CALMScience 1(4): 509-514 (1995)

Assessment of Wickepin fence post trial after 62 years

G.K. BRENNAN[1], J.A. PITCHER[1], R. RULE[1] AND D.A. GREEP[2]

[1]Science and Information Division, Department of Conservation and Land Management, Wood Utilisation Research Centre, Harvey 6220, Western Australia.

[2]Formerly as above. Present address: Australian Furniture Research and Development Institute, Launceston 7250, Tasmania.

SUMMARY

The Wickepin fence post trial was one of three trials established in 1930 to assess timber preservatives for use in different hazard levels of fungal and insect attack in Western Australia, set up by the then Council for Scientific and Industrial Research (CSIR). The species assessed, in order of decreasing expected natural durability, were wandoo (*Eucalyptus wandoo* Blakely), jam (*Acacia acuminata* Benth.), brown mallet (*E. astringens* (Maiden) Maiden), jarrah (*E. marginata* Donn ex Sm.), marri (*E. calophylla* R. Br. ex Lindl.) and radiata pine (*Pinus radiata* D. Don.). Several preservative treatments were tested on the last four species, using hot and cold bath methods, but wandoo and jam were left untreated. Although the CSIR objectives were met by 1951, the Wickepin fence line was still functional, and the Department of Conservation and Land Management (CALM) carried out assessments in 1987 and 1992.

The 1992 assessment reported here gave the percentage of posts remaining in service, an estimation of the service life remaining, and the reasons for failure. The percentage of posts estimated in 1987 to fail by 1992, was compared with the actual failures assessed in the 1992 assessment.

The untreated wandoo and jam are performing extremely well, with 94 per cent and 67 per cent respectively remaining in service. Jarrah, marri and radiata pine treated with a mixture of zinc chloride and arsenic trioxide, jarrah and marri treated with a mixture of sodium fluoride and arsenic trioxide, and marri and radiata pine treated with a mixture of creosote and oil are performing well with generally more than 50 per cent of the posts remaining in service. Brown mallet posts treated with any of the preservatives had 30 per cent of posts remaining in service, which is still a good performance after 62 years.

INTRODUCTION

In 1930 the Council for Scientific and Industrial Research (CSIR), now CSIRO, in conjunction with the then Forests Department, established three preservative-treated fence post trials in Western Australia (Cummins 1932). Only the Wickepin fence line, located on a site then rated as having light decay and intermediate termite hazard, remains in service, with the treated posts used in a fence line. The other two trials were located near Pemberton and Southern Cross, on sites rated as having a severe decay hazard and severe termite hazard respectively, and are no longer operational after road clearing or vandalism. The major aim of these trials was to determine differences between the durability of treated and untreated fence posts of six locally-used species.

At the three sites, eleven different timber species were included principally as small round posts, with under bark butt diameters between 100 and 150 mm (Tamblyn 1954). Only two of the chemicals in this trial are still used today, e.g. creosote and crude oil, although their formulations have changed, and the trial provides long-term data on service life of fence posts treated with these chemicals. The continuation of assessments of wandoo and jam will provide long-term natural durability data, as untreated posts still remain in service.

The last CSIRO assessment of the Wickepin trial was by Mr N. Tamblyn in 1951, based on the extent of deterioration of each post, and indicated that treated posts were at that time out-performing untreated posts (Tamblyn 1954). The Department of Conservation and Land Management (CALM) has continued evaluation of this trial and made assessments in 1987 (Rule 1989) and 1992. This report gives the results of the September 1992 assessment of the Wickepin trial, in which the future life of the posts was estimated, and the factors contributing to post failure were assessed. Estimates made in the 1987 assessment of posts expected to fail by 1992 were compared with actual failures by September 1992.

METHODS

This preservative treatment trial is a fence line located about 8 km south-west of Wickepin, which is about

200 km south-east of Perth. With a mean annual rainfall of about 500 mm, the area was considered by CSIR to have a light hazard for fungal attack but an intermediate hazard for termite attack (Cummins 1932). By 1987 many nails had fallen out of the posts, making identification difficult, therefore it was necessary to re-tag many of the posts.

The Wickepin trial used posts cut from six species, detailed in Table 1, that were subsequently dried to a moisture content of below 30 per cent before treatment to aid preservative penetration, although some brown mallet posts were treated green.

TABLE 1

Species and total number of posts in the Wickepin fence post trial.

SPECIES	TOTAL No. POSTS INSTALLED IN 1930
Wandoo (*Eucalyptus wandoo* Blakely)	50[a](untreated)
Jam (*Acacia acuminata* Benth.)	9 (untreated)
Brown mallet (*E. astringens* (Maiden) Maiden)	175
Jarrah (*E. marginata* Donn ex Sm.)	150
Marri (*E. calophylla* R. Br. ex Lindl.)	150
Radiata pine (*Pinus radiata* D. Don.)	150

[a] This included 16 wandoo strainers and 34 ordinary posts, but the latter had disappeared by 1987 for reasons other than fungal or termite attack. Subsequent discussion is therefore based on the sixteen strainers.

Each species is located in different blocks along the fence line with the wandoo strainers strategically located to support the fence. Untreated jam posts were included to complete the fence.

Six different treatments were used. These include four open tank (hot and cold bath) treatments, one dry powder treatment and an untreated control. The bottom 760 mm of the debarked posts was treated with sapwood moisture contents below fibre saturation point (f.s.p.) of about 30 per cent. Drying the sapwood bands to below f.s.p. took between 8 and 17 months. The hot and cold bath process involved heating the posts in hot liquid preservative to force out any air in the posts, followed by cooling in preservative, when atmospheric pressure assists capillary forces in moving the liquid to replace the air driven out. Heating to just below 100°C in water, or to higher temperatures in oil or steam, was most effective.

The chemicals and treatment methods used were :

(1) *Creosote and crude oil.* Hot and cold bath treatment with two parts of Australian vertical retort creosote mixed with one part crude oil. The posts were placed butt down to a depth of 760 mm in the preservative which was then heated to about 99°C (range 93° - 103°C) and maintained at this temperature for a minimum of 1.5 hours, and up to 6 hours. Following heating they were allowed to cool in the mixture or were transferred to a cold bath of the same mixture to cool for 3 to 21 hours. There was a temperature drop of over 38°C.

(2) *Zinc chloride and arsenic trioxide* (syn. white arsenic). A 53.8 per cent zinc chloride solution was added to water containing arsenic trioxide, and boiled for 20 minutes to allow it to dissolve. Using the hot and cold bath method as in (1), posts were immersed in the final preservative solution of 3.5 per cent zinc chloride and 2.0 per cent arsenic trioxide.

(3) *Sodium fluoride and arsenic trioxide.* A mixture of 3.5 per cent sodium fluoride and 2.0 per cent arsenic trioxide was dissolved in soda ash and water to produce the preservative. Butt sections were immersed to 760 mm and treated by the hot and cold bath method described in (1). Brown mallet was treated using green posts as well as dry posts.

(4) *Arsenic trioxide.* 4.1 kg (9 lb) of arsenic trioxide were added to 200 L (44 gallons) of water to form a 2.0 per cent solution. The immersed butt sections were treated using the hot and cold bath method decribed in (1).

(5) *Solid arsenic.* Arsenic trioxide powder was applied as a collar around the posts at and below ground-line at the rate of 0.45 kg (1.0 lb) per post, with larger quantities (0.7 and 0.9 kg) used when the post's top diameter exceeded 100 mm and 150 mm respectively. The object of treatment was to form a preservative barrier around the posts and also to permit the arsenic to diffuse slowly into the wood.

(6) *Untreated.* This was the control.

Posts were installed to a depth of approximately 600 mm, in fence lines with wires passing through bored holes or held by staples. In some cases no wires were attached (Tamblyn and Bond 1948).

The 1992 assessment included an estimate of the future life of each post in categories of 0-4 years, 5-9 years and 10+ years. Each post was assessed by pushing the top of the upright post by hand, with the assessor maintaining a uniform loading. If the post was considered doubtful, it was inspected more closely after scraping soil away from the ground-line to a depth of 150 mm and examining the wood for the extent of fungal or insect attack, by probing with a pocket knife. Any damage to the exposed section of the post from weathering, fire or mechanical damage was recorded, as well as the reason for any post failure (i.e. decay, termites or fire) between the 1987 and 1992 assessments.

RESULTS AND DISCUSSION

The untreated wandoo and jam have lasted extremely well, considering that wandoo may be expected to last an average minimum 25 years and jam 15 to 25 years when used in ground contact (Thornton *et al.* 1983). Since the 1987 assessment no wandoo posts have failed, however, 25 per cent of jam posts failed (Table 2), indicating that wandoo has a higher natural durability than jam. As stated previously, only 16 wandoo strainers remain because 34 posts were missing.

The 1987 assessment indicated a ranking of preservative-treated species (from best to worst), as

TABLE 2

Condition of treated and untreated posts, and their estimated future performance, relating to the inspections carried out in 1987 and 1992.

		FROM THE 1987 INSPECTION		FROM THE 1992 INSPECTION		
Species	Preservative treatment	No. of posts remaining after this inspection	Estimated failure at Sept.1992 (%)	No. of posts remaining after this inspection	Actual failure at Sept. 1992 (%)	Estimated failure by 1997(%)
Wandoo	Untreated	15	7	15	0	7
Jam	Untreated	8	0	6	25	17
Brown mallet	Creosote + oil	11	81.8	7	36	43
	$ZnCl_2 + As_2O_3$	11	45.5	7	36	0
	$NaF + As_2O_3$ (treated dry)	17	41.2	9	47	67
	As above (treated green)	8	37.5	4	50	0
	As_2O_3 solution	16	62.5	8	50	50
	As_2O_3 powder	7	57.1	4	43	50
	Untreated	-	-	-	-	-
Jarrah	Creosote + oil	12	41.7	5	58	40
	$ZnCl_2 + As_2O_3$	18	5.56	16	11	19
	$NaF + As_2O_3$ (treated dry)	18	5.56	11	39	18
	As_2O_3 solution	15	13.3	11	27	27
	As_2O_3 powder	13	23.1	7	46	71
	Untreated	-	-	-	-	-
Marri	Creosote + oil	17	35.5	14	18	36
	$ZnCl_2 + As_2O_3$	23	13	19	17	5
	$NaF + As2O_3$ (treated dry)	23	8.7	16	30	31
	As_2O_3 solution	21	19	15	29	40
	As_2O_3 powder	15	13.3	12	20	25
	Untreated	-	-	-	-	-
Radiata pine	Creosote + oil	16	18.8	12	25	17
	$ZnCl_2 + As_2O_3$	17	5.88	16	6	31
	$NaF + As2O_3$ (treated dry)	6	66.7	4	33	75
	As_2O_3 solution	8	62.5	4	50	25
	As_2O_3 powder	13	15.4	11	15	45
	Untreated	-	-	-	-	-

Note: 1987 and 1992 estimates are based on the number of posts remaining at those inspections, not the original number installed in 1930.

follows: marri, jarrah, radiata pine and brown mallet. In comparison, the 1992 assessment has indicated the following order: marri, radiata pine, brown mallet and jarrah.

The latter assessment indicated little difference in performance between brown mallet and jarrah, considering that 58 per cent of creosote plus oil treated jarrah had failed since 1987. Marri and radiata pine are out-performing brown mallet and jarrah, presumably owing to a wider sapwood band giving better penetration and retention of preservative. In some treated posts, hollowing of the heartwood was found in the top of the posts, inside the annulus of treated sapwood.

Creosote and furnace oil plus an insecticide are currently used commercially in Australia to treat transmission poles and railway sleepers. Creosote is available to land owners who can treat their own fence posts on-site using a hot and cold bath or cold soaking methods. The other chemicals used in this trial are no longer available, having been replaced by copper-chrome-arsenic (CCA), which can be fixed into the timber cells using a vacuum/pressure treatment process. This trial has indicated the advantages of preservative treatment of fence posts and the long-term natural durability of wandoo and jam. The advantage of using creosote can be seen, particularly in species with wide sapwood bands.

Table 3 gives the causes of post failure up to and including the 1992 assessment. The Wickepin trial was considered to have a light decay and intermediate termite hazard (Cummins 1932). In 1992, more failures were caused by decay than termite attack, which differs from the 1987 assessment (Rule 1989). The posts assessed as having decay in 1987 presumably failed because the decay had subsequently spread through the moist timber around the ground-line, which could be considered unusual after 60 years of service. The combination of decay and termite attack resulted in a high proportion of failures. Generally, decaying wood attracts termites, which could access the untreated heartwood through splits in the treated sapwood band.

Cummins (1932) found five species of termites in the area, of which three were attacking the fence posts and two were in the vicinity. The species attacking the posts were:

Amitermes obeuntis (Silvestri) (formerly *Hamitermes obeuntis*);
Amitermes westraliensis (Hill) (formerly *Eutermes westraliensis*);
Coptotermes sp.

The two other species occurring in the vicinity were:

Occasitermes occasus (Silvestri) (formerly *Eutermes occasus*);
Heterotermes occiduus (Hill) (formerly *Heterotermes occidus*).

TABLE 3
Overall causes of post failure, including the 1992 assessment.

SPECIES	PRESERVATIVE TREATMENT	FAILURES BETWEEN 1987 AND 1992 (%)					
		Decay	Decay and Termites	Termites	Fire or accident	Missing	Other
Wandoo	Untreated	-	-	-	-	-	
Jam	Untreated	13	-	-	-	12	
Brown mallet	Creosote + oil	-	15	15	-	6	
	$Zn Cl_2 + As_2 O_3$	18	-	9	-	9	
	$Na F + As_2 O_3$ (treated dry)	16	10	5	-	16	
	As above (treated green)	37	-	13	-	-	
	$As_2 O_3$ solution	43	7	-	-	-	
	$As_2 O_3$ powder	-					
	Untreated *	-	-	-	-	-	
Jarrah	Creosote + oil	8	-	25	-	25	
	$Zn Cl_2 + As_2 O_3$	-	-	-	-	11	
	$Na F + As_2 O_3$ (treated dry)	28	-	-	-	11	
	$As_2 O_3$ solution	7	-	13	-	7	
	$As_2 O_3$ powder	31	-	8	-	7	
	Untreated*	-	-	-	-	-	
Marri	Creosote + oil	-	12	-	-	6	
	$Zn Cl_2 + As_2 O_3$	13	-	-	4	-	
	$Na F + As_2 O_3$ (treated dry)	26	-	-	-	-	4
	$As_2 O_3$ solution	23	-	-	-	-	6
	$As_2 O_3$ powder	13	-	-	-	7	
	Untreated *	-	46	33	-	-	
Radiata pine	Creosote + oil	-	-	13	20	12	
	$Zn Cl_2 + As_2 O_3$	-	-	-	6	-	
	$Na F + As_2 O_3$ (treated dry)	-	16	17	-	-	
	$As_2 O_3$ solution	-	20	30	-	-	
	$As_2 O_3$ powder	-	-	8	-	7	
	Untreated *	-	-	-	-	-	

Notes: (1) Reasons for failure between 1930 and 1992 were unable to be determined owing to different assessment methods by CSIRO and CALM.
(2) 26 per cent of failed posts were affected by weathering but are not recorded. These posts failed at ground-line owing to decay, termite attack or fire, and failure is recorded as being one of these causes. Other causes of failure were owing to weathering or mechanical failure.
Untreated post data (*) are from Tamblyn (1954)

In 1995 a CALM officer collected specimens from four occurrences adjacent to the residual fence line. *Amitermes conformis* Gay and *Heterotermes platycephalus* Froggatt were identified, but the other two samples could not be identified because no soldiers were sampled.

Ninety-four per cent of those wandoo strainers and 67 per cent of jam are still in service after 62 years (Table 4). Two thirds of the untreated wandoo and jam posts are expected to be remaining in service for at least another 10 years. Untreated posts of the other species had failed many years previously, long before Tamblyn's 1951 assessment (Tamblyn 1954).

The individual preservative treatments can be ranked in decreasing efficacy, using the data from Tables 1, 2 and 3:

zinc chloride and arsenic trioxide;
sodium fluoride and arsenic trioxide;
creosote and mineral oil (equal);
arsenic trioxide solution (equal);
solid arsenic.

This is the same ranking as in the 1987 assessment. Jarrah posts treated with creosote and oil, and radiata pine posts treated with sodium fluoride plus arsenic trioxide or arsenic trioxide solution are performing worse than the other treatments.

As might be expected, after 62 years in service the life of many posts is becoming limited, irrespective of preservative treatment. In the last five years, there has been a rapid decline in the number of posts capable of supporting a fence line, e.g. only 42 per cent of the 20 per cent of creosote and oil treated jarrah posts still in service in 1987 survived until 1992. A final assessment will be conducted in 1997 because the number of posts in service is declining, and as stated previously, many of the preservatives used in the trial are either no longer available or have different formulations.

Table 4
Percentage of posts in service since 1930 and 1987, and estimated life following the 1992 assessment.

SPECIES	PRESERVATIVE TREATMENT	IN SERVICE SINCE 1930 (%)	IN SERVICE SINCE 1987 (%)	ESTIMATED LIFE (YEARS) 0-4	5-9	10+
Wandoo	Untreated	94	100	7	27	66
Jam	Untreated	67	75	13	0	63
Brown mallet	Creosote + oil	28	64	27	36	0
	$ZnCl_2 + As_2O_3$	28	64	0	45	18
	$NaF + As_2O_3$ (treated dry)	36	53	35	6	12
	As above (treated green)	16	50	0	50	0
	As_2O_3 solution	32	50	25	25	0
	As_2O_3 powder	16	57	29	14	14
	Untreated	0	0	-	-	-
Jarrah	Creosote + oil	20	42	17	8	17
	$ZnCl_2 + As_2O_3$	64	89	17	44	28
	$NaF + As_2O_3$ (treated dry)	44	61	11	17	33
	As_2O_3 solution	44	79	21	36	21
	As_2O_3 powder	28	54	38	8	8
	Untreated *	0	0	-	-	-
Marri	Creosote + oil	56	82	29	18	35
	$ZnCl_2 + As_2O_3$	76	83	4	30	48
	$NaF + As_2O_3$ (treated dry)	64	70	22	13	35
	As_2O_3 solution	60	71	29	29	14
	As_2O_3 powder	48	80	20	27	33
	Untreated	0	0	-	-	-
Radiata pine	Creosote + oil	48	75	13	19	44
	$ZnCl_2 + As_2O_3$	64	94	29	47	18
	$NaF + As_2O_3$ (treated dry)	16	67	50	0	17
	As_2O_3 solution	16	50	13	25	13
	As_2O_3 powder	44	85	38	31	15
	Untreated	0	0	-	-	-

REFERENCES

Cummins, J.E. (1932). Preservative treatment of fence posts in Western Australia. Progress Report No.2: First Inspection Report. CSIR Division of Forest Products. Project P4-1. Limited distribution.

Rule, R. (1989). The Wickepin fence post trial after 57 years of service. Department of Conservation and Land Management, WURC Report No. 11.

Tamblyn, N. (1954). Preservative treatment of fence posts in Western Australia: Eighth inspection - November 1951. CSIRO Division of Forest Products. Sub-project P4-1, Progress Report No.9. Limited distribution.

Tamblyn, N. and Bond, R.W. (1948). Preservative treatment of fence posts in Western Australia. Seventh inspection - March 1948. CSIR Division of Forest Products. Sub-project P4-1, Progress report No. 8. Limited distribution.

Thornton, J.D., Walters, N.E.M. and Saunders, I.W. (1983). An in-ground natural durability field test of Australian timbers and exotic reference species. I. Progress report after more than 10 years' exposure. *Material und Organismen* **18**, 27-49.