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PROCESSING PLANTATION-GROWN TASMANIAN BLUE GUM

G.K. Brennan, W.R. Hanks and S.L. Ward

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W.U.R.C. Technical-Report No 41.

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SUMMARY

Tasmanian blue gum (*Eucalyptus globulus* Labill ssp. *globulus*) from an 8-year-old plantation on a former pastured site and from a 10-year-old plantation on a former bush site, were processed into panels. A green sawn recovery of 52.7 per cent was achieved of which 15.1 per cent was processed into finished panels. Shrinkage, edge trimming, dressing, and docking end splits accounted for lost recovery during processing. Four adhesives were tested, and consequently, urea formaldehyde is recommended for interior use and resorcinol formaldehyde for exterior use.

INTRODUCTION

The Western Australian Government, in association with the Department of Conservation and Land Management and private industry, plans to establish Tasmanian blue gum (*Eucalyptus globulus* Labill ssp. *globulus*) as a major species in approximately 100 000 ha of plantations in the south-west of Western Australia. The major objective is to provide a plantation-grown resource for the wood chip industry.

Tasmanian blue gum occurs naturally in south-east Tasmania, the Bass Strait Islands and south-east Victoria. Its low level of frost tolerance restricts its distribution to low altitudes and near-coastal locations. This species has proved adaptable and productive, and it has become the most important temperate zone eucalypt in world forestry. It is also widely planted at high altitudes in tropical latitudes. Its common uses include fuelwood, poles for roundwood construction, sawn timber, and more recently it has become a major pulpwood species.

In this study Tasmanian blue gum logs were processed into VALWOOD®, which is a system for producing value-added dimensioned wood for use in furniture manufacturing to supplement existing supplies of furniture wood. By targeting the specific needs of manufacturers, VALWOOD® can improve the efficiency in the use of wood resources. The process involves crosscutting logs to order lengths, sawing into boards, drying, ripping to maximum width, dressing to 10 mm, and building up the width and thickness by edge-and-face jointing to produce a blank panel, the dimensions of which are calculated for subsequent efficient production of multiple furniture components. Using Tasmanian blue gums in the VALWOOD® process gives plantation owners a value-added end use which is an alternative to pulp and paper manufacture.

METHODS

Log source and storage

The Tasmanian blue gum logs used in this study were supplied by Bunnings Treefarms from an 8-year-old ex-pasture site plantation and a 10-year-old ex-bush site plantation, both in Manjimup District. The logs were delivered to the Wood Utilisation Research Centre (W.U.R.C.) on the day they were harvested, and were stockpiled under water spray storage for five months until the research program allowed processing in the W.U.R.C. sawmill.

Prior to milling, the logs were separated into ex-pasture and ex-bush site plantation logs, and debarked by axe. Most logs were docked to 2.4 m or 1.2 m, and the remainder to 1.8 m or less than 1.2 m. Length, small end diameter under bark (s.e.d.u.b.) and large end diameter under bark (l.e.d.u.b.) were measured and log volumes calculated using Smalian's formula (Carron 1968).

Sawmilling

Log breakdown was done with a 'Forestor 150' horizontal bandsaw and resultant flitches were resawn to 18 mm thick boards on a 'Jonsereds' bandsaw. The widths produced were 70, 95, 105, 130 or 165 mm.

The green thickness of the boards was sawn at 18 mm to allow for large shrinkage in the ash-type eucalypts. Six bundles of boards were produced, of which three were from the ex-pasture site and three from the ex-bush site.

Drying

One bundle of boards from the ex-pasture site and one bundle from the ex-bush site were dried in an experimental high temperature kiln to between 6 and 8 per cent moisture content. The ex-bush site bundle received 22 days of air drying, (while the ex-pasture site bundle was being kiln dried) before the former was kiln dried to final moisture content. All other bundles were air dried, and then kiln dried to between 6 and 8 per cent in the commercial high temperature kiln.

The drying schedules and resulting moisture contents were as follows (Table 1):-

Table 1
Drying schedules and moisture contents of ex-pasture and ex-bush site boards of Tasmanian blue gum

Ex-pasture site boards

Time (Days)	DBT (^0C)	WBT (^0C)	Air velocity (m/s)	Moisture content (%) Mean	Range
0	30	27	1	103.4	101-107
1	30	27	1		
2	30	27	1		
3	40	35	2		
4	40	35	2		
5	40	35	4	45.4	31-56
6	40	35	4		
7 (8 hrs)	60	50	4		
8 (8 hrs)	80	60	4		
(8 hrs)	105	60	4		
R (45 mins)	90	90	1	7.7	6.2-8.7

DBT - Dry bulb temperature
WBT - Wet bulb temperature
R - Reconditioning treatment

Ex-bush site boards

Time (Days)	DBT (^0C)	WBT (^0C)	Air velocity (m/s)	Moisture content (%) Mean	Range
0	40	35	2	24.6	13-30
1	60	50	4		
2 (8 hrs)	80	60	4		
(6 hrs)	105	60	4		
R (45 mins)	90	90	1	4.2	3.9-4.6

DBT - Dry bulb temperature
WBT - Wet bulb temperature
R - Reconditioning treatment.

Following between 10 and 17 days air-drying, four bundles of Tasmanian blue gum were dried in the commercial high temperature kiln to approximately 5 per cent moisture content. Eight regrowth jarrah bundles were included to make up the charge. The drying schedule and moisture contents are given below (Table 2).

Table 2

Alternative drying schedule and mean moisture contents for Tasmanian blue gum

Time (Days)	DBT (^{0}C)	WBT (^{0}C)	Air velocity (m/s)	Moisture content (%)	
				Mean	Range
*0	21-32	Floating (vent quarter open)	5-7	73	61 - 99
6	60	Floating	5-7		
7	80	Floating	5-7		
12	80	Floating	5-7	5	4 - 7

* For the first 5 days air is applied to the charge, which increased the DBT to between 21 and 32^{0}C.

When the bundles were removed from the kiln on day 13, moisture content had increased to a range of 6 to 8 per cent.

Shrinkage

Twenty-five boards were randomly selected for measuring width and thickness before and after drying and reconditioning. Shrinkage was estimated by the formula:-

$$\text{Shrinkage}(\%) = \frac{\text{Green dimension - dry dimension}}{\text{Green dimension}} \times 100$$

True tangential and radial shrinkage could not be estimated because of growth ring curvature in the boards.

Density

Basic densities of three ex-bush site samples and three ex-pasture site samples were estimated. Density scans were done using a gamma ray densitometer developed by Chisholm Institute of Technology in Melbourne (Davis 1988).

Three logs from each of the ex-pasture and ex-bush sites had a 20 mm disc section cut approximately 300 mm from the end of each log. Radial samples were cut from each of these discs, producing pieces approximately 140 x 20 mm. Samples were stored in a plastic bag to prevent any drying before scanning.

Scanning was done radially across the growth rings (140 mm side) from the centre to the outer ring in 1 mm increments (Fig. 1). Initial scans were done on the green samples then they were oven-dried and scanned dry.

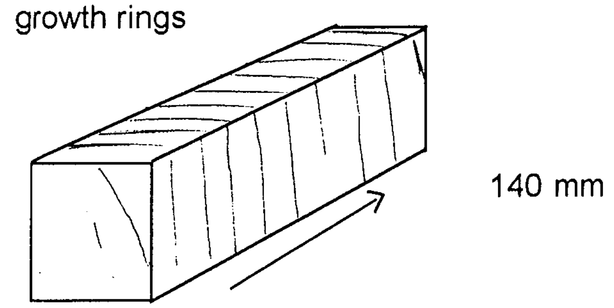

Figure 1 Scanning direction for a 140 x 20 mm wood sample using a gamma ray densitometer.

Basic density was calculated at every 1 mm scan by the formula:-

$$BD = \frac{\text{Measured dry density x dry length}}{\text{green length}}$$

Mean overall basic density and maximum and minimum values were determined for both ex-pasture site and ex-bush site logs.

Dressing and grading

Following drying, the timber was left for one week to stabilize. The boards were dressed all around using a 'Guilliet' 4-side planer. Boards were graded using the feature grading rules for Western Australian hardwoods for furniture use and the VALWOOD® grading rules developed by the W.U.R.C.

Glue lamination and quality control

Following planing and docking to remove end splits, the timber was stored under stable mild conditions in the processing shed before gluing into panels.

Four adhesives were assessed, with glue lamination being done under similar conditions. The adhesives were :

Urea formaldehyde (Grasp)
Resorcinol/polyphenolic formaldehyde (Bondtite 145)
Resorcinol formaldehyde (Resobond A3)
Melamine urea formaldehyde (Selleys 308 - now Aerolite 308)

Edge-and-face jointing was done with an 'Orma' glue press with an oil-heated platen set at 90°C, downward pressure of 1500 p.s.i. (10.3 MPa) and lateral pressure of 1200 p.s.i. (8.3 MPa). Curing time was 8 minutes.

For quality control purposes, glueline strengths were assessed by dry cleavage tests. These tests involved cutting a 50 mm wide strip from one end and from the centre of each panel, giving eight gluelines for testing. Each glueline was broken apart, following the requirements of AS1328 - 1987 (Standards Association of Australia 1987), and the percentage of wood failure was estimated.

RESULTS AND DISCUSSION

Log quality

Although log quality was not assessed, observations during sawmilling indicated that quality was good, with few knots and no incipient rot, or actual rot. The absence of incipient rot and rots could be owing to the young age of the logs, where symptoms have not yet developed. Thomson and Hanks (1990) found large knots and kino were the major defects downgrading appearance boards in Tasmanian blue gum, but structural material of acceptable stress grades could be produced. Very little incipient rot was noticed in the graded material, because of the practice of discarding the core material of each log.

Recoveries

Table 3 lists the mean s.e.d.u.b., lengths and green sawn recoveries for the ex-bush site, ex-pasture site and combined. S.e.d.u.b. and length showed very little variation between sites, but mean recovery from the ex-pasture site logs was approximately 5 per cent higher than the ex-bush site logs. The combined recovery of 18 mm thick boards was 52.7 per cent. In comparison, Brennan and Ward (1990) reported a mean green sawn recovery of 23.2 per cent for 25 mm boards milled from regrowth jarrah from four different areas in the northern jarrah forest. Theoretically the recovery decreases with decreasing thickness, but the incidence of defects was presumably greater in the jarrah timber.

Table 3
Green sawn recovery of Tasmanian blue gum logs from ex-bush and ex-pastured sites

Log Source	N	S.e.d.u.b. (cm)			Length (m)			Recovery (%)		
		Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
Ex-bush Site	61	20.6	4.1	15-30	2.1	0.5	1.1-2.4	49.9	7.5	34.9-77.0
Ex-pasture Site	68	19.9	3.2	15-31	2.0	0.5	1.2-2.4	55.2	10.8	20.7-72.4
Combined	129	20.2	3.6	15-31	2.0	0.5	1.1-2.4	52.7	9.7	20.7-77.0

Waugh (1980) stated that the two most critical factors affecting recovery are log sweep and the size of the knotty core. Logs used in this trial were straight and required no docking for sweep. The VALWOOD® system can utilise the knotty core and brittle heart, provided it has not excessively split or warped, and therefore higher recoveries can be achieved.

The green sawn recoveries by diameter and length classes for the combined sites (Table 4) showed only a slight increase in recovery as diameter and length increased. When VALWOOD® boards are cut any brittle heart can be utilized in inner laminates, however, when larger sections are cut from small diameter logs for appearance or structural grades the brittle heart is discarded.

Table 4
Green sawn recovery of Tasmanian blue gum for the combined areas by diameter and length class

	No. of samples	Recovery (%)		
		Mean	S.D.	Range
S.e.d.u.b. class (cm)				
15-19.5	63	51.6	11.0	23.1-77.0
20-24.5	52	53.7	8.7	20.7-71.9
25-29.5	9	52.5	7.2	42.4-62.0
30-34.5	5	56.6	1.7	54.7-58.7
Length class (m)				
<1.2	1	47.1	-	-
1.2	35	51.6	10.9	20.7-71.9
1.8-2.2	5	52.2	12.1	36.8-65.4
2.4	88	53.2	9.2	23.1-77.0

Thomson and Hanks' (1990) sawmilling study on 24-year-old Tasmanian blue gum from Willow Springs Arboretum, Nannup District, converted logs into structural timber (40 mm and 50 mm thick) and appearance timber (30 mm thick). They achieved a sawn recovery of 30.5 per cent, with structural timber comprising 14.6 per cent and appearance timber 15.9 per cent.

In comparison with the present trial, Thomson and Hanks (1990) observed excessive deflections during sawing. Bow and spring resulting from sawing in the present trial were small and did not cause any problems during sawing, presumably because only 2.4 m or shorter logs were milled, which would have reduced the amount of deflection during sawing.

Timber characteristics

The light/pale coloured timber has an oak/beech appearance and if required would readily stain darker. Attractive grain streaks were present in many boards. Very little colour variation occurred between boards making colour matching a simple process.

Knots were a feature of many boards, with the larger knots having some minor checks. Some boards contained pithy heartwood which is associated with juvenile wood in the centre of young regrowth trees.

Drying properties

The board quality following seasoning was good, with surface checks presenting no problems. End splitting occurred on many boards as a result of the combination of growth or drying stresses. Board bow and spring and excessive shrinkage around large knots (causing splitting) presented some problems. Uneven shrinkage also resulted in cupping and undersizing during planing. Some staining was observed around the heartwood.

Shrinkage

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 of shrinkage assessment after reconditioning are given as width shrinkage instead of tangential, and thickness shrinkage instead of radial.

Width shrinkage	9.45 $\pm$ 2.1 per cent (range 6.5 to 13.3 per cent)
Thickness shrinkage	6.9 $\pm$ 1.9 per cent (range 4.7 to 13.7 per cent)

Cutting green boards at 18 mm thick results in dimensional losses of an average of 1.2 mm and a maximum 2.5 mm owing to shrinkage. The general practice is to remove 4 mm in dressing, therefore if the required finished size is 10 mm then a green thickness of 16.5 mm could be cut without producing undersize boards. However, when dressing timber using a straightening planer, additional size is needed if the board is distorted to achieve the nominal size.

Kingston and Risdon (1961) quoted pre-reconditioning tangential shrinkage of 14.4 per cent and radial of 6.9 per cent, and post-reconditioning tangential shrinkage of 9.4 per cent and radial of 4.6 per cent for 17- to 23-year-old Tasmanian blue gum. Similar shrinkage values were observed in this trial with 8- and 10-year-old logs.

Density

The density values recorded by densitometer scans on three specimens indicated that the overall basic densities of the bush site samples were less than those of the pasture site samples (Table 5).

Table 5

Basic densities of Tasmanian blue gum determined by densitometer scans (kg/m^3)

	Ex-pasture site		Ex-bush site	
	Mean	Range	Mean	Range
Sample 1	553.9	398 - 776	481.1	424 - 609
Sample 2	574.2	431 - 701	455.4	368 - 565
Sample 3	453.1	259 - 409	472.0	378 - 574
Overall mean	527.1		469.5	

Kingston and Risdon (1961) quoted a mean basic density for 17- to 23-year-old Tasmanian blue gum of 561 kg/m^3. In the present trial, mean values for pasture and bush sites were 527 kg/m^3 and 469 kg/m^3 respectively. The difference in age between the trees assessed in this trial and those assessed by Kingston and Risdon would be a factor in the differences in densities.

Machining characteristics

Resawing and docking characteristics were excellent owing to a straight even grain. The planer successfully dressed the timber using a medium to high feed speed, indicating that this light to medium density timber could be successfully dressed by most commercial planers and moulders. Sanding produced smooth even surfaces suitable for most commercial surface finishes and polishes.

Panel production

Tables 6, 7, and 8 list the panel sizes, grades of single laminate panels and grade of individual boards respectively. Grading of panels was done using the VALWOOD® rules, whereas the boards were graded using the VALWOOD® and feature grade rules. The panel (20 mm, 30 mm, 40 mm, 50 mm or 100 mm thick) volume is lower than the single laminates volume because final trimming was required and sampling for testing glue line strengths were taken.

Table 6
Dimensions of VALWOOD® panels constructed in the trial

Length x Width (m)	Thickness (mm)					
	20	30	40	50	100	Total
2.1 x 0.9	2	2	2	2		8
2.1 x 0.6	2		2	2	2	8
2.1 x 0.1					4	4
1.2 x 0.9		1	1	1		3
1.2 x 0.6		1	1	1		3
0.9 x 0.9		2	2	2		6
0.9 x 0.6		2	2	2		6
	4	10	10	10	4	38

Table 7
Grades of one laminate (10 mm) VALWOOD®
panels manufactured from Tasmanian blue gum

Length and width(m)	Feature grade F1		Feature grade F2		Core grade	
	No. of Panels	Volume (m^3)	No. of Panels	Volume (m^3)	No. of Panels	Volume (m^3)
2.1 x 0.6	17	0.210	20	0.250	42	0.530
1.2 x 0.6	9	0.065	4	0.029	17	0.120
0.9 x 0.6	18	0.097	10	0.054	30	0.162
Total No.	44	0.372	34	0.333	89	0.812
Percentage	24.5		22.0		53.5	

Table 8
Grading Tasmanian blue gum boards using VALWOOD®
and Feature grading rules

VALWOOD®rules		Feature rules	
Grade	(%)	Grade	(%)
1F	41.5	1F1E	4.9
2F	11.5	1F2E	29.4
		2F2E	18.7
Core	36.6	Core	36.6
Reject	10.4	Reject	10.4

1F = one face
2F = two faces
2F2E = two faces two edges
1F1E = one face one edge
1F2E = one face two edges

Based on log volume, 15 per cent was converted into finished panels and based on green sawn volume 28.3 per cent was converted to finished panels. Boards were cut at 18 mm and finished at 10 mm thick, which included 44.4 per cent of sawn volume lost through shrinkage and dressing and 27.3 per cent of sawn volume in docking end splits and edge trimming. The results indicated that provided that they were straight, boards can be cut at 16.5 mm, which would produce higher overall recoveries.

The majority of dry cleavage tests were done on urea formaldehyde-bonded panels, because production concentrated on making panels for interior furniture. A smaller sample size was used for testing the other adhesives owing to the limited number of panels produced. The mean values for percentage wood failure listed in Table 7 indicated that three adhesives gave very good results and resorcinol formaldehdye a satisfactory result when edge-joints were tested. All adhesives satisfied the requirements of Australian Standard 1328 - 1987. Only urea formaldehyde passed the face test, but a much larger sample was tested than with the two resorcinol formaldehydes, and melamine urea formaldehyde was not tested.

Table 9

Adhesive effects on percentage wood failure in edge-glued Tasmanian blue gum (the mean of samples each from end and centre of the panel)

Adhesive	Wood failure (%) *					
	Face			Edge		
	Mean	S.D.	N	Mean	S.D.	N
Urea formaldehyde	89.6	19.6	96	77.3	19.5	94
Resorcinol/polyphenolic formaldehyde	44.0	15.6	18	83.7	6.2	17
Resorcinal formaldehyde	42.0	24.2	18	62.0	10.7	13
Melamine urea formaldehyde			-	84.0		18

* The optimum glueline has 100 per cent wood failure, and no adhesive failure.

Newby and Siemon (1989) had reported good results when regrowth jarrah glued with urea formaldehyde and resorcinal formaldehyde and wood failure was assessed using dry cleavage tests. Edge- and face-dressing within an hour of gluing gives à clean, smooth surface and improves adhesion between the surfaces.

The dry cleavage test is a useful guide to the efficiency of different adhesives for gluing particular species. Long term strength and stability also must be assessed to rate the performance of a particular glue.

Clear gluelines are required when laminated timber is used for interior furniture, particularly when light coloured timber is used. Both urea formaldehyde and melamine urea formaldehyde gave a clear finish and had satisfactory dry cleavage results, but urea formaldehyde is recommended because it is easier to mix and apply and has a good workable pot life of at least twenty minutes.

For exterior use, resorcinol/polyphenolic and resorcinol formaldehyde adhesives result in dark glue-lines. Despite poor face cleavage results, edge cleavage results indicated that both adhesives would be suitable for gluing Tasmanian blue gum for exterior applications. Resorcinol formaldehyde is preferred because it is easier to mix and apply and has a longer pot life. Wet cleavage testing is necessary when VALWOOD® is to be used in exterior situations.

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