Service Life of Treated and Untreated Fence Posts

1976 Progress Report on the Post Farm

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Research Paper 37

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SUMMARY

Eight series of untreated posts (including five series of steel), 18 series of nonpressure-treated posts, and 11 series of pressure-treated posts remain in test at the Oregon State University post farm in western Oregon. So far all posts have failed in 36 untreated series, 33 nonpressure-treated series, and 2 pressure-treated series. Causes of failures since 1949 have been: fungi, 75 percent of failures; fungi and termites, 16 percent; fungi and insects other than termites, 6 percent; and termites, 2 percent. Some steel posts have failed because of corrosion.

Some series of wood posts deserve special mention for their notably good durability, sometimes the result of simple preservative treatments. Exceptionally durable series include some that were pressure-treated with creosote (series 7, 23) and whose average life should exceed 50 years, as well as untreated posts of Osage-orange that should have an average life of 45 years or more. Soaking posts as little as 3 hours, depending on species, in solutions of creosote or pentachlorophenol has lengthened the average lives of lodgepole pine (series 86), Douglas-fir (94), and black cottonwood (87). With that simple treatment, these 26 year old series have had few or no failures, and their average lives should easily exceed 30 years. A similarly soaked series (88) with bark left on the upper portions of the posts should last about 28 years. Brushing undried posts with Osmosalts (series 75), a convenient treatment, will extend their average life beyond 30 years.

Untreated Posts

Western juniper and black locust, two of the three durable heartwood species remaining in test, will have average service lives exceeding 20 years. No Osage-orange posts have failed since they were set 43 years ago, but their exceptional durability is mainly of academic interest since Osage-orange is not available in the Pacific Northwest. Posts of other durable heartwood species such as Pacific yew averaged 25 years, redwood and most species of cedar averaged 19 to 24 years, and Oregon white oak averaged 18 years. Series of 28 nondurable species had average lives that usually ranged from 4 to 6 years and not longer than 9 years.

Only steel posts in series 61 have failed, the result of corrosion at ground level. Although the average age of the series will exceed 25 years, other series of steel posts have had no failures during 28 years of testing.

Nonpressure-treated Posts

For the longest service with nonpressure-treated posts, the entire post of nondurable wood requires preservative treatment.

Double-diffusion butt treatment with solutions of copper sulfate and sodium chromate did not increase the life of posts. Similar treatment with sodium fluoride and copper sulfate should extend post life to 20 years or more although the poorly treated tops are decaying. Soaking the whole post, rather than the butt only, would have improved this treatment.

Most brushed-on treatments added only a few years to the life of Douglas-fir posts, but two coats of pentachlorophenol-diesel oil solution extended average life from 6 (untreated) to 14 years. Diffusion treatments with Anaconda Copper Mining Company (ACM) paste or dust or with Osmosalts have been effective. Posts butt-treated with ACM paste probably will have an average life of 30 or more years despite badly decayed tops. Posts brushed with a slurry of Osmosalts and water and then piled under a tarp for 3 weeks to allow the chemicals to diffuse into the wood have had very few failures, and all tops remain sound after 27 years of testing.

Treatment with sodium pentachlorophenate or sodium trichlorophenate in holes at the ground line was ineffective. Similar treatment with salt and mercuric chloride was effective, but post tops have decayed.

Cold-soaking incised butts of posts of Douglas-fir and lodgepole pine for 43 hours or more in a 5 percent solution of pentachlorophenol will extend their average lives to 25 years or longer. Incised posts of black cottonwood soaked 3 hours in creosote or 6 hours in pentachlorophenol solution will give similar service. Soaking in copper napthenate (1 percent copper) was less effective. Douglas-fir posts peeled only on butts, incised, and soaked for 6 to 7 days in creosote are expected to last an average of 20 or more years; the posts have retained their bark, and tops are sound. Ponderosa pine posts soaked for 17 hours in Permatol had an average life of 19 years.

Hot-cold bath treatment of unincised butts with creosote for 6 hours extended average life of split black cottonwood posts to 22 years and could extend average life of square Douglas-fir posts beyond 35 years if the tops do not decay severely. Similar treatments with carbolineum and with creosote diluted with oil were less effective.

Pressure-treated Posts

No creosote-treated posts have failed since installation 37 to 48 years ago. However, two series of posts treated with water-borne preservatives have failed. Treatment with chromated zinc chloride extended average life to 20 years while other posts treated twice with zinc-meta-arsenite lasted an average of 26 years. Failed posts of series treated with other water-borne preservatives had average service lives of 17 to 32 years. Treated tops of all posts are sound.

SERVICE LIFE OF TREATED AND UNTREATED FENCE POSTS

1976 Progress Report on the Post Farm

Donald J. Miller
Robert D. Graham

THE POST FARM

In 1927, Professor T. J. Starker of the School of Forestry at Oregon State University (OSU) established a "post farm" to yield data on the natural durability of native woods and the effectiveness of various preservative treatments for species used as fence posts. Since the first posts were set on January 7, 1928, OSU has placed 2,662 posts in the farm. Three introduced and 25 native species in untreated condition and 8 Oregon species receiving various preservative treatments have been, or are being, tested.

The post farm is located on School of Forestry land in the Peavy Arboretum about 7 miles north of Corvallis, Oregon, on the west side of Highway 99W. Soil in the test area, located on an excellently drained south slope, is Olympic silty-clay loam. The top 8 inches of soil, slightly acid with a pH of 5.4, have one-half inch or less of humus. Its organic matter and nitrogen content are 4.71 and 0.14 percent, respectively. In the past the test site has been sprayed with herbicides to control brush.

Test Specimens

Posts usually are installed in groups of 25, each group constituting a test series. Posts in each series are placed 2 feet apart in a row running in a northerly direction up the test slope, and test series are spaced 3 feet apart. All posts are set 2 feet into the ground.

Before 1947, test posts ranged from 4 to 7 feet in length and from 3 to 70 square inches in cross-sectional area at the ground line. Since then posts in most series have been 5 feet long with cross sections of 7 to 27 square inches. In 1950 post size was standardized at a length of 5 feet and cross sections limited to 8 to 24 square inches at 2 feet from the butt ends. The cross-sectional area must average 14 to 18 square inches for each series of posts.

Post Inspections

All posts are inspected every October. The inspector applies a moderate pull to the top of each post, then examines each post that breaks to establish the point and probable cause of failure. Deterioration of the top is rated by visual inspection.

Post-farm Records

Recorded data for each series of posts include source and species, sizes and type of individual posts, percentage of sapwood, processing before installation or preservative treatment, preservative treatment (if any), date of installation, and other pertinent facts.

Climatic Conditions

Corvallis typically has dry summers and rainy winters, a generally mild climate that favors growth of wood-destroying organisms throughout the year. During the past 83 years through 1975, annual precipitation averaged 40 inches. Eighty-two percent of this precipitation fell during the months of October through March when average monthly temperatures ranged from 39 to 53 F. Only 2 percent fell during July and August when temperatures averaged 66 F. Occasionally the temperature falls below freezing or rises above 85 F. Cool afternoon breezes from the Pacific Ocean occur almost daily during summer months.

Wood-destroying Organisms

Since 1949, we have identified the various causes of deterioration of posts installed at the test site. During the October inspections, discarded wings of damp-wood termites have been found at bases of some posts, and entry holes have been detected at or below ground line. However, termites alone have been the primary cause of failure in only a few instances. Actually decay-producing fungi or fungi in combination with damp-wood termites do the most damage; carpenter ants and wood-boring beetles also contribute to the general deterioration of posts.

Causes of failure in wood posts*

Primary agent	Failure from 1950 to 1976 inclusive	
	Number	*Percent*
Fungi	904	75.5
Fungi and termites	193	16.1
Fungi and insects other than termites	75	6.3
Termites	21	1.8
Other insects	4	0.3
All	1,197	100.0

*Does not include corrosion of steel posts.

Although carpenter ants have been found in some failed posts, their galleries may have been initially constructed by termites. After destroying the termites, ants usually enlarge the galleries.

Some failed posts have been attacked by wood-boring grubs although damage seldom approaches that caused by fungi or termites.

INTERPRETATION OF DATA

Posts and other wood products in contact with the ground and exposed to weather are subject to attack by insects and wood-destroying fungi. The most vulnerable section of a post extends from a short distance above to some distance below the ground surface. This zone usually has a sustained supply of moisture and air favorable to destructive fungi. In exceptionally rainy and humid areas, tops of posts may deteriorate also, but that normally proceeds slowly. Any evaluation of post serviceability must simultaneously consider these and many other factors.

Limitations of Test Data

The detailed data tabulated in this report should not be applied indiscriminately to every locality or to all service requirements for posts. Data are comparative within our test site and generally west of the Cascade Mountains. To fit other situations such as drier climate, colder climate, or summer irrigation, the data must be adjusted according to local experience.

Posts tested at the farm usually are not subject to stapling, nailing, and physical forces that frequently reduce the service life of posts actually in use. But, on the other hand, these test posts are placed in climatic conditions conducive to almost continuous attack by insects and decay. Admittedly the arbitrary method used to determine failure is not comparable to physical forces that may be exerted on posts in actual service.

Influence of Climatic Conditions

Climate determines how long conditions suitable for decay exist in a given region. Optimal temperatures for growth of decay-producing fungi range from 75 to 90 F, and growth slows as temperature departs from optimum. If wood has a moisture content of 20 percent or less (ovendry basis), fungi probably will not grow.

In western Oregon where favorable conditions of moisture and temperature exist for long periods, posts adequately treated with a good preservative at the butts often decay at the top long before ground-line sections are seriously weakened. Undoubtedly the long periods of dry or cold conditions in eastern Oregon retard the deterioration of post tops there.

Consideration of Post Characteristics

Any evaluation of post service must consider characteristics of the wood. Size, amount of sapwood, and extractive constituents in the heartwood greatly influence serviceability of untreated posts. Sapwood is not naturally insect- and decay-resistant, but extractive constituents in heartwood of a few species promote resistance to attack by insects and fungi and give it a darker color. Untreated posts can give long service if they contain a large amount of durable heartwood and little sapwood. Conversely, if posts are to be impregnated with preservative, an outer layer of permeable sapwood is desirable because it absorbs the preservative readily.

Steel posts having 'T' cross sections corroded away near the ground and could be easily broken there.

Importance of Preservatives and Methods of Preservation

The service life of treated wood is influenced by the effectiveness of the preservative, portion of the post treated, amount of preservative retained by the wood, and depth and uniformity of treatment. Most preservatives are effective fungicides and insecticides as long as the preservative remains present in a concentration toxic to the destructive organisms.

Although a preservative may fail under one set of climatic conditions, it may prove very successful under others. For example, a preservative readily soluble in water may leach from wood in a rainy region but not in a dry climate. Successful treatment provides uniform penetration into the treated area with retention of enough preservative to protect the wood under its expected conditions of use. However, high total retention of preservatives does not necessarily mean successful treatment. For example, in some species, rapid penetration of the preservative into end grain but slow penetration into side grain will completely protect the end of the post, but provide almost no protection to the important ground-line zone.

PRESERVATIVES, TESTS, AND RECOMMENDATIONS

Preservative Materials

Virtually all preservatives are poisonous, and some are extremely toxic and corrosive. Many cause irritations when the chemical itself, its solutions, or its vapor touch the skin. Users should handle all preservatives carefully and frequently wash exposed parts of the body.

All preservatives should be stored in clearly labeled, closed containers and used only and exactly as recommended by the manufacturer.

The following list describes compounds that have been used, with varying degrees of success, to preserve wood. Those most readily available to the public are pentachlorophenol, creosotes, and copper napthenate.

Asphalt emulsion. Asphalt is a black-to-dark-brown, solid or semisolid material mostly composed of bitumens. The emulsion, a suspension of fine asphalt particles dispersed in water, has little or no preservative value.

Boliden salts. This preservative contains arsenic acid, sodium arsenate, sodium bichromate, and zinc sulfate in a water solution.

Carbolineum. Carbolineum, or anthracene oils, are coal-tar distillates, but the exact composition of Carbolineum "B" is unknown. The specific gravity and boiling range for Carbolineum are higher than for ordinary coal-tar creosote.

Chemonite. Chemonite solution consists of copper, arsenic, and ammonium acetate dissolved in an ammonia solution.

Chromated zinc chloride. This preservative contains about 82 percent zinc chloride and 18 percent sodium bichromate in a water solution.

Copper naphthenate. For optimum performance, solutions of this oil-soluble copper salt of naphthenic acid should contain 2 percent copper by weight. Test solutions contained 1 percent copper.

Creosote, creosote oil, or coal-tar creosote. Produced by high-temperature carbonization of bituminous coal, this distillate of coal tar consists principally of liquid and solid aromatic hydrocarbons, as well as appreciable quantities of tar acids and tar bases. Its continuous boiling point begins near 392 F and ranges to at least 617 F.

Creosote mixtures. Creosote may be mixed in varying proportions with petroleum, crankcase oil, or other diluents that act as carriers for the creosote. Dilutions of more than 50 percent are less effective and therefore not recommended. Because it can cause hyperkeratosis in cattle, crankcase oil should not be used where the animals can come in contact with it.

Gasco creosote. This distillate of tar residue from asphaltic-base petroleum oils is a by-product of the production of artificial fuel gas.

Osmosalts. This proprietary wood preservative contains sodium fluoride, sodium bichromate, dinitrophenol, and sometimes arsenic.

Pentachlorophenol. This is an oil-soluble chemical formed from phenol and chlorine. Solutions usually contain 5 percent pentachlorophenol by weight.

Permatol "A." A preservative containing pentachlorophenol as its toxic constituent, Permatol was developed–but since discontinued–by the Western Pine Association for the millwork industry.

Salt and corrosive sublimate. Not recommended as a preservative, this is a mixture of equal proportions, by weight, of two water-soluble compounds. The extremely poisonous mercuric chloride, or corrosive sublimate, is the toxic chemical, and the salt holds moisture.

Salt, corrosive sublimate, and arsenous oxide. Also not recommended as a preservative is this mixture of equal proportions, by weight, of the three chemicals.

The water-soluble arsenous oxide apparently contributes little, if anything, to the effectiveness of the highly toxic corrosive sublimate.

Sodium pentachlorophenate. The sodium salt of pentachlorophenol is water soluble.

Sodium trichlorophenate. This is the water-soluble salt of trichlorophenol.

Tanalith. This proprietary wood preservative normally contains sodium fluoride, dinitrophenol, sodium chromate, and sodium arsenate in a water solution.

Treater dust, granular treater dust, and treater paste. These discontinued preservatives formerly were produced by the Anaconda Copper Mining Company as by-products of copper smelting. Arsenic trioxide was the principal toxic component of the preservatives sold in dust, granular, and paste forms.

Zinc chloride. This compound should be dissolved in water to make a 2 to 5 percent solution.

Zinc-meta-arsenite. Dissolving zinc oxide and arsenic trioxide in water acidified with acetic acid yields this preservative.

Tests and Recommendations

Determining the service life of a series is simple when most or all of its posts have failed. However, average service life can only be estimated for those series with posts remaining. In this report, estimated service life is based on the number of failed posts and on the service age and condition of remaining posts. Natural resistance to decay as determined in other service tests is another factor considered when estimating service life for a few untreated species.

Tests of Untreated Posts

Table 1 shows characteristics and service records of untreated posts, and Table 2 summarizes the service records of posts remaining in test. Average service life of untreated posts varies greatly because of differences in the amount and durability of heartwood. Posts from durable species and largely of heartwood could have an average service life of 18 years or longer; such species include the cedars, juniper, black locust, white oak, Osage-orange, redwood, and yew. Because natural durability varies greatly, all untreated woods will have a few early failures. Posts from nondurable-heartwood species, or posts that are largely sapwood, will have an average service life of 4 to 7 years; these posts should be treated with a preservative.

Tests of Treated Posts: Nonpressure Processes

Table 3 shows characteristics and service records for posts treated by nonpressure processes, and Table 4 summarizes the service records of posts remaining in test. Preservative treatments increased service life of Douglas-fir posts as estimated in Table 5. We've tried to evaluate these treatments and make recommendations when possible.

Bore hole. One or more holes three-fourths inch in diameter were drilled about 2 inches deep and slanting downward from near ground level toward the butt of each freshly cut, unpeeled post. Holes should be spaced 5 or less inches apart and staggered vertically around the circumference to prevent weakening the post seriously. One tablespoon of a dry mixture (equal proportions by weight) of salt, corrosive sublimate, and arsenous oxide was placed in each hole. A snugly fitting wood plug sealed each hole.

Effectiveness of the ground-line treatment increased with the number of holes. The treatments increased the average life of lodgepole pine posts to 18 years and that of Douglas-fir posts to more than 28 years. Similar treatments using more salt or the sodium salts of chlorinated phenols were less effective—inadequately protected by this method, post tops decayed severely.

Because the chemicals applied in this treatment are very poisonous, we do not recommend using it.

Brushing. During hot days, two applications of preservative solution were flooded onto thoroughly air-dried posts. Oily solutions of copper naphthenate, pentachlorophenol, and creosote have added 3 to 8 years to average lives of some series of Douglas-fir posts. The best treatment was with a solution of 5 percent pentachlorophenol in diesel oil. However, because penetration and retention of preservative usually is slight, the brushing treatment is not recommended for wood in contact with soil.

Charring. Charring the surface of wood is not a preservative treatment. If anything, it reduces the life of posts by reducing their size at the critical ground-line area.

Double diffusion. Freshly cut and peeled posts are soaked in an aqueous chemical solution for 2 or 3 days, then transferred to a similar solution of another chemical to soak for 2 or 3 more days. The chemicals diffuse into the wood where they react to form a toxic compound that is resistant to leaching.

Treatments with copper sulfate and sodium chromate have not been effective in our tests. Treatments with sodium fluoride and copper sulfate, though ineffective with alder, have increased the estimated average life of Douglas-fir posts to 23 years. Lodgepole pine posts treated with zinc sulfate, arsenic acid, and sodium chromate will probably have an average life of about 15 years. Most posts treated by the double diffusion method had decayed tops by their eleventh year of life. For longer life, the entire post, rather than just the butts, should be soaked in the preservative.

Hot-cold bath. For this, also called the thermal treatment, dry posts are soaked in a hot (about 200 F), oily preservative solution for several hours, then either left in the solution while it cools to 100-150 F or transferred to cool solution.

Our tests used several creosotes and a creosote-crankcase oil mixture. Generally effective, they prolonged the life of nondurable black cottonwood and Douglas-fir posts to as many as 22 and 18 years, respectively. A series (54) of sawed posts of Douglas-fir heartwood not dried before treatment had unaccountably good durability. Their average life could have reached 40 years or more, but untreated tops decayed badly and will cause premature failures.

Posts for hot-cold bath treatment should be free of bark, thoroughly seasoned if oily solutions will be used, and treated full length during the cold bath.

Osmoplastic bandage. A strip 9 inches wide was peeled free of bark around the ground-line zone of each unseasoned post, then coated with Osmoplastic preservative and tightly wrapped with a water-resistant covering. Osmoplastic also was applied to post ends.

The treatment was ineffective on posts of black cottonwood, but did increase the average life of Douglas-fir posts to 11 years. Osmoplastic bandages are not recommended for posts with nondurable heartwood.

Osmosalts. Peeled, unseasoned posts were fully coated with a brushed-on slurry of Osmosalts (2 pounds of Osmosalts per pound of water). Coated posts were closely piled under a tarpaulin for 30 days to allow the preservative mixture to diffuse into the moist wood.

Tested only on Douglas-fir, this simple and effective treatment has extended the life of the posts; only 2 of 25 have failed in 27 years.

Soaking. Posts should be peeled, then thoroughly seasoned before soaking in the commonly used oil-type preservative solutions. Usually that part of the post 6 inches above and 12 inches below ground should be incised about one-half inch deep for better penetration of preservative. Post butts usually were soaked longer than tops, but the entire post may be immersed. Soaking time varied from several hours to 8 days in unheated solution.

Soaking in a solution of 5 percent pentachlorophenol in diesel oil has proven an effective treatment. Soaking incised butts for 48 hours and tops for 6 hours in pentachlorophenol solution has produced an estimated average life of 30 years for Douglas-fir posts (series 64); absorbent posts of black cottonwood (series 68), with butts and tops respectively soaked only 6 and 1 hours, have an estimated life span of 36 years. Gasco creosote, no longer available, also was effective. Douglas-fir posts, peeled only at the butts and then incised, dried, and soaked in Gasco creosote, have an estimated life of 28 years; their soaking periods were long, 7 days for butts and 2 days for tops. Copper naphthenate (1 percent copper) in diesel oil has been less effective. Treatments with water solutions of sodium pentachlorophenate (series 74) and zinc chloride (series 12) were not effective.

For longest life, the full length of incised and well-seasoned posts should be soaked in an effective preservative.

Tire tube with chemonite. One end of a section of an automobile inner tube was slipped over the butt end of an unpeeled, freshly cut post laid on an inclined rack so its butt was higher than its top. The open end of the tube was elevated, and the tube was filled with a water-soluble preservative that diffused through the sapwood and finally dripped from the lower end of the post.

This end-diffusion treatment has extended the estimated average life of Douglas-fir posts to 29 years, but the tops are decaying. Although posts can be treated without peeling or drying, the diffusion process is slow and each post must be treated individually.

Treater dust and paste. These preservatives, no longer available, were tested on freshly cut Douglas-fir posts. Dust and granules were sprinkled around unpeeled posts while the postholes were backfilled with soil. Otherwise, 2 to 4 pounds of paste were applied to butts of peeled posts.

The 2 and 4 pounds of paste extended estimated average life of posts to 26 and 29 years, respectively, while dust and granules respectively extended average life to 26+ and 21 years.

Tests of Treated Posts: Pressure Processes

Characteristics and service records of posts treated by pressure processes are listed in Tables 6 and 7.

Before treatment, posts are air-dried, seasoned in the preservative by boiling under vacuum, or conditioned by steaming. Usually oily preservatives are heated to higher temperatures than water-borne preservative solutions. Preservative is injected into the wood under pressure in a closed vessel and a final vacuum usually is applied to remove excess preservative. The full length of the post receives treatment.

Square posts sawed from West Coast hemlock have had fewer failures than similar posts of Douglas-fir. Two series of pressure-treated Douglas-fir posts have failed. Average life of posts treated with chromated zinc chloride was 20 years; those treated with zinc-meta-arsenite had an average life of 26 years. Average life of most remaining series is expected to exceed 30 years; that of posts treated with Chemonite or Tanalith is likely to reach 40 or more years. Some series treated with creosote or creosote-petroleum have reached 47 to 48 years of age with no failures; their average life will exceed 50 years.

Because pressure treatments have been consistently effective in greatly increasing the service life of posts of nondurable wood, such treatments are recommended to yield longest service under severe conditions.

Table 1. Average Characteristics and Service Life of Untreated Posts.

Species	Series number	Number of posts	Post description	Sapwood	Groundline perimeter	Avg service life[2]
				Percent	*Inches*	*Years*
Alder, red	16	25	Split	25	20	5
Alder, red	106	25	Round, peeled	100	12	3
Ash, Oregon	28	25	Split	30	19	6
Cascara buckthorn	20	12	Round, peeled	70	9	5
Cascara buckthorn	47	26	Round, unpeeled	35	17	8
Cedar, Alaska	46	24	Split, mostly heartwood, same tree	--	18	19
Cedar, incense	29	25	Split	0	20	14
Cedar, Port Orford	21	25	Split	0	24	20
Cedar, western red	10[1]	25	Split, dark colored	0	20	24
Cedar, western red	11[1]	25	Split, light colored	0	19	22
Cottonwood, black	14	25	Split	20	22	5
Cottonwood, black	82	25	Round, unpeeled	95	14	4
Cypress, Arizona	84	25	Round, unpeeled	100	13	4
Douglas fir	1	25	Round, unpeeled	60	19	7
Douglas fir	55	25	Square	0	16	6
Douglas fir	57	25	Square	0	16	4
Douglas fir	72	25	Round, unpeeled	48	14	7
Douglas fir	97	25	Square	5	15	4
Douglas fir	100	25	Round, 4 strips peeled	80	16	4
Fir, grand	15	25	Split	65	22	9
Hemlock, mountain	109	25	Square, dry	--	15	3
Hemlock, West Coast	38	25	Square	0	16	6
Juniper, western	30	25	14 split, 11 round	40	23	--
Larch, western	37	25	Square	0	16	7
Locust, black	40	22	8 round, 14 split	20	14	--
Madrone, Pacific	26	25	Round and split	40	21	6
Maple, Oregon	17	25	Split	25	20	7
Metal, aluminum paint	60	25	Angle iron, 1.1 lb per foot	--	--	--
Metal, red oxide paint	61	25	"T" post, 1.2 lb per foot	--	--	--
Metal, green enamel	69	9	H-beam, 4 lb per foot	--	--	--
Metal, green enamel	70	10	Flanged channel, 1.3 lb per foot	--	--	--
Metal, green enamel	71	10	"T" post, 1.5 lb per foot	--	--	--
Oak, Oregon white	19	23	Split	20	19	18
Osage-orange	32	26	15 split, 11 round	10	19	--
Pine, lodgepole	48	26	Round, peeled, dead trees	55	16	5
Pine, lodgepole	49	25	Round, peeled, live trees	55	16	4
Pine, lodgepole	103	25	Round, 4 strips peeled	80	12	3
Pine, ponderosa	36	25	Square	0	16	6
Pine, sugar	35	25	Square	0	16	7
Pine, Idaho white	34	25	Square	0	16	6
Redwood	58	25	Square	0	16	21
Spruce, Sitka	31	26	Square	0	16	6
Tanoak	76	25	Round, unpeeled	100	12	4
Yew, Pacific	13	23	Round, peeled	10	16	25

[1]Series 10 and 11 were from the same group of posts.
[2]Series in which all posts have failed. Series with posts remaining are described further in Table 2.

Table 2. Service Records of Untreated Posts Remaining in Test in 1976.

Species	Series number	Posts remaining	Age	Avg life failed posts	Remarks
		Percent	*Years*	*Years*	
Juniper, western	30	16	46	23	Slight-mod. top decay
Locust, black	40	18	41	22	None to slight top decay
Steel, L-section	60	100	28	--	Tops rusty
Steel, T-section	61[1]	76	28	25	Tops rusty, failure at ground
Steel, I-section	69	100	28	--	Tops rusty
Steel, U-section	70	100	28	--	Tops rusty
Steel, T-section	71	100	28	--	Tops rusty
Osage-orange	32	100	43	--	Tops sound

[1]Failure at last inspection.

Table 3. Average Characteristics and Service Life of Nonpressure-Treated Posts.

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment[1]	Retention: In a cu ft wood: Butt	Retention: In a cu ft wood: Top	Retention: In a post	Avg service life[2]
				Percent	*Inches*		*Lb*	*Lb*	*Lb*	*Years*
Alder, red	105	25	Round, peeled, undried	100	12	Double diffusion, butts, 6% copper sulfate--2 days; 8% sodium chromate--2 days	--	--	--	6
Alder, red	108	25	Round, undried, 4 strips peeled	100	13	Double diffusion, butts, 4% sodium fluoride--2 days; 6% copper sulfate--2 days	--	--	--	--
Cedar, Port Orford	9	10	Round, peeled	25	20	Hot-cold bath, Carbolineum "B", butt	--	--	--	21
Cottonwood, black	27	24	Split, peeled	20	22	Hot-cold bath, creosote, B-6	--	--	--	22
Cottonwood, black	68	25	Round, peeled, incised, dry	89	14	Soak, 5% pentachlorophenol-diesel oil, B-6, T-1	7.3	4.1	2.86	--
Cottonwood, black	74	22	Round, peeled, incised, dry	99	14	Soak, 5% sodium pentachlorophenate, B-4, T-1	7.7	4.5	2.93	11
Cottonwood, black	77	25	Round, peeled, incised, dry	95	14	Soak, copper naphthenate-diesel oil (1% copper), B-6, T-1	2.7	1.5	1.04	8
Cottonwood, black	78	25	Round, ground line peeled, undried	83	14	Osmoplastic bandage	--	--	--	5
Cottonwood, black	87	25	Round, peeled, incised, dry	90	14	Soak, Gasco creosote oil, B-3, T-2	10.9	10.1	5.80	--
Douglas-fir	2	23	Round, unpeeled, undried	60	18	Salt and mercuric chloride, 1 hole; butt	--	--	--	28[3]

Douglas-fir	3	22	Round, unpeeled, undried	60	20	Salt, mercuric chloride and arsenous oxide, 2 holes; butt	--	--	--	28[3]
Douglas-fir	4	22	Round, unpeeled, undried	60	18	Salt, mercuric chloride, and arsenous oxide, 3 holes; butt	--	--	--	28[3]
Douglas-fir	5	25	Round, unpeeled, undried	60	16	ACM Co. treater dust; butt	--	--	--	26[3]
Douglas-fir	6	25	Round, unpeeled, undried	60	17	ACM Co. granulated treater dust; butt	--	--	--	21
Douglas-fir	8	22	Round, peeled	60	17	Hot-cold bath, butt, Carbolineum "B", B-6	--	--	--	12
Douglas-fir	12	25	Round, peeled	60	14	Soak, 5% zinc chloride, B-192	--	--	--	7
Douglas-fir	18	24	Round, peeled	60	16	Hot-cold, creosote and crankcase oil (50:50), B-20	--	--	0.88	18
Douglas-fir	22	25	Round, peeled	60	15	Charred 1/4 inch deep; butt	--	--	--	6
Douglas-fir	24	24	Round, peeled, undried	60	14	ACM Co. treater paste; butt	--	--	2.00	--
Douglas-fir	25	25	Round, peeled, undried	60	16	ACM Co. treater paste; butt	--	--	4.00	--
Douglas-fir	39	25	Round, peeled	60	19	Brush, asphalt emulsion; butt	--	--	--	5
Douglas-fir	54	25	Square	0	16	Hot-cold bath, Gasco creosote, B-6	--	--	0.57	--

Table 3. (Continued)

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment[1]	Retention: In a cu ft wood: Butt	Retention: In a cu ft wood: Top	Retention: In a post	Avg service life[2]
				Percent	*Inches*		*Lb*	*Lb*	*Lb*	*Years*
Douglas-fir	59	12	Round, unpeeled, undried	60	17	Tire-tube, full-length diffusion, Chemonite	--	--	6.00	--
Douglas-fir	62	25	Round, peeled, incised, dry	33	14	Soak, 5% pentachlorophenol-diesel oil, B-3, T-2	1.0	0.4	0.37	16
Douglas-fir	63	25	Round, peeled, incised, dry	26	14	Soak, copper naphthenate-diesel oil (1% copper), B-48, T-6	1.6	0.3	0.50	12
Douglas-fir	64	25	Round, peeled, incised, dry	46	14	Soak, 5% pentachlorophenol-diesel oil, B-48 T-6	2.2	0.4	0.95	--
Douglas-fir	65	25	Round, peeled, incised, dry	40	14	Soak, copper naphthenate-diesel oil (1% copper) B-2, T-2	0.7	0.3	0.29	9
Douglas-fir	66	25	Round, peeled, dry	40	14	Soak, 5% pentachlorophenol-diesel oil, B-48, T-6	1.0	0.2	0.35	15
Douglas-fir	67	25	Round, peeled, dry	33	14	Soak, copper naphthenate-diesel oil (1% copper), B-48, T-6	0.7	0.2	0.25	9
Douglas-fir	73	25	Round, ground line peeled, undried	58	14	Osmoplastic bandage	--	--	--	--
Douglas-fir	75	25	Round, peeled, undried	46	14	Osmosalts, covered 30 days	--	--	--	--
Douglas-fir	79	24	Round, peeled, dry	40	14	Brush, 2 coats, 5% pentachlorophenol-diesel oil	--	--	--	--

Douglas-fir	80	24	Round, peeled, dry	46	14	Brush, 2 coats, copper naphthenate-diesel oil	--	--	--	11
Douglas-fir	81	24	Round, peeled, dry	44	15	Brush, 2 coats, coatl-tar creosote	--	--	--	9
Douglas-fir	88	23	Round, butt peeled and incised, dry	40	14	Soak, Gasco creosote oil, B-168, T-48	3.1	2.2	1.40	--
Douglas-fir	89	25	Round, unpeeled, undried	45	14	Sodium trichlorophenate, 3 holes, butt	--	--	--	10
Douglas-fir	90	25	Round, unpeeled undried	39	14	Sodium pentachloro-phenate, 3 holes; butt	--	--	--	7
Douglas-fir	91	25	Round, unpeeled, undried	32	14	Salt and mercuric chlor-ide (2:1), 1 hole; butt	--	--	--	16
Douglas-fir	92	23	Round, peeled, dry	46	14	Brush, 2 coats Avenarious carbolineum	--	--	--	7
Douglas-fir	93	25	Round, peeled, incised, dry	32	14	Soak, copper naphthenate-diesel oil (1% copper), B-144, T-47	3.0	1.2	1.20	--
Douglas-fir	94	25	Round, peeled, incised, dry	33	14	Soak, 5% pentachloro-phenol-diesel oil, B-144, T-48	3.5	1.5	1.30	--
Douglas-fir	95	25	Round, peeled, incised, dry	32	14	Soak, Gasco creosote oil, B-144, T-48	3.2	1.5	1.30	--
Douglas-fir	101	25	Round, undried, 4 strips peeled	65	17	Double diffusion, butts, 4% sodium fluoride--2 days; 6% copper sulfate--2 days	--	--	--	--
Douglas-fir	102	25	Round, undried, 4 strips peeled	65	16	Double diffusion, butts, 6% copper sulfate--2 days; 8% sodium chromate-2 days	--	--	--	--

Table 3. (Continued)

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment[1]	Retention: In a cu ft wood		Retention: In a post	Avg service life[2]
							Butt	Top		
				Percent	*Inches*		*Lb*	*Lb*	*Lb*	*Years*
Maple, Oregon	83	25	Round, peeled, incised, dry	75	14	Soak, 5% pentachlorophenol-diesel oil, B-24, T-2	7.5	2.0	2.72	--
Pine, lodgepole	50	25	Round, unpeeled	55	16	Salt, mercuric chloride, and arsenous oxide, 1 hole; butt	--	--	--	18
Pine, lodgepole	85	25	Round, peeled, incised, dry	65	14	Soak, Gasco creosote oil, B-43, T-24	4.1	1.8	1.5	--
Pine, lodgepole	86	25	Round, peeled, incised, dry	76	14	Soak, 5% pentachlorophenol-diesel oil, B-43, T-24	4.1	2.5	1.6	--
Pine, lodgepole	99	25	Round, undried, 4 strips peeled	75	12	Double diffusion, butts, 6% copper sulfate--2 days; 8% sodium chromate--2 days	--	--	--	5
Pine, lodgepole	104	25	Round, undried, 4 strips peeled	80	14	Double diffusion, butts, 5% zinc sulfate plus 0.7% arsenic acid--2 days; 8% sodium chromate--2 days	--	--	--	--
Pine, ponderosa	56	25	Square	0-35	16	Soak, Permatol "A," 17 hours	--	--	0.61	19

[1]B (butt) and T (top) are followed by treating time in hours.
[2]Series in which all posts have failed. Series having posts remaining are described further in Table 4.
[3]Removed from test in 1955 at 28 years of age. Most posts were severely decayed, but few had failed.

Table 4. Service Records of Nonpressure-Treated Series Remaining in Test in 1976.

Species	Series number	Posts remaining	Age	Avg life, failed posts	Condition of tops
		Percent	*Years*	*Years*	
Alder, red	108	4	24	9	Slight decay
Cottonwood, black	68	76	28	24	Sound
Cottonwood, black	87[1]	92	26	23	Sound
Douglas-fir	24	8	47	28	Mod.-severe decay
Douglas-fir	25	8	47	30	Severely decayed
Douglas-fir	54[1]	68	37	34	Most had severe decay
Douglas-fir	59	17	34	26	Slight-mod. decay
Douglas-fir	64[1]	56	28	24	Sound
Douglas-fir	75	92	27	24	Sound
Douglas-fir	88[1]	52	26	17	Sound
Douglas-fir	93	56	26	18	Sound
Douglas-fir	94	92	26	23	Sound
Douglas-fir	95	76	26	17	Sound
Douglas-fir	101[1]	36	24	18	Slight-mod. decay
Maple, Oregon	83	88	27	15	Sound but split
Pine, lodgepole	85	80	26	22	Sound
Pine, lodgepole	86	100	26	--	Sound
Pine, lodgepole	104	36	24	12	Most had decay

[1]Failure at last inspection.

Table 5. Estimated Increase in Service Life of Douglas-Fir Posts Attributed to Preservative Treatment.

Treatment	Series	Age without failure	Failures	Estimated increase[1]
		Years	*Percent*	*Years*
Bore hole				
Salt + $HgCl_2$	2[2],91	--.--	4,100	22[2],10
Salt + $HgCl_2$ + As_2O_3	3[2],4[2]	28,28	0,0	22[2],22[2]
Sodium pentachlorophenate	90	--	100	1
Sodium trichlorophenate	89	--	100	4
Brushing				
Asphalt	39	--	100	0
Carbolineum	92	--	100	1
Copper naphthenate	80	--	100	5
Creosote	81	--	100	3
Pentachlorophenol	79	--	100	8
Charring	22	--	100	0
Double diffusion				
NaF-$CuSO_4$	101	--	64	17
$CuSO_4$-$NaCrO_4$	102	--	100	0
Hot-cold bath				
Carbolineum	8	--	100	6
Creosote-petroleum	18	--	100	12
Gasco creosote	54	--	32	38
Osmose				
Bandage	73	--	100	6
Salts	75	--	8	--[3]
Soaking				
Pentachlorophenol	62,64,66,94	--,--,--,--	100,44,100,8	10,25,9,--[3]
Copper naphthenate	63,65,67,93	--,--,--,--	100,100,100,44	6,3,3,23
Gasco creosote	88,95	--,--	48,24	22,28
Zinc chloride	12	--	100	1
Tire tube				
Chemonite	59	--	83	23
Treater dust or paste As_2O_3	5[2],6,24,25	--,--,--,--	28,100,92,92	20[2],15,31,31
Pressure processes				
Boliden salts	96,98	--,--	32,52	23,19
Chemonite	45	--	44	37
Chromated zinc chloride	43	--	100	14
Creosote	23,53	47,37	0,0	--[3],--[3]
Creosote-petroleum	7,51	48,37	0,0	--[3],--[3]
Gasco creosote	52	37	0	--[3]
Tanalith	42	--	40	40
Zinc-meta-arsenite	33	--	100	20

[1]Estimated increase is based on actual or estimated average service life of a treated series minus average service life of untreated series of 6 years. Estimated average service life was determined by the method explained in *Percentage Renewal and Average Service Life of Railway Ties*. Report R886, Forest Products Laboratory, U.S. Department of Agriculture, Madison, Wisconsin.

[2]Removed after 28 years; most posts severely decayed, but few had failed.

[3]No estimate could be made of service life of series in which no, or too few, posts failed.

Table 6. Average Characteristics of Pressure-Treated Posts.

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment	Avg service life[1]
				Percent	*Inches*		*Years*
Douglas-fir	7	25	Round, peeled	60	18	70% creosote, 30% fuel oil, 1.5 to 16 lb (average 7.2 lb) per post, treated twice	--
Douglas-fir	23	47	Round, peeled	60	15	Creosote, absorption unknown	--
Douglas-fir	33	25	Square	0	15	Zinc-meta-arsenite, 0.1 lb per post, treated twice	26
Douglas-fir	42	25	Square	0	16	Wolman salts (Tanalith) 0.302 lb dry salt per cu ft, kiln dried after treatment	--
Douglas-fir	43	25	Round, peeled	60	14	Chromated zinc chloride, 0.78 lb dry salt per post (1 lb per cu ft)	20
Douglas-fir	45	25	Square	0	16	Chemonite, 0.58 lb dry salt per cubic foot	--
Douglas-fir	51	25	Square, incised	0	16	Coal-tar creosote and petroleum mixture; 3.8 lb per post (6.2 lb per cu ft)	--
Douglas-fir	52	25	Square, incised	0	16	Gasco creosote oil, 4.23 lb per post (7.6 lb per cu ft)	--
Douglas-fir	53	25	Square, incised	0	16	Coal tar creosote, 8.1 lb per post (13.0 lb per cu ft)	--
Douglas-fir	96	25	Round, peeled	60	22	Boliden salts, 0.44 lb dry salt per cu ft	--
Douglas-fir	98	24	Square	5	15	Boliden salts, 0.40 lb dry salt per cu ft	--
Hemlock, West Coast	41	25	Square	0	16	Wolman salts (Tanalith), 0.302 lb dry salt per cu ft, posts kiln dried after treatment	--
Hemlock, West Coast	44	25	Square	0	16	Chemonite, 0.75 lb of dry salt per cu ft	--

[1]Series in which all posts have failed. Series having posts remaining are described further in Table 7.

Table 7. Service Records of Pressure-Treated Posts Remaining in Test in 1976. All Tops of Posts Remaining Were Sound.

Species	Series number	Posts remaining	Age	Avg life, failed posts
		Percent	*Years*	*Years*
Douglas-fir	7	100	48	--
Douglas-fir	23	100	47	--
Douglas-fir	42	60	40	28
Douglas-fir	45	56	39	26
Douglas-fir	51	100	37	--
Douglas-fir	52	100	37	--
Douglas-fir	53	100	37	--
Douglas-fir	96	68	24	19
Douglas-fir	98	48	24	17
Hemlock, West Coast	41[1]	92	40	32
Hemlock, West Coast	44	88	39	26

[1]Failure at last inspection.