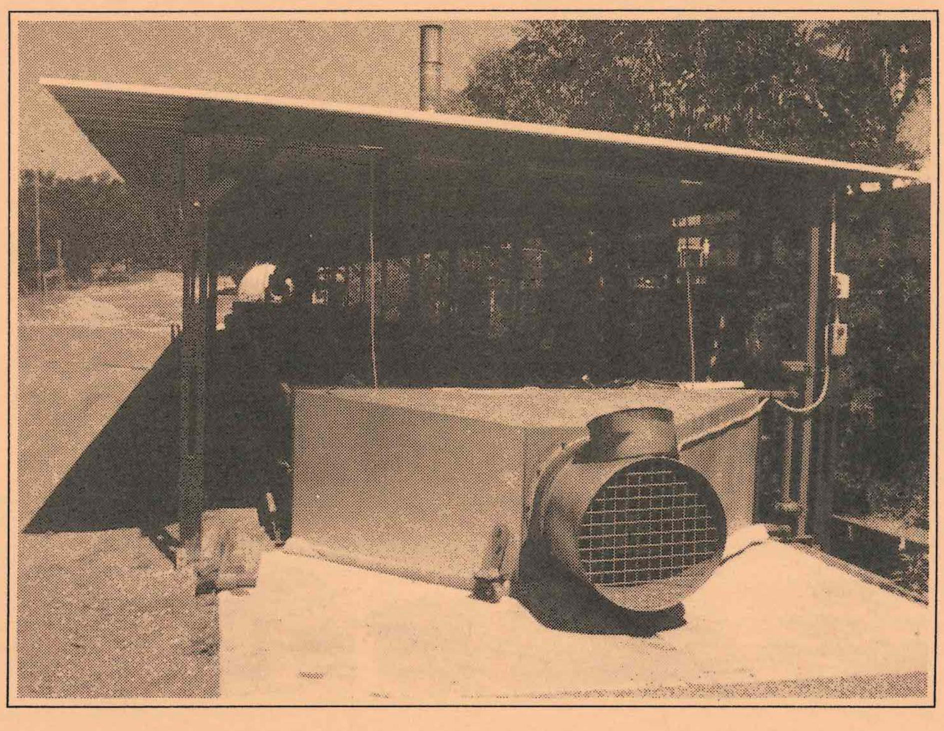
Small Eucalypt Processing

Drying 25 mm Boards Milled from Regrowth Jarrah Logs

G.K. Brennan



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January 1990

Wood Utilisation Research Centre
Department of Conservation and Land Management

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This report is part of a program of industrial research and development aimed at establishing techniques and developing equipment to allow processing of small eucalypt regrowth logs in a commercially viable manner, particularly with a view to use in high quality furniture. The research program is funded jointly by the Commonwealth Government under a Public Interest Project, the Department of Conservation and Land Management, and the Western Australian timber industry.

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SUMMARY

Regrowth jarrah (*Eucalyptus marginata* Donn ex Sm.) logs from two different areas in the northern jarrah forest were milled into backsawn 25 mm boards, which were then dried to below fibre saturation point (f.s.p.) in a modified tunnel kiln. Timber dried in the mild winter ambient conditions had minimal degrade, but material dried under hot dry summer conditions had surface checks, bow, and twist. Bow and spring in boards from logs in one area reduced during seasoning. Spring in boards cut from logs from the second area increased during seasoning by a mean 1 mm per board.

Shrinkage, after the boards were dried from below f.s.p. to final moisture content by high temperature drying, was 7.0 per cent in width and 6.7 per cent in thickness.

INTRODUCTION

Most of the northern jarrah (*Eucalyptus marginata* Donn ex Sm.) forest of Western Australia has been cut-over in the last eighty years and now carries dense regrowth stands (Stoneman 1986). These stands are slow growing because of intense competition and the slow process of self-thinning. Most of the northern jarrah forest is managed as water catchments for Perth's water supply, and country irrigation. Consequently Shea *et al.* (1975) had suggested that thinning of dense regrowth jarrah stands could result in substantial increases in the production of both high quality water and merchantable timber.

Bradshaw's (1983) silvicultural prescription involves:

- retention of crop trees;
- thinning to promote crop tree growth;
- prevention of coppice growth following thinning;
- felling groups of mature trees;
- promoting regeneration in the gaps created.

The primary land-use of the forest is for water production and without thinning virtually no streamflow is generated from these densely forested areas. However, thinning may produce a large quantity of currently unutilisable wood for no direct return, which is not only costly but also wasteful of a potentially valuable resource. The consequences of not using the thinnings is loss of both merchantable and overall wood production, slow diameter growth rates, and inefficient use of the land.

Improving the utilisation status of thinnings from the jarrah forest allows the thinning operation to become a commercial proposition and enhance the management of the jarrah forest. Milling regrowth jarrah logs into seasoned appearance grade boards provides a value-added product.

After milling, jarrah boards must be dried slowly from green to fibre saturation point (f.s.p) slowly to avoid degrade. Drying from f.s.p. to final moisture content can then be done using either high temperature or conventional methods. A modified progressive tunnel kiln based on the concept developed by CSIRO (Fricke 1983) was used for the initial drying to f.s.p.

This type of kiln is an effective way of drying timber from green to f.s.p., before final high temperature drying to the required moisture content. The reduction in drying time made by kiln drying hardwoods from green, compared to partly air drying then kiln drying, has commercial advantages. Timber degrade is also likely to be less than with preliminary air drying in the open (Fricke 1983).

The present trial was designed to determine the overall drying behaviour of 25 mm backsawn regrowth jarrah boards, milled from logs from two different areas which were stockpiled under water sprays for up to 2 months or for 15 months, when the sawn timber was dried from green to below f.s.p.. In addition, shrinkage in width and thickness was assessed after the boards were further dried to final moisture content.

MATERIALS AND METHODS

The logs processed in this trial were produced when Bradshaw's (1983) thinning prescription was applied to a 9.5 ha high quality jarrah pole stand adjacent to Banksiadale Road, Dwellingup District, and to a 60 ha area containing regrowth and mature forest in Kent Block, Harvey District. In the Banksiadale Road operation, general purpose sawlogs and poles were initially removed from the stand, which was then thinned to a basal area of between 10 and 12 m^2/ha by removing regrowth sawlogs and minor forest produce (m.f.p.).

Specifications for small sawlogs and m.f.p. are given in Appendices 1 and 2. All small sawlogs were taken to the Wood Utilisation Research Centre (W.U.R.C.) at Harvey for stockpiling, sawmilling and seasoning trials, and the m.f.p. was sold locally.

Some logs from harvesting trials, conducted in Kent Block to obtain information on logging costs and yield of small sawlogs (Clark and Brennan 1988), were stockpiled for up to 2 months for use in the present trial. The remainder were used in a stockpiling trial with different watering regimes, or sent to Bunnings sawmill at Yarloop for company sawmilling trials.

White (1989) carried out a sawmilling study on these logs, comparing three different sawing patterns to minimise the effects of the growth stresses which are characteristic of regrowth eucalypts. Milling produced 25 mm thick boards, which were seasoned in the present trial.

A tunnel kiln at the W.U.R.C. was used in this trial. Its operation is simple, with ambient air blown through the kiln by a large centrifugal fan and directed through the timber stacks by baffles located between the sides of each stack and the kiln wall (Fig. 1). The kiln has a capacity of approximately 6 m^3 (10 stacks averaging 0.6 m^3). At the time of this study, wet and dry bulb temperature sensors were located at the green and dry ends, midway along the tunnel and above the kiln. The air velocity through the stacks was approximately 1.0 m/s and the direction of flow was from the dry end to the green end.

Modifications were subsequently made, although the general principles have remained the same. Stacks are moved progressively on trolleys against the counter flow of air, towards the dry end where they are removed. Standard practice is to load either one or two stacks a week, depending on the time needed to dry to below f.s.p.

10 stacks of 2.2 m x 1.0 m x 0.5 m

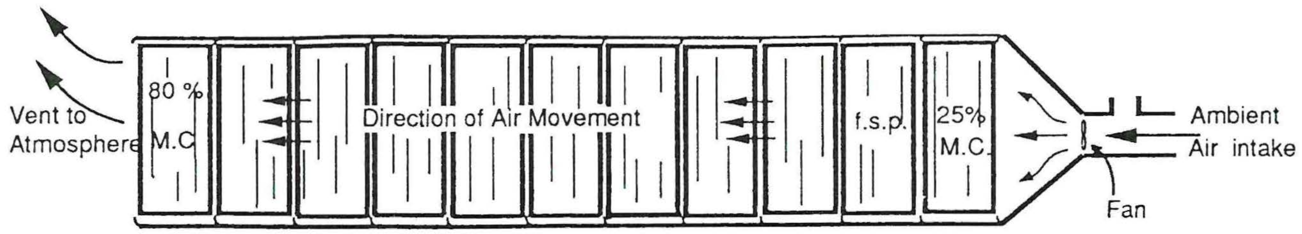

Figure 1.
Diagram of the W.U.R.C. tunnel kiln.

The 25 mm boards were dried from green to f.s.p. using the tunnel kiln described previously. The first 25 mm regrowth jarrah stack was placed in the kiln in August 1985, with mild winter drying conditions. Wet and dry bulb temperature charts produced in a drying trial of 25 mm mature jarrah boards (Brennan and Glossop 1989) were used to estimate desirable temperature and relative humidity (R.H.) conditions.

Shrinkage of Regrowth Jarrah

Four randomly selected sample boards in each bundle were measured for width and thickness, before being placed in the tunnel kiln, and remeasured at the same positions after being dried to final moisture content in an experimental high temperature kiln. Further measurements were taken after reconditioning, and shrinkage in width and thickness were estimated. True tangential and radial shrinkage could not be estimated because of growth ring curvature in the boards.

The high temperature drying schedule used was:

Treatment	Time (h)	R.H. (%)(a)	Air temp. (°C)	Wood temp. (°C)
Heat-up phase	0 to 2	40	112	108
Drying phase	2 to 12	20	112	108
Kiln adjustment	12 to 13	20	112 to 96	108 to 94
High humidity	13 to 17	45	96	94

NOTE:
- air velocity ranged from 5 to 7 m/s.
- drying time varied from 8 to 12 h depending on bundle moisture content.
- all boards were dried to between 6 and 12 per cent moisture content.

(a) R.H. = relative humidity

RESULTS AND DISCUSSION

The average conditions at the green end of the tunnel kiln from 25 July to 12 September 1984 were estimated by Brennan and Glossop (1989), using temperature charts from a drying trial of mature jarrah, as:

Tunnel Kiln	**Time**	**Range**
R.H. (a)	0300 h	81 to 87%
R.H.	1500 h	77 to 85%
Temp.	0300 h	12.0 to 15.5°C
Temp.	1500 h	15.0 to 17.0°C

(a) R.H. = relative humidity

These conditions are very mild compared with summer conditions which produce severe drying conditions. Ambient temperature and humidity conditions for this time of year were also estimated from the temperature charts used in the mature jarrah trial:

Ambient	Time	Range
R.H. (a)	0300 h	70 to 79%
R.H.	1500 h	64 to 75%
Temp.	0300 h	12.0 to 15.5°C
Temp.	1500 h	19.0 to 22.0°C

(a) R.H. = relative humidity

Results from the mature jarrah seasoning trials (Brennan and Glossop 1989) indicated that when the R.H. at the green end drops below 75 per cent, and temperature rises to between 19oC to 22oC, timber will surface check, bow, and twist. These conditions occur when the hot summer ambient conditions prevail. Dried under mild winter ambient conditions, the timber had minimal surface checking, bow and twist.

When evaluating drying conditions, the accuracy and precision of the temperature sensors used must be considered. Although the sensors gave precise readings, it became obvious that there were possible problems with accuracy because they were assumed to be calibrated by the supplier. Consequently the Department installed resistance temperature devices (R.T.D.'s) and a computerised control system, and the accuracy of the R.H. and temperature measurements has been established.

Drying rates of 25 mm regrowth jarrah boards

Moisture contents of four sample boards per stack were assessed when the timber was placed in the tunnel kiln, and after drying for two days, one week, two weeks and 10 weeks (when the bundle was removed). Mean moisture losses from boards cut from logs from each water spray treatment varied from 1.0 per cent/day to 5.0 per cent/day for the first week, and from 0.8 per cent/day to 1.2 per cent/day over the kiln cycle. These drying rates depend on the initial moisture contents and kiln drying conditions. The majority of boards had dried to below f.s.p. after 10 weeks.

A drying rate of approximately 1.0 per cent/day during the early stages of drying would slow the overall drying rate down and prevent timber degradation. To achieve this rate at the green end of the kiln, predictions from a drying rate equation developed for the tunnel kiln when drying mature jarrah indicated that either an R.H. of 93 per cent at 10oC or an R.H. of 97 per cent at 25oC is required (Brennan and Glossop 1989).

Air conditioning and kiln control over R.H., temperature and air velocity are necessary to achieve these conditions.

Department of CALM staff subsequently modified the tunnel kiln, and installed computer equipment to control and monitor the kiln drying conditions. These modifications included adding several fogging devices to the kiln, which gave greater flexibility in control of drying rates.

Collapse and internal checking did occur on some boards after 10 weeks drying. These defects are often associated with brittle heart, and preventing collapse when drying this type of timber is difficult.

Drying degrade

Drying degrade was assessed on sample boards (20 per cent sample of the total boards) when the stack was placed in the tunnel kiln, and after 2 days, one week, two weeks and 10 weeks drying. The major factors degrading the timber were face checking, end splitting, and warping, although collapse and internal checking did occur in some boards after 10 weeks drying.

Bow and spring changes in drying from green to f.s.p. and to final moisture content

When the timber from the Banksiadale Road logs dried from green to f.s.p., the mean reduction in bow was 3.3 mm per board with a maximum of 15 mm, and spring 0.5 mm per board with a maximum of 8 mm. For the timber from Kent Block the mean reduction in bow was 4 mm with a maximum of 16 mm, while spring had a mean increase of 1 mm per board.

The same trend could be seen in drying the timber from both sources from green to final moisture content, with the difference being that the mean reduction in bow was 5 mm per board. Drying from f.s.p. to final moisture content was done in an experimental high temperature kiln, using a schedule of 112°C dry bulb and 70°C wet bulb temperatures. The bow results could be due to both log source and stockpiling treatment.

In Victoria, McKimm et al. (1985), using 20-year-old plantation grown E. nitens *(Deane and Maiden)* Maiden, found that bow and spring of 25 mm and 50 mm material was decreased by drying, with bow reducing by between 7 mm and 9 mm. Their results showed that distortion after seasoning is well within the permissible limits for bow, spring and twist described in AS2082-1979 (Standards Association of Australia 1979).

Shrinkage of regrowth jarrah

When timber is cut from small logs it is difficult to obtain truly backsawn boards because of curvature of the growth rings. Consequently, the results are given as:

Width shrinkage	7.0 ± 2.1 per cent (range 4.1 to 10.7 per cent).
Thickness shrinkage	6.7 ± 2.5 per cent (range 1.6 to 13.9 per cent).

Although the green sizes milled were standard for mature jarrah, a large number of boards did not make the thickness required for furniture quality due to excessive shrinkage. This was caused by the higher shrinkage occurring with regrowth jarrah than was reported for mature jarrah by Kingston and Von Stiegler (1966). Similarly, McKimm *et al.* (1985) found 20-year-old E. nitens had significantly higher shrinkage in both the tangential and radial direction, despite reconditioning, than mature *E. nitens* had.

The shrinkage results from this trial cannot be regarded as true tangential or radial shrinkage, but as a practical guide to the dimensions that need to be cut to avoid downgrading furniture quality timber through undersized boards evidenced by planer skipping over part of the board. To obtain true shrinkage, measurements need to be taken exactly perpendicular to the rays for tangential, and parallel to the rays for radial shrinkage assessment.

The high dimensional shrinkage (particularly thickness on backsawn boards) of regrowth jarrah compared with mature jarrah has resulted in the W.U.R.C. sawmill cutting nominal 25 mm boards to 30 mm instead of the industry standard for mature jarrah of 27 mm to 28 mm in thickness. This has resulted in improved furniture grade recovery but a reduced volume recovery overall.

REFERENCES

BRADSHAW, J. (1983). Silvicultural treatment of jarrah forest for wood production. Forests Department of Western Australia. Unpublished report.

BRENNAN, G.K. and GLOSSOP, B.R. (1989). Seasoning 25 mm mature jarrah using a progressive tunnel kiln. Department of Conservation and Land Management, W.U.R.C. Technical Report. Limited distribution.

CLARK, J.D. and BRENNAN, G.K. (1988). Small jarrah sawlog and residue log harvesting trials near Harvey, W.A. Department of Conservation and Land Management, WURC Report No. 4.

FRICKE, K.W. (1983). The CSIRO low temperature low cost, progressive kiln. Australian Forest Industries Journal 49(4):14-16.

KINGSTON, R.S.T. and VON STIEGLER, A.E. (1966). Shrinkage and density of Australian and other woods. CSIRO Forest Products Newsletter No. 332-6.

McKIMM, R.J. WAUGH, G. and NORTHWAY, R.L. (1985). Studies on the utilisation of dominant 20 year old plantation grown trees of Eucalyptus nitens. Victorian Department of Conservation, Forests and Lands, State Forest and Lands Service. Research Branch Report No. 304.

STANDARDS ASSOCIATION OF AUSTRALIA (1979). Visually stress graded hardwoods for structural purposes. AS2082-1979.

SHEA, S.R., HATCH, A.B., HAVEL, J.J. and RITSON, P. (1975). The effect of changes in forest structure and composition on water quality and yields from the northern jarrah forest. In: Managing Terrestrial Ecosystems (Kikkawa, J. and Nix, H.A. - Eds). Proceedings Ecological Society of Australia 9:58-73.

STONEMAN, G.L. (1986). Wood generated by thinning in the northern jarrah forest. Australian Forestry 49(2):115-122.

WHITE, K.J. (1989). Regrowth jarrah stockpile and sawing trial. Department of Conservation and Land Management. W.U.R.C. Technical Report. Limited distribution. August 1989.

APPENDIX 1

Specification for small sawlogs used in the trial

1. Small end diameter under bark (s.e.d.u.b.)
   * Minimum 150 mm
   * Maximum 350 mm

2. Large end diameter under bark (l.e.d.u.b.)
   * Minimum 150 mm
   * Maximum 400 mm

3. Length
   Any of the following, aiming for long lengths:
   2.4, 3.6 or 4.8 m

4. Quality
   * straightness - maximum 30 mm sweep in any 2.1 m length.
   * log ends at least 50% solid wood.
   * both log ends cut square.
   * no deformities such as dry sides, bumps or protrusions.

APPENDIX 2

Specification for minor forest produce harvested commercially

1. Fence posts

Small end diameter under bark (s.e.d.u.b.)
* Less than 150 mm

Length 1.8 to 1.85 m

2 Strainers

Small end diameter under bark (s.e.d.u.b.)
* Up to 250 mm

Length 2.3 m

3. Rails

Small end diameter under bark (s.e.d.u.b.)
*No restrictions

Length 3.35 to 7.0 m

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W. U. R. C. REPORTS

No.	TITLE
1.	Economic utilisation of thinnings from the jarrah forest. G.K. Brennan (1988).
2.	Sawing performance in Western Australian sawmills. W.M. McKenzie (1988).
3.	Moisture content of jarrah logging residues. G.K. Brennan. and B.R. Doust (1988).
4.	Small jarrah sawlog and residue log harvesting trials near Harvey, W.A. J.D. Clark and G.K. Brennan. (1988).
5.	Splitting of W.A. sheoak *(Allocasuarina fraseriana)* logs stored under water spray or dry stockpiled. G.K. Brennan (1988).
6.	Penetration of copper-chrome-arsenic preservative into regrowth jarrah posts. G.K. Brennan (1988).
7.	Using pine timber. G.R. Siemon (1988).
8.	Sawmilling trial of agroforestry and conventionally-grown radiata pine. G.R. Siemon, K.J. White and A.B. Thomson (1989).
9.	Survey of solid wood sizes used by the furniture industry in Western Australia D.J. Challis (1989).
10.	Effect of pencilling and furnace oil treatment on strength properties of jarrah. L. Siamos and G.R. Siemon (1989).
11.	The Wickepin fence post trial after 57 years of service. R. Rule (1989).
12.	Adhesives for manufacture of furniture blanks. P. Newby and G.R. Siemon (1989).
13.	Shrinkage, collapse and dimensional recovery of regrowth jarrah. A.B. Thomson (1989).
14.	Drying 25 mm boards milled from regrowth jarrah logs. G.K. Brennan (1990).