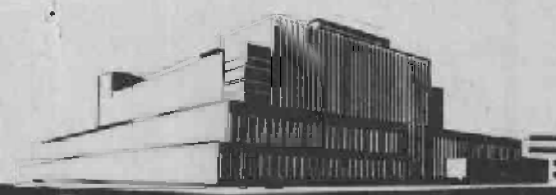
COMPARISON OF WOOD PRESERVATIVES IN STAKE TESTS

(1962 Progress Report)

March 1962

No. 1761



FOREST PRODUCTS LABORATORY
MADISON 5, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

COMPARISON OF WOOD PRESERVATIVES IN STAKE TESTS

(1962 Progress Report)

By

J. OSCAR BLEW, Jr., Technologist

Forest Products Laboratory,[1] Forest Service
U. S. Department of Agriculture

Abstract

Test stakes of southern yellow pine sapwood 2 by 4 inches (nominal) by 18 inches in size were treated by pressure and nonpressure processes and installed by the Forest Products Laboratory and cooperators in decay and termite exposure test at various times since 1938 at the Harrison Experimental Forest, Saucier, Miss., Madison, Wis., Bogalusa , 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, modified woods, laminated paper plastic, and pine infected with Trichoderma mold. Southern yellow pine untreated control stakes have had an average life of about 1 year in the Canal Zone, 2 to 3 years in Mississippi, Florida, and Louisiana, and about 6 years in Wisconsin. Superficial treatments by dipping and brushing with preservatives such as coal-tar creosote and petroleum oils containing copper naphthenate, zinc naphthenate, phenyl mercury oleate, and pentachlorophenol have added a few months to 4 years to the life of the untreated stakes. Some waterborne preservatives have provided less protection to the stakes than the standard preservative oils, such as coal-tar creosote and pentachlorophenol solutions, when preservative retentions have corresponded to those in commercial use. Other waterborne preservatives, during the time they have been in test, have shown results that compare favorably with those from the standard preservative oils.

---

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

Introduction

The results of an international termite exposure test[2] have indicated that pine sapwood stakes 2 by 4 by 18 inches provide 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 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., test station. Also installed at that station, so that 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, wood infected with Trichoderma mold, and embedded fiberboard (western hemlock strands in Portland cement).

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, 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 nonexperimental or actual service conditions.

This publication is a progress report on the condition of modified-wood products and stakes treated with various preservatives and oils. The inspections were made during 1961. The tests at Panama were completed with the final inspection in January 1956. Progress reports showing the condition of the test stakes in 1947, and during each of the years 1949 to 1960, inclusive, were prepared previously.[3]

---

[2] Hunt, G. M., and Snyder, T. E. An International Termite Exposure Test. American Wood-Preservers' Association Proceedings, 1930, pp. 318-334. Annual progress reports published in these Proceddings each year from 1930 to 1949 and again in 1952, 1956, and 1957 (final report).

[3] Blew, J. O. Comparison of Wood Preservatives in Stake Tests, American Wood-Preservers' Association Proceedings, 1948, pp. 88-119, and Forest Products Laboratory Report No. 1761, issued annually 1950 to date.

Preservatives and Modified-Wood Products Tested

Table 1 lists preservatives and other products tested, and refers to existing specifications in cases in which specifications had been issued. Table 1 also refers to tables 2 through 42 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 1 or 2 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 yellow pine, uniformly seasoned, surfaced four sides, and selected, as far as possible, for freedom from heartwood, wane, objectionable knots, and other visible defects. Four installations included stakes of smaller size for comparison (tables 6, 35, 37, and 42). The stakes 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 (table 5). Preservative retentions, in practically all instances, were computed for individual stakes[4] from the difference in weight before and after treatment. 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 (plus or minus) of that sought. The stakes not acceptable for the test provided material for checking preservative penetrations. For stakes treated in liquified petroleum gas (table 42) it was impracticable to follow this general procedure. These stakes were treated at a commercial plant during the presence of a Laboratory representative and retentions were determined from the analysis of extra matched stakes included for that purpose.

[4] Preservative retentions on individual stakes have not been included in this report because of the large amount of space that would be required.

The 10 acceptable test stakes were usually identified by a numbered metal tag nailed (riveted in the case of hard or 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 (fig. 1), 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 last and final inspection of stakes installed at the Canal Zone was made during January 1956 by representatives of the Forest Insect Laboratory, Gulfport, Miss., and the Forest Products Laboratory. The last inspection of the stakes at Bogalusa, La., and Jacksonville, Fla., was made in 1960 by representatives of the Chapman Chemical Co. and the Forest Products Laboratory. The Madison, Wis., and Saucier, Miss., installations were inspected by 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 trials
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]

[5] Fisher, R. A., and Yates, F. Statistical Tables for Agricultural and Medical Research. London. 90 pp. 1938.

[6] Fifty percent or more of cross section destroyed.

In tables 2 through 42, 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 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 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 or 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.

Some persons who have used the system and prefer to have greater precision, especially in the rating of the stakes with partial decay or limited termite attack, have, however, used plus (+) or minus (-) ratings along with the numerical and letter ratings.

Tables 2 through 42 show the condition of the test stakes at the most recent inspection. Table 43 shows a summary of results obtained at the Canal Zone and in Mississippi on 2- by 4-inch pine stakes treated with wood preservatives that are in general use. Excluded from this table are stakes installed too recently to show significant results.

Summary of Results

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

Southern Yellow 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, 2 to 3 years at Saucier, Miss., Bogalusa, La., and Jacksonville, Fla., and 5 to 6 years at Madison, Wis.

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.

Pressure-treated stakes.--Because of the limited number of stakes thus far removed, the average life of stakes pressure-treated with various preservatives cannot yet be determined, except for the Canal Zone tests and for the materials of limited effectiveness. In the Canal Zone, stakes treated with several retentions of chromated zinc arsenate (Boliden salt) have been destroyed during the 15-1/3 years since the installation was made. Stakes with 0.33 pound per cubic foot of the preservative have had an average life of 9 years, while those with approximately 1.0 pound had an average life of 15.3 years. With chromated zinc arsenate retentions of 0.33 pound to 0.78 pound per cubic foot, failures have occurred in Wisconsin while none have been noted after 21 years in Mississippi. This is attributed to the presence of arsenic-tolerant fungi at the Wisconsin test area.

Stakes treated with retentions of from 0.5 to 1.0 pound of chromated zinc chloride per cubic foot have lasted, on an average, about 5 to 7 years in Panama. Those treated with 0.5, 0.75, and 1.0 pound of zinc chloride per cubic foot have had an average life of about 3 to 4 years, and those treated with 1.5 pounds of zinc chloride per cubic foot have lasted about 5 to 7 years. Also, in Panama, stakes treated with fluor chrome arsenate phenol (Tanalith) with average retentions of 0.2 to 0.3 pound per cubic foot have had an average life of about 3 and 6 years, respectively. With stakes treated with 0.6 pound per cubic foot, the average life in Panama is 14 years. In Mississippi, stakes treated with 0.2 pound fluor chrome arsenate phenol (Tanalith) per cubic foot have had an average life of about 10 years.

Pentachlorophenol solutions with heavy gas oil, Denver No. 3 blend oil, and lube oil extract and retentions as low as 4.0 pounds per cubic foot have furnished better protection in Mississippi than solutions with various other oils, particularly those of the lighter type. Stakes in Panama treated with approximately 5 and 10 pounds per cubic foot of a solution of 5 percent of

pentachlorophenol in light fuel oil have lasted 13 and 14 years on an average, respectively. One installation of stakes treated with 4.3 pounds of coal-tar creosote per cubic foot had an average life of 13 years in Panama. Other installations with retentions of creosote varying from 8 to 16 pounds per cubic foot are performing somewhat better in Panama. After 13 years in Mississippi, retentions of 8 pounds per cubic foot of low-residue coal-tar creosote are not performing as well as medium- and high-residue creosotes and of English-produced creosotes, the vertical retort oil is showing better results than coke oven oil. Stakes in Panama treated with sodium pentachlorophenate, with retentions of from 0.25 pounds to 1.25 pounds per cubic foot, show an average life of 6 to 14 years. In Wisconsin, an average life of 12.5 to 17 years has been noted with retentions of 0.26 pound and 0.49 pound per cubic foot of sodium pentachlorophenate. The addition of borax or sodium chromate showed no significant benefit. Under commercial conditions, however, the addition of these compounds may be more beneficial.

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 of 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 26.3 pounds per cubic foot of 1.1 percent pentachlorophenol in Stoddard solvent have shown an average life of 11 years in Mississippi.

The results of stake tests in Mississippi thus far show copper naphthenate is furnishing 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 quite so 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. With a heavy petroleum solvent, however, the difference in the two preservatives is less apparent. 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 resin has also shown limited protection. Stakes pressure treated with 5.8 pounds per cubic foot had an average life of 9.1 years in Mississippi. Other

products showing limited preservative value in the retentions used are amyl phenyl acetate, capric acid, diamyl phenol, DDT, dodecyl amine, and nickel stearate.

Nonpressure-treated stakes.--Southern pine stakes and Douglas-fir plywood stakes treated by superficial applications, such as brushing and brief dipping in coal-tar cresote 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. Stakes dipped for 15 minutes in coal-tar creosote had a life of about 8 years in Mississippi, however. For the plywood stakes in which the veneer was treated by dipping or long soaking in the preservatives before gluing, the results have 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 are lasting 8 to 13 years. Douglas-fir plywood stakes treated by brushing, dipping, and 18-hour soaking and 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. The results have been somewhat better in the 18-hour soaking treatments with coal-tar creosote for Douglas-fir plywood.

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 urea-formaldehyde solution have lasted about 3 to 4 years longer than the controls.

Pine stakes that had copper chromate and copper arsenate retentions of 1.25 pounds per cubic foot or higher after a double-diffusion treatment have continued in good condition after 20 years in Mississippi.

Modified-Wood Stakes

Plywood impregnated with phenolic resin (impreg) and impregnated and compressed (compreg) has 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 somewhat better results have been noted when the edges of the plywood have been protected with a phenolic-resin

coating. Southern yellow pine 2-by-4 inch stakes impregnated with a low resin content had an average life of 12 years while those with a higher content of phenolic resin are lasting 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 but after 17 years in test in Mississippi is showing significant deterioration due principally to decay fungi.

Table 1.--Index to materials tested

Materials	Existing specification or A.W.P.A. reference	Table No.
Chemicals:		
Acid copper chromate (Celcure)	Fed. Spec. TT-W-546, A.W.P.A. P5	15, 16
Acrylonitrile		36
Aldrin		41
Ammoniacal copper arsenite (Chemonite)	Fed. Spec. TT-W-549, A.W.P.A. P5	14
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 (Erdalith or Greensalt)	A.W.P.A. P5, Fed. Spec. TT-W-550	15
Chromated zinc arsenate (Boliden salt)	Fed. Spec. TT-W-538, A.W.P.A. P5	4, 24
Chromated zinc chloride	Fed. Spec. TT-W-551, A.W.P.A. P5	2, 16, 25, 35
Chromated zinc chloride, copperized	Fed. Spec. TT-W-562, A.W.P.A. P5	31
Chromated zinc chloride (FR)	A.W.P.A. P10	25
Copper arsenate	A.W.P.A. Proc. 1941 pp. 23-31	9
Copper-arsenic-chromium salts		20
Copper chromate	A.W.P.A. Proc. 1941 pp. 23-31	9
Copper formate		34
Copper naphthenate	A.W.P.A. P8	7, 12, 16,17, 29
Copper-8-quinolinolate		38
Creosote, coal-tar	A.W.P.A. P1, Fed. Spec. TT-W-556	4, 5, 6, 8, 16, 17, 18, 19, 20, 31, 35
Creosote, coal-tar (English)		18, 19
Creosote, coal-tar (low-temperature)		28

Table 1.--Index to materials tested (Continued)

Materials	Existing specification or A.W.P.A. reference	Table No.
Creosote, coal-tar (Texas lignite)		32
Creosote, coal-tar solution	A.W.P.A. P2, Fed. Spec. TT-W-566	18
Creosote-petroleum solution	Fed. Spec. TT-W-568	18
Creosote-toluene		6
Diamyl phenol		14
Dichloro-diphenyl-trichloro-ethane (DDT)		14
Dieldrin		41
Dodecyl amine		14
Drop liquor concentrate		27
Fire retardants	A.W.P.A. P10	25
Fluor chrome arsenate phenol (Tanalith, Wolman Salts)	A.W.P.A. P5, Fed. Spec. TT-W-00535	2, 33, 37
Fluor chrome arsenate phenol (Tanalith, modified)		37
Fuel oils		5, 27
KP (copper oxide and chloro-phenol)		35
Lignite-tar extracts		39
Mercuric chloride		12
Minalith	A.W.P.A. P10	25
Nickel-chromium-arsenic salt		15
Nickel stearate		14
Oleo resin		27
Paraffin		32
Pentachlorophenol	A.W.P.A. P8, Fed. Spec. TT-W-570	5, 8, 12, 16, 17, 22, 23, 27, 29, 31, 32, 33, 41, 42
Petroleum oils (various types)		17, 18, 21, 23
Phenyl mercury oleate		12
Pyresote	A.W.P.A. P10	25
Rosin amine D copper acetate complex		27

Table 1.--Index to materials tested (Continued)

Materials	Existing specification or A.W.P.A. reference	Table No.
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-arsenic-chromium salts		20
Zinc chloride		2, 4, 20, 26
Zinc naphthenate		7, 8
Modified woods, plywood, and paper plastic:		
Acetylated wood		14
Cyanoethylated wood		36
Embedded fiberboard		40
Heat-stabilized wood (staypak)		11
Laminated paper plastic (papreg)		11
Impreg and compreg		3
Mold infected wood		31
Plywood		3, 8, 16, 33
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 Tanalith chrome arsenate phenol (Tanalith), zinc chloride, and chromated zinc chloride after about 22 to 23 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, September 1939; Beaumont, Tex., December 1938; Jacksonville, Fla., January 1939; Harrison Experimental Forest, Gulfport, Miss., December 1938; and Madison, Wis., November 1949

Preservative	Location	Retention of salts: Minimum	Retention of salts: Maximum	Retention of salts: Average	Number in test	Condition of stakes late in 1961[1]: 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-: Termites	Destroyed by-: Decay fungi and termites	Total removed: Number	Total removed: Percent	Average life
		Lb. per cu. ft.	Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Sodium pentachlorophenate	Canal	0.24	0.28	0.26	10							100.0	10	100.0	6.9
	La.	.24	.28	.26	10					10.0		90.0	10	100.0	9.2
	Fla.	.25	.28	.26	9					11.1		88.9	9	100.0	14.2
	Miss.	.24	.28	.26	10				10.0	10.0	20.0	60.0	9	90.0	
	Wis.	.24	.28	.26	10					100.0			10	100.0	12.5
				Total	49				2.0	26.5	4.1	67.4	48	98.0	
	Canal	.45	.54	.50	10						20.0	80.0	10	100.0	11.2
	La.	.45	.53	.49	10					30.0		70.0	10	100.0	10.7
	Fla.	.46	.55	.50	10				20.0			80.0	8	80.0	
	Miss.	.44	.54	.49	10				50.0	10.0		40.0	5	50.0	
	Wis.	.44	.53	.49	10					100.0			10	100.0	16.4
				Total	50				14.0	28.0	4.0	54.0	43	86.0	
	Canal	.69	.81	.75	10					10.0	20.0	70.0	10	100.0	11.7
	La.	.69	.85	.75	10					10.0		90.0	10	100.0	15.6
	Fla.	.68	.82	.74	10				40.0	10.0		50.0	6	60.0	
	Miss.	.69	.84	.76	10				70.0	10.0		20.0	3	30.0	
	Wis.	.67	.81	.76	10		40.0			60.0			6	60.0	
				Total	50		8.0		22.0	20.0	4.0	46.0	35	70.0	
	Canal	.92	1.06	.98	10						10.0	90.0	10	100.0	14.3
	La.	.93	1.09	.99	10					10.0		90.0	10	100.0	16.2
	Fla.	.92	1.08	.98	10				60.0	10.0		30.0	4	40.0	
	Miss.	.93	1.09	.97	10				90.0			10.0	1	10.0	
	Wis.	.86	1.01	.90	10		70.0			30.0			3	30.0	
				Total	50		14.0		30.0	10.0	2.0	44.0	28	56.0	
Sodium tetrachlorophenate	Canal	.24	.27	.25	10						60.0	40.0	10	100.0	8.8
	La.	.23	.27	.25	10					20.0		80.0	10	100.0	8.1
	Fla.	.23	.28	.25	9					22.2		78.8	9	100.0	11.3
	Miss.	.23	.27	.25	10						10.0	90.0	10	100.0	10.7
	Wis.	.24	.27	.25	10					100.0			10	100.0	11.4
				Total	49					28.6	14.3	57.1	49	100.0	
	Canal	.47	.56	.51	10						20.0	80.0	10	100.0	9.9
	La.	.46	.55	.50	10					30.0		70.0	10	100.0	10.9
	Fla.	.47	.55	.51	10							100.0	10	100.0	15.3
	Miss.	.48	.56	.52	10							100.0	10	100.0	15.1
	Wis.	.47	.55	.50	10					100.0			10	100.0	14.5
				Total	50					26.0	4.0	70.0	50	100.0	
	Canal	.70	.83	.76	10							100.0	10	100.0	13.1
	La.	.71	.83	.77	10					30.0		70.0	10	100.0	11.9
	Fla.	.68	.83	.76	9						11.1	88.9	9	100.0	16.7
	Miss.	.68	.82	.75	10				40.0			60.0	6	60.0	
	Wis.	.67	.81	.75	9					100.0			9	100.0	16.7
				Total	48				8.3	29.0	2.1	64.6	44	91.7	
Fluor chrome arsenate phenol (Tanalith)	Canal	.18	.22	.20	10						100.0		10	100.0	2.9
	La.	.19	.22	.20	10					50.0		50.0	10	100.0	9.6
	Fla.	.18	.21	.20	10					90.0		50.0	10	100.0	13.9
	Miss.	.18	.21	.20	10					10.0	50.0	40.0	10	100.0	10.2
	Wis.	.13	.22	.20	10					100.0			10	100.0	13.8
				Total	50					42.0	30.0	28.0	50	100.0	
	Canal	.28	.33	.30	10						30.0	70.0	10	100.0	6.4
	La.	.28	.32	.30	10					20.0		80.0	10	100.0	13.7
	Fla.	.29	.32	.30	10					100.0			10	100.0	15.4
	Miss.	.29	.32	.30	10				20.0			80.0	8	80.0	
	Wis.	.27	.30	.28	10					100.0			10	100.0	16.5
				Total	50				4.0	44.0	6.0	46.0	48	96.0	
	Canal	.53	.66	.60	10					40.0		60.0	10	100.0	14.2
	La.	.56	.64	.60	10					50.0		50.0	10	100.0	15.6
	Fla.	.57	.65	.61	10					100.0			10	100.0	17.3
	Miss.	.57	.65	.61	10				70.0	20.0		10.0	3	30.0	
	Wis.	.59	.68	.65	10					100.0			10	100.0	16.0
				Total	50				14.0	62.0		24.0	43	86.0	

(Sheet 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 (Wolmanith), zinc chloride, and chromated zinc chloride after about 22 to 23 years of service. Stakes placed in test at Barro Colorado Island, Canal Zone, September 1938; Bogalusa, La., December 1938; Jacksonville, Fla., January 1939; Harrison Experimental Forest, Saucier, Miss., December 1938; and Madison, Wis., November 1939 (Continued)

Preservative	Location	Retention of salts			Number in test[2]	Condition of stakes late in 1961[1]									Average life
		Minimum	Maximum	Average		Good	Serviceable but showing some:			Destroyed by-			Total removed		
							Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites	Number	Percent	
		Lb. per cu. ft.	Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Sodium pentachlorophenate and sodium chloride[3]	Canal	0.52	0.55	0.54	10						30.0	70.0	10	100.0	8.7
	La.	.46	.53	.49	10							100.0	10	100.0	13.3
	Fla.	.48	.54	.50	10				50.0	10.0		40.0	5	50.0	
	Miss.	.46	.53	.49	10				20.0			80.0	8	80.0	
	Wis.	.46	.53	.50	10					100.0			10	100.0	16.8
				Total	50				14.0	22.0	6.0	58.0	43	86.0	
Zinc chloride	Canal	.44	.53	.47	10						30.0	70.0	10	100.0	3.9
	La.	.45	.55	.50	10					30.0		70.0	10	100.0	8.1
	Fla.	.45	.53	.49	10					20.0		80.0	10	100.0	12.9
	Miss.	.45	.54	.50	10				10.0	30.0		60.0	9	90.0	
	Wis.	.45	.53	.49	10		10.0			90.0			9	90.0	
				Total	50		2.0		2.0	34.0	6.0	56.0	48	96.0	
	Canal	.70	.82	.76	10							100.0	10	100.0	3.9
	La.	.70	.78	.74	10					40.0		60.0	10	100.0	12.1
	Fla.	.71	.82	.75	10					40.0		60.0	10	100.0	13.5
	Miss.	.70	.79	.74	10					20.0	10.0	70.0	10	100.0	16.7
	Wis.	.65	.87	.75	9		11.1			88.9			8	88.9	
				Total	49		2.0			36.7	2.0	59.3	48	98.0	
	Canal	.94	1.08	1.00	10						40.0	60.0	10	100.0	4.0
	La.	.94	1.08	1.01	10					70.0		30.0	10	100.0	11.6
	Fla.	.95	1.08	1.02	10					20.0		80.0	10	100.0	15.4
	Miss.	.94	1.07	1.00	10				10.0	10.0		80.0	9	90.0	
	Wis.	.93	1.13	1.02	10					100.0			10	100.0	19.0
				Total	50				2.0	40.0	8.0	50.0	49	98.0	
	Canal	1.40	1.62	1.49	10						10.0	90.0	10	100.0	7.3
	La.	1.44	1.63	1.52	10					40.0		60.0	10	100.0	11.1
	Fla.	1.41	1.62	1.49	10					20.0		80.0	10	100.0	15.7
	Miss.	1.43	1.63	1.52	10				20.0	50.0		30.0	8	80.0	
	Wis.	1.36	1.74	1.59	10					100.0			10	100.0	18.7
				Total	50				4.0	42.0	2.0	52.0	48	96.0	
Chromated zinc chloride	Canal	.45	.55	.49	10							100.0	10	100.0	4.9
	La.	.46	.55	.49	10					40.0	10.0	50.0	10	100.0	8.6
	Fla.	.45	.53	.49	8					25.0		75.0	8	100.0	14.3
	Miss.	.45	.55	.49	10					30.0	10.0	60.0	10	100.0	14.2
	Wis.	.43	.53	.47	10		10.0			90.0			9	90.0	
				Total	48		2.1			37.5	4.2	56.2	47	97.9	
	Canal	.70	.81	.76	10							100.0	10	100.0	7.2
	La.	.70	.80	.76	10					40.0		60.0	10	100.0	10.6
	Fla.	.73	.81	.77	9					11.1		88.9	9	100.0	14.3
	Miss.	.72	.81	.76	10				20.0	30.0		50.0	8	80.0	
	Wis.	.70	.86	.80	10					100.0			10	100.0	14.7
				Total	49				4.1	36.7		59.2	47	95.9	
	Canal	.95	1.11	1.02	10						10.0	90.0	10	100.0	6.6
	La.	.93	1.07	1.00	10					40.0		60.0	10	100.0	11.9
	Fla.	.96	1.09	1.02	10				10.0	20.0		70.0	9	90.0	
	Miss.	.96	1.09	1.02	10				20.0	40.0		40.0	8	80.0	
	Wis.	.89	1.13	1.02	10		20.0			80.0			8	80.0	
				Total	50		4.0		6.0	38.0		52.0	45	90.0	
Untreated controls	Canal				10						100.0		10	100.0	.7
	La.				10					20.0	20.0	60.0	10	100.0	2.9
	Fla.				10						10.0	90.0	10	100.0	2.8
	Miss.				10						60.0	40.0	10	100.0	2.9
	Wis.				10					100.0			10	100.0	5.7
				Total	50					24.0	30.0	54.0	50	100.0	

[1] Final inspection at Canal Zone February 1954 and at Bogalusa December 1958. Data reported for last inspection in Jacksonville in 1960.

[2] Ten 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.

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

Table 5.--Condition of the plywood stakes and resin-impregnated stakes set January 1940 on the Harrison Experimental Forest, Saucier, Miss., after about 22 years of service

Group number	Stake numbers	Treatment	Approximate average increase in weight	Number in test	Condition of specimens December 1961: Good	Serviceable but showing some-: Decay	Serviceable but showing some-: Termite attack and decay	Destroyed by-: Termites	Destroyed by-: Decay fungi	Destroyed by-: Termites and decay fungi	Total removed: Number	Total removed: Percent	Average life
			Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
					Plywood[1]								
1	1-1-40 to 1-10-40	Each ply impregnated with a 50 percent aqueous solution of phenolic resin, slowly dried, and cured for 1 day at 220° F. Bonded with phenolic-resin film.	10	8					33.3	55.6	8	100.0	12.4
2	2-1-40 to 2-10-40	Same as group 1 except that a 25 percent solution was used.	5	10					60.0	40.0	10	100.0	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.	2/10	10				100.0			3/10	100.0	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.	2/5	10				100.0			2/10	100.0	3.5
5	5-1-40 to 5-10-40	Same as group 3 except that edges of specimens were given a protective treatment by dipping in a phenolic resin containing 15 percent alcohol.	2/10	10				70.0	30.0		3/10	100.0	4.9
6	6-1-40 to 6-10-40	Same as group 4 except that edges were protected as in group 5.	2/5	9				44.5	22.2	33.3	3/9	100.0	9.3
7	7-1-40 to 7-10-40	Untreated plies bonded with phenolic-resin film.		10				70.0		30.0	10	100.0	1.9
8	8-1-40 to 8-10-40	Untreated plies bonded with hot-press urea resin.		10				70.0		30.0	10	100.0	1.9
9	9-1-40 to 9-10-40	Untreated plies bonded with casein glue (FPL formula 4B).		10				90.0		10.0	4/10	100.0	1.0
10	10-1-40 to 10-10-40	Untreated plies (yellow birch) bonded with phenolic-resin film.		10				30.0	10.0	60.0	10	100.0	1.9
11	11-1-40 to 11-10-40	Untreated controls -- solid wood (1/4" x 4" x 18").		10				80.0		20.0	10	100.0	2.4
					Stakes (impreg)[5]								
12	12-1-40 to 12-10-40	Impregnated same as group 1.	10	10		20.0	20.0		50.0	10.0	6	60.0	
13	13-1-40 to 13-10-40	Impregnated same as group 2.	5	10					50.0	50.0	10	100.0	11.7
14	14-1-40 to 14-10-40	Controls -- untreated.		10				20.0		80.0	10	100.0	2.7
					Compressed plywood (compreg)[6]								
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 in a hot press at 330° F. and 1,000 pounds pressure per square inch.	10	3	100.0								
	15-4-50 to 15-6-40	Yellow-poplar -- all plies impregnated and compressed the same as for Douglas-fir.	10	3					33.3	66.7	3	100.0	19.5

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

[2] Increase based on treated faces.

[3] Deterioration principally in cores.

[4] Some separation of plies had also occurred.

[5] Specimens are southern yellow pine sapwood, 2 by 4 (nominal) by 18 inches in size.

[6] Specimens of both Douglas-fir and yellow-poplar made of fifteen 1/16-inch plies, compressed to a thickness of 3/8-inch. Size of specimens 3/8 by 4 by 14 inches.

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 about 21 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: Oil	Average retention: Dry salt	Number in test	Condition of stakes late in 1961[1]: 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--: Termites	Destroyed by--: Decay fungi and termites	Total removed: Number	Total removed: Percent	Average life
		Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Zinc chloride	Wis.		0.50	10					100.0			10	100.0	14.8
	Miss.		.50	10					60.0		40.0	10	100.0	14.2
	Canal		.49	10							100.0	10	100.0	3.0
			Total	30					53.3		46.7	30	100.0	
	Wis.		1.03	10		40.0			60.0			6	60.0	
	Miss.		1.02	10				10.0	60.0	10.0	20.0	9	90.0	
	Canal		1.01	10							100.0	10	100.0	3.6
			Total	30		13.3		3.3	40.1	3.3	40.0	25	83.4	
	Wis.		1.51	10		70.0			30.0			3	30.0	
	Miss.		1.51	10				30.0	60.0		10.0	7	70.0	
	Canal		1.49	10							100.0	10	100.0	4.5
			Total	30		23.3		10.0	40.0		36.7	20	66.7	
Chromated zinc arsenate (Boliden salts)[2]	Wis.		.33	10		40.0			60.0			6	60.0	
	Miss.		.33	10		50.0		50.0						
	Canal		.33	10							100.0	10	100.0	9.2
			Total	30		30.0		16.7	20.0		33.3	16	53.3	
	Wis.		.44	10		80.0			20.0			2	20.0	
	Miss.		.44	9		44.4		55.6						
	Canal		.44	10					30.0	10.0	60.0	10	100.0	11.6
			Total	29		41.3		17.3	17.3	3.4	20.7	12	41.4	
	Wis.		.60	10		60.0			40.0			4	40.0	
	Miss.		.58	10		60.0		40.0						
	Canal		.58	10					60.0	40.0		10	100.0	14.6
			Total	30		40.0		13.3	33.4	13.3		14	46.7	
	Wis.		.78	10		90.0			10.0			1	10.0	
	Miss.		.78	10		70.0		30.0						
	Canal		.78	10					100.0			10	100.0	15.1
			Total	30		53.3		10.0	36.7			11	36.7	
	Wis.		1.06	10		100.0								
	Miss.		1.06	10		80.0		20.0						
	Canal		1.05	10					100.0			10	100.0	15.3
			Total	30		60.0		6.7	33.3			10	33.3	

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 about 21 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 (continued)

Preservative	Location	Average retention		Number in test	Condition of stakes late in 1961[1]							Average life
					Good	Serviceable but showing some--			Destroyed by--		Total removed	
		Oil	Dry salts			Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
		Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Coal-tar creosote	Wis.	4.3		10		100.0								
	Miss.	4.2		10				40.0	40.0		20.0	6	60.0	
	Canal	4.3		10					40.0		60.0	10	100.0	
			Total	30		33.3		13.3	26.7		26.7	16	53.4	13.4
	Wis.	8.0		10	10.0	90.0								
	Miss.	8.0		10	10.0	50.0		40.0						
	Canal	8.0		10		60.0		10.0	30.0			3	30.0	
			Total	30	6.7	66.7		16.6	10.0			3	10.0	19
	Wis.	11.8		10	70.0	30.0								
	Miss.	11.8		10	10.0	70.0		20.0						
	Canal	11.8		10		60.0			40.0			4	40.0	
			Total	30	26.7	53.3		6.7	13.3			4	13.3	18
	Wis.	16.3		10	90.0	10.0								
	Miss.	16.5		10	20.0	80.0								
	Canal	16.5		10		90.0		10.0						
			Total	30	36.7	60.0		3.3						
	Wis.	1.8[4]		10					100.0			10	100.0	12.4
	Miss.	1.8[4]		10					10.0	30.0	60.0	10	100.0	7.7
	Canal	1.8[4]		10						80.0	20.0	10	100.0	4.8
			Total	30					36.7	36.7	26.6	30	100.0	
	Wis.	.71[5]		10										
	Miss.	.76[5]		10					100.0			10	100.0	8.4
	Canal	.76[5]		10						50.0	50.0	10	100.0	4.2
			Total	30						90.0	10.0	10	100.0	2.5
									33.3	46.7	20.0	30	100.0	
Untreated	Wis.			10										
	Miss.			10					100.0			10	100.0	6.2
	Canal			10						50.0	50.0	10	100.0	2.2
			Total	30						90.0	10.0	10	100.0	1.1
									33.3	46.7	20.0	30	100.0	

[1] Final inspection at Canal Zone January 1956.

[2] Retention based upon total anhydrous salts: $ZnSO_4 + H_3AsO_4 + Na_2HAsO_4 + Na_2Cr_2O_7$. These values should be increased approximately 26 percent to obtain retentions as computed in AWPA Standard P5-56.

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

[4] Fifteen-minute dip at room temperature.

[5] Brush treatment, two 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 about 21 years of service. Stakes placed in test at Harpe Colorado Island, Canal Zone, February 1941; Hogalusa, La., March 1941; Jacksonville, Fla., March 1941; and Harrison Experimental Forest, Saucier, Miss., February 1941

Preservative	Location	Retention of preservative[1]			Number in test	Condition of stakes late in 1961[2]									Average life
		Minimum	Maximum	Average		Sound	Serviceable but showing some: Decay	Termite attack	Decay and termite attack	Destroyed by: Decay fungi	Termites	Decay fungi and termites	Total removed: Number	Total removed: Percent	
		lb. per cu. ft.	lb. per cu. ft.	lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Sodium pentachlorophenate	Canal	0.23	0.27	0.25	10						60.0	40.0	10	100.0	6.4
	La.	.23	.26	.25	10					10.0		90.0	10	100.0	10.0
	Fla.	.23	.26	.25	9							100.0	9	100.0	14.5
	Miss.	.23	.26	.25	10				10.0	20.0		50.0	7	70.0	
				Total	39				7.7	7.7	15.4	69.2	36	92.3	
	Canal	.31	.34	.33	10						10.0	90.0	10	100.0	10.9
	La.	.31	.34	.33	10							100.0	10	100.0	10.4
	Fla.	.32	.34	.33	8						12.5	87.5	8	100.0	16.3
	Miss.	.31	.34	.33	10				60.0	20.0		20.0	4	40.0	
				Total	38				15.8	5.3	5.3	73.6	32	84.2	
	Canal	.47	.55	.51	10						20.0	80.0	10	100.0	12.9
	La.	.48	.54	.51	10							100.0	10	100.0	15.5
	Fla.	.47	.54	.50	10				50.0			50.0	5	50.0	
	Miss.	.47	.55	.51	10				70.0	10.0		20.0	3	30.0	
				Total	40				30.0	2.5	5.0	62.5	28	70.0	
	Canal	.73	.81	.77	10					50.0	20.0	30.0	10	100.0	14.3
	La.	.72	.82	.77	9				55.6			44.4	4	44.4	
	Fla.	.72	.83	.77	10				80.0			20.0	2	20.0	
	Miss.	.72	.83	.77	10				90.0			10.0	1	10.0	
				Total	39				56.4	12.8	5.1	25.7	17	43.6	
	Canal	.92	1.09	.99	10					70.0		30.0	10	100.0	14.2
	La.	.92	1.09	.99	10				70.0			30.0	3	30.0	
	Fla.	.91	1.10	.99	9				100.0						
	Miss.	.93	1.08	.99	10				100.0						
				Total	39				66.6	33.0		15.4	13	33.4	
Sodium pentachlorophenate and sodium chromate; chemical ratio, 3.24:1	Canal	.43	.47	.44	10						20.0	80.0	10	100.0	11.1
	La.	.43	.47	.44	10							100.0	10	100.0	15.6
	Fla.	.40	.47	.44	9				44.4			55.6	5	55.6	
	Miss.	.40	.47	.44	10				100.0						
				Total	39				35.9		5.1	59.0	25	64.1	
Sodium pentachlorophenate and borax; chemical ratio, 1:0.76	Canal	.54	.62	.58	10							100.0	10	100.0	12.8
	La.	.54	.62	.58	9					11.1		88.9	8	100.0	11.4
	Fla.	.53	.62	.57	8							100.0	8	100.0	17.9
	Miss.	.54	.61	.58	10				70.0	10.0		20.0	3	30.0	
				Total	37				18.9	5.4		75.7	30	81.1	
Sodium pentachlorophenate and borax; chemical ratio, 1:2	Canal	.71	.80	.75	10							100.0	10	100.0	12.2
	La.	.71	.81	.75	10					10.0		90.0	10	100.0	9.9
	Fla.	.72	.82	.76	10							100.0	10	100.0	12.9
	Miss.	.71	.80	.75	10				40.0			60.0	6	60.0	
				Total	40				10.0	2.5		87.5	36	90.0	
Sodium pentachlorophenate and borax; chemical ratio, 1:1.52	Canal	.78	.88	.83	10					50.0		50.0	10	100.0	13.0
	La.	.77	.88	.83	10					30.0		70.0	10	100.0	10.0
	Fla.	.79	.86	.82	9							100.0	9	100.0	16.7
	Miss.	.79	.87	.83	10				50.0			50.0	5	50.0	
				Total	39				12.8	20.5		66.7	34	87.2	
Sodium pentachlorophenate and borax; chemical ratio, 1:3	Canal	.91	1.06	.98	10					10.0		100.0	10	100.0	11.5
	La.	.90	1.07	.98	10							90.0	10	100.0	9.0
	Fla.	.92	1.05	.98	10							100.0	10	100.0	13.2
	Miss.	.92	1.06	.98	10				10.0	10.0		80.0	8	90.0	
				Total	40				2.5	5.0		92.5	39	97.5	
Sodium pentachlorophenate and borax; chemical ratio, 1:2.27	Canal	1.00	1.19	1.09	10							100.0	10	100.0	12.7
	La.	1.01	1.16	1.09	10					20.0		80.0	10	100.0	9.9
	Fla.	1.01	1.18	1.09	10							100.0	10	100.0	15.6
	Miss.	1.01	1.18	1.09	10				20.0			80.0	8	80.0	
				Total	40				5.0	5.0		90.0	38	95.0	
Sodium pentachlorophenate and borax; chemical ratio, 1:1.50	Canal	1.17	1.32	1.25	10					10.0		90.0	10	100.0	12.8
	La.	1.17	1.32	1.25	10							100.0	10	100.0	14.6
	Fla.	1.17	1.32	1.25	10				20.0	10.0		70.0	8	80.0	
	Miss.	1.17	1.33	1.25	10				70.0	10.0		20.0	3	30.0	
				Total	40				22.5	7.5		70.0	31	77.5	

Table 5.--Condition of southern pine stakes (1- × 4 in. nominal × 18 in.) treated with chlorinated phenols and coal-tar creosote after about 21 years of service. Stakes placed in test at Puerto Rico (Rio Piedras and Luquillo), 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[1]			Number in test	Condition of stakes late in 1961[1]								Average life
						Good	Serviceable but showing some-		Destroyed by-				Total removed		
		Mini-mum	Maxi-mum	Average			Decay	Termite attack	Decay and termite attack	Decay (fungi)	Termites	Decay (fungi) and termites		
		Lb. per cu. ft.	Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
5 percent pentachlorophenol in fuel oil[4]	Canal	4.0	5.4	4.7	10					40.0		60.0	10	100.0	15.0
	La.	4.0	5.4	4.8	10				10.0			90.0	9	90.0	
	Fla.	4.0	5.6	4.8	10				40.0			60.0	6	60.0	
	Miss.	4.2	5.4	4.7	10				90.0			10.0	1	10.0	
				Total	40				35.0	10.0		55.0	26	65.0	
	Canal	8.6	10.5	9.6	10					30.0		70.0	10	100.0	14.4
	La.	8.4	10.9	9.6	10				70.0			30.0	3	30.0	
	Fla.	8.8	10.5	9.6	9				66.7			33.3	3	33.3	
	Miss.	8.6	10.5	9.6	10				100.0						
				Total	39				59.0	7.7		33.3	16	41.0	
	Canal	14.0	16.5	15.3	10				40.0	10.0		50.0	5	60.0	2 15
	La.	14.2	16.3	15.3	10				100.0						
	Fla.	14.3	16.3	15.3	10				100.0						
	Miss.	14.0	16.3	15.3	10				100.0						
				Total	40				85.0	2.5		10.5	6	15.0	
	Canal	18.6	21.5	20.1	10				100.0						
	La.	18.2	21.7	20.1	9				100.0						
	Fla.	18.2	21.7	20.1	9		22.2		77.8						
	Miss.	18.2	21.9	20.0	10		10.0		10.0						
				Total	38		13.2		86.8						
3 percent pentachlorophenol + 2 percent chloro-2-phenylphenol in fuel oil[4]	Canal	4.2	5.8	4.9	10					20.0		80.0	10	100.0	12.6
	La.	4.4	5.8	4.9	10							100.0	10	100.0	14.2
	Fla.	4.4	5.8	4.9	9				22.2			77.8	7	77.8	
	Miss.	4.2	5.8	4.9	10				40.0			60.0	6	60.0	
				Total	39				15.4	5.1		79.5	33	84.6	
	Canal	9.1	10.9	10.0	10					50.0		50.0	10	100.0	13.7
	La.	9.1	10.9	10.0	9				100.0						
	Fla.	8.9	11.0	10.0	8				75.0			25.0	2	25.0	
	Miss.	8.9	11.0	10.0	10				90.0			10.0	1	10.0	
				Total	37				64.9	13.5		21.6	13	35.1	
	Canal	14.2	16.3	15.4	10				10.0	10.0		80.0	9	90.0	2 12
	La.	13.8	16.3	15.3	10				100.0						
	Fla.	13.8	16.3	15.3	9				100.0						
	Miss.	14.4	16.1	15.3	10		10.0		90.0						
				Total	39		2.6		74.3	2.6		20.5	9	25.7	
Coal-tar creosote, grade 1	Canal	3.5	6.7	4.7	10				10.0	90.0			9	90.0	2 12
	La.	3.3	6.7	4.7	9				77.8			22.2	2	22.2	
	Fla.	3.3	6.5	4.7	9				33.3	33.4		33.3	2	66.7	
	Miss.	3.5	6.5	4.6	10		10.0		50.0			40.0	4	40.0	
				Total	38		2.6		42.1	31.6		23.7	21	55.3	
	Canal	8.4	11.6	10.0	10		60.0		20.0	10.0		10.0	2	20.0	2 20
	La.	8.6	11.2	10.0	10				90.0			10.0	1	10.0	
	Fla.	8.6	11.4	10.0	10				90.0	10.0			1	10.0	
	Miss.	8.4	11.4	10.0	10		50.0		50.0						
				Total	40		27.5		62.5	5.0		5.0	4	10.0	
	Canal	13.5	15.4	14.4	10	10.0	90.0								
	La.	13.5	15.9	14.5	10	40.0	30.0		30.0						
	Fla.	13.5	15.9	14.5	9	22.2	55.6		22.2						
	Miss.	13.5	16.1	14.5	10	10.0	90.0								
				Total	39	20.5	66.7		12.8						
Fuel oil[4]	Canal	8.2	11.9	9.9	10					40.0	60.0	40.0	10	100.0	5.9
	La.	8.4	11.7	9.8	10					60.0		60.0	10	100.0	8.4
	Fla.	8.2	11.7	9.8	8					12.5		87.5	8	100.0	9.7
	Miss.	8.2	11.7	9.8	10					20.0	10.0	70.0	10	100.0	6.5
				Total	38					18.4	18.4	63.2	38	100.0	
	Canal	18.2	21.0	19.4	10						50.0	50.0	10	100.0	7.8
	La.	18.2	21.4	19.4	10				10.0	90.0		90.0	9	90.0	
	Fla.	18.2	21.4	19.4	9							100.0	9	100.0	12.4
	Miss.	18.0	21.9	19.4	10					30.0	10.0	60.0	10	100.0	9.1
				Total	39				2.6	20.5	10.5	66.8	38	97.4	
5 percent pentachlorophenol in fuel oil[4] and naphtha; 3-minute dip	Canal	.5	1.4	.8	10					30.0		70.0	10	100.0	2.7
	La.	.5	1.2	.8	10					12.5		87.5	8	100.0	4.2
	Fla.	.5	1.2	.8	8					10.0	20.0	70.0	10	100.0	5.0
	Miss.	.5	1.2	.8	10					13.2	28.9	57.9	38	100.0	3.2
				Total	38										

Table 5.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with chlorinated phenols and coal-tar creosote after about 21 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[1]			Number in test[2]	Condition of stakes late in 1951[3]								Average life
		Minimum	Maximum	Average		Good	Serviceable but showing name- Decay	Termite attack	Decay and termite attack	Destroyed by- Decay fungi	Termites	Decay fungi and termites	Total removed	
		Lb. per cu. ft.	Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number / Percent	Yr.
5 percent pentachlorophenol in fuel oil[4] and naphtha; 18-hour soaking:	Canal	2.1	2.6	2.4	10							100.0	10 / 100.0	9.1
	La.	2.1	2.8	2.4	9					33.3		66.7	9 / 100.0	8.4
	Fla.	2.1	3.0	2.4	10							100.0	10 / 100.0	11.9
	Miss.	1.9	3.0	2.4	10							100.0	10 / 100.0	12.9
				Total	39					7.7		92.3	39 / 100.0	
5 percent pentachlorophenol in soybean oil, naphtha, and fuel oil[4,5,6] 3-minute dip	Canal	.7	1.2	.9	10						100.0		10 / 100.0	3.3
	La.	.5	1.2	.9	10					50.0		50.0	10 / 100.0	4.0
	Fla.	.5	1.6	.9	7						14.3	85.7	7 / 100.0	5.4
	Miss.	.7	1.2	.9	10						60.0	40.0	10 / 100.0	4.9
				Total	37					13.5	46.0	40.5	37 / 100.0	
18-hour soaking	Canal	2.3	3.7	2.8	10							100.0	10 / 100.0	10.4
	La.	2.1	3.9	2.8	10					30.0		70.0	10 / 100.0	7.6
	Fla.	2.3	3.2	2.7	10							100.0	10 / 100.0	12.2
	Miss.	2.3	3.5	2.8	10				10.0			90.0	9 / 90.0	90.0
				Total	40				2.5	7.5		90.0	39 / 97.5	
18-hour soaking[7]	Canal	1.1	3.0	2.3	10						30.0	70.0	10 / 100.0	7.0
	La.	1.8	2.6	2.3	10					20.0		80.0	10 / 100.0	6.3
	Fla.	1.8	2.8	2.3	8					12.5		87.5	8 / 100.0	9.8
	Miss.	1.1	2.8	2.2	10					10.0	10.0	80.0	10 / 100.0	11.9
				Total	38					10.5	10.5	79.0	38 / 100.0	
3 percent pentachlorophenol + 2 percent chloro-2-phenylphenol in naphtha and fuel oil[4]; 3-minute dip	Canal	.9	1.6	1.2	10						100.0		10 / 100.0	2.3
	La.	.9	1.6	1.2	10					40.0		60.0	10 / 100.0	4.1
	Fla.	.7	1.6	1.2	10					10.0	10.0	80.0	10 / 100.0	5.0
	Miss.	.5	1.8	1.2	10					20.0	20.0	60.0	10 / 100.0	5.3
				Total	40					17.5	32.5	50.0	40 / 100.0	
18-hour soaking	Canal	2.5	4.0	3.1	10						10.0	90.0	10 / 100.0	9.0
	La.	2.5	4.0	3.1	10					10.0		90.0	10 / 100.0	7.2
	Fla.	2.3	3.9	3.1	8					12.5		87.5	8 / 100.0	10.8
	Miss.	2.6	4.4	3.1	10							100.0	10 / 100.0	13.8
				Total	38					5.3	2.6	92.1	38 / 100.0	
3 percent pentachlorophenol + 2 percent chloro-2-phenylphenol in solvent of 80 percent mineral spirits and 20 percent moisture repellent; 3-minute dip	Canal	.5	.9	.8	10						90.0	10.0	10 / 100.0	1.6
	La.	.5	.9	.7	10					30.0		70.0	10 / 100.0	3.9
	Fla.	.5	.9	.8	10					20.0	10.0	70.0	10 / 100.0	2.8
	Miss.	.5	.9	.8	10					20.0	30.0	50.0	10 / 100.0	3.6
				Total	40					17.5	32.5	50.0	40 / 100.0	
18-hour soaking	Canal	2.1	5.8	3.4	10						90.0	10.0	10 / 100.0	4.8
	La.	2.3	4.6	3.4	10							100.0	10 / 100.0	9.2
	Fla.	2.3	4.9	3.4	10					20.0		80.0	10 / 100.0	9.6
	Miss.	2.3	5.1	3.4	10					20.0	10.0	70.0	10 / 100.0	12.7
				Total	40					10.0	25.0	65.0	40 / 100.0	
Untreated controls	Canal				10						100.0		10 / 100.0	1.2
	La.				10					50.0	20.0	30.0	10 / 100.0	2.2
	Fla.				10					10.0	20.0	70.0	10 / 100.0	1.8
	Miss.				10					40.0	30.0	30.0	10 / 100.0	2.3
				Total	40					25.0	42.5	32.5	40 / 100.0	

[1] 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 2 stakes originally installed.

[2] Ten 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.

[3] Final inspection at Canal Zone January 1956. Data reported for Jacksonville and Bogalusa are for last inspection in 1960.

[4] 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.

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

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

[7] 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 20-1/2 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., May 1941

Preservative	Size of stakes	Average retention	Number in test	Condition of stakes December 1961								Average life
				Good	Serviceable but showing some--		Destroyed by--			Total removed		
					Termite attack	Decay	Termite attack and decay	Decay fungi	Termites	Termites and decay fungi		
	In.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Coal-tar creosote	1/2 x 1/2 x 18	7.8	8				12.5	75.0		12.5	7	87.5	
	1 x 1 x 18	8.0	10			10.0	50.0	30.0		10.0	4	40.0	
	1-1/2 x 1-1/2 x 18	7.9	10			10.0	80.0	10.0			1	10.0	
	2 x 4 (nominal) x 18	3.3	10				80.0			20.0	2	20.0	
	2 x 4 (nominal) x 18	7.8	10			40.0	60.0						
	2 x 4 (nominal) x 18	13.2	10	20.0		60.0	20.0						
Toluene	2 x 4 (nominal) x 18	29.5	10						100.0		10	100.0	2.1
Coal-tar creosote: 11.25 percent by weight in toluene	2 x 4 (nominal) x 18	1/3.4	10				10.0	30.0		60.0	9	90.0	
25.2 percent by weight in toluene	2 x 4 (nominal) x 18	1/8.1	10			50.0	50.0						
39.0 percent by weight in toluene	2 x 4 (nominal) x 18	1/12.6	10	30.0		50.0	20.0						

[1] Creosote only.

Table 7.--Condition of southern yellow pine stakes (2 x 4 in. nominal x 18 in.) treated with copper naphthenate and zinc napthenate after about 20 years of service. Stakes placed in test at Madison, Wis., October 1941 and at Harrison Experimental Forest, Saucier, Miss., February 1942

Preservative	Treatment	Location	Average retention of solution	Number in test	Condition of stakes late in 1961								Average life
					Good	Serviceable but showing some-			Destroyed by-			Total removed	
						Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
			Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Zinc naphthenate solution:														
17 percent (2 percent zinc metal)	Brush, one coat	Miss.	0.6	10						20.0	80.0	10	100.0	2.9
		Wis.	.5	10					100.0			10	100.0	6.4
17 percent (2 percent zinc metal)	Dipped, 3 minutes	Miss.	1.0	10						40.0	60.0	10	100.0	2.2
		Wis.	.9	10					100.0			10	100.0	7.7
1 percent (0.12 percent zinc metal)	Pressure	Miss.	9.9	10					50.0		50.0	10	100.0	11.2
		Wis.	9.7	10		20.0			80.0			8	80.0	
2.5 percent (0.29 percent zinc metal)	Pressure	Miss.	10.3	10			10.0		50.0		40.0	9	90.0	
		Wis.	9.8	10		40.0			60.0			6	60.0	
5.0 percent (0.59 percent zinc metal)	Pressure	Miss.	10.2	10					60.0		40.0	10	100.0	13.5
		Wis.	10.3	10		50.0			50.0			5	50.0	
7.5 percent (0.88 percent zinc metal)	Pressure	Miss.	10.4	10				30.0	50.0		20.0	7	70.0	
		Wis.	10.0	10		100.0								
Copper naphthenate solution:														
17.5 percent (2 percent copper metal)	Brush, one coat	Miss.	.5	10					20.0	-0.0	40.0	10	100.0	3.7
		Wis.	.5	10					100.0			10	100.0	6.2
17.5 percent (2 percent copper metal)	Dipped, 3 minutes	Miss.	.7	10						40.0	60.0	10	100.0	5.2
		Wis.	.8	10					100.0			10	100.0	9.5
1 percent (0.11 percent copper metal)	Pressure	Miss.	10.3	10				20.0	80.0			8	80.0	
		Wis.	10.3	10		80.0			20.0			2	20.0	
2.5 percent (0.29 percent copper metal)	Pressure	Miss.	10.2	10				80.0			20.0	2	20.0	
		Wis.	9.6	10		100.0								
5.0 percent (0.57 percent copper metal)	Pressure	Miss.	10.6	10		20.0	10.0	60.0	10.0			1	10.0	
		Wis.	10.6	10		90.0			10.0			1	10.0	
7.5 percent (0.86 percent copper metal)	Pressure	Miss.	9.6	10	20.0	30.0	10.0	40.0						
		Wis.	9.8	10	10.0	90.0								
Untreated		Miss.		10						30.0	70.0	10	100.0	1.8
		Wis.		10					100.0			10	100.0	4.9

[1] Average retention based on nine stakes.

Table 8.--Condition of treated five-ply exterior Douglas-fir plywood stakes (approximately 1/2 x 4 x 18 in.) after approximately 20 years of exposure. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., in February 1942

Preservative	Treatment	Retention of preservative (average)		Number in test[1]	Condition of stakes December 1961								Average life
					Good	Serviceable but showing some-			Destroyed by-			Total removed	
						Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
		Lb. per cu. ft.			Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Coal-tar creosote	Brush, one coat	Oil	1.5	30					26.7	26.7	46.6	30	100.0	6.2
	Dipped, 3 minutes	Oil	1.9	30					16.7	20.0	63.3	30	100.0	9.4
	Soaked 18 hours	Oil	5.6	30		6.7		56.7	23.3		13.3	11	36.6	
	Pressure	Oil	9.9	30				83.4	13.3		3.3	4	16.6	
	Pressure	Oil	12.3	29	17.1	65.5	3.4	13.8						
Pentachlorophenol:[2]														
5 percent solution	Brush, one coat	Soln.	1.0	30					10.0	60.0	30.0	[3]30	100.0	2.8
5 percent solution	Dipped, 3 minutes	Soln.	1.3	30					13.3	60.0	26.7	30	100.0	3.3
5 percent solution	Soaked, 18 hours	Soln.	3.2	30					3.3	36.7	60.0	[4]30	100.0	5.0
1.11 percent solution	Pressure	Soln.	26.3	30					20.0		80.0	[4]30	100.0	11.1
2.25 percent solution	Pressure	Soln.	26.3	30				33.3	10.0	3.3	53.4	20	66.7	
Zinc naphthenate:[2]														
4.8 percent solution (0.55 percent zinc)	Brush, one coat	Soln.	.7	30					10.0	30.0	60.0	[4]30	100.0	2.1
4.8 percent solution (0.55 percent zinc)	Dipped, 3 minutes	Soln.	1.1	30					10.0	56.7	33.3	[4]30	100.0	2.0
4.8 percent solution (0.55 percent zinc)	Soaked, 18 hours	Soln.	3.0	30					13.4	43.3	43.3	[4]30	100.0	2.9
1.11 percent solution (0.13 percent zinc)	Pressure	Soln.	25.5	30					13.3	20.0	66.7	[4]30	100.0	3.3
2.25 percent solution (0.25 percent zinc)	Pressure	Soln.	25.6	30					13.3	6.7	80.0	30	100.0	10.7
Chloro-2-phenylphenol:[5]														
5 percent solution	Brush, one coat	Soln.	.9	30					10.0	50.0	40.0	30	100.0	2.2
5 percent solution	Dipped, 3 minutes	Soln.	1.1	30					20.0	50.0	30.0	30	100.0	2.4
5 percent solution	Soaked, 18 hours	Soln.	2.9	30					13.3	60.0	26.7	30	100.0	2.5
Untreated controls				30					20.0	43.4	36.6	[4]30	100.0	1.8

[1] 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.

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

[3] Two stakes showed some delamination.

[4] One stake showed some delamination.

[5] 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 20 years of service. Stakes placed in test February 1942 at the Harrison Experimental Forest, Saucier, Miss.

Treatment	Calculated retention of chemical[1]				Number of test	Condition of stakes December 1961							Average life
	Copper as $CuSO_4$	Chromium as Na_2CrO_4	Arsenic as Na_2HAsO_4	Total		Good	Serviceable but showing some decay	Destroyed by- Decay fungi	Termites	Decay fungi and termites	Total removed		
	Lb. per cu. ft.	Lb. per cu. ft.	Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
6 days' soaking in 10.6 percent copper sulfate solution and 6 days' soaking in 9.8 percent sodium arsenate solution	0.66	.....	0.59	1.25	10	90.0	10.0	.....	.....	.....	.....	.....	.....
6 days' soaking in 10.6 percent copper sulfate solution and 12 days' soaking in 9.8 percent sodium arsenate solution	.66	.....	.75	1.41	10	100.0	.....	.....	.....	.....	.....	.....	.....
6 days' soaking in 10.6 percent copper sulfate solution and 12 days' soaking in 11.8 percent sodium chromate solution	.66	2.58	.....	3.24	10	100.0	.....	.....	.....	.....	.....	.....	.....
3 days' soaking in 10.6 percent copper sulfate solution and 6 days' soaking in 9.8 percent sodium arsenate solution	.88	.....	.55	1.43	10	100.0	.....	.....	.....	.....	.....	.....	.....
3 days' soaking in 10.6 percent copper sulfate solution and 6 days' soaking in 11.8 percent sodium chromate solution	.88	1.57	.....	2.45	10	100.0	.....	.....	.....	.....	.....	.....	.....
3 days' soaking in 5.3 percent copper sulfate solution and 6 days' soaking in 4.9 percent sodium arsenate solution	.31	.....	.17	.48	10	100.0	.....	.....	.....	.....	.....	.....	.....
3 days' soaking in 5.3 percent copper sulfate solution and 6 days' soaking in 5.9 percent sodium chromate solution	.31	.50	.....	.81	10	60.0	.....	20.0	.....	20.0	4	40.0	.....
Untreated					10	.....	.....	.....	20.0	80.0	10	100.0	1.9

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

Table 10.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with urea after about 11 to 16-1/2 years of service. Stakes placed in test at 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[1]	Average retention of urea or solids	Number in test	Condition of stakes late in 1958							Average life
					Good	Serviceable but showing some decay	Destroyed by- Decay fungi	Destroyed by- Termites	Destroyed by- Decay fungi and termites	Total removed		
		Lb.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Installed 1942												
2 days' soaking[2]	Miss.	4.7	3.4	10				10.0	90.0	10	100.0	3.4
	Wis.	4.7	3.4	10			100.0			10	100.0	8.1
4 days' soaking[2]	Miss.	6.9	5.0	10				20.0	80.0	10	100.0	3.3
	Wis.	6.9	5.0	10			100.0			10	100.0	8.0
6 days' soaking[2]	Miss.	10.2	7.4	10				20.0	80.0	10	100.0	2.9
	Wis.	10.2	7.4	10			100.0			10	100.0	6.0
B_1[3] (thermosetting) 2 days' soaking	Miss.	9.9	7.1	10				20.0	80.0	10	100.0	4.5
	Wis.	9.9	7.1	10			10.0			10	100.0	12.5
B_1[3] (thermosetting) 4 days' soaking	Miss.	11.2	8.1	10					100.0	10	100.0	5.1
	Wis.	11.2	8.1	10			100.0			10	100.0	13.1
B_1[3] (thermosetting) 6 days' soaking	Miss.	11.7	8.4	10				10.0	90.0	10	100.0	5.6
	Wis.	11.7	8.4	10			100.0			10	100.0	15.2
Untreated	Miss.			10				20.0	80.0	10	100.0	1.8
	Wis.			10			100.0			10	100.0	4.8
Installed 1946												
Urea resin pressure[4]	Miss.		5.8	10			10.0		90.0	10	100.0	9.1

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

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

[3] Solution made up of 580 parts urea, 344 parts of 37 percent formaldehyde solution, 231 parts of water, 6 parts of sodium hydroxide, and 39 parts of borax by weight.

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

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 at the Harrison Experimental Forest, Saucier, Miss.

Stake numbers	Composition	Number in test	Condition of stakes December 1950						Average life
			Destroyed by --						
			Decay fungi		Termites		Decay fungi and termites		
			Number	Percent	Number	Percent	Number	Percent	Years
	Laminated paper plastic (papreg). Installed Dec. 2, 1942								
1 to 10	37.0% phenolic resin[1] + 2% hardener, 4.7% volatile matter	10	7	70.0			3	30.0	7.4
11 to 20	31.6% phenolic resin[1] + 2% hardener, 4.4% volatile matter	10	3	30.0	1	10.0	6	60.0	5.6
21 to 30	41.0% phenolic resin[1] + 2% hardener, 4.6% volatile matter	10	7	70.0			3	30.0	8.0
31 to 40	37.0% phenolic resin[1] + 2% hardener, 4.7% volatile matter with surface sheets using 42.6% phenolic resin[1], 4.6% volatile matter[2]	10	7	70.0			3	30.0	7.2
41 to 50	37.0% phenolic resin[1] + 0.5% oleic acid, 4.7% volatile matter	10	4	40.0	1	10.0	5	50.0	7.6
	Heat-stabilized plywood (staypak). Installed June 4, 1943								
19-1 and 19-2	20 plies 1/16-inch birch bonded with phenolic resin and compressed to thickness of 1/2 inch; sp.gr. 1.37	2			1	50.0	1	50.0	4.5
	Heat-stabilized plywood (staypak). Installed Dec. 6, 1943								
S-1 to S-5	32 plies 1/16-inch birch bonded with phenolic resin and compressed to thickness of 1 inch; sp.gr. 1.33	5	2	40.0			3[3]	60.0	6.0
21-1 to 21-5	10 plies 1/8-inch maple bonded with phenolic resin and compressed to thickness of 5/8 inch; sp.gr. 1.36	5					5	100.0	4.3

[1] Alcohol-soluble.

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

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

Z M 84722 F

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

Preservative	Treatment	Average retention of solution	Number in test	Condition of stakes December 1961								Average life
				Good	Serviceable but showing some-			Destroyed by-		Total removed		
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Phenyl mercury oleate (percentage in naphtha solvent):												
0.4	3-minute dip	1.40	10						20.0	80.0	10	100.0	3.8
.4	18-hour soaking	3.20	10					10.0	30.0	60.0	10	100.0	5.0
.4	Pressure	5.90	10						10.0	90.0	10	100.0	6.7
.4	Pressure	12.10	10					30.0		70.0	10	100.0	8.8
.2	18-hour soaking	3.10	10					10.0	30.0	60.0	10	100.0	4.4
.2	Pressure	6.00	10						30.0	70.0	10	100.0	5.6
.2	Pressure	11.80	10						30.0	70.0	10	100.0	6.2
.1	18-hour soaking	3.60	10						40.0	60.0	10	100.0	4.5
.1	Pressure	5.90	10						30.0	70.0	10	100.0	4.7
.1	Pressure	11.60	10						40.0	60.0	10	100.0	5.2
1/ .4	3-minute dip	1.20	10						60.0	40.0	10	100.0	4.0
1/ .1	18-hour soaking	6.00	10						20.0	80.0	10	100.0	5.5
1/ .1	Pressure	6.10	10					10.0	40.0	50.0	10	100.0	6.2
1/ .1	Pressure	12.00	10						10.0	90.0	10	100.0	8.4
Pentachlorophenol (5.0 percent in pine oil-naphtha (1:12) solvent)	Pressure	12.10	10				70.0	10.0		20.0	3	30.0	
Copper naphthenate (0.5 percent copper metal in naphtha solvent)	Pressure	13.10	10				100.0						
Mercuric chloride (1.0 percent in water)	3-minute dip	.014 (dry salt)	10						50.0	50.0	10	100.0	4.8
	18-hour soaking	.072 (dry salt)	10						20.0	80.0	10	100.0	7.8
Untreated controls			10						60.0	40.0	10	100.0	2.8

1/ Solution contained 16 percent solids as a water repellent.

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 yellow 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 at 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 -				
			Termites		Decay fungi and termites		
	Lb. per cu. ft.		Number	Percent	Number	Percent	Yr.
Ammonium sulfate, 78 parts; ammonium phosphate, 19 parts; and sodium dichromate, 3 parts (by weight)	3.01	10	5	50.0	5	50.0	2.4
	6.17	10	6	60.0	4	40.0	3.4
Ammonium phosphate, 10 parts; ammonium sulfate, 60 parts; borax, 10 parts; and boric acid, 20 parts (by weight)	2.98	10	5	50.0	5	50.0	3.9
	6.19	10	2	20.0	8	80.0	4.3
Borax, 60 parts; and boric acid, 40 parts (by weight)	3.01	10	3	30.0	7	70.0	6.0
	6.29	10	6	60.0	4	40.0	6.5
Untreated control stakes	.....	10	2	20.0	8	80.0	2.2

Z M 84724 F

Table 14.--Condition of southern yellow 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 17 years of service. Stakes placed in test December 1944 at the Harrison Experimental Forest, Saucier, Miss.

Preservative[1]	Average retention of preservative or dry salt	Number in test	Condition of stakes December 1961									Average life
			Good*	Serviceable but showing some--			Destroyed by--			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Pine Stakes												
Ammoniacal copper arsenite (Chemonite) (percentage[2] in solution):												
0.612	[2]0.25	10	30.0	70.0								
1.29	[2].53	10	100.0									
2.57	[2]1.00	10	100.0									
3.21	[2]1.29	10	100.0									
Amyl phenyl acetate (percentage in Stoddard solvent):												
0.37	.10	10							100.0	10	100.0	6.7
.93	.25	10							100.0	10	100.0	8.5
1.85	.50	10						40.0	60.0	10	100.0	10.0
Capric acid (percentage in Stoddard solvent):												
0.37	.10	10					10.0	30.0	60.0	10	100.0	5.0
.93	.25	10					10.0	20.0	70.0	10	100.0	5.3
1.84	.50	10						10.0	**90.0**	**10**	**100.0**	5.5
Diamyl phenol (percentage in Stoddard solvent):												
0.37	.10	10						10.0	90.0	10	100.0	5.8
.90	.25	10						10.0	90.0	10	100.0	8.4
1.76	.51	10						10.0	**90.0**	**10**	**100.0**	11.4
DDT (Dichloro-diphenyl-trichloro-ethane) (percentage in Stoddard solvent):												
1.25	.35	10					100.0			10	100.0	7.1
2.7	.74	10					70.0		30.0	10	100.0	9.0
Dodecyl amine (percentage in Stoddard solvent):												
0.37	.10	10						20.0	80.0	10	100.0	5.4
.93	.25	10							100.0	10	100.0	5.7
1.85	.50	10						10.0	90.0	10	100.0	6.8
Nickel stearate (percentage in coal-tar naphtha):												
0.33	.10	10					10.0		90.0	10	100.0	5.6
.93	.27	10					30.0		70.0	10	100.0	4.9
1.85	.52	10					10.0	10.0	80.0	10	100.0	5.5
Untreated		10						40.0	60.0	10	100.0	2.1
Yellow Birch (Laminated)[3]												
Acetylated		10		40.0	10.0		50.0			5	50.0	
Untreated		10					10.0	20.0	70.0	10	100.0	2.7

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

[2]Figures based on CuO plus As_2O_3 and should be increased approximately 12 percent on basis of $Cu(OH)_2$ plus As_2O_3 as required in AWPA Standard P5-54.

[3]Prepared from six-ply, parallel-laminated, acetylated 1/16-inch veneer glued with hot-press phenolic resin. Average acetyl content 19.2 percent 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 yellow pine stakes (2 x 4 in. nominal x 18 in.) treated with acid copper chromate (Celcure), chromated copper arsenate (Greensalt or Erdalith), and nickel-arsenic-chromium salts after 16 years of service. Stakes placed in test December 1945 on the Harrison Experimental Forest, Saucier, Miss.

Preservative	Average retention	Number in test	Condition of stakes December 1961									Average life
			Good	Serviceable but showing some--			Destroyed by--			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Acid copper chromate (Celcure) --	0.26	10				20.0	10.0	30.0	40.0	8	80.0	
Equal parts copper sulfate ($CuSO_4 \cdot 5H_2O$) and sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$) (by weight). Treating solution contained 0.25 percent glacial acetic acid (80 percent)	.52	10	30.0		30.0	40.0						
	.75	10	90.0			10.0						
Chromated copper arsenate (Greensalt or Erdalith) -- Sodium dichromate ($Na_2Cr_2O_7 \cdot 2H_2O$), 5 parts; copper sulfate ($CuSO_4 \cdot 5H_2O$), 3 parts; and arsenic acid (H_3AsO_4), 1 part (by weight)	.26	10	10.0		20.0	60.0			10.0	1	10.0	
	.50	10	90.0	10.0								
	.78	10	80.0		20.0							
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	10		20.0	10.0	40.0	10.0	10.0	10.0	3	30.0	
	.50	10	10.0	40.0	10.0	40.0						
	.77	10	30.0	50.0	10.0	10.0						
Untreated		10					10.0	30.0	60.0	10	100.	3.2

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

Preservative	Treatment	Plywood[1]		Average retention of preservative[2]	Number in test	Condition of stakes December 1961								Average life
		Number of plies	Veneer thickness			Good	Serviceable but showing some--			Destroyed by--		Total removed		
							Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
			In.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Plywood from Veneer Treated before Gluing															
Coal-tar creosote	Pressure	13	1/16	40.9	10	100.0									
	Pressure	7	1/8	30.9	10	100.0									
	Heating and 1-hour cold bath	7	1/8	12.6	10				10.0	10.0	20.0	60.0	9	90.0	
	Cold soaking, 24 hours	13	1/16	12.9	10		40.0		60.0						
	Cold soaking, 24 hours	7	1/8	8.4	10		50.0	10.0	40.0						
	Dipping, 10 seconds	13	1/16	5.1	10				100.0						
	Dipping, 10 seconds	7	1/8	4.6	10				100.0						
Copper naphthenate (2 percent copper metal) in coal-tar naphtha	Pressure	13	1/16	15.5	10	100.0									
	Pressure	7	1/8	10.2	10	80.0	10.0		10.0						
	Heating and 1-hour cold bath	7	1/8	6.7	10	90.0	10.0								
	Cold soaking, 24 hours	13	1/16	10.1	10	80.0	10.0	10.0							
	Cold soaking, 24 hours	7	1/8	6.2	10	90.0				10.0			1	10.0	
	Dipping, 10 seconds	13	1/16	4.2	10	40.0	20.0	20.0	20.0						
	Dipping, 10 seconds	7	1/8	2.8	10	50.0	20.0	10.0	20.0						
Pentachlorophenol 5 percent in No. 2 fuel oil	Pressure	13	1/16	21.4	10	30.0	30.0	10.0	30.0						
	Pressure	7	1/8	18.2	10	10.0	20.0		70.0						
	Heating and 1-hour cold bath	7	1/8	10.3	10				100.0						
	Cold soaking, 24 hours	13	1/16	7.4	10				100.0						
	Cold soaking, 24 hours	7	1/8	4.8	10				90.0	10.0		10.0	2	20.0	
	Dipping, 10 seconds	13	1/16	4.9	10				70.0	20.0		10.0	3	30.0	
	Dipping, 10 seconds	7	1/8	1.0	10				50.0	10.0		40.0	5	50.0	
Chromated zinc chloride	Pressure	13	1/16	1.02	10	10.0		60.0	30.0						
	Pressure	7	1/8	1.06	10	20.0		50.0	20.0			10.0	1	10.0	
	Heating and 1-hour cold bath	7	1/8	.98	10				20.0		50.0	30.0	8	80.0	
	Steeping, 24 hours	13	21/16	1.07	9		10.1	33.3	55.6						
	Steeping, 24 hours	13	1/16	1.84	9	11.1		55.6	33.3						
	Steeping, 24 hours	7	21/8	.59	10		10.0		50.0		10.0	30.0	4	40.0	
	Steeping, 24 hours	7	1/8	1.30	10	20.0	10.0	40.0	30.0						
	Dipping, 10 seconds	13	21/16	.61	10		10.0		80.0	10.0			1	10.0	
	Dipping, 10 seconds	13	1/16	.66	10				90.0	10.0			1	10.0	
	Dipping, 10 seconds	7	1/8	.35	10						20.0	80.0	10	100.0	10.9
Acid copper chromate (Celcure)	Pressure	13	1/16	.76	10	80.0		20.0							
	Pressure	7	1/8	.79	10	90.0				10.0			1	10.0	
	Heating and 1-hour cold bath	7	1/8	1.07	10	50.0	10.0	10.0	30.0						
	Steeping, 24 hours	13	21/16	.88	10	100.0									
	Steeping, 24 hours	13	1/16	1.89	10	100.0									
	Steeping, 24 hours	7	21/8	.54	9	100.0									
	Steeping, 24 hours	7	1/8	1.32	10	100.0									
	Dipping, 10 seconds	13	21/16	.87	10	60.0			10.0	30.0			3	30.0	
	Dipping, 10 seconds	13	1/16	.61	10	70.0			10.0	20.0			2	20.0	
	Dipping, 10 seconds	7	21/8	.27	10				60.0	20.0		20.0	4	40.0	
	Dipping, 10 seconds	7	1/8	.38	10	10.0		30.0	50.0	10.0			1	10.0	

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

Preservative	Treatment	Plywood[1]		Average retention of preservative[2]	Number in test	Condition of stakes December 1961									Average life
		Number of plies	Veneer thickness			Good	Serviceable but showing some--			Destroyed by--			Total removed		
							Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
			In.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Plywood Treated after Gluing															
Coal-tar creosote	Pressure	5	1/8	19.6	10	100.0									
	Hot bath, 1 hour, and cold bath, 1 hour	5	1/8	2.0	10	20.0	40.0	10.0	30.0						
	Cold soaking, 24 hours	5	1/8	5.3	10				10.0	20.0	20.0	50.0	9	90.0	
	Dipping, 10 seconds	5	1/8	4 1.0	6 8						50.0	50.0	8	100.0	5.4
Copper naphthenate (2 percent copper metal) in coal-tar naphtha	Pressure	5	1/8	2.9	10	10.0	20.0		10.0	30.0	10.0	20.0	6	60.0	
	Hot bath, 1 hour and cold bath, 1 hour	5	1/8	1.2	10		10.0		10.0	60.0		20.0	8	80.0	
	Cold soaking, 24 hours	5	1/8	1.1	10		10.0		10.0	30.0		50.0	8	80.0	
	Dipping, 10 seconds	5	1/8	.4	10					60.0		40.0	10	100.0	10.5
Pentachlorophenol 5 percent in No. 2 fuel oil	Pressure	5	1/8	12.5	10		30.0	20.0	30.0	20.0			2	20.0	
	Hot bath, 1 hour, and cold bath, 1 hour	5	1/8	2.1	10						40.0	60.0	10	100.0	8.1
	Cold soaking, 24 hours	5	1/8	2.0	10					20.0	10.0	70.0	10	100.0	8.5
	Dipping, 10 seconds	5	1/8	.7	10					10.0	20.0	70.0	10	100.0	7.0
Chromated zinc chloride	Pressure	5	1/8	4 .62	10		10.0	10.0	30.0	30.0		20.0	5	50.0	
	Steeping, 24 hours	5	1/8	.35	10					10.0	30.0	60.0	10	100.0	3.2
	Dipping, 10 seconds	5	1/8	.03	10						40.0	60.0	10	100.0	4.0
Acid copper chromate (Celcure)	Pressure	5	1/8	.46	10	50.0		30.0	10.0			10.0	1	10.0	
	Steeping, 24 hours	5	1/8	.28	10					10.0	40.0	50.0	10	100.0	5.3
	Dipping, 10 seconds	5	1/8	.06	10					10.0	60.0	30.0	10	100.0	3.2
None	Untreated	13	1/16		10						50.0	50.0	10	100.0	3.7
	Untreated	7	1/8		10						50.0	50.0	10	100.0	3.6

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

[2] Oils or dry salt absorbed by 21-inch by 38-inch 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.

[3] Veneer heated in drier and then submerged for 1 hour in unheated preservative.

[4] Approximate values.

[5] Veneer treated prior to drying.

[6] Two specimens delaminated and were eliminated from test.

Table 17.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with various petroleum oils, pentachlorophenol solutions, copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives after about 13-1/2 years of service. Stakes placed in test at the Harrison Experimental Forest, Gaulfer, Miss., and at Bogalusa, La., April 1948

Oil or preservative	Location	Average retention	Number in test	Condition of stakes December 1961[1]									Average life
				Good	Serviceable but showing some-			Destroyed by-			Total removed		
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Unfortified petroleum oils:													
Commercial aromatic solvent (Mid-United States)	Miss.	4.1	10					10.0		90.0	10	100.0	2.1
	La.	4.1	10						20.0	80.0	10	100.0	2.9
Stoddard solvent (Mid-United States)	Miss.	4.0	10					10.0	20.0	70.0	10	100.0	2.2
	La.	4.0	10					10.0	20.0	70.0	10	100.0	2.2
No. 2 fuel oil (Mid-United States)	Miss.	4.1	10					10.0	10.0	80.0	10	100.0	4.4
	La.	4.0	10					70.0		30.0	10	100.0	4.1
Heavy thermal side cut (Mid-United States)	Miss.	4.2	10						10.0	90.0	10	100.0	3.5
	La.	4.2	10					30.0		70.0	10	100.0	4.2
No. 200 Diesel oil (West Coast)	Miss.	4.0	10					20.0	20.0	60.0	10	100.0	4.2
	La.	4.0	10					80.0		20.0	10	100.0	4.6
Catalytic gas-base oil (West Coast)	Miss.	4.0	10					40.0		60.0	10	100.0	7.6
	La.	4.0	10				10.0	60.0		30.0	9	90.0	
	Miss.	8.0	10				50.0	20.0		30.0	5	50.0	
	La.	8.0	10				80.0	10.0		10.0	2	20.0	
	Miss.	12.0	10	10.0	10.0	10.0	40.0	30.0			3	30.0	
	La.	11.9	10		20.0		80.0						
No. 300 fuel oil (West Coast)	Miss.	4.2	10					90.0		10.0	10	100.0	7.1
	La.	4.2	10				20.0	80.0			8	80.0	
No. 400 fuel oil (West Coast)	Miss.	4.2	10					80.0		20.0	10	100.0	5.8
	La.	4.2	10					90.0		10.0	10	100.0	5.5
Light gas oil (Mid-United States)	Miss.	4.1	10					50.0		50.0	10	100.0	6.7
	La.	4.1	10					60.0		40.0	10	100.0	6.0
Denver No. 3 blend (50-50 topped crude residual and recycled overhead gas oil)	Miss.	4.0	10					60.0		40.0	10	100.0	6.5
	La.	4.0	10					80.0		20.0	10	100.0	5.9
Heavy gas oil (Mid-United States)	Miss.	4.0	10	10.0	10.0		20.0	60.0			6	60.0	
	La.	4.0	10				60.0	40.0			4	40.0	
	Miss.	7.9	10	20.0	40.0		10.0	30.0			3	30.0	
	La.	7.9	10		50.0		50.0						
	Miss.	12.1	10	60.0	30.0		10.0						
	La.	12.1	10	70.0	10.0		20.0						
Tube oil extract (Texas)	Miss.	4.1	10		20.0		20.0	60.0			6	60.0	
	La.	4.2	10				80.0	20.0			2	20.0	
Fortified petroleum oils and mixtures:													
Commercial aromatic solvent (Mid-United States, with 5 percent pentachlorophenol	Miss.	4.2	10				10.0			90.0	9	90.0	
	La.	4.2	10					10.0		90.0	10	100.0	5.5
Stoddard solvent (Mid-United States) with 5 percent pentachlorophenol	Miss.	4.0	10				60.0			40.0	4	40.0	
	La.	4.0	10					20.0		80.0	10	100.0	8.8
No. 2 fuel oil (Mid-United States) with 5 percent pentachlorophenol	Miss.	4.0	10	10.0			50.0	10.0		30.0	4	40.0	
	La.	3.8	10				30.0			70.0	7	70.0	
Heavy thermal side cut (Mid-United States) with 5 percent pentachlorophenol	Miss.	4.0	10				60.0	10.0		30.0	4	40.0	
	La.	4.0	10				10.0	10.0		80.0	9	90.0	
No. 200 Diesel oil (West Coast) with 5 percent pentachlorophenol	Miss.	4.1	10				80.0	10.0		10.0	2	20.0	
	La.	4.1	10				70.0			30.0	3	30.0	

Table 17.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with various petroleum oils, pentachlorophenol solutions, copper naphthenate solutions, coal-tar creosote, and mixtures of these preservatives after about 11-1/2 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., and at Bogalusa, La., April 1949 (continued)

Oil of preservative	Location	Average retention	Number in test	Condition of stakes December 1961[1]							Average life
				Good	Serviceable but showing some-			Destroyed by-		Total removed	
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Catalytic gas-base oil (West Coast) with 5 percent pentachlorophenol	Miss.	4.1	10				90.0			10.0	1	10.0	
	La.	4.1	10				100.0						
	Miss.	8.0	10		20.0		80.0						
	La.	7.9	10				100.0						
	Miss.	12.0	10	50.0	30.0		20.0						
	La.	12.0	10	20.0	10.0		70.0						
No. 300 fuel oil (West Coast) with 5 percent pentachlorophenol	Miss.	4.0	10		40.0		30.0	30.0			3	30.0	
	La.	4.1	10				90.0	10.0			1	10.0	
No. 400 fuel oil (West Coast) with 5 percent pentachlorophenol	Miss.	4.2	10		10.0		40.0	20.0		30.0	5	50.0	
	La.	4.2	9				33.3	11.1		55.6	5	55.7	
Light gas oil (Mid-United States) with 5 percent pentachlorophenol	Miss.	4.0	10				80.0			20.0	2	20.0	
	La.	4.2	10				80.0			20.0	2	20.0	
Power No. 5 blend (50-50 topped crude and cycl and recycled overhead gas oil) with 5 percent pentachlorophenol	Miss.	4.0	10		10.0		70.0						
	La.	4.0	10				90.0	10.0			1	10.0	
Heavy gas oil (Mid-United States) with 5 percent pentachlorophenol	Miss.	4.1	9	78.8	22.2								
	La.	4.1	10		10.0		90.0						
	Miss.	7.9	10	50.0	40.0		10.0						
	La.	7.9	10	10.0	20.0		70.0						
	Miss.	12.0	10	80.0	20.0								
	La.	12.0	10	40.0	30.0		30.0						
Lube oil extract (Texas) with 5 percent pentachlorophenol	Miss.	4.2	10	40.0	40.0	10.0	10.0						
	La.	4.2	10		10.0		90.0						
Catalytic gas-base oil (West Coast) with copper naphthenate (0.5 percent copper metal)	Miss.	4.2	10		10.0		10.0	60.0	10.0	10.0	8	80.0	
	La.	4.2	10		10.0		70.0	10.0		10.0	2	20.0	
Catalytic gas-base oil (West Coast) with copper naphthenate (0.75 percent copper metal)	Miss.	4.4	9	11.1	11.1		55.6	22.2			2	22.2	
	La.	4.2	10	10.0	10.0		70.0	10.0			1	10.0	
Coal-tar creosote	Miss.	4.1	10		30.0		20.0	40.0		10.0	5	50.0	
	La.	4.1	10				70.0	30.0			3	30.0	
Coal-tar creosote, 50 percent and catalytic gas-base oil (West Coast) with 5 percent pentachlorophenol, 50 percent, by volume	Miss.	4.1	10		20.0		30.0	40.0		10.0	5	50.0	
	La.	4.1	10				90.0			10.0	1	10.0	
Coal-tar creosote, 50 percent, and catalytic gas-base oil (West Coast) with copper naphthenate (0.5 percent copper metal), 50 percent by volume	Miss.	4.2	10	10.0	20.0		30.0	40.0			4	40.0	
	La.	4.3	10				90.0	10.0			1	10.0	
Coal-tar creosote, 25 percent, and catalytic gas-base oil (West Coast) with copper naphthenate (0.75 percent copper metal), 75 percent by volume	Miss.	4.1	10	10.0	10.0		30.0	50.0			5	50.0	
	La.	4.2	10				80.0	10.0		10.0	2	20.0	
Catalytic gas-base oil (West Coast) with 5 percent pentachlorophenol, 50 percent, and catalytic gas-base oil (West Coast) with copper naphthenate (0.5 percent copper metal), 50 percent by volume	Miss.	4.2	10	20.0	60.0		20.0						
	La.	4.2	10		10.0		90.0						
Untreated controls	Miss.		10					20.0	20.0	60.0	10	100.0	2.2
	La.		10							100.0	10	100.0	2.8

[1] Data reported for last inspection at Bogalusa in 1960.

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 3 years service. Stakes placed in test at Madison, Wis., October 1958 and at the Harrison Experimental Forest, Saucier, Miss., December 1958

Preservative	Location	Average retention	Number in test	Condition of stakes late in 1961								Average life
				Good	Serviceable but showing some-			Destroyed by-			Total removed	
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Coal-tar creosote:													
Low residue, straight run	Miss.	8.0	10				70.0	20.0		10.0	3	30.0	
	Wis.	8.0	10		100.0								
Medium residue, straight run	Miss.	8.0	10	10.0	30.0		60.0						
	Wis.	8.0	10		100.0								
High residue, straight run	Miss.	7.8	10		70.0		30.0						
	Wis.	7.8	10	30.0	70.0								
Medium residue, low in tar acids	Miss.	8.1	10		60.0		40.0						
	Wis.	8.1	10	30.0	70.0								
Medium residue, low in naphthalene	Miss.	8.2	10		50.0		50.0						
	Wis.	8.2	10	10.0	90.0								
Medium residue, low in tar acids and naphthalene	Miss.	8.0	10		40.0		50.0	10.0			1	10.0	
	Wis.	8.0	10	30.0	70.0								
Low residue, low in tar acids and naphthalene	Miss.	8.0	10		30.0		60.0			10.0	1	10.0	
	Wis.	8.0	10	10.0	90.0								
High residue, low in tar acids and naphthalene	Miss.	8.2	10	10.0	40.0		50.0						
	Wis.	8.1	10	30.0	70.0								
English, vertical retort	Miss.	8.0	10		60.0		30.0	10.0			1	10.0	
	Wis.	8.0	10	70.0	30.0								
English, coke oven	Miss.	7.9	10				40.0	30.0		10.0	6	60.0	
	Wis.	7.9	10		100.0								
English, coke oven, 30 percent, and English vertical retort, 50 percent by volume	Miss.	8.1	10				80.0	10.0		10.0	2	20.0	
	Wis.	8.1	10	10.0	90.0								
Medium residue, low in tar acids and naphthalene, 70 percent and coal tar, 30 percent by volume	Miss.	8.1	10	10.0	60.0		30.0						
	Wis.	8.1	10	20.0	80.0								
Medium residue, low in tar acids and naphthalene, 70 percent and petroleum oil (Wyoming residual), 30 percent by volume	Miss.	8.1	10	10.0	60.0		20.0	10.0			1	10.0	
	Wis.	8.1	10	20.0	80.0								
Petroleum oil (Wyoming residual)	Miss.	8.1	10					90.0		10.0	10	100.0	5.4
	Wis.	8.1	10	30.0	10.0			60.0			6	60.0	
Untreated controls	Miss.		10					10.0	10.0	80.0	10	100.0	1.4
	Wis.		10					100.0			10	100.0	3.4

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 13 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 1961									Average life
			Good	Serviceable but showing some-			Destroyed by-			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites	Number	Percent	
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent			Yr.
Coal-tar creosote:												
English vertical-retort	5.3	10	10.0	70.0		20.0						
	10.1	10	60.0	40.0								
	15.0	10	100.0									
English coke-oven	4.7	10				80.0	20.0			2	20.0	
	10.1	10	20.0	50.0		30.0						
	14.8	10		70.0		30.0						
Untreated controls		10							100.0	10	100.0	1.9

Table 20.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with zinc-arsenic-chromium and copper-arsenic-chromium salts after about 12 years of service. Stakes placed in test at Madison, Wis., November 1949, and at the Harrison Experimental Forest, Saucier, Miss., December 1949

Preservative	Location	Average retention	Number in test	Condition of stakes late in 1961								Average life
				Good	Serviceable but showing some-			Destroyed by-			Total removed	
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Zinc-arsenic-chromium salt (S32)[1]	Wis.	0.96	10	70.0	30.0								
	Miss.	.96	10	100.0									
	Wis.	.74	10	30.0	70.0								
	Miss.	.72	10	100.0									
	Wis.	.50	10	10.0	90.0								
	Miss.	.50	10	70.0	20.0	10.0							
	Wis.	.35	10		90.0			10.0			1	10.0	
	Miss.	.35	10	30.0	60.0		10.0						
	Wis.	.22	10		100.0								
	Miss.	.22	10	10.0	80.0		10.0						
Copper-arsenic-chromium salt (K33)[2]	Wis.	1.03	10	100.0									
	Miss.	1.04	10	100.0									
	Wis.	.78	10	100.0									
	Miss.	.79	10	100.0									
	Wis.	.52	10	90.0	10.0								
	Miss.	.52	10	100.0									
	Wis.	.37	10	70.0	30.0								
	Miss.	.37	10	100.0									
	Wis.	.26	10	30.0	70.0								
	Miss.	.26	10	100.0									
Zinc chloride	Wis.	1.04	10		40.0			60.0			6	60.0	
	Miss.	1.04	10		10.0		80.0	10.0			1	10.0	
Coal-tar creosote	Wis.	8.4	10		100.0								
	Miss.	8.3	10		50.0		50.0						
Untreated	Wis.		10					100.0			10	100.0	7.0
	Miss.		10					10.0	30.0	60.0	10	100.0	2.8

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

[2] CuO, 96 parts; CrO_3, 175 parts; and As_2O_5, 217 parts.

Table 21.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with two fortified aromatic petroleum oils after 12 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 1961									Average life
			Good	Serviceable but showing some--			Destroyed by--			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Standard wood preservative[1]	3.7	10				10.0	10.0	10.0	70.0	9	90.0	
	8.2	10	10.0	20.0		30.0			40.0	4	40.0	
	11.7	10	40.0			30.0	20.0		10.0	3	30.0	
Wood preservative No. 51746-R[2]	4.0	10				50.0	10.0		40.0	5	50.0	
	8.0	10				90.0	10.0			1	10.0	
	12.1	10	20.0			80.0						
Untreated		10						30.0	70.0	10	100.0	2.2

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

[2] Reported to be a mixture of petroleum cresylic acids, aromatic oils, and 1.0 percent 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 12 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 1961							Average life
			Good	Serviceable but showing some-			Destroyed by		Total removed	
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Rosin amine D pentachlorophenate, 5 percent, in Stoddard solvent	4.0	10						20.0	80.0	10	100.0	3.8
	7.9	10							100.0	10	100.0	5.1
	11.8	10				20.0			80.0	8	80.0	
Rosin amine D pentachlorophenate, 5 percent, and paraffin wax, 2 percent, in Stoddard solvent	4.2	10						20.0	80.0	10	100.0	4.5
	8.0	10				10.0	10.0		80.0	9	90.0	
Rosin amine D pentachlorophenate, 5 percent, paraffin wax, 2 percent, and pentalyn H, 10 percent, in Stoddard solvent	4.0	10						30.0	70.0	10	100.0	8.0
	8.0	10					30.0	30.0	40.0	10	100.0	8.7
Pentachlorophenol, 5 percent, and pine oil, 5 percent, in Stoddard solvent	4.1	10				30.0			70.0	7	70.0	
	8.0	9				100.0						
Rosin amine D pentachlorophenate, 5 percent, in No. 4 aromatic oil	4.0	10			10.0	70.0	20.0			2	20.0	
	7.6	10		30.0		50.0	20.0			2	20.0	
	12.3	10	70.0	10.0		20.0						
Pentachlorophenol, 5 percent, pine oil, 5 percent, paraffin wax, 2 percent, and pentalyn H, 10 percent, in Stoddard solvent	4.1	10				50.0			50.0	5	50.0	
	7.8	10		10.0		70.0	10.0		10.0	2	20.0	
Pentachlorophenol, 5 percent, in No. 4 aromatic oil	4.2	10		10.0		80.0	10.0			1	10.0	
	8.2	10	50.0	10.0	10.0	30.0						
Untreated controls		10						30.0	70.0	10	100.0	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 10 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 1961								Average life
			Good	Serviceable but showing some-			Destroyed by-		Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number / Percent	Yr.
Rosin amine D pentachlorphenate 5 percent, in petroleum oil (Wyoming residual)	4.0	10	20.0	70.0		10.0					
	8.0	10		80.0		20.0					
	12.7	10	60.0	40.0							
Pentachlorophenol, 5 percent in petroleum oil (Wyoming residual)	4.0	10	10.0	80.0		10.0					
	8.0	10	60.0	40.0							
	11.7	10	100.0								
Petroleum oil (Wyoming residual)	7.7	10		50.0			40.0		10.0	5 / 50.0	
	12.2	10	20.0	30.0		10.0	40.0			4 / 40.0	
Untreated controls		10						20.0	80.0	10 / 100.0	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 10 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 1961							Average life
			Good	Serviceable but showing some-		Destroyed by-		Total removed		
				Decay	Decay and termite attack	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Chromated zinc arsenate (Boliden salts) (H_3AsO_4, 20 parts; Na_2HAsO_4, 21 parts; $Na_2Cr_2O_7 \cdot 2H_2O$, 16 parts; and $ZnSO_4$, 43 parts)[1]	0.22	10		80.0	20.0					
	.38	10	30.0	60.0	10.0					
	.77	2/10	70.0	30.0						
	1.01	2/10	100.0							
Boliden salts S-25 (CrO_3, 32 parts; CuO, 5 parts; ZnO, 14 parts; and As_2O_5, 49 parts)	.30	10	100.0							
	.50	10	100.0							
	.75	10	100.0							
	1.01	10	100.0							
Untreated controls		10				20.0	80.0	10	100.0	1.8

[1] Retentions are shown on an anhydrous basis, and figures should be increased approximately 26 percent to obtain values as computed in A.W.P.A. Standard P5-55.

[2] 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 (A.W.P.A. P10-51) after about 10 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., March 1952[1]

Preservative	Average retention	Number in test	Condition of stakes December 1961							Average life
			Good	Serviceable but showing some-			Destroyed by-		Total removed	
				Decay	Termite attack	Decay and termite attack	Termites	Decay fungi and termites		
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Number / Percent	Yr.
Chromated zinc chloride ($ZnCl_2$, 77.5 parts, and $Na_2Cr_2O_7 \cdot 2H_2O$, 17.5 parts)	1.50	10	70.0	10.0	20.0					
	2.91	10	90.0		10.0					
	6.00	10	90.0		10.0					
Chromated zinc chloride (FR) (Chromated zinc chloride, 80 parts, H_3BO_3, 10 parts; and $(NH_4)_2SO_4$, 10 parts)	1.53	10	10.0		40.0	40.0		10.0	1 / 10.0	
	3.00	10	70.0		30.0					
	6.08	10	80.0		20.0					
Minalith ($(NH_4)_2HPO_4$, 10 parts; $(NH_4)_2SO_4$, 60 parts; $Na_2B_4O_7$, 10 parts; and H_3BO_3, 20 parts)	1.50	10					10.0	90.0	10 / 100.0	3.6
	3.00	10					10.0	90.0	10 / 100.0	4.8
	6.13	10					30.0	70.0	10 / 100.0	5.0
Pyresote ($ZnCl_2$, 35 parts; $(NH_4)SO_4$, 35 parts; H_3BO_3, 25 parts; and $Na_2Cr_2O_7 \cdot 2H_2O$, 5 parts)	1.50	10				70.0		30.0	3 / 30.0	
	3.01	10		10.0	10.0	70.0	10.0		1 / 10.0	
	6.26	10			70.0	30.0				
Untreated controls		10					20.0	80.0	10 / 100.0	2.6

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

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 10 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 1961									Average life
			Good	Serviceable but showing some-			Destroyed by-			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Basic zinc chloride[1]	1.00	10	50.0		10.0	40.0						
	2.11	10	60.0	10.0	30.0							
	4.13	10	100.0									
Zinc chloride	1.02	10	10.0	10.0	10.0	70.0						
Untreated controls		10					10.0	20.0	70.0	10	100.0	2.2

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

Table 27.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with naval-stores products after about 10 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 1961									Average life
			Good	Serviceable but showing some-			Destroyed by-			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Rosin oil and No. 2 fuel oil (2:7)[1]	4.1	10					30.0		70.0	10	100.0	6.8
	8.0	10					60.0		40.0	10	100.0	5.8
	12.3	10				30.0	10.0		60.0	7	70.0	
Rosin oil and No. 2 fuel oil (1:7)[1]	4.0	10					10.0		90.0	10	100.0	5.6
	8.0	10					50.0		50.0	10	100.0	5.8
	12.1	10				30.0	40.0		30.0	7	70.0	
Rosin oil and No. 2 fuel oil (1:7)[1] with 2.98 percent[1] pentachlorophenol	4.0	10				60.0	20.0		20.0	4	40.0	
	8.0	10		10.0		50.0	20.0		20.0	4	40.0	
	12.1	10		20.0	10.0	70.0						
No. 2 fuel oil	4.1	10					30.0	10.0	60.0	10	100.0	6.2
No. 2 fuel oil with 2.92 percent[1] pentachlorophenol	4.0	10				50.0	10.0		40.0	5	50.0	
	8.0	10				70.0	10.0		20.0	3	30.0	
	12.3	10	10.0	10.0		80.0						
No. 2 fuel oil with 4.94 percent[1] pentachlorophenol	4.1	10				60.0	30.0		10.0	4	40.0	
	8.0	10				70.0	20.0		10.0	3	30.0	
	12.0	10	20.0	40.0	10.0	30.0						
Rosin oil and Stoddard solvent (1:7)[1] with 3.21 percent[1] pentachlorophenol	8.0	10				40.0	30.0		30.0	6	60.0	
Oleo resin and No. 2 fuel oil (2:7)[1]	4.0	10				20.0			80.0	8	80.0	
	8.1	10				10.0	40.0	10.0	40.0	9	90.0	
	12.2	10				50.0	20.0		30.0	5	50.0	
Oleo resin and Stoddard solvent (1:7)[1] with 3.11 percent[1] pentachlorophenol	8.2	10				30.0	40.0	10.0	20.0	7	70.0	
Drop liquor concentrate and Stoddard solvent (1:7)[1] with 2.99 percent[1] pentachlorophenol	7.9	10				30.0	20.0		50.0	7	70.0	
Oleo resin and No. 2 fuel oil (1:7)[1] with 2.94 percent[1] pentachlorophenol	4.1	10				40.0	40.0		20.0	6	60.0	
	8.0	10				70.0	10.0		20.0	3	30.0	
	12.0	10	10.0			70.0	10.0		10.0	2	20.0	
Drop liquor concentrate and No. 2 fuel oil (2:7)[1]	4.0	10					10.0		90.0	10	100.0	6.8
	8.0	10				10.0	20.0		70.0	9	90.0	
	12.0	10				40.0			60.0	6	60.0	
Drop liquor concentrate and No. 2 fuel oil (1:7)[1] with 3.05 percent[1] pentachlorophenol	4.0	10				80.0			20.0	2	20.0	
	8.0	10				80.0	20.0			2	20.0	
	12.0	10	20.0	20.0	10.0	50.0						
No. 2 fuel oil with 5 percent[1] rosin-amine D copper acetate complex	4.1	10				20.0	40.0		40.0	8	80.0	
	8.0	10				40.0	40.0		20.0	6	60.0	
	12.1	10	10.0	10.0		60.0	20.0			2	20.0	
Untreated controls		10					10.0	20.0	70.0	10	100.0	2.8

[1] Ratios and percentages on a weight basis.

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 9 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 1961								Average life
			Good	Serviceable but showing some-			Destroyed by-		Total removed		
				Decay	Termite attack	Decay and termite attack	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Low-temperature coal-tar creosote, Type 1 (tar acids present)	5.0	10	70.0	20.0		10.0					
	10.2	10	70.0	30.0							
	15.4	10	90.0	10.0							
Low-temperature coal-tar creosote, Type 2 (high percentage of tar acids removed)	5.0	10	60.0	30.0		10.0					
	9.8	10	40.0	50.0		10.0					
	15.2	10	100.0								
Untreated controls		10					40.0	60.0	10	100.0	2.3

Table 29.--Condition after about 8 -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 at the Harrison Experimental Forest, Saucier, Miss., April 1953[1]

Stake Nos.	Preservative	Conditioning after treatment	Number in test	Average preservative retention		Condition of stakes December 1961								
				From weights before and after treatment[2]: Solution	From weights before and after treatment[2]: By analysis 2 months after treatment: Pentachlorophenol or copper metal	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: Termites	Destroyed by: Decay fungi and termites	Total removed	Average life
				Lb. per cu. ft.	Lb. per cu. ft.	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yrs.
V1-V10	Pentachlorophenol, 2.5 percent in light aromatic solvent[3]	None	10	4.2	0.105	0.082			70.0	20.0		10.0	3	30.0	
V11-V20		Steaming[4]	10	4.2	.105	.091			80.0	10.0		10.0	2	20.0	
V21-V30	Pentachlorophenol, 2.3 percent in light aromatic solvent	Vapor cleaning[5]	10	4.1	.102	.069			90.0	10.0			1	10.0	
V31-V40	Pentachlorophenol, 4.5 percent in light aromatic solvent[3]	Steaming[4]	10	4.4	.200	.139			70.0	10.0		20.0	3	30.0	
V41-V50	Pentachlorophenol, 5 percent in light aromatic solvent	Vapor cleaning[5]	10	4.5	.225	.136			80.0	20.0			2	20.0	
V51-V60	Pentachlorophenol, 5 percent in light aromatic solvent[3]	None	10	4.6	.270	.186			100.0						
V61-V70		Steaming[4]	10	4.8	.240	.222			80.0	10.0		10.0	2	20.0	
V71-V80	Pentachlorophenol, 5 percent in light aromatic solvent	Vapor cleaning[5]	10	6.0	.300	.173			70.0			30.0	3	30.0	
V81-V90	Pentachlorophenol, 9.1 percent in light aromatic solvent[3]	Steaming[4]	10	4.4	.400	.319		10.0	90.0						
V91-V100	Pentachlorophenol, 10 percent in light aromatic solvent	Vapor cleaning[5]	10	6.0	.600	.397			100.0						
V101-V110	Pentachlorophenol, 5 percent in No. 2 fuel oil	None	10	6.2	.310	.191			80.0	10.0					
V111-V120		Steaming[4]	10	6.6	.330	.146			100.0						
V121-V130		Vapor cleaning[5]	10	7.2	.360	.111		10.0	80.0	10.0			1	10.0	
V131-V140	Copper naphthenate, 0.5 percent in light aromatic solvent	None	10	4.6	.023	.020		10.0	60.0	20.0		10.0	3	30.0	
V141-V150		Steaming[4]	10	4.5	.022	.020		10.0	60.0	20.0			2	20.0	
V151-V160		Vapor cleaning[5]	10	4.6	.023	.018		10.0	50.0	30.0			3	30.0	
V161-V170	Copper naphthenate, 0.59 percent copper in light aromatic solvent	Steaming[4]	10	4.4	.026	.023		10.0	70.0	10.0			1	10.0	
V171-V180	Copper naphthenate, 0.7 percent copper in light aromatic solvent	Vapor cleaning[5]	10	4.2	.029	.021			80.0			10.0	1	10.0	
V181-V190	Untreated controls		10								90.0	10.0	10	100.0	2.-

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

[2] Prior to conditioning.

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

[4] One hour steaming with maximum temperature 259° F., and 1 hour vacuum, following which steaming and vacuum periods were repeated.

[5] One hour heating in vapor of aromatic solvent with maximum temperature of 280° F., and 1 hour 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 7 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 1961									Average life
			Good	Serviceable but showing some-			Destroyed by-			Total removed		
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Basilit UA[1]	0.25	10	20.0	10.0	30.0	40.0						
Do	.53	10	90.0		10.0							
Do	.75	10	80.0	10.0		10.0						
Untreated controls		10						20.0	80.0	10	100.0	1.8

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

Table 31.--Condition, after 7 years of service, 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. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1954

Preservative	Average retention	Number in test	Condition of stakes December 1961: 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-: Termites	Destroyed by-: Decay fungi and termites	Total removed: Number	Total removed: Percent	Average life
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Yr.
Stakes from Wood without Mold Infection												
Coal-tar creosote (high residue, straight run)	3.9	10	40.0	60.0								
	7.8	10	80.0	20.0								
	12.2	10	90.0	10.0								
Coal-tar creosote (low residue, low in tar acids and naphthalenes)	4.0	10	60.0	20.0		20.0						
	8.0	10	90.0	10.0								
	12.4	10	100.0									
Pentachlorophenol (4.7 percent in No. 2 fuel oil)	4.2	10		20.0		70.0	10.0			1	10.0	
	8.1	10			70.0	30.0						
	12.1	10	70.0		10.0	20.0						
Copperized chromated zinc chloride	.34	10	20.0		60.0	20.0						
	.73	10	50.0		40.0	10.0						
	1.15	10	80.0		20.0							
Untreated controls		10						60.0	40.0	10	100.0	2.1
Stakes from Wood Infected with Trichoderma Mold												
Coal-tar creosote (high residue, straight run)	4.0	10	30.0	40.0		30.0						
	8.0	10	50.0	50.0								
	12.0	10	90.0	10.0								
Coal-tar creosote (low residue, low in tar acids and naphthalenes)	4.1	10	10.0	60.0		30.0						
	8.0	10	20.0	80.0								
	12.0	10	100.0									
Pentachlorophenol (4.7 percent in No. 2 fuel oil)	4.2	10			30.0	60.0	10.0			1	10.0	
	7.8	10	10.0	20.0	40.0	30.0						
	11.9	10	80.0		20.0							
Copperized chromated zinc chloride	.34	10	10.0		70.0	20.0						
	.74	10	30.0		70.0							
	1.17	10	80.0		20.0							
Untreated controls		10					10.0	30.0	60.0	10	100.0	2.5

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 7 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 1961								
			Good	Serviceable but showing some-			Destroyed by-			Total removed	
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		Average life
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Years
Texas lignite coal-tar creosote	5.1	10	60.0	20.0	10.0	10.0						
Do	9.8	10	90.0	10.0								
Do	15.2	10	100.0									
25 percent paraffin in aromatic volatile solvent (by weight)	25.9	10		30.0		70.0						
5 percent pentachlorophenol plus 28.5 percent paraffin in aromatic volatile solvent (by weight)	26.3	10	100.0									
Untreated controls		10						30.0	70.0	10	100.0	2.3

Table 33.--Condition of Douglas-fir, sweetgum, and tangile plywood stakes treated with pentachlorophenol and with fluor chrome arsenate phenol (Tanalith) after about 6 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., January 1956

Item No.	Species	Preservative	Treatment	Average retention	Number in test	Condition of stakes December 1961							Total removed		Average life
						Good	Serviceable but showing some-			Destroyed by-					
							Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
				Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Years
Plywood from Veneer Treated before Gluing															
1	Douglas-fir	Pentachlorophenol[2]	Hot and cold[3]	10.0	10	10.0	10.0		50.0	20.0		10.0	3	30.0	
2	do.	do.	Cold soaked	6.3	10			10.0	50.0	30.0		10.0	4	40.0	
3	do.	Fluor chrome arsenate phenol (Tanalith)	Hot and cold[3]	.52	10	40.0	10.0		50.0						
4	Sweetgum	Pentachlorophenol[2]	do.	15.1	10				50.0	30.0		20.0	5	50.0	
5	do.	Fluor chrome arsenate phenol (Tanalith)	do.	.62	10		10.0		80.0	10.0			1	10.0	
6	Tangile	Pentachlorophenol[2]	do.	9.4	10				60.0	40.0			4	40.0	
7	do.	Fluor chrome arsenate phenol (Tanalith)	do.	.59	10	10.0	60.0		30.0						
Plywood Treated after Gluing															
8	Douglas-fir	Pentachlorophenol[2]	Pressure	9.6	10	10.0	50.0		40.0						
9	do.	do.	Cold soaked	.9	10				20.0	20.0	10.0	50.0	8	80.0	
10	do.	do.	do.	1.4	10				70.0		10.0	20.0	3	30.0	
11	do.	Fluor chrome arsenate phenol (Tanalith)	Pressure	.61	10	90.0						10.0	1	10.0	
12	Sweetgum	Pentachlorophenol[2]	do.	10.6	10				30.0	60.0		10.0	7	70.0	
13	do.	Fluor chrome arsenate phenol (Tanalith)	do.	.55	10		40.0		20.0	[4]20.0		20.0	4	40.0	
14	Tangile	Pentachlorophenol[2]	do.	10.4	10	10.0	40.0		50.0						
15	do.	Fluor chrome arsenate phenol (Tanalith)	do.	.60	10	90.0	10.0								
Untreated Controls															
16	Douglas-fir				10				10.0			90.0	9	90.0	
17	Sweetgum				10					10.0	10.0	80.0	10	100.0	1.4
18	Tangile				10					40.0		60.0	10	100.0	1.9

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

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

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

[4] One stake by soft-rot fungus.

Note: The stakes were of 5-ply veneer, 5/8 by 4 by 18 inches and cut from panels 24 by 48 inches. 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 5 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 1961							
			Good	Serviceable but showing some--			Destroyed by--		Total removed	Average life
				Decay	Termite attack	Decay and termite attack	Decay fungi	Decay fungi and termites		
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Number / Percent	Years
Copper formate	0.030	10	.....	.....	30.0	40.0	10.0	20.0	3 / 30.0	.....
Do.	.060	10	50.0	.....	40.0	.....	10.0	.....	1 / 10.0	.....
Do.	.090	10	50.0	20.0	20.0	10.0	.....	.....	..... /	.....
Do.	.120	10	90.0	10.0	.....	.....	.....	.....	..... /	.....
Untreated controls	.....	10	.....	.....	.....	.....	.....	100.0	..... /	.....

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

Preservative	Average retention	Location	Number in test	Good	Condition of stakes December 1961									
					Serviceable but showing some-			Destroyed by -			Total removed		Average life
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites			
	Lb. per cu. ft.			Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent	Years
Stakes 3/4- by 3/4 x 18 in.													
KP[1] preservative	0.09	Miss.	[2] 9	55.6	22.2		22.2						
do	.18	do	10	70.0	30.0								
do	.28	do	10	100.0									
do	.37	do	10	100.0									
Chromated zinc chloride	1.20	Miss.	[2] 9	100.0									
Coal-tar creosote	11.6	do	10	100.0									
Untreated controls		do	10					40.0		60.0	10	100.0	2.1
Stakes 2- by 4- by 18 in.													
KP[1] preservative	.09	Miss.	10	40.0	30.0		30.0						
do	.09	Wis.	10	90.0	10.0								
KP[1] preservative	.19	Miss.	10	80.0	10.0		10.0						
do	.18	Wis.	10	100.0									
KP[1] preservative	.27	Miss.	10	100.0									
do	.26	Wis.	10	100.0									
KP[1] preservative	.37	Miss.	10	100.0									
do	.35	Wis.	10	100.0									
Chromated zinc chloride	1.16	Miss.	10	100.0									
do	1.21	Wis.	10	100.0									
Coal-tar creosote	10.2	Miss.	10	100.0									
do	10.2	Wis.	10	100.0									
Untreated controls		Miss.	10					20.0		80.0	10	100.0	2.5
do		Wis.	10		20.0			80.0			8	80.0	

[1] Copper oxide and chlorophenol.

[2] One specimen found broken was eliminated from test.

Table 36.--Condition of southern pine stakes (2 x 4 in. nominal x 18 in.) treated with tributyltin oxide after 3 years at the Harrison Experimental Forest, Saucier, Miss., and of those of cyanoethylated wood and wood treated for destruction of thiamine after approximately 3 years in Mississippi and 2-1/2 years at Madison, Wis. Stakes placed in test in Mississippi in December 1958 and in Wisconsin in April 1959

Preservative	Location	Average retention	Number in test	Condition of stakes late in 1961								
				Good	Serviceable but showing some--			Destroyed by--			Total removed	
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent
Tributyltin oxide[1]	Miss.	0.015	10				100.0					
Do	do	.030	10			10.0	90.0					
Do	do	.045	10				100.0					
Stoddard solvent (controls)	do	7.1	10				60.0		20.0	20.0	4	40.0
Acrylonitrile[2]	do	1.23	10				70.0		10.0	20.0	3	30.0
Do	Wis.	1.22	10	10.0	80.0			10.0			1	10.0
Do	Miss.	2.46	10				100.0					
Do	Wis.	2.48	10	30.0	70.0							
Ammonium hydroxide[3]	Miss.		10				60.0		10.0	30.0	4	40.0
Untreated controls	do		10				50.0			50.0	5	50.0
Do	Wis.		10	10.0	40.0			50.0			5	50.0

[1] In Stoddard solvent.

[2] Used with ammonium hydroxide for cyanoethylation.

[3] 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 (Tanalith--AWPA-P5 and modification) after 2 years of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1959

Preservative	Average retention	Number in test	Condition of stakes December 1961								
			Good	Serviceable but showing some--			Destroyed by--			Total removed	
				Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent
Stakes 2 by 4 (nominal) by 18 in.											
Fluor chrome arsenate phenol (Tanalith--AWPA-P5-58)	0.35	10	100.0								
	.50	10	100.0								
	.75	10	100.0								
Fluor chrome arsenate phenol (Tanalith--modified)[1]	.35	10	90.0		10.0						
	.50	10	90.0		10.0						
	.76	10	90.0		10.0						
Untreated controls		10				30.0	20.0	20.0	30.0	7	70.0
Stakes 3/4 by 3/4 by 18 in.											
Fluor chrome arsenate phenol (Tanalith--AWPA-P5-58)	.36	[2] 9	100.0								
	.51	10	90.0		10.0						
	.77	10	90.0		10.0						
Fluor chrome arsenate phenol (Tanalith--modified)[1]	.37	10	70.0		30.0						
	.52	10	70.0		30.0						
	.80	[2] 9	77.8		22.2						
Untreated controls		10				10.0	20.0	20.0	50.0	9	90.0

[1] Sodium pentachlorophenate substituted for dinitrophenol.

[2] One stake broken and eliminated from test.

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

Preservative	Average retention		Number in test	Condition of stakes December 1961								
	Solution	Copper-8-quinolinolate		Good	Serviceable but showing some--			Destroyed by--			Total removed	
					Decay	Termite attack	Decay and termite attack	Decay fungi	Termites	Decay fungi and termites		
	Lb. per cu. ft.	Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent	Percent	Number	Percent
Copper-8-quinolinolate, 0.1 percent in Stoddard solvent	9.9	0.010	10			50.0	50.0					
Copper-8-quinolinolate, 0.2 percent in Stoddard solvent	9.9	.020	10			20.0	80.0					
Copper-8-quinolinolate, 0.6 percent in Stoddard solvent	10.0	.060	10	30.0	10.0	20.0	40.0					
Copper-8-quinolinolate, 1.2 percent in Stoddard solvent	10.2	.123	10	70.0	10.0	10.0	10.0					
Copper-8-quinolinolate, 0.6 percent, paraffin, 2 percent, and Pentylan H, 10 percent in Stoddard solvent	10.1	.061	10	90.0	10.0							
Copper-8-quinolinolate, 0.6 percent, Dieldrin, 0.5 percent in Stoddard solvent	10.1	.060	10	60.0	40.0							
Untreated controls			10				50.0		20.0	30.0	5	50.0

Table 39.--Condition of southern pine stakes (2- by 4-inch nominal by 18 inch), treated with blends of extracts from Texas lignite tar, after 1 year of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1960

Lignite-tar extracts	Average retention	Number in test	Condition of stakes December 1961			
			Good	Serviceable but showing some--		
				Decay	Termite attack	Decay and termite attack
			Percent	Percent	Percent	Percent
Hexane-soluble residue, 25 percent; and hexane distillate, 75 percent (by weight)	5.1	10	100.0			
	10.0	10	100.0			
	14.1	10	100.0			
High-boiling methanol solubles, 25 percent; and hexane distillate, 75 percent (by weight)	5.0	10	100.0			
	9.3	10	100.0			
	15.2	10	100.0			
High-boiling methanol solubles, 10 percent; hexane soluble residue, 20 percent; and hexane distillate, 70 percent (by weight)	5.1	10	100.0			
	10.1	10	100.0			
	14.7	10	100.0			
High-boiling methanol solubles, 20 percent; hexane soluble residue, 10 percent; and hexane distillate, 70 percent (by weight)	5.2	10	100.0			
	10.0	10	100.0			
	15.2	10	100.0			
High-boiling methanol solubles, 15 percent; and hexane distillate, 85 percent (by weight)	5.0	10	100.0			
	10.2	10	100.0			
	14.9	10	100.0			
High-boiling methanol solubles, 24.5 percent; hexane distillate, 74.5 percent; and petroleum sulfonate (morpel X-914), 1 percent (by weight)	5.1	10	100.0			
	9.9	10	100.0			
	15.0	10	100.0			
Untreated controls		10	10.0	20.0	20.0	50.0

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

Material	Number in test	Condition of stakes December 1961						
		Good	Serviceable but showing some--			Destroyed by--	Total removed	
			Decay	Termite attack	Decay and termite attack	Termites		
		Percent	Percent	Percent	Percent	Percent	Number	Percent
Embedded fiberboard[1]	10	100.0						
Douglas-fir heartwood	10	20.0	50.0	10.0	10.0	10.0	1	10.0

[1] Western hemlock strands in Portland cement.

Table 41.--Condition of southern pine stakes (2- by 4-inch nominal by 18 inch) treated with tributyltin oxide and pentachlorophenol solutions with heavy and light petroleum solvents and with and without the addition of Dieldrin and Aldrin after 1 year of service. Stakes placed in test at the Harrison Experimental Forest, Saucier, Miss., December 1960

Preservative	Average retention	Number in test	Condition of stakes December 1961			
			Good	Serviceable but showing some--		
				Decay	Termite attack	Decay and termite attack
	Lb. per cu. ft.		Percent	Percent	Percent	Percent
Solutions with Stoddard solvent:						
Tributyltin oxide, 0.3 percent; and Dieldrin, 0.3 percent	8.0	10	60.0	40.0		
Tributyltin oxide, 0.6 percent; and Dieldrin, 0.3 percent	8.0	10	60.0	40.0		
Tributyltin oxide, 0.3 percent; and Aldrin 0.3 percent	8.0	10	50.0	50.0		
Tributyltin oxide, 0.3 percent	8.2	10	50.0	50.0		
Tributyltin oxide, 0.6 percent	7.9	10	60.0	40.0		
Tributyltin oxide, 0.3 percent; Dieldrin, 0.3 percent, and water repellant, 4.7 percent	8.0	10	60.0	40.0		
Tributyltin oxide, 0.3 percent; Aldrin, 0.3 percent, and water repellant, 4.7 percent	8.0	10	70.0	30.0		
Dieldrin, 0.6 percent	8.0	10	40.0	50.0		10.0
Pentachlorophenol, 5 percent; pine oil, 5 percent; and water repellant, 4.7 percent	8.0	10	100.0			
Pentachlorophenol, 5 percent; pine oil, 5 percent; Dieldrin, 0.3 percent; and water repellant, 4.7 percent	8.0	10	100.0			
Water repellant, 4.7 percent	8.0	10	50.0	40.0		10.0
Pentachlorophenol, 5 percent; pine oil, 5 percent; Dieldrin, 0.3 percent; stabilizer wax, 2 percent; and water repellant, 4.7 percent	8.0	10	100.0			
Solutions with heavy petroleum solvent (AWPA-P9):						
Tributyltin oxide, 0.3 percent; and Dieldrin, 0.3 percent	8.0	10	100.0			
Tributyltin oxide, 0.6 percent; and Dieldrin, 0.3 percent	8.0	10	100.0			
Tributyltin oxide, 0.3 percent	8.0	10	100.0			
Tributyltin oxide, 0.6 percent	8.0	10	100.0			
Pentachlorophenol, 5 percent	8.0	10	100.0			
Pentachlorophenol, 5 percent; and stabilizer wax, 2 percent	7.7	10	100.0			
Petroleum solvent controls	8.0	10	100.0			
Untreated controls		10	50.0	30.0	10.0	10.0

Table 42.--Condition of southern pine stakes (2 by 4 inch (nominal) by 18 inch and 3/4 by 3/4 inch by 17 inch) treated with pentachlorophenol in liquified petroleum gas1 and in heavy and light petroleum solvents after approximately 4-1/2 months of service. Stakes installed at Valley View Test Plot, Madison, Wis., and at Harrison Experimental Forest, Saucier, Miss., during July 1961

Preservative	Location	Average retention			Number in test	Condition of stakes December 1961					
		By weight		By analysis		Good	Serviceable but showing some--			Destroyed by--	Total removed
		Solution: Pentachlorophenol		Pentachlorophenol			Decay	Termite attack	Decay and termite attack	Termites	
		Lb. per cu. ft.		Lb. per cu. ft.		Percent	Percent	Percent	Percent	Percent	Percent
Stakes 2 by 4 (nominal) by 18 inch											
Pentachlorophenol in liquified petroleum gas[1]	Mississippi			0.14	10	90.0		10.0			
	do.			.19	10	90.0	10.0				
	do.			.34	10	100.0					
	do.			.58	10	100.0					
Solutions with AWPA-P-9 (heavy petroleum solvent):											
Pentachlorophenol, 3.5 percent (by weight)	do.	3.0	0.11	.14	10	100.0					
Pentachlorophenol, 4.2 percent (by weight)	do.	4.5	.19	.22	10	100.0					
	do.	6.8	.29	.32	10	100.0					
	do.	16.0	.67	.69	10	100.0					
Solutions with Stoddard solvent:											
Pentachlorophenol, 4.0 percent; paraffin, 2 percent; and Pentalyn-H, 10 percent (by weight)	do.	3.6	.14	.14	10	100.0					
	do.	4.6	.18	.18	10	100.0					
Pentachlorophenol, 5 percent; paraffin, 2 percent; and Pentalyn-H, 10 percent (by weight)	do.	7.6	.38	.39	10	100.0					
	do.	13.5	.67	.70	10	100.0					
Untreated controls	do.				10	60.0	40.0				
Stakes 3/4 by 3/4 by 17 inch											
Pentachlorophenol in liquified petroleum gas[1]	do.			2/.14	10	100.0					
	Wisconsin			2/.14	15	100.0					
	Mississippi			2/.19	10	100.0					
	Wisconsin			2/.19	15	100.0					
	Mississippi			2/.34	10	100.0					
	Wisconsin			2/.34	15	100.0					
	Mississippi			2/.58	10	100.0					
	Wisconsin			2/.58	15	100.0					
Solutions with AWPA P-9 (heavy petroleum solvent):											
Pentachlorophenol, 4.2 percent (by weight)	Mississippi	3.2	.13		10	100.0					
	Wisconsin	3.3	.14		15	100.0					
	Mississippi	3.8	.16		10	100.0					
	Wisconsin	3.9	.16		15	100.0					
	Mississippi	5.7	.24		10	100.0					
	Wisconsin	5.5	.23		15	100.0					
	Mississippi	16.7	.70		10	100.0					
	Wisconsin	17.2	.99		15	100.0					
Solutions in Stoddard solvent:											
Pentachlorophenol, 4.0 percent; paraffin, 2 percent; and Pentalyn-H, 10 percent (by weight)	Mississippi	3.5	.14		10	100.0					
	Wisconsin	3.0	.12		15	100.0					
	Mississippi	3.9	.16		10	100.0					
	Wisconsin	4.0	.16		15	100.0					
Pentachlorophenol, 5.0 percent, paraffin, 2.0 percent, and Pentalyn-H, 10 percent (by weight)	Mississippi	6.4	.32		10	100.0					
	Wisconsin	6.6	.33		15	100.0					
	Mississippi	14.4	.72		10	100.0					
	Wisconsin	14.6	.73		15	100.0					
Untreated controls	Mississippi				10	40.0	10.0	20.0	20.0	10.0	1	10.0
	Wisconsin				15	100.0					

[1] Cellon process.

[2] Based on analysis of 2- by 4-inch stakes treated in the same charge.

Table 43.--Summary of results obtained with wood preservatives in general use

Preservative	Average retention[1]	Test station	Data from table No.	Average life	Remarks
	Lb. per cu. ft.			Yrs.	
Chromated zinc arsenate (Boliden salts) (AWPA P5)	0.33	Canal	4	9.2	
	.44	...do...	4	11.6	
	.58	...do...	4	14.6	
	.78	...do...	4	15.1	
	1.05	...do...	4	15.3	
	.33 to 1.06	Miss.	4		no failures after 21 years
Acid copper chromate (Celcure) (AWPA P5)	.26	...do...	15		60 percent failed after 16 years
	.52, .75	...do...	15		no failures after 16 years
Ammoniacal copper arsenite (Chemonite) (AWPA P5)	.28, .59				
	1.12, 1.45	...do...	14		no failures after 17 years
Chromated zinc chloride (AWPA P5)	.49	Canal	2	4.9	
	.76	...do...	2	7.2	
	1.02	...do...	2	6.6	
	.49	Miss.	2	14.2	
	.76	...do...	2		80 percent failed after 23 years
	1.02	...do...	2		80 percent failed after 23 years
Copper naphthenate (2 percent copper solution)	2/ .5	...do...	7	3.7	
	2/ .7	...do...	7	5.2	
Copper naphthenate (0.11 percent copper solution)	10.3	...do...	7		80 percent failed after 20 years
Copper naphthenate (0.29 percent copper solution)	10.2	...do...	7		20 percent failed after 20 years
Copper naphthenate (0.5 percent copper in naphtha)	13.1	...do...	12		no failures after 18 years
Copper naphthenate (0.57 percent copper solution)	10.6	...do...	7		10 percent failed after 20 years
Copper naphthenate (0.86 percent copper solution)	9.6	...do...	7		no failures after 20 years
Creosote, coal tar (AWPA P1)	2/ .76	...do...	4	4.2	
	2/ 1.8	...do...	4	7.7	
(for results on various types of coal-tar creosote see also table 18)	4.2	...do...	4		60 percent failed after 21 years
	8.0, 11.8, 16.5	...do...	4		no failures after 21 years
	2/ .76	Canal	4	2.5	
	2/ 1.8	...do...	4	4.8	
	4.3	...do...	4	13.4	
	8.0	...do...	4	2/ 19	30 percent failed after 15 years
	11.8	...do...	4	2/ 18	40 percent failed after 15 years
	16.5	...do...	4		no failures after 15 years
	4.7	...do...	5	2/ 12	90 percent failed after 15 years
	10.0	...do...	5	2/ 20	20 percent failed after 15 years
	14.4	...do...	5		no failures after 15 years
	4.6	Miss.	5		40 percent failed after 21 years
	10.0, 14.5	...do...	5		no failures after 21 years
	4.1	...do...	17		50 percent failed after 13-1/2 years
Chromated copper arsenate (Greensalt or Erdalith)	.26, .50 and .78	...do...	15		10 percent failed after 16 years
		...do...	15		no failures after 16 years
Pentachlorophenol, 5 percent in light fuel oil	4.7	Canal	5	13.0	
	9.6	...do...	5	14.4	
	15.3	...do...	5	2/ 15	60 percent failed after 15 years
	20.1	...do...	5		no failures after 15 years
	4.7	Miss.	5		10 percent failed in 21 years
	9.6, 15.3, 20.0	...do...	5		no failures after 21 years
Pentachlorophenol, 5 percent in No. 2 fuel oil	4.0	...do...	17		40 percent failed after 13-1/2 years

Table 43.--Summary of results obtained with wood preservatives in general use (Continued)

Preservative	Average retention[1]	Test station	Data from table No.	Average life	Remarks
	Lb. per cu. ft.			Yrs.	
Pentachlorophenol, 5 percent in light aromatic solvent	4.2	Miss.	17		90 percent failed after 13-1/2 years
	12.1		12		30 percent failed after 18 years
Pentachlorophenol, 5 percent in 300 fuel oil	4.0	...do...	17		30 percent failed after 13-1/2 years
Pentachlorophenol, 5 percent in 400 fuel oil	4.2	...do...	17		50 percent failed after 13-1/2 years
Pentachlorophenol, 5 percent in light gas oil	4.0	...do...	17		20 percent failed after 13-1/2 years
Pentachlorophenol, 5 percent in 200 Diesel oil	4.1	...do...	17		20 percent failed after 13-1/2 years
Pentachlorophenol, 5 percent in heavy thermal side cut oil	4.0	...do...	17		40 percent failed after 13-1/2 years
Pentachlorophenol, 5 percent in Stoddard solvent	4.0	...do...	17		40 percent failed after 13-1/2 years
Pentachlorophenol, 5 percent in catalytic gas-base oil	4.1	...do...	17		10 percent failed after 13-1/2 years
	8.0 and 12.0	...do...	17		no failures after 13-1/2 years
Pentachlorophenol, 5 percent in Denver No. 3 blend oil, and lube oil extract	4.0 and 4.2	...do...	17		no failures after 13-1/2 years
Pentachlorophenol, 5 percent in heavy gas oil	4.1, 7.9, and 12	...do...	17		no failures after 13-1/2 years
Fluor chrome arsenate phenol (Tanalith) (AWPA P5)	.2	Canal	2	2.9	
	.3	...do...	2	6.4	
	.6	...do...	2	14.2	
	.2	Miss.	2	10.2	
	.3	...do...	2		80 percent failed after 23 years
	.61	...do...	2		30 percent failed after 23 years
Zinc chloride	.47	Canal	2	3.9	
	.49	...do...	4	3.0	
	.76	...do...	2	3.9	
	1.01	...do...	4	3.6	
	1.00	...do...	2	4.0	
	1.49	...do...	2	7.3	
	1.49	...do...	4	4.5	
	.50	Miss.	2		90 percent failed after 23 years
	.74	...do...	2	16.7	
	1.00	...do...	2		90 percent failed after 23 years
	1.52	...do...	2		80 percent failed after 23 years
Untreated stakes		Canal	2	.7	
		...do...	4	1.1	
		...do...	5	1.2	
		Miss.	2	2.9	
		...do...	4	2.2	
		...do...	5	2.3	
		...do...	7	1.8	

[1] Preservatives applied by pressure impregnation except where noted otherwise.

[2] Brush coating.

[3] Dipped 3 minutes.

[4] Dipped 15 minutes.

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

SUBJECT LISTS OF PUBLICATIONS ISSUED BY THE FOREST PRODUCTS LABORATORY

The following are obtainable free on request from the Director, Forest Products Laboratory, Madison 5, Wisconsin:

List of publications on Box and Crate Construction and Packaging Data

List of publications on Chemistry of Wood and Derived Products

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

List of publications on Glue, Glued Products, and Veneer

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

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

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

List of publications on Fire Protection

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

List of publications on Pulp and Paper

List of publications on Seasoning of Wood

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

List of publications on Wood Finishing

List of publications on Wood Preservation

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

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