stabilized plywood (staypak) stakes (4 x 18 in.) of several thicknesses after 7 to 8 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss.

Stake number	Composition	Number in test	Condition of stakes December 1950						Average life
			Destroyed by--						
			Decay fungi		Termite attack		Decay fungi and termite attack		
			Number	Pct	Number	Pct	Number	Pct	Yr
	LAMINATED PAPER PLASTIC (PAPREG)--INSTALLED DECEMBER 2, 1942								
1 to 10	37.0 pct phenolic resin[a] + 2 pct hardener, 4.7 pct volatile matter	10	7	70	--	--	3	30	7.4
11 to 20	31.6 pct phenolic resin[a] + 2 pct hardener, 4.4 pct volatile matter	10	3	30	1	10	6	60	5.6
21 to 30	41.0 pct phenolic resin[a] + 2 pct hardener, 4.6 pct volatile matter	10	7	70	--	--	3	30	8.0
31 to 40	37.0 pct phenolic resin[a] + 2 pct hardener, 4.7 pct volatile matter with surface sheets using 42.6 pct phenolic resin,[a] 4.6 pct volatile matter[b]	10	7	70	--	--	3	30	7.2
41 to 50	37.0 pct phenolic resin[a] + 0.5 pct oleic acid, 4.7 pct volatile matter	10	4	40	1	10	5	50	7.6
	HEAT-STABILIZED PLYWOOD (STAYPAK)--INSTALLED JUNE 4, 1943								
19-1 and 19-2	20 plies 1/16-in. birch bonded with phenolic resin and compressed to thickness of 1/2 in.; specific gravity 1.37	2	--	--	1	50	1	50	4.5
	HEAT-STABILIZED PLYWOOD (STAYPAK)--INSTALLED DECEMBER 6, 1943								
S-1 to S-5	32 plies 1/16-in. birch bonded with phenolic resin and compressed to thickness of 1 in. specific gravity 1.33	5	2	40	--	--	3[c]	60	6.0
21-1 to 21-5	10 plies 1/8-in. maple bonded with phenolic resin and compressed to thickness of 5/8 in.; specific gravity 1.36	5	--	--	--	--	5	100	4.3

[a] Alcohol-soluble.

[b] Single surface sheet on each side, coated side out.

[c] Heavy swelling at edges due to moisture absorption.

Table 12.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with phenyl mercury oleate, pentachlorophenol, copper naphthenate, and mercuric chloride, at final inspection after 20 years of service. Stakes placed in test *December 1943 on the Harrison Experimental Forest, Saucier, Miss.*

Preservative	Treatment	Average retention of solution	Number in test	Condition of stakes December 1963							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Phenyl mercury oleate (percentage in naphtha solvent)													
0.4	3-min dip	1.40	10	--	--	--	--	--	20	80	10	100	3.8
.4	18-hr soaking	3.20	10	--	--	--	--	10	30	60	10	100	5.0
.4	Pressure	5.90	10	--	--	--	--	--	10	90	10	100	6.7
.4	Pressure	12.10	10	--	--	--	--	30	--	70	10	100	8.8
.2	18-hr soaking	3.10	10	--	--	--	--	10	30	60	10	100	4.4
.2	Pressure	6.00	10	--	--	--	--	--	30	70	10	100	5.6
.2	Pressure	11.80	10	--	--	--	--	--	30	70	10	100	6.2
.1	18-hr soaking	3.60	10	--	--	--	--	--	40	60	10	100	4.5
.1	Pressure	5.90	10	--	--	--	--	--	30	70	10	100	4.7
.1	Pressure	11.60	10	--	--	--	--	--	40	60	10	100	5.2
.4[a]	3-min dip	1.20	10	--	--	--	--	--	60	40	10	100	4.0
.1[a]	18-hr soaking	6.00	10	--	--	--	--	--	20	80	10	100	5.5
.1[a]	Pressure	6.10	10	--	--	--	--	10	40	50	10	100	6.2
.1[a]	Pressure	12.00	10	--	--	--	--	--	10	90	10	100	8.4
Pentachlorophenol (5.0 pct in pine-oil naphtha (1:12) solvent)	Pressure	12.10	10	--	--	--	40	20	--	40	6	60	20.0[b]
Copper naphthenate (0.5 pct copper metal in naphtha solvent)	Pressure	13.10	10	--	--	--	70	20	--	10	3	30	25.0[b]
Mercuric chloride (1.0 pct in water)	3-min dip	.014 (dry salt)	10	--	--	--	--	--	50	50	10	100	4.8
	18-hr soaking	.072 (dry salt)	10	--	--	--	--	--	20	80	10	100	7.5
Untreated controls	--	--	10	--	--	--	--	--	60	40	10	100	2.0

[a] Solution contained 16 pct solids as a water repellent.

[b] Estimate based on percentage stakes remaining after final inspection.

NOTE: The stakes remaining in test after the 1952 inspection were taken up and reset in the same general area.

Table 13.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with fire-retardant chemicals, after 7 years of service. Stakes placed in test December 1943 on the Harrison Experimental Forest, Saucier, Miss., and inspected December 1950

Treating chemicals	Retention of dry salt	Number in test	Condition of stakes December 1950				Average life
			Destroyed by--				
			Termite attack		Decay fungi and termite attack		
	Pcf		Number	Pct	Number	Pct	Yr
Ammonium sulfate, 78 parts; ammonium phosphate, 19 parts; and sodium dichromate, 3 parts (by weight)	3.01	10	5	50	5	50	2.4
	6.17	10	6	60	4	40	3.4
Ammonium phosphate, 10 parts; ammonium sulfate, 60 parts; borax, 10 parts; and boric acid, 20 parts (by weight)	2.98	10	5	50	5	50	3.9
	6.19	10	2	20	8	80	4.3
Borax, 60 parts; and boric acid, 40 parts (by weight)	3.01	10	3	30	7	70	6.0
	6.29	10	6	60	4	40	6.5
Untreated controls	--	10	2	20	8	80	2.2

Table 14.--Condition of southern pine sapwood stakes (2 x 4 in. nominal x 18 in.), treated with various chemicals, and of laminated acetylated yellow birch sapwood stakes (0.4 x 3-1/2 x 15-3/4 in.), after 36 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1944

Preservative[a]	Average retention of preservative or dry salt	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
PINE STAKES												
Ammoniacal copper arsenate (Fed. Spec. TT-W-549) (percentage in solution)												
0.612 (0.59)[b]	0.25 (.24)	10	--	--	--	60	40	--	--	4	40	--
1.29 (1.24)	.53 (.51)	10	80	10	--	10	--	--	--	--	--	--
2.57 (2.48)	1.00 (.97)	10	100	--	--	--	--	--	--	--	--	--
3.21 (3.10)	1.29 (1.25)	10	100	--	--	--	--	--	--	--	--	--
Amyl phenyl acetate (percentage in Stoddard solvent)												
0.37	.10	10	--	--	--	--	--	--	100	10	100	6.7
.93	.25	10	--	--	--	--	--	--	100	10	100	8.5
1.85	.50	10	--	--	--	--	--	40	60	10	100	10.0
Capric acid (percentage in Stoddard solvent)												
0.37	.10	10	--	--	--	--	10	30	60	10	100	5.0
.93	.25	10	--	--	--	--	10	20	70	10	100	5.3
1.84	.50	10	--	--	--	--	--	10	90	10	100	5.5
Diamyl phenol (percentage in Stoddard solvent)												
0.37	.10	10	--	--	--	--	--	10	90	10	100	5.8
.90	.25	10	--	--	--	--	--	10	90	10	100	8.4
1.76	.51	10	--	--	--	--	--	10	90	10	100	11.4
DDT (Dichloro-diphenyl-trichloroethane) (percentage in Stoddard solvent)												
1.25	.35	10	--	--	--	--	100	--	--	10	100	7.1
2.7	.74	10	--	--	--	--	70	--	30	10	100	9.0
Dodecyl amine (percentage in Stoddard solvent)												
0.37	.10	10	--	--	--	--	--	20	80	10	100	5.4
.93	.25	10	--	--	--	--	--	--	100	10	100	5.7
1.85	.50	10	--	--	--	--	--	10	90	10	100	6.8
Nickel stearate (percentage *in coal-tar naphtha)*												
0.33	.10	10	--	--	--	--	10	--	90	10	100	5.6
.93	.27	10	--	--	--	--	30	--	70	10	100	4.9
1.85	.52	10	--	--	--	--	10	10	80	10	100	5.5
Untreated controls	--	10	--	--	--	--	--	40	60	10	100	2.1
YELLOW BIRCH (LAMINATED)[c]												
Acetylated	--	10	--	--	--	--	90	--	10	10	100	17.5
Untreated controls	--	10	--	--	--	--	10	20	70	10	100	2.7

[a] All stakes except laminated yellow birch were pressure treated.

[b] Ammoniacal copper arsenate solution and retention figures in parentheses are oxides (CuO and As_2O_5).

[c] Prepared from 6-ply, parallel-laminated, acetylated 1/16-in. veneer glued with hot-press phenolic resin. Average acetyl content 19.2 pct based upon ovendry weight of wood. Untreated controls prepared from untreated veneer.

NOTE: The stakes remaining in test after the 1952 inspection were reset in the same general area.

Table 15.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with acid copper chromate, chromated copper arsenate type I, and nickel-arsenic-chromium salts, after 35 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1945

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Acid copper chromate (Fed. Spec. TT-W-546)	0.26 (0.13)[a]	10	--	--	--	--	10	30	60	10	100	11.6
	.52 (.26)	10	--	--	--	80	10	--	10	2	20	--
	.75 (.37)	10	20	--	40	--	40	--	--	4	40	--
Chromated copper arsenate type I (Fed. Spec. TT-W-550)	.26 (.15)	10	--	--	--	30	--	10	60	7	70	--
	.50 (.29)	10	30	--	20	50	--	--	--	--	--	--
	.78 (.44)	10	90	--	10	--	--	--	--	--	--	--
Nickel-arsenic-chromium salts (nickel sulfate ($NiSO_4 \cdot 6H_2O$), 5.5 parts; sodium arsenate ($NaHAsO_4 \cdot 12H_2O$), 4.0 parts; arsenic acid (H_3AsO_4), 1.5 parts; and sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$), 3.0 parts)	.26 (.16)	10	--	--	--	--	10	30	60	10	100	17.4
	.50 (.32)	10	--	--	--	80	--	10	10	2	20	--
	.77 (.50)	10	--	--	10	90	--	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	10	30	60	10	100	3.2

[a] Retention values in parentheses based on preservative oxides.

Table 16 --Condition of stakes of Douglas-fir plywood, treated with several wood preservatives, either before or after gluing of the veneer, after 15 years of service. Stakes placed in test December 1945 on the Harrison Experimental Forest, Saucier, Miss

Preservative	Treatment	Plywood[a]		Average retention of preservative[b,c]	Number in test	Condition of stakes December 1960							Total removed		Average life
						Serviceable but showing some--				Destroyed by--					
		Number of plies	Veneer thickness			Good	Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
			In.	Pcf		Pct							Number	Pct	Yr
PLYWOOD FROM VENEER TREATED BEFORE GLUING															
Coal-tar creosote	Pressure	13	1/16	40.9	10	100	--	--	--	--	--	--	--	--	--
	Pressure	7	1/8	30.9	10	90	10	--	--	--	--	--	--	--	--
	Heating and 1-hr cold bath[d]	7	1/8	12.6	10	--	--	--	--	10	20	70	10	100	10.2
	Cold soaking, 24 hr	13	1/16	12.9	10	--	--	--	100	--	--	--	--	--	--
	Cold soaking, 24 hr	7	1/8	8.4	10	--	--	--	100	--	--	--	--	--	--
	Dipping, 10 sec	13	1/16	5.1	9	--	--	--	100	--	--	--	--	--	--
	Dipping, 10 sec	7	1/8	4.6	9	--	--	--	100	--	--	--	--	--	--
Copper naphthenate, (2 pct copper metal in coal-tar naphtha	Pressure	13	1/16	15.5	9	100	--	--	--	--	--	--	--	--	--
	Pressure	7	1/8	10.2	10	50	10	--	40	--	--	--	--	--	--
	Heating and 1-hr cold bath[d]	7	1/8	6.7	10	20	10	--	60	10	--	--	1	10	--
	Cold soaking, 24 hr	13	1/16	10.1	10	70	10	10	10	--	--	--	--	--	--
	Cold soaking, 24 hr	7	1/8	6.2	10	40	10	--	30	20	--	--	2	20	--
	Dipping, 10 sec	13	1/16	4.2	10	--	10	--	90	--	--	--	--	--	--
	Dipping, 10 sec	7	1/8	2.8	10	--	--	--	40	40	--	20	6	60	--
Pentachlorophenol, 5 pct in No. 2 fuel oil	Pressure	13	1/16	21.4	10	--	--	--	100	--	--	--	--	--	--
	Pressure	7	1/8	18.2	10	--	--	--	80	10	--	10	2	20	--
	Heating and 1-hr cold bath[d]	7	1/8	10.3	10	--	--	--	60	--	--	40	4	40	--
	Cold soaking, 24 hr	13	1/16	7.4	10	--	--	--	80	10	--	10	2	20	--
	Cold soaking, 24 hr	7	1/8	4.8	10	--	--	--	10	10	10	70	9	90	--
	Dipping, 10 sec	13	1/16	4.9	10	--	--	--	40	20	--	40	6	60	--
	Dipping, 10 sec	7	1/8	1.0	10	--	--	--	--	10	--	90	10	100	15.8
Chromated zinc chloride	Pressure	13	1/16	1.02[e] (0.62)	7	--	--	--	86	--	--	14	1	14	--
	Pressure	7	1/8	1.06[e] (.65	10	--	--	--	--	--	40	60	10	100	25.8
	Heating and 1-hr cold bath[d]	7	1/8	.98 (.60)	10	--	--	--	--	--	50	50	10	100	10.3
	Steeping, 24 hr	13	1/16[f]	1.07 (.65)	8	--	--	12	88	--	--	--	--	--	--
	Steeping, 24 hr	13	1/16	1.84 (1.12)	8[g]	--	--	--	100	--	--	--	--	--	--
	Steeping, 24 hr	7	1/8[f]	.59 (.36)	10	--	--	--	--	--	10	90	10	100	17.0
	Steeping, 24 hr	7	1/8[f]	1.30 (.79)	10	--	--	--	--	10	20	70	10	100	23.6
	Dipping, 10 sec	13	1/16[f]	.61 (0.37)	10	--	--	--	--	30	10	60	10	100	22.7
	Dipping, 10 sec	13	1/16	.66 (.40)	10	--	--	--	--	10	--	90	10	100	22.1
	Dipping, 10 sec	7	1/8	.35 (.21)	10	--	--	--	--	--	20	80	10	100	10.8
Acid copper chromate	Pressure	13	1/16	.76 (.38)	9[g]	22	--	45	33	--	--	--	--	--	--
	Pressure	7	1/8	.79 (.39)	9	22	--	45	11	22	--	--	2	22	--
	Heating and 1-hr cold bath[d]	7	1/8	1.07 (.53)	10	20	--	--	50	20	--	10	3	30	--
	Steeping, 24 hr	13	1/16[f]	.88 (.44)	10	100	--	--	--	--	--	--	--	--	--
	Steeping, 24 hr	13	1/6	1.89 (.94)	10	80	10	10	--	--	--	--	--	--	--
	Steeping, 24 hr	7	1/8	.54 (.27)	9	56	--	22	11	11	--	--	1	11	--
	Steeping, 24 hr	7	1/8	1.32 (.65)	10	90	--	10	--	--	--	--	--	--	--
	Dipping, 10 sec	13	1/16	.87 (.43)	10	--	--	--	70	30	--	--	3	30	--
	Dipping, 10 sec	13	1/16	.61 (.30)	10	--	--	--	70	30	--	--	3	30	--
	Dipping, 10 sec	7	1/8	.27 (.11)	10	--	--	--	--	20	--	80	10	100	18.4
	Dipping, 10 sec	7	1/8	.38 (.19)	10	--	--	--	--	30	10	60	10	100	22.2
PLYWOOD TREATED AFTER GLUING															
Coal-tar creosote	Pressure	5	1/8	19.6	10	100	--	--	--	--	--	--	--	--	--
	Hot bath, 1 hr, and cold bath, 1 hr	5	1/8	2.0	10	--	--	--	100	--	--	--	--	--	--
	Cold soaking, 24 hr	5	1/8	5.3	10	--	--	--	--	20	30	50	10	100	11.3
	Dipping, 10 sec	5	1/8	1.0[e]	8[g]	--	--	--	--	--	50	50	8	100	5.4
Copper naphthenate, (2 pct copper metal) in coal-tar naphtha	Pressure	5	1/8	2.9	10	--	--	--	20	40	10	30	8	80	--
	Hot bath, 1 hr, and cold bath, 1 hr	5	1/8	1.2	10	--	--	--	--	60	--	40	10	100	12.8
	Cold soaking, 24 hr	5	1/8	1.1	10	--	--	--	--	50	--	50	10	100	13.8
	Dipping, 10 sec	5	1/8	.4	10	--	--	--	--	60	--	40	10	100	10.5
Pentachlorophenol, 5 pct in No. 2 fuel oil	Pressure	5	1/8	12.5	10	--	--	--	40	20	--	40	6	60	--
	Hot bath, 1 hr, and cold bath, 1 hr	5	1/8	2.1	10	--	--	--	--	--	40	60	10	100	8.3
	Cold soaking, 24 hr	5	1/8	2.0	10	--	--	--	--	20	10	70	10	100	8.3
	Dipping, 10 sec	5	1/8	.7	10	--	--	--	--	10	20	70	10	100	7.8
Chromated zinc chloride	Pressure	5	1/8	.62[e] (.38)	10	--	--	--	--	40	--	60	10	100	17.9
	Steeping, 24 hr	5	1/8	.35 (.21)	10	--	--	--	--	10	30	60	10	100	8.2
	Dipping, 10 sec	5	1/8	.03 (.02)	10	--	--	--	--	--	40	60	10	100	4.0
Acid copper chromate	Pressure	5	1/8	.46 (.23)	10	10	--	--	40	20	--	30	5	50	--
	Steeping, 24 hr	5	1/8	.28 (.14)	10	--	--	--	--	10	40	50	10	100	5.3
	Dipping, 10 sec	5	1/8	.06 (.03)	10	--	--	--	--	10	60	30	10	100	8.2
None	Untreated	13	1/16	--	10	--	--	--	--	--	50	50	10	100	3.7
	Untreated	7	1/8	--	10	--	--	--	--	--	50	50	10	100	3.6

[a] Plywood glued with hot-press phenolic-resin adhesive.

[b] Oils or dry salt absorbed by 21- x 28-in. plywood panel. Stakes were cut from plywood panels after treatment, and all edges exposed during cutting were dipped in the preservative before installation of the stakes.

[c] Retention values in parentheses based on preservative oxides.

[d] Veneer heated in dryer and then submerged for 1 hr in unheated preservative.

[e] Approximate values.

[f] Veneer treated prior to drying.

[g] 2 specimens delaminated and were eliminated from test.

Table 17.--Condition of southern pine stakes (2 x 4 nominal x 18 in.), treated with various petroleum oils, pentachlorophenol solution, copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives, after about 32-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., and at Bogalusa, La., April 1948

Oil or preservative	Location	Average retention	Number in test[a]	Condition of stakes December 1980[b]							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Unfortified petroleum oil:													
Commercial aromatic solvent (Mid-United States)	Miss.	4.1	10	--	--	--	--	10	--	90	10	100	2.4
	La.	4.1	10	--	--	--	--	--	20	80	10	100	2.9
Stoddard solvent (Mid-United States)	Miss.	4.0	10	--	--	--	--	10	20	70	10	100	2.2
	La.	4.0	10	--	--	--	--	10	20	70	10	100	2.8
No. 2 fuel oil (Mid-United States)	Miss.	4.1	10	--	--	--	--	10	10	80	10	100	4.4
	La.	4.0	10	--	--	--	--	70	--	30	10	100	4.1
Heavy thermal side cut (Mid-United States)	Miss.	4.2	10	--	--	--	--	--	10	90	10	100	3.5
	La.	4.2	10	--	--	--	--	30	--	70	10	100	4.6
No. 200 Diesel oil (West Coast)	Miss.	4.0	10	--	--	--	--	20	20	60	10	100	4.8
	La.	4.0	10	--	--	--	--	80	--	20	10	100	4.6
Catalytic gas-base oil (West Coast)	Miss.	4.0	10	--	--	--	--	40	--	60	10	100	7.6
	La.	4.0	10	--	--	--	--	60	--	40	10	100	7.7
	Miss.	8.0	10	--	--	--	--	30	--	70	10	100	14.6
	La.	8.0	10	--	10	--	50	20	--	20	4	40	--
	Miss.	12.0	10	--	--	--	--	40	--	60	10	100	17.1
	La.	11.9	8	--	25	--	63	12	--	--	1	12	--
No. 300 fuel oil (West Coast)	Miss.	4.2	10	--	--	--	--	90	--	10	10	100	7.1
	La.	4.2	10	--	--	--	20	80	--	--	8	80	6.5[c]
No. 400 fuel oil (West Coast)	Miss.	4.2	10	--	--	--	--	80	--	20	10	100	5.8
	La.	4.2	10	--	--	--	--	90	--	10	10	100	5.5
Light gas oil (Mid-United States)	Miss.	4.1	10	--	--	--	--	50	--	50	10	100	6.7
	La.	4.1	10	--	--	--	--	60	--	40	10	100	6.0
Denver No. 3 blend (50-50 topped crude residual and recycled overhead gas oil)	Miss.	4.0	10	--	--	--	--	60	--	40	10	100	6.5
	La.	4.0	10	--	--	--	--	80	--	20	10	100	5.9
Heavy gas oil (Mid-United States)	Miss.	4.0	10	--	--	--	--	100	--	--	10	100	12.9
	La.	4.0	10	--	--	--	60	40	--	--	4	40	--
	Miss.	7.9	10	--	--	--	30	70	--	--	7	70	--
	La.	7.9	9	--	33	--	67	--	--	--	--	--	--
	Miss.	12.1	10	--	--	--	90	10	--	--	1	10	--
	La.	12.1	5	60	40	--	--	--	--	--	--	--	--
Lube oil extract (Texas)	Miss.	4.1	10	--	--	--	--	100	--	--	10	100	12.0
	La.	4.2	8	--	--	--	63	25	--	12	3	37	--
Fortified petroleum oils and mixtures:													
Commercial aromatic solvent (Mid-United States with 5 pct pentachlorophenol	Miss.	4.2	10	--	--	--	--	--	--	100	10	100	10.9
	La.	4.2	10	--	--	--	--	10	--	90	10	100	8.5
Stoddard solvent (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	10	--	90	10	100	13.7
	La.	4.0	10	--	--	--	--	20	--	80	10	100	8.8
No. 2 fuel oil (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	10	10	80	10	100	14.9
	La.	3.8	10	--	--	--	20	--	--	80	8	80	12.5[c]
Heavy thermal side cut (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	20	--	80	10	100	14.0
	La.	4.0	10	--	--	--	--	10	--	90	10	100	10.6
No. 200 Diesel oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.1	10	--	--	--	--	10	--	90	10	100	17.0
	La.	4.1	10	--	--	--	50	--	--	50	5	50	--
Catalytic gas-base oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.1	10	--	--	--	--	--	--	100	10	100	16.3
	La.	4.1	8	--	--	--	88	12	--	--	1	12	--
	Miss.	8.0	10	--	--	--	--	10	--	90	10	100	21.3
	La.	7.9	8	--	12	--	88	--	--	--	--	--	--
	Miss.	12.0	10	--	--	--	20	20	--	60	8	80	--
	La.	12.0	9	--	56	--	44	--	--	--	--	--	--

(Page 1 of 2)

Table 17.--Condition of southern *pine* stakes (2 x 4 nominal x 18 in.), treated with various petroleum oils, pentachlorophenol solution, copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives, after about 32-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., and at Bogalusa, La., April 1948--continued

Oil or preservative	Location	Average retention	Number in test[a]	Condition of stakes December 1980[b]							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Fortified petroleum oils and mixtures:--*continued*													
No. 300 fuel oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	80	--	20	10	100	14.6
	La.	4.1	8	--	12	--	51	12	--	25	3	37	--
No. 400 fuel oil (West Coast) with 5 pct pentachlorophenol	Miss.	4.2	10	--	--	--	--	40	--	60	10	100	13.9
	La.	4.2	9	--	--	--	22	22	--	56	7	78	12.5[c]
Light gas oil (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	--	--	100	10	100	15.6
	La.	4.2	10	--	--	--	50	--	--	50	5	50	--
Denver No. 3 blend (50-50 topped crude residual and recycled overhead gas oil) with 5 pct pentachlorophenol	Miss.	4.0	10	--	--	--	--	70	--	30	10	100	19.5
	La.	4.0	7	--	--	--	86	14	--	20	9	14	--
Heavy gas oil (Mid-United States) with 5 pct pentachlorophenol	Miss.	4.1	9	--	--	--	67	--	--	33	3	33	--
	La.	4.1	8	--	12	--	88	--	--	--	--	--	--
	Miss.	7.9	10	--	--	--	90	10	--	--	1	10	--
	La.	7.9	6	--	33	--	67	--	--	--	--	--	--
	Miss.	12.0	10	--	10	--	80	10	--	--	1	10	--
	La.	12.0	5	60	--	--	40	--	--	--	--	--	--
Lube oil extract (Texas) with 5 pct pentachlorophenol	Miss.	4.2	10	--	--	--	30	60	--	10	7	70	--
	La.	4.2	8	--	--	--	100	--	--	--	--	--	--
Catalytic gas-base oil (West Coast) with copper naphthenate (0.5 pct copper *metal*)	Miss.	4.2	10	--	--	--	--	70	10	20	10	100	14.3
	La.	4.2	10	--	10	--	60	10	--	20	3	30	--
Catalytic gas-base oil (West Coast) with copper naphthenate (0.75 pct copper metal)	Miss	4.4	8	--	--	--	--	75	--	25	8	100	17.4
	La.	4.2	8	13	13	--	62	12	--	--	1	12	--
Coal-tar creosote	Miss.	4.1	10	--	--	--	--	70	--	30	10	100	14.2
	La.	4.1	10	--	--	--	50	40	--	10	5	50	--
Coal-tar creosote, 50 pct, and catalytic gas-base oil (West Coast) with 5 pct pentachlorophenol, 50 pct by volume	Miss.	4.1	10	--	--	--	10	50	--	40	9	90	--
	La.	4.1	8	--	--	--	62	--	--	38	3	38	--
Coal-tar creosote, 50 pct, and catalytic gas-base oil (West Coast) with copper naphthenate (0.5 pct copper metal) 50 pct by volume	Miss.	4.2	10	--	--	--	10	90	--	--	9	90	--
	La.	4.3	10	--	--	--	90	10	--	--	1	10	--
Coal-tar creosote, 25 pct, and catalytic gas-base oil (West Coast) with copper naphthenate (0.75 pct copper metal), *75 pct by volume*	Miss.	4.1	10	--	--	--	--	90	--	10	10	100	14.6
	La.	4.2	8	--	--	--	50	38	--	12	4	50	--
Catalytic gas-base oil (West Coast) with 5 pct pentachlorophenol, 50 pct, and catalytic gas-base oil (West Coast) *with copper naphthenate* (0.5 pct copper metal), 50 pct by volume	Miss.	4.2	10	--	--	--	20	20	10	50	8	80	--
	La.	4.2	9	--	--	--	100	--	--	--	--	--	--
Untreated controls	Miss.	--	10	--	--	--	--	20	20	60	10	100	2.2
	La.	--	10	--	--	--	--	--	--	100	10	100	2.8

[a] 10 stakes were originally installed at each test station. This number has since been reduced because of failure to locate the stakes at the time of inspection.

[b] Final inspection at Bogalusa, November 1962.

[c] Estimate based on percentage of stakes remaining after final inspection.

Table 18.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with various coal-tar creosotes and creosote solutions, after about 32 years of service. Stakes placed in test at Madison, Wis., October 1948, and on the Harrison Experimental Forest, Saucier, Miss., December 1948

Preservative	Location	Average retention	Number in test	Condition of stakes December, 1980[a]							Total removed		Average
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Coal-tar creosote													
Low residue, straight run	Miss.	8.0	10	--	--	--	30	60	--	10	7	70	17.8[b]
	Wis.	8.0	10	--	70	--	--	30	--	--	3	30	--
Medium residue, straight run	Miss.	8.0	10	--	10	--	10	80	--	--	8	80	18.8[b]
	Wis.	8.0	10	--	90	--	--	10	--	--	1	10	--
High residue, straight run	Miss.	7.8	10	--	20	--	20	60	--	--	6	60	20.3[b]
	Wis.	7.8	10	10	90	--	--	--	--	--	--	--	--
Medium residue													
Low in tar acids	Miss.	8.1	10	--	10	--	20	70	--	--	7	70	19.4[b]
	Wis.	8.1	10	10	90	--	--	--	--	--	--	--	--
Low in naphthalene	Miss.	8.2	10	--	10	--	50	40	--	--	4	40	21.3[b]
	Wis.	8.2	10	--	90	--	--	10	--	--	1	10	--
Low in tar acids and naphthalene	Miss.	8.0	10	--	--	--	30	60	--	10	7	70	18.9[b]
	Wis.	8.0	10	--	100	--	--	--	--	--	--	--	--
Low residue, low in tar acids and naphthalene	Miss.	8.0	10	--	10	--	20	50	--	20	7	70	19.2[b]
	Wis.	8.0	10	--	70	--	--	30	--	--	3	30	--
High residue, low in tar acids and naphthalene	Miss.	8.2	10	--	10	--	10	70	--	10	8	80	20.0[b]
	Wis.	8.1	10	2	80	--	--	--	--	--	--	--	--
English vertical retort	Miss.	8.0	10	--	--	--	30	60	--	10	7	70	18.9[b]
	Wis.	8.0	10	--	100	--	--	--	--	--	--	--	--
English coke oven	Miss.	7.9	10	--	--	--	--	70	--	30	10	100	13.6
	Wis.	7.9	10	--	40	--	--	60	--	--	6	60	--
English coke oven, 50 pct, and English vertical retort, 50 pct by volume	Miss.	8.1	10	--	--	--	10	40	--	50	9	90	16.9[b]
	Wis.	8.1	10	10	90	--	--	--	--	--	--	--	--
Medium residue, low in tar acids and naphthalene, 70 pct, and coal tar, 30 pct by volume	Miss.	8.1	10	--	20	--	10	70	--	--	7	70	20.4[b]
	Wis.	8.1	10	--	100	--	--	--	--	--	--	--	--
Medium residue, low in tar acids and naphthalene, 70 pct, and petroleum oil (Wyoming residual) 30 pct by volume	Miss.	8.1	10	--	10	--	20	70	--	--	7	70	19.6[b]
	Wis.	8.1	10	--	78	--	--	22	--	--	2	22	--
Petroleum oil (Wyoming residual)	Miss.	8.1	10	--	--	--	--	90	--	10	10	100	3.4
	Wis.	8.1	10	--	--	--	--	100	--	--	10	100	14.8
Untreated controls	Miss.	--	10	--	--	--	--	10	10	80	10	100	1.9
	Wis.	--	10	--	--	--	--	100	--	--	10	100	5.6

[a] Final inspection in Mississippi, November 1968.

[b] Estimate based on percentage of stakes remaining after final inspection.

Table 19.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with English coke oven and vertical retort coal-tar creosotes, after about 32 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1948

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Coal-tar creosote	5.3	10	--	--	--	30	60	--	10	7	70	--
English vertical retort	10.1	10	--	--	--	60	30	--	10	4	40	--
	15.0	10	--	--	--	100	--	--	--	--	--	--
English coke oven	4.7	10	--	--	--	--	80	--	20	10	100	16.3
	10.1	10	--	--	--	30	60	10	--	7	70	--
	14.8	10	--	--	--	30	50	--	20	7	70	--
Untreated controls	--	10	--	--	--	--	--	--	100	10	100	1.9

Table 20.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with zinc-arsenic chromium and chromated copper arsenate salts, after about 31 years of service. Stakes placed in test at Madison, Wis., November 1949, and on the Harrison Experimental Forest, Saucier, Miss., December 1949

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Zinc-arsenic-chromium salt (S-32)[a]	Wis.	(0.96)	10	--	90	--	--	10	--	--	1	10	--
	Miss.	(.96)	10	20	20	--	60	--	--	--	--	--	--
	Wis.	(.74)	10	--	70	--	--	30	--	--	3	30	--
	Miss.	(.72)	10	--	30	--	70	--	--	--	--	--	--
	Wis.	(.50)	10	--	10	--	--	90	--	--	9	90	--
	Miss.	(.50)	10	--	10	--	90	--	--	--	--	--	--
	Wis.	(.35)	10	--	--	--	--	100	--	--	10	100	18.5
	Miss.	(.35)	10	--	--	--	100	--	--	--	--	--	--
	Wis.	(.22)	10	--	10	--	--	90	--	--	9	90	--
	Miss.	(.22)	10	--	--	--	80	--	--	20	2	20	--
Chromated copper arsenate, type II (Fed. Spec. TT-W-550)	Wis.	(2.03)[b]	10	90	10	--	--	--	--	--	--	--	--
	Miss.	(1.04)	10	100	--	--	--	--	--	--	--	--	--
	Wis.	(.78)	10	100	--	--	--	--	--	--	--	--	--
	Miss.	(.79)	9	100	--	--	--	--	--	--	--	--	--
	Wis.	(.52)	9	22	78	--	--	--	--	--	--	--	--
	Miss.	(.52)	10	90	10	--	--	--	--	--	--	--	--
	Wis.	(.37)	10	--	100	--	--	--	--	--	--	--	--
	Miss.	(.37)	10	100	--	--	--	--	--	--	--	--	--
	Wis.	(.26)	10	--	100	--	--	--	--	--	--	--	--
	Miss.	(.26)	10	10	30	--	60	--	--	--	--	--	--
Zinc chloride	Wis.	1.03 (.61)	10	--	--	--	--	100	--	--	10	100	12.8
	Miss.	1.04 (.62)	10	--	--	--	--	20	--	80	10	100	16.9
Coal-tar creosote	Wis.	8.4	10	--	90	--	--	10	--	--	1	10	--
	Miss.	8.3	10	--	--	--	80	10	--	10	2	20	--
Untreated controls	Wis.	--	10	--	--	--	--	100	--	--	10	100	7.0
	Miss.	--	10	--	--	--	--	10	30	60	10	100	2.8

[a] ZnO, 97 parts; CrO_3, 170 parts; and As_2O_5, 213 parts.

[b] Retention figures in parentheses are based on preservative oxides.

Table 21.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with two fortified *aromatic petroleum* oils, after about 31 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss. December 1949

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Standard wood preservative[a]	3.7	10	--	--	--	--	20	10	70	10	100	7.3
	8.2	10	--	--	--	20	10	10	60	8	80	--
	11.7	10	--	--	--	30	40	--	30	7	70	--
Wood preservative No. 51746-R[b]	4.0	10	--	--	--	--	20	--	80	10	100	11.6
	8.0	10	--	--	--	20	20	--	60	8	80	--
	12.1	10	--	--	--	40	10	--	50	6	60	--
Untreated controls	--	10	--	--	--	--	--	30	70	10	100	2.2

[a] Reported to be a mixture of heavy petroleum cresylic acids, an aromatic solvent, and copper naphthenate equivalent to 0.3 pct copper metal.

[b] Reported to be a mixture of petroleum cresylic acids, aromatic oils, and 1.0 pct pentachlorophenol.

Table 22.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with oil solutions of rosin amine D pentachlorophenate and pentachlorophenol, after about 31 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1949

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Rosin amine D pentachlorophenate, 5 pct, in Stoddard solvent	4.0	10	--	--	--	--	--	20	80	10	100	3.8
	7.9	10	--	--	--	--	--	--	100	10	100	5.1
	11.8	10	--	--	--	--	--	--	100	10	100	9.5
Rosin amine D pentachlorophenate, 5 pct; and paraffin wax, 2 pct, in Stoddard solvent	4.2	10	--	--	--	--	--	20	80	10	100	4.5
	8.0	10	--	--	--	--	10	--	90	10	100	7.8
Rosin amine D pentachlorophenate, 5 pct; paraffin wax, 2 pct; and pentalyn H, 10 pct, in Stoddard solvent	4.0	10	--	--	--	--	--	30	70	10	100	8.0
	8 0	10	--	--	--	--	30	30	40	10	100	8.7
Rosin amine D pentachlorophenate, 5 pct, in No. 4 aromatic oil	4.0	10	--	--	--	--	60	--	40	10	100	12.7
	7.6	10	--	--	--	--	50	--	50	10	100	15.9
	12.3	10	--	--	--	60	40	--	--	4	40	--
Pentachlorophenol, 5 pct; and pine oil, 5 pct, in Stoddard solvent	4.1	10	--	--	--	--	--	--	100	10	100	9.5
	8.0	10	--	--	--	--	--	--	100	9	100	15.5
Pentachlorophenol, 5 pct; pine oil, 5 pct; paraffin wax, 2 pct; and pentalyn H, 10 pct, in Stoddard solvent	4.1	10	--	--	--	--	--	10	90	10	100	12.8
	7.8	10	--	--	--	--	20	--	80	10	100	15.7
Pentachlorophenol, 5 pct, in No. 4 aromatic oil	4.2	10	--	--	--	10	60	--	30	9	90	--
	8.2	10	--	--	--	70	20	--	10	3	30	--
Untreated controls	--	10	--	--	--	--	--	30	70	10	100	2.3

Table 23.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with rosin amine D pentachlorophenate and pentachlorophenol in petroleum oil (Wyoming residual), after about 29 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Rosin amine D pentachlorophenate 5 pct, in petroleum oil (Wyoming residual)	4.0	10	--	--	--	30	40	--	30	7	70	--
	8.0	10	--	--	--	40	40	--	20	6	60	--
	12.7	10	10	--	--	60	20	--	10	3	30	--
Pentachlorophenol 5 pct, in petroleum oil (Wyoming residual)	4.0	10	--	--	--	10	50	--	40	9	90	--
	8.0	10	--	--	--	80	20	--	--	2	20	--
	11.7	10	30	--	--	70	--	--	--	--	--	--
Petroleum oil (Wyoming residual)	7.7	10	--	--	--	10	70	--	20	9	90	--
	12.2	10	--	--	--	30	70	--	--	7	70	--
Untreated controls	--	10	--	--	--	--	--	20	80	10	100	2.0

Table 24.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with two Boliden salt formulations, after about 29 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952

Preservative	Average retention (anhydrous salts)	Number in test	Condition of stakes December 1980					Total removed		Average life
			Good	Serviceable but showing some--		Destroyed by--				
				Decay	Decay and termite attack	Termite attack	Decay fungi and termite attack			
	Pcf		Pct					Number	Pct	Yr
Chromated zinc arsenate (H_3AsO_4,	0.22 (0.11)[a]	10	--	--	20	10	70	8	80	--
20 parts; Na_2HAsO_4, 21 parts	.38 (.20)	10	--	--	100	--	--	--	--	--
	.77 (.40)	10	--	--	100	--	--	--	--	--
$Na_2Cr_2O_7 \cdot H_2O$, 16 parts; and	1.01 (.53)	[c]10	--	--	100	--	--	--	--	--
$AnSO_4$, 43 parts)[b]										
Boliden salts S-25 (CrO_3,	(.30)	10	--	10	90	--	--	--	--	--
	(.50)	10	50	40	10	--	--	--	--	--
32 parts; CuO, 5 parts,	(.75)	10	100	--	--	--	--	--	--	--
ZnO, 14 parts; and	(1.01)	10	100	--	--	--	--	--	--	--
As_2O_5, 49 parts)										
Untreated controls	--	10	--	--	--	20	80	10	100	1.8

[a] Retention values in parentheses are based on preservative oxides.

[b] Retentions are shown on an anhydrous basis, and figures should be increased approximately 26 pct to obtain values as computed in AWPA Standard P5-55.

[c] This stake group placed in test in August 1952.

Table 25.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with four fire-retardant formulations (AWPA P10-51), after about 29 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., March 1952[a]

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Chromated zinc chloride ($ZnCl_2$, 80.4 parts; $Na_2Cr_2O_7 \cdot 2H_2O$, 19.6 parts)	1.50 (0.92)[b]	10	--	--	--	20	30	--	50	8	80	--
	2.91 (1.78)	10	30	--	10	20	10	10	20	4	40	--
	6.00 (3.67)	10	50	--	50	--	--	--	--	--	--	--
Chromated zinc chloride (FR) (Chromated zinc chloride, 80 parts) H_3BO_3, 10 parts; and $(NH_4)_2SO_4$, 10 parts)	1.53	10	--	--	--	--	30	20	50	10	100	16.5
	3.00	10	--	--	20	30	10	10	30	5	50	--
	6.08	10	10	--	90	--	--	--	--	--	--	--
Minalith ($(NH_4)_2HPO_4$, 10 parts; $(NH_4)_2SO_4$, 60 parts; $Na_2B_4O_7$, 10 parts; and H_3BO, 20 parts)	1.50	10	--	--	--	--	--	10	90	10	100	3.6
	3.00	10	--	--	--	--	--	10	90	10	100	4.8
	6.13	10	--	--	--	--	20	30	70	10	100	5.0
Pyresote ($ZnCl_2$, 35 parts; $(NH_4)SO_4$, $Na_2Cr_2O_7 \cdot 2H_2O$, 5 parts)	1.50	10	--	--	--	--	--	10	90	10	100	11.2
	3.01	10	--	--	--	--	--	20	80	10	100	13.0
	6.26	10	--	--	--	10	20	10	60	9	90	--
Untreated controls	--	10	--	--	--	--	--	20	80	10	100	2.6

[a] In cooperation with Bureau of Ships, Department of the Navy.

[b] Retention values in parentheses based on preservative oxides.

Table 26.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with basic zinc chloride and zinc chloride, after about 29 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Basic zinc chloride[a]	1.00	10	--	--	--	100	--	--	--	--	--	--
	2.11	10	20	30	--	70	--	--	--	--	--	--
	4.13	10	90	--	--	10	--	--	--	--	--	--
Zinc chloride	1.02 (0.61)[b]	10	--	--	--	10	10	--	80	9	90	--
Untreated controls	--	10	--	--	--	--	10	20	70	10	100	2.2

[a] Pershall process. Compound intended as fire retardant with retentions of 3-1/2 to 4 pcf. Retentions of basic zinc chloride are expressed as weight of zinc oxide.

[b] Retention value in parentheses based on preservative oxide ZnO.

Table 27.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with naval-stores products, after about 29 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., March 1952

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		- - - - - - - - - - - - - - Pct - - - - - - - - - - - - - -							Number	Pct	Yr
Rosin oil and No. 2 fuel oil (2:7)[a]	4.1	10	--	--	--	--	30	--	70	10	100	6.8
	8.0	10	--	--	--	--	60	--	40	10	100	5.8
	12.3	10	--	--	--	--	20	--	80	10	100	9.3
Rosin oil and No. 2 fuel oil (1:7)[a]	4.0	10	--	--	--	--	10	--	90	10	100	5.6
	8.0	10	--	--	--	--	50	--	50	10	100	5.8
	12.1	10	--	--	--	--	40	--	60	10	100	8.6
Rosin oil and No. 2 fuel oil (1:7)[a] with 2.98 pct[a] pentachlorophenol	4.0	10	--	--	--	--	20	--	80	10	100	11.4
	8.0	10	--	--	--	--	20	--	80	10	100	14.8
	12.1	10	--	--	--	50	10	--	40	5	50	--
No. 2 fuel oil	4.1	10	--	--	--	--	30	10	60	10	100	6.2
No. 2 fuel oil with 2.92 pct[a] pentachlorophenol	4.0	10	--	--	--	--	10	--	90	10	100	11.1
	8.0	10	--	--	--	--	20	--	80	10	100	12.8
	12.3	10	--	--	--	50	--	--	50	5	50	--
No. 2 fuel oil with 4.94 pct[a] pentachlorophenol	4.1	10	--	--	--	--	50	--	50	10	100	12.4
	8.0	10	--	--	--	--	40	--	60	10	100	13.2
	12.0	9[b]	--	--	--	67	33	--	--	3	33	--
Rosin oil and Stoddard solvent (1:7)[a] with 3.21 pct[a] pentachlorophenol	8.0	10	--	--	--	--	50	--	50	10	100	12.5
Oleo resin and No. 2 fuel oil (2:7)[a]	4.0	9[b]	--	--	--	--	--	--	100	9	100	6.1
	8.1	10	--	--	--	--	40	10	50	10	100	6.8
	12.2	10	--	--	--	--	30	--	70	10	100	10.7
Oleo resin and Stoddard solvent (1:7)[a] with 3.11 pct[a] pentachlorophenol	8.2	10	--	--	--	--	40	10	50	10	100	10.4
Drop liquor concentrate and Stoddard solvent (1:7)[a] with 2.99 pct[a] pentachlorophenol	7.9	10	--	--	--	--	20	--	80	10	100	8.7
Oleo resin and No. 2 fuel oil (1:7)[a] with 2.94 pct[a] pentachlorophenol	4.1	10	--	--	--	--	50	--	50	10	100	10.0
	8.0	10	--	--	--	--	30	--	70	10	100	13.5
	12.0	10	--	--	--	10	20	--	70	9	90	--
Drop liquor concentrate and No. 2 fuel oil (2:7)[a]	4.0	10	--	--	--	--	10	--	90	10	100	6.8
	8.0	10	--	--	--	--	20	--	80	10	100	7.8
	12.0	10	--	--	--	--	--	--	100	10	100	10.2
Drop liquor concentrate and No. 2 fuel oil (1:7)[a] with 3.03 pct[a] pentachlorophenol	4.0	10	--	--	--	--	--	--	100	10	100	12.2
	8.0	10	--	--	--	--	30	--	70	10	100	16.3
	12.0	10	--	--	--	10	20	--	70	9	90	--
No. 2 fuel oil with 5 pct[a] rosin amine D copper acetate complex	4.1	10	--	--	--	--	50	--	50	10	100	8.0
	8.0	10	--	--	--	--	50	--	50	10	100	9.6
	12.1	10	--	--	--	10	60	--	30	9	90	--
Untreated controls	--	10	--	--	--	--	10	20	70	10	100	2.8

[a] Ratios and percentages on a weight basis.

[b] 1 stake missing, eliminated from test.

Table 28.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with coal-tar creosotes from tars produced by low-temperature carbonization (Disco process), after 28 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1952

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Low-temperature coal-tar creosote, type 1 (tar acids present)	5.0	10	--	--	--	90	10	--	--	10	--	--
	10.2	10	--	--	--	100	--	--	--	--	--	--
	15.4	10	10	--	--	90	--	--	--	--	--	--
Low-temperature coal-tar creosote, type 2 (high percentage of tar acids removed)	5.0	10	--	--	--	50	20	--	30	5	50	--
	9.8	10	--	--	--	100	--	--	--	--	--	--
	15.2	10	--	--	--	100	--	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	--	40	60	10	100	2.3

Table 29.--Condition, after about 27-1/2 years of service, of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with preservative oils and conditioned by vapor cleaning and steaming to remove residual solvents. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., April 1953[a]

Preservative	Conditioning after treatment	Number in test	Average preservative retention: From weights before and after treatment[b] — Solution	Average preservative retention: From weights before and after treatment[b] — Pentachlorophenol or copper metal	Average preservative retention: By analysis 2 months after treatment; pentachlorophenol or copper metal	Condition of stakes December 1980: Good	Serviceable but showing some-- Decay	Serviceable but showing some-- Termite attack	Serviceable but showing some-- Decay and termite attack	Destroyed by-- Decay fungi	Destroyed by-- Termite attack	Destroyed by-- Decay fungi and termite attack	Total removed		Average life
			Pcf			Pct							Number	Pct	Yr
Pentachlorophenol, 2.5 pct in light aromatic solvent[c]	None	10	4.2	0.105	0.082	--	--	--	--	20	10	70	10	100	11.6
	Steaming[d]	10	4.2	.105	.091	--	--	--	--	10	--	90	10	100	12.4
	Vapor cleaning[e]	10	4.1	.102	.069	--	--	--	--	10	10	80	10	100	11.3
Pentachlorophenol, 4.5 pct in light aromatic solvent[c]	Steaming[d]	10	4.4	.200	.139	--	--	--	--	30	--	70	10	100	10.8
	Vapor cleaning[e]	10	4.5	.225	.136	--	--	--	--	20	--	80	10	100	14.2
Pentachlorophenol, 5 pct in light aromatic solvent[c]	None	10	4.6	.230	.186	--	--	--	--	10	--	90	10	100	14.1
	Steaming[d]	10	4.8	.240	.222	--	--	--	--	10	--	90	10	100	12.9
	Vapor cleaning[e]	10	[illegible]	.300	.173	--	--	--	--	--	--	10	10	100	12.3
Pentachlorophenol, 9.1 pct in light aromatic solvent[c]	Steaming[d]	10	4.4	.400	.319	--	--	--	20	10	--	70	8	80	--
	Vapor cleaning[e]	10	6.0	.600	.397	--	--	--	30	--	--	70	7	70	--
Pentachlorophenol, 10 pct in light aromatic solvent	None	10	6.2	.310	.121	--	--	--	--	--	--	100	10	100	16.5
	Steaming[d]	10	6.6	.330	.146	--	--	--	10	20	--	70	9	90	--
	Vapor cleaning[e]	10	7.2	.360	.111	--	--	--	--	20	--	80	10	100	13.1
Pentachlorophenol, 5 pct in No. 2 fuel oil	None	10	4.6	.023	.020	--	--	--	--	50	--	50	10	100	11.0
	Steaming[d]	10	4.5	.022	.020	--	--	--	--	40	--	60	10	100	12.0
	Vapor cleaning[e]	10	4.6	.023	.018	--	--	--	--	40	--	60	10	100	11.8
Copper naphthenate, 0.5 pct copper in light aromatic solvent	Steaming[d]	10	4.4	.026	.023	--	--	--	--	30	--	70	10	100	14.3
	Vapor cleaning[e]	10	4.2	.029	.021	--	--	--	--	30	--	70	10	100	13.7
Copper naphthenate, 0.59 pct copper in light aromatic solvent	Vapor cleaning[e]	10	4.2	.029	.021	--	--	--	--	30	--	70	10	100	13.7
Untreated controls	--	10	--	--	--	--	--	--	--	--	60	40	10	100	2.4

[a] In cooperation with the Bureau of Ships, Department of the Navy.

[b] Prior to conditioning.

[c] Solution contained 5 pct ester gum (by weight) as a bloom preventative.

[d] 1 hr steaming with maximum temperature 259° F and 1 hr vacuum, following which steaming and vacuum periods were repeated.

[e] 1 hr heating in vapor of aromatic solvent with maximum temperature of 280° F, and 1 hr vacuum, following which vapor heating and vacuum periods were repeated.

Table 30.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with Basilit UA, after about 26 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1954

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
						Pct				Number	Pct	Yr
	Pcf											
Basilit UA[a]	0.25 (0.19)[b]	10	--	--	--	20	--	50	30	8	80	--
Basilit UA[a]	.53 (.39)	10	--	--	--	100	--	--	--	--	--	--
Basilit UA[a]	.75 (.56)	10	--	--	--	100	--	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	--	20	80	10	100	1.8

[a] Contains sodium fluoride, sodium dichromate, and sodium arsenate.

[b] Retention values in parentheses based on preservative oxides.

Table 31.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) of uninfected and Trichoderma mold-infected wood, treated with coal-tar creosote, pentachlorophenol solution, and copperized chromated zinc chloride, after about 26 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1954

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
STAKES FROM WOOD WITHOUT MOLD INFECTION												
Coal-tar creosote	3.9	10	--	--	--	40	50	--	10	6	60	--
(high residue,	7.8	10	--	--	--	100	--	--	--	--	--	--
straight run)	12.2	10	--	10	--	90	--	--	--	--	--	--
Coal-tar creosote (low	4.0	10	--	--	--	30	20	--	50	7	70	--
residue, low in tar	8.0	10	--	10	--	80	--	--	10	1	10	--
acids and naphthalenes)	12.4	10	40	--	--	60	--	--	--	--	--	--
Pentachlorophenol	4.2	10	--	--	--	--	10	20	70	10	100	16.7
(4.7 pct in No. 2	8.1	10	--	--	--	20	20	--	60	8	80	--
fuel oil)	12.1	10	--	--	--	90	--	--	10	1	10	--
Copperized chromated	0.34 (0.20)[a]	10	--	--	--	--	--	20	80	10	100	16.0
zinc chloride	.73 (.45)	10	--	--	--	80	20	--	--	2	20	--
	1.15 (.71)	10	--	--	70	20	--	--	10	1	10	--
Untreated controls	--	10	--	--	--	--	--	60	40	10	100	2.1
STAKES FROM WOOD INFECTED WITH TRICHODERMA MOLD												
Coal-tar creosote	4.0	10	--	--	--	30	40	--	30	7	70	--
(high residue,	8.0	10	--	--	--	80	20	--	--	2	20	--
straight run)	12.0	10	--	--	--	100	--	--	--	--	--	--
Coal-tar creosote	4.1	10	--	--	--	20	60	--	20	8	80	--
(low residue, low in	8.0	10	--	--	--	80	10	--	10	2	20	--
tar acids and	12.0	10	--	20	--	80	--	--	--	--	--	--
napthalenes)												
Pentachlorophenol	4.2	10	--	--	--	10	20	20	50	9	90	--
(4.7 pct in No. 2	7.8	10	--	--	--	20	10	--	70	8	80	--
fuel oil)	11.9	10	--	--	--	80	10	--	10	2	20	--
Copperized chromated	0.34 (0.20)	10	--	--	--	20	--	20	60	8	80	--
zinc chloride	.74 (.45)	10	--	--	10	80	--	--	10	1	10	--
	1.17 (.71)	10	10	--	60	30	--	--	--	--	--	--
Untreated controls	--	--	--	--	--	--	10	30	60	10	100	2.5

[a] Retention values in parentheses based on preservative oxides.

Table 32.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with Texas lignite coal-tar creosote and with paraffin alone and fortified with pentachlorophenol, after 26 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1954

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Texas lignite coal-tar creosote	5.1	10	--	--	--	20	10	--	70	8	80	--
	9.8	10	--	--	--	80	--	--	20	2	20	--
	15.2	10	20	--	10	70	--	--	--	--	--	--
25 pct paraffin in aromatic volatile solvent (by weight)	25.9	10	--	--	--	10	10	10	70	9	90	--
5 pct pentachlorophenol plus 28.5 pct paraffin in aromatic volatile solvent (by weight)	26.3	10	10	--	--	90	--	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	--	30	70	10	100	2.3

Table 33.--Condition of Douglas-fir, sweetgum, and tangile plywood stakes, treated with pentachlorophenol and with fluor chrome arsenate phenol type A, after about 25 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., January 1956[a]

Species	Preservative	Treatment	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
					Good	Serviceable but showing some--			Destroyed by--					
						Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
			Pcf		- - - - - - - - - - - - - - Pct - - - - - - - - - - - - - -							Number	Pct	Yr
PLYWOOD FROM VENEER TREATED BEFORE GLUING														
Douglas-fir	Pentachlorophenol[b]	Hot and cold[c]	10.0	9	--	--	--	11	22	--	67	8	89	--
	Pentachlorophenol[b]	Cold soaked	6.3	10	--	--	--	--	30	--	70	10	100	8.2
	Fluor chrome arsenate phenol type A	Hot and cold[c]	.52 (0.32)[d]	10	--	--	--	--	50	--	50	10	100	12.3
Sweetgum	Pentachlorophenol[b]	Hot and cold[c]	15.1	10	--	--	--	--	30	--	70	10	100	7.4
	Fluor chrome arsenate phenol type A	Hot and cold[c]	.62 (.39)	10	--	--	--	--	60	--	40	10	100	8.5
Tangile	Pentachlorophenol[b]	Hot and cold[c]	9.4	10	--	--	--	--	60	--	40	10	100	6.8
	Fluor chrome arsenate phenol type A	Hot and cold[c]	.59 (.37)	10	--	--	--	--	100	--	--	10	100	10.4
PLYWOOD TREATED AFTER GLUING														
Douglas-fir	Pentachlorophenol[b]	Pressure	9.6	10	--	--	--	20	20	--	60	8	80	--
	Pentachlorophenol[b]	Cold soaked	.9	10	--	--	--	--	20	10	70	10	100	5.3
	Pentachlorophenol[b]	Cold soaked	1.4	10	--	--	--	--	--	20	80	10	100	7.1
	Fluor chrome arsenate phenol type A	Pressure	.61 (.38)	9	--	--	--	--	22	22	56	9	100	18.4
Sweetgum	Pentachlorophenol[b]	Pressure	10.6	10	--	--	--	--	70	--	30	10	100	6.3
	Fluor chrome arsenate phenol type A	Pressure	.55 (.34)	10	--	--	--	--	50[e]	10	40	10	100	7.6
Tangile	Pentachlorophenol[b]	Pressure	10.4	10	--	--	--	--	70	--	30	10	100	13.5
	Fluor chrome arsenate phenol type A	Pressure	.60 (.37)	10	--	--	--	--	90	--	10	10	100	15.0
UNTREATED CONTROL														
Douglas-fir	--	--	--	10	--	--	--	--	--	--	100	10	100	3.6
Sweetgum	--	--	--	10	--	--	--	--	10	10	80	10	100	1.4
Tangile	--	--	--	10	--	--	--	--	40	--	60	10	100	1.9

[a] In cooperation with the Bureau of Ships, Department of the Navy.

[b] Five percent solution conforming to MIL-W-18142 (SHIPS) specification 27 August 1954.

[c] Consisted of heating in a veneer dryer and immersion in unheated preservative solution until desired retention was obtained.

[d] Retention values in parentheses are based on preservative oxides.

[e] One stake by soft-rot fungus.

NOTE: The stakes were of 5-ply veneer, 5/8 x 4 x 18 in., and cut from panels 24 x 48 in. For item 10 the stakes were cut from the panels and then treated. For other treated items the stakes were cut after treatment and the edges exposed in sawing were brush coated with the preservative.

Table 34.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper formate, after about 24 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1956

Preservative	Average retention (copper)	Number in test	Condition of stakes December 1980						Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--				
				Decay	Termite attack	Decay and termite attack	Decay fungi	Decay fungi and termite attack			
	Pcf		Pct						Number	Pct	Yr
Copper formate	0.030	10	--	--	--	--	30	70	10	100	7.4
	.060	10	--	--	--	80	20	--	2	20	--
	.090	10	--	--	--	80	20	--	2	20	--
	.120	10	--	--	10	80	10	--	1	10	--
Untreated controls	--	10	--	--	--	--	--	100	10	100	3.4

Table 35.--Condition of southern pine stakes (2 x 4 in. and 3/4 x 3/4 in. nominal x 18 in.), treated with KP[a] preservative, after about 22-1/2 to 23 years of service. Stakes placed in test at Madison, Wis., May 1958, and on the Harrison Experimental Forest, Saucier, Miss., December 1957

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
STAKES 3/4 BY 3/4 BY 18 INCHES													
KP[a] preservative	Miss.	0.09	9[b]	--	--	--	--	56	11	33	9	100	9.5
	Miss.	.18	8[b]	--	--	--	38	50	--	12	5	62	--
	Miss.	.28	9[b]	22	--	22	34	22	--	--	2	22	--
	Miss.	.37	10	50	--	--	30	20	--	--	2	20	--
Chromated zinc chloride	Miss.	1.20 (0.73)[c]	9[b]	--	--	--	11	11	67	11	8	89	--
Coal-tar creosote	Miss.	11.6	9	11	--	22	44	11	--	11	2	22	--
Untreated controls	Miss.	--	10	--	--	--	--	40	--	60	10	100	2.1
STAKES 2 BY 4 BY 18 INCHES													
KP[a] preservative	Miss.	.09	10	--	--	--	20	50	--	30	8	80	--
	Wis.	.09	8[b]	--	12	--	--	88	--	--	7	88	--
	Miss.	.19	10	--	--	--	70	30	--	--	3	30	--
	Wis.	.18	10	--	50	--	--	50	--	--	5	50	--
	Miss.	.27	10	50	--	10	20	20	--	--	2	20	--
	Wis.	.26	9	11	67	--	--	22	--	--	2	22	--
	Miss.	.37	10	70	10	--	--	20	--	--	2	20	--
	Wis.	.35	9[b]	33	67	--	--	--	--	--	--	--	--
Chromated zinc chloride	Miss.	1.16 (.71)	10[b]	--	--	10	40	--	--	50	5	50	--
	Wis.	1.21 (.74)	8[b]	25	12	--	--	63	--	--	5	63	--
Coal-tar creosote	Miss.	10.2	10	20	10	10	60	--	--	--	--	--	--
	Wis.	10.2	10	40	60	--	--	--	--	--	--	--	--
Untreated controls	Miss.	--	10	--	--	--	--	20	--	80	10	100	2.5
	Wis.	--	10	--	--	--	--	100	--	--	10	100	3.6

[a] Copper oxide and chlorophenols.

[b] Specimens found broken and eliminated from test.

[c] Retention values in parentheses are based on preservative oxides.

Table 36.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with tributyltin oxide, after 8 years on the Harrison Experimental Forest, Saucier, Miss., and of those of cyanoethylated wood and wood treated for destruction of thiamine, after approximately 8 years in Mississippi and 9-1/2 years at Madison, Wis. Stakes placed in test in Mississippi in December 1958 and in Wisconsin in May 1959

Preservative	Location	Average retention	Number in test	Condition of stakes November 1968							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Tributyltin oxide[a]	Miss.	0.015	10	--	--	--	--	--	10	90	10	100	6.3
	Miss.	.030	10	--	--	--	--	10	--	90	10	100	7.2
	Miss.	.045	10	--	--	--	--	10	--	90	10	100	7.4
Stoddard solvent (controls)	Miss.	7.1	10	--	--	--	--	--	20	80	10	100	4.0
Acrylonitrile[b]	Miss.	1.23	10	--	--	--	--	--	10	90	10	100	3.9
	Wis.	1.22	10	--	--	--	--	100	--	--	10	100	6.3
	Miss.	2.46	10	--	--	--	--	--	10	90	10	100	5.3
	Wis.	2.48	10	--	--	--	--	100	--	--	10	100	7.8
Ammonium hydroxide[c]	Miss.	--	10	--	--	--	--	--	10	90	10	100	3.5
Untreated controls	Miss.	--	10	--	--	--	--	--	--	100	10	100	3.6
	Wis.	--	10	--	--	--	--	100	--	--	10	100	4.0

[a] In Stoddard solvent.

[b] Used with ammonium hydroxide for cyanoethylation.

[c] Followed by steaming for thiamine destruction.

Table 37.--Condition of southern pine stakes (2 x 4 in. nominal and 3/4 x 3/4 in. x 18 in.), treated with fluor chrome arsenate phenol type A (AWPA-P5 and modification), after about 21 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1959

Preservative	Average retention		Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf			Pct							Number	Pct	Yr
STAKES 2 BY 4 NOMINAL BY 18 INCHES													
Fluor chrome arsenate phenol (Federal Spec. TT-W-535) (Type A)	0.35	(0.22)[a]	8[b]	--	--	--	25	51	--	24	7	88	--
	.50	(.31)	10	--	--	--	30	50	--	20	7	70	--
	.75	(.47)	10	--	--	--	90	10	--	--	1	10	--
Fluor chrome arsenate phenol (Type A)	.35	(.22)	9[b]	--	--	--	--	33	11	56	9	100	16.7
	.50	(.31)	10	--	--	--	--	80	--	20	10	100	17.5
(Modified)[c]	.76	(.47)	10	--	--	--	50	40	--	10	5	50	--
Untreated controls	--		10	--	--	--	--	40	20	40	10	100	2.1
STAKES 3/4 BY 3/4 BY 18 INCHES													
Fluor chrome arsenate phenol (Federal Spec. TT-W-535) (Type A)	.36	(.22)	9[b]	--	--	--	--	34	33	33	9	100	6.7
	.51	(.32)	9[b]	--	--	--	--	56	33	11	9	100	11.8
	.77	(.48)	8[b]	--	--	--	--	50	12	38	8	100	16.5
Fluor chrome arsenate phenol (Type A)	.37	(.23)	10	--	--	--	--	20	30	50	10	100	8.2
	.52	(.32)	10	--	--	--	--	20	40	40	10	100	11.6
(Modified)[c]	.80	(.38)	9[b]	--	--	--	11	44	11	33	8	89	--
Untreated controls	--		10	--	--	--	--	30	20	50	10	100	1.4

[a] Retention values in parentheses are based on preservative oxides.

[b] Stakes damaged mechanically and eliminated from test.

[c] Sodium pentachlorophenate substituted for dinitrophenol.

Table 38.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper-8-quinolinolate, after about 9 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1959

Preservative	Average retention		Number in test	Condition of stakes November 1968							Total removed		Average life
					Serviceable but showing some--			Destroyed by--					
	Solution	Copper-8-quinolinolate		Good	Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf			Pct							Number	Pct	Yr
Copper-8-quinolinolate													
0.1 pct in Stoddard solvent	9.9	0.010	10	--	--	--	--	10	--	90	10	100	5.3
.2 pct in Stoddard solvent	9.9	.020	10	--	--	--	--	20	10	70	10	100	4.2
.6 pct in Stoddard solvent	10.0	.060	10	--	--	--	10	40	--	50	9	90	5.6[a]
1.2 pct in Stoddard solvent	10.2	.123	10	--	--	--	10	60	--	30	9	90	7.8[a]
.6 pct; paraffin, 2 pct; and Pentalyn-H, 10 pct in Stoddard solvent	10.1	.061	10	--	10	--	20	70	--	--	7	70	8.8[a]
.6 pct; Dieldrin, 0.5 pct in Stoddard solvent	10.1	.060	10	--	--	--	10	70	--	20	9	90	6.6[a]
Untreated controls	--	--	10	--	--	--	--	--	20	80	10	100	2.2

[a] Estimate based on percentage of stakes remaining after final inspection.

Table 39.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with blends of extracts from Texas lignite tar, after about 20 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1960

Lignite-tar extracts	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Hexane-soluble residue, 25 pct; and hexane distillate, 75 pct (by weight)	5.1	10	--	--	--	40	20	--	40	6	60	--
	10.0	10	10	--	--	80	--	--	10	1	10	--
	14.1	10	--	20	--	80	--	--	--	--	--	--
High-boiling methanol solubles, 25 pct; and hexane distillate, 75 pct (by weight)	5.0	10	--	--	--	40	--	--	60	6	60	--
	9.3	10	--	--	--	90	--	--	10	1	10	--
	15.2	10	30	10	10	50	--	--	--	--	--	--
High-boiling methanol solubles, 10 pct; hexane-soluble residue, 20 pct; and hexane distillate, 70 pct (by weight)	5.1	10	--	--	--	30	10	--	60	7	70	--
	10.1	10	10	--	--	70	--	--	20	2	20	--
	14.7	10	30	--	--	70	--	--	--	--	--	--
High-boiling methanol solubles, 20 pct; hexane-solution residue, 10 pct; and hexane distillate, 70 pct (by weight)	5.2	10	--	--	--	50	20	--	30	5	50	--
	10.0	10	--	--	--	100	--	--	--	--	--	--
	15.2	10	60	--	--	40	--	--	--	--	--	--
High-boiling methanol solubles, 15 pct; and hexane distillate, 85 pct (by weight)	5.0	10	--	--	--	50	10	10	30	5	50	--
	10.2	10	--	--	10	80	--	--	10	1	10	--
	14.9	10	30	10	--	60	--	--	--	--	--	--
High-boiling methanol solubles, 24.5 pct; hexane distillate, 74.5 pct; and petroleum sulfonate (Morpel X-914), 1 pct (by weight)	5.1	10	--	--	--	50	20	--	30	5	50	--
	9.9	10	--	--	--	100	--	--	--	--	--	--
	15.0	10	20	--	--	80	--	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	--	--	100	10	100	2.6

Table 40.--Condition of 1- x 4- x 18-in. stakes of embedded fiberboard[a] and untreated Douglas-fir heartwood after 18 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1960

Material	Number in test	Condition of stakes November 1978							Total removed		Average life
		Good	Serviceable but showing some--			Destroyed by--					
			Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pct							Number	Pct	Yr
Embedded fiberboard[a]	9[b]	--	--	--	--	100[c]	--	--	9	100	9.3
Douglas-fir heartwood	10	--	--	--	--	70	10	20	10	100	3.0

[a] Western hemlock strands in portland cement.

[b] Stake missing and eliminated from test.

[c] Failures attributed mainly to the effect of moisture.

Table 41.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with tributyltin oxide and pentachlorophenol solutions with heavy and light petroleum solvents and with and without the addition of Dieldrin and Aldrin, after about 20 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1960

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
SOLUTIONS WITH STODDARD SOLVENT												
Tributyltin oxide, 0.3 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	--	90	--	10	10	100	4.9
Tributyltin oxide, 0.6 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	--	90	--	10	10	100	6.9
Tributyltin oxide, 0.3 pct; and Aldrin, 0.3 pct	8.0	10	--	--	--	--	90	--	10	10	100	4.6
Tributyltin oxide												
0.3 pct	8.2	10	--	--	--	--	80	--	20	10	100	4.5
0.6 pct	7.9	10	--	--	--	--	50	--	50	10	100	7.0
Tributyltin oxide, 0.3 pct; Dieldrin, 0.3 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	--	100	--	--	10	100	6.9
Tributyltin oxide, 0.3 pct; Aldrin, 0.3 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	--	70	--	30	10	100	5.3
Dieldrin, 0.6 pct	8.0	10	--	--	--	--	90	--	10	10	100	4.0
Pentachlorophenol, 5 pct; pine oil, 5 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	--	--	--	--
Pentachlorophenol, 5 pct; pine oil, 5 pct; Dieldrin, 0.3 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	--	--	--	--
Water repellent, 4.7 pct	8.0	10	--	--	--	--	80	--	20	10	100	4.3
Pentachlorophenol, 5 pct; pine oil, 5 pct; Dieldrin, 0.3 pct; stabilizer wax, 2 pct; and water repellent, 4.7 pct	8.0	10	--	--	--	100	--	--	--	--	--	--
SOLUTIONS WITH HEAVY PETROLEUM SOLVENT (AWPA P9)												
Tributyltin oxide, 0.3 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	60	40	--	--	4	40	--
Tributyltin oxide, 0.6 pct; and Dieldrin, 0.3 pct	8.0	10	--	--	--	80	--	--	20	2	20	--
Tributyltin oxide												
0.3 pct	8.0	10	--	--	--	50	20	--	30	5	50	--
0.6 pct	8.0	10	--	--	--	70	--	--	30	3	30	--
Pentachlorophenol, 5 pct	8.0	10	--	--	--	100	--	--	--	--	--	--
Pentachlorophenol, 5 pct; and stabilizer wax, 2 pct	7.7	10	10	--	--	90	--	--	--	--	--	--
Petroleum solvent controls	8.0	10	--	--	--	60	--	--	40	4	40	--
UNTREATED CONTROLS												
None	--	10	--	--	--	--	70	--	30	10	100	3.1

Table 42.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in. and 3/4 x 3/4 in. x 17 in.), treated with pentachlorophenol in liquefied petroleum gas and in heavy and light petroleum solvents, after about 19-1/2 years of service. Stakes installed at Valley View Test Plot, Madison, Wis., and on Harrison Experimental Forest, Saucier, Miss., July 1961

Preservative	Location	Average retention			Number in test	Condition of stakes December 1980							Total removed		Average life
		By weight		By analysis, pentachlorophenol		Good	Serviceable but showing some--			Destroyed by--					
		Solution	Pentachlorophenol				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pct				Pct							Number	Pct	Yr
STAKES 2 BY 4 NOMINAL BY 18 INCHES															
Pentachlorophenol in liquefied petroleum gas[a]	Miss.	--	--	0.14[b]	10	--	--	--	30	--	--	70	7	70	--
		--	--	.19[b]	10	--	--	--	20	10	--	60	7	70	--
		--	--	.34[b]	10	--	--	--	100	--	--	--	--	--	--
		--	--	.58[b]	10	--	--	--	100	--	--	--	--	--	--
Solutions with AWPA P9 (heavy petroleum solvent) Pentachlorophenol															
3.5 pct (by weight)		3.0	0.11	.14	10	--	--	--	90	--	--	10	1	10	--
		4.5	.19	.22	10	--	--	--	100	--	--	--	--	--	--
4.2 pct (by weight)		6.8	.29	.32	10	--	--	--	100	--	--	--	--	--	--
		16.0	.67	.69	10	90	--	--	10	--	--	--	--	--	--
Solutions with Stoddard solvent Pentachlorophenol, 4.0 pct; paraffin, 2 pct; and Pentalyn-H, 10 pct (by weight)		3.6	.14	.14	10	--	--	--	--	10	--	90	10	100	13.8
		4.6	.18	.18	10	--	--	--	10	--	--	90	9	90	--
Pentachlorophenol, 5 pct; paraffin, 2 pct; and Pentalyn-H, 10 pct (by weight)		7.6	.38	.39	10	--	--	--	100	--	--	--	--	--	--
		13.5	.67	.70	10	10	10	--	80	--	--	--	--	--	--
Untreated controls		--	--	--	10	--	--	--	--	30	30	40	10	100	2.1
STAKES 3/4 BY 3/4 BY 17 INCHES															
Pentachlorophenol in liquefied petroleum gas[a]	Miss.	--	--	.15[c]	10	--	--	--	--	40	--	60	10	100	5.5
	Wis.	--	--	.15[c]	15	--	--	--	--	100	--	--	15	100	10.0
	Miss.	--	--	.19[c]	8[d]	--	--	--	--	50	--	50	8	100	4.6
	Wis.	--	--	.19[c]	14[d]	--	--	--	--	100	--	--	14	100	12.4
	Miss.	--	--	.31[c]	9[d]	--	--	--	--	22	11	67	9	100	12.0
	Wis.	--	--	.31[c]	13[d]	--	--	--	--	100	--	--	13	100	13.9
	Miss.	--	--	.48[c]	8[d]	--	--	--	--	38	12	50	8	100	15.1
	Wis.	--	--	.48[c]	10[d]	--	50	--	--	50	--	--	5	50	--
Solutions with AWPA P9 (heavy petroleum solvent) *Pentachlorophenol*, 4.2 pct (by weight)	Miss.	3.2	.13	--	9[d]	--	--	--	--	11	--	89	9	100	14.6
	Wis.	3.3	.14	--	5[d]	--	--	--	--	100	--	--	5	100	16.7
	Miss.	3.8	.16	--	10[d]	--	--	--	10	10	10	70	9	90	--
	Wis.	3.9	.16	--	7[d]	--	--	--	--	100	--	--	7	100	16.1
	Miss.	5.7	.24	--	4[d]	--	--	--	50	--	--	50	2	50	--
	Wis.	5.5	.23	--	7[d]	--	14	--	--	86	--	--	6	86	--
	Miss.	16.7	.70	--	9[d]	56	11	--	33	--	--	--	--	--	--
	Wis.	17.2	.72	--	4[d]	--	75	--	--	25	--	--	1	25	--
Solutions in Stoddard solvent Pentachlorophenol, 4.0 pct; paraffin, 2 pct; and Pentalyn-H, 10 pct (by weight)	Miss.	3.5	.14	--	9[d]	--	--	--	--	45	10	45	9	100	5.6
	Wis.	3.0	.12	--	11[d]	--	--	--	--	100	--	--	11	100	11.4
	Miss.	3.9	.16	--	10[d]	--	--	--	--	30	--	70	10	100	4.9
	Wis.	4.0	.16	--	13[d]	--	--	--	--	100	--	--	13	100	10.8
Pentachlorophenol, 5.0 pct; paraffin, 2.0 pct; and Pentalyn-H, 10 pct (by weight)	Miss.	6.4	.32	--	9[d]	--	--	--	12	22	--	66	8	88	--
	Wis.	6.6	.33	--	14[d]	--	--	--	--	100	--	--	14	100	14.6
	Miss.	14.4	.72	--	8[d]	--	--	--	100	--	--	--	--	--	--
	Wis.	14.6	.73	--	11[d]	--	91	--	--	9	--	--	1	9	--
Untreated controls	Miss.	--	--	--	10	--	--	--	--	40	30	30	10	100	1.5
	Wis.	--	--	--	15	--	--	--	--	100	--	--	15	100	4.0

[a] It has been reported that the formulation of treating solution in liquefied petroleum gas has been changed since the stakes were treated.

[b] From the analysis of composite sample of cross-section wafers taken at midpoint from ten 2- x 4- x 18-in. stakes and matched to the 10 stakes treated for installation. Since retentions were not determined for individual test stakes, extra stakes were not treated to provide a selection, according to retentions, for the test installation.

[c] Based on analysis by Bell Telephone Laboratories of 2-in. sections cut adjacent to the test stakes.

[d] Stakes injured mechanically and eliminated from test.

Table 43.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper-8-quinolinolate and pentachlorophenol in heavy petroleum solvent, after 17 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1963

Preservative	Average retention		Number in test	Condition of stakes December 1980							Total removed		Average life
					Serviceable but showing some--			Destroyed by--					
	Solution	Copper-8-quinolinolate or pentachlorophenol		Good	Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf			Pct							Number	Pct	Yr
Solutions with heavy petroleum solvent (AWPA P9): Copper-8-quinolinolate													
0.15 pct	9.4	0.014	10	--	--	--	90	--	--	10	1	10	--
0.3 pct	10.1	.030	10	10	--	--	90	--	--	--	--	--	--
0.6 pct	9.9	.059	10	--	--	--	100	--	--	--	--	--	--
1.2 pct	10.3	.124	10	30	--	10	60	--	--	--	--	--	--
Pentachlorophenol 4.98 pct	10.6	.54	10	50	--	10	40	--	--	--	--	--	--
Petroleum solvent controls	8.5	--	10	--	--	--	70	--	10	20	3	30	--
Untreated controls	--	--	10	--	--	--	--	20	--	80	10	100	2.9

Table 44.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with heptadecyltrimethyltetrahydropyrimidine (HTP) in No. 2 fuel oil, after about 17 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1963

Preservative	Average retention		Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
	Solution	HTP			Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf			Pct							Number	Pct	Yr
HTP, 2.5 pct, in No. 2 fuel oil	6.0	0.150	10	--	--	--	20	--	--	80	8	80	--
HTP, 5 pct, in No. 2 fuel oil	8.1	.406	10	--	--	--	100	--	--	--	--	--	--
HTP, 5 pct, in No. 2 fuel oil	10.0	.498	10	--	--	--	100	--	--	--	--	--	--
Untreated controls	--	--	10	--	--	--	100	--	--	100	10	100	2.3

Table 45.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in. and 3/4 x 3/4 x 16 in.) treated with pentachlorophenol in liquefied petroleum gas and in heavy petroleum solvent, after about 17 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1963

Preservative	Average retention		Number in test	Condition of stakes December 1980							Total removed		Average life
					Serviceable but showing some--			Destroyed by--					
	Solution	Pentachlorophenol		Good	Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf			Pct							Number	Pct	Yr
STAKES 2 BY 4 INCHES													
Pentachlorophenol in liquefied petroleum gas[b]	--	0.34[a]	10	--	--	--	80	10	--	10	2	20	--
	--	.49[a]	10	--	--	--	100	--	--	--	--	--	--
	--	.65[a]	10	--	--	--	100	--	--	--	--	--	--
	--	.39[a,c]	10	--	--	--	100	--	--	--	--	--	--
Pentachlorophenol, 5 pct in heavy petroleum oil	10.6	.53[d]	10	60	--	10	30	--	--	--	--	--	--
Heavy petroleum oil	8.0	--	10	--	--	--	70	10	--	20	3	30	--
Untreated controls	--	--	10	--	--	--	--	20	--	80	10	100	2.5
STAKES 3/4 BY 3/4 INCH													
Pentachlorophenol in liquefied petroleum gas[b]	--	.34[a]	10	--	--	--	10	60	--	30	9	90	--
	--	.40[a]	8[e]	--	--	--	--	75	--	25	8	100	5.1
	--	.59[a]	8[e]	--	--	--	38	38	--	24	5	62	--
	--	.70[a]	9[e]	--	--	--	67	22	--	11	3	33	--
Pentachlorophenol, 5 pct in heavy petroleum oil	10.8	.54[d]	8[e]	25	--	--	63	--	--	12	1	12	--
Heavy petroleum oil	8.3	--	8[e]	--	--	--	--	75	25	--	8	100	6.6
Untreated controls	--	--	10	--	--	--	--	50	10	40	10	100	1.4

[a] By X-ray analysis of samples from pieces from which stakes were cut.

[b] With cosolvent of isopropyl ether.

[c] Treated in commercial charge with poles and crossarms.

[d] Computed.

[e] Stake mechanically damaged and eliminated from test.

Table 46.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper-chrome-boron and acid copper chromate preservatives, after approximately 14 years of service. Stakes installed during January 1967 on the Harrison Experimental Forest, Saucier, Miss.

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Copper-chrome-boron (CB)	0.25 (0.13)[a]	10	--	--	--	--	70	--	30	10	100	3.9
(a product of	.30 (.16)	10	--	--	--	--	60	--	40	10	100	4.9
Dr. Wolman, GmbH,	.60 (.31)	10	--	--	--	--	90	--	10	10	100	5.5
Sinzheim, Germany,	1.11 (.58)	10	--	--	--	10	90	--	--	9	90	--
covered by U.S. patent	1.24 (.65)	10	10	10	--	40	20	--	20	4	40	--
No. 3,007,844)	1.64 (.86)	10	30	--	--	60	10	--	--	1	10	--
Acid copper chromate	.30 (.14)	10	--	--	--	--	100	--	--	10	100	6.1
(AWPA P5-68)	.60 (.29)	10	--	--	--	--	100	--	--	10	100	4.6
Untreated controls	--	10	--	--	--	--	10	--	90	10	100	2.6

[a] Retention values in parentheses based on preservative oxides.

Table 47.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with 11 standard wood preservatives, after about 13 years of service. Stakes placed in test in November 1967 at Lake Charles, La., in an area infested by Formosan termites, and on the Harrison Experimental Forest, Saucier, Miss.

Preservative	AWPA standard	Location	Average retention	Number in test	Condition of stakes December 1980[a]							Total removed		Average life
					Good	Serviceable but showing some--			Destroyed by--					
						Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
			Pcf		Pct							Number	Pct	Yr
Creosote, coal-tar	P1-65	La.	4.9	10	10	10	--	80	--	--	--	--	--	--
			10.2	10	90	10	--	--	--	--	--	--	--	--
			15.0	10	100	--	--	--	--	--	--	--	--	--
		Miss.	5.1	10	10	--	--	90	--	--	--	--	--	--
			9.7	10	70	10	20	--	--	--	--	--	--	--
			15.4	10	100	--	--	--	--	--	--	--	--	--
Creosote-coal-tar solution (70-30)	P2-68	La.	4.7	10	30	10	--	60	--	--	--	--	--	--
			9.9	10	100	--	--	--	--	--	--	--	--	--
			14.9	10	100	--	--	--	--	--	--	--	--	--
		Miss.	3.9	10	20	10	10	60	10	--	--	1	10	--
			10.6	10	90	--	--	10	--	--	--	--	--	--
			16.2	10	100	--	--	--	--	--	--	--	--	--
Creosote-petroleum solution (50-50)	P3-67	La.	5.8	10	40	10	--	40	--	--	10	1	10	--
			12.1	10	90	10	--	--	--	--	--	--	--	--
			18.3	10	100	--	--	--	--	--	--	--	--	--
		Miss.	6.0	10	20	10	--	70	--	--	--	--	--	--
			12.1	10	100	--	--	--	--	--	--	--	--	--
			18.5	10	100	--	--	--	--	--	--	--	--	--
Pentachlorophenol, 5 pct in heavy petroleum	P8-64 and P9-67	La.	5.8	10	40	10	--	50	--	--	--	--	--	--
			9.9	10	90	--	--	10	--	--	--	--	--	--
			15.1	10	100	--	--	--	--	--	--	--	--	--
		Miss.	7.0	10	10	--	--	90	--	--	--	--	--	--
			9.5	10	60	10	--	30	--	--	--	--	--	--
			14.6	10	100	--	--	--	--	--	--	--	--	--
Acid copper chromate	P5-68	La.	.50 (0.25)[b]	10	10	--	--	10	20	60	10	9	90	9.8[c]
			1.00 (.50)	10	20	10	--	50	--	--	10	1	10	--
			1.49 (.74)	10	50	20	--	30	--	--	--	--	--	--
		Miss.	.51 (.25)	10	40	--	--	10	40	--	10	5	50	--
			1.01 (.50)	10	70	--	--	--	30	--	--	3	30	--
			1.54 (.76)	10	80	--	--	--	20	--	--	2	20	--
Ammoniacal copper arsenate	P5-68	La.	.25 (.24)	10	10	--	--	20	50	--	20	7	70	11.4[c]
			.46 (.44)	10	--	--	10	90	--	--	--	--	--	--
			.67 (.63)	10	10	30	--	60	--	--	--	--	--	--
		Miss.	.26 (.25)	10	30	10	--	50	10	-	--	1	10	--
			.48 (.45)	10	100	--	--	--	--	--	--	--	--	--
			.70 (.66)	10	100	--	--	--	--	--	--	--	--	--
Chromated copper arsenate type A	P5-68	La.	.40 (.23)	10	20	30	--	40	--	--	10	1	10	--
			.76 (.44)	10	70	--	20	10	--	--	--	--	--	--
			1.11 (.64)	10	100	--	--	--	--	--	--	--	--	--
		Miss.	.39 (.22)	10	90	--	--	--	10	--	--	1	10	--
			.76 (.44)	10[d]	100	--	--	--	--	--	--	--	--	--
			1.14 (.66)	9[d]	100	--	--	--	--	--	--	--	--	--

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Table 47.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with 11 standard wood preservatives, after about 13 years of service. Stakes placed in test in November 1967 at Lake Charles, La., in an area infested by Formosan termites, and on the Harrison Experimental Forest, Saucier, Miss.--continued

Preservative	AWPA standard	Location	Average retention	Number in test	Condition of stakes December 1980[a]							Total removed		Average life
					Good	Serviceable but showing some--			Destroyed by--					
						Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
			Pcf		Pct							Number	Pct	Yr
Chromated copper arsenate type B	P5-68	La.	.25 (0.23)	10	10	30	--	50	--	--	10	1	10	--
			.44 (.40)	10	70	20	--	10	--	--	--	--	--	--
			.65 (.59)	10	90	10	--	--	--	--	--	--	--	--
		Miss.	.25 (.23)	10	80	--	--	--	20	--	--	2	20	--
			.42 (.38)	10	100	--	--	--	--	--	--	--	--	--
			.61 (.55)	10	100	--	--	--	--	--	--	--	--	--
Chromated zinc chloride	P5-68	La.	.76 (.46)	10	--	--	--	--	--	80	20	10	100	6.0
			1.02 (.62)	10	--	--	--	--	10	60	30	10	100	7.2
			1.50 (.92)	9	--	--	--	--	10	60	20	9	100	9.4
		Miss.	.76 (.46)	10	--	--	--	50	10	--	40	5	50	--
			1.02 (.62)	10	--	--	30	30	40	--	--	4	40	--
			1.57 (.96)	10	10	--	--	60	20	--	--	2	20	--
Fluor chrome arsenate phenol type A	P5-68	La.	.35 (.22)	10	--	10	--	50	--	20	20	4	40	13.4[c]
			.50 (.31)	10	--	--	--	60	--	10	30	4	40	13.8[c]
			1.11 (.69)	10	--	20	--	70	10	--	--	1	10	--
		Miss.	.35 (.22)	10	--	--	10	90	--	--	--	--	--	--
			.51 (.31)	10	--	--	--	80	20	--	--	2	20	--
			1.16 (.72)	10	40	10	20	30	--	--	--	--	--	--
Fluor chrome arsenate phenol type B	P5-68	La.	.35 (0.21)	10	--	--	--	60	--	10	30	4	40	13.4[c]
			.50 (.30)	10	--	--	--	90	--	--	10	1	10	--
			1.12 (.68)	10	20	--	10	60	10	--	--	1	10	--
		Miss.	.35 (.21)	10	10	10	--	70	--	10	--	1	10	--
			.51 (.30)	10	20	10	20	50	--	--	--	--	--	--
			1.19 (.72)	10	70	10	--	20	--	--	--	--	--	--
Untreated controls		La.	-- --	10	--	--	--	--	10	90	--	10	100	2.3
		Miss.	-- --	10	--	--	--	--	30	20	50	10	100	2.0

[a] Final inspection at Lake Charles, La., December 1979.

[b] Retention values in parentheses are based on preservative oxides.

[c] Estimate based on percentage of stakes remaining after final inspection.

[d] Stake damaged by falling tree eliminated from test.

Table 48.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with copper-chrome-phosphorus and chromated copper arsenate type III preservatives, after about 9 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1971, and Madison, Wis., May 1972

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
Copper-chrome-phosphorus	Miss.	0.26[a]	10	40	--	10	10	40	--	--	4	40	--
	Wis.	.27[a]	10	40	30	--	--	30	--	--	3	30	--
	Miss.	.46[a]	10	60	--	--	20	20	--	--	2	20	--
	Miss.	.75[a]	10	80	--	--	20	--	--	--	--	--	--
	Wis.	.74[a]	10	50	50	--	--	--	--	--	--	--	--
	Miss.	1.50[a]	10	80	--	--	20	--	--	--	--	--	--
Chromated copper arsenate type III (Fed. Spec. TT-W-550)	Miss.	.20[b]	10	90	--	--	10	--	--	--	--	--	--
	Wis.	.20[b]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.40[b]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.40[b]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.60[b]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.60[b]	10	90	10	--	--	--	--	--	--	--	--
Untreated controls	Miss.	--	--	--	--	--	--	10	--	90	10	100	2.9
	Wis.	--	9[c]	--	20	--	--	70	--	--	7	78	--

[a] Retention based on Osmose Company's analysis of preservative oxides.

[b] Retention based on preservative oxides.

[c] 10 stakes originally installed, eliminated stakes removed for causes other than decay or insect attack.

Table 49.--Condition of stakes of aspen particleboard[a] (3/4 x 4 x 18 in.), treated with chromated copper arsenate type III, fluor chrome arsenate phenol type A, and pentachlorophenol in ethanol or mineral spirits, after 7-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., May 1973

Preservative	Average retention based on preservative oxides	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
FLAKES TREATED BEFORE FABRICATION INTO PARTICLEBOARD[b]												
Chromated copper arsenate type III (Fed. Spec. TT-W-550)	0.25	10	30	60	--	10	--	--	--	--	--	--
	.40	10	60	40	--	--	--	--	--	--	--	--
	.80	10	100	--	--	--	--	--	--	--	--	--
Fluor chrome arsenate phenol type A (Fed. Spec. TT-W-535)	.25	10	--	10	--	--	80	--	10	9	90	--
	.50	10	--	--	--	50	50	--	--	5	50	--
Pentachlorophenol (Fed. Spec. TT-W-570) in ethanol	.25	10	--	--	--	10	40	--	50	9	90	--
	.40	10	--	--	--	40	40	--	20	6	60	--
	.80	10	--	--	--	80	20	--	--	2	20	--
PRESSURE-TREATED PARTICLEBOARD												
Chromated copper arsenate type III (Fed. Spec. TT-W-550)	.26	10	50	20	--	20	10	--	--	1	10	--
	.41	10	60	20	--	20	--	--	--	--	--	--
	.84	10	100	--	--	--	--	--	--	--	--	--
Fluor chrome arsenate phenol type A (Fed. Spec. TT-W-535)	.26	10	--	10	--	20	50	--	20	7	70	--
	.54	10	--	30	--	40	30	--	--	3	30	--
Pentachlorophenol (Fed. Spec. TT-W-570) 5 pct in mineral spirits and 4 pct pine oil	.22	10	--	--	--	--	70	--	30	10	100	5.4
	.40	10	--	--	--	50	50	--	--	5	50	--
	.82	10	--	--	--	90	10	--	--	1	10	--
Untreated controls	--	10	--	--	--	--	10	10	80	10	100	2.0

[a] Density 40 pcf.

[b] Flakes sprayed with predetermined amount of preservative solution while being tumbled in screen.

Table 50.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with propylene oxide, butylene oxide, and epichlorohydrin/propylene oxide combinations, after 2 and 6 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., October 31, 1974 and September 1978[a]

Nontoxic preservatives	Average loading	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
	Weight add on			Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pct		Pct							Number	Pct	Yr
Propylene oxide	15-27	2	0	--	--	--	--	--	100	2	100	2.0
	29-33	3	--	--	--	33	--	--	67	2	67	--
Butylene oxide	17-22	2	--	--	--	--	--	--	100	2	100	4.2
	37-40	3	33	--	--	67	--	--	--	--	--	--
	31[b]	15	53	27	--	20	--	--	--	--	--	--
Epichlorohydrin, 1 part; propylene oxide, 2 parts	10	1	--	--	--	100	--	--	--	--	--	--
	26	1	--	--	--	--	--	--	100	1	100	--
Controls	--	6	--	--	--	--	33	--	67	6	100	2.9

[a] The data presented here is part of a larger study under the guidance of R. M. Rowell.

[b] 15 Butylene oxide treated stakes installed in Mississippi, September 1978.

Table 51.--Condition of southern pine, Douglas-fir, and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 5 years of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., December 1975

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
SOUTHERN PINE[a,b] 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED													
Chromated copper arsenate type III	Miss.	0.23	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.14	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.28	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.19	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.47	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.30	10	100	--	--	--	--	--	--	--	--	--
None	Miss.	--	10	--	--	--	60	10	--	30	4	40	--
	Wis.	--	10	80	20	--	--	--	--	--	--	--	--
SOUTHERN PINE[a,b] 2- BY 4-INCH NOMINAL BY 18-INCH INCISED													
Chromated copper arsenate type III	Miss.	.27	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.19	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.47	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.30	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.61	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.37	10	100	--	--	--	--	--	--	--	--	--
SOUTHERN PINE[a] 3/4- BY 3-1/2- BY 18-INCH PLYWOOD													
Chromated copper arsenate type III[c]	Miss.	.39	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.38	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.80	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	.78	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.21	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.17	9[d]	100	--	--	--	--	--	--	--	--	--
None	Miss.	--	10[d]	--	--	--	--	10	10	80	10	100	2.8
	Wis.	--	9[d]	--	11	--	--	89	--	--	8	89	--
Chromated copper arsenate type III[e]	Miss.	.36[f]	10	90	10	--	--	--	--	--	--	--	--
	Wis.	.36[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.74[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.74[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.62[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.62[f]	10	100	--	--	--	--	--	--	--	--	--
Chromated copper arsenate type III[g]	Miss.	.36[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.36[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.74[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.74[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.62[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.62[f]	10	100	--	--	--	--	--	--	--	--	--

Table 51.--Condition of southern pine, Douglas-fir, and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 5 years of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., December 1975--continued

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
SOUTHERN PINE[a,b] 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED													
Ammoniacal copper arsenate	Miss.	0.11	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.07	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.30	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.16	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.42	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.26	10	100	--	--	--	--	--	--	--	--	--
SOUTHERN PINE[a,b] 2- BY 4-INCH NOMINAL BY 18-INCH INCISED													
Ammoniacal copper arsenate	Miss.	.14	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.07	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.30	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.15	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.65	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.39	10	100	--	--	--	--	--	--	--	--	--
SOUTHERN PINE[a] 3/4- BY 3-1/2- BY 18-INCH PLYWOOD													
Ammoniacal copper arsenate[c]	Miss.	.39	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.38	10	100	--	--	--	--	--	--	--	--	--
	Miss.	*.80*	*10*	*100*	--	--	--	--	--	--	--	--	--
	Wis.	.79	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.19	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.15	9[d]	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate[e]	Miss.	.38[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.38[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.77[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.77[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.08[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.08[f]	10	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate[g]	Miss.	.38[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.38[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.77[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.77[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.08[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.08[f]	10	100	--	--	--	--	--	--	--	--	--

Table 51.--Condition of southern pine, Douglas-fir, and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 5 years of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., December 1975--continued

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
DOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED													
Chromated copper arsenate type III	Miss.	0.66	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.55	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.24	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.82	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.62	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.41	10	100	--	--	--	--	--	--	--	--	--
None	Miss.	--	10	--	--	--	--	10	10	80	10	100	3.7
	Wis.	--	10	60	40	--	--	--	--	--	--	--	--
DOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH INCISED													
Chromated copper arsenate type III	Miss.	.66	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.56	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.28	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.96	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.88	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.28	10	100	--	--	--	--	--	--	--	--	--
DOUGLAS-FIR 3/4- BY 3-1/2- BY 18-INCH PLYWOOD													
Chromated copper arsenate type III[c]	Miss.	.62	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.62	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.25	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.22	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.88	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.83	10	100	--	--	--	--	--	--	--	--	--
None	Miss.	--	10	100	--	--	--	20	20	60	10	100	3.2
	Wis.	--	9[d]	--	22	--	--	78	--	--	7	78	--
Chromated copper arsenate type III[e]	Miss.	.60[f]	9[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	.60[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.22[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.22[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.82[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.82[f]	10	100	--	--	--	--	--	--	--	--	--
Chromated copper arsenate type III[g]	Miss.	.60[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.60[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.22[f]	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.22[f]	8[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.82[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.82[f]	10	100	--	--	--	--	--	--	--	--	--

Table 51.--Condition of southern pine, Douglas-fir, and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 5 years of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., December 1975--continued

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
DOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED													
Ammoniacal copper arsenate	Miss.	0.70	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.61	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.42	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.29	10	100	--	--	--	--	--	--	--	--	--
	Miss.	2.14	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.95	9[d]	100	--	--	--	--	--	--	--	--	--
DOUGLAS-FIR 2- BY 4-INCH NOMINAL BY 18-INCH INCISED													
Ammoniacal copper arsenate	Miss.	.70	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.62	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.41	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.26	10	100	--	--	--	--	--	--	--	--	--
	Miss.	2.17	10	100	--	--	--	--	--	--	--	--	--
	Wis.	2.00	10	100	--	--	--	--	--	--	--	--	--
DOUGLAS-FIR 3/4- BY 3-1/2- BY 18-INCH PLYWOOD													
Ammoniacal copper arsenate[c]	Miss.	.63	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.62	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.30	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.27	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.97	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.93	10	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate[e]	Miss.	.64[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.64[f]	9	100	--	--	--	--	--	--	--	--	--
	Miss.	1.30[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.30[f]	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.98[f]	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.98[f]	9[d]	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate[g]	Miss.	.64[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.64[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.30[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.30[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.98[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.98[f]	10	100	--	--	--	--	--	--	--	--	--

Table 51.--Condition of southern, pine Douglas-fir and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 5 years of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., December 1975--continued

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED													
Chromated copper arsenate type III	Miss.	0.31	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.21	9	100	--	--	--	--	--	--	--	--	--
	Miss.	.50	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.40	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.64	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.48	10	100	--	--	--	--	--	--	--	--	--
None	Miss.	--	10	--	--	--	--	10	10	80	10	100	3.3
	Wis.	--	10	--	80	--	--	20	--	--	2	20	--
ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH INCISED													
Chromated copper arsenate type III	Miss.	.40	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.28	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.66	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.56	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.02	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.86	10	100	--	--	--	--	--	--	--	--	--
ENGELMANN SPRUCE 3/4- BY 3-1/2- BY 18-INCH PLYWOOD													
Chromated copper arsenate type III[c]	Miss.	.71	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	.70	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.38	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.34	10	100	--	--	--	--	--	--	--	--	--
	Miss.	2.03	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.82	10	100	--	--	--	--	--	--	--	--	--
None	Miss.	--	10[d]	--	--	--	--	10	20	70	10	100	2.6
	Wis.	--	8[d]	--	--	--	--	100	--	--	8	100	5.1
Chromated copper arsenate type III[e]	Miss.	.54[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.54[f]	9	89	11	--	--	--	--	--	--	--	--
	Miss.	1.25[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.25[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.76[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.76[f]	10	100	--	--	--	--	--	--	--	--	--
Chromated copper arsenate type III[g]	Miss.	.54[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.54[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.25[f]	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.25[f]	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.76[f]	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.76[f]	9[d]	100	--	--	--	--	--	--	--	--	--

Table 51.--Condition of southern pine, Douglas-fir, and Engelmann spruce heartwood stakes, treated with ammoniacal copper arsenate and chromated copper arsenate, after about 5 years of service. Stakes placed in test at Madison, Wis., May 1976, and on the Harrison Experimental Forest, Saucier, Miss., December 1975--continued

Preservative	Location	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
				Good	Serviceable but showing some--			Destroyed by--					
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
		Pcf		Pct							Number	Pct	Yr
ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH UNINCISED													
Ammoniacal copper arsenate	Miss.	0.26	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.20	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.63	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.50	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.03	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.75	10	100	--	--	--	--	--	--	--	--	--
ENGELMANN SPRUCE 2- BY 4-INCH NOMINAL BY 18-INCH INCISED													
Ammoniacal copper arsenate	Miss.	.42	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.30	10	100	--	--	--	--	--	--	--	--	--
	Miss.	.97	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	.81	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	1.41	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.61	10	100	--	--	--	--	--	--	--	--	--
ENGELMANN SPRUCE 3/4- BY 3-1/2- BY 18-INCH PLYWOOD													
Ammoniacal copper arsenate[c]	Miss.	.70	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.68	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.42	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.38	10	100	--	--	--	--	--	--	--	--	--
	Miss.	2.44	10	100	--	--	--	--	--	--	--	--	--
	Wis.	2.68	10	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate[e]	Miss.	.65[f]	10	90	--	10	--	--	--	--	--	--	--
	Wis.	.65[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.29[f]	10[d]	100	--	--	--	--	--	--	--	--	--
	Wis.	1.29[f]	9[d]	100	--	--	--	--	--	--	--	--	--
	Miss.	2.02[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	2.02[f]	10	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate[g]	Miss.	.65[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	.65[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	1.29[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	1.29[f]	10	100	--	--	--	--	--	--	--	--	--
	Miss.	2.02[f]	10	100	--	--	--	--	--	--	--	--	--
	Wis.	2.02[f]	10	100	--	--	--	--	--	--	--	--	--

[a] Some southern pine contained a small amount of sapwood, and the southern pine plywood was mixed heartwood and sap.

[b] Resin content of the southern pine ranged from 0.87 to 27.4 percent.

[c] Treated as 3/4- x 3-1/2- x 18-inch stakes.

[d] 10 stakes originally installed, eliminations were for causes other than decay or insect attack.

[e] Stakes cut from treated 2- x 4-foot panel.

[f] Retention-by-weight of panels from which stakes were cut.

[g] Stakes cut from treated 2- x 4-foot panel, all cut surfaces given a liberal brush coat of a 4.5 percent solution of the preservative the panels were treated with.

Table 52.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with ammoniacal copper borate and ammoniacal copper arsenate, after about 5 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1975[a]

Preservative	Average retention[b]	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
Ammoniacal copper borate	1.33	25	100	--	--	--	--	--	--	--	--	--
	.655	25	100	--	--	--	--	--	--	--	--	--
	.455	25	100	--	--	--	--	--	--	--	--	--
	.323	24	96	--	--	--	4	--	--	1	4	--
	.225	25	60	20	--	12	8	--	--	1	8	--
	.165	24	54	4	--	4	38	--	--	9	38	--
Ammoniacal copper arsenate	1.35	25	100	--	--	--	--	--	--	--	--	--
	.655	25	100	--	--	--	--	--	--	--	--	--
	.469	25	100	--	--	--	--	--	--	--	--	--
	.330	25	100	--	--	--	--	--	--	--	--	--
	.226	25	100	--	--	--	--	--	--	--	--	--
	.165	23	92	4	4	--	--	--	--	--	--	--
Untreated controls	--	17	--	--	--	--	5	24	71	17	100	3.0

[a] The data presented here is part of a study under investigation by B. R. Johnson.

[b] Retention based on preservative oxides.

Table 53.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.), treated with fire-retardant chemicals, after about 4-1/2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., May 1976

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
UDFP[a] fire retardant	2.8	10	10	--	80	10	--	--	--	--	--	--
	6.0	10	--	--	70	30	--	--	--	--	--	--
	9.5	10	--	--	30	20	--	50	--	5	50	--
Untreated controls	--	10	--	--	--	--	10	--	90	10	100	2.5

[a] Reported to contain urea, dicyandiamide, formaldehyde, and phosphoric acid.

Table 54.--Condition of southern pine stakes (2 x 4 in. and 3/4 x 3/4 in. nominal x 18 in.), treated with pentachlorophenol in light cycle oil and copper-8-quinolinolate, after 4 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1976

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
2- BY 4- BY 18-INCH STAKES												
Pentachlorophenol	0.48	10	90	--	--	10	--	--	--	--	--	--
Copper-8-quinolinolate[a]	1.12	10	30	30	30	10	--	--	--	--	--	--
Untreated controls	--	10	--	--	--	--	30	20	50	10	100	2.5
3/4- BY 3/4- BY 18-INCH STAKES												
Pentachlorophenol	.21	10	20	--	30	50	--	--	--	--	--	--
	.31	10	100	--	--	--	--	--	--	--	--	--
	.38	10	90	--	10	--	--	--	--	--	--	--
	.47	10	90	--	10	--	--	--	--	--	--	--
	.67	10	100	--	--	--	--	--	--	--	--	--
Copper-8-quinolinolate[a]	0.34	9[b]	0	--	--	--	12	44	44	9	100	3.3
	.38	10	--	--	--	10	20	30	40	9	90	--
	.50	10	--	--	--	50	10	10	30	5	50	--
	.94	10[b]	--	--	--	80	--	20	--	2	20	--
	1.16	9[b]	11	--	22	56	11	--	--	1	11	--
	1.30	10[b]	--	--	10	80	10	--	--	1	10	--
	1.84	9[b]	--	22	--	67	11	--	--	1	10	--
Untreated controls	--	8[b]	--	12	--	25	38	12	50	8	100	2.4

[a] Copper-8-quinolinolate is a water-soluble form that contains 1.07 percent copper metal (PQ-8).

[b] 10 stakes originally installed, eliminations were for mechanical damage or causes other than decay or insect attack.

Table 55.--Condition of southern pine and Douglas-fir comply stakes (2 x 4 in. nominal x 18 in.), treated with chromated copper arsenate and ammoniacal copper arsenate, after about 2 years of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., November 1978

Preservative	Average retention based on preservative oxides	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
SOUTHERN PINE												
Chromated copper arsenate type III	0.25	10	100	--	--	--	--	--	--	--	--	--
	.41	10	100	--	--	--	--	--	--	--	--	--
	.77	10	100	--	--	--	--	--	--	--	--	--
Untreated controls	--	10	--	--	10	40	--	--	50	5	50	--
DOUGLAS-FIR												
Chromated copper arsenate type III	.26	10	100	--	--	--	--	--	--	--	--	--
	.60	10	100	--	--	--	--	--	--	--	--	--
Ammoniacal copper arsenate	.25	10	100	--	--	--	--	--	--	--	--	--
	.39	10	100	--	--	--	--	--	--	--	--	--
	.63	10	100	--	--	--	--	--	--	--	--	--
Untreated controls	--	10	30	--	30	40	--	--	--	--	--	--

Table 56.--Condition of southern pine stakes (3/4 x 3/4 in. nominal x 18 inch) treated with butylene oxide, after 1 year of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., December 1979[a]

Preservative	Average loading	Number in test	Condition of stakes December 1980							Total removed		Average life
				Serviceable but showing some--			Destroyed by--					
	Weight add on		Good	Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pct		Pct							Number	Pct	Yr
Butylene oxide	33.2	20	85	5	5	5	--	--	--	--	--	--
Untreated controls	--	10	20	20	10	40	--	--	10	1	10	--

[a] The data presented here is part of a larger study under the guidance of R. M. Rowell.

Table 57.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in. and 3/4 x 3/4 x 18 in.) treated with chromated copper arsenate type C using conventional full-cell (FC) process and Mississippi State University (MSU process--empty cell), after 1/2 year of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., April 1980

Preservative	Average retention	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
2- BY 4- BY 18-INCH STAKES												
Chromated copper arsenate type C												
Full cell	0.135	10	100	--	--	--	--	--	--	--	--	--
	.275	10	100	--	--	--	--	--	--	--	--	--
	.396	10	100	--	--	--	--	--	--	--	--	--
	.624	10	100	--	--	--	--	--	--	--	--	--
	.788	10	100	--	--	--	--	--	--	--	--	--
3/4- BY 3/4- BY 18-INCH STAKES												
	.140	10	100	--	--	--	--	--	--	--	--	--
	.273	10	100	--	--	--	--	--	--	--	--	--
	.402	10	100	--	--	--	--	--	--	--	--	--
	.612	10	100	--	--	--	--	--	--	--	--	--
	.815	10	100	--	--	--	--	--	--	--	--	--
2- BY 4- BY 18-INCH STAKES												
Empty cell	.135[a]	10	100	--	--	--	--	--	--	--	--	--
	.275	10	100	--	--	--	--	--	--	--	--	--
	.396	10	100	--	--	--	--	--	--	--	--	--
	.624	10	100	--	--	--	--	--	--	--	--	--
	.788	10	100	--	--	--	--	--	--	--	--	--
3/4- BY 3/4- BY 18-INCH STAKES												
Empty cell--continued	.140[a]	10	100	--	--	--	--	--	--	--	--	--
	.273	10	100	--	--	--	--	--	--	--	--	--
	.402	10	100	--	--	--	--	--	--	--	--	--
	.612	10	100	--	--	--	--	--	--	--	--	--
	.815	10	100	--	--	--	--	--	--	--	--	--
2- BY 4- BY 18-INCH STAKES												
Untreated controls	--	10	20	20	10	50	--	--	--	--	--	--
3/4- BY 3/4- BY 18-INCH STAKES												
Untreated controls	--	10	50	30	10	--	10	--	--	1	10	--

[a] The retentions for the empty cell treatments are estimates based on the full cell treatments.

Table 58.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in. and 2.5 x 5.0 cm x 50 cm), treated with chromated copper fluoride (CFK), after 1/2 year of service. Stakes placed in test on the Harrison Experimental Forest, Saucier, Miss., June 1980[a]

Preservative	Average retention based on preservative oxides	Number in test	Condition of stakes December 1980							Total removed		Average life
			Good	Serviceable but showing some--			Destroyed by--					
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termite attack	Decay fungi and termite attack			
	Pcf		Pct							Number	Pct	Yr
2- BY 4- BY 18-INCH STAKES												
Chromated copper fluoride (CFK)	0.28	10	100	--	--	--	--	--	--	--	--	--
	.59	10	100	--	--	--	--	--	--	--	--	--
	1.22	10	100	--	--	--	--	--	--	--	--	--
	1.57	10	100	--	--	--	--	--	--	--	--	--
Untreated controls	--	10	50	--	30	10	10	--	--	1	10	--
2.5- x 5.0- x 50-cm STAKES												
Chromated copper fluoride (CFK)	.30	10	100	--	--	--	--	--	--	--	--	--
	.62	10	100	--	--	--	--	--	--	--	--	--
	1.26	10	100	--	--	--	--	--	--	--	--	--
	1.69	10	100	--	--	--	--	--	--	--	--	--
Untreated controls	--	10	40	--	40	10	--	10	--	1	10	--

[a] Data presented here is part of a study under investigation by R. C. DeGroot.

Table 59.--Summary of 2- by 4-inch-stake test results obtained in Mississippi with wood preservatives in general use

Preservative	Average retention	Data from table No.	Average life	Remarks
	Pcf		Yr	
Acid copper chromate (Fed. Spec. TT-W-546)	0.26 (0.13)[a]	15	11.6	--
	.30 (.14)	46	6.1	--
	.51 (.25)	47	--	50 pct failed after 13 yr
	.52 (.26)	15	--	20 pct failed after 35 yr
	.60 (.29)	46	4.6	--
	.75 (.37)	15	--	40 pct failed after 35 yr
	1.01 (.50)	47	--	30 pct failed after 13 yr
	1.54 (.76)	47	--	20 pct failed after 13 yr
Ammoniacal copper arsenate (Fed. Spec. TT-W-549)	.25 (.24)	14	--	40 pct failed after 36 yr
	.26 (.25)	47		10 pct failed after 13 yr
	.53 (.51)	14	--	No failures after 36 yr
	1.00 (.97)	14	--	No failures after 36yr
	1.29 (1.25)	14	--	No failures after 36 yr
Chromated copper arsenate Type I (Fed. Spec. TT-W-550)	.26 (.15)	15	--	70 pct failed after 35 yr
	.25 (.23)	47		20 pct failed after 13 yr
	.50 (.29)	15	--	No failures after 35 yr
	.78 (.44)	15	--	No failures after 35 yr
Type II (Fed. Spec. TT-W-550)	(.26)	20	--	No failures after 31 yr
	(.37)	20	--	No failures after 31 yr
	(.52)	20	--	No failures after 31 yr
	(.79)	20	--	No failures after 31 yr
	(1.04)	20	--	No failures after 31 yr
Chromated zinc arsenate (former Fed. Spec. TT-W-538)	.22 (.11)	24	--	80 pct failed after 29 yr
	.33 (.22)	4	33.0	--
	.44 (.29)	4	--	78 pct failed after 40-1/2 yr
	.38 (.20)	24	--	No failures after 29 yr
	.77 (.40)	24	--	No failures after 29 yr
	1.01 (.53)	24	--	No failures after 29 yr
	.58 (.38)	4	--	20 pct failed after 40-1/2 yr
	.78 (.52) to 1.06 (.70)	4	--	No failures after 40-1/2 yr
Chromated zinc chloride (Fed. Spec. TT-W-551)	.49 (.30)	2	14.2	--
	.76 (.47)	2	20.2	--
	.76 (.46)	47	--	50 pct failed after 13 yr
	1.02 (.63)	2	20.1	--
	1.02 (.62)	47	--	40 pct failed after 13 yr
	1.50 (.92)	25	--	80 pct failed after 29 yr
	1.57 (.96)	47	--	20 pct failed after 13 yr
	2.91 (1.78)	25	--	40 pct failed after 29 yr
	6.00 (3.67)	25	--	No failures after 29 yr
Copper-8-quinolinolate Stoddard solvent	.01	38	5.3	--
	.02	38	4.2	--
	.06	38	5.6	
	.06	38	7.8	--
	.12	38	7.8	--
Copper-8-quinolinolate AWPA P9 heavy petroleum	.014	43	--	10 pct failed after 17 yr
	.03	43	--	No failures after 17 yr
	.059	43	--	No failures after 17 yr
	.124	43	--	No failures after 17 yr

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Table 59.--Summary of 2- by 4-inch-stake test results obtained in Mississippi with wood preservatives in general use--continued

Preservative	Average retention		Data from table No.	Average life	Remarks
	Pcf			Yr	
Copper naphthenate					
0.11 pct copper in No. 2 fuel oil	10.3		7	15.9	--
.29 pct copper in No. 2 fuel oil	10.2		7	21.8	--
.57 pct copper in No. 2 fuel oil	10.6		7	27.2	--
.86 pct copper in No. 2 fuel oil	9.6		7	--	70 pct failed after 39 yr
Creosote, coal-tar	3.3		6	24.9	--
	4.1		17	14.2	--
	4.2		4	17.8	--
	4.6		5	21.3	--
	7.8		6	--	60 pct failed after 39-1/2 yr
	8.0		4	--	50 pct failed after 40-1/2 yr
	8.3		20	--	20 pct failed after 31 yr
	10.0		5	--	70 pct failed after 40 yr
	11.8		4	--	20 pct failed after 40-1/2 yr
	13.2		6	--	20 pct failed after 39-1/2 yr
	14.5		5	--	No failures after 40 yr
	16.5		4	--	No failures after 40-1/2 yr
Low residue, straight run	8.0		18	17.8	--
Medium residue, straight run	8.0		18	18.8	--
High residue, straight run	7.8		18	20.3	--
Medium residue					
Low in tar acids	8.1		18	19.4	--
Low in naphthalene	8.2		18	21.3	--
Low in tar acids and naphthalene	8.0		18	18.9	--
Low residue, low in tar acids and naphthalene	8.0		18	19.2	--
High residue, low in tar acids and naphthalene	*8.2*		*18*	*20.0*	--
English vertical retort	5.3		19	--	70 pct failed after 32 yr
	8.0		18	18.9	--
	10.1		19	--	40 pct failed after 32 yr
	15.0		19	--	No failures after 32 yr
English coke oven	4.7		19	16.3	--
	7.9		18	13.6	--
	10.1		19	--	70 pct failed after 32 yr
	14.8		19	--	70 pct failed after 32 yr
Fluor chrome arsenate phenol type A (Fed. Spec. TT-W-535)	.2	(0.12)[a]	2	10.2	--
	.3	(.19)	2	18.0	--
	.35	(.22)	37	--	88 pct failed after 21 yr
	.50	(.31)	37	--	70 pct failed after 21 yr
	.61	(.38)	2	24.1	--
	.75	(.47)	37	--	10 pct failed after 21 yr
Pentachlorophenol (various solvents)[b]					
Liquefied petroleum gas	.14		42	--	70 pct failed after 19-1/2 yr
	.19		42	--	70 pct failed after 19-1/2 yr
	.34		42	--	No failures after 19-1/2 yr
	.34		45	--	20 pct failed after 17 yr
	.49		45	--	No failures after 17 yr
	.58		42	--	No failures after 19-1/2 yr
	.65		45	--	No failures after 17 yr

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Table 59 --Summary of 2- by 4-inch-stake test results obtained in Mississippi with wood preservatives in general use--continued

Preservative	Average retention	Data from table No.	Average life	Remarks
	Pcf		Yr	
Pentachlorophenol (various solvents)[b]--continued				
Stoddard solvent (mineral spirits)	.14	42	13.8	--
	.18	42	--	90 pct failed after 19-1/2 yr
	.20	22	9.5	--
	.20	17	13.7	--
	.38	42	--	No failures after 19-1/2 yr
	.40	22	15.5	--
	.67	42	--	No failures after 19-1/2 yr
Heavy gas oil (Mid-United States)	.20	17	--	33 pct failed after 32-1/2 yr
	.40	17	--	10 pct failed after 32-1/2 yr
	.60	17	--	10 pct failed after 32-1/2 yr
No. 4 aromatic oil (West Coast)	.21	22	--	90 pct failed after 31 yr
	.41	22	--	30 pct failed after 31 yr
AWPA P9 (heavy petroleum)	.11	42	--	10 pct failed after 19-1/2 yr
	.19	42	--	No failures after 19-1/2 yr
	.29	42	--	No failures after 19-1/2 yr
	.53	45	--	No failures after 17 yr
	.67	42	--	No failures after 19-1/2 yr
Tributyltin oxide				
Stoddard solver	.015	36	6.3	--
	.025	41	4.5	--
	.030	36	7.2	--
	.045	36	7.4	--
	.047	41	7.0	--
AWPA P9 (heavy petroleum)	.024	41	--	20 pct failed after 20 yr
	.048	41	--	No failures after 20 yr
Petroleum solvent controls	4.0	17	7.6	--
	4.1	17	4.4	--
	4.7	17	12.9	--
	7.7	23	--	90 pct failed after 29 yr
	7.9	17	--	70 pct failed after 32-1/2 yr
	8.0	45	--	30 pct failed after 17 yr
	8.0	41	--	40 pct failed after 20 yr
	8.0	17	14.6	--
	8.1	18	3.4	--
	8.5	43	--	30 pct failed after 17 yr
	9.8	5	6.3	--
	12.0	17	17.1	--
	12.1	17	--	10 pct failed after 32-1/2 yr
	19.4	5	9.1	--
Untreated stakes	--	Misc.	1.8 to 3.6	--

[a] Retention values in parentheses are based on preservative oxides.

[b] See tables 5 and 17 for pentachlorophenol in other solvents.

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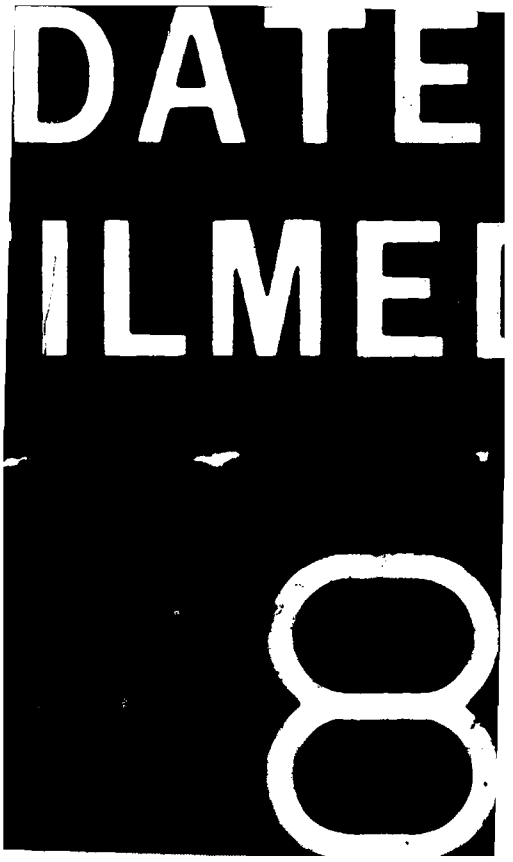
PR 5-2-2

U.S. Forest Products Laboratory.

Comparison of wood preservatives in stake tests (1981 progress report), by L. R. Gjovik and D. I. Gutzmer, Madison, Wis., FPL, 1981.
83 pp., tables (USDA For. Serv. Res. Note FPL-02).

Compares wood preservatives used on test stakes of southern pine sapwood on five different sites.

KEYWORDS: Wood preservatives, preservative retention, service life, outdoor exposure, stakes.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