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Service Life of
Treated and Untreated Fence Posts

1971 Progress Report on the Post Farm

Donald J. Miller
Robert D. Graham

Progress Report 14
August 1971

Forest Research Laboratory
School of Forestry
OREGON STATE UNIVERSITY
Corvallis



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CONTENTS

	Page
SUMMARY	v
Untreated posts	v
Nonpressure-treated posts	v
Pressure-treated posts	v
THE POST FARM	1
Climatic conditions	1
Wood-destroying organisms	1
Test specimens	2
Post inspections	2
Post-farm records	2
INTERPRETATION OF DATA	2
Limitations of test data	2
Influence of climatic conditions	3
Consideration of post characteristics	3
Importance of preservatives and methods of preservation	3
PRESERVATIVES, TESTS, AND RECOMMENDATIONS	4
Preservative materials	4
Tests and recommendations	5
Tests of untreated posts	5
Tests of treated posts: nonpressure processes	5
Tests of treated posts: pressure process	7

SUMMARY

Eight series of untreated posts (including 5 series of steel), 22 series of nonpressure-treated posts, and 13 series of pressure-treated posts remain in test. Series in which all posts have failed now number 36 for untreated and 29 for nonpressure-treated. Causes of failures since 1949 were: fungi, 75 percent of failures; fungi and termites, 16 percent; fungi and insects other than termites, 6 percent; termites, 2 percent.

Preservative treatment of the entire post is needed for longest service of nondurable woods at this test site in western Oregon.

Untreated posts

Of the three durable heartwood species remaining in test, the average service lives of western juniper and black locust will exceed 20 years; no Osage-orange posts have failed since they were set 37 years ago. The first failure of steel posts occurred after 21 years because of corrosion at ground level.

Posts of other durable heartwood species such as Pacific yew had an average life of 25 years, redwood and most species of cedar averaged 19 to 24 years, and Oregon white oak averaged 18 years. Average lives of other series of posts did not exceed 9 years and usually were from 4 to 6 years for 28 nondurable species tested.

Nonpressure-treated posts

Double-diffusion butt treatment with solutions of copper sulfate and sodium chromate did not increase life of posts. Certain other chemical combinations extend the life of some series well beyond 15 years, but poorly treated tops are decaying.

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 ACM paste or dust or with Osmosalts have been effective. Posts butt-treated with ACM paste are likely to attain an average life of 32 to 35 years but have badly decayed tops. There have been no failures in 20-year-old posts brushed with a slurry of Osmosalts and water.

Treatment with sodium pentachlorophenate or sodium trichlorophenate in holes at the ground line was not effective. Similar treatment with salt and mercuric chloride was effective, but tops of posts are decayed.

Cold soaking of incised 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 exceed 20 years. Incised posts of black cottonwood soaked 3 hours in creosote or 6 hours in pentachlorophenol solution are giving similar service. Douglas fir posts peeled only on butts, incised, and butts and tops soaked for 6 to 7 days in creosote are expected to have average lives of 20 or more years; posts have retained bark, and tops are sound. Ponderosa pine posts that were soaked for 17 hours in Permatol had an average life of 19 years.

Hot-cold bath butt-treatment with creosote for 6 hours extended average life of black cottonwood posts to 22 years and will extend average life of Douglas fir posts beyond 30 years, but tops of posts of both species are severely decayed. Similar treatments with carbolineum and with creosote diluted with oil were less effective.

Pressure-treated posts

All creosote-treated posts are without failure since installation from 31 to 42 years ago. Failed posts treated with water-borne preservatives had an average service life of 12 to 28 years. Treated tops of all posts were sound when inspected.

SERVICE LIFE OF TREATED AND UNTREATED FENCE POSTS

1971 Progress Report

by

Donald J. Miller

Robert D. Graham

THE POST FARM

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

The post farm is located on land of the School of Forestry 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 slightly acid, top 8 inches of soil have a pH of 5.4, organic-matter content of 4.71 percent, humus of ½ inch or less in thickness, and nitrogen content of 0.1415 percent. Old Douglas fir stumps are present in the test site.

Climatic conditions

The temperate climate of Corvallis typically has dry summers and rainy winters. During the past 79 years, average annual precipitation was 38 inches. Most of this precipitation (81 percent) fell during the months of October through March, when monthly average temperatures ranged from 39 to 54 F. Only 2 percent fell during July and August, which had an average temperature of 66 F. Occasionally, the temperature falls below freezing, or rises above 85 F. Cool afternoon breezes from the Pacific Ocean usually arise daily during summer months.

These mild climatic conditions favor growth of wood-destroying organisms throughout the year.

Wood-destroying organisms

Since 1949, an attempt has been made to determine the various organisms responsible for deterioration of posts installed in the test site. Although decay-producing fungi and damp-wood termites are primary causes of failure, carpenter ants and wood-boring beetles frequently contribute to general deterioration of posts. Damp-wood termites swarm during late summer and early fall. At time of annual inspection in early October, discarded wings of reproductives have been found at bases of some posts. Entry holes have been made at or below ground line. In only a few instances have termites been the primary cause of failure.

Although carpenter ants have been found in some failed posts, there is evidence to indicate galleries were constructed initially by termites. After destroying the termites, ants usually enlarge the galleries somewhat.

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

Causes of failure in posts:

Primary agent	Failures from 1950 to 1970 inclusive	
	Number	Percent
Fungi	841	75.4
Fungi and termites	183	16.4
Fungi and insects other than termites	68	6.1
Termites	20	1.8
Other insects	4	0.3
All	1,116	100.0

Test specimens

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

Before 1947, installed 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 1950, test posts have been standardized at a length of 5 feet, and cross-sectional areas of individual posts are limited to from 8 to 24 square inches at 2 feet from the butt ends. The average cross-sectional area, 2 feet from the butt ends of posts in each series, must fall within the limits of 14 to 18 square inches.

Post inspections

Annual inspections are made during October. A moderate pull is applied to the top of each post, and each post that breaks is examined to establish the point and cause of failure. Deterioration of the top is rated by visual inspection. Each post that fails is examined to determine nature and probable cause of failure.

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 given (if any), date of installation, and other pertinent facts.

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 these destructive agents. In areas of abundant rainfall or prolonged periods of high humidity, deterioration may occur in tops of posts also, but normally it proceeds slowly. The ground-line section of a post also is important, because preservatives are most subject to leaching action there, and, on windy, arid sites, blowing sand often cuts deeply into wood of this zone. To evaluate the results of any test of serviceability, these and many other factors must be considered simultaneously.

Limitations of test data

The detailed tabular data presented in this report cannot be applied indiscriminately to every locality and to all service requirements for posts. Data are basically comparative and

applicable to one area and one type of use; these data must be adjusted empirically to fit other situations.

Posts tested in the post farm usually are not subject to stapling, nailing, ground-line erosion, 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. The arbitrary method used to determine failure is admittedly not comparable to physical forces that may be exerted on posts in actual service.

Influence of climatic conditions

Climate determines, to a great extent, the proportion of time that suitable conditions for decay exist in a given region. Optimal temperatures for growth of decay-producing fungi usually range from 75 to 90 F, and growth slows as temperature departs from optimum. If all parts of a wood post have a moisture content of 20 percent or less (ovendry basis), there is almost no probability of fungal growth.

In western Oregon, where favorable conditions of moisture and temperature exist for long periods, untreated tops of posts that have been given adequate treatment with a good preservative at the butts often decay long before ground-line sections are weakened seriously. Deterioration of tops of posts doubtlessly is retarded in eastern Oregon where long periods of dry or cold conditions prevail.

Consideration of post characteristics

Service records of posts in this report mean little, if characteristics of the wood are not taken into consideration. Size, amount of sapwood, and extractive constituents in the heartwood greatly influence serviceability of untreated posts. No native species has sapwood that is naturally insect- and decay-resistant, but extractive constituents in heartwood of a few species promote resistance to attack by insects and fungi. With some exceptions, these extractives give heartwood a color darker than that of sapwood. Untreated posts may 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 more readily.

Importance of preservatives and methods of preservation

The service life of treated wood is influenced by effectiveness of preservative applied, portion of the product treated, amount of preservative retained by the wood, and depth and uniformity of treatment. Most preservatives are effective fungicides and insecticides, but extension of the service life of wood requires continued presence of preservative in a concentration toxic to organisms responsible for deterioration.

Although a preservative may fail under one set of climatic conditions, it may prove extremely successful under different conditions. A preservative that is readily soluble in water, for example, may leach from wood in a region of abundant rainfall but not in a dry climate. Successful treatment provides uniform penetration into the treated area and retention of a sufficient quantity of preservative within the wood structure to protect the wood under conditions in which it is to be used. High total retention of preservatives is not necessarily an indication of successful treatment. In some species, rapid penetration of the preservative into end grain, but slow penetration into side grain, may result in complete protection of the end of the post, but almost no protection of the important ground-line zone.

PRESERVATIVES, TESTS, AND RECOMMENDATIONS

Preservative materials

Virtually all preservatives are poisonous. Many cause irritations when the chemical itself, its solutions, or its vapor touch the skin. Some are extremely poisonous and corrosive. Care should be exercised in handling all preservatives; exposed portions of the body should be washed frequently.

All preservatives should be stored in closed, clearly identified containers. Manufacturer's recommendations should be followed implicitly.

Asphalt Emulsion. An emulsion or suspension of finely dispersed particles of asphalt in water. Asphalt is a black-to-dark-brown, solid or semisolid material composed predominately of bitumens. This material has little or no preservative value.

Boliden Salts. This preservative contains arsenic acid, sodium arsenate, sodium bichromate, and zinc sulfate.

Carbolineum. Carbolineum,¹ or anthracene oils, are coal-tar distillates of specific gravity and boiling range higher than for ordinary coal-tar creosote. The exact composition of Carbolineum "B" is not known.

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

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

Copper Naphthenate. The oil-soluble copper salt of naphthenic acid. Solutions containing 2 percent copper by weight are recommended for optimum performance. Test solutions contained 1 percent copper.

Creosote, Creosote Oil, or Coal-Tar Creosote. A distillate of coal tar produced by high-temperature carbonization of bituminous coal. It consists principally of liquid and solid aromatic hydrocarbons, contains appreciable quantities of tar acids and tar bases, and has a continuous boiling-point range beginning about 200 C and extending to at least 325 C.

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 not recommended. Because it may cause hyperkeratosis in cattle, crankcase oil should not be used where they could come in contact with it.

Gasco Creosote. A distillate of tar residue from asphaltic-base petroleum oils in which artificial fuel gas is the main product.

Osmosalts. A proprietary wood preservative containing sodium fluoride, sodium bichromate, dinitrophenol, and sometimes arsenic. The chemicals are water-soluble.

Pentachlorophenol. An oil-soluble chemical formed from phenol and chlorine. Solutions containing 5 percent pentachlorophenol by weight are recommended for wood in contact with soil.

Permatol "A". A preservative containing pentachlorophenol as its toxic constituent. The name "Permatol" has been copyrighted by the Western Pine Association.

Salt and Corrosive Sublimate. A mixture of equal proportions by weight of two water-soluble chemicals. Corrosive sublimate (mercuric chloride, extremely poisonous) is the toxic chemical, and the salt serves to hold moisture. This mixture is not recommended.

Salt, Corrosive Sublimate, and Arsenous Oxide. A mixture of equal proportions by weight of the three chemicals. Addition of the water-soluble arsenous oxide apparently contributes

little, if anything, to the effectiveness of the highly poisonous corrosive sublimate. This mixture is not recommended.

Sodium Pentachlorophenate. The water-soluble sodium salt of pentachlorophenol.

Sodium Trichlorophenate. The water-soluble salt of trichlorophenol.

Tanalith. A proprietary wood preservative that normally contains sodium fluoride, dinitrophenol, sodium chromate, and sodium arsenate. It is injected in water solution.

Treater Dust, Granular Treater Dust, and Treater Paste. Preservatives formerly produced by the Anaconda Copper Mining Company as byproducts of copper smelting. Arsenic trioxide is the principal toxic constituent of the preservatives that were sold in dust, granular, and paste forms. Manufacture of these preservatives has been discontinued.

Zinc Chloride. A chemical applied to wood in a 2- to 5-percent water solution.

Zinc-Meta-Arsenite. A preservative prepared by dissolving zinc oxide and arsenic trioxide in water acidified with acetic acid.

Tests and recommendations

Service life of a series in which most or all posts have failed is simple to determine, but for series in which few posts have failed, average service life cannot be estimated accurately. Estimated service life, when given for any series in this report, is based on number of posts failed and on service age and condition of remaining posts. For a few untreated species, natural resistance to decay as determined in other service tests has been considered in making estimates of service life.

Tests of untreated posts

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

Tests of treated posts: nonpressure processes

Characteristics and service records for posts treated by nonpressure processes are given in Table 3. Service records of posts remaining in test are summarized in Table 4. Estimated increases in service life resulting from preservative treatments of Douglas fir posts are shown in Table 5. An attempt has been made to evaluate these treatments and, when possible, recommendations have been made concerning them.

Bore Hole. One or more holes of $\frac{3}{4}$ -inch diameter were drilled about 2 inches deep and slanting downward from near ground level toward the butt of each freshly cut, unpeeled post. 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 was driven into each hole. Holes should be spaced not more than 5 inches apart around the circumference of each post and staggered vertically to prevent weakening the post seriously.

These treatments have increased the estimated average life of lodgepole pine posts to 19 years; average lives of series of Douglas fir posts increased to 12 and to more than 22 years.

Tops of posts were not protected adequately by this method and decayed severely. Effectiveness of the ground-line treatment increased with number of holes.

Because the chemicals applied in this treatment are very poisonous, it is no longer recommended.

Brushing. Two applications of preservative solution were flooded onto thoroughly air-dried posts during hot days. 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. Penetration and retention of preservative ordinarily is slight, and for that reason the brushing treatment has not been 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 the size of the post 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: those with sodium fluoride and copper sulfate were not effective with alder, but have increased the estimated average life of Douglas fir posts to 24 years. Lodgepole pine posts treated with zinc sulfate, arsenic acid, and sodium chromate now have an estimated life of 19 years. Tops of most posts treated by the double diffusion method had decayed tops by their 11th year of life. For longer life, treatment by soaking full length, rather than just the butts, is recommended.

Hot-Cold Bath. For this treatment, also called the thermal treatment, dry posts are ordinarily soaked in hot (about 200 F), oily preservative solution for several hours and then allowed to remain in the solution while it cools to 100-150 F or transferred to cool solution.

In our tests, preservative solutions were limited to several creosotes and a creosote-crankcase oil mixture. They generally were effective, and prolonged the life of nondurable black cottonwood and Douglas fir posts to as many as 22 and 18 years, respectively. Unaccountably good durability has been obtained in a series (+54) of sawed posts of Douglas fir heartwood that were not dried before treatment; only 1 of 25 posts has failed during 31 years of test, but tops have decayed badly and presumably were not treated.

Usual recommendations for treatment are that posts be free of bark, thoroughly seasoned if oily, solutions will be used, and treated full length.

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

The treatment was not effective on posts of black cottonwood, but was of some value to those of Douglas fir by increasing their average life to 11 years. It is not recommended for posts with nondurable heartwood.

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

This simple and effective treatment has extended the life of Douglas fir posts to 21 years without failure. We have not tested it on other species.

Soaking. Posts should be peeled, then thoroughly seasoned before soaking in the commonly used oil-type preservative solutions. Usually, that portion of the post 6 inches

above and 12 inches below ground should be incised to a depth of 1/2 inch 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 is proving to be an effective treatment. Gasco creosote, no longer available, was also effective. Copper naphthenate (1 percent copper) in diesel oil has been less effective. 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); absorbant posts of black cottonwood (series 68), with butts and tops soaked only 6 and 1 hours, have the same estimated lifespan. Douglas fir posts, peeled only at the butts and then incised, dried, and soaked in Gasco creosote, have an estimated life of 24 years; their soaking periods were long, 7 days for butts and 1 day for tops. Treatments with water solutions of sodium pentachlorophenate (series 74) and zinc chloride (series 12) were not effective.

For longest life, full-length treatment of incised and well-seasoned posts is recommended.

Tire Tube with Chemonite. One end of a portion of an automobile inner tube was slipped over the butt end of an unpeeled, freshly cut post. The butt of the post was higher than its top, on an inclined rack. The open end of the tube is elevated, and the tube is filled with a water-soluble preservative which diffuses through the sapwood and finally drips out from the low end of the post.

This end-diffusion treatment has extended the estimated average life of Douglas fir posts to 27 years, but the tops are decaying. The method has the advantage that posts can be treated without first peeling or drying, but the diffusion process is slow and each post must be treated individually.

Treater Dust and Paste. These preservatives were tested on freshly cut Douglas fir posts. Dust and granular forms were sprinkled around unpeeled posts while their postholes were backfilled with soil. Otherwise, 2 to 4 pounds of paste were applied to butts of peeled posts being set.

Applications of paste extended estimated average life of posts to 26 and 29 years; dust and granules extended average life to 26+ and 21 years. These products are no longer available.

Tests of treated posts: pressure process

Characteristics and service records of posts treated by pressure processes are shown in Tables 6 and 7. Estimated increases in the service life of Douglas fir posts because of preservative treatment are given in Table 5.

Before treatment, posts are air-dried, seasoned in the preservative by boiling under vacuum, or conditioned by steaming. Oily preservatives are heated, but water-borne preservative solutions may be heated or unheated depending on plant design. Preservative is injected into the wood under pressure in a closed vessel and a final vacuum usually is applied to remove excess preservative and to dry the surface of the wood. The full length of the post receives treatment.

All but two series of posts have been in test for at least 31 years. Average life of most series is not expected to exceed 30 years; that of posts treated with Chemonite or Tanalith is likely to reach 40 years. Some series treated with creosote or creosote-petroleum have reached 41-42 years of age with no failures.

Pressure treatments have been consistently effective in greatly increasing the service life of posts of nondurable wood and are recommended for longest service under severe conditions.

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

Species	Series number	Number of posts	Post description	Sap-wood	Ground-line perimeter	Avg service life ²
				Per- cent	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 a foot	--	--	--
Metal, red oxide paint	61	25	"T" post, 1.2 lb a foot	--	--	--
Metal, green enamel	69	9	H-beam, 4 lb a foot	--	--	--
Metal, green enamel	70	10	Flanged channel, 1.3 lb a foot	--	--	--
Metal, green enamel	71	10	"T" post, 1.5 lb a 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

¹Series 10 and 11 were from the same group of posts.²Series 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 1970.

Species	Se- ries num- ber	Posts re- main - ing	Age	Avg life failed posts	Remarks
		Percent	Years	Years	
Juniper, western	30	20	40	22	Slight-mod. top decay
Locust, black	40	27	35	20	None to slight top decay
Steel, L-section	60	100	22	--	Tops rusty
Steel, T-section	61 ¹	92	22	21	Tops rusty, failure at ground
Steel, I-section	69	100	22	--	Tops rusty
Steel, U-section	70	100	22	--	Tops rusty
Steel, T-section	71	100	22	--	Tops rusty
Osage-orange	32	100	37	--	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	Sap-wood	Ground-line perimeter	Preservative treatment ¹	Retention			Avg service life ²
							In a cu ft wood		In a post	
							Butt	Top		
				Per-cent	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% penta-chlorophenol-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 penta-chlorophenate, 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	--
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 ⁺

Douglas fir	3	22	Round, unpeeled, undried	60	20	Salt, mercuric chloride and arsenous oxide, 2 holes; butt	--	--	--	28 ⁺
Douglas fir	4	22	Round, unpeeled, undried	60	18	Salt, mercuric chloride, and arsenous oxide, 3 holes; butt	--	--	--	28 ⁺
Douglas fir	5	25	Round, unpeeled, undried	60	16	ACM Co. treater dust; butt	--	--	--	26 ⁺
Douglas fir	6	25	Round, unpeeled, undried	60	17	ACM Co. granualted 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	Se- ries num- ber	Num- ber of posts	Description	Sap- wood	Ground- line perim- eter	Preservative treatment ¹	Retention			Avg serv- ice life ²
							In a cu ft wood		In a post	
							Butt	Top		
				Per- cent	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% pentachloro- phenol-diesel oil, B-3, T-2	1.0	0.4	0.37	--
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% pentachloro- phenol-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	--	--	--	11
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	--	--	--	14

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, coal- 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	--	--	--	--
Douglas fir	92	23	Round, peeled, dry	46	14	Brush, 2 coats Avenarius 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, indried, 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	--	--	--	6

Table 3. (Continued)

Species	Series number	Number of posts	Description	Sap-wood	Ground-line perimeter	Preservative treatment ¹	Retention			Avg service life ²
							In a cu ft wood		In a post	
							Butt	Top	Lb	
				Per-cent	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	--	--	--	--
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.

*Removed from test 1955. See Appendix to 1955 Progress Report on Post Farm for details on condition of these series.

Table 4. Service Records of Nonpressure-Treated Series
Remaining in Test in 1970.

Species	Se- ries num- ber	Posts re- main- ing	Age	Avg life, failed posts	Condition of tops
			Years	Years	
		Per- cent			
Alder, red	108 ¹	4	18	9	Slight-mod. decay
Cottonwood, black	68 ¹	92	22	20	Sound
Cottonwood, black	77	4	21	7	Sound
Cottonwood, black	87 ¹	96	20	20	Sound
Douglas fir	24	8	41	28	Mod.-severe decay
Douglas fir	25	16	41	29	Severely decayed
Douglas fir	54	96	31	27	Most had severe decay
Douglas fir	59	33	28	24	Slight-mod. decay
Douglas fir	62	4	22	16	Sound
Douglas fir	64 ¹	80	22	21	Sound
Douglas fir	75	100	21	--	Sound
Douglas fir	88	65	20	14	Sound
Douglas fir	91 ¹	12	21	15	Severely decayed
Douglas fir	93 ¹	64	20	17	Sound
Douglas fir	94	100	20	--	Sound
Douglas fir	95	84	20	14	Sound
Douglas fir	101	80	18	12	Most had decay
Maple, Oregon	83	92	21	10	Sound but split
Pine, lodgepole	50	4	32	17	Severely decayed
Pine, lodgepole	85 ¹	92	20	20	Sound
Pine, lodgepole	86	100	20	--	Sound
Pine, lodgepole	104	48	18	10	Most had decay

¹Failure at last inspection.

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

Treatment	Series	Age without failure	Failures	Estimated increase ¹
		Years	Percent	Years
<i>Bore hole</i>				
Salt + HgCl ₂	2 ⁺ , 91	--, --	4, 88	22 ⁺ , 12 ⁺
Salt + HgCl ₂ + As ₂ O ₃	3 ⁺ , 4 ⁺	28, 28	0, 0	22 ⁺ , 22 ⁺
Sodium pentachlorophenate	90	--	100	1
Sodium trichlorophenate	89	--	100	4
<i>Brushing</i>				
Asphalt	39	--	100	0
Carbolineum	92	--	100	1
Copper naphthenate	80	--	100	5
Creosote	81	--	100	3
Pentachlorophenol	79	--	100	8
<i>Charring</i>	22	--	100	0
<i>Double diffusion</i>				
NaF-CuSO ₄	101	--	20	18
CuSO ₄ -NaCrO ₄	102	--	100	0
<i>Hot-cold bath</i>				
Carbolineum	8	--	100	6
Creosote-petroleum	18	--	100	12 ⁻²
Gasco creosote	54	--	4	-- ²
<i>Osmose</i>				
Bandage	73	--	100	5 ⁻²
Salts	75	20	0	-- ²
<i>Soaking</i>				
Pentachlorophenol	62, 64, 66, 94	--, --, --, 20	96, 20, 100, 0	10, 24, 9, -- ²
Copper naphthenate	63, 65, 67, 93	--, --, --, --	100, 100, 100, 36	6, 3, 3, 18
Gasco creosote	88, 95	--, --	35, 16	18, 22 ⁺
Zinc chloride	12	--	100	1
<i>Tire tube</i>				
Chemonite	59	--	67	21
<i>Treater dust or paste As₂O₃ 5⁺</i>	6, 24, 25	--, --, --, --	28, 100, 92, 84	20 ⁺ , 15, 26, 29
<i>Pressure processes</i>				
Boliden salts	96, 98	--, --	8, 26	-- ² , 17
Chemonite	45	--	36	33
Chromated zinc chloride	43	--	92	21
Creosote	23, 53	41, 31	0, 0	-- ² , -- ²
Creosote-petroleum	7, 51	42, 31	0, 0	-- ² , -- ²
Gasco creosote	52	31	0	-- ²
Tanalith	42	--	40	33
Zinc-meta-arsenite	33	--	84	26

¹Estimated 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.

²No estimate could be made of service life of series in which no, or too few, posts failed.

*Removed before all posts failed.

Table 6. Average Characteristics of Pressure-Treated Posts.

Species	Se- ries num- ber	Num- ber of posts	Description	Sapwood	Ground- line perim- eter	Preservative treatment
				Percent	Inches	
Douglas fir	7	25	Round, peeled	60	18	70% creosote, 30% fuel oil, 1.5 to 16 lb (average 7.2 lb) a 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 a post, treated twice
Douglas fir	42	25	Square	0	16	Wolman salts (Tanalith) 0.302 lb dry salt a cu ft, kiln dried after treatment
Douglas fir	43	25	Round, peeled	60	14	Chromated zinc chloride, 0.78 lb dry salt to a post (1 lb a cu ft)
Douglas fir	45	25	Square	0	16	Chemonite, 0.58 lb of dry salt to a cubic foot
Douglas fir	51	25	Square, incised	0	16	Coal-tar creosote and petroleum mixture, 3.8 lb a post (6.2 lb a cu ft)
Douglas fir	52	25	Square, incised	0	16	Gasco creosote oil, 4.23 lb a post (7.6 lb a cu ft)
Douglas fir	53	25	Square, incised	0	16	Coal tar creosote, 8.1 lb a post (13.0 lb a cu ft)
Douglas fir	96	25	Round, peeled	60	22	Boliden salts, 0.44 lb dry salt a cu ft
Douglas fir	98	24	Square	5	15	Boliden salts, 0.40 lb dry salt a cu ft
Hemlock, West Coast	41	25	Square	0	16	Wolman salts (Tanalith) 0.302 lb dry salt a cu ft, posts kiln dried after treatment
Hemlock, West Coast	44	25	Square	0	16	Chemonite, 0.75 lb of dry salt a cu ft

Table 7. Service Records of Pressure-Treated Posts
 Remaining in Test in 1970.
 All Tops of Posts Remaining Were Sound.

Species	Se- ries num- ber	Posts re- main- ing	Age	
			<i>Percent</i>	<i>Years</i>
Douglas fir	7	100	42	--
Douglas fir	23	100	41	--
Douglas fir	33	16	37	23
Douglas fir	42	60	34	28
Douglas fir	43	8	34	18
Douglas fir	45	64	33	24
Douglas fir	51	100	31	--
Douglas fir	52	100	31	--
Douglas fir	53	100	31	--
Douglas fir	96	92	18	15
Douglas fir	98	74	18	12
Hemlock, West Coast	41	96	34	24
Hemlock, West Coast	44	88	33	26