CREOSOTE TREATMENTS FOR REGROWTH EUCALYPT AND PINE FENCE POSTS

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SUMMARY

The preservative treatment of round fence posts from different regrowth eucalypts was assessed using the following species :

jarrah (*Eucalyptus marginata* Donn ex Sm.)
marri (*E. calophylla* R. Br. ex Lindl.)
W.A. blackbutt (*E. patens* Benth.)
Tasmanian bluegum (*E. globulus* Labill. subsp. *globulus*)
radiata pine (*Pinus radiata* D. Don).

High temperature creosote and 'Cleansote' (emulsified creosote) were assessed, using hot and cold bath, cold soak or sap displacement methods. The efficacy of treating green and dry posts was assessed for the first two methods and the advantages and disadvantages of each treatment are discussed.

INTRODUCTION

Many landowners could utilise small diameter trees on their properties as fence posts but the sapwood of such posts might be destroyed in a few years by decay and insects. This problem can be overcome in most timbers by using preservatives to impregnate the sapwood, creating a protective envelope around the impermeable heartwood and giving most timbers a far greater durability. In many cases service life can be extended to 30 years or more. Provided the sapwood band is at least 12 mm thick, most hardwood timber species are suitable for preservative treatment (Anon. 1980).

Strength and durability are the two major properties of timber. Sapwood and heartwood have similar strength capabilities but differ in durability with in-ground use. Sapwood is far more susceptible to fungal and insect attack than heartwood, owing mainly to its higher starch content and lack of extractives. Heartwood contains extractives which are toxic to fungi and insects, and its vessels are blocked by tyloses which impede fungal growth. This increases durability but makes the heartwood impenetrable to chemical preservatives. The sapwood vessels are not blocked and therefore can be penetrated by preservatives.

When using young regrowth trees for fencing rounds, irrespective of heartwood durability, it is essential to utilise the sapwood because it can provide more than half the strength of posts (Tamblyn 1978). Brennan(1988) estimated that the sapwood of

regrowth jarrah in posts of 150 mm small end diameter under bark contributed about 60 per cent of the strength.

Past cutting of the jarrah-marri forest has resulted in regeneration of even-aged regrowth stands which are well stocked with saplings and poles. Regrowth stands are often in a state of stagnation, experiencing decline in vigour and diameter growth (Podger 1959; Abbott and Loneragan 1983). This change in resource means more small regrowth trees are available for utilisation and the number of mature trees is declining. Future fencing material will come from small diameter regrowth trees, rather than from split posts from mature trees. Thinning these regrowth stands for fence posts will help to stimulate growth on retained trees.

Structural tests on round wooden posts, split wooden posts, steel posts and concrete posts showed that round posts were twice as strong as split posts (their nearest rival) when loads were applied at the same height above ground (Johnstone 1966). Small round posts given proper treatment will be as strong as and last as long as split posts, irrespective of the timber used (CSIRO 1961).

Creosote has been successfully used for many years throughout the world, and was used in this trial because of its low cost, availability and past performance. It is generally considered that creosote sets the standard of performance and reliability for a general purpose wood preservative for outdoor construction timbers such as sleepers, posts, poles and marine piling (Tamblyn 1967). Copper-chrome-arsenic (C.C.A.) is available only to commercial treatment plants, which must adhere to waste disposal and chemical storage restrictions imposed by the relevant authorities, making approval an involved process. Consequently it was not considered for use in this trial.

The treatment methods (hot and cold bath, and cold soaking) used to treat dry posts were reported previously by the CSIRO Division of Forest Products (CSIRO 1955; 1961). Field trials were established by the CSIRO in the 1930s at Pemberton, Southern Cross and Wickepin using locally grown timber species. Only the Wickepin trial remains and the treated posts are over 60 years old (Rule 1989). Information on the durability of local regrowth timbers treated with a preservative is an ongoing requirement.

In addition small scale trials were carried out using creosote to treat green posts using hot and cold bath (Barnacle 1978) , cold soaking, and sap replacement. Treating green posts is normally recommended with a water borne preservative using the sap replacement method (CSIRO 1961). If successful these methods would have the advantages of utilising fencing rounds immediately after felling and reducing drying degrade. Hot and cold bath treatment for green and dry posts consists of heating the posts in preservative oil and then allowing them to cool in it, and the posts are then drained to remove the excess preservative. Cold soaking green and dry posts consists simply of soaking the posts in cold preservative for several days and then draining them. Sap replacement involves standing the butt end of a freshly felled and barked round post vertically in a bath of preservative, and as the sap evaporates from the top, the preservative is drawn up through the sapwood.

The aim of the present trial was to assess preservation of fence posts using creosote products, as well as treatment methods, with the required efficiency, safety, permanency and economy, which would be useful to farmers. The species used were regrowth jarrah, marri and W.A. blackbutt, radiata pine and Tasmanian blue gum.

MATERIALS AND METHODS

Hot and Cold Bath for Dry Posts

Forty-six eucalypt and 25 radiata pine posts were selected for treatment. The eucalypt posts (18 regrowth marri, 14 regrowth jarrah and 14 regrowth W.A. blackbutt) were randomly chosen from within and adjacent to Harvey Weir and Tallanalla plantations in Harvey District, and were cut from trees aged between 10 and 20-years-old. The pine posts were selected from poor quality sites within Harvey Weir plantation, and were cut from trees aged between 10 and 25-years-old.

The trees were felled, and posts cut to longer than 1.8 m, debarked and stacked within 24 hours. The mid diameter under bark varied between 55 mm and 140 mm (Table 1). Stacking with each layer at right angles to adjacent layers allowed efficient drying to approximately fibre saturation point (f.s.p.), at 25-30 per cent moisture content. Half the posts were stacked in the open and covered with plastic (ends were left open to allow air movement), and the remainder were stacked in an open ended shed (Plate 1).

Immediately prior to treatment, the posts were docked to 1.8 m to remove any end splits, allow fresh ends to be exposed, and standardise the lengths. The following parameters were then measured or estimated; mid-diameter under bark, mid heartwood diameter (by taking an average of the visually assessed heartwood diameters on each end), and moisture content (using a 'Bollman' moisture meter). Posts were numbered on the crown end with a pole hammer. The differences between the mid and average heartwood diameter (estimated from the post ends) were used to calculate sapwood volumes. Sapwood volume and length immersed in preservative were used to estimate the volume of preservative taken up by each post.

High temperature creosote complying with Australian Standard AS1143 (Standards Association of Australia 1973) was purchased from Kopper's Picton treatment plant. The recommended preservative loading required for adequate butt treatment (760 mm) is 160 kg/m^3 of sapwood, and for the remaining sapwood a lighter treatment of 48 to 64 kg/m^3(CSIRO 1961). An adequate and even absorption of preservative in each section of the post is essential, but nearly twice the volume of creosote is required for a uniform full length treatment on a 1.8 m post. Creosote has a density of 1.095 kg/l at 20^{o}C (Wallbank personal communication), which gives a liquid requirement for adequate treatment of 146 l/m^3 and 44-58 l/m^3 of sapwood for the butt and crown ends

Mr P. Wallbank. Koppers. Aust Pty Ltd. Now at Launceston, Tasmania.

respectively. When handling creosote, the following safety procedures and equipment must be used. Enclosed safety goggles for eye protection, full length rubber gloves and overalls for skin protection must be worn. Barrier cream for facial protection is recommended when using creosote for long periods. Treatment in the open or in an open ended shed will reduce exposure to vapours.

A standard 205 litre oil drum extended in length by 300 mm was used as the treatment vessel (Plate 2). The extension enabled a greater length of the post to be treated and allowed for any expansion in the creosote when heated. The creosote was heated with a 2.4 kilowatt, 9.5 amp electric oil element which was linked to a thermostat with a temperature range of 50°C to 80°C and powered from a standard 240 volt power outlet. The element was installed inside the base of the drum and protected by a removable metal covering which had holes through it and was itself covered by a heavy wire mesh. This allowed the creosote to circulate freely and exposed the end of the post, giving better access for the preservative to enter the sapwood vessels and fibres or tracheids. To improve the heating efficiency a double skinned insulation blanket was placed around the drum (Plate 2). Heating rates of the creosote were measured with and without the insulation blanket. The cost of running the unit was estimated using an in-line meter supplied by SECWA.

Before and after treatments the creosote level was measured from the top of the drum (at similar temperatures). Actual preservative uptake (per batch) can be estimated from the differences in these levels, allowing for any excess drained from the posts after treatment. A 205 litre oil drum cut lengthwise was used to catch any excess after each treatment.

Five batches of dry posts were treated using the hot and cold bath method. It is generally recommended that each species is treated separately to measure preservative uptakes accurately, but time constraints prevented this. The treatment batches used were: two batches of marri, jarrah and W.A. blackbutt, two batches of pine, and one batch of eucalypts and pine. The two batches using the mixed eucalypt species and the two using pine were butt treated to 760 mm (160 mm above groundline). The final level of treatment was measured and used to estimate the preservative retention per post. The number of posts in each batch varied from 8 to 20, depending on the size. The first batch of posts treated, which was prior to the insulation blanket being used, received 1.5 hours hot cycle of 75^{o} C (Table 1). Subsequently the creosote was heated to 80^{o} C, maintained at that temperature for between 2 to 3 hours, and allowed to cool overnight for a period of approximately 16 hours.

The batch using mixed eucalypt species and pine was placed crown first into the creosote while it was being heated to 80°C. When this temperature was reached, the posts were

reversed, and the butt ends remained in the hot creosote for 3 hours and were then cooled overnight. When crown-treating posts there is no set height for the creosote to reach, but to reduce weathering effects and possible insect damage, it is desirable to treat the untreated section in the centre of the post.

Photographs were taken of radial longitudinal and transverse sections from posts within each batch, in accordance with Australian Standard 1605-1974 (Standards Association of Australia 1974). The transverse sections were taken at the following intervals from the butt: 0.1 m, 0.3 m, 0.76 m, 1.2 m and 1.7 m. The 1.2 m and 1.7 m sections were not taken if the crown was not treated. The radial section taken was either full length, or between the 0.3 m and 0.76 m transverse sections if the crown end was not treated.

Hot and Cold Bath for Green Posts

Ten regrowth marri posts, one regrowth jarrah post and one Tasmanian blue gum post 1.9 m long and about 100 mm mid diameter, were selected in and adjacent to Tallanalla pine plantation in Harvey District. The age of the posts varied between 10 and 15-years-old.

Posts were totally debarked, and approximately 50 mm was docked from each end. The time between felling and immersion was less than six hours, as recommended by Barnacle (1978). Prior to immersion of the posts, the creosote was heated to 80°C. The butts were then immersed and left for 6 hours at that temperature, and then left overnight to cool in the creosote.

The equipment and method were the same as used for dry posts. Sapwood moisture contents were approximately 100 per cent. Photographs were taken of transverse and radial longitudinal sections from two marri posts and the jarrah and Tasmanian blue gum posts (as per the hot and cold bath for dry posts).

Cold Soaking for Dry Posts

Thirty-five regrowth eucalypt posts, consisting of 12 jarrah, 11 marri and 12 W.A. blackbutt were randomly selected from regrowth trees within and adjacent to Harvey Weir and Tallanalla plantations. Seven radiata pine posts were selected from poor quality stands within Harvey Weir plantation. Post size and age were similar to those of posts used for the hot and cold bath method for dry posts. The equipment and methods were the same as those used for the hot and cold bath method for dry posts.

Six batches of dry posts were treated using the cold soak method. Posts of the four species were treated separately, treating the butt end only. In addition a batch of 13 pine posts and a batch of 15 eucalypt posts (five jarrah, five marri and five W.A. blackbutt), which were butt treated by the hot and cold bath method were also crown-treated.

Posts were placed into the creosote at ambient temperature, and left for several days. Immersion times for butt treatments were: pine 4 days, jarrah 5 days, W.A. blackbutt 6

days, and marri 12 days. The times for crown treatments were pine 1 day and eucalypts 3 days. Sampling of the initial jarrah batch to assess butt treatment, indicated that extended treatment times were required for the other eucalypt batches to improve retentions.

Cold Soaking for Green Posts

Ten pine posts, one regrowth jarrah post and one regrowth marri post 1.9 m long and approximately 125 mm mid diameter under bark (m.d.u.b.) were selected within and adjacent to Harvey Weir pine plantation. The trees varied between 15 and 25-years-old. The equipment and methods used were the same as those used for the hot and cold bath treatment for green posts.

Post butts were immersed in the creosote at ambient temperature for 7 days, and crowns 3 days. Photographs were taken of radial longitudinal and transverse sections from one pine post and the marri and jarrah posts, as carried out for samples from the hot and cold bath method.

Sap-replacement for Green Posts

Two pine, four regrowth jarrah and four regrowth marri posts, 1.9 m in length and approximately 125 mm m.d.u.b. were selected within and adjacent to Harvey Weir Plantation. The age of the posts varied between 10 and 25-years-old. Because waterborne preservatives are normally recommended for this treatment method (CSIRO 1961), a small sample was considered sufficient to give a visual indication of the efficiency of this treatment method using the oil-borne creosote.

High temperature creosote and 'Cleansote' (emulsified creosote) were used as the preservatives. A 60 litre oil drum with its top removed was used as the treatment vessel, with a piece of wire mesh in the bottom to ensure that the ends of the posts were exposed to the preservative. The 'Cleansote' was agitated prior to treatment.

Two batches of posts were treated with this method. Initially two posts from each eucalypt species were immersed in HT creosote at ambient temperature for 9 days. The second batch using two posts from each eucalypt species and two pine posts were immersed in 'Cleansote' at ambient temperature for 9 days. On each occasion half of the posts from each species were totally debarked, and with the remainder only the immersed sections (300 mm) were debarked. Just prior to immersion approximately 50 mm was docked from the ends of each post. The time between felling and immersion was less than 6 hours. All posts were sliced transversely and radially and photographed, but preservative uptakes were not assessed.

RESULTS

Heating the Creosote

The electric oil element, when used in conjunction with the insulation blanket, heated the creosote to 80°C in three hours compared to five hours without the insulation blanket (Figure 1) The treatment vessel cost approximately $250 to construct, and when used with the insulation blanket consumed only 80 cents of power to complete the hot cycle of a hot and cold bath treatment on dry posts (Figure 1). This cost would be shared between the number of posts per treatment (e.g. 10 posts at 8 cents each).

Hot and Cold Bath for Dry Posts

Creosote uptakes varied using this method, as shown by the ratios of 0.65 to 1.19 for actual to required uptake (Table 1). The initial treatment batch of eucalypt posts was given only 1.5 hours for the hot cycle and showed the lowest uptake ratio of 0.65. This was confirmed by inspection of transverse sections taken from a post within this batch (Plate 4).

The two batches using only pine (2 and 5) had the highest uptake ratios. Comparing transverse sections taken from posts within these two batches with sections from pine from batch 3 showed that posts in batches 3 and 5 had a better groundline treatment than posts in batch 2 (Plates 5,6 and 7). Photographs of transverse sections taken from eucalypt posts (Batches 3 and 4) indicated that treatment was adequate, even though uptake ratios were lower than CSIRO requirements of 160 l/m^3 in the butt (CSIRO 1961), and lower than pine posts treated in batches 2 and 5 (Table 1) (Plates 8,9 and 10). The amount of sapwood contained by the posts was high in all batches (85 per cent to 96 per cent) and moisture contents in the pine posts (22 per cent) were lower than in the eucalypt posts (27 per cent).

Hot and Cold Bath for Green Posts

The uptake ratio (Table 2) was less than required for adequate treatment according to CSIRO (1961). Photographs of transverse sections from each species indicated that the creosote was reaching the desired level up the post, but was not in sufficient quantity to treat all of the sapwood (Plates 11,12 and 13). The marri post (Plate 11) indicated a better treatment than the jarrah and Tasmanian blue gum posts (Plates 12 and 13). The amount of sapwood contained by the posts was high (90.5 per cent).

Cold Soak for Dry Posts

The uptake ratios (Table 3) indicated that the pine posts were adequately treated at both butt and crown ends (Batches 1 and 3) and the eucalypt posts (Batches 2,4,5 and 6) at the crown end only (Batch 2). Photographs taken of transverse and radial sections confirmed these results for pine (Plates 14 and 5), and for eucalypt (Plates 15,16,17 and 10). Uptake

ratios for the butt treated eucalypt posts did increase, but not proportionally, with longer immersion times.

Table 3 also shows that pine posts can be treated much faster than eucalypt posts, that the amount of sapwood was high in all posts (73 per cent-88 per cent), and that generally moisture contents in the pine posts were lower than in the eucalypt posts.

Cold Soak for Green Posts

This method gave the highest uptake ratio for any of the butt treatments and the second highest for any of the crown treatments (Table 4), indicating that the posts were more than adequately treated. Inspection of photographs of radial longitudinal and transverse sections suggested a very high retention of creosote in all sections from the pine post, adequate retention in the jarrah post, and lower retention in the marri post, based on transverse sections taken from the 76 cm and 120 cm sample points (Plates 18,19,20 and 21). Table 4 also shows that the posts contained a high proportion of sapwood (68 per cent).

Sap-replacement

The results from this trial are based on photographs taken of radial longitudinal and transverse sections, which showed a negligible difference in the uptake of high temperature creosote between totally and butt section debarked eucalypt posts (Plates 22,23,24 and 25). In comparison, eucalypt posts showed higher retentions of 'Cleansote' if bark was totally removed (Plates 26,27,28 and 29). Pine posts behaved similarly to the creosote level, but above this level a greater length of post was treated at lower retention when bark remained intact (Plates 30 and 31).

DISCUSSION

Equipment

The electric treatment unit, when used in conjunction with the insulation blanket, provided a safe, effective and inexpensive method to heat creosote to 80^{o}C and treat dry regrowth fence posts. CSIRO (1961) had recommended heating the preservative to between 82 and 104^{o}C for effective treatment, which can be achieved with an electric baseplate heater. Following correct safety procedure is essential because creosote will burn the skin on contact (even at ambient temperature). Using a mask (although not essential) and treating in a well ventilated environment does reduce the strong odour of creosote, especially when heated. The odour of 'Cleansote' is not as strong as HT creosote, but when used in the sap-replacement method it must be agitated on a regular basis, otherwise a sludge will form. Trials by a Dardanup farmer (Mr B Humphries, of Feguson Road) using 'Cleansote' in the hot and cold method resulted in the emulsifiers being separated from the creosote and therefore a sludge forming in the hot cycle.

Consequently 'Cleansote' should not be used at temperatures above ambient, because sludging occurs even with agitation.

Hot and Cold Bath for Dry Posts

When the recommended procedure set out by the CSIRO (1961) was followed, this method proved to be an effective way to treat dry posts. Costs and operator time required are greater with this method, but treatment times are faster and both pine and eucalypts can be effectively treated.

The pine posts had higher uptakes of creosote than eucalypt posts (Table 1) but photographs of transverse sections showed both to be adequately treated (Plates 7 and 8). Pine posts given a 3 hour hot cycle (Batches 3 and 5) (Plates 6 and 7) gave a higher loading of creosote at groundline than pine posts given a 2 hour hot cycle (Batch 2) (Plate 5).

Inspection of transverse sections of posts treated in Batch 3 indicated that the crown treatment was adequate for eucalypt posts, but not pine posts (Plates 6 and 9). Great care must be exercised with this method, because the creosote is at 80°C when the posts are reversed, and extra space must be allowed when reversing from the crown to butt end because of the larger diameter of the latter.

Increasing the uptake of creosote in the eucalypt posts to the required retention (CSIRO 1961) may be achieved by increasing the length of hot cycle and lowering the moisture contents before treatment, but increased loading in crowns would increase costs. According to Dale (1967), most absorption occurs in the first 21° to 27°C fall in temperature i.e. absorption occurs in the cold cycle, and lowering moisture content would presumably have most effect on achieving the required retention. Drying the posts in a full summer period would decrease and even out moisture contents within and between posts (CSIRO 1961), but time constraints in this trial did not permit this. Pine does not have this problem because its cell structure allows faster and more even drying.

Improving efficiency and possibly retention could be achieved by using a separate drum containing cold creosote. Posts could be transferred to this drum after completion of the hot cycle, allowing the cold cycle to immediately commence and releasing the heating vessel for further hot cycles (CSIRO 1961). This would reduce time and heating costs.

Hot and Cold Bath for Green Posts

The eucalypt posts were not adequately treated by this method, but results were encouraging considering that only one batch of posts was treated. The retention was below the CSIRO requirements (Table 2), and photographs of radial and transverse sections showed that creosote was reaching the groundline area, but not in sufficient quantity to give a thorough treatment (Plates 11-13). To improve results, further trials using only one species per batch could assess the effects of increasing the temperature of the creosote (Barnacle 1978) and/or extending the heating cycle. To increase the

temperature of the creosote, a treatment vessel with 15 amp capabilities would be required because the 9.5 amp unit was working at its maximum power. A 15 amp unit would cost more to establish and run. A 2.4 kW, 240 V base hot plate was used in subsequent trials, heating HT creosote from ambient temperatures to 120°C in 3 to 4 hours.

If adequate treatments could be achieved using this method it has the advantage of producing a usable post green off the stump, reducing time and effort by eliminating handling, storage and monitoring procedures associated with drying posts. However, subsequent drying could result in checks and splits which expose untreated heartwood.

Cold Soak for Dry Posts

Cold soaking was more successful on pine posts than eucalypt posts. Pine posts could be treated faster than eucalypt posts (in one third of the time) and gave good results for butt and crown treatments (Table 3 and Plates 14 and 15). Eucalypt posts were adequately treated at the crown end only (Table 3 and Plates 8 and 10), probably because preservative retention in the crown is approximately one third of that required for the butt treatment. Because the uptake ratios for butt-treated eucalypt posts did increase with longer immersion times (Table 3), increasing the immersion time beyond that used in this trial could give the desired result (Tamblyn 1954). Reducing moisture contents (as per hot and cold bath dry posts) and treating posts when summer conditions prevail will also help improve results in the eucalypt posts.

The biggest advantage of this method over the hot and cold bath method is its simplicity, low costs and minimal time input by the user.

Cold Soak for Green Posts

This trial showed that green pine posts (and possibly eucalypt posts) can be successfully treated with cold creosote (Plates 18 and 21). The former CSIRO Division of Forest Products recommended treating green posts with waterborne preservatives using sap-replacement or sap-displacement only (CSIRO 1961), and limited research has been done using creosote to treat green posts.

The highest uptake of creosote for a butt treatment was achieved using this method (Table 4). Photographs of transverse and radial sections taken from sample posts suggested that the pine post had a higher retention of creosote than both the regrowth jarrah post and the regrowth marri post (Plates 18-21). The regrowth jarrah did show a better treatment than the regrowth marri post (76 cm and 120 cm sections, Plates 19-21), presumably owing to its narrower sapwood band which could have been partially dried. Treating these two regrowth eucalypt posts indicated that this method may also be

suitable as a treatment for green eucalypts. Further trials using one species per treatment batch would be required to thoroughly test this method's efficacy on regrowth eucalypt posts.

The uptake of creosote in the pine posts was well above requirements (Table 4), giving a longer service life but increasing preservative costs per post. To reduce this cost one of the following is suggested:- dilute the creosote with a less expensive oil (furnace oil or distillate, or furnace oil with a proprietary insecticide and/or fungicide) but not less than two parts of creosote to one part of oil (Tamblyn 1954), reduce the immersion time, leave bark on the post above the creosote level (as in the sap-replacement trial), or a combination of the above.

Sap-replacement

Because oil-based preservatives are not recommended for this method (CSIRO 1961), only small numbers of posts were treated in this trial. Photographs of radial and transverse sections (Plates 22-31) showed that none of the posts was adequately treated, but creosote was penetrating the sapwood of some posts in considerable concentration, especially below the creosote level (Plates 22-26,28 and 30). This was most evident in the pine post immersed in 'Cleansote' and the jarrah posts immersed in H.T. creosote (Plates 22, 24 and 30). From this observation the cold soak trial using green posts immersed in H.T. creosote was established. The pine posts used in this trial and the cold soak trial showed a negligible difference in uptake of both types of creosote when using them on totally debarked green pine posts (Plates 18 and 30).

Leaving bark on green posts above the creosote level was an attempt to increase the length of post treatment. This technique worked only on the pine post immersed in 'Cleansote', with the retention of creosote also being reduced (Plates 18 and 30). This may be a method of reducing the excessive retention of creosote in the green pine posts treated in the cold soak trial, while providing a crown treatment without reversing the post in the creosote. When this technique was used on regrowth eucalypt posts immersed in 'Cleansote', the length of post treated and retention of creosote were reduced (Plates 27-29). However, regrowth eucalypt posts immersed in H.T. creosote showed no differences in the length of pole effectively treated and creosote retention when partially or totally debarked (Plates 22-25).

CONCLUSION AND RECOMMENDATIONS

The area of sapwood contributes significantly to the sectional area of young regrowth trees (Tables 1-4). Irrespective of heartwood durability, the sapwood of regrowth posts must be treated if they are to give prolonged life in-service. It is important that this band of durable treated wood is available, because it can provide more than half the strength of the post (Tamblyn 1978). The method of treatment will depend on its suitability for the user.

When treating dry posts the two methods used had advantages and disadvantages that the user must consider before choosing a treatment method :

Hot and Cold Bath :	Advantages	-	suitable for all species
		-	quick treatment time
		-	relatively low costs
	Disadvantages	-	higher establishment and running costs
		-	more time input required
		-	greater care required (hot creosote)
		-	can use only H T creosote (P.E.C. has yet to be assessed)
Cold Soak :	Advantages	-	less time input required low costs
		-	suitable for butt and crown treatments on pine posts.
		-	low safety hazard (cold creosote)
		-	'Cleansote' and H.T. creosote suitable
	Disadvantages	-	only suitable to crown treat eucalypt posts
		-	longer immersion times required.

Because only small numbers of green regrowth posts were treated in this trial and the minimal research done elsewhere using creosote, the advantages and disadvantages of the different treatment methods cannot confidently be quantified. However, the advantages and disadvantages of treating regrowth posts green rather than dry can be seen.

Advantages	-	usable post produced within days of culling tree
	-	time, effort and shed space required to dry posts is eliminated.
Disadvantages	-	more procedure care required with treatment method
	-	high initial time input to refine treatment methods and improve user confidence
	-	subsequent drying can produce checks and splits, exposing untreated sapwood and heartwood.

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Figure 1

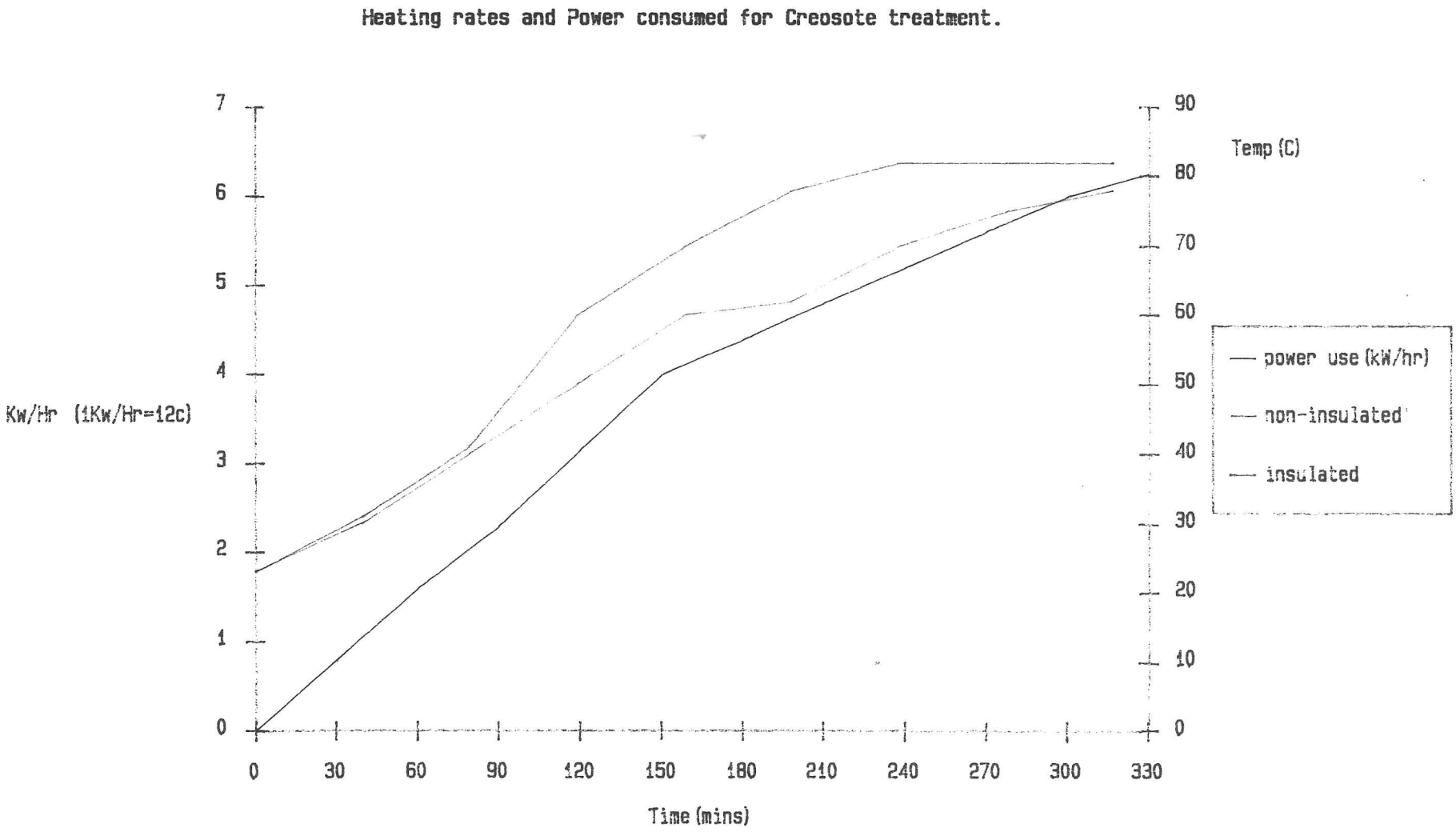
Heating rates and Power consumed for Creosote treatment.
Kw/Hr (1Kw/Hr=12c)
Temp (C)
Time (mins)
power use (kW/hr)
non-insulated
insulated
0
1
2
3
4
5
6
7
0
10
20
30
40
50
60
70
80
90
0
30
60
90
120
150
180
210
240
270
300
330

Table 1: Details of hot and cold bath treatment for dry posts

Species treated	Type of treatment (No)	Mid diameter (mm)			Moisture Content %			Sapwood vol immersed ($m^3 \times 10^{-3}$)			Preservative required (1)			Ratio of actual to required uptake	Time immersed for hot cycle
		Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range		
Marri Jarrah Blackbutt	Butt (1)	65	5.1	55-75	26.5	6.8	19-45	2.6 (96)	0.5 (7.3)	2-3 (71-100)	0.4	0.07	0.29-0.44	0.65	Temp never reached 80°C at 70°-75°C for 1.5 hrs
Radiata pine	Butt (2)	95	1.1	80-115	22.5	1.1	21-24	6.0 (89)	1.3 (6.7)	4-8 (78-96)	0.86	0.20	0.6 - 1.17	0.95	2 hours
Radiata Marri Jarrah	Butt and (3) Crown	90	19.6	65-125	26.7	7.1	20-45	9.3 (89)	2.1 (19.5)	2-9 (24-100)	0.98	0.32	0.29 - 1.31	0.86	3 hours butt crown immers in creosote until 80°C reached
Marri Jarrah Blackbutt	Butt (4)	82	9.8	70-100	28.1	3.1	22-32	4.1 (87)	1.5 13.1	2-6 (64-100)	0.60	0.21	0.29-0.92	0.90	3 hours
Radiata pine	Butt (5)	120	10.9	100-140	24.0	4.1	21-31	10.5 (85)	1.7 (5.9)	9-13 (75-95)	1.5	0.25	1.31-1.90	1.19	3 hours

Table 2: Experimental details of hot and cold bath for green posts

Species treated	Type of treatment (No)	Mid diameter (mm)			Sapwood vol immersed ($m^3 \times 10^{-3}$)			Percentage of Sapwood			Preservative required (1)			Ratio of actual to required uptake	Time immersed for hot cycle
		Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range		
Marri Jarrah Blackbutt	Butt	96	9.5	85-110	5.5	1l.2	4-7	90.5	7.2	75-100	0.80	0.17	0.58 - 1.02	0.77	6 hours

Table 3. Experimental details of cold soak treatment for dry posts

Species treated	Type of treatment (No)	Mid diameter (mm)			Moisture Content %			Sapwood vol immersed ($m^3 \times 10^{-3}$) (% of sapwood)			Preservative required (1)			Ratio of actual to required uptake	No of days soaked
		Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range		
Radiata pine	Crown (1)	103	14.6	80-125	23.8	3.1	21-31	5.6 (87)	1.6 (7.1)	3-7 (75-96)	0.286	0.08	0.153 - 0.408	1.8	1
Jarrah Blackbutt	Crown (2)	82	9.8	70-100	28.1	3.1	22-32	2.8 (87)	0.9 (13.1)	1-4 (64-100)	0.14	0.05	0.05 - 0.2	1.3	3
Radiata pine	Butt (3)	141	17.2	115-160	22.8	2.3	21-26	14.0 (84)	2.8 (5.2)	9-16 (78-93)	2.04	0.42	1.31 - 2.34	1.0	4
Jarrah	Butt (4)	93	11.9	75-100	26.6	4.0	21-35	3.9 (76)	1.1 (15.2)	2-6 (55-110)	0.57	0.16	0.29 - 0.87	0.5	5
Blackbutt	Butt (5)	103	15.0	80-140	26.2	3.4	21-29	5.7 (73)	1.7 (12-2)	2-8 (53-94)	0.83	0.25	0.29 - 1.16	0.7	6
Marri	Butt (6)	94	10.7	80-110	22.8	1.9	19-25	5.7 (88)	1.9 (12.3)	3-8 (61-100)	0.84	0.28	0.44 - 1.17	0.8	12

Table 4: Experimental details of cold soak treatment for green posts

Species treated	Type of treatment (No)	Mid diameter (mm)			Sapwood vol immersed ($m^3 \times 10^{-3}$)			Percentage of Sapwood			Preservative required (1)			Ratio of actual to required uptake	No of days soaked
		Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range	Mean	Std dev	Range		
Marri Jarrah Radiata pine	Butt	113	13.290	-130	6.7	1.7	4-9	68	11.8	36-89	1.0	0.25	0.58 - 1.31	2.5	7
Radiata pine Jarrah Marri	Crown	1134	13.290	-130	4.7	1.2	2-6	68	11.8	36-89	0.24	0.06	0.1 - 1.31	1.5	4

Plate 1

Fencing rounds being dried in an open-ended shed.

Plate 2

Treatment vessel with insulation blanket.

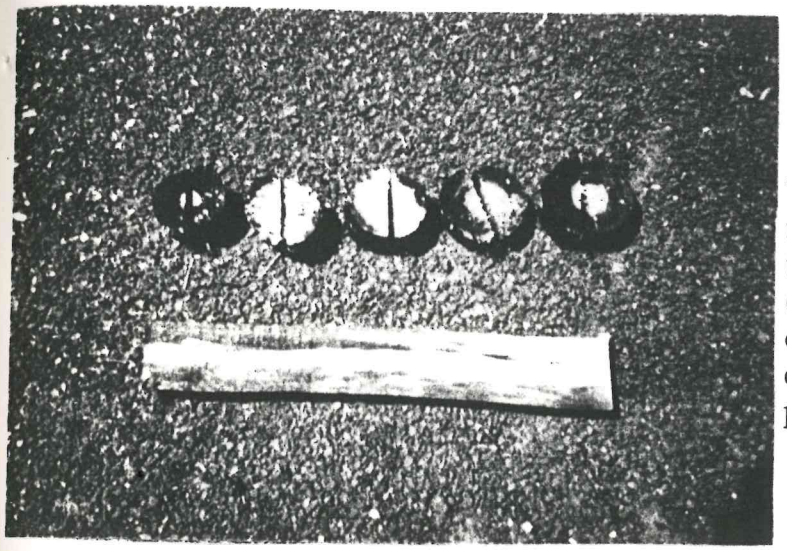

Plate 4

Transverse samples taken from a treated marri post. The post was dried, the butt treated using the hot and cold bath method (1.5 h hot cycle, cool overnight), and the crown treated by the cold soak method (1 day). Butt to crown is right to left on photograph. Note the patchy treatment.

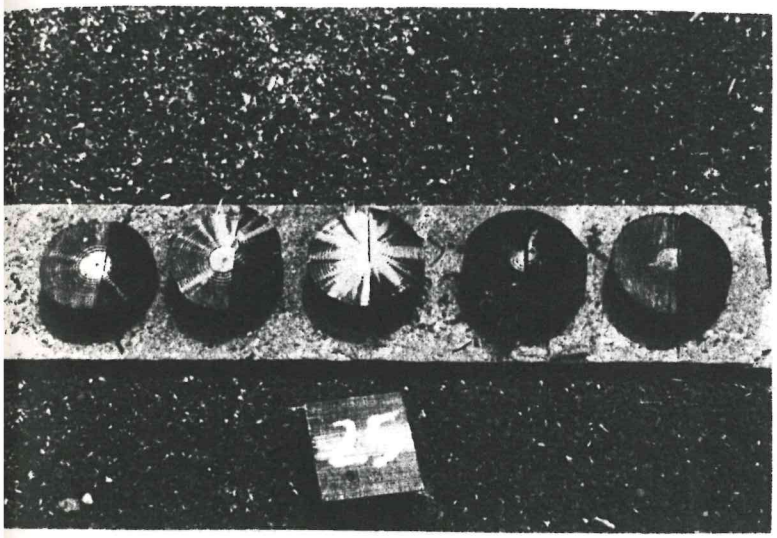

Plate 5

Transverse samples taken from a treated radiata pine post. The post was dried, the butt treated using the hot and cold bath method (2 h hot cycle, cool overnight), and the crown treated by the cold soak method (1 day). Butt to crown is right to left on photograph. Note the patchy treatment at the 760 mm sample point.

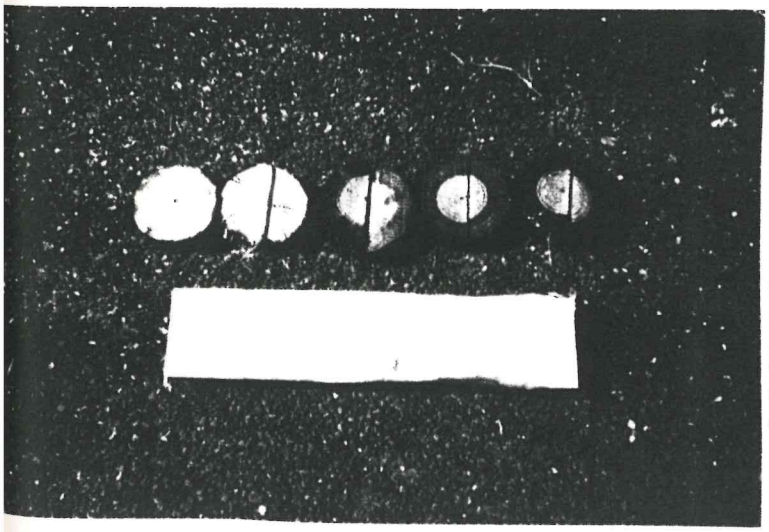

Plate 6

Transverse samples taken from a treated radiata pine post. The post was dried, the butt treated using the hot and cold bath method (3 h hot cycle, cool overnight), and the crown treated by immersion in the creosote while it was being heated for a butt treatment (2.5 h). Butt to crown is right to left on photograph. Note the poor crown treatment and improved treatment at the 760 mm transverse section.

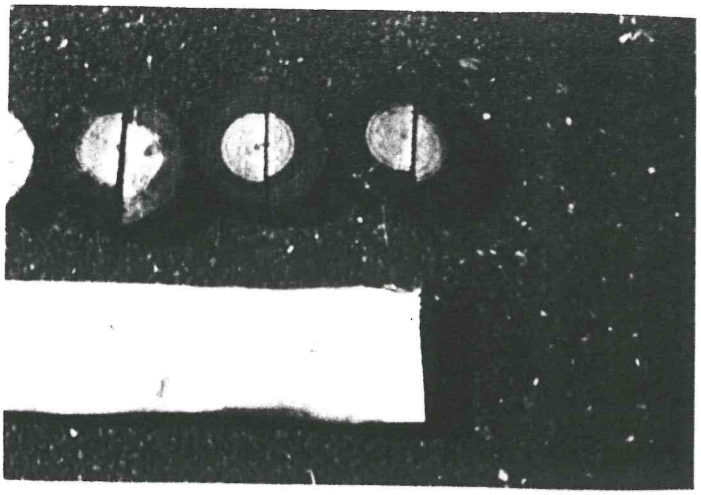

Plate 7

Transverse samples taken from a treated radiata pine post. The post was dried and the butt treated using the hot and cold bath method (3 h hot cycle, cool overnight). Butt to groundline is right to left on the photograph.

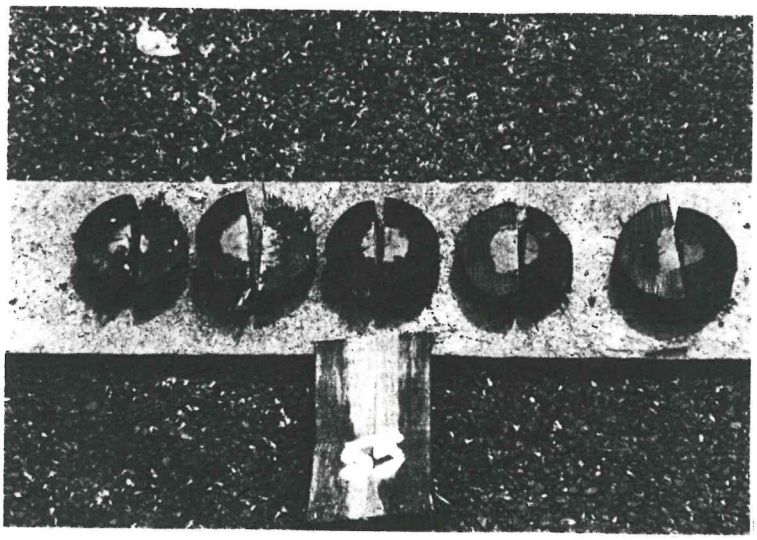

Plate 8

Transverse samples taken from a treated jarrah post. The post was dried, the butt treated using the hot and cold bath method (3 h hot cycle, cool overnight), and the crown treated by the cold soak method (3 days). Butt to crown is right to left on photograph.

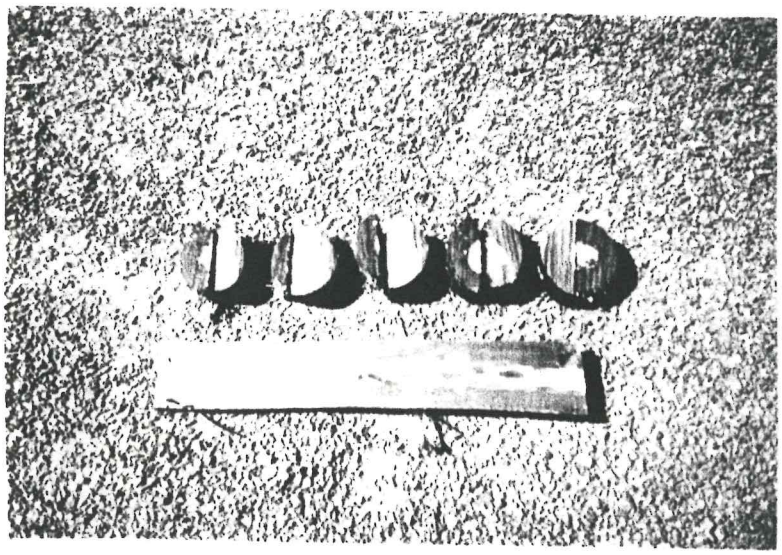

Plate 9

Transverse samples taken from a treated W.A. blackbutt post. The post was dried, the butt treated using the hot and cold bath method (3 h hot cycle, cool overnight), and the crown treated as in Plate 6. Butt to crown is right to left on photograph.

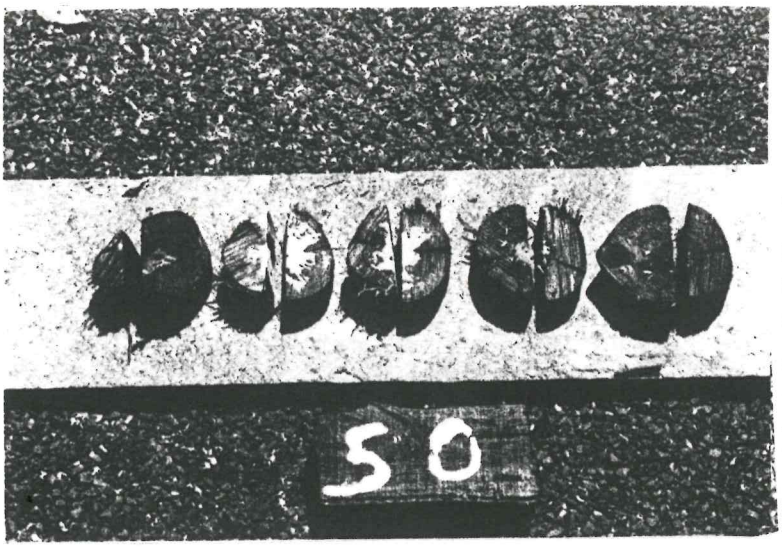

Plate 10

Transverse samples taken from a treated marri post. The post was dried, the butt treated using the hot and cold bath method (3 h hot cycle, cool overnight), and the crown treated by the cold soak method (3 days). Butt to crown is right to left on photograph.

Plate 11

Transverse samples taken of a treated marri post. The post was treated in its green state using the hot and cold bath method (6 h hot cycle, cool overnight). Butt to groundline is shown from right to left on the photograph. Note how the quality of treatment decreases between the 300 mm and 760 mm sample points.

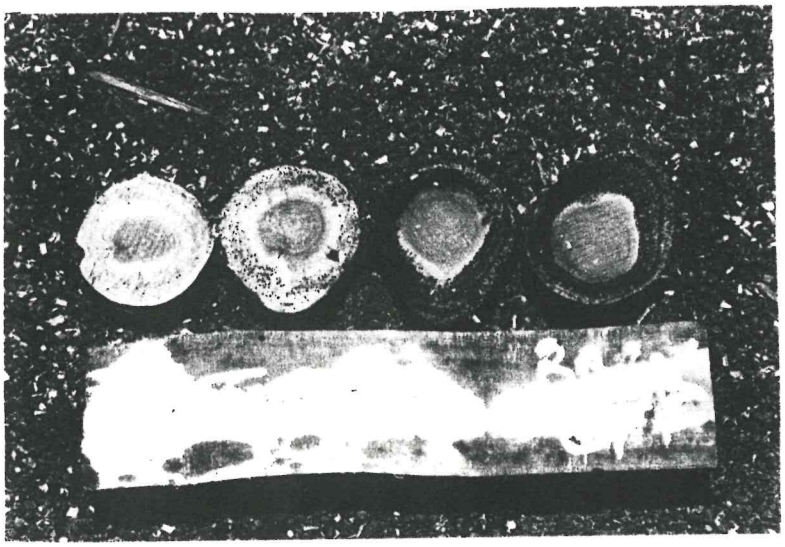

Plate 12

Transverse samples taken of a treated jarrah post. The post was treated in its green state using the hot and cold bath method (6 h hot cycle, cool overnight). Butt to crown is shown from right to left on the photograph. Note the poorer treatment compared to the marri post above.

Plate 13

Transverse samples taken of a treated Tasmanian bluegum post. The post was treated in its green state using the hot and cold bath method (6 h hot cycle, cool overnight). Butt to groundline is shown from right to left on the photograph. Note the poorer treatment compared with the marri post above.

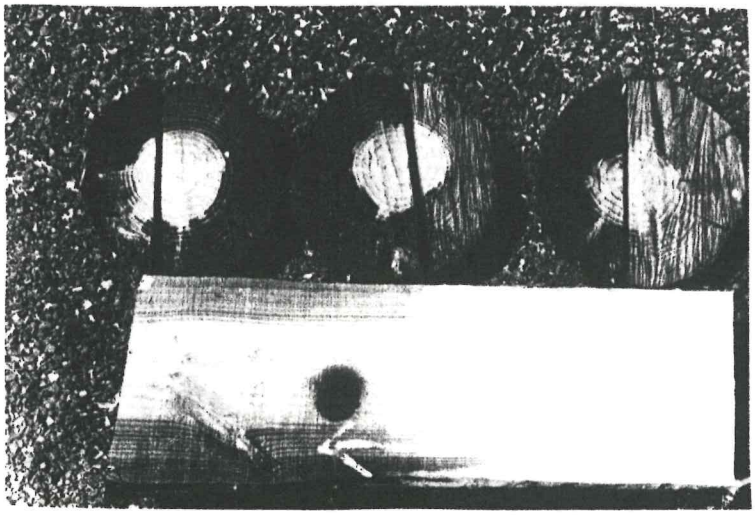

Plate 14

Transverse samples taken from a treated radiata pine post. The post was dried, and the butt treated using the cold soak method (4 days). Butt to groundline is shown right to left on the photograph. Note the good treatment at the 760 mm sample point.

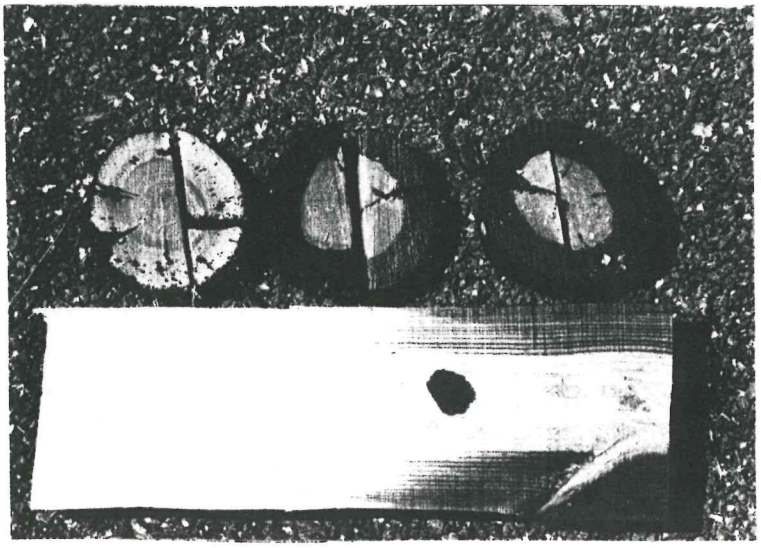

Plate 15

Transverse samples taken from a treated jarrah post. The post was dried, and the butt treated using the cold soak method (5 days). Butt to groundline is shown right to left on the photograph. Note the poor treatment at the 760 mm sample point.

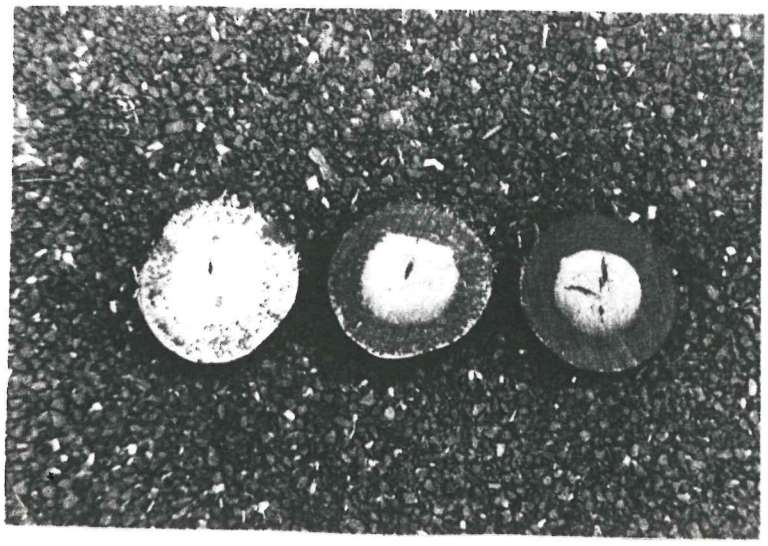

Plate 16

Transverse samples taken from a treated W.A. blackbutt post. The post was dried, and the butt treated using the cold soak method (6 days). Butt to groundline is shown right to left on the photograph. Note the poor treatment at the 760 mm sample point.

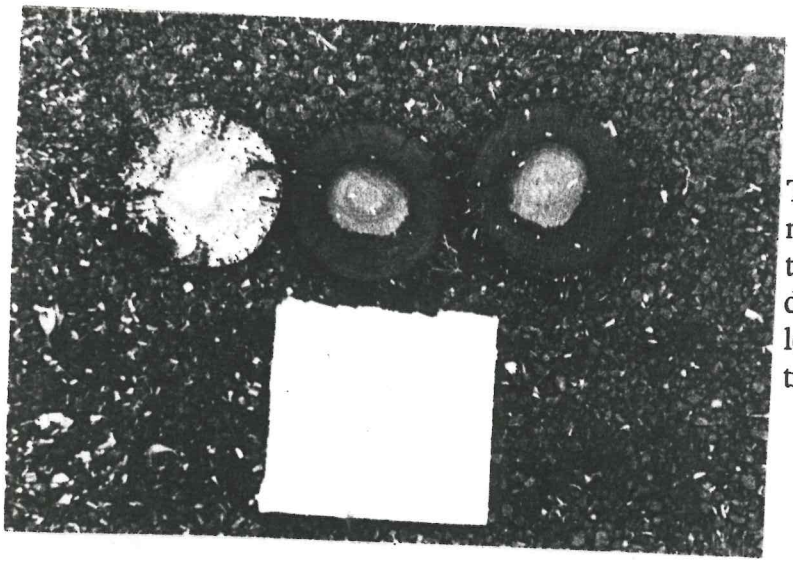

Plate 17

Transverse samples taken from a treated marri post. The post was dried, and the butt treated using the cold soak method (12 days). Butt to groundline is shown right to left on the photograph. Note the poor treatment at the 760 mm sample point.

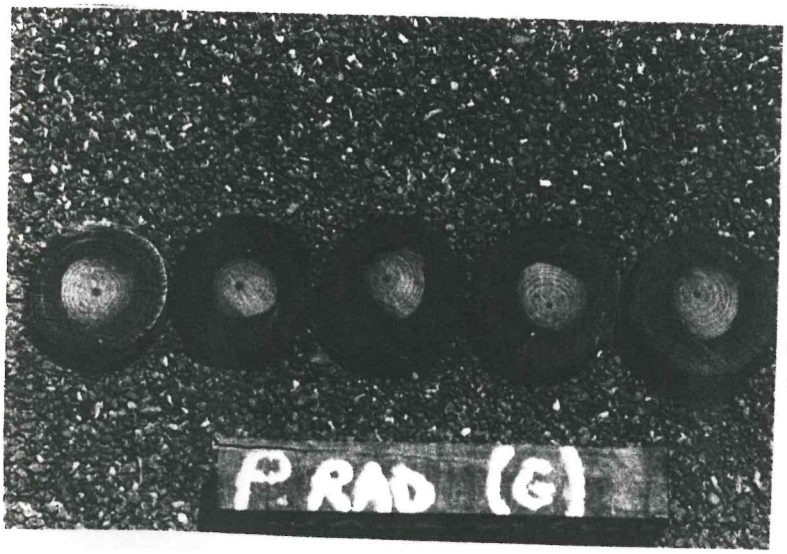

Plate 18

Transverse samples taken of a treated radiata pine post. The post was treated in its green state using the cold soak method. The butt was soaked for 6 days and the crown 3 days. Butt to crown is shown from right to left on the photograph. Note the dark collar of treatment, signifying a high retention of creosote.

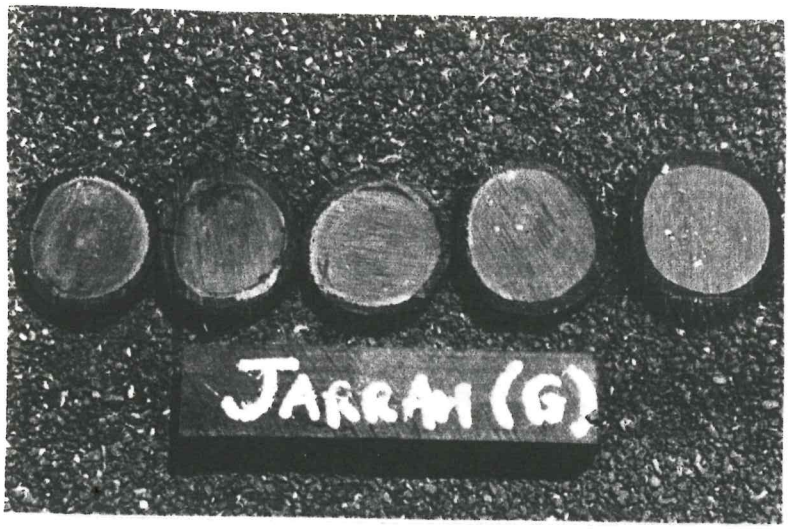

Plate 19

Transverse samples taken from a treated jarrah post. The post was treated in its green state using the cold soak method. The butt was soaked for 7 days and the crown 3 days. Butt to crown is shown from right to left on the photograph. Note the very narrow sap band.

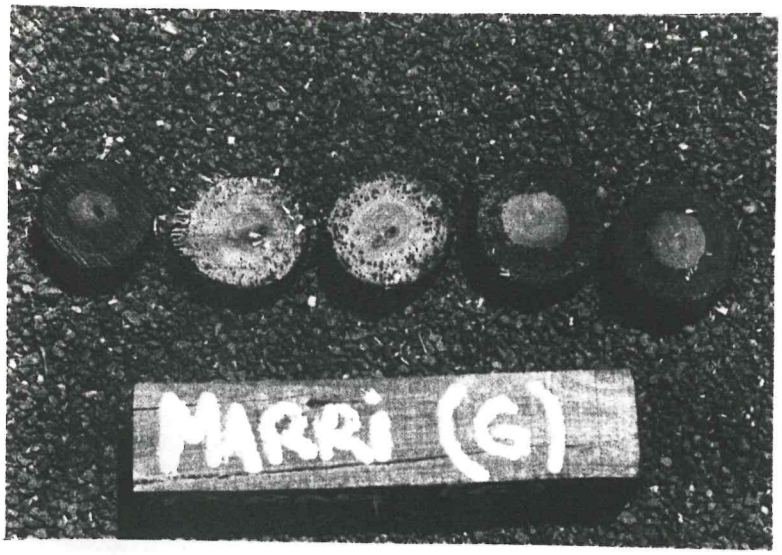

Plate 20

Transverse samples taken from a treated marri post. The post was treated in its green state using the cold soak method. The butt was soaked for 7 days and the crown 3 days. Butt to crown is shown from right to left on the photograph. Note the poorer treatment compared with the pine and jarrah post above.

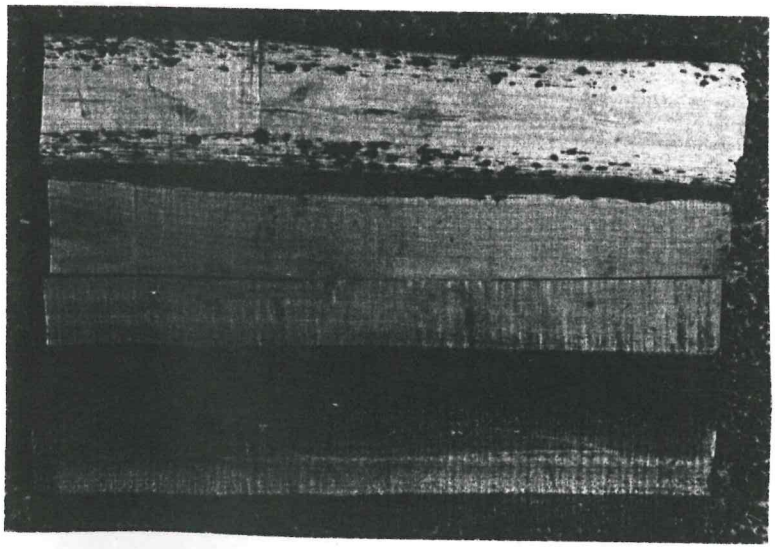

Plate 21

Radial longitudinal samples of the three treated posts above. The sample is between the 300 mm and 760 mm transverse sample points, right to left on the photograph. The order is pine, jarrah and marri, from top to bottom on the photograph.

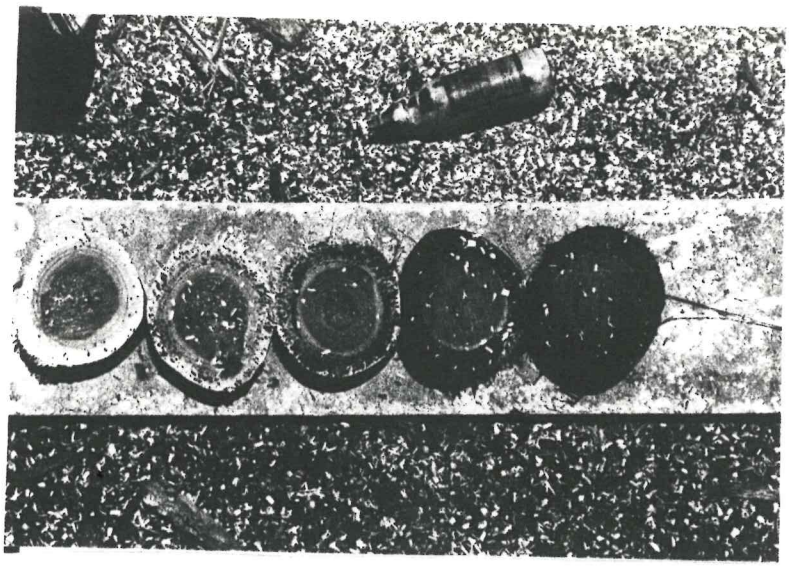

Plate 22

Transverse samples taken from a treated jarrah post. The post was treated in its green state (total bark removal) using the sap-replacement method (H.T Creosote). Butt to crown is shown from right to left on the photograph. Note the superior treatment compared with the marri post below.

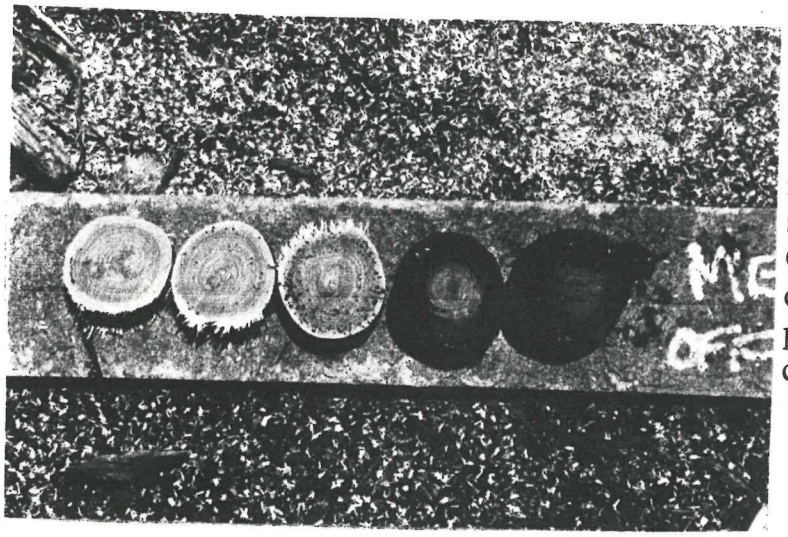

Plate 23

Transverse samples taken from a treated marri post. The post was treated in its green state (total bark removal) using the (H.T. Creosote) sap-replacement method. Butt to crown is shown from right to left on the photograph. Note the poorer treatment compared with the jarrah post above.

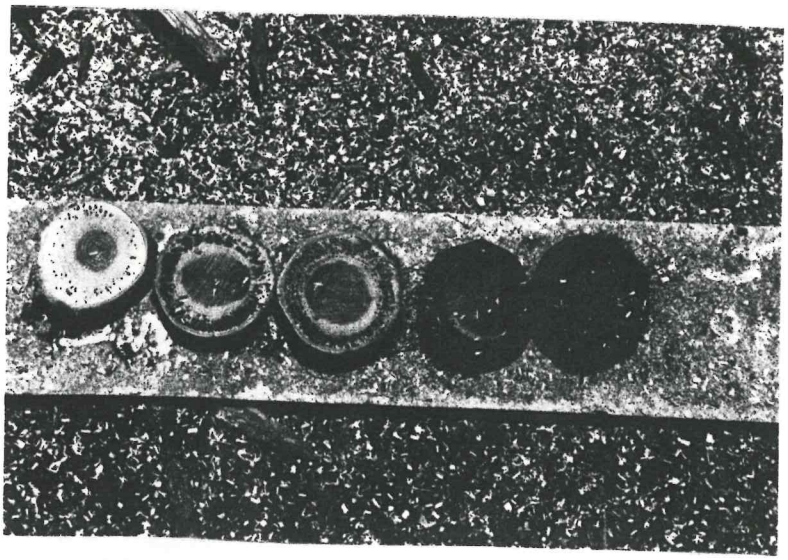

Plate 24

Transverse samples taken from a treated jarrah post. The post was treated in its green state (partial bark removal) using the sap-replacement method (H.T. Creosote). Butt to crown is shown right to left on the photograph. Note the superior treatment compared with the marri post below and that there was little difference between treatments of the two jarrah posts (TBR & PBR).

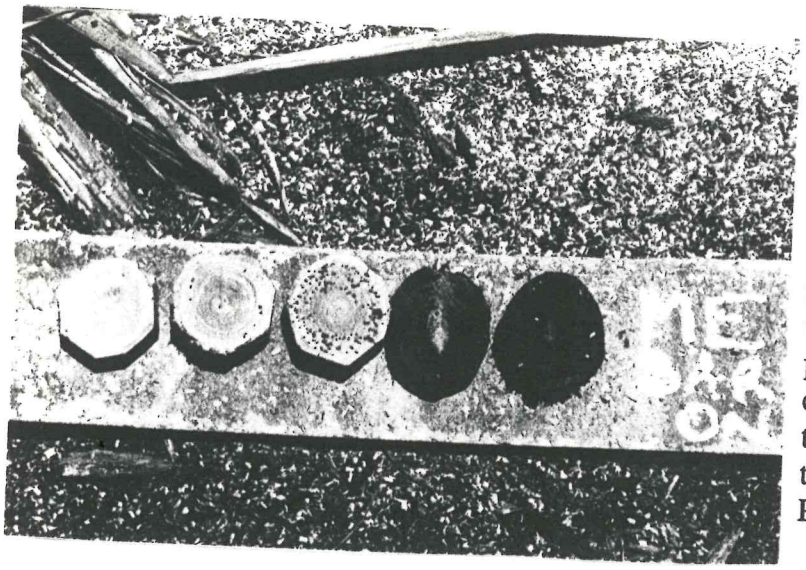

Plate 25

Transverse samples taken from a treated marri post. The post was treated in its green state (partial bark removal) using the sap-replacement method (H.T. Creosote). Butt to crown is shown from right to left on the photograph. Note the poorer treatment compared with the jarrah post above and that there was little difference between treatments on the two marri posts (TBR and PBR).

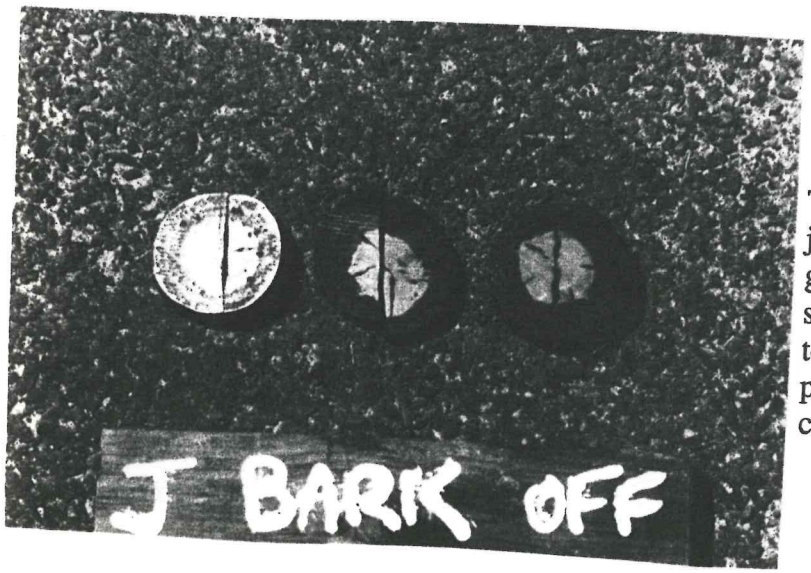

Plate 26

Transverse samples taken from a treated jarrah post. The post was treated in its green state (total bark removal) using the sap-replacement method ('Cleansote'). Butt to groundline is shown right to left on the photograph. Note the superior treatment compared with the jarrah post below (PBR).

Plate 27

Transverse samples taken from a treated jarrah post. The post was treated in its green state (partial bark removal) using the sap-replacement method ('Cleansote'). Butt to groundline is shown from right to left on the photograph. Note the poorer treatment compared with the jarrah post above (TBR).

Plate 28

Transverse samples taken from a treated marri post. The post was treated in its green state (total bark removal) using the sap-replacement method ('Cleansote'). Butt to groundline is shown from right to left on the photograph. Note the superior treatment compared with marri post below. (PBR).

Plate 29

Transverse samples taken from a treated marri post. The post was treated in its green state (partial bark removal) using the sap-replacement method ('Cleansote'). Butt to groundline is shown from right to left on the photograph Note the poorer treatment compared with the marri post above (TBR).

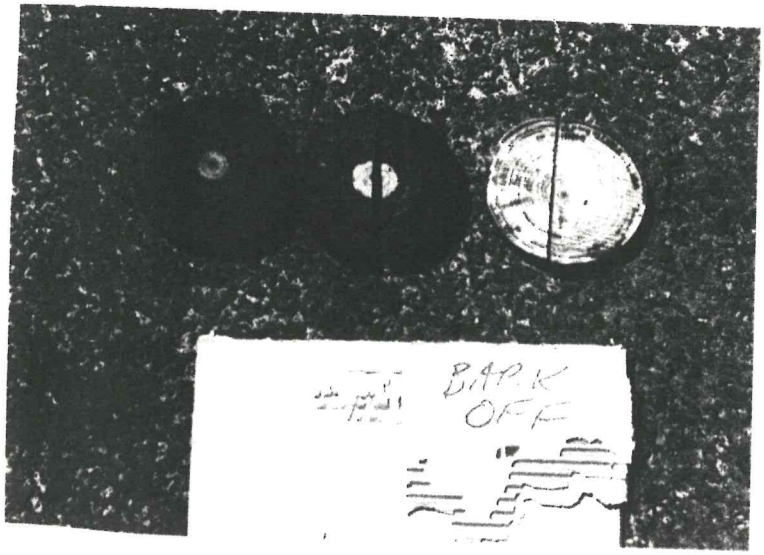

Plate 30

Transverse samples taken from a treated radiata pine post. The post was treated in its green state (total bark removal) using the sap-replacement method ('Cleansote'). Butt to groundline is shown from left to right on the photograph. Note the higher uptake of creosote at the 300 mm sample point compared with the pine post shown below (PBR).

Plate 31

Transverse samples taken from a treated radiata pine post. The post was treated in its green state (partial bark removal) using the sap-replacement method ('Cleansote'). Butt to groundline is shown left to right on the photograph. Note how much further the creosote travelled up the post compared with the pine post above (TBR).