IMPROVED CCA TREATMENT OF SEVERAL WESTERN SPECIES USING A FINE-TOOTH, CLOSE-INCISING PATTERN

by R. de Lissa (with valuable technical assistance from Gordon Leontowich and Jim Powers),
Western Wood Preservers Ltd., Aldergrove, B.C.

INTRODUCTION

During the past fifteen years there has taken place in North America a rapidly escalating growth in treated wood products for residential applications.

Popular "do it yourself" products, such as decks, fencing, landscaping and construction of outdoor furniture, as well as more ambitious contractor-styled applications - preserved wood foundations - has generated a substantial demand for treatable species such as Southern Yellow Pine, Ponderosa Pine and Red Pine.

As the "do it yourself" boom intensified in the North, Mid West and West Coast regions of the continent, it became apparent that species such as Southern Yellow Pine could not, due to transportation logistics, compete with less treatable Northern and West Coast species such as Douglas Fir, Jack Pine or Hemlock.

In order to improve the retentions and penetrations of preservative in these less treatable species, the practice of incising was more commonly used, especially for material that would be used for preserved wood foundations, where standards were more rigidly enforced. However, for many residential applications, such as decking and furniture, incising was not, and is still not, commonly used because of its detrimental effect on appearance.

The practice of treating these Northern and West Coast species without incising has resulted, in most cases, in very poor to non-measurable penetrations of preservative, particularly in the heartwood, with considerable scepticism focused on the life expectancy of such material.

In the early 1980's, the author carried out some initial incising work on the treatability of Douglas Fir, using a very fine razor-type knife, with incisions very closely spaced. This initial "look-see" incising study was carried out by hand, using a ground down chisel. The reason for this was to see if a fine-toothed, close pattern of incising could result in a product that was adequately penetrated by preservative, as well as having an acceptable appearance for decking and other high profile applications.

In this earlier "hands-on" study, using a modified fire extinguisher as a pressure vessel, the results of treatment were sufficiently encouraging to promote eventual design and construction of an industrial incisor for Western Wood Preservers' new plant in 1985.

At this point, the project evolved from conceptual to realization, largely due to the practical, innovative flair of my co-workers, Jim Powers and Gordon Leontowich.

The following report describes our experience in treating six batches of fifty samples each of several west coast species, including Douglas Fir, Hemlock, White Spruce, Lodgepole Pine and Abies Fir (Balsam), and comparing the retentions and penetrations of CCA preservative on end-matched samples, with and without close incising.

METHOD - SELECTION OF WOOD SAMPLES

In order to be as impartial as possible and to reproduce the typical custom treating situation where no control exists over the selection of incoming material, the untreated test material was purchased from three separate retail outlets, without any prior inspection of the material by the author or co-workers.

Batch #1 consisted of fifty pieces of coastal Hem-Fir - 2 x 4 #2 and Btr., 8 ft. long, air dried stock. Typical moisture content by resistance-type moistsure meter was in the 30 - 40% range.

Batch #2 consisted of fifty pieces of coastal Douglas Fir, slow grown, 2 x 4 std. and Btr. Typical moisture content: 20 - 25%.

Batch #3, fifty pieces of coastal Douglas Fir (Washington), fast grown, 6 - 10 rings per inch - 2 x 4 x 8 ft. Moisture content: 18 - 25%.

Batch #4, fifty pieces of coastal Douglas Fir (Washington), fast grown, 6 - 10 rings per inc h - 2 x 6 x 8 ft. Moisture content 22 - 30%.

*Batch #5, SPF - 70% White Spruce. Fifty pieces of 2 x 4 x 8 ft. stud grade (Prince George), kiln dried stock. Moisture content: 15 - 20%.

*Batch #6, SPF - 88% Lodgepole Pine. Fifty pieces of 2 x 4 ft. (Quesnel, Williams Lake), air dried stock. Moisture content: 25 - 30%.

*Note: for the SPF material, a microscopic species identification was performed by Forintek, W. Canada on each of the fifty samples.

HANDLING OF SAMPLES

1. Upon arrival at this plant all samples were identified and labelled using waterproof ink.

2. A moisture content of each sample was taken and recorded using a Delmhorst resistance-type meter.

3. Samples were cut in half to 4 ft. long pieces. Each piece was marked, using a simple, numerical-alphabetical system for end-matching purposes; incised and unincised. For the SPF samples, a 6 in. portion was cut from each piece and sent to Forintek, for species identification.

4. One set from each batch of fifty samples was incised on all four sides, using the Western Wood Preservers' ultra fine tooth, close incising pattern. The remaining fifty samples of end-matched were left unincised.

5. Prior to treatment each sample was weighed and the weights recorded for each sample. This was done for the purpose of determining retentions for each individual sample.

TREATMENT

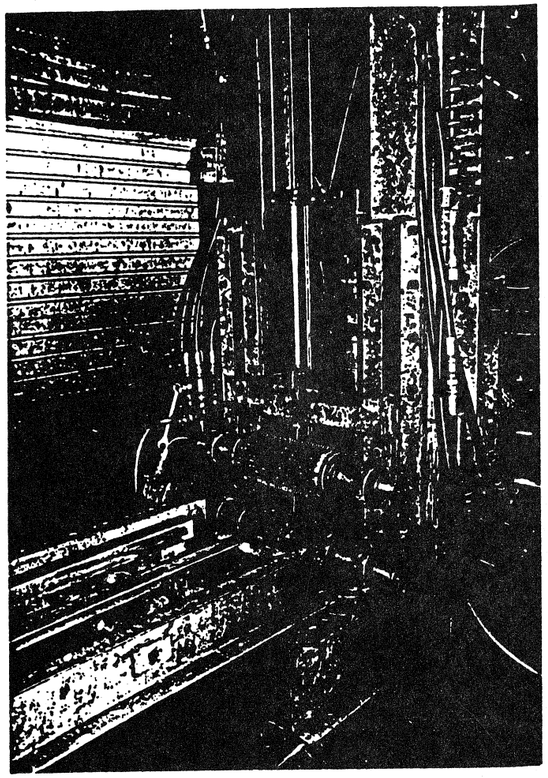
All samples were treated for a five hour pressure period and initial one-half hour vacuum, according to CSA 080-1 and AWPAC 1, maximum pressure of 150 p.s.i.. Solution strength was pre-adjusted to 3%, + or - .1%, for all samples of batches. No final vacuum was pulled.

Directly following treatment, samples were individually re-weighed and the weights recorded.

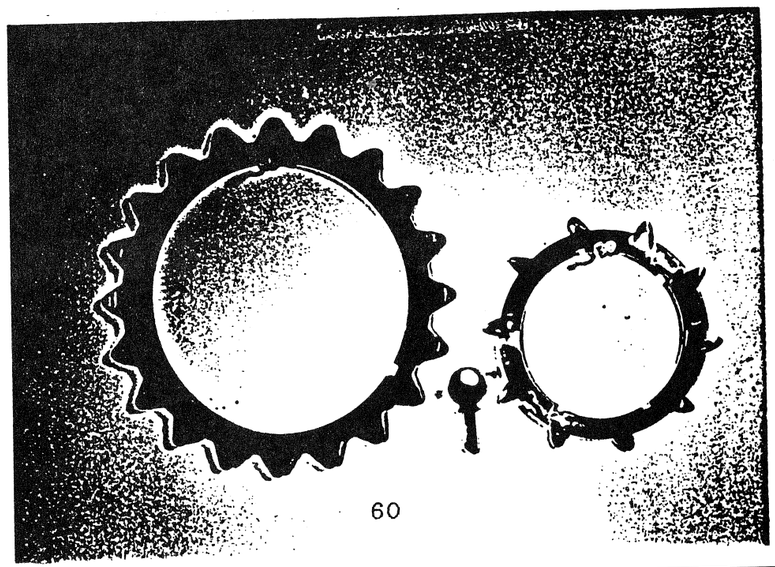
Following a CCA fixation period of three days, core boring samples were taken from each sample for assay and penetration. Assay samples were evaluated by Forintek, using an X-ray spectrophotometer. Core samples for penetration were sprayed with Chrome Azurol and measured to the nearest millimeter.

Samples of incised and uncised end-matched samples were cross-cut at least two ft. from their ends, for close visual inspection of penetration patterns. Cross-cut samples were sprayed with Chrome Azurol reagent and photographed for a permanent record of testing in batches of fifty, twenty and ten sample comparison sets, incised and unincised. Samples were left laid out in respective batches for a permanent record of testing.

Western Wood Preservers
Fine Tooth Incisor



Conventional Sized Ring (Left)
and WWP's 5" Diameter Ring



INCISING

The fine-tooth incisor, built by Western Wood Preservers Ltd., incorporated a normal four roll principle, with mechanical dampening to over-ride large knots.

The incising pattern can be described as an offset diamond-type, with incisions spaced 5/16 in. laterally, and 1/2 in. longitudinally, measured from the mid-point of the incision. The incisions were offset laterally from adjacent longitudinal rows by a factor of 3/32 in.. Total incisions per square foot: 756.

Unlike other industrial incisors, this unit features a tooth ring measuring only 5 in. in diameter from the outer ring. (Most incisors observed had tooth rings over 8 in. in diameter.)

Tooth rings were fabricated from high tensile steel, case hardened to withstand many hours of repeated use.

The actual tooth pattern we selected was a canted, rounded tip-type, honed to razor sharpness and designed to minimize friction and fibre damage during passage through the wood by separating, rather than macerating, wood fibre.

In designing the tooth and ring, great emphasis was placed on minimizing appearance degrade due to incising. The slicing effect, coupled with the narrow gauge tooth rings we designed, did prove highly effective, resulting in barely discernible incisions. To date, over five million FBM of 2 x 4 and 2 x 6 have been incised by us, much of which has been used for residential sundecks, with no complaints on appearance.

Following earlier trials, we elected to eliminate spacer rings between incising rings in order to obtain the closest lateral spacing possible. Under current patent submission is a process we have incorporated which allows lateral dampening of adjacent incising rings resulting in greatly reduced pickup of wood fibre.

DISCUSSION

Retention

Although the retention values differ somewhat between methods used - assay versus weight pickup determination (particularly for the slow grown Douglas Fir) - generally, the values are comparable proportionately between incised and unincised samples.

Whereas, assays from at least twenty 16 mm (5/8 in.) core boring samples is the recognized CSA and AWPA method, the method's limitation is that it does not give any values except the overall average based on a single twenty sample composite.

Although we used this assay method (we submitted not twenty, but fifty borings), we also obtained weights before and after for each sample so that we could obtain some idea of the CCA retention distributions in .1 pcf (1.6 kg/m^3) increments to over 1.0 pcf. See accompanying graphs.

As may be observed, incising made a noticeable increase to the incised retentions for all species listed over unincised samples and created a more uniform spread of retentions around the values of .3 to .6 pcf range.

The 3% CCA solution strength is higher than is normally used for residential applications, such as decking and fencing, but is in line with retentions used for more demanding service uses, such as preserved wood foundations and marine applications. Note that, regardless of whether the retentions were determined by assay or weight method, the average values for the incised samples were always at least 50% greater than for the unincised samples.

In every case except the slow grown Douglas Fir, incised retentions would have met or exeeceded the .5 pcf 080-15 CSA requirement for wood foundation lumber.

The wide variance in retentions for Douglas Fir material illustrates the extreme unpredictability of this species. Our experience in over twenty years of trying to treat Douglas Fir with any consistent degree of acceptable treatment, suggests that it cannot be done. Some recent material proved so refactory, that even after double incising and two treatments, the 10 mm penetration requirement could not be met. The slower grown, high altitude coastal Fir appears to be just as refactory as interior or intermountain Douglas Fir, and is a poor choice for applications demanding deep and uniform penetration of CCA.

The results of the coastal Hem-Fir came as no surprise, with retentions even for the unincised samples, at .58 pcf. However, the incising did make an appreciable improvement, with an average retention of .90 pcf and only 10% of the samples showing individual retentions below .4 pcf. Unincised Hem-Fir had 22% of samples below this commonly specified ground contact retention.

The comparative retentions for the SPF material showed quite dramatic improvements when close incised. This was particularly evident for the SPF batch containing 70% White Spruce, where incised retentions were almost double over unincised samples (.34 - .65 pcf) with only 4% of the samples showing any values below 0.4 pcf.

Our results for retentions-by-weight method for individual samples show quite extreme ranges of values; many below 0.4 pcf ground contact specification, even when the overall average, by assay or weight determination, reflects an apparent acceptable value. Note the assay result for slow grown Douglas Fir, incised, of .52 pcf, but also the retention-by-weight where 70% of samples were below 0.3 pcf.

PENETRATION

Penetration determination was performed according to CSA M Standards. Cores were sprayed with Chrome Azurol for copper determination.

All the 4 ft. samples were cut in half, using a "clean cut" planer blade, and the ends then sprayed with Chrome Azurol, for determination of copper as per borings. Samples were photographed in batches of 100 (50 incised and fifty unincised end-matched), and in smaller batches to allow for more detailed close-up photos of penetration.

Following penetration analysis of core boring samples to nearest millimeter, the results were plotted on bar graphs, in penetration increments of 0-4, 5-8, 9-12, 13-16 and 17-21 mm against frequency percentage. (See figures 2-A, 2-B, 2-C, 2-D, 2-E and Table 2).

DOUGLAS FIR, SLOW GROWN. Penetration values for Douglas Fir slow grown incised samples showed marginal improvement over unincised; over 9 mm in 40% versus 14% for unincised samples. However, photographs of cross cut sections reveal how penetrations from adjacent incisions failed to meet up on heartwood samples, resulting in a castellated effect of untreated zones between lateral incisions.

DOUGLAS FIR, FAST GROWN. Much better, more uniform penetration was achieved on the fast grown Douglas Fir from Washington state. One hundred percent of incised samples showed better than 5 mm (1/4") penetration and 72% of incised samples showed more than 9 mm (38") penetration. Note that, in the 2 x 6 fast grown Douglas Fir, 90% of the samples were over 9 mm but no control batch was taken for this material, which was fairly high in the number of pieces showing significant sapwood content.

COASTAL Hem-Fir. Excellent penetration results were obtained on incised samples, with 96% of the fifty samples over 9 mm penetration. In fact, highest results were also obtained for Hem-Fir in the 13 mm+ grouping (i.e., 75% of incised samples over this thickness compared to only 26% of unincised controls). Note, however, that respectable penetrations were obtained in the 9 mm - 12 mm grouping for unincised samples (i.e., 68%), and 90% of unincised Hem-Fir samples over 5 mm.

In fact, as expected, Hem-Fir was easily the most treatable species group tested; incised and unincised.

Based on our industrial experience, Coastal Hem-Fir is fairly reliable in its treatability and will accept treatment readily, even at higher M.C. percentages than other species are usually treated.

In this test, the M.C. percentage for the air seasoned Hem-Fir was in the average region of 30-40%, with some samples as high as 100% M.C.. Nevertheless, retention values were high - .90 pcf incised, .58 pcf controls.

SPF (88% LODGEPOLE PINE). Greatly improved penetration results were obtained for incised samples over controls. Note that, 84% compliance over the 9 mm depth was obtained for incised samples, compared to only 38% for unincised controls. However, these penetration results were taken from core borings as per CSA M Standards, whereas visual observation of the cut ends of 2 x 4 samples shows some lack of penetration continuity around the outer 9 mm margins in about 30% of the Lodgepole samples.

Note that in the M2 Standard, penetration is measured from the outer end of the core to the first untreated annual ring, or definite break in penetration, and that an annual ring shall be considered penetrated if any portion of that ring shows evidence of preservative penetration. Thus, allowance is made for non-uniform penetration, where, for example, the core receives glancing penetration from an adjacent incision, but is not wholly penetrated for its total volume.

Clearly, the imperfections of this type of non-uniform penetration are revealed when the ends are cut and sprayed with CCA reagent.

SPF (70% WHITE SPRUCE). This test batch showed the most dramatic improvement between controls and incised sample penetrations (See graph 2-E). Whereas 68% of unincised samples fell below 4 mm penetration, only 2% of incised fell below 4 mm.

Note too, that 78% of incised samples were over 9 mm, but that only 12% of the unincised were over 9 mm.

Visual observation of the cut ends showed a good solid zone of penetration, with only a few breaks between incisions for incised samples. These results strongly suggested better overall treatment results for White Spruce heartwood, compared to Lodgepole Pine heartwood - an observation also paralleling the findings of Silcox, B.C. Cleanwood and McGill Timber Specialties Ltd.

CONCLUSIONS

Significant increases in CCA preservative retention and penetration resulted from a close-pattern, fine-tooth incising process in a series of tests conducted by Western Wood Preservers Ltd., involving Coastal Hem-Fir, Douglas Fir and Spruce Pine Fir material.

The process described has been in commercial use for the past year and a half, and has been widely used for high profile esthetic uses such as residential decking and landscaping, where appearance of treated material is of great importance.

Retention and penetration values for incised Hem-Fir and SPF indicates its acceptability for ground contact and above ground use. Of the unincised material, only the Hem-Fir gave retentions and penetrations worthy of consideration for above ground use. The remainder of the unincised material totally failed to meet any current AWPA or CSA Standards for penetration, and showed a high degree of variance for retentions between individual samples.

RESULTS OF TREATMENT

TABLE 1

Retentions, CCA

		RETENTIONS: CCA			
		By Assay		By Weight	
		pcf	kg/m3	pcf	kg/m3
COASTAL DOUGLAS FIR slow grown (B.C.)	unincised	.23	(3.8)	.10	(1.6)
	incised	.52	(8.4)	.26	(4.2)
COASTAL DOUGLAS FIR fast grown (Wash.)	unincised	.53	(8.5)	.41	(6.6)
	incised	.84	(13.4)	.61	(9.8)
COASTAL DOUGLAS FIR fast grown (Wash.) 2x6	incised no control	1.0	(16.2)	--	----
COAST HEMFIR	unincised	.57	(9.2)	.58	(9.3)
	incised	.99	(15.8)	.90	(14.1)
SPF (70% White Spruce)	unincised	.38	(6.0)	.34	(5.4)
	incised	.68	(10.9)	.65	(10.4)
SPF (88% Lodgepole Pine)	unincised	.55	(8.9)	.37	(5.9)
	incised	.84	(13.5)	.65	(10.4)

TABLE 2

RESULTS OF TREATMENT

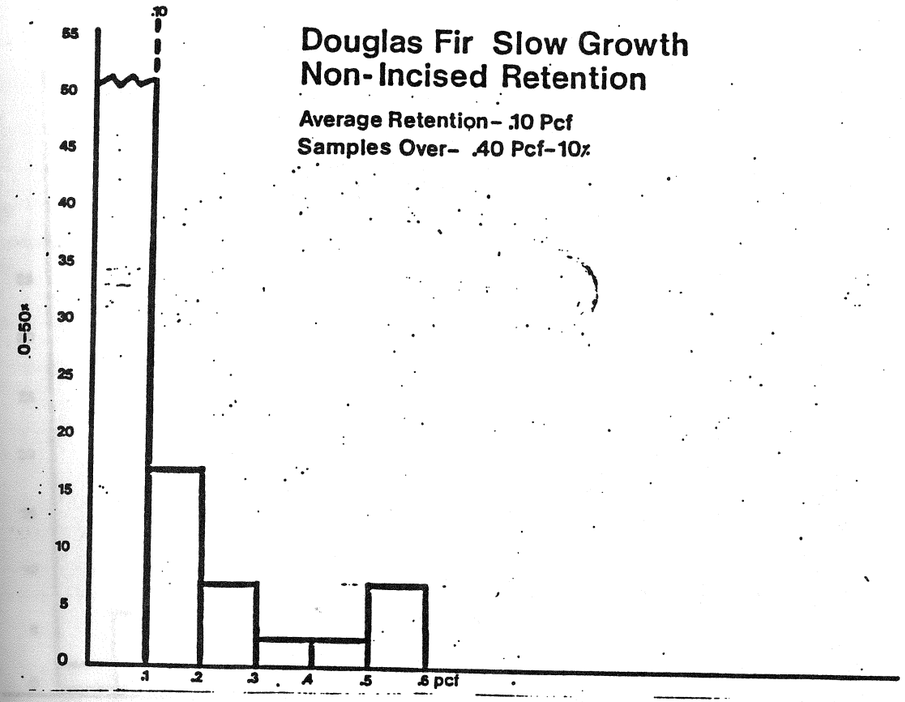
Penetrations, CCA

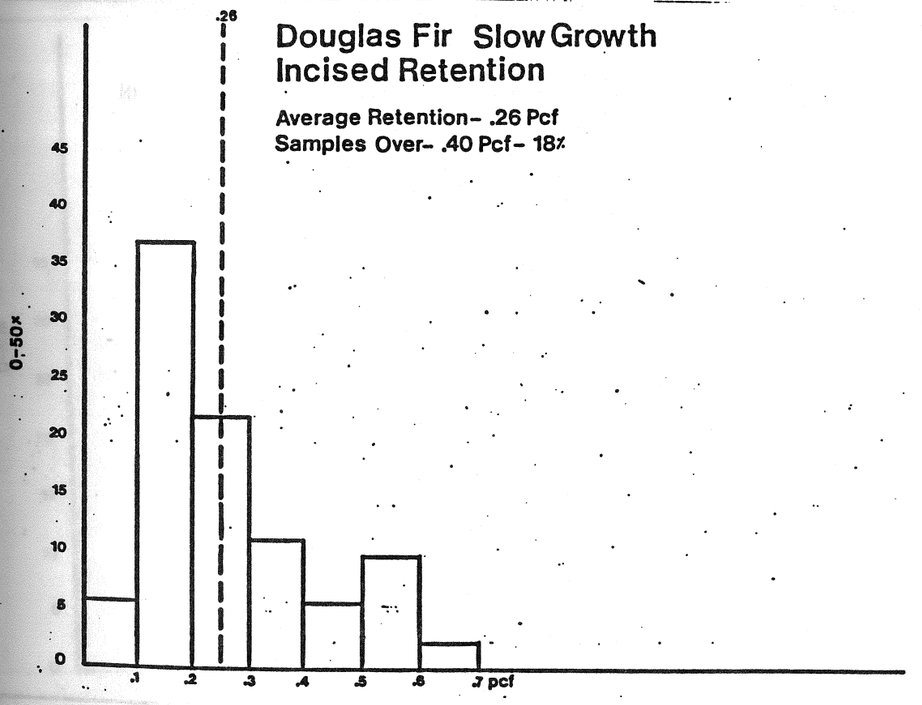
		PENETRATIONS percent over:		
		5mm+	9mm+	13mm+
DOUGLAS FIR (B.C.) slow grown-M.C. 20-25%	unincised	26	14	10
	incised	64	40	18
DOUGLAS FIR (Wash.) fast grown-M.C. 18-25%	unincised	62	38	26
	incised	100	72	20
DOUGLAS FIR (Wash.) fast grown-M.C. 18-25%	incised 2 x 6	100	90	46
COASTAL HEMFIR M.C. 35%	unincised	90	68	26
	incised	98	96	76
SPF (70% Spruce) K.D. M.C. 15-20%	unincised	28	12	8
	incised	98	78	32
SPF (88% Lodgepole Pine) M.C. 25-30%	unincised	66	38	30
	incised	100	82	46

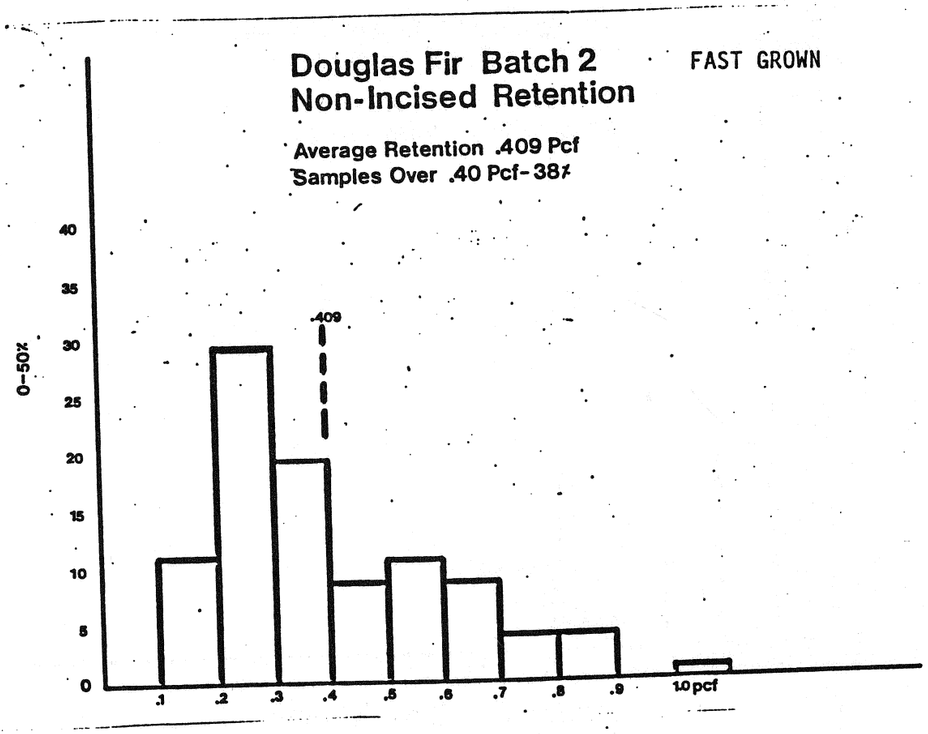
TABLE 3

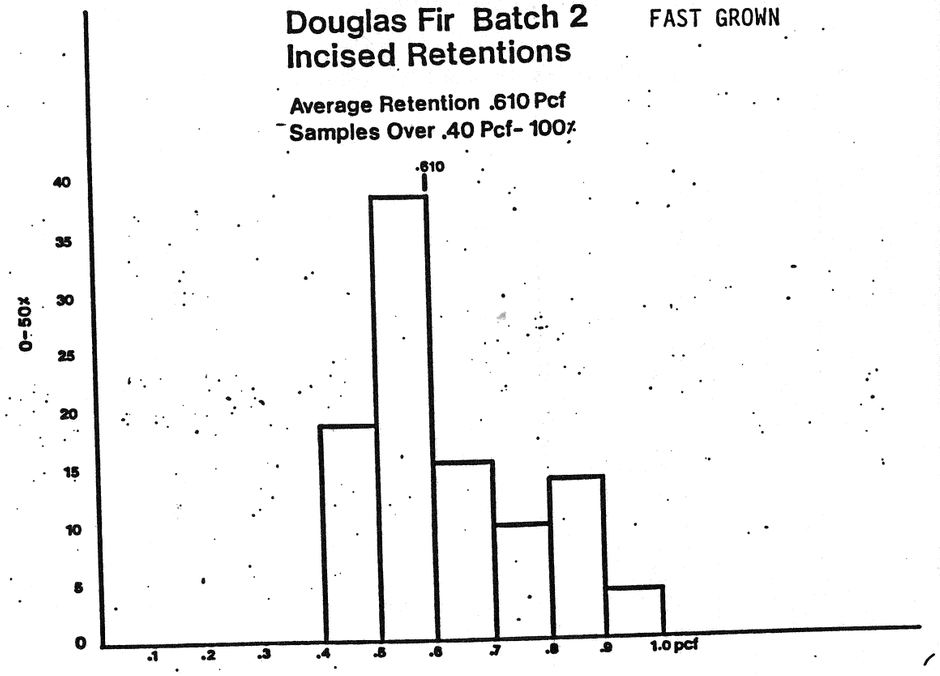
SUMMARY OF RETENTIONS & PENETRATIONS

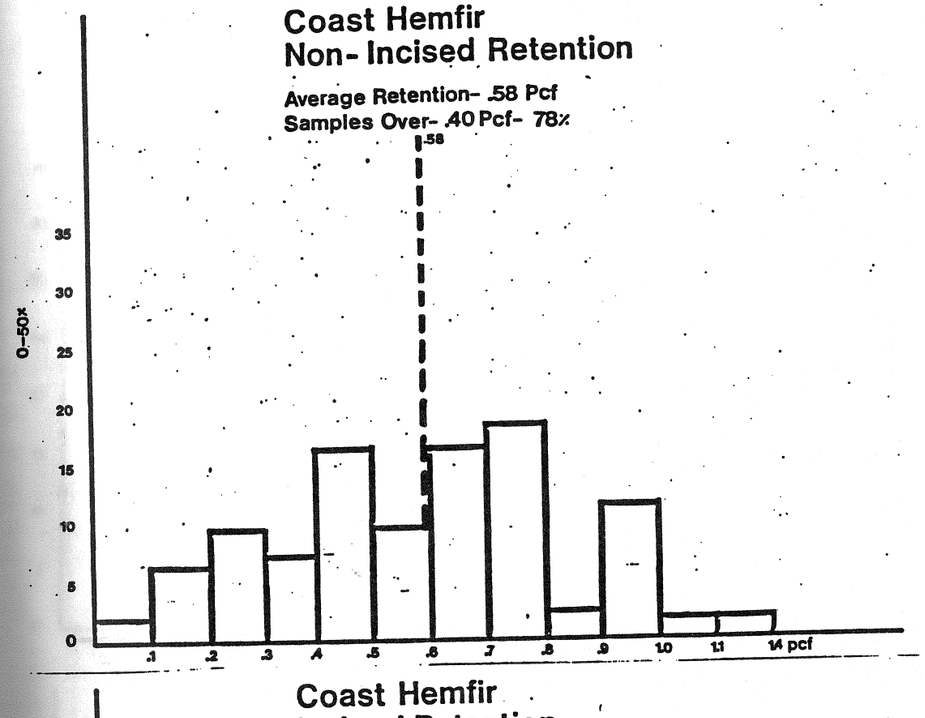
		RETENTIONS PCF		PENETRATIONS
		by weight	by assay	% over 9mm (3/8")
HEMFIR	incised	.90	.84	96
	unincised	.58	.57	68
DOUGLAS FIR (slow grown)	incised	.26	.52	40
	unincised	.10	.23	14
DOUGLAS FIR (fast grown)	incised	.61	.84	72
	unincised	.41	.53	38
DOUGLAS FIR (fast grown)	incised 2 x 6	--	1.01	90
SPF (70% Spruce)	incised	.65	.68	78
	unincised	.34	.37	12
SPF (88% L.Pine)	incised	.65	.84	84
	unincised	.41	.55	38

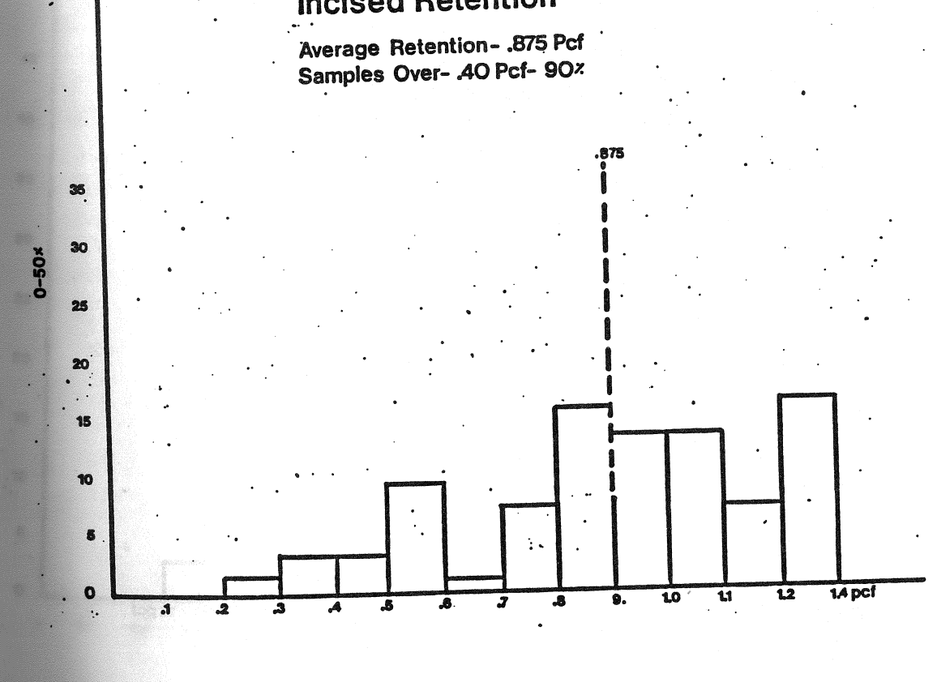





Douglas Fir Batch 2
Non-Incised Retention
FAST GROWN
Average Retention .409 Pcf
Samples Over .40 Pcf- 38%
0-50%
.409
40
35
30
25
20
15
10
5
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0 pcf


Douglas Fir Batch 2
Incised Retentions
FAST GROWN
Average Retention .610 Pcf
Samples Over .40 Pcf- 100%
0-50%
.610
40
35
30
25
20
15
10
5
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0 pcf

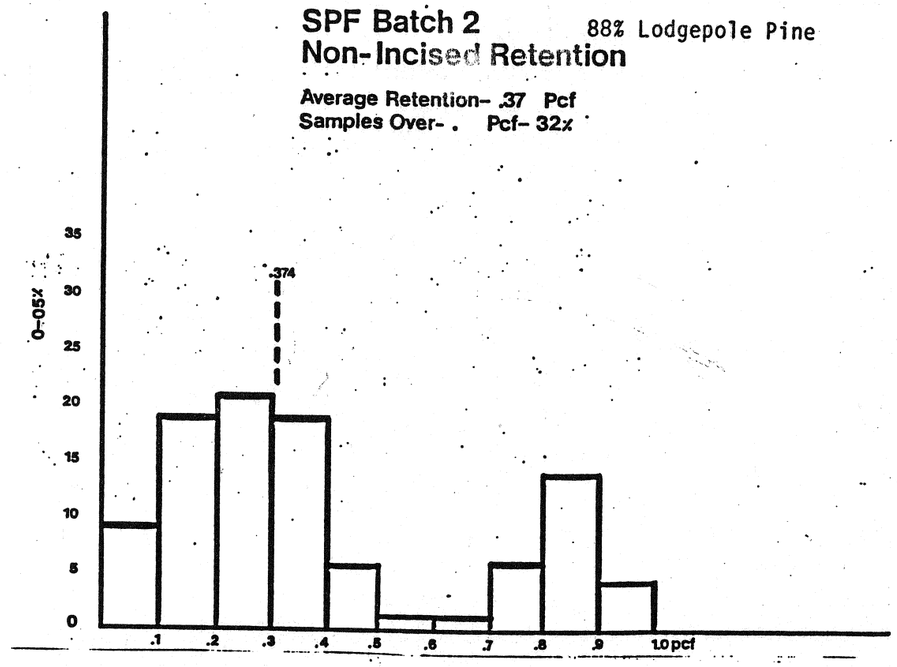

Coast Hemfir
Non- Incised Retention
Average Retention- .58 Pcf
Samples Over- .40 Pcf- 78%
0-50%
.58
35
30
25
20
15
10
5
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.4 pcf


Coast Hemfir
Incised Retention
Average Retention- .875 Pcf
Samples Over- .40 Pcf- 90%
0-50%
.875
35
30
25
20
15
10
5
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
1.1
1.2
1.4 pcf

SPF Batch 2
Non-Incised Retention

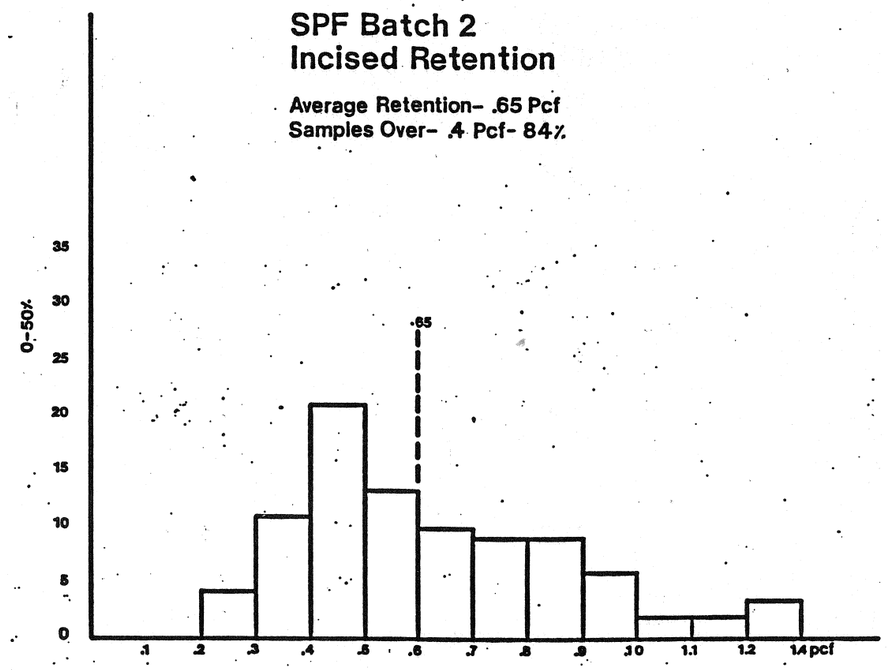
88% Lodgepole Pine

Average Retention- .37 Pcf
Samples Over- . Pcf- 32%



SPF Batch 2
Incised Retention

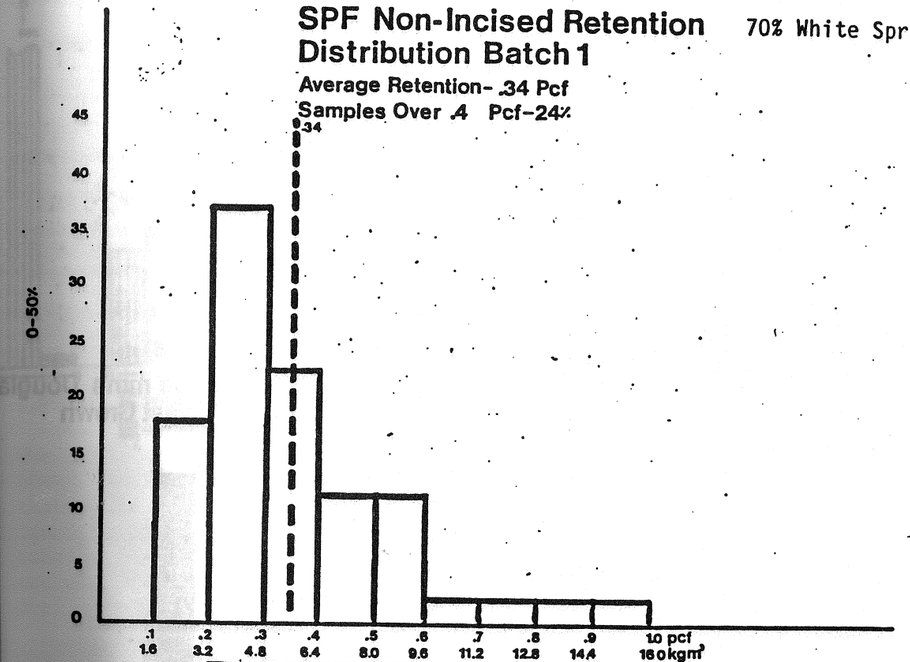
Average Retention- .65 Pcf
Samples Over- .4 Pcf- 84%



SPF Non-Incised Retention
Distribution Batch 1

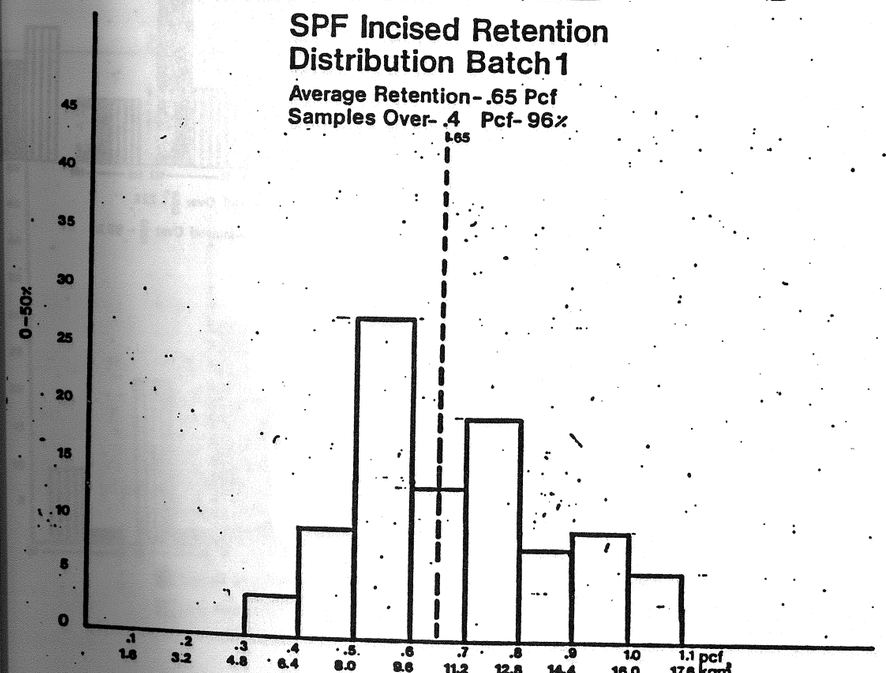
70% White Spruce

Average Retention- .34 Pcf
Samples Over .4 Pcf-24%



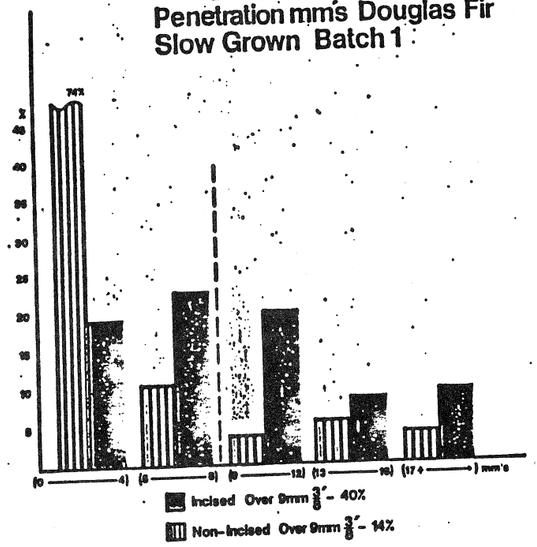
SPF Incised Retention
Distribution Batch 1

Average Retention- .65 Pcf
Samples Over- .4 Pcf- 96%



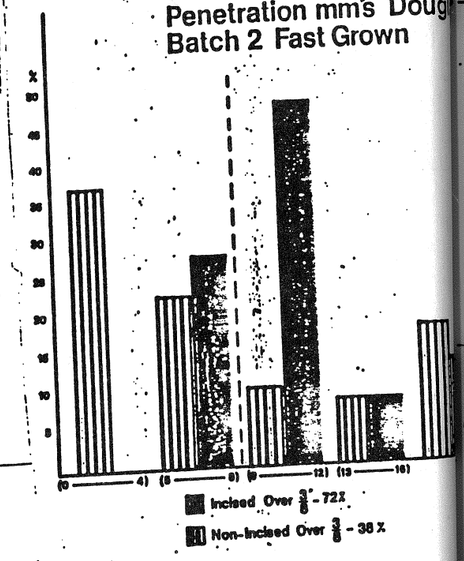
2 - A

Penetration mm's Douglas Fir
Slow Grown Batch 1

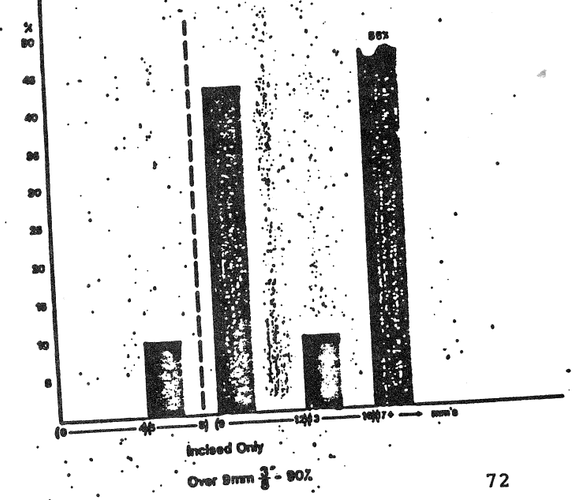


2 - B

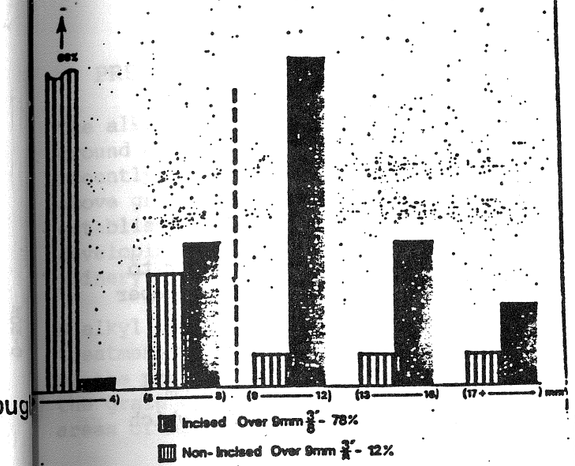
Penetration mm's Doug
Batch 2 Fast Grown



Penetration mm's Douglas Fir
Batch 3 Fast Grown

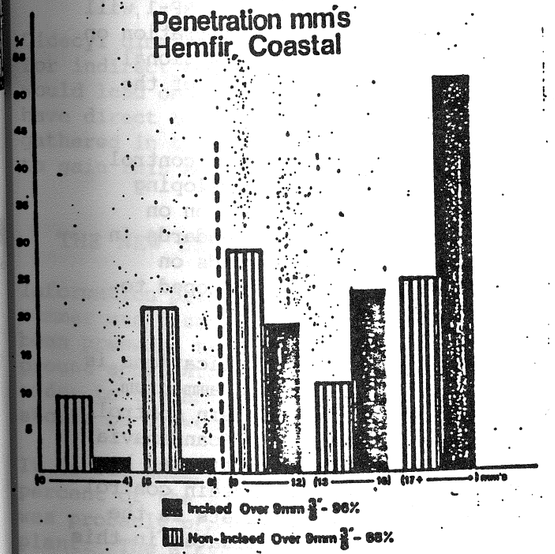


Penetration mm's
SPF Batch1 70% Spruce



2 - C

Penetration mm's
Hemfir, Coastal



2 - D

Penetration mm's SPF
Batch 2 88% L. Pine