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TITLE: DRYING AND PRESSURE TREATMENT OF POPLAR ROUND PRODUCE

AUTHOR(S): D.H. WILLIAMS AND I.G. SIMPSON DATE: JULY 1986

KEYWORDS:

ABSTRACT

Posts of an Italian-hybrid poplar were kiln dried at high (120°C/70°C) or medium (70°C/60°C) temperatures or air dried before pressure treatment with multi-salt preservative. Drying was slow in all cases and hitemp dried posts had internal checking, strongly correlated with diameter, at levels up to very severe. No internal checking was found in medium temperature dried posts. The external appearance of both series was excellent. Solution uptake was high in both kiln dried series with little variation. Highest uptake was in the hitemp dried series. It was concluded that medium temperature kiln dried poplar posts could meet TPA requirements and might be acceptable to the commercial end-user but would be uneconomically slow to dry, have poor nail or staple holding properties, and low strength. Air dried posts were generally treated at a moisture content above that specified by TPA. Uptake was unsatisfactory but distribution acceptable, with sapwood completely penetrated. Surface checking was at normal levels.

INTRODUCTION

Poplar in New Zealand is rarely planted as a potential timber tree or for future production of sawn timber or round produce but inevitably trees planted for shelter, erosion control, or amenity require thinning or felling and are available for further processing. To reach full potential in the processing of poplar round produce it is necessary that drying and preservation properties are known. Results of the present study will assist in this.

Note: This material is unpublished and must not be cited as a literature reference.

MATERIAL AND PROCESSING

Material

- Source: Peka Block, Maori Affairs Department, Rotorua.
- Clone: One of a number of Italian hybrids.
- History:
 - Planted 1969.
 - Pruned first and second years.
 - Affected by poplar rust through late 1970s and 1980s.
- Test material: Ten trees were felled adjacent to the Taupo Highway some 8 kilometres south of Rotorua. Cross-sections were taken at the butt of each and at 2.4 m intervals up each stem. These were used for the calculation of green moisture contents and densities.

The 2.4 m lengths were machine peeled courtesy Waipa Sawmill and allocated to high temperature drying (18, 2.4 m lengths), medium temperature drying (12, 2.4 m lengths), and air drying (12, 2.4 m lengths). Mid-girth diameters ranged from 2636 mm to 869 mm, green weights per post from 98 kg to less than 1 kg. This report details results on the drying and pressure treatment of these posts.

Drying

- 120°C/70°C: Dried in the Wood Drying group experimental 2.4 m kiln. The schedule of 120/70°C was applied throughout. Air flow was approximately 5 m/s. Drying continued for a total of 12 days although posts whose weight remained unchanged through two successive days were considered dry and removed from the kiln. Nine of the 18 posts remained in the kiln for the full period. Posts were removed and weighed to monitor drying rate every 12 hours for the first two days and daily thereafter.
- 70°C/60°C: Drying as for the 120°C charge. Air flow approximately 2.5 m/s. Posts were weighed after 3, 6, 9, 13, 17, and 20 days. After 20 days a kiln breakdown forced cessation of drying. All posts were in the kiln for this length of time.

Air Drying

Air drying was in a small air drying stack on a sealed area on the FRI campus. The stack was covered with corrugated iron sheets as protection from the worst effects of sun and rain. All posts were weighed after 1, 2, 4, 6, 8, 10, 12, 17, and 19 weeks.

Degrade

Checks and splits were noted at each weighing in each set of posts but specific measurements on these forms of degrade were carried out after drying and again after treatment. Measurement consisted of noting

the approximate length and width of all checks and splits that subtended circumferential lines drawn at 0.3 m from the large end of the post, and at the mid-point of the length, 1.2 m from the large end. Splits severe enough to subtend both lines were counted twice.

Allocation

Two posts from the hitemp drying and the air drying series were kept as representative samples. All others were pressure treated - 16 from the 120°C series, 12 from the 70°C series, and 10 from air drying.

Treatment

Pressure treatment was carried out in the experimental treatment cylinder in the Preservation laboratory at the Institute on the two kiln dried series. The schedule used was an extended full-cell process:

- (i) Initial vacuum, 30 minutes at -85 kPa
- (ii) Pressure at 140 kPa to refusal - approximately 2 hours
- (iii) Final vacuum, 30 minutes at -85 kPa

[The air dried series was treated at a local commercial plant.]

Treatment Assessment

All posts to be treated were weighed:

- (i) Immediately before treatment
- (ii) Immediately after treatment
- (iii) After 4 days storage under black plastic

Following this, five posts in each series had cross-sections 40-50 mm thick taken at mid-length. Any internal degrade was noted, one cross-section was chemically tested for the presence of preservative (spot tested), and segments from outer circumference to pith were cut from one further cross-section to allow the analysis of preservative component levels in:

- (i) The outer 25 mm
- (ii) The remaining sapwood
- (iii) Any heartwood present (Fig. 1)

Other Measurements and Assessments Made

- (i) Mid-girth was measured green, dry and after treatment on all posts undergoing this full series of operations.
- (ii) Length of each post was measured green; lengths were re-measured after the 120°C drying but, as they did not measurably change in drying, green lengths were thereafter used for all stages of calculation.

RESULTS

Drying Times

TABLE 1 - Post drying times at 120/70°C

Post identification	Green mid-girth (cm)	Estimated drying time to 15% m.c.	
		Hours*	Approximate days
1/3	15.92	102.05	4.25
1/4	14.16	88.54	3.69
2/2	8.69	30.34	1.26
3/1	26.36	281.99	11.75
3/6	13.00	52.30	2.18
4/2	14.68	125.13	5.21
4/4	10.30	46.95	1.96
5/1	16.39	104.81	4.37
6/1	16.13	126.19	5.26
6/4	10.84	36.97	1.54
7/3	14.90	65.02	2.71
7/4	12.67	41.00	1.71
8/1	19.40	190.81	7.95
8/4	13.14	44.22	1.84
8/5	10.69	30.00	1.25
9/1	18.41	181.38	7.56
9/2	17.64	143.00	5.96
9/4	10.99	35.54	1.48

* As shown in Graph 1 at rear of report.

A regression analysis of drying time against mid-girth gave an r^2 value of 91.5% when adjusted for degrees of freedom and a regression equation of:

$$\text{Drying time to 15\% m.c. (hr)} = -138 + 15.9 (\text{mid-girth})$$

TABLE 2 - Post drying times at 70/60°C

Post identification	Green mid-girth diameter (cm)	Calculated moisture content after 20 days kiln drying
1/1	19.55	34.1
1/5	10.73	9.0
3/2	24.50	36.9
3/4	19.33	8.5
5/3	11.40	10.4
5/4	9.89	9.6
6/2	15.18	10.5
6/3	13.06	10.0
8/2	17.20	20.6
8/3	15.15	8.7
10/1	14.52	16.0
10/4	8.72	10.0

TABLE 3 - Air drying post rates

Week	Average m.c. %	Maximum	Minimum
0	147.1	164.4	129.7
1	122.7	137.4	99.8
2	107.6	123.2	81.4
4	93.4	107.3	65.4
6	80.6	96.0	54.5
8	70.8	86.0	47.6
10	63.3	78.9	40.4
12	58.2	71.5	36.0
17	52.3	66.1	25.4
19	44.2	57.6	19.2
Average treated mid-girth	14.63	21.87	9.95

Regressions

- Air dry m.c. % vs. gn mid-girth

$$\begin{aligned} n &= 5 \\ r^2 &= 94.2 \end{aligned}$$

2. Air dry m.c. % vs. uptake L/m³

$$\begin{aligned} n &= 5 \\ r^2 &= 31.8 \end{aligned}$$

3. Gn mid-girth vs. uptake L/m³

$$\begin{aligned} n &= 10 \\ r^2 &= 19.9 \end{aligned}$$

Preservative Uptake

120°C: Preservative uptake on the 16 posts treated averaged 667.8 l/m³*, standard deviation 62.3. Spot testing on cross-section of five posts showed complete sapwood penetration.

70°C: Preservative uptake on the 12 posts treated averaged 585.1 l/m³*, s.d. 38.4. Spot testing on cross-sections of five posts covering the range of mid-girth showed complete sapwood penetration.

Air dry: Preservative uptake on the 10 posts treated averaged 395.1 l/m³, s.d. 56.5. Spot testing on cross-sections of five posts covering the range of mid-girth showed complete sapwood penetration.

Total active elements on a weight/weight basis are shown in Table 4 below.

TABLE 4 - Total active elements (copper, chrome, arsenate) on weight/weight basis for each zone (A = outer sapwood, B = inner sapwood, C = heartwood) for each drying regime (120/70°C, 70/60°C, air drying)

Drying temperature	Zone	Number analyses	Total active element % wt/wt
120°C	A	5	3.374
	B	5	3.534
	C	3	1.767
70°C	A	5	1.700
	B	5	3.212
	C	4	0.180
Air dry	A	5	1.936
	B	4	1.495
	C	5	0.152

* On a post-treated volume basis.

Post Shrinkage at 120°C

TABLE 5 - Changes in Dimensions During Drying and Pressure Treatment

Post identification	Mid-girth measurement				
	Green girth	Kiln dried		Pressure treated	
		Girth	Post % volume change from green	Girth	Post % volume change from green
1/3	15.92	15.29	-7.8	*	-
1/4	14.16	13.59	-7.9	14.05	-1.5
2/2	8.69	8.25	-9.9	8.55	-3.2
3/1	26.36	25.32	-7.7	25.72	-4.8
3/6	13.00	12.50	-7.5	12.90	-1.5
4/2	14.68	14.02	-8.8	14.72	+0.5
4/4	10.30	9.80	-9.5	10.12	-3.5
5/1	16.39	15.60	-9.4	16.07	-3.9
6/1	16.13	15.42	-8.6	15.92	-2.6
6/4	10.84	10.30	-9.7	10.68	-2.9
7/3	14.90	14.11	-10.3	14.60	-4.0
7/4	12.67	12.06	-9.4	12.50	-2.7
8/1	19.40	18.50	-9.1	19.10	-3.1
8/4	13.14	12.50	-9.5	12.92	-3.3
8/5	10.69	10.16	-9.7	10.55	-2.6
9/1	18.41	17.56	-9.0	18.25	-1.7
9/2	17.64	16.88	-8.4	*	-
9/4	10.99	10.54	-8.0	10.80	-3.4

* Kept as kiln dried display samples.

Degrade

120°C: Little degrade was noted during drying. One post developed a 1 m long end split and some posts showed slight ring checks on the ends. This was formalised in the assessment made after drying when measurements made at 0.3 m and 1.2 m from the large end showed post 3/1 to have one split 356 mm long and 1 mm wide. No other post showed degrade, nor was this split still visible after pressure treatment. The visual appearance of these treated poplar posts was excellent.

The five posts cross-cut for treatment assessment and analysis covered a range of mid-girths and included the largest post of the series. Assessments and comments made on internal degrade at that time were that the heartwood, not easily distinguished in green posts but turned a distinctive red-brown in 120°C drying, suffered severe checking (Fig. 2), the severity dependent on the amount of heartwood present; smaller posts contained no such zone. Specific comments were:

TABLE 6 - Internal checking in hitemp dried poplar posts

Post identification	Mid-girth (cm)	Assessment of internal degrade
3/1	26.36	Very severe internal checking; post centre almost disappeared.
6/1	16.13	Very severe internal checking; post centre almost disappeared.
6/4	10.84	Very slight internal check at centre.
7/4	12.67	Very slight internal check at centre.
8/1	19.40	Very severe internal checking; post centre almost disappeared.

70°C: Some slight or moderate end checking appeared in a minority of posts during drying but two posts were recorded as having very severe checking for over half the 2.4 m lengths. These reached maximum severity after nine days and were still severe after a full 20 days drying. Posts with checking recorded at 0.3 m and/or 1.2 m from the butt were:

TABLE 7 - Surface checking in medium temperature dried poplar posts

Post identification	Mid-girth diameter (cm)	Checking length/width (mm)	
		0.3	1.2
3/4	19.33	- 1202/8 -	
6/2	15.18	- 1205/9 -	
8/2	17.20	1251/12	
10/1	14.52	366/3	

Air dry: Surface checking recorded at 0.3 m and/or 1.2 m from the butt was:

TABLE 8 - Surface checking in air dried poplar posts

Post identification	Green mid-girth diameter (cm)	Checking length/width (mm)	
		0.3	1.2
1/2	17.66	342/3	-
2/1	10.25	418/2 311/2	-
3/3	21.96	-	-
3/5*	16.48	412/1.5 511/2	-
4/1	16.19	565/2	-
4/3*	12.81	953/4	-
5/2	14.07	1167/3	1442/3
7/1	19.19	372/1.5	-
7/5	9.90	652/3 392/2	-
9/3	13.72	- 1356/5 -	-
10/2	12.80	- 1015/4	-
10/3	11.00		-

* Kept for display.

No internal checking was recorded.

The general pattern is therefore one of one wide end split (in those posts containing such splits) usually extending slightly beyond mid-length in kiln drying, rarely so in air drying.

No internal checking was recorded in any of the five medium temperature-dried posts cross-cut for preservative analysis (Fig. 3).

DISCUSSION

All posts were dried under near-ideal conditions. In the kiln the posts were stacked three wide in each layer and would be exposed to near the set limits of the schedule from beginning to end. In air drying the stack was three posts wide and four high, giving excellent drying. Air dried surface checking (Table 8) generally consisted of one check from the butt extending some distance up the post. Of the 12 sample posts two

showed no checking at the measurement points, 10 showed the typical butt checking (average check length 711 mm, average width 3 mm), one showed a severe check crossing lines at both 0.3 and 1.2 m from the butt and one had a check at 0.3 m and a further one at 1.2 m. This level of checking would be regarded as low for a hardwood species.

On pressure treatment, it can be said that following unsatisfactory treatment of round produce and sawn timber treated on a radiata schedule the time at full pressure in the present series was extended to refusal, with the normal 30 minutes initial and final vacuums. This resulted in full sapwood penetration and high levels of uptake. The uptake was higher in the hitemp dried series (667.8 l/m^3 , s.d. 62.3) than the medium temperature series (585.1 l/m^3 , s.d. 38.4) and this, again, was greater than in the air dried series (395.1 l/m^3 , s.d. 56.5).

The drying time of almost 12 days for the largest (264 mm mid-girth) hitemp dried post illustrates once again the difficulty of removing moisture from a wet interior through dry outer layers, just as some of the variations in drying times are the result of a smaller diameter post being screened between larger ones. This results in a reduced air flow in the vicinity of that post and an extended drying time. For best results it appears that posts should not vary greatly in diameter in any one layer.

Preservation uptake and distribution show that adequate preservation can take place at moisture contents significantly higher than those resulting from the hitemp drying regime. Kiln drying at $70^\circ\text{C}/60^\circ\text{C}$ for 20 days and treating at average within-post moisture contents up to 37% still resulted in commercially acceptable levels of preservative retention.

The close correlation between air dry m.c. % and uptake ($r^2 = 94.2$) indicates that had air drying continued for some time - certainly 2.3 months - beyond the 19 weeks given these posts, a more acceptable level of uptake would have been possible in those posts currently not acceptable under TPA specifications. Further drying was not possible, owing to other staff and processing commitments but the present indications are that poplar is slow to air dry but, once dry, may be pressure treated, although heartwood zones may not slow the high retention achieved in hitemp drying. Treatment should be to refusal, as specified.

On degrade, the severe internal checking found in the larger hitemp dried posts may be unacceptable to end-users, while the surface checking found after drying by other methods is reduced or disappears in subsequent treatment, leaving acceptable posts without the internal checking as a concealed defect. This must be balanced against the higher solution uptake possible in hitemp dried posts. $70/60^\circ\text{C}$ have acceptable uptake and appearance and, where kiln residence time is not a deciding factor, may prove the most acceptable process.

TPA REQUIREMENTS

The relevant portions of the Timber Preservation Authority specifications on Bethell-treated round produce may be summarised as:

Category and Retention

N.Z. TPA commodity	End use	Retention kg/m ³ recommended preservative minimum
H4	Group A: Posts and sawn timber in ground contact	12.0
	Group B: Sawn fence posts	
	Group C: Plywood, ground contact	
H5	Group A: Round line poles, e.g., power and telephone	16.0
	Group B: Round building poles and piles in extreme conditions or fresh water	
	Group C: Round or sawn timber for horticultural use	
H6	Marine piles and timber in sea water	Round 27.0-48.0

Moisture Content

Immediately before treatment the moisture content of any part of the zone to be treated shall not exceed:

- 25% m.c. - species other than pines
- 30% m.c. - pine species

Penetration

Process	Species	Product and minimum requirements
P4	All approved species	Rounds - Complete sapwood with a minimum total penetration of not less than 10 mm

Retention

Process	Species	Product	Preservative	Retention (kg/m ³)	Retention zone
P4	All approved species	Rounds	Tanalith C	12.0	Sapwood - the outer 2.25 mm or 2 mm to the full sapwood depth where this is between 10 mm and 25 mm

Pumping to Refusal

All charges shall be pumped to refusal.

A fuller text of these requirements is listed in the Appendix.

Poplar is not an approved species and TPA would require a greater retention than those listed in the specifications for approved timbers, particularly as poplar is a hardwood. Individual hardwood species must have an added safety factor to take into account their susceptibility to soft-rot fungi.

The reference to "2-25 mm" or "2 mm to the full sapwood depth" in the retention requirements indicates that the outer 2 mm is removed and discarded to eliminate the effects of any surface deposition of chemical and the retention analysed on the zone(s) interior to this. This was not done in this study.

The 25% moisture content requirement in the zone to be treated, which is the full sapwood zone in such cases was met in the hitemp charge and in all but the two posts of greatest diameter in the moderate temperature charge.

The fact that full sapwood penetration was achieved in both high and moderate temperature charges and that uptake of preservative solution was comparatively even both within and between posts in both charges would indicate that any necessary level of preservative retention may be achieved by adjustment of the solution strength. Earlier studies have shown that there is little variation in properties through the range of poplars available in New Zealand.

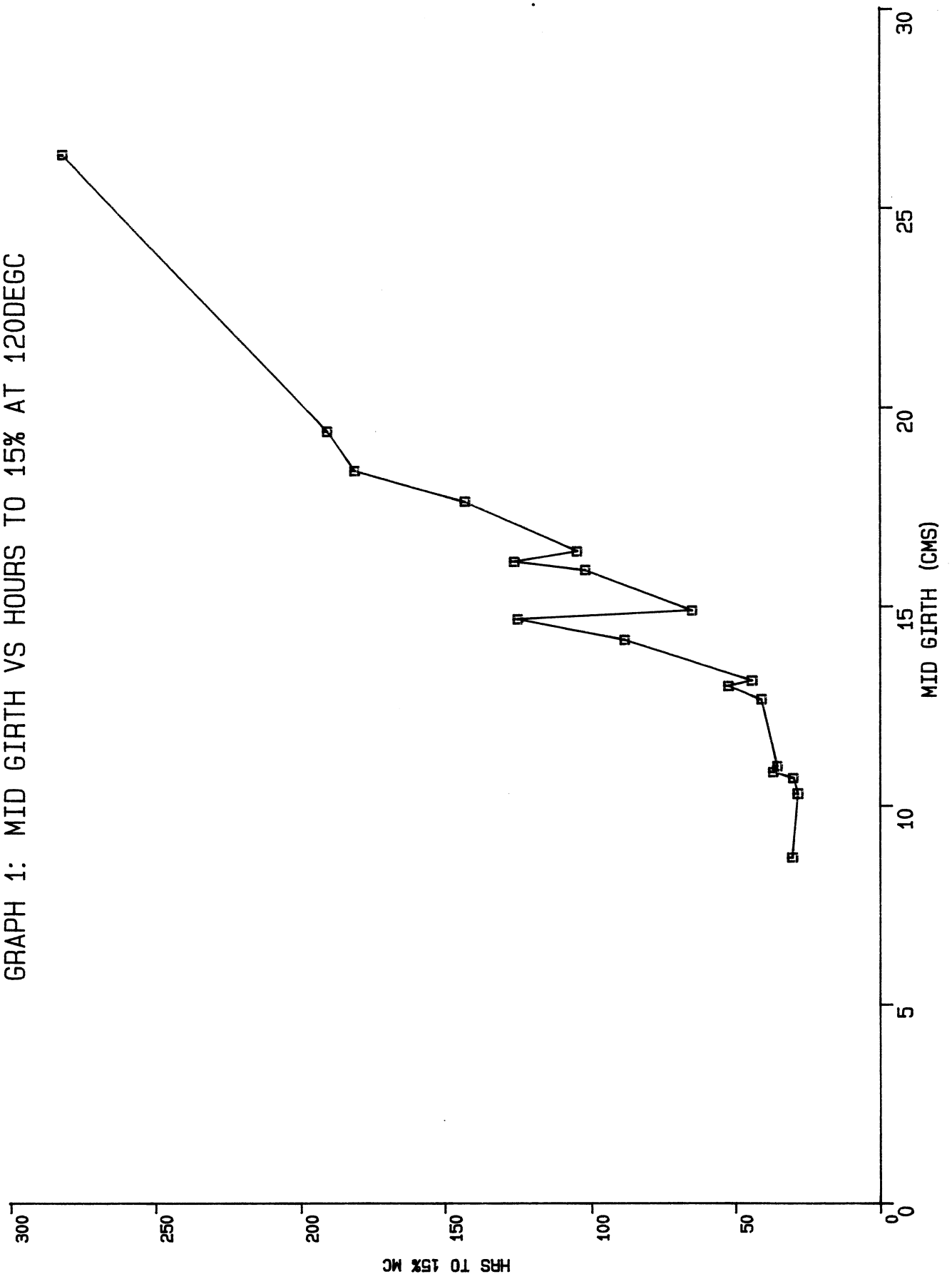
From this study it can be concluded that:

- (a) Poplar posts may be either high or medium temperature kiln dried.
- (b) Best quality in hitemp dried posts will be in smaller diameter material where internal checking is minimal or non-existent.
- (c) Even where internal checking is severe the surface appearance of hitemp dried pressure treated posts is excellent.
- (d) Moderate temperature kiln drying results in excellent quality posts internally and externally.
- (e) Both moderate and hitemp dried posts may be pressure treated and achieve the required full sapwood penetration.
- (f) Poplar is uneconomically slow in drying.
- (g) With low density giving low strength and poor nail or staple holding qualities.

Commercial trials should now be undertaken to confirm these results.

Details of moisture contents during drying, preservative uptake, analytical analysis, and density will be found in the print-outs at the rear of the report.

GRAPH 1: MID GIRTH VS HOURS TO 15% AT 120DEGC



GRAPH 2: MID-GIRTH GN, KD, TR

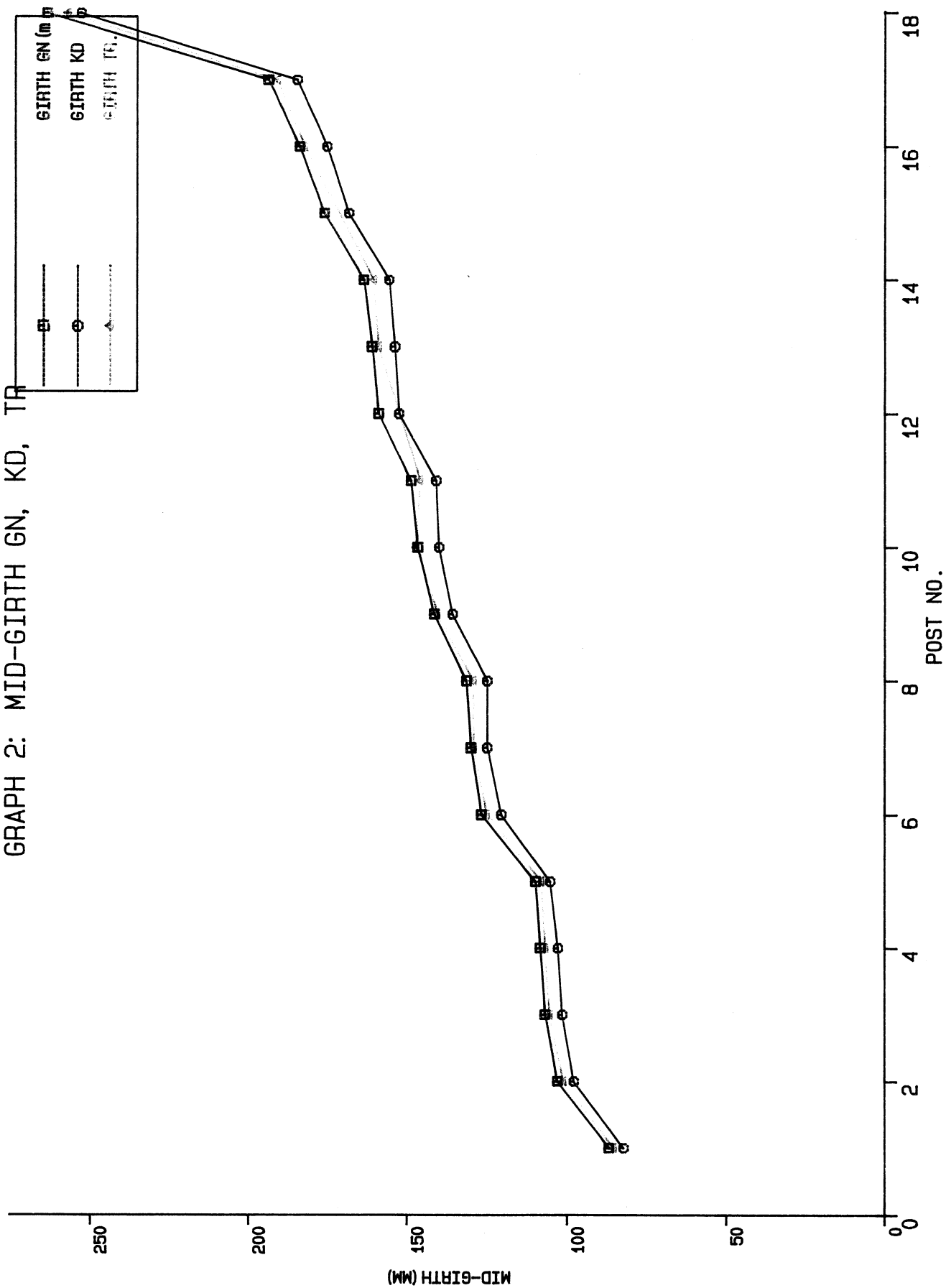


FIG. 1 - Preservative analysis zones

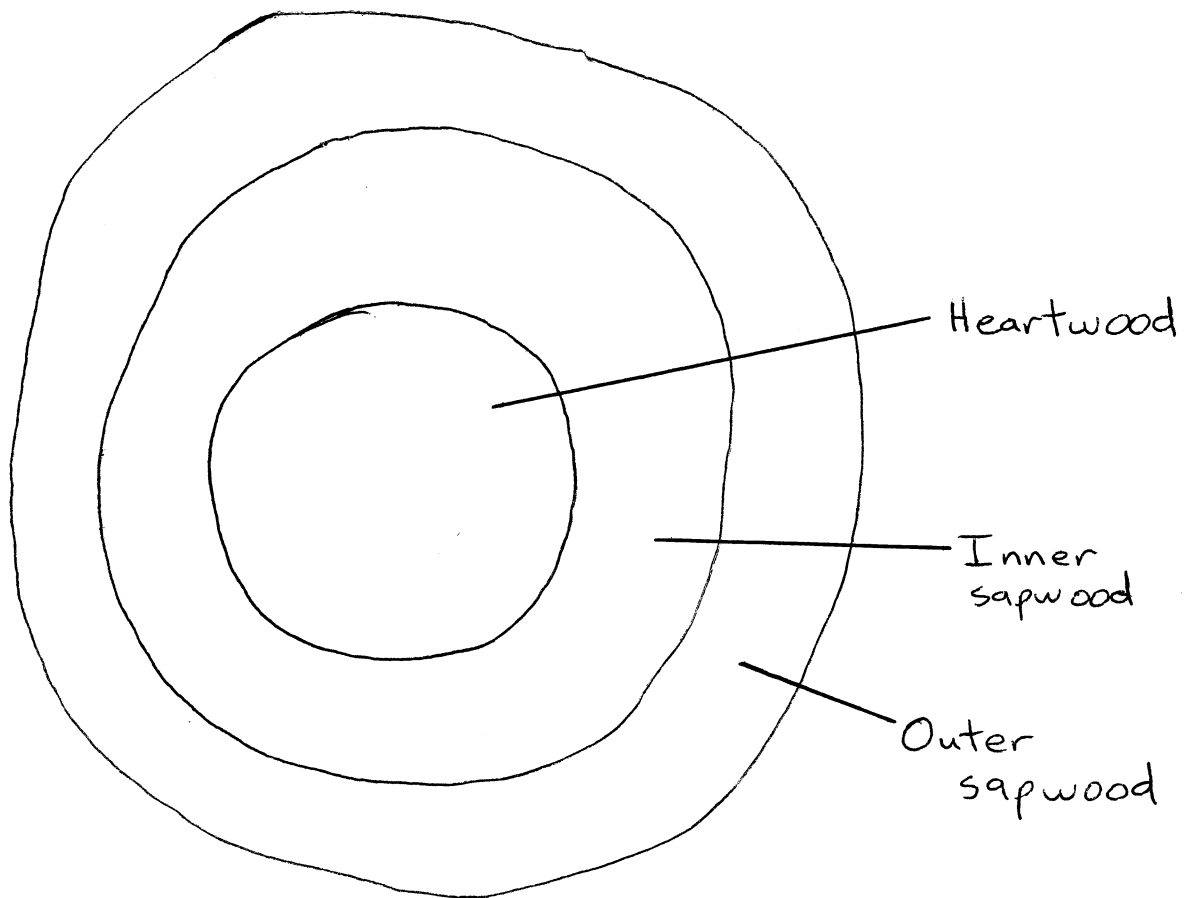


FIG. 2 - Spot-tested hitemp dried cross-sections showing
sapwood penetration and internal checking
(FRI Negative 59243)

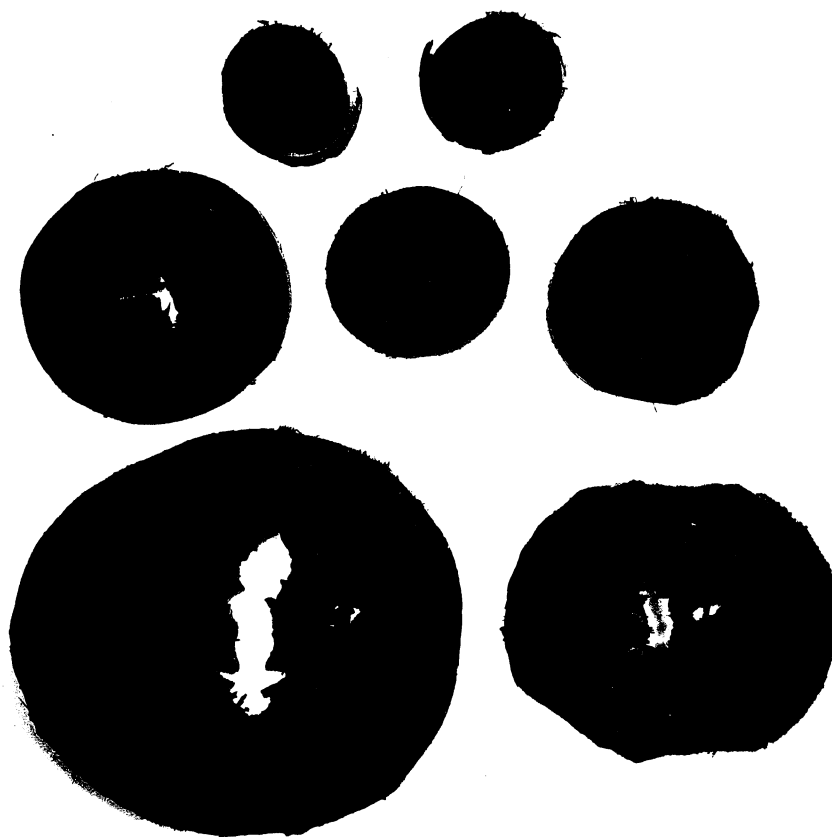
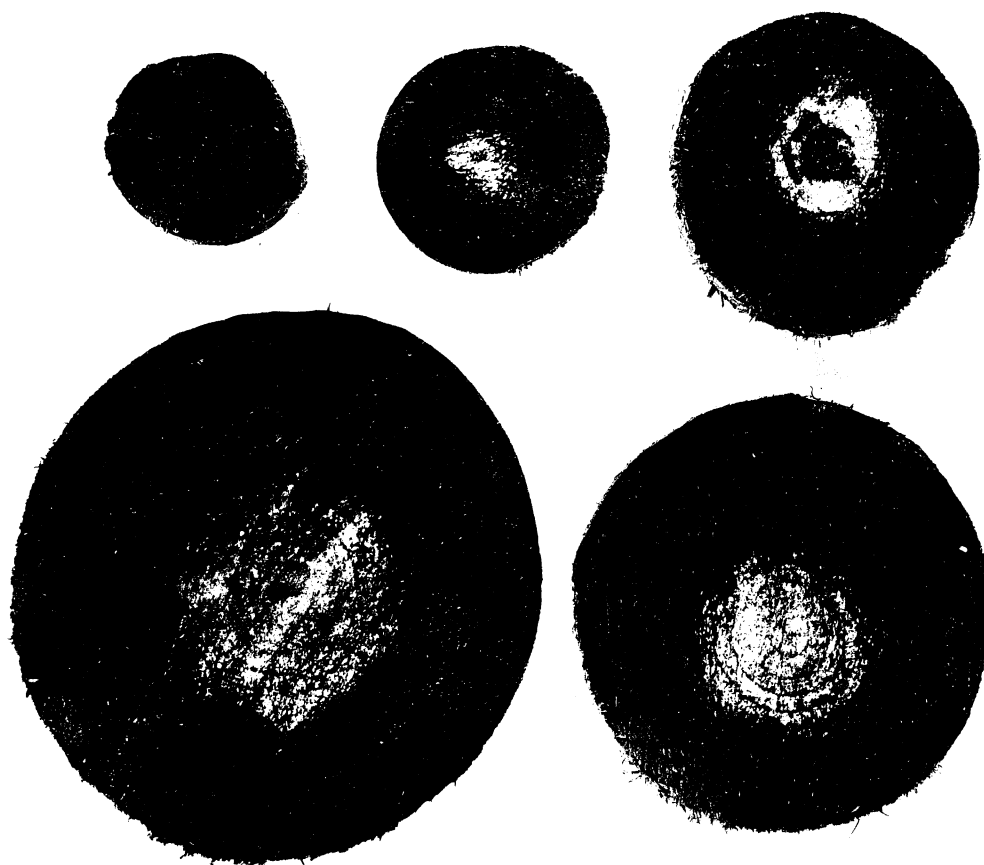


FIG. 3 - Spot-tested medium temperature dried cross-sections showing complete sapwood penetration and absence of internal checking (FRI Negative 59394)



APPENDIX 1

RELEVANT SECTIONS OF TIMBER PRESERVATION SPECIFICATIONS

PROCESS SPECIFICATION P4

BETHELL (FULL CELL) VACUUM PRESSURE PROCESS

Process Principles

Bethell treatment is an easily controlled and precise method of applying waterborne preservatives at any desired concentration to meet the requirements of a variety of Hazard Classes.

The treatment method comprises five phases:

- (a) *Initial vacuum.* Timber is placed in the treating cylinder and a vacuum is drawn to remove the air from the cells.
- (b) *Flooding.* Whilst maintaining the vacuum, treating solution is run in until the cylinder is full.
- (c) *Pressure period.* Pressure is applied and maintained until the flow rate from the working tank is negligible (pumping to refusal).
- (d) *Emptying.* The pressure is released and the surplus solution is returned to the working tank. The final displacement volume is calculated and this is then used to calculate the charge retention.
- (e) *Final vacuum.* A final vacuum should be applied to remove surplus solution and reduce dripping after the charge is removed.

The initial vacuum and flooding are the most critical phase. The object of the process is to remove as much air as possible from the cells, and replace this with the maximum amount of preservative solution by pumping to refusal.

1. Preservatives

The following preservatives are approved for use with this process and are defined in Section F: Formulations:

Boron compounds
BTB Type A
Immutan B
Tanalith FMP

Optimum CCA formulations

BTB Type C
Celcure AC
Celcure K33(C)
Celcure Type C
Koppers Type C
Tanalith C

Other CCA formulations

Celcure AN
Celcure K33
Koppers Type B
Tanalith NCA

2. Uses

This process may be used to treat produce as defined in Hazard Class Specifications H1, H3, H4, H5, H6.

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3. Moisture content and condition of timber before treatment

Immediately before treatment the moisture content of any part of the zone to be treated shall not exceed

- 25% m.c.—Species other than pines
 - H4 Group B Timbers
 - Re-treatment of pine charges sub-standard in penetration
- 30% m.c.—pine species
- 35% m.c.—H3 Group B. Palings and battens only

Steam dried produce shall have conformed with the relevant steaming schedule and storage requirements. The steam and air drying of produce, moisture content determination and condition prior to treatment is detailed in Section S: Preparation and condition of timber for treatment.

4. Treatment

The material shall be treated in a pressure plant as described above.

4.1 Charge Preparation

Timber in any charge shall consist of the same species and shall be similar in form and size, moisture content and treatability. When this is not practicable, the treating procedure shall be that which will ensure that all timber in the charge will comply with the requirements of the appropriate hazard specification.

4.2 Solution Preparation

4.2.1 Expected net absorption. Before each charge is treated the operator shall estimate the net absorption expected to be achieved when the whole charge is pumped to refusal.

4.2.1.1 Absorptions below 400 litres. For Hazard Classes H1 and H3 when the estimated absorption of a charge is expected to be less than 400 litres per cubic metre the solution concentration need not be increased beyond that required for an absorption of 400 litres per cubic metre. This does not apply to steam dried produce.

4.2.2 Concentration adjustment. Care shall be taken in calculating and adjusting the solution concentration so that the specified net retention is obtained. The treating solution shall be thoroughly mixed and of a uniform concentration before flooding the cylinder.

4.2.3 Solution temperature. The maximum temperature of all waterborne preservative solutions containing chromate shall be 50°C for those solutions which are or have been in contact with wood.

4.2.4 Determination of Concentration.

4.2.4.1 When to test. For the purpose of calculating net retention the concentration of a solution used to treat a charge shall be determined by the examination of a sample of the treatment solution taken immediately after it has been returned to the working tank.

4.2.4.2 Method. The concentration of the treating solution shall be determined as described in Section T: Tests and Analysis.

4.3 Treatment Cycle

4.3.1 Initial Vacuum. An initial vacuum of not less than -85 kPa shall be drawn and held for a minimum of 15 minutes. The initial vacuum shall be maintained at not less than -75 kPa while the preservative solution is being admitted to the treating cylinder.

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4.3.2 Pressure. Unless otherwise approved the working pressure for the treatment of all species shall be 1400 kPa and at no time shall the pressure fall below 1300 kPa. The required pressure shall be reached and held as set out below.

4.3.2.1 Pumping to refusal. All charges shall be pumped to refusal. Refusal shall be considered to have been reached when the rate of absorption of treating liquid being applied at the specified working pressure has fallen to not more than the values shown in the following table.

Hazard Class and Group	Species	Rounds	Final rate of flow ℓ/m ³ /10 min.	
			Part Rounds and sawn, heartwood penetration not required	Part Rounds and sawn, heartwood penetration required
H1 Group A	Pine species absorbing less than 440 ℓ/m ³ and all other suitable species	N/A	4	N/A
H1 Group A	Pine species absorbing more than 480 ℓ/m ³	N/A	8	N/A
H1 Group A	Podocarps	N/A	2	N/A
H3 Group A and C	All other suitable species absorbing less than 480 ℓ/m ³	2	2	N/A
H3 Group A and C	Radiata pine and suitable species absorbing more than 480 ℓ/m ³	4	4	N/A
H3 Group B	All suitable species	N/A	4	N/A
H4 Group A	Podocarps	2	N/A	N/A
H4 Group A	As specified	4	N/A	2
H4 Group B and C	As specified	N/A	N/A	N/A
H5 Group A, B and C	As specified	4	N/A	2
H5 Group D	As specified	N/A	N/A	N/A
H6	As specifically approved	4	N/A	2
Irrespective of hazard class the final rate of flow for steam dried produce— 2 litres/m ³ /10 mins.				

4.3.2.2 Final rate of flow measurements. The measurements for rate of absorption are to be made over a minimum period of 10 minutes. Where the pressure period exceeds two hours, at least two such measurements of the rate of flow shall be made. All measurements shall be taken at the same pressure using devices as detailed in Section G: General Requirements, section G3.

4.3.2.3 Leakage. All plants should be maintained to a standard where leakage is negligible. Excessive leakage can be indicative of poor plant maintenance and/or poor operational practice and shall be rectified immediately.

P4. Bethell

4.3.2.4 *Correction for leakage.* In the estimation of net retention of each charge, correction shall be made for leakages from the cylinder during the pressure period. Leakages shall be collected and measured.

4.3.2.5 *Accumulation.* Leakage shall not be allowed to accumulate in the sump but shall be recovered back into the working tank at the completion of each charge.

4.3.3 *Final vacuum.*

4.3.3.1 Where a final vacuum is drawn, not less than -85 kPa shall be reached and held for a period of not less than 15 minutes. Excessive "kickback" drip can be indicative of poor treatment control and represents a shortfall in net charge absorption.

4.3.3.2 Plants may elect to allow freshly treated timber to drip in the cylinder for an extended period e.g. overnight, in lieu of a final vacuum. All resultant drip recovery shall be recovered back into the working tank and corrected against the charge retention. All pertinent details shall be noted on the charge sheet.

4.3.3.3 *Dispensation.* Notwithstanding 4.3.3.2 above plants may apply for a dispensation not to draw a final vacuum. Approval shall be subject to local plant conditions. Where dispensation is granted the local TPA officer shall approve an adjustment to the measured absorption to allow for the loss of solution in drip. Full details shall be entered on charge sheets.

4.3.4 *Drip recovery.* Drip recovery areas should be prevented from gathering rain water run-off. Sumps should be protected against rain water accumulation and overflow.

4.3.4.1 *Sumps isolated from plant.* Drip should not be allowed to accumulate but should be recovered back into solution storage daily, i.e., to a working tank not in use. After thorough circulation a fresh solution determination may result in an adjustment in solution concentration. All such details shall be recorded on charge sheets.

4.3.4.2 *Common sumps for leakage and drip.* Overnight drip shall be fully recovered back into storage tanks before commencing treatment.

5. Measurement of Timber Quantity

Timber quantity for the calculation of net retention shall be the displacement volume out of the charge after treatment.

6. Determination of Retention

The retention of preservative shall be calculated from the volume of the charge, the net absorption of solution *after correction for leakage* and final vacuum (Clause 4.3.2.4 above) and the concentration of preservative in the treating solution and shall be shown on the charge sheet as kilograms of commercial preservative per cubic metre of timber.

H4. A

HAZARD CLASS H4

DESCRIPTION: WHERE TIMBER IS USED IN CONTACT WITH THE GROUND, OR IN FRESH WATER, OR IN OTHER SITUATIONS FAVOURABLE TO DECAY. VERY SEVERE ENVIRONMENTS SUCH AS SOME HORTICULTURAL SITES CONSTITUTE A HIGHER HAZARD CLASS (H5) WHICH SHOULD ALSO BE USED FOR CRITICAL END USERS SUCH AS TIMBER FOR BUILDING FOUNDATIONS.

GROUP A: Round, part round or sawn timber used in ground contact or in other situations favourable to decay. Wherever possible timber should be treated in its final size, shape, and form, but if subsequent cutting is unavoidable, cut surfaces should be clear of the ground and should be treated *in situ* with one of the formulations shown in Section F:5.

1. Uses

Fence posts, poles for barns or similar industrial use, sawn timber for bridges, wharf decking, fire escapes.

2. Preservatives

The following preservatives are approved for use with this specification and are defined in Section F: Formulations:

Creosote

5% PCP/oil

Optimum CCA Formulations

BTB Type C

Celcure AC

Celcure Type C

Celcure K33(C)

Koppers Type C

Tanalith C

Other CCA Formulations

Celcure AN

Celcure K33

Koppers Type B

Tanalith NCA

3. Processes

Timber in this group may be treated by processes as defined in Process Specifications P1, P2, P4, P9.

H4. A

4. Species

Species	Processes	Type of produce
Beech—red	1, 2	Rounds—part rounds—sawn
Hard	1, 2	Rounds—part rounds—sawn
Silver	1, 2	Rounds only
Douglas fir	1, 2	Rounds—part rounds—sawn
Larch*	1, 2	Rounds—part rounds only
Kahikatea†	1, 2, 4	Rounds only
Kauri	1, 2, 4	Rounds only
Poplar	1, 2	Rounds—part rounds—sawn
Totara†	1, 2	Rounds—part rounds—sawn
	4	Rounds only
Pines		
Austrian	1, 2, 4	Rounds—part rounds—sawn
Corsican	1, 2, 4, 9	Rounds—part rounds—sawn
Loblolly	1, 2, 4	Rounds only except under P4
Lodgepole	1, 2, 4	Rounds only
Maritime	1, 2, 4	Rounds—part rounds—sawn
Muricata	1, 2, 4	Rounds—part rounds—sawn Except under P4—rounds only
Ponderosa	1, 2, 4	Rounds—part rounds—sawn
Radiata	1, 2, 4, 9	Rounds—part rounds—sawn
Strobus	1, 2, 4	Rounds—part rounds—sawn
Longleaf	4	Rounds—part rounds—sawn
Shortleaf	4	Rounds—part rounds—sawn
Slash	4,	Rounds only
Patula	4	Rounds only

* The treatment of part round larch posts is only permitted where satisfactory evidence is produced to show that the Authority's requirements can be consistently attained.

† For treatment of these species by P4, see Clause 11 of this specification.

NOTE: Sawn timber should be carefully selected as it is difficult to achieve the specified penetration and retention zone requirements in the heartwood of most species.

5. Brands

Timber treated to this specification shall carry the symbol "H4" in addition to the plant number. Kahikatea and totara posts treated to the requirements of Clause 11 of this specification shall be branded with the plant number only. Refer to Section B: Branding.

6. Penetration

6.1 *Penetration required.* The minimum penetration of preservative shall be:

Process	Species		Product and minimum requirements
P1, P2	Approved Species except pines	Rounds	Complete sapwood with a minimum penetration of not less than 10 mm
		Part Rounds	
		Sawn	
P4, P9	All approved species	Rounds	Complete sapwood with a minimum total penetration of not less than 10 mm
		Part rounds	As above except that when exposed heartwood is less than one third the width of the original diameter, no heartwood penetration is required.
		Sawn Timbers	As above except that when the heartwood is less than 20 percent of the cross-section at either end, no heartwood penetration is required.

6.2 *Measurement of penetration*

6.2.1 The operator shall sample in accordance with the relevant intensity schedule set out in Section T: Tests and Analyses Penetration must be continuous with both earlywood and latewood penetrated.

6.2.2 In part round posts where the width of the heartwood exceeds one third of the original diameter and in sawn timber where the heartwood exceeds 20 percent of the cross section at either end, penetration checks shall be made in exposed heartwood.

6.2.3 Penetration shall be determined by examination for colour or by an approved spot test as defined in Section T: Tests and Analyses.

7. Penetration tolerance

7.1 If more than 10 percent of sub-standards is found in any set of samples all materials represented by those samples shall be re-treated.

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8. Retention

8.1 The specified retentions (without allowance for undercharge; see Clause 9) shall be as shown in the table below:

Process	Species	Product	Preservative	Retention kg/m ³	Retention zone
P1, P2	Douglas fir Larch	Rounds	Creosote	96	N/A
		Part rounds	5 percent PCP/oil		
	All other approved species	Rounds	Creosote	128	N/A
		Part Rounds	5 percent PCP/oil		
	All approved species	Sawn timber:	Creosote	144	N/A
		1. With a section up to 15 000 mm ²	5 percent PCP/oil		
		2. With a section greater than 15 000 mm ²	Creosote 5 percent PCP/oil	112	
P4	All approved species	Rounds Part rounds Sawn timber	BTB Type C	12.0	Sapwood: the outer 2-25 mm or 2 mm to the full sapwood depth when this is between 10 mm and 25 mm. Heartwood: the outer 10 mm.
			Celcure AC	11.3	
			Celcure Type C	12.0	
			Celcure K33(C)	9.4	
			Koppers Type C	12.0	
			Tanalith C	12.0	
			Celcure AN	11.5	
			Celcure K33	10.8	
			Koppers Type B	11.6	
			Tanalith NCA	11.6	
P5	Radiata pine Corsican pine	Rounds Part rounds Sawn timber	BTB Type C	N/A	
			Celcure AC	N/A	
			Celcure Type C	N/A	
			Celcure K33(C)	N/A	
			Koppers Type C	N/A	
			Tanalith C	N/A	
			Celcure AN	N/A	
			Celcure K33	N/A	
			Koppers Type B	N/A	
			Tanalith NCA	N/A	

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8.2 Retention zone. The retention zone requirement is for a minimum total active element loading plus minimum individual element loadings.

Optimum CCA Formulations

Total: 0.72% of oven dry wood weight
Cu: 0.16% of oven dry wood weight
Cr: 0.31% of oven dry wood weight
As: 0.22% of oven dry wood weight

Other CCA Formulations

Total: 0.86% of oven dry wood weight.
Cu: 0.17% of oven dry wood weight.
Cr: 0.22% of oven dry wood weight.
As: 0.26% of oven dry wood weight.

Full analyses will be required when percentage of copper is:

Optimum CCA Formulations

0.16-0.17%

Other CCA Formulations

0.17-0.22%

9. Retention tolerance

9.1 Except for treatments by Process Specifications P9 where no charge loadings are specified, the net retention in any charge of timber shall be not less than 90 percent of the quantity specified, and over any 10 consecutive charges shall be not less than 95 percent of the quantity specified.

9.2 If analysed, not less than 90 percent of the samples taken in accordance with Clause 6.2.1 of this specification shall comply with the retention zone requirements specified in Clause 8 above.

10. Re-treatment of sub-standard charges

The following action shall be taken where charges fail to comply with the requirements of this specification for penetration and/or retention: sawn timbers not complying in heartwood penetration are unlikely to show any improvement in heartwood penetration on re-treatment.

10.1 Material treated with creosote or 5 percent PCP/oil shall be re-treated so as to comply with the standards laid down.

10.2 Material treated with multi-salt preservatives in the manner set out in Process Specification P4 shall be re-dried to the moisture content set out in Clause 3 of that specification and treated to refusal as laid down. Except that those timbers not complying in respect of retention only, need be dried only to an extent necessary to allow the required retention to be achieved. Previous retention shortfall and retention achieved on re-treatment shall be recorded on the re-treatment charge sheet.

10.3 Material treated by P9 not meeting the requirements of this specification shall be dried to the moisture content set out in the appropriate process specification and re-treated in accordance with the requirements of Process Specification P4.

10.4 Charge sheets shall be clearly marked "Reject Charge" and the reasons for failure recorded in the remarks column. (If the charge is undergoing re-drying its yard location shall be indicated on the charge record.)

10.5 All packets of a sub-standard charge undergoing air drying shall be clearly marked in bold letters with "Re-treat", charge number, date in stack and comply with the relevant section of Section S: Clauses 1 and 2.

10.6 The charge sheets of re-dried sub-standard material undergoing re-treatment shall state in the remarks column: Re-treatment of Charge Number Date

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10.7 All material which has been re-treated shall be re-examined for compliance with this specification. Penetration checks on material previously failed on penetration are mandatory.

10.7.1 Material complying in penetration but not retention may be re-branded and sold in a lower Hazard class providing that the material complies in retention and with all other requirements pertaining to that lower Hazard class.

11. Treatment of round fence posts of kahikatea and totara species

The treatment of fence posts of kahikatea and totara species is restricted to fence posts with a maximum diameter of 150 mm and is subject to the following conditions:

11.1 Treatment is limited to the custom treatment of a user's own posts.

11.2 The posts must be dried thoroughly. At the time of treatment no part of any post shall have a moisture content greater than 25 per cent. It is strongly recommended that final seasoning be carried out under cover.

11.3 Treatment charges must contain only kahikatea or totara species; mixed charges containing other species are not permitted.

11.4 The final rate of flow shall be 2 litres/m³/10 min.

11.5 The minimum acceptable solution absorption shall be 600 litres/m³ except that a pro rata reduction shall be made for heartwood content if it occurs, assessed prior to treatment by an officer of the Authority.

11.6 The charge retention shall be as for H3 Group A except that in any individual charge the retention shall be not less than 95% of the retention specified.

11.7 Charges which fail to comply with requirements Clauses 11.5 or 11.6 above shall be re-dried completely (to the requirements of Clause 11.2) and re-treated. Re-treated charges must comply with Clause 11.5 and total retention must comply with Clause 11.6.

11.8 Treated posts must be branded with the plant number but not the symbol "H4". Refer Section B: Branding.

APPENDIX 2: GREEN & BASIC DENSITIES AND GREEN MOISTURE CONTENT OF:-

POST MATERIAL FROM PEKA FARM. TREE 1

SAMPLE NO	RAW DATA			RESULTS		
	*****			*****		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	1535.1	578.4	2158.4	711.	268.	165.
2	1131.9	435.4	1549.8	730.	281.	160.
3	1103.4	444.1	1622.2	680.	274.	148.
4	614.0	254.7	927.8	662.	275.	141.
5	462.2	191.1	677.5	682.	282.	142.
6	442.5	189.0	624.1	709.	303.	134.
DISC WEIGHTED MEANS:				700.	277.	153.

POST MATERIAL FROM PEKA FARM. TREE 2

SAMPLE NO	RAW DATA			RESULTS		
	*****			*****		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	430.8	173.6	586.4	735.	296.	148.
2	198.9	83.1	276.1	721.	301.	139.
3	210.8	91.5	297.0	710.	308.	130.
DISC WEIGHTED MEANS:				725.	300.	141.

POST MATERIAL FROM PEKA FARM. TREE 3

SAMPLE NO	RAW DATA			RESULTS		
	*****			*****		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	4147.9	1528.8	5983.2	693.	256.	171.
2	1987.9	780.7	3078.4	646.	254.	155.
3	1748.5	688.3	2730.3	640.	252.	154.
4	1097.1	462.7	1703.9	644.	272.	137.
5	842.0	359.5	1296.8	649.	277.	134.
6	808.9	341.3	1218.5	664.	280.	137.
7	294.4	128.0	396.9	742.	322.	130.
DISC WEIGHTED MEANS:				666.	261.	155.

POST MATERIAL FROM PEKA FARM. TREE 4

SAMPLE NO	RAW DATA			RESULTS		
	*****			*****		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	941.1	377.2	1328.6	708.	284.	149.
2	839.1	312.1	1139.3	737.	274.	169.
3	367.7	153.8	549.9	669.	280.	139.
4	442.2	182.7	652.7	677.	280.	142.
5	211.2	88.9	308.0	686.	289.	138.
DISC WEIGHTED MEANS:				704.	280.	151.

POST MATERIAL FROM PEKA FARM. TREE 5

SAMPLE NO	RAW DATA			RESULTS		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	931.3	386.6	1331.0	700.	290.	141.
2	582.7	228.1	776.9	750.	294.	155.
3	490.3	205.1	703.9	697.	291.	139.
4	471.5	198.8	667.1	707.	298.	137.
5	168.3	71.2	234.9	716.	303.	136.
6	101.4	43.7	141.0	719.	310.	132.
DISC WEIGHTED MEANS:				712.	294.	142.

POST MATERIAL FROM PEKA FARM. TREE 6

SAMPLE NO	RAW DATA			RESULTS		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	883.4	357.6	1218.4	725.	293.	147.
2	608.9	252.3	842.9	722.	299.	141.
3	282.6	122.8	416.1	679.	295.	130.
4	240.8	104.3	346.9	694.	301.	131.
5	142.8	61.7	199.5	716.	309.	131.
6	90.1	37.8	123.2	731.	307.	138.
DISC WEIGHTED MEANS:				715.	298.	140.

POST MATERIAL FROM PEKA FARM. TREE 7

SAMPLE NO	RAW DATA			RESULTS		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	1443.1	568.4	1993.8	724.	285.	154.
2	1144.6	441.9	1653.0	692.	267.	159.
3	980.9	403.1	1475.8	665.	273.	143.
4	833.6	356.1	1238.3	673.	288.	134.
5	325.0	142.9	482.6	673.	296.	127.
6	264.2	118.0	382.5	691.	308.	124.
7	118.2	53.8	168.0	704.	320.	120.
DISC WEIGHTED MEANS:				691.	282.	145.

POST MATERIAL FROM PEKA FARM. TREE 8

SAMPLE NO	RAW DATA			RESULTS		
	WEIGHT GREEN	WEIGHT O-DRY	VOLUME GREEN	DENSITY		MOISTURE
	GMS	GMS	CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	1850.1	737.3	2709.3	683.	272.	151.
2	1365.4	512.8	1858.3	735.	276.	166.
3	914.4	362.0	1332.6	686.	272.	153.
4	623.7	265.4	941.3	663.	282.	135.
5	598.6	257.1	870.7	687.	295.	133.
6	409.8	185.8	583.8	702.	318.	121.
7	121.5	55.1	172.9	703.	319.	121.
				695.	280.	148.

POST MATERIAL FROM PEKA FARM. TREE 9

SAMPLE NO	RAW DATA			RESULTS		
	WEIGHT	WEIGHT	VOLUME	DENSITY		MOISTURE
	GREEN GMS	O-DRY GMS	GREEN CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	1434.5	560.6	1909.3	751.	294.	156.
2	716.9	278.7	997.0	719.	280.	157.
3	617.9	256.4	897.6	688.	286.	141.
4	468.6	202.3	655.2	715.	309.	132.
5	310.4	130.1	439.4	706.	296.	139.
6	101.5	43.0	140.3	723.	306.	136.
DISC WEIGHTED MEANS:				724.	292.	148.

POST MATERIAL FROM PEKA FARM. TREE 10

SAMPLE NO	RAW DATA			RESULTS		
	WEIGHT	WEIGHT	VOLUME	DENSITY		MOISTURE
	GREEN GMS	O-DRY GMS	GREEN CC.	GREEN KG/M3	BASIC KG/M3	CONTENT %
1	1043.3	432.4	1501.1	695.	288.	141.
2	688.2	258.9	862.7	798.	300.	166.
3	482.6	201.1	694.7	695.	289.	140.
4	247.2	107.3	360.0	687.	298.	130.
5	71.2	36.7	116.6	611.	315.	94.
DISC WEIGHTED MEANS:				716.	293.	144.

N.B. FROM CROSS-SECTIONS TAKEN ON TEN FRESHLY FELLED TREES AT THE BUTT AND AT 2.4m INTERVALS UP THE STEM THEREAFTER

APPENDIX 3:

MC % AND SOLUTION UPTAKE ON 18 PEKA POPLAR POSTS HITEMP DRIED AT 120/70degC

ROW	GN MC	12 HRS	24	36	48	3 DAYS	4	5	6	7	8	9
1	151.043	102.843	67.310	48.1539	37.4942	25.1352	16.9473	9.2229	3.8159	2.7344	2.4255	2.2710
2	152.643	99.320	63.464	45.2606	35.5153	22.0925	11.7955	3.8889	2.2341	1.8663	1.4986	1.4986
3	133.500	48.678	21.039	9.6021	4.8368	2.4541	1.9776	1.5011	1.5011	1.5011	*	*
4	163.003	133.884	110.670	93.0922	80.2104	64.6449	55.4399	48.6233	42.8265	37.7274	33.3262	29.1933
5	133.984	79.199	43.839	27.2509	16.9922	5.8605	2.5865	1.9317	1.4951	1.4951	*	*
6	174.228	119.590	83.626	67.0269	56.1338	39.8807	27.4315	16.8842	8.0661	3.3976	2.5331	2.1873
7	136.828	64.502	27.577	12.4229	5.7269	2.9075	2.2026	1.8502	1.8502	1.4978	*	*
8	160.433	102.995	67.515	50.2108	39.1595	25.3454	17.3477	10.9495	6.4418	3.8243	2.6610	2.2248
9	158.168	108.490	75.817	60.6856	50.2410	35.7793	25.7365	16.8988	9.5340	4.7134	3.1066	2.5710
10	138.466	75.606	32.641	15.6286	7.8431	3.2295	2.3645	1.7878	1.4994	1.4994	*	*
11	138.323	81.713	47.384	32.0350	22.9576	11.7346	5.9581	3.4824	2.8222	2.4922	2.3271	2.1621
12	135.168	67.977	32.714	18.1796	10.5552	3.8837	2.6924	1.9776	1.7393	1.5011	*	*
13	170.768	125.758	94.945	79.3374	69.6707	54.8686	44.4970	35.7366	27.9831	20.9345	14.6914	9.1532
14	135.420	75.285	36.475	20.6952	12.3787	4.4888	2.7828	2.1431	1.7166	1.5034	1.5034	*
15	130.644	54.522	21.015	8.9785	4.4242	2.4724	2.1470	1.4964	1.4964	1.4964	*	*
16	173.948	128.378	95.179	78.8962	68.5346	52.9922	42.2077	33.3263	25.2908	18.4183	12.2859	6.8936
17	165.923	117.224	80.315	62.8861	52.3773	38.4083	29.4374	21.6199	14.6995	8.9325	4.5752	2.7810
18	137.020	68.378	29.950	14.4031	6.7762	2.9627	2.0827	1.7894	1.4960	1.4960	*	*

ROW BEF TR AFT TR AFT KICK

1	1.9620	1.4985	*	2.9328	244.305	*	239.800	*
2	*	*	*	3.2881	202.788	*	190.779	*
3	*	*	*	14.3793	219.629	*	213.859	*
4	24.9530	13.5741	*	3.0230	244.865	*	240.063	*
5	*	*	*	2.7492	229.385	*	219.530	*
6	2.0144	1.4956	*	3.5771	253.674	*	252.423	*
7	*	*	*	2.6683	239.901	*	232.703	*
8	1.9340	1.4977	*	2.8187	212.667	*	201.285	*
9	2.0354	1.4997	*	2.9844	251.442	*	242.791	*
10	*	*	*	2.7975	231.408	*	221.505	*
11	1.8320	1.5019	*	3.1808	260.972	*	259.304	*
12	*	*	*	2.7540	224.741	*	216.685	*
13	4.5212	1.5004	*	2.9321	263.045	*	258.887	*
14	*	*	*	3.3182	211.679	*	201.041	*
15	*	*	*	3.0979	207.147	*	200.381	*
16	3.6160	1.5014	*	*	*	*	*	*
17	2.1402	1.4994	*	3.1974	248.255	*	245.908	*
18	*	*	*	*	*	*	*	*

ROW	UPTAKE LITRES	CN MID- DIAMETER CMS.	POST' VOL M3	UPTAKE L/M3	STDEV	SEMEAN	MIN	MAX	
1	*	15.92	*	*					
2	26.254	14.16	0.038424	683.275					
3	8.373	8.69	0.014149	591.782					
4	76.480	26.36	0.128866	593.483					
5	22.160	13.00	0.032260	686.909					
6	26.215	14.68	0.042125	622.319					
7	14.193	10.30	0.019854	714.861					
8	32.629	16.39	0.050307	648.596					
9	31.343	16.13	0.049173	637.399					
10	17.233	10.84	0.021987	783.786					
11	27.703	14.90	0.040771	679.479					
12	21.639	12.67	0.030193	716.698					
13	44.091	19.40	0.070235	627.760					
14	24.396	13.14	0.031993	762.531					
15	12.810	10.69	0.021506	593.440					
16	38.598	18.41	0.061731	605.641					
17	*	17.64	*	*					
18	16.708	10.99	0.022676	736.810					
UPL/M3	N	N*	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN	MIN	MAX
	16	2	667.8	664.0	664.9	62.3	15.6	591.8	783.8

APPENDIX 4:

MC% AND SOLUTION UPTAKE FOR 12 PEKA POPLAR POSTS KILN DRIED AT 70/60degC

ROW	GN MC	3 DAYMC	6 DAYMC	9 DAYMC	13 DAYMC	17 DAYMC	20 DAYMC	BEFTRMC	AFTTRMC	AFTKIKMC
1	162.695	99.5325	71.0847	57.8555	47.9087	41.3438	34.1374	34.2020	224.265	213.075
2	138.017	48.4598	29.5267	19.3088	12.6972	10.2930	9.0158	9.5567	196.844	192.817
3	154.304	97.8464	71.1723	57.8190	48.5894	42.5018	36.8724	36.8724	235.635	224.180
4	135.599	68.0337	41.3411	27.9021	19.1900	13.8144	8.5129	8.6241	198.438	184.072
5	138.186	46.4081	25.9219	16.6348	12.2644	11.1718	10.4206	10.9396	227.274	223.464
6	136.900	39.7380	19.7234	13.1732	10.6259	10.2620	9.6070	10.2074	219.905	216.230
7	135.702	63.2005	45.2917	34.1710	24.4945	17.5621	10.4997	10.6514	178.741	164.876
8	146.823	55.6559	35.9101	25.1969	17.2146	13.0133	9.9990	10.2720	207.510	205.672
9	159.400	81.6603	56.6820	44.6604	34.7759	28.0972	20.6371	20.7373	233.267	211.628
10	143.800	57.8537	33.3645	23.5377	16.2065	12.1510	8.7038	8.8676	220.933	217.267
11	153.594	75.0929	50.8642	39.5574	29.8659	23.0819	15.9587	16.1929	201.244	185.576
12	142.655	34.2452	16.0081	11.4488	10.4357	10.4357	10.0051	10.7903	226.722	224.544

ROW	UPTAKE LITRES	GN MID-DIAMETER	POST VOL M3	UPTAKE L/M3
1	38.216	19.55	0.070951	538.626
2	12.464	10.73	0.021378	583.025
3	60.730	24.50	0.114310	531.275
4	40.960	19.33	0.069999	585.154
5	15.840	11.40	0.024435	648.262
6	11.525	9.89	0.018211	632.864
7	23.277	15.18	0.043796	531.492
8	18.779	13.06	0.032234	582.578
9	31.822	17.20	0.055390	574.505
10	27.191	15.15	0.043458	625.689
11	22.913	14.52	0.038983	587.767
12	8.525	8.72	0.014204	600.167

UPL/M3	N	MEAN	MEDIAN	TRMEAN	STDEV	SEMEAN	MIN	MAX	Q1	Q3
	12	585.1	584.1	584.2	38.4	11.1	531.3	648.3	547.6	619.3

APPENDIX 5:

MC% AND SOLUTION UPTAKE ON 12 AIR DRIED PEKA POPULAR POSTS

POST	GN MID- LENGTH DIAM (cms)	GN MC	1 WK	2 WEEK	4 WEEK	6 WEEK	8 WEEK	10 WEEK	12 WEEK	17 WEEK	19 WEEK	AFT TR
1/2	17.66	150.702	128.470	116.290	107.302	95.9497	86.0163	78.9209	71.5418	63.3703	54.6726	186.770
2/1	10.25	129.698	99.816	81.404	65.407	54.5404	47.5830	40.3842	36.0378	25.3980	19.2104	130.000
3/3	21.96	*	*	*	*	*	*	*	*	*	*	*
3/5	16.48	*	*	*	*	*	*	*	*	*	*	*
4/1	16.19	164.360	137.397	123.188	106.317	92.8982	82.5567	74.9877	70.1358	61.8113	54.0621	184.599
4/3	12.81	*	*	*	*	*	*	*	*	*	*	*
5/2	14.07	141.902	120.307	103.561	86.111	71.0467	59.5611	52.0550	47.6924	44.8015	35.5190	168.199
7/1	19.19	148.786	127.475	113.394	101.788	88.6586	78.1934	70.1067	65.7304	66.1109	57.5485	171.999
7/5	9.90	*	*	*	*	*	*	*	*	*	*	*
9/3	13.72	*	*	*	*	*	*	*	*	*	*	*
10/2	12.80	*	*	*	*	*	*	*	*	*	*	*
10/3	11.00	*	*	*	*	*	*	*	*	*	*	*

POST	UPTAKE (L/TRES)	POST VOL (m3)	UPTAKE (l/m ³)
1/2	22.341	0.0594179	375.990
2/1	7.341	0.0193603	379.178
3/3	34.050	0.0909575	374.351
3/5	*	*	*
4/1	18.833	0.0505970	372.216
4/3	*	*	*
5/2	15.237	0.0379431	401.575
7/1	24.060	0.0705587	340.993
7/5	8.316	0.0191383	434.521
9/3	16.512	0.0361942	456.206
10/2	9.704	0.0311703	311.522
10/3	11.398	0.0226034	504.261

UPL/M3	N	MEAN	STDEV	MIN	MAX
10	10	395.1	56.5	311.3	504.3

	GN MC	N	MEAN	STDEV	MIN	MAX
		5	147.09	12.68	129.70	164.36
1 WK		5	122.69	14.16	99.82	137.40
2 WEEK		5	107.57	16.24	81.40	123.19
4 WEEK		5	93.38	17.80	65.41	107.30
6 WEEK		5	80.62	17.48	54.54	95.95
8 WEEK		5	70.78	16.51	47.58	86.02
10 WEEK		5	63.29	16.42	40.38	78.92
12 WEEK		5	58.23	15.64	36.04	71.54
17 WEEK		5	52.30	17.20	25.40	66.11
19 WEEK		5	44.20	16.47	19.21	57.55

#REGRESS AD MC% VS GN MID GIRTH

The regression equation is

19 WEEK = - 26.9 + 4.60 GNMDGIR

5 cases used 7 cases contain missing value s

s = 4.590 R-sq = 94.2% R-sq(adj) = 92.2%

#REGRESS AD MC% VS UPTAKE

The regression equation is

19 WEEK = 204 - 0.428 UPL/M3

s = 15.71 R-sq = 31.8% R-sq(adj) = 9.1%

#REGRESS GN MID GIRTH VS UPTAKE

The regression equation is

GNMDGIR = 27.2 - 0.0317 UPL/M3

s = 3.816 R-sq = 19.9% R-sq(adj) = 9.8%

APPENDIX 6

PRESERVATIVE ANALYSIS - COPPER, CHROME, AND ARSENATE SALT RETENTION

ANALYTICAL CHEMISTRY LABORATORY

FOREST RESEARCH INSTITUTE, PRIVATE BAG, ROTORUA. Ph 475889 (operator)

SUBMITTED BY D H Williams

DATE SUBMITTED. 3.6.88.

REQUIRED BY August.

JOB NO 88

SAMPLE DESCRIPTION Disc sections.

Pop no bark

ANALYSIS REQUIRED. Cu. Cr. As.

120/70°C

a = 0 - 25 mm

b = Inner sap

c = Heart

d = Bark

SAMPLE NO. %Cu w/w %Cr w/w %As w/w

3a.	0.91	1.59	1.19
b	1.02	1.74	1.31
c	0.46	0.88	0.73

4a	1.00	1.82	1.34
b	1.03	1.83	1.33
c	0.25	0.48	0.33

5a	0.82	1.45	1.09
b	0.81	1.37	1.00
c	0.58	1.09	0.52

7a	0.81	1.36	0.91
b	0.74	1.39	0.90

8a	0.80	1.41	0.97
b	0.82	1.38	1.00

ANALYTICAL CHEMISTRY LABORATORY

FOREST RESEARCH INSTITUTE, PRIVATE BAG, ROTORUA.

Ph 475899 (operator)

SUBMITTED BY D.H. Williams.

DATE SUBMITTED. 23.6.86.

REQUIRED BY August.

JOB NO 50

SAMPLE DESCRIPTION Conventionally dried poplar.
Disc sections without bark.

70/60°C

ANALYSIS REQUIRED. Cu Cr As

a = outer 25mm - b = remaining sapwood c = heart

SAMPLE NO.		%Cu w/w	%Cr w/w	%As w/w
1/1	a	0.46	0.78	0.55
	b	0.42	0.61	0.51
	c	0.02	0.04	<0.01
1/5	a	0.41	0.63	0.46
	b	0.38	0.53	0.48
	c	0.01	0.06	0.04
1/10	a	0.40	0.69	0.55
	b	0.40	0.54	0.45
	c	0.14	0.21	0.15
3/2	a	0.54	0.91	0.62
	b	0.53	0.64	0.57
	c	0.01	0.03	0.01
10/4	a	0.37	0.65	0.48
	b	0.37	0.62	0.51

ANALYTICAL CHEMIST

DATE 15.8.86.

B. S.

ANALYTICAL CHEMISTRY LABORATORY

FOREST RESEARCH INSTITUTE, PRIVATE BAG, ROTORUA. TEL: (073) 475-899

SUBMITTED BY: D. Williams

POSTAL ADDRESS: FRI

DATE SUBMITTED: 22.10.86

JOB NO: 159

TELEPHONE:

URGENT?: NO

SAMPLE DESCRIPTION: CCA in wood

ANALYSIS REQUIRED: CCA

EXPECTED VALUE:

AIR DRY

		CU	CR	AS
POST				
1/2	A	0.54	0.89	0.81
	B	0.43	0.66	0.65
	C	0.04	0.09	0.07
2/1	A	0.47	0.67	0.64
	C	—	0.02	0.01
4/1	A	0.48	0.77	0.73
	B	0.44	0.51	0.56
	C	0.03	0.06	0.05
5/2	A	0.47	0.63	0.65
	B	0.43	0.52	0.57
	C	0.01	0.05	0.03
7/1	A	0.48	0.74	0.71
	B	0.33	0.42	0.46
	C	0.08	0.11	0.11

ACTIVE ELEMENTAL SALT RETENTION ON WT/WT BASIS

ROW	120ACU	120ACR	120AAS	120BCU	120BCR	120BAS	120CCU	120CCR	120CAS	70ACU	70ACR	70AAS	70BCU	70BCR	70BAS	70CCU	70CCR
1	0.31	1.59	1.19	1.02	1.74	1.31	0.46	0.98	0.73	0.46	0.78	0.55	0.42	0.61	0.51	0.02	0.04
2	1.00	1.92	1.34	1.03	1.83	1.33	0.25	0.48	0.33	0.41	0.63	0.46	0.38	0.53	0.48	0.01	0.06
3	0.82	1.45	1.09	0.81	1.37	1.00	0.56	1.09	0.52	0.40	0.69	0.55	0.40	0.54	0.45	0.14	0.21
4	0.81	1.36	0.91	0.74	1.29	0.90	*	*	*	0.54	0.91	0.62	0.53	0.84	0.57	0.01	0.03
5	0.80	1.41	0.97	0.82	1.38	1.00	*	*	*	0.37	0.65	0.48	0.37	0.82	0.51	*	*

ROW	70CAS	ADACU	ADACR	ADAAS	ADBCU	ADBCR	ADBAS	ADCCU	ADCCR	ADCAS
-----	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

1	0.00	0.54	0.89	0.81	0.43	0.66	0.65	0.04	0.09	0.07
2	0.04	0.47	0.67	0.64	*	*	*	0.00	0.02	0.01
3	0.15	0.48	0.77	0.73	0.44	0.51	0.56	0.03	0.06	0.05
4	0.01	0.47	0.63	0.65	0.43	0.52	0.57	0.01	0.05	0.03
5	*	0.48	0.74	0.71	0.33	0.42	0.46	0.08	0.11	0.11

AVERAGE, SD, MAX AND MIN FOR EACH CHEMICAL IN EACH OF THE THREE ZONES
A = OUTER 25mm SAWWOOD, B = INNER SAWWOOD, C = HEARTWOOD FOR EACH OF
THE THREE DRYING METHODS

	N	MEAN	STDEV	MIN	MAX
120 A CU	5	0.748	0.258	0.310	1.000
120 A CR	5	1.5260	0.1853	1.3600	1.8200
120 A AS	5	1.1000	0.1723	0.9100	1.3400
120 B CU	5	0.8940	0.1274	0.7400	1.0300
120 B CR	5	1.5420	0.274	1.370	1.930
120 B AS	5	1.1080	0.1979	0.9000	1.3300
120 C CU	3	0.4133	0.1582	0.2500	0.5600
120 C CR	3	0.517	0.210	0.480	1.090
120 C AS	3	0.527	0.200	0.330	0.730
70 A CU	5	0.4360	0.0666	0.3700	0.5400
70 A CR	5	0.7320	0.1196	0.6300	0.9100
70 A AS	5	0.5320	0.0638	0.4900	0.6200
70 B CU	5	0.4200	0.0644	0.3700	0.5200
70 B CR	5	0.5680	0.0497	0.5300	0.6400
70 B AS	5	0.5040	0.0445	0.4500	0.5700
70 C CU	4	0.0450	0.0635	0.0100	0.1400
70 C CR	4	0.0850	0.0843	0.0300	0.2100
70 C AS	4	0.0500	0.0688	0.0000	0.1500
AD A CU	5	0.4880	0.0295	0.4700	0.5400
AD A CR	5	0.7400	0.1005	0.6300	0.8900
AD A AS	5	0.7080	0.0687	0.6400	0.8100
AD B CU	4	0.4075	0.0519	0.3300	0.4400
AD B CR	4	0.5275	0.0991	0.4200	0.6600
AD B AS	4	0.5600	0.0779	0.4600	0.6500
AD C CU	5	0.0320	0.0311	0.0000	0.0800
AD C CR	5	0.0660	0.0351	0.0200	0.1100
AD C AS	5	0.0540	0.0385	0.0100	0.1100