Service Life of Treated and Untreated Fence Posts

1960 PROGRESS REPORT ON THE T. J. STARKER POST FARM

By **R. D. Graham** and **D. J. Miller**

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Forest Products Research

OREGON FOREST RESEARCH CENTER

Corvallis

OREGON FOREST RESEARCH CENTER

Two State programs of research are combined in the Oregon Forest Research Center to improve and expand values from timberlands of the State.

A team of forest scientists is investigating problems in forestry research of growing and protecting the crop, while wood scientists engaged in forest products research endeavor to make the most of the timber produced.

The current report stems from studies of forest products.

Purpose . . .

Fully utilize the resource by:

- developing more by-products from mill and logging residues to use the material burned or left in the woods.
- expanding markets for forest products through advanced treatments, improved drying, and new designs.
- directing the prospective user's attention to available wood and bark supplies, and to species as yet not fully utilized.
- creating new jobs and additional dollar returns by suggesting an increased variety of salable products. New products and growing values can offset rising costs.

Further the interests of forestry and forest products industries within the State.

Current Program . . .

Identify and develop uses for chemicals in wood and bark to provide markets for residues.

Improve pulping of residue materials.

Develop manufacturing techniques to improve products of wood industries.

Extend service life of wood products by improved preserving methods.

Develop and improve methods of seasoning wood to raise quality of wood products.

Create new uses and products for wood.

Evaluate mechanical properties of wood and wood-based materials and structures to increase and improve use of wood.

TABLE OF CONTENTS

SUMMARY

Sixteen series of untreated posts, 38 series of nonpressure-treated posts, and 13 series of pressure-treated posts were inspected. Series in which all posts have failed now number 31 for untreated, and 15 for nonpressure-treated. Causes of failures since 1949 were: fungi, 75 per cent of failures; fungi and termites, 17 per cent; fungi and insects, 6 per cent; termites, 2 per cent.

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

Untreated posts

Remaining posts of western red cedar, Douglas fir, and Oregon white oak have failed, after average service lives of 22, 18, and 7 years. Average service of untreated Douglas fir posts has been 6 years. All posts of osage-orange have been in service 28 years without failure.

Nonpressure-treated posts

Double-diffusion treatment with copper sulfate and sodium chromate has not increased service life of posts; other chemical combinations have been effective.

Brushed-on preservatives have added only a few years to the life of Douglas fir posts. Osmosalt treatment has given promising results; Osmoplastic bandages have been less effective.

Posts treated with sodium pentachlorophenate or sodium trichlorophenate in holes at the ground line are failing rapidly; some untreated tops broke off during inspection.

Ninety-five per cent of posts soaked in a 5 per cent solution of pentachlorophenol or in creosote remain in good condition after ten years of service. Nearly all ponderosa pine posts treated by soaking in Permatol "A" have failed after an average service life of 18 years.

There have been no failures in 21-year-old posts butt-treated with creosote by the hot-cold bath method.

Pressure-treated posts

All creosote-treated posts have been without failure since installation from 21 to 32 years ago. Failed posts treated with water-borne preservatives had an average service life of 17-24 years.

SERVICE LIFE OF TREATED AND UNTREATED FENCE POSTS
1960 Progress Report on the T. J. Starker Post Farm

by

R. D. Graham

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THE T. J. STARKER POST FARM

In 1927, the School of Forestry at Oregon State College established and has since maintained a "post farm" to obtain data on natural durability of native woods and effectiveness of different 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 T. J. Starker 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 has a pH of 5.4, and organic matter content of 4.71 per cent, a humus of one-half inch or less in thickness, and a nitrogen content of 0.1415 per cent. A number of old Douglas fir stumps are present in the test site.

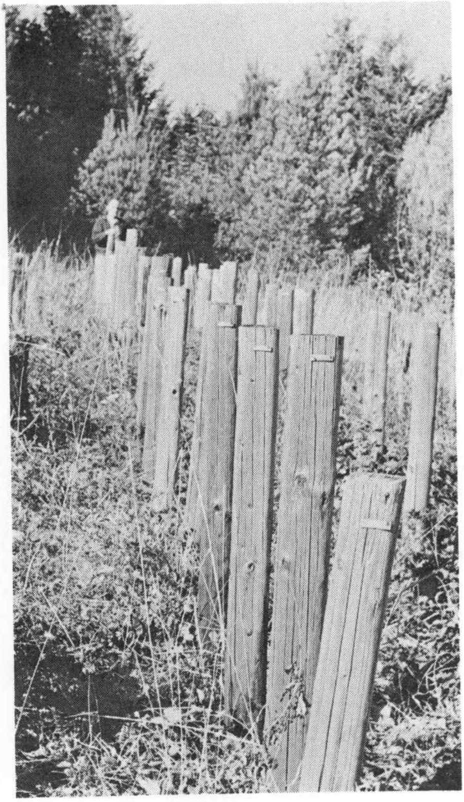
Climatic conditions

The temperate climate of Corvallis typically has dry summers and rainy winters. During the past 69 years, average annual precipitation was 37 inches. Most of this precipitation (81 per cent) fell during the months of October through March, when monthly average temperatures ranged from 45 to 55 F. Only 2 per cent 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 the primary causes of failures, 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 many posts. Entry holes have been made at or below ground line. In only a few instances have termites been the primary cause of failure.

Figure 1. All Douglas fir posts that were pressure-treated with coal-tar creosote 31 years ago remained in excellent condition.

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

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

<u>Test specimens</u>

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 into the ground to a depth of 2 feet.

Prior to 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. Test posts now are standardized at a length of 5 feet, and cross-sectional areas of individual posts are limited to 16 ± 8 square inches at a distance of 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 16 ± 2 square inches.

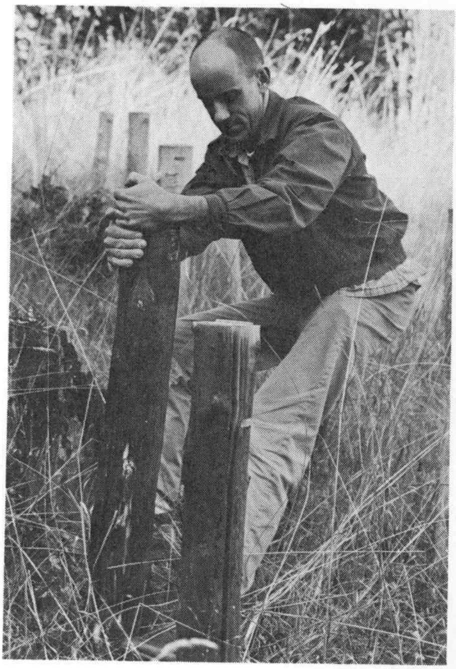


Figure 2. During annual inspection, each post received a moderate pull at the top to test for failure.

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. Formerly, a 50-pound horizontal pull was applied 2 feet above the ground. Deterioration of the top is rated by visual inspection, while both stability of the post and a prod are used to estimate deterioration below ground.

Post-farm records

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

INTERPRETATION OF DATA

Posts and other wood products used 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 favorable supply of moisture and air necessary for existence of these destructive agents. In areas of abundant rainfall or prolonged periods of high humidity, tops of posts also are subject to deterioration, but normally it proceeds at a slow rate. The ground-line section of a post also is important, because preservatives are most subject to leaching action there and, on windy sites, blowing sand often cuts deeply into wood of this zone. To evaluate intelligently 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 T.J. Starker 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 virtually continuous insect attack 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.

Figure 3. Undried Douglas fir posts received an end-diffusion treatment with Chemonite by the tire-tube method. Service life was increased, but where bark remained on posts, most tops contained decay.

Influence of climatic conditions

Climate determines to a great extent the proportion of time that suitable conditions for decay exist in a given region. Optimum temperatures for the growth of decay-producing fungi ranged from 60 to 80 F, but some fungi can develop at temperatures as low as 35 F or as high as 120 F. If all parts of a wood post have a moisture content of 20 per cent or less (oven-dry basis), there is virtually no possibility of fungal growth. During long periods of extremely dry weather, and in periods when the temperature approaches freezing, rate of decay in posts is retarded. Rate of deterioration in posts doubtlessly is retarded in regions where long periods of unfavorable conditions prevail. In western Oregon, for example, where favorable conditions of moisture and temperature exist for long periods, untreated tops of posts that have been given adequate treatment at the butts with a good preservative often decay long before ground-line sections are weakened seriously.

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 wood greatly influence serviceability of untreated posts. Large posts may give long service, not only because of great gross volume of wood, but also because of the high proportion of heartwood they usually contain. The sapwood of no native species is naturally insect- and decay-resistant. Extractive constituents in heartwood of a few species promote resistance to insect and fungal attack. With some exceptions, these extractives give heartwood a color darker than that of sapwood.

Equal importance of preservatives and methods of preservation

The service life of treated wood is affected by nature of preservative used, portion of the product treated, amount of preservative retained by the wood, method of treatment, 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.

Figure 4. After 31 years in service, Douglas fir posts were in good condition because of pressure treatment with coal-tar creosote.

Preservative should be present in areas subject to attack, which are principally the ground-line zone and, in some instances, the top of the post.

Method of treatment and preservative used are equally important, for poor treatment produces poor results. For this reason, a preservative cannot be condemned until the treatment can be shown to be unsatisfactory despite application of the preservative by a proper treating method. 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 in a dry climate it may be permanent. 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, penetration of the preservative may be rapid into end grain, but penetration into side grain may be slow, which may result in complete protection of the end of the post, with virtually no protection of the ground-line zone.

EVALUATION OF TESTS

Determination of the service life of a series in which most or all posts have failed is simple, but for many naturally decay-resistant untreated series and for treated series in which few posts have failed, estimation of average service life cannot be made with accuracy. 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 decay resistance as determined in other service tests has been taken into consideration in making estimates of service life.

Untreated posts

Characteristics and service records of untreated posts are shown in Tables 1, 2, and 3. The various species tested are classified into two groups, based largely on durability and amount of heartwood present in the posts. Series numbers are enclosed in parentheses for convenience in referring to tabular data. Actual or estimated average service life is expressed in years.

- Durable species (posts largely of heartwood)

	Years
Cedar, Alaska (46)	18
Cedar, incense (29)	14
Cedar, Port Orford (21)	20
Cedar, western red (10, 11)	23, 22
Juniper, western (30)	27
Locust, black (40)	24
Oak, Oregon white (19)	18
Osage-orange (32)	over 30
Redwood (58)	23
Yew, Pacific (13)	28

- Nondurable species (posts largely of sapwood, or heartwood not durable)

	Years
Alder, red (16, 106)	5,3
Ash, Oregon (28)	6
Cascara buckthorn (20, 47)	5,8
Cottonwood, black (14, 82)	5,4
Cypress, Arizona (84)	5
Douglas fir (1,55,57,72,97,100)	7,6,4,7,4,4
Fir, grand (15)	9
Hemlock, mountain (109)	3
Hemlock, West Coast (38)	6
Larch, western (37)	7
Madrone, Pacific (26)	6
Maple, Oregon (17)	7
Pine, lodgepole (48,49,103)	5,4,3
Pine, ponderosa (36)	6
Pine, sugar (35)	7
Pine, Idaho white (34)	6
Spruce, Sitka (31)	6
Tanoak (76)	4

Average service life of untreated posts varies greatly, due to differences in durability and amount of heartwood in each post. Posts from durable species that are largely sapwood and posts from nondurable species can be expected to have an average service life of only 4-6 years west of the Cascade mountains. Such posts should be treated properly with a preservative prior to installation in the ground.

Treated posts: nonpressure processes

Characteristics and service records for posts treated by nonpressure processes are given in Tables 4, 5, and 6. Estimated increases

Table 1. Average Characteristics of Untreated Posts.

Species	Series number	Number of posts	Post description	Sapwood	Groundline perimeter	Remarks
				Per cent	Inches	
Alder, red	16	25	Split	25	20	
Alder, red	106	25	Round, peeled	100	12	
Ash, Oregon	28	25	Split	30	19	
Cascara buckthorn	20	12	Round, peeled	70	9	
Cascara buckthorn	47	26	Round, unpeeled	35	17	
Cedar, Alaska	46	24	Split, mostly heartwood	--	18	Same tree
Cedar, incense	29	25	Split	0	20	
Cedar, Port Orford	21	25	Split	0	24	
Cedar, western red	10*	25	Split	0	20	Dark colored
Cedar, western red	11*	25	Split	0	19	Light colored
Cottonwood, black	14	25	Split	20	22	
Cottonwood, black	82	25	Round, unpeeled	95	14	
Cypress, Arizona	84	25	Round, unpeeled	100	13	
Douglas fir	1	25	Round, unpeeled	60	19	
Douglas fir	55	25	Square	0	16	
Douglas fir	57	25	Square	0	16	
Douglas fir	72	25	Round, unpeeled	48	14	
Douglas fir	97	25	Square	5	15	
Douglas fir	100	25	Round, 4 strips peeled	80	16	
Fir, grand	15	25	Split	65	22	
Hemlock, mountain	109	25	Square, dry	--	15	
Hemlock, West Coast	38	25	Square	0	16	
Juniper, western	30	11	Round, peeled	40	22	
	30	14	Split	40	24	
Larch, western	37	25	Square	0	16	
Locust, black	40	8	Round	20	10	
	40	14	Split	20	16	
Madrone, Pacific	26	25	Round and split	40	21	
Maple, Oregon	17	25	Split	25	20	
Metal	60	25	Angle iron, 1.1 lb a foot	--	--	Aluminum paint
Metal	61	25	"T" post, 1.2 lb a foot	--	--	Red oxide paint
Metal	69	9	H-beam, 4 lb a foot	--	--	Green enamel
Metal	70	10	Flanged channel, 1.3 lb a foot	--	--	Green enamel
Metal	71	10	"T" post, 1.5 lb a foot	--	--	Green enamel
Oak, Oregon white	19	23	Split	20	19	
Osage-orange	32	11	Round, unpeeled	10	20	
		15	Split	10	18	
Pine, lodgepole	48	26	Round, peeled	55	16	Dead trees
Pine, lodgepole	49	25	Round, peeled	55	16	Live trees
Pine, lodgepole	03	25	Round, 4 strips peeled	80	12	
Pine, ponderosa	36	25	Square	0	16	
Pine, sugar	35	25	Square	0	16	
Pine, Idaho white	34	25	Square	0	16	
Redwood	58	25	Square	0	16	
Spruce, Sitka	31	26	Square	0	16	
Tanoak.	76	25	Round, unpeeled	100	12	
Yew, Pacific	13	23	Round, peeled	10	16	

* From same group of posts.

Table 2. Service Records of Untreated Posts Remaining in Test in 1960.

Species	Series number	Posts remaining	Age	Avg life of failed posts	Remarks
		Per cent	Years	Years	
Cedar, Alaska	46	17	23	17	Slight top decay
Cedar, western red	10*	4	32	23	Slight top decay
Hemlock, mountain	109*	8	4	2	
Juniper, western	30	20	31	23	Moderate top decay
Locust, black	40*	36	26	19	Tops sound
Steel, L section	60	100	12	--	Tops rusty
Steel, T section	61	100	12	--	Tops rusty
Steel, I section	69	100	12	--	Tops rusty
Steel, U section	70	100	12	--	Tops rusty
Steel, T section	71	100	12	--	Tops rusty
Osage-orange	32	100	28	--	Tops sound
Redwood	58*	52	21	18	Slight top decay
Yew, Pacific	13	26	32	21	Sapwood decay

* Indicates failure at last inspection.

Table 3. Average Service Life of Untreated Series in Which all Posts have Failed.

Species	Series number	Average life
		Years
Alder, red	16	5
Alder, red	106	3
Ash, Oregon	28	6
Cascara buckthorn	20	5
Cascara buckthorn	47	8
Cedar, incense	29	14
Cedar, Port Orford	21	20
Cedar, western red	11*	22
Cottonwood, black	14	5
Cottonwood, black	82	4
Cypress, Arizona	84	4
Douglas fir	1	7
Douglas fir	55	6
Douglas fir	57	4
Douglas fir	72*	7
Douglas fir	97	4
Douglas fir	100	4
Fir, grand	15	9
Hemlock, West Coast	38	6
Larch, western	37	7
Madrone, Pacific	26	6
Maple, Oregon	17	7
Oak, Oregon white	19*	18
Pine, lodgepole	48	5
Pine, lodgepole	49	4
Pine, lodgepole	103	3
Pine, ponderosa	36	6
Pine, sugar	35	7
Pine, Idaho white	34	6
Spruce, Sitka	31	6
Tanoak	76	4

* Indicates failure at last inspection.

Table 4. Average Characteristics of Nonpressure-Treated Posts.

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment*	Retention: In a cu ft wood, Butt	Retention: In a cu ft wood, Top	Retention: In a post
				Per cent	Inches		Lb	Lb	Lb
Alder, red	105	25	Round, peeled, undried	100	12	Double diffusion, butts, 6 % copper sulfate--2 days; 8 % sodium chromate--2 days	--	--	--
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 Orfora	9	10	Round, peeled	25	20	Hot-cold bath, carbolineum "B", butt	--	--	--
Cottonwood, black	27	24	Split, peeled	20	22	Hot-cold bath, creosote, B-6	--	--	--
Cottonwood, black	68	25	Round, peeled, incised, dry	89	14	Soak, 5 per cent pentachlorophenol-diesel oil, B-6, T-1	7.31	4.06	2.86
Cottonwood, black	74	22	Round, peeled, incised, dry	99	14	Soak, 5 % sodium pentachlorophenate, B-4, T-1	7.66	4.47	2.93
Cottonwood, black	77	25	Round, peeled, incised, dry	95	14	Soak, copper naphthenate-diesel oil (1% copper), B-6, T-1	2.71	1.47	1.04
Cottonwood, black	78	25	Round, ground line peeled, undried	83	14	Osmoplastic bandage	--	--	--
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	--	--	--

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

Table 4. (Continued)

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment*	Retention: In a cu ft wood, Butt	Retention: In a cu ft wood, Top	Retention: In a post
				Per cent	Inches		Lb	Lb	Lb
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-2, T-2	1.02	0.40	0.37
Douglas fir	63	25	Round, peeled, incised, dry	26	14	Soak, copper naphthenate-diesel oil (1% copper), B-48, T-6	1.64	0.26	0.50
Douglas fir	64	25	Round, peeled, incised, dry	46	14	Soak, 5% pentachlorophenol-diesel oil, B-48, T-6	2.22	0.45	0.95
Douglas fir	65	25	Round, peeled, incised, dry	40	14	Soak, copper naphthenate-diesel oil (1% copper), B-2, T-2	0.75	0.30	0.29
Douglas fir	66	25	Round, peeled, dry	40	14	Soak, 5% pentachlorophenol-diesel oil, B-48, T-6	1.03	0.23	0.35
Douglas fir	67	25	Round, peeled, dry	33	14	Soak, copper naphthenate-diesel oil (1% copper), B-48, T-6	0.73	0.24	0.25
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	25	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	--	--	--
Douglas fir	81	24	Round, peeled, dry	44	15	Brush, 2 coats, coal-tar creosote	--	--	--
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	--	--	--
Douglas fir	90	25	Round, unpeeled, undried	39	14	Sodium pentachloro-phenate, 3 holes; butt	--	--	--
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	--	--	--
Douglas fir	93	25	Round, peeled, incised, dry	32	14	Soak, copper naphthenate-diesel oil (1% copper), B-144, T-48	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 4. (Continued)

Species	Series number	Number of posts	Description	Sapwood	Groundline perimeter	Preservative treatment*	Retention: In a cu ft wood, Butt	Retention: In a cu ft wood, Top	Retention: In a post
				Per cent	Inches		Lb	Lb	Lb
Maple, Oregon	83	25	Round, peeled, incised, dry	75	14	Soak, 5% pentachlorophenol-diesel oil, B-24, T-2	7.49	2.03	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	--	--	--
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

* B (butt) and T (top) are followed by treating time in hours.

Table 5. Service Records of Nonpressure-Treated Series Remaining in Test.

Species	Series number	Posts remaining	Age	Avg life, failed posts	Remarks
		Per cent	Years	Years	
Alder, red	105*	16	8	5	
Alder, red	108*	60	8	7	
Cottonwood, black	68	100	12	-	
Cottonwood, black	74*	41	12	9	Tops sound
Cottonwood, black	77*	20	12	6	Tops sound
Cottonwood, black	87	100	10	-	All sound
Douglas fir	24	33	31	26	Variable top decay
Douglas fir	25	52	31	24	Variable top decay
Douglas fir	54	100	21	-	Variable top decay
Douglas fir	59	100	18	-	Bark favors top decay
Douglas fir	62*	84	12	10	
Douglas fir	63*	44	12	8	
Douglas fir	64	100	12	-	Excellent condition
Douglas fir	65*	16	12	8	
Douglas fir	66*	72	12	10	
Douglas fir	67*	20	12	7	
Douglas fir	73*	24	12	9	
Douglas fir	75	100	12	-	Excellent condition
Douglas fir	79*	72	11	10	Tops sound
Douglas fir	80*	46	11	8	Tops sound
Douglas fir	81*	21	11	8	Tops sound
Douglas fir	88*	91	10	10	
Douglas fir	89*	28	12	7	
Douglas fir	90*	12	12	6	Tops severely decayed
Douglas fir	91*	68	11	8	Tops severely decayed
Douglas fir	92*	9	11	6	
Douglas fir	93*	96	10	10	
Douglas fir	94	100	10	-	Excellent condition
Douglas fir	95	100	10	-	Excellent condition
Douglas fir	101	92	8	6	
Maple, Oregon	83*	92	12	10	Tops badly split
Pine, lodgepole	50*	16	22	16	Variable top decay
Pine, lodgepole	85	100	10	-	Excellent condition
Pine, lodgepole	86	100	10	-	Excellent condition
Pine, lodgepole	99*	8	8	5	
Pine, lodgepole	104*	80	8	7	Some top decay
Pine, ponderosa	56*	12	21	18	Tops sound

* Indicates failure at last inspection.

Table 6. Average Service Life of Nonpressure-Treated Series in which all Posts have Failed.

Species	Series number	Life	Remarks
		Years	
Cedar, Port Orford	9	21	Some top decay
Cottonwood, black	27	22	Largely top failure
Cottonwood, black	78	5	
Douglas fir	2**	28	Badly decayed
Douglas fir	3**	28	Badly decayed
Douglas fir	4**	28	Variable top decay
Douglas fir	5**	26	Variable top decay
Douglas fir	6	21	Variable top decay
Douglas fir	8	12	
Douglas fir	12	7	
Douglas fir	18	18	Some top decay
Douglas fir	22	6	
Douglas fir	39	5	
Douglas fir	102*	6	

* Indicates failure at last inspection.

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

resulting from preservative treatments are shown in Table 9. An attempt has been made to evaluate these treatments and, when possible, recommendations have been made concerning their use.

Bore Hole (chemicals placed in holes drilled in undried, unpeeled posts). Combinations of salt and mercuric chloride with or without arsenous oxide have increased the service life of pine and Douglas fir posts. Effectiveness has increased with number of holes used. Tops of the posts are not protected adequately by this method. The chemicals used are very poisonous and should be handled with extreme care.

Brushing Treatment. Brushing posts with preservatives did little or nothing to increase the service life of posts in 4 series and was somewhat more effective in a fifth series. The posts were air-dried thoroughly and two coats were applied on a hot day.

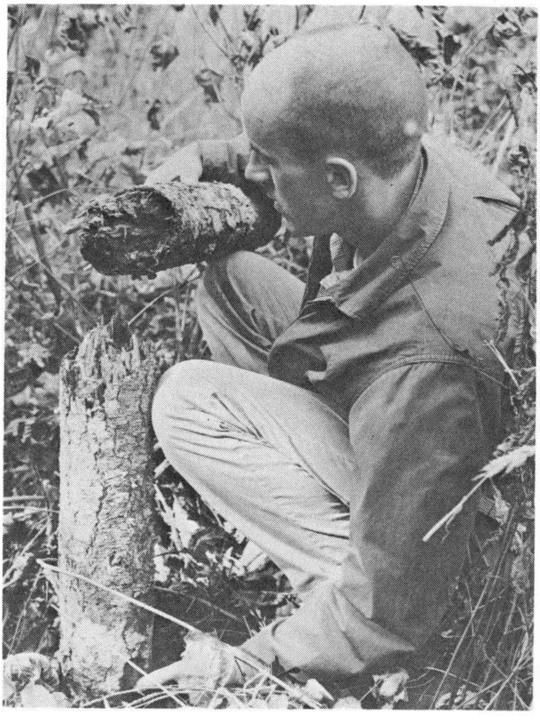


Figure 5. Tops of Douglas fir posts were not protected adequately when chemicals were placed in holes drilled near the ground line of undried, unpeeled posts.

Brushing is not recommended for posts regardless of the preservative applied, for penetration of preservative is low, and amount of preservative retained by posts is small, even under optimum conditions.

Charring. Charring is not a preservative treatment. If anything, it shortens the life of posts by reducing the size of the post in the critical ground-line area.

Double Diffusion. Treatments with copper sulfate and sodium chromate have not been effective; those with sodium fluoride and copper sulfate were not effective with alder but are increasing the life of Douglas fir posts. Zinc sulfate, arsenic acid, and sodium chromate treatment of lodgepole pine posts is proving

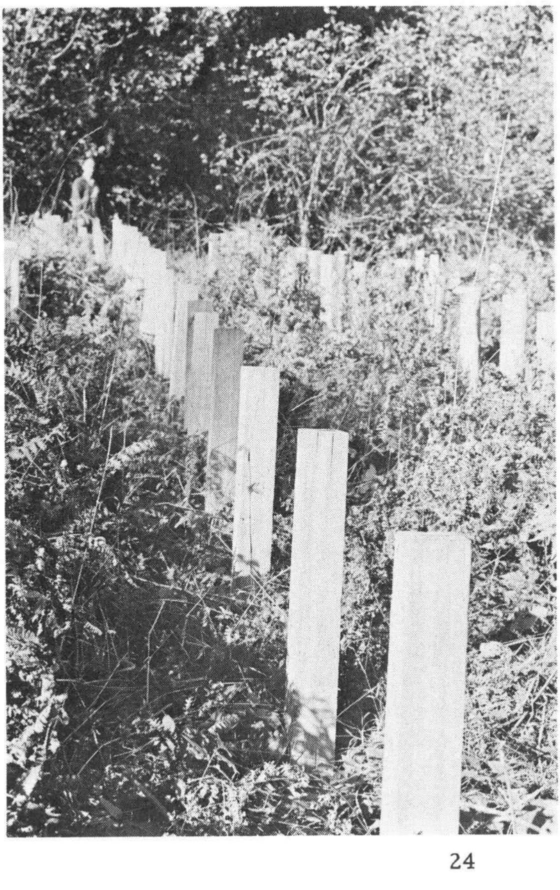


Figure 6. Posts of West Coast hemlock that were pressure-treated with Chemonite and Wolman salts had 96 per cent remaining in service after 23 years.

effective, but service records are not long enough to warrant its recommendation at this time.

Hot and Cold Bath. Hot-cold baths with various creosotes are effective treatments. However, full-length treatment of posts by this method is recommended to provide protection for tops of the posts.

Osmose Bandage and Salts. The ground-line-bandage treatment was not effective for cottonwood and was only of slight value to Douglas fir. It is not recommended for posts of nondurable heartwood species.

Osmosalts is proving effective for Douglas fir posts. This treatment for freshly cut and peeled posts is promising and merits further study.

Soaking. Soaking treatments with a copper naphthenate-petroleum solution containing 1 per cent copper, or with a 5 per cent solution of zinc chloride, have not proved effective. A 5 per cent solution of sodium pentachlorophenate has increased the service life of cottonwood posts, although not sufficiently to warrant its use.

Soaking air-seasoned posts with Gasco creosote and with a 5 per cent solution of pentachlorophenol is proving effective. Full-length treatments are desirable.

Tire Tube with Chemonite. This end-diffusion treatment for undried posts has increased the life of Douglas fir posts, although most tops contain moderate-to-severe decay. The method is slow; each post must be treated individually.

Treater Dust or Paste. Application of dust or paste containing a high percentage of arsenic trioxide to freshly cut, peeled, and unpeeled Douglas fir posts as they were installed, and then adding the chemical to the back-fill greatly increased their service life. These pastes and dusts no longer are available.

Treated posts: pressure processes

Characteristics and service records of posts treated by pressure processes are shown in Tables 7 and 8. Estimated increases in the service life of posts due to preservative treatment are given in Table 9. All but two series have been in service for 21 years. Boliden Salt-treated series 96 and 98 have been in service for only 8 years. Chromated zinc chloride and zinc-meta-arsenite (estimated increase in service life of 15 and 19 years, respectively) have been less effective than preservatives listed below, which are estimated to have increased the service life of the series indicated in parentheses by at least 25 years.

Figure 7. After 12 years in service, Oregon maple that was soaked in 5 per cent pentachlorophenol-diesel oil had 92 per cent of posts remaining. Many tops of these posts were split.

Table 7. Average Characteristics of Pressure-Treated Posts.

Species	Series number	Number of posts	Description	Sapwood	Ground-line perimeter	Preservative treatment
				Per cent	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 8. Service Records of Pressure-Treated Posts Remaining in Test.

Species	Series number	Posts remain-ing	Age	Avg life of failed posts	Remarks
		Per cent	Years	Years	
Douglas fir	7	100	32	--	Excellent condition
Douglas fir	23	100	31	--	Excellent condition
Douglas fir	33	24	28	22	Tops sound
Douglas fir	42	96	24	21	Excellent condition
Douglas fir	43*	20	24	17	Tops sound
Douglas fir	45*	84	23	21	Tops sound
Douglas fir	51	100	21	--	Excellent condition
Douglas fir	52	100	21	--	Excellent condition
Douglas fir	53	100	21	--	Excellent condition
Douglas fir	96	100	8	--	Deep checks
Douglas fir	98*	96	8	8	Tops sound
Hemlock, West Coast	41*	96	24	24	Tops sound
Hemlock, West Coast	44*	96	23	23	Tops sound

* Indicates failure at last inspection.

Table 9. Estimated Increase in Service Life of Douglas Fir Posts Attributed to Preservative Treatment.

Treatment	Series	Service life: Estimated* increase	Service life: Without failure to 1957**
		Years	Years
Bore hole			
Salt + $HgCL_2$	2, 91	22[+], 4	
Salt + $HgCL_2$ + As_2O_3	3, 4	22[+], 22[+]	
Sodium pentachlorophenate	90	3	
Sodium trichlorophenate	89	4	
Brushing			
Asphalt	39	0	
Carbolineum	92	1	
Copper naphthenate	80	5	
Creosote	81	4	
Pentachlorophenol	79	8	
Charring	22	0	
Double diffusion			
NaF — $CuSO_4$	101	7	
$CuSO_4$ — Na_2CrO_4	102	0	
Hot-cold bath			
Carbolineum	8	6	
Creosote-petroleum	18	12	
Gasco creosote	54	---	18
Osmose			
Bandage	73	5	
Salts	75	---	8
Soaking			
Pentachlorophenol	62, 64, 66, 94	12, ---, 8, ---	---, 12, ---, 10
Copper naphthenate	63, 65, 67, 93	6, 3, 4, 13	
Gasco creosote	88, 95	10, ---	---, 10
Zinc chloride	12	1	
Tire tube			
Chemonite	59		18
Treater dust or paste As_2O_3	5, 6, 24, 25	20[+], 15, 24, 29	
Pressure processes			
Boliden salts	96, 98	---, 9	8, ---
Chemonite	45	27	
Chromated zinc chloride	43	15	
Creosote	23, 53		31, 21
Creosote-petroleum	7, 51		32, 21
Gasco creosote	52		21
Tanalith	42	39	
Zinc-meta-arsenite	33	19	

*Estimated increase is based on actual or estimated average service life of a treated series minus average service life of untreated series of the same species. 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.

**No estimate could be made of service life of series in which no posts have failed.

[+]Removed before all posts failed.

Chemonite (Douglas fir, 45; West Coast hemlock, 44)

Coal-tar creosote (Douglas fir, 23 and 53)

Coal-tar creosote--petroleum mixture (Douglas fir, 7 and 51)

Gasco creosote (Douglas fir, 52)

Tanalith (Douglas fir, 42; West Coast hemlock, 41)

Pressure treatments have been consistently effective in greatly increasing the service life of posts of nondurable species.

METHODS OF APPLYING PRESERVATIVES TO TEST POSTS

Brush Treatment. Preservatives are applied to the wood surface with a brush. Brush treatment of fence posts is not recommended.

Bore Hole. A 3/4-inch hole slanting toward the butt is drilled to a depth of about 2 inches just above the ground line of an unpeeled, freshly cut pole. One tablespoonful of a dry mixture of equal proportions by weight of salt (sodium chloride) and corrosive sublimate (mercuric chloride), or one tablespoonful of dry mixture of equal proportions by weight of salt, corrosive sublimate, and arsenous oxide is placed in the hole. A snug-fitting wood plug then is driven into the hole. Holes should be spaced not more than five inches apart around the circumference of each post and staggered vertically to prevent weakening the post seriously. Corrosive sublimate and arsenous oxide are very poisonous chemicals. Handle with extreme care!

Charring. Charring the surface of wood is not a preservative treatment.

Double Diffusion. Undried, peeled posts are placed in a water solution of one chemical for 2 or 3 days and then transferred to a second water solution of a different chemical for 2 or 3 days. The chemicals diffuse into the wood, where they react to form a toxic compound difficutly soluble in water. Full-length treatment is desirable.

Hot and Cold Bath. In this treatment, often called the open-tank method, posts first are soaked in a hot preservative solution for a number of hours; then posts either are allowed to cool in the preservative or are transferred into a cool solution. Posts to be treated by this method should be peeled, thoroughly seasoned and treated full length.

Osmoplastic Bandage. A 9-inch strip of the bark of an undried post is removed at the ground line, and the peeled area is coated with a preservative mixture. A water-resistant covering is wrapped tightly around the coated area. The preservative mixture also is applied to post ends.

Osmosalts. Osmosalts in a thick slurry of water are applied to ends and to peeled surfaces of undried posts, which then are piled closely and covered for 3 weeks or longer to allow the preservative mixture to diffuse into the wood.

Pressure Treatments. Prior to treatment, posts are air-dried, artificially seasoned in the preservative by boiling under vacuum, or conditioned by steaming. Hot preservative is injected into the wood under pressure in a closed container, and a final vacuum usually is applied to remove excess preservative and dry the surface of the wood. The full length of the post receives treatment.

Salt Treatment. See Bore-Hole Method.

Soaking Treatment. Posts are placed in preservative solution to the desired depth and permitted to soak for a number of hours or days. Posts should be peeled and thoroughly seasoned. For many species, that portion of the post 6 inches above and 12 inches below ground line should be incised to a depth of 1/2 inch. This treatment has proved successful for some species and much less effective for others. It is primarily a sapwood treatment.

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

PRESERVATIVE MATERIALS USED FOR TEST POSTS

Virtually all preservatives are poisonous. Many may cause irritations when the chemical itself, its solutions, or its vapor contact 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, 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 per cent zinc chloride and 18 per cent sodium bichromate in a water solution.

Copper Naphthenate. The oil-soluble copper salt of naphthenic acid. Solutions containing 2 per cent copper by weight have been recommended for optimum performance.

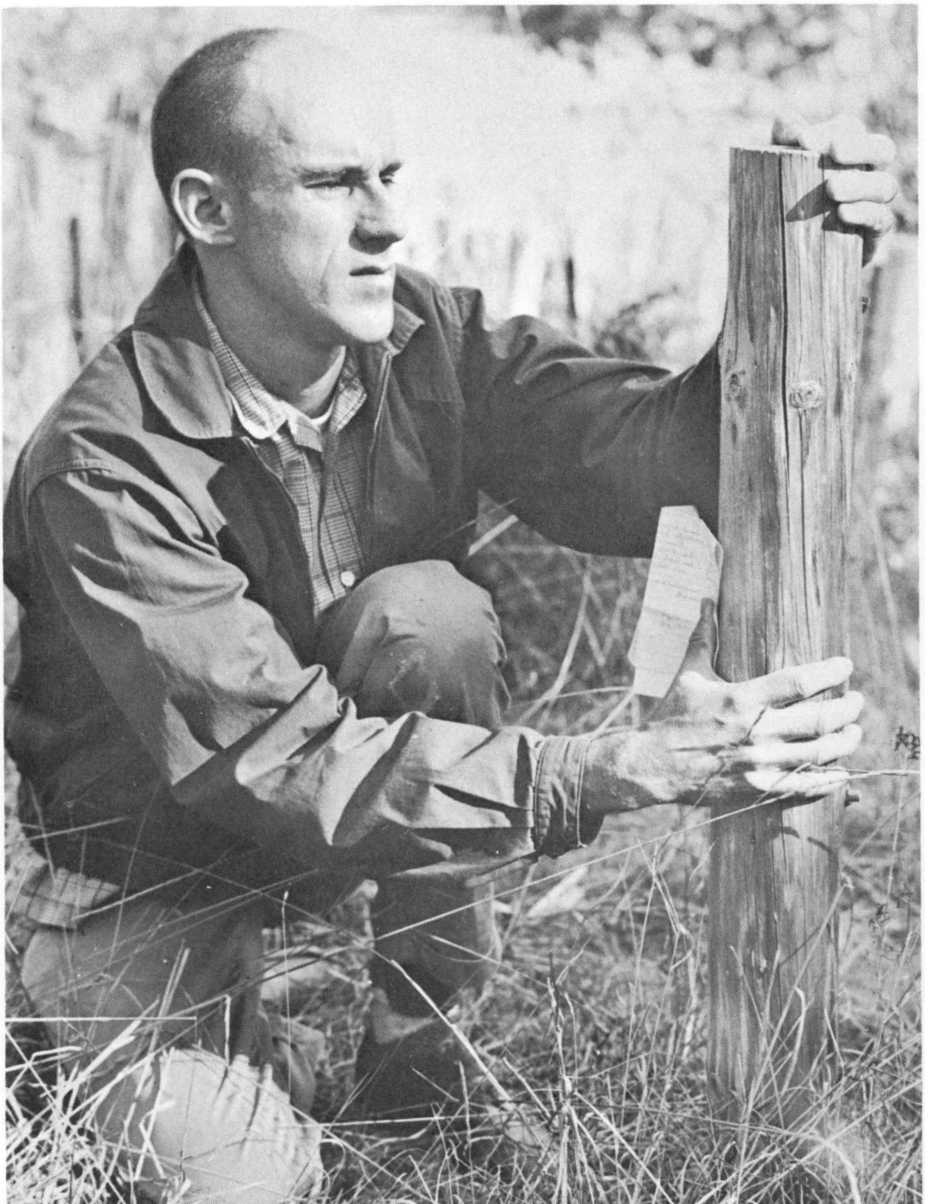


Figure 8. All posts of Douglas fir that were soaked in a solution of Osmosalts were in excellent condition after 12 years in service.

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.

Gasco Creosote. A distillate of tar residue resulting from cranking 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 per cent 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) is the toxic chemical, and the salt serves to hold moisture. Corrosive sublimate is an extremely poisonous chemical.

Salt, Corrosive Sublimate, and Arsenous Oxide. A mixture of equal porportions by weight of the three chemicals. Arsenous oxide is an additional water-soluble toxic agent. Addition of this chemical apparently contributes little, if anything, to effectiveness of the corrosive sublimate. Corrosive sublimate is an extremely poisonous chemical.

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

Sodium Trichlorophenate. The water-soluble sodium salt of trichlorophenol.

Tanalith. A proprietary wood preservative normally containing 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. The paste form was applied directly to wood; the dust and granular forms were placed around posts as earth was backfilled in setting posts. Manufacture of these preservatives has been discontinued.

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

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

424
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p.1

Service Life of Treated and Untreated Fence Posts

Supplement to Progress Report 12

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Forest Products Research
December 1962

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Failures of posts during 1961 and 1962 on the post farm started in 1927 by Professor T. J. Starker of the School of Forestry are summarized in Tables 1 and 2. Detailed Progress Reports are issued at intervals of 2-5 years.

Decay continued to be the most frequent cause of post failure:

Primary cause of failure	Number of failures 1950-1960	1961	1962
Fungi	665	22	26
Fungi and termites	123	8	5
Fungi and other insects	40	1	2
Termites	16	2	0
Other insects	1	0	0

Pressure-treated posts

Failures occurred in posts treated with Tanalith (42)*, chromated zinc chloride (43), and Chemonite (44,45). Average life of each of these series now is estimated to be 41,20,42, and 32 years, respectively. Estimated average life of each series treated with creosote solutions, Tanalith, and Chemonite exceeds 30 years. Series treated with zinc-meta-arsenite, and with chromated zinc chloride have estimated average lives of 25 years. Posts treated with Boliden salts have been in test 10 years; average lives of these series cannot be estimated yet.

Nonpressure-treated posts

Additional posts having bore holes near the butt zone treated with sodium trichlorophenate (89), and with a mixture of salt, mercuric chloride, and arsenious oxide (50), have failed. Posts having bore holes treated with a mixture containing mercuric chloride (2,3,4,50,91) usually had actual or estimated average service lives of 20 years or more--ranging from 16 to 28 years. Bored posts treated with sodium pentachlorophenate (90) and sodium trichlorophenate (89) have estimated average lives of 8 and 9 years.

*Numbers in parentheses refer to series of posts described in Progress Report 12.

Failures occurred in each of the remaining series of posts brushed with preservatives. Average life of posts brushed with pentachlorophenol solution (79) was estimated to be 14 years; average life of posts brushed with copper naphthenate solution (80), or coal tar creosote (81), was estimated to be 10 years. Remaining posts brushed with carbolineum (92) failed in 1962; average life was 7 years.

Four of 6 series of posts treated by double diffusion and installed 10 years ago remain in test. Remaining posts of series 105 failed during 1962; posts also failed in series 99, 104, 108. Posts of 3 species treated with copper sulfate-sodium chromate (99, 102, 105), have had actual or estimated average service life of 6 years. Average life of posts treated with sodium fluoride-copper sulfate (108), was estimated to be 9 years; average life of posts treated with zinc sulfate-arsenic acid-sodium chromate (104) was estimated to be 12 years.

Posts that were incised and soaked for various periods of time in pentachlorophenol, copper naphthenate, and creosote solutions (64, 68, 85, 87, 94) have not failed after 12-14 years. Some preservative-soaked posts (63, 66, 67, 74, 77, 88) failed during 1961-1962. Those soaked in sodium pentachlorophenate (74) and pentachlorophenol (66) solutions have estimated average lives of 11 and 15 years, respectively; others soaked in copper naphthenate (77, 67, 63) have average lives estimated to

Table 1. Service Records of Untreated and Pressure-Treated Posts Sustaining Failures During 1961-62.

Species	Series	Posts remaining: Number	Posts remaining: Age	Average life[1]: Failed posts	Average life[1]: Series
		Per cent	Years	Years	Years
Untreated					
Cedar, Alaska	46	8	25	18	19
Cedar, western red	10	0[2]	--	24	24
Hemlock, mountain	109	0[2]	--	3	3
Locust, black	40	32	28	20	24
Redwood	58	32	23	19	23
Yew, Pacific	13	13	34	23	24
Pressure-treated					
Douglas fir	42	92	26	23	41
Douglas fir	43	16	26	18	20
Douglas fir	45	80	25	21	32
Hemlock, western	44	92	25	24	42

[1]Average life of a series was estimated by the method described in *Percentage Renewal and Average Service Life of Railway Ties*, Report R 886, Forest Products Laboratory, U.S. Dept. of Agriculture, Madison, Wisconsin.

[2]Remaining posts failed during 1961.

be from 8 to 10 years. Average life of creosote-soaked posts (88) was estimated to be 17 years.

Posts treated at the butt with ACM Co. treater paste (24,25), continued to fail slowly after 31 and 32 years in test. Average life of each series was estimated to be 31 years; average life of failed posts was 26-27 years.

Untreated posts

Remaining posts of western red cedar (10), and mountain hemlock (109), failed. Average life of the western red cedar posts was 24 years; that of mountain hemlock posts was 3 years.

Failures also occurred in durable heartwood posts of Alaska cedar (46), black locust (40), redwood (58), and Pacific yew (13). Average life of the Alaska cedar was estimated to be 19 years; that of black locust, redwood, and Pacific yew was estimated to be 23-24 years.

Table 2. Service Records of Nonpressure-treated Posts Sustaining Failures During 1961-62.

Species	Series	Posts remaining		Average life[1]	
		Number	Age	Failed posts	Series
		Per cent	Years	Years	Years
Alder, red	105	0[2]	--	6	6
Alder, red	108	28	10	8	9
Cottonwood, black	74	27	14	10	11
Cottonwood, black	77	12	14	7	8
Douglas fir	24	25	33	27	31
Douglas fir	25	40	33	26	31
Douglas fir	63	40	14	9	10
Douglas fir	66	68	14	10	15
Douglas fir	67	12	14	8	9
Douglas fir	79	58	13	11	14
Douglas fir	80	25	13	9	10
Douglas fir	81	8	13	9	10
Douglas fir	88	83	12	11	17
Douglas fir	89	24	14	8	9
Douglas fir	92	0[2]	--	7	7
Pine, lodgepole	50	12	24	16	17
Pine, lodgepole	99	4	10	5	6
Pine, lodgepole	104	68	10	8	12

[1] Average life of a series was estimated by the method described in Percentage Renewal and Average Service Life of Railway Ties, Report R 886, Forest Products Laboratory, U.S. Dept. of Agriculture, Madison, Wisconsin.

[2] Remaining posts failed during 1962.