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Eight year final inspection of model windows exposed in the accelerated field simulator

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Eight year final inspection of model windows exposed in the accelerated field simulator

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by

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EXECUTIVE SUMMARY

Objective

The objective of this research was to conduct the eight year final inspection of a model window exposure trial designed to assess the efficacy of various wood preservatives and treatment schedules for ash eucalypts, in comparison to light organic solvent preservative (LOSP) treated-*Shorea* spp. (meranti). Other objectives were to compare the performance of the latest azole-containing LOSP formulation with an older TBTN-containing LOSP formulation, and to examine the protective effects provided by H1 lyctine boron treatment, remedial diffusible rods, and end-grain sealing.

Key Results

- After eight years alternating between Accelerated Field Simulator (AFS) exposure and placement of the windows on a roof, there was severe decay in painted untreated *Eucalyptus regnans, E. delegatensis* and *Shorea* spp. window frames. Light to light-moderate decay was detected in *E. sieberi* and *E. obliqua* frames. There was generally only light decay in *Thuja plicata* (western red cedar) windows, although two windows had patches of extensive decay.
- In previous inspections unpainted untreated *E. regnans* windows were in slightly better condition than untreated painted windows; however, after eight years both types were severely decayed.
- Untreated *E. regnans* windows with end grain sealed before window assembly were also severely decayed, and had the lowest mean decay rating of all window types.
- Only light decay was found in eucalypt windows treated using a commercial schedule with azole LOSP and then painted. The end grain of all but one window was sound, with the majority of minor decay occurring under glass edges and timber bead.
- There was no difference in performance of azole LOSP-treated *E. regnans* windows when painted cream or brown. However, similar unpainted windows had moderate to heavy decay.
- *E. regnans* windows dipped in azole LOSP performed much better than untreated windows, although one window had heavy decay in one corner. More consistent and improving performance was obtained when retentions increased using a ‘commercial’ or more severe ‘low pressure Bethell’ treatment schedule.
- After six years, there was little difference between *E. regnans* painted windows that had been treated with LOSP containing TBTN or azoles. However, the eight year inspection has seen a rapid decline in the performance of TBTN-treated windows which had moderate to heavy decay.
- The vacuum pressure impregnation (VPI) of green *E. obliqua, E. regnans* and *E. delegatensis* with boron to meet H1 requirements for lyctine borer control also mostly protected the windows from decay as their mean ratings indicated only light damage. The retention of boron achieved in *E. sieberi* did not improve decay resistance.
- When the ends cut after VPI boron-treatment were resealed by dipping in boron solution, there were nine examples of end grain decay. In comparison, all of the azole LOSP-treated eucalypts (commercial schedule) where cut ends were resealed by a three minute dip in azole LOSP were sound.

- Least decay in all window types was found in untreated *E. regnans* windows containing No-Rot® diffusible preservative rods.

Application of Results

This trial has progressed to a stage where many interesting comparisons can be made between the various treatments and timber variations. It has demonstrated that azole LOSP will adequately protect eucalypt windows, especially when higher retentions are used. It has shown the importance of paint protection for the longer term performance of azole LOSP, and has also shown the superiority of azole over TBTN formulation. A surprising result was the good performance of a boron treatment aimed at the H1 market, suggesting that this treatment could also be used an alternative to LOSP treatment for painted windows. Diffusible preservative rods containing boron were also effective, and offer a relatively inexpensive method for window protection.

Further Work

It would be useful to chemically analyse the boron-treated windows to determine the levels of boron remaining.

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INTRODUCTION

The reasons for using timber windows have received a boost recently through the Window Energy Rating Scheme (WERS), due to the superior insulating properties of wood compared to competitive materials such as aluminium and steel. The main drawback for timber is its susceptibility to biodegradation, primarily through decay. Largely for this reason, relatively few timber windows are installed in northern Australia, whereas in Victoria and Tasmania timber windows are widely used. The aim of this project was to investigate and improve the durability of timber windows.

The timbers used most for window joinery are meranti (*Shorea* spp.) and western red cedar (*Thuja plicata*). *Shorea* spp. is normally treated with light organic solvent preservative (LOSP), while western red cedar is naturally durable for above ground uses where it is a class 2 timber[1]. Of the local timbers available, ash eucalypts such as mountain ash (*Eucalyptus regnans*), alpine ash (*E. delegatensis*), silvertop ash (*E. sieberi*) and messmate (*E. obliqua*) are used, but on a smaller scale. These are mostly used untreated, and because the timbers have low natural durability, may suffer from early decay[2].

The problem of durability can be reduced by shielding windows with eaves, or by sealing ends before window assembly[3]. Another alternative is to treat to AS 1604[4], but the required penetration is almost impossible to achieve in the heartwood of hardwoods, even in *Shorea* spp.[5]. Previous research using laboratory decay techniques showed that the thin envelope treatments achieved with LOSP in hardwood window joinery could provide sufficient durability to be considered 'fit for purpose'. Mountain ash heartwood could be treated and protected in the end grain with LOSP, but suffered from thin side grain penetration[6]. However, it seemed possible that this level of treatment might be sufficient to give good service life to windows. Most of the decay in windows occurs in end grain near joints, which in some eucalypts is the region most easily treated.

A large trial of small model windows was prepared to examine alternative protection systems. Variations included painting, end-grain sealing, and diffusible preservative rods. The preservative treatments examined were a TBTN-containing LOSP, and a newer azole-containing LOSP, and impregnation using a variety of treatment schedules. Boron was also examined as an alternative treatment. Even though boron can leach, other research has shown that boron-treated wood can last 2-4 times as long as untreated timbers[7,8], which may be enough to give acceptable service life for eucalypt windows. For some lyctine

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[1] Australian Standard 5604-2005. Timber – Natural durability ratings. Standards Australia, Sydney.

[2] Ellwood, E.L. (1955). Preventing deterioration in exterior joinery. CSIRO DFP, Forest Products Newsletter No. 212, 2pp.

[3] Australian Standard 2047-1999/Amendment 1/2001-01-31. Windows in buildings – Selection and installation. Standards Australia, Sydney.

[4] Australian Standard 1604.1-2005. Specification for preservative treatment. Part 1: Sawn and round timber. Standards Australia, Sydney.

[5] Cookson, L.J. and Trajstman, A. (1996). Decay evaluation of the effectiveness of a LOSP envelope treatment in eucalypt and meranti heartwoods for window joinery. Internat. Res. Group on Wood Preservation, Document No. IRG/WP/96-30099.

[6] Ladu, G.E., Cookson, L.J. and Dougal, E.F. (1995). Treatability of regrowth *Eucalyptus regnans* heartwood using light organic solvent. Wood Protection 3: 33-39.

[7] Carr, D.R. (1964). Diffusion impregnation for house timbers. Internat. Pest Control 6 (2): 13-19, (3): 11-15.

[8] Drysdale, J.A. (1994). Boron treatments for the preservation of wood- a review of efficacy data for fungi and termites. Internat. Res. Group on Wood Preserv. Document No. IRG/WP/94-30037.

susceptible timbers such as *E. obliqua,* boron treatment to meet hazard class 1 is already standard industry practice. Painting may help to lock the boron within the timber substrate.

The 138 model windows were exposed for nine months of each year in the accelerated field simulator (AFS), with the remaining three months on a roof during summer for maximum UV. The results after three[9] and six years[10] have been reported, and this report gives the eight years inspection results. This was also the final inspection as windows were disassembled and sectioned to assist examination.

RECOMMENDATIONS AND CONCLUSIONS

After eight years exposure, the least durable untreated windows were those constructed from untreated *E. regnans, E. delegatensis* and *Shorea* spp. Light to light moderate decay was found in untreated *E. obliqua* and *E. sieberi* windows, while *T. plicata* windows were lightly decayed (two windows had moderate or severe decay). Worst performing windows were untreated *E. regnans* with end grain and all other surfaces sealed before assembly. Performance may have improved if glazing had been sealed to prevent water entry from that direction.

Only light decay was found in eucalypt windows treated using a commercial schedule with azole LOSP and then painted. However, similar unpainted windows had moderate to heavy decay. *E. regnans* windows dipped in azole LOSP performed much better than untreated windows. More consistent and improving performance was then obtained when retentions were increased using a commercial or 'low pressure Bethell' treatment schedule. TBTN-treated *E. regnans* painted windows performed much worse than those treated with azoles.

The vacuum pressure impregnation (VPI) of green *E. obliqua*, *E. regnans* and *E. delegatensis* with boron to meet H1 requirements for lyctine borer control also mostly protected the windows from decay. VPI boron treatment of *E. sieberi* did not improve decay resistance with the retention achieved. When the ends cut after VPI boron-treatment were resealed by dipping in boron solution, there were nine examples of end grain decay. In comparison, all of the azole LOSP-treated eucalypts (commercial schedule) where ends were cut after treatment but resealed by a 3 minute dip in azole were sound. Least decay in all window types was found in untreated *E. regnans* windows containing No-Rot® diffusible preservative rods.

This trial has progressed to a stage where useful comparisons can be made between the various treatments and timber variations available for timber window protection. Treatments using azole LOSP, VPI boron treatment and boron-based diffusible rods have all provided protection from decay.

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[9] Scown, D.K., Cookson, L.J., McCarthy, K.J. and Chew, N. (2004). Accelerated testing of window joinery made from eucalypts. CSIRO, FFP Client Report No. 1434. FWPRDC Project No. PN98.702., 45 pp. http://www.fwprdc.org.au/content/pdfs/PN98.702.pdf

[10] Cookson, L.J. (2007). Six year interim inspection of model windows exposed in the Accelerated Field Simulator. Ensis Client Report No. 1759. FWPRDC Project No. PN07.2034, 25 pp.

RESULTS AND DISCUSSION

The results for the eight year (final) inspection of all model windows are summarised in Table 1, with variations listed in relative order of performance. There were six replicate windows in each variation, with three replicates placed in bottom rows in the Accelerated Field Simulator (AFS), and three in the top rows (Figure 1). The results for individual windows are given in Appendix 1, and their photos are in Appendix 2.

Table 1: Mean decay ratings for windows after 8 years of exposure.

Window type	Paint	Code no.	Mean for top 3 windows (sd)	Mean for bottom 3 windows (sd)	Mean for all 6 windows (sd)
E. regnans, No-rot rods	cream	MA 13-18	8.0 (0.0)	7.9 (0.1)	8.0 (0.1)
Shorea, azole, commercial	cream	MN 1-6	7.9 (0.1)	7.9 (0.1)	7.9 (0.1)
E. obliqua, azole, commercial	cream	MSN 1-6	7.9 (0.1)	7.7 (0.2)	7.8 (0.2)
E. sieberi, azole, commercial	cream	SAN 1-6	7.7 (0.3)	7.8 (0.3)	7.7 (0.2)
E. regnans, azole, commercial	brown	MANC 7-12	7.8 (0.3)	7.5 (0.3)	7.6 (0.3)
E. regnans, azole, LP Bethell	cream	MANLP 1-6	7.5 (0.3)	7.5 (0.3)	7.5 (0.2)
E. regnans, azole, commercial	cream	MANC 1-6	7.5 (0.3)	7.3 (0.3)	7.4 (0.3)
E. obliqua, VPI boron	cream	MSB 1-6	7.5 (0.3)	7.3 (0.3)	7.4 (0.3)
E. regnans, VPI boron	cream	MAB 1-6	7.7 (0.4)	7.1 (0.5)	7.4 (0.5)
T. plicata, untreated	cream	WR 1-6	7.2 (1.2)	7.5 (0.4)	7.4 (0.8)
E. delegatensis, azole, commercial	cream	AAN 1-6	7.3 (0.0)	7.4 (0.1)	7.3 (0.1)
E. regnans, azole, dip treatment	cream	MAND 1-6	7.0 (0.9)	7.1 (0.3)	7.1 (0.6)
E. delegatensis, VPI boron	cream	AAB 1-6	7.7 (0.4)	6.3 (2.1)	7.0 (1.6)
E. obliqua, untreated	cream	MS 1-6	7.2 (0.2)	6.0 (1.3)	6.6 (1.1)
E. sieberi, untreated	cream	SA 1-6	7.0 (0.3)	5.8 (1.5)	6.4 (1.2)
E. sieberi, VPI boron	cream	SAB 1-6	5.3 (1.8)	6.6 (0.8)	6.0 (1.4)
E. regnans, azole, commercial	none	MANC 13-18	4.4 (2.5)	4.6 (3.1)	4.5 (2.5)
E. regnans, TBTN, commercial	cream	MAOC 1-6	5.5 (1.8)	3.4 (3.5)	4.5 (2.8)
Shorea, untreated	cream	M 1-6	2.1 (1.2)	1.8 (1.0)	2.0 (1.0)
E. regnans, untreated	cream	MA 1-6	1.8 (0.3)	0.0 (0.0)	0.9 (1.0)
E. delegatensis, untreated	cream	AA 1-6	1.3 (1.2)	0.0 (0.0)	0.7 (1.0)
E. regnans, untreated	none	MA 7-12	0.9 (0.9)	0.3 (0.6)	0.6 (0.8)
E. regnans, untreated, sealed	cream	MA 19-24	0.0 (0.0)	0.5 (0.9)	0.3 (0.6)
All			5.8 (2.7)	5.4 (2.9)	5.7 (2.7)

Rating scale: 8 = sound, 0 = destroyed

Figure 1. Exposure of model windows in the AFS. Note irrigation system (e.g. white arrow).

Untreated timbers

A summary of the results for windows constructed from untreated timbers is given in Table 2.

Table 2: Mean decay ratings for untreated windows after 8 years of exposure.

Window type	Paint	Code no.	Mean for top 3 windows (sd)	Mean for bottom 3 windows (sd)	Mean for all 6 windows (sd)
T. plicata, untreated	cream	WR 1-6	7.2 (1.2)	7.5 (0.4)	7.4 (0.8)
E. obliqua, untreated	cream	MS 1-6	7.2 (0.2)	6.0 (1.3)	6.6 (1.1)
E. sieberi, untreated	cream	SA 1-6	7.0 (0.3)	5.8 (1.5)	6.4 (1.2)
Shorea, untreated	cream	M 1-6	2.1 (1.2)	1.8 (1.0)	2.0 (1.0)
E. regnans, untreated	cream	MA 1-6	1.8 (0.3)	0.0 (0.0)	0.9 (1.0)
E. delegatensis, untreated	cream	AA 1-6	1.3 (1.2)	0.0 (0.0)	0.7 (1.0)
E. regnans, untreated	none	MA 7-12	0.9 (0.9)	0.3 (0.6)	0.6 (0.8)
E. regnans, untreated, sealed	cream	MA 19-24	0.0 (0.0)	0.5 (0.9)	0.3 (0.6)
All windows			3.4 (3.1)	2.7 (3.2)	3.1 (3.1)

Rating scale: 8 = sound, 0 = destroyed

Decay was most severe in painted window frames constructed from *E. regnans*, *E. delegatensis* and *Shorea* spp., (Table 2, Figure 2). The heartwood of these timbers is known to be non-durable in-ground contact (Class 4), and also has low natural durability above ground (Class 3)[11]. There was some variation in the colour of the *Shorea* timbers used, indicating that a number of species were involved. It is noteworthy that the bottom sill of window M1 was a dark red colour, and virtually free from decay, unlike the *Shorea* timbers used in the other sills (Figure 3). Light to light-moderate decay was detected in painted frames made of untreated *E. sieberi* (mean rating 6.4) and slightly less again in *E. obliqua* (mean rating 6.6), which is consistent with their higher in-ground natural durability ratings (Class 3), although their above ground natural durability ratings differ and are Class 3 and 2 respectively. There was generally only light decay in *T. plicata* windows (mean rating 7.4), although WR4 had moderate decay on one side of the window under beading (Figure 4), and WR5 was destroyed from one corner of its sill (Figure 5). The heartwood of *T. plicata* has a natural durability rating in-ground of Class 3 and above ground of Class 2.

There was some difference in the extent of decay found between the two rows exposed in the AFS. For example, in the bottom row *E. regnans* cream painted windows had a mean rating of 0.0 compared to the mean for the top three windows at 1.8. However, the difference appears to be less than in previous inspections. Conditions tended to be damper in the bottom row of windows. It is interesting that white-rotting fungi caused most damage to *Shorea* windows, while brown-rotting fungi caused most damage to the eucalypt windows.

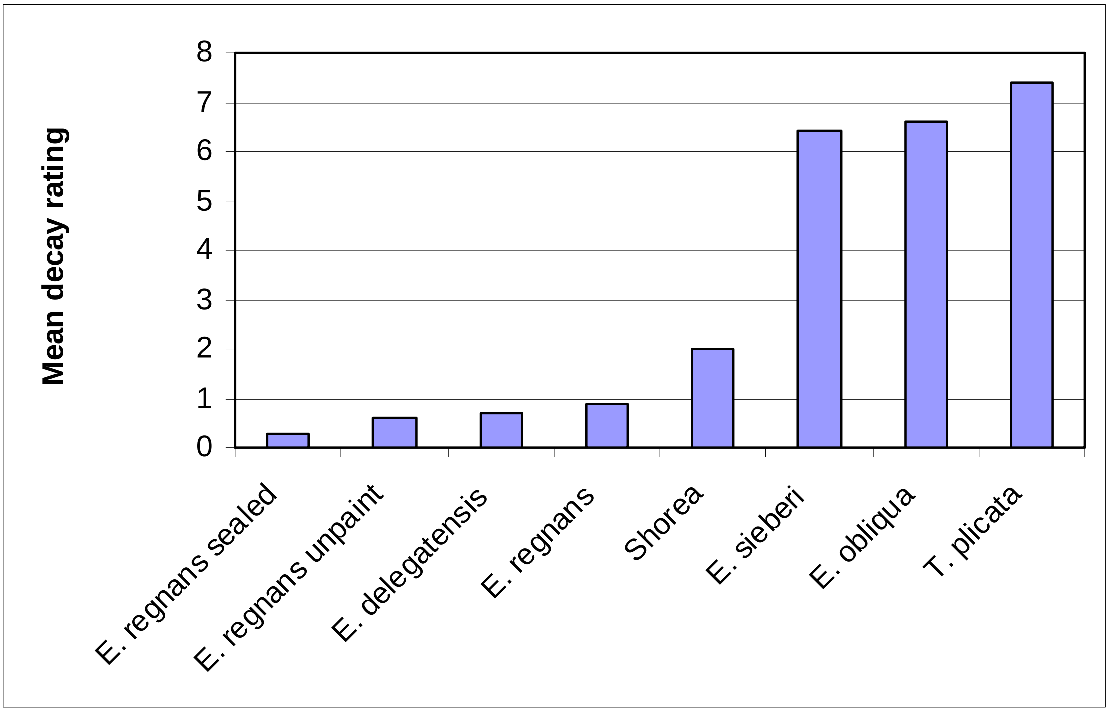


Figure 2. Comparison of mean decay ratings of untreated windows. Sealed = joints painted before window assembly. Unpaint = unpainted *E. regnans* window. Other windows painted cream.

[11] Australian Standard AS 5604-2005. Timber – Natural durability ratings. Standards Australia, Sydney.

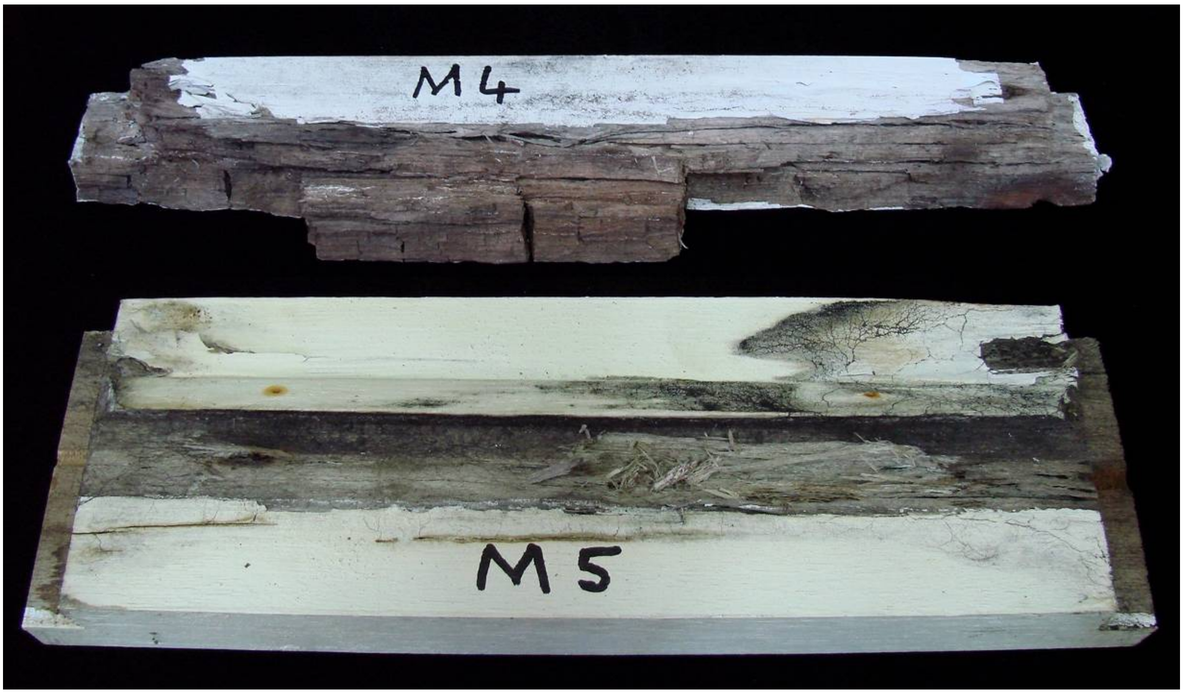


Figure 3. Bottom sills of untreated painted *Shorea* windows M4 (brown rot) and M5 (white rot) after eight years' exposure.

Figure 4. Bottom sill of untreated painted *T. plicata* window WR4 with 12 mm deep brown rot under glass + beading after eight years' exposure.

Figure 5. Bottom sill of untreated painted *T. plicata* window WR5 with 35+ mm deep brown rot from right end after eight years' exposure.

During previous inspections, unpainted untreated *E. regnans* windows were in better condition than painted windows. After six years, the bottom sills of unpainted windows had a mean rating of 4.8 in the lower rebates, compared to 0.9 for painted windows. However, for this eight year inspection the mean ratings were similar, at 0.6 and 0.9 respectively (Table 2).

The practice of sealing the end grain before window assembly appeared to promote window durability when 30-40 year-old ash eucalypt windows were examined in Bairnsdale[9]. The end grain in these windows had been sealed with a lead-based paint which is no longer available. End grain sealing with paint also improved the durability of L-joints exposed in the United Kingdom[12]. It was thought that additional protection to untreated windows might be obtained by end sealing the internal rebates and all other surfaces with primer prior to window assembly. While after three years there was some retardation of decay in sealed *E. regnans* windows compared to similar windows without end grain sealing[9], there was little difference after six years as the mean rating in lower rebates was 1.1 compared to 0.9 respectively, and after eight years the sealed windows had the lowest mean rating of all windows at 0.3 (Figure 2). The water trap provided by the loose fitting glass would have allowed moisture to enter from that direction more readily than would occur during the service of a well maintained window, and has overcome the protective effects provided by painting all surfaces before construction.

LOSP-treated timbers

A summary of the inspection results for LOSP-treated window frames after eight years' exposure is presented in Table 3.

[12] Boxall, J., Carey, J.K. and Miller, E.R. (1992). The effectiveness of end-grain sealers in improving paint performance on softwood joinery. Part 3: Influence of coating type and wood species on moisture content and fungal colonisation. Halz als Roh- und Werkstoff 50: 227-232.

Table 3: Mean decay ratings for LOSP-treated model window frames after 8 years of exposure.

Window type	Paint	Code no.	Mean for top 3 windows (sd)	Mean for bottom 3 windows (sd)	Mean for all 6 windows (sd)
Shorea, azole, commercial	cream	MN 1-6	7.9 (0.1)	7.9 (0.1)	7.9 (0.1)
E. obliqua, azole, commercial	cream	MSN 1-6	7.9 (0.1)	7.7 (0.2)	7.8 (0.2)
E. sieberi, azole, commercial	cream	SAN 1-6	7.7 (0.3)	7.8 (0.3)	7.7 (0.2)
E. regnans, azole, commercial	brown	MANC 7-12	7.8 (0.3)	7.5 (0.3)	7.6 (0.3)
E. regnans, azole, LP Bethell	cream	MANLP 1-6	7.5 (0.3)	7.5 (0.3)	7.5 (0.2)
E. regnans, azole, commercial	cream	MANC 1-6	7.5 (0.3)	7.3 (0.3)	7.4 (0.3)
E. delegatensis, azole, commercial	cream	AAN 1-6	7.3 (0.0)	7.4 (0.1)	7.3 (0.1)
E. regnans, azole, dip treatment	cream	MAND 1-6	7.0 (0.9)	7.1 (0.3)	7.1 (0.6)
E. regnans, azole, commercial	none	MANC 13-18	4.4 (2.5)	4.6 (3.1)	4.5 (2.5)
E. regnans, TBTN, commercial	cream	MAOC 1-6	5.5 (1.8)	3.4 (3.5)	4.5 (2.8)
All			7.1 (1.2)	6.8 (1.5)	6.9 (1.3)

Rating scale: 8 = sound, 0 = destroyed

After six years' exposure in the AFS and on the roof at Clayton, the LOSP-treated window frames were in good condition, as only one *E. regnans* window had light decay. However, after eight years there was at least light decay in most windows (Figure 6), possibly because of the daily watering employed during the latter stages of the trial. There were few problems in windows treated with the azole LOSP using a commercial treatment schedule (-60 kPa initial vacuum and 50 kPa pressure) and painted cream, with only light decay in those windows that had decay (Table 3). The end grain of all eucalypt windows treated by the commercial schedule with azole LOSP were sound, except for one section of an *E. regnans* window (MANC6) with minor decay. When decay occurred, virtually all of it was under the glass and timber bead (side grain entry for decay).

Brown and dark painted timber is known to absorb more heat when exposed outdoors, which can accelerate checking. However, there was no difference in performance for azole LOSP-treated *E. regnans* windows when painted cream or brown (Table 3).

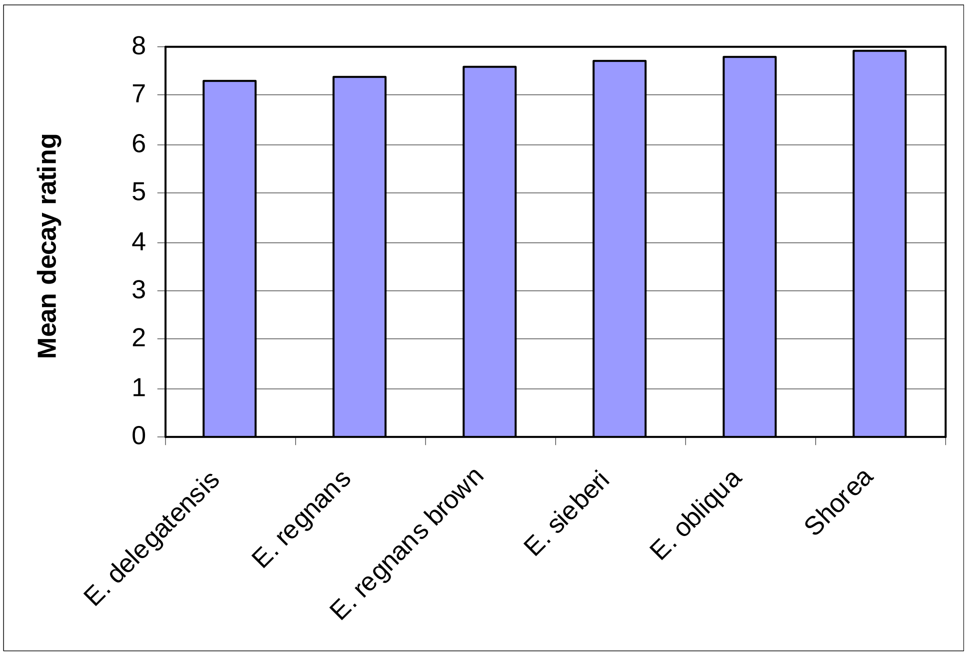


Figure 6. Comparison of mean decay ratings of azole LOSP-treated windows treated using a 'commercial' schedule. *E. regnans* brown painted brown, remainder painted cream.

A comparison was also made of increasingly severe treatment schedules for *E. regnans* windows treated with azole LOSP, where treatment was by dipping, commercial schedule, or low pressure Bethell (-95 kPa initial vacuum and 150 kPa pressure). Mean ratings were 7.1, 7.4 and 7.5 respectively, indicating small improvements in performance according to increasing retentions (Figure 7). Unlike the commercial and low pressure Bethell treated windows with cut ends dipped after treatment, there were two examples in dipped windows (no VPI involved) of decay in the end grain.

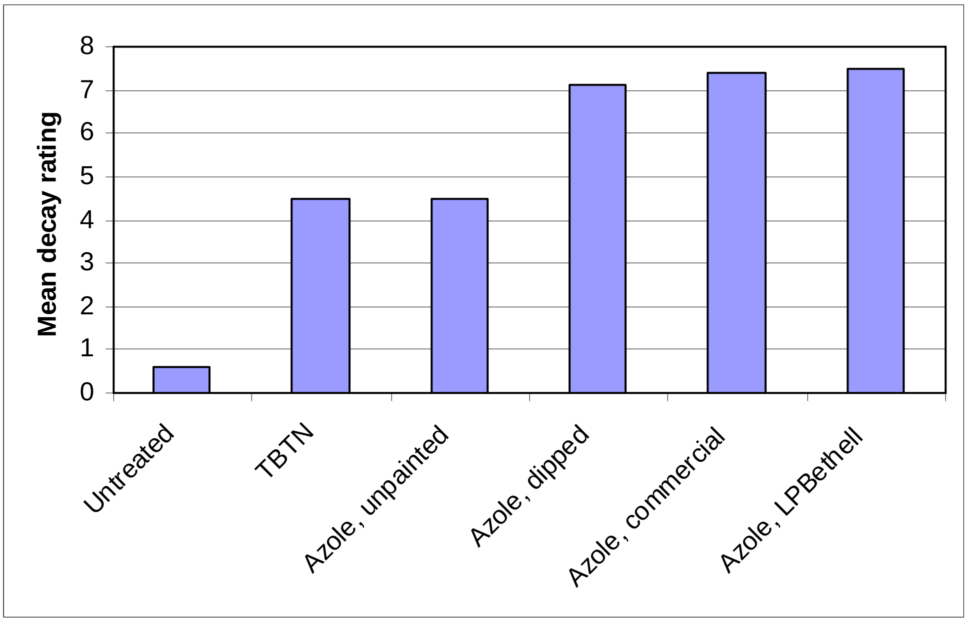


Figure 7. Comparison of mean decay ratings of *E. regnans* for LOSP treatment variations, painted cream.

A major contrast in performance was for *E. regnans* treated with azole LOSP using the commercial schedule, and then painted or left unpainted. Painted windows had only light decay (mean rating 7.4) while unpainted windows had moderate to heavy decay (mean rating 4.5, Figure 8). This result clearly illustrates the benefits to LOSP-treated wood of paint protection. Note that retentions for the LOSP-treated timber assigned to the unpainted set of windows were slightly higher than for similar windows that were painted (Appendix 1). In unpainted windows, some decay occurred on the top face of the window (Figure 8), compared to painted windows where decay from this direction was absent.

Figure 8. Unpainted azole LOSP-treated *E. regnans* windows. Top piece shows upper surface of top section of MAND14. Lower piece shows upper surface of bottom sill (one beading retained) of MAND13.

After six years, there was little difference between *E. regnans* painted windows that had been treated with LOSP containing TBTN or azoles. However, the eight year inspection has seen a rapid decline in the performance of TBTN-treated windows (Figures 7 and 9) and the mean rating was 4.5 compared to 7.4 for azoles. This result appears due to the premature degradation of TBTN, as discussed in a recent review[13].

Although not inspected in detail, it was noted that the TBTN LOSP-treated *Shorea* beading was generally sound, although often decayed if other sections of the window was also decayed.

[13] Cookson, L.J. and Hedley, M.E. (2005). Adequacy of H3 LOSP tin-based preservative treatment for exposed external structural uses. FWPRDC Project No. PN05.1013, 21 pp. http://www.fwpa.com.au/Resources/RD/Reports/PN05.1013.pdf

Figure 9. TBTN LOSP-treated *E. regnans* window MOAC4, painted. Lower piece shows upper face of bottom sill with 35+ mm brown rot in the left end (reversed in photo) that was dipped after machining. Top piece shows inside face of left piece with 2 mm decay under beading (it also has 35+ mm decay at either end).

Boron-treated timbers

The eucalypt windows included timbers that had been vacuum pressure impregnated (VPI) with boron following the treatment procedures used to immunize against lyctine borers. These timbers were treated while still green, and were dressed after seasoning. Boron-treated eucalypt samples cut from the boards used for window construction were chemically analysed previously (Table 4). The retention of elemental boron required for lyctine borer control is 0.047 % m/m based on oven-dried wood. Sapwood from two boards of mountain ash (a non-susceptible timber) contained 0.059 and 0.077% m/m boron, thereby meeting minimum requirements. All other boards lacked sapwood. The treatment of green hardwoods with boron by VPI has been shown in a more extensive study normally to satisfy AS 1604 requirements for H1 lyctine control[14]. The full heartwood cross-sections of *E. sieberi*, *E. delegatensis* and *E. obliqua* contained mean boron contents of between 0.013 and 0.028% m/m, while *E. regnans* heartwood had a higher mean boron content of 0.042% m/m (Table 4).

[14] Cookson, L.J., Scown, D.K. and McCarthy, K. (1998). Boron treatment methods for lyctid susceptible hardwoods growing in Tasmania. Internat. Res. Group on Wood Preserv. Document No. IRG/WP/98-30168.

Table 4: Boron content as % m/m oven dried wood analysed in the heartwood of eucalypt boards.

Timber species	Replicate board number						Mean
	1	2	3	4	5	6	
E. delegatensis	0.021	0.044	0.032	0.020	0.024	0.026	0.028
E. obliqua	0.012	0.008	0.013	0.010	0.011	0.022	0.013
E. regnans	0.026	0.065	0.027	0.052	0.046	0.033	0.042
E. sieberi	0.015	0.014	0.012	0.014	0.009	0.023	0.015

A summary of the results of the inspection of the boron-treated window frames after eight years of exposure is presented in Table 5.

Table 5: Mean decay ratings for boron-treated windows after 8 years of exposure.

Window type	Paint	Code no.	Mean for top 3 windows (sd)	Mean for bottom 3 windows (sd)	Mean for all 6 windows (sd)
E. regnans, No-rot rods	cream	MA 13-18	8.0 (0.0)	7.9 (0.1)	8.0 (0.1)
E. obliqua, VPI boron	cream	MSB 1-6	7.5 (0.3)	7.3 (0.3)	7.4 (0.3)
E. regnans, VPI boron	cream	MAB 1-6	7.7 (0.4)	7.1 (0.5)	7.4 (0.5)
E. delegatensis, VPI boron	cream	AAB 1-6	7.7 (0.4)	6.3 (2.1)	7.0 (1.6)
E. sieberi, VPI boron	cream	SAB 1-6	5.3 (1.8)	6.6 (0.8)	6.0 (1.4)

Rating scale: 8 = sound, 0 = destroyed

The results show that VPI of green hardwood with boron to meet H1 requirements significantly improved resistance to decay. Only slight decay was found in the boron-treated *E. obliqua*, *E. regnans* and *E. delegatensis* windows (Table 5, Figure 10), with mean ratings of 7.4, 7.4 and 7.0 respectively. These results were similar to those achieved for *E. regnans* using azole LOSP treatments (Table 3). A similar result of improved resistance to decay was found for softwood interior house framing treated with boron for the control of *Anobium* [15]. There was one example (MAB2) in the *E. regnans* windows of moderate decay, and two (AAB2) of severe decay in *E. delegatensis*. These three examples were in ends cut and dipped after the initial preservative treatment. The dark staining observed, especially on *E. obliqua* and *E. sieberi* windows (Appendix 2), may be due to boric acid reacting with iron (from the saw, or from nails and screws) and tannins. This problem is usually less in borate (as used here) rather than boric acid treated timbers[16]. Oddly, the VPI boron treatment of *E. sieberi* did not improve decay resistance (mean rating 6.0) compared to untreated *E. sieberi* windows (mean rating 6.4, Table 5). The reason is unclear, although boron content was relatively low (Table 4). It should also be noted that the green (unseasoned) timbers were 90 x 45 mm in profile when treated, and were then dressed to 80 x 35 mm profile after seasoning. This was a fairly severe level of dressing that may have removed proportionally more boron-treated wood than would a lighter dressing.

[15] M. Hedley, D. Page and B. Patterson (2002). A new technique for testing the decay resistance of framing lumber. Internat. Res. Group on Wood Pres. Document No. IRG/WP02-20247.
[16] Tamblyn, N. (1949). A momentary dip treatment for green veneer. CSIR Forest Products Newsletter No. 171, pp. 1-2.

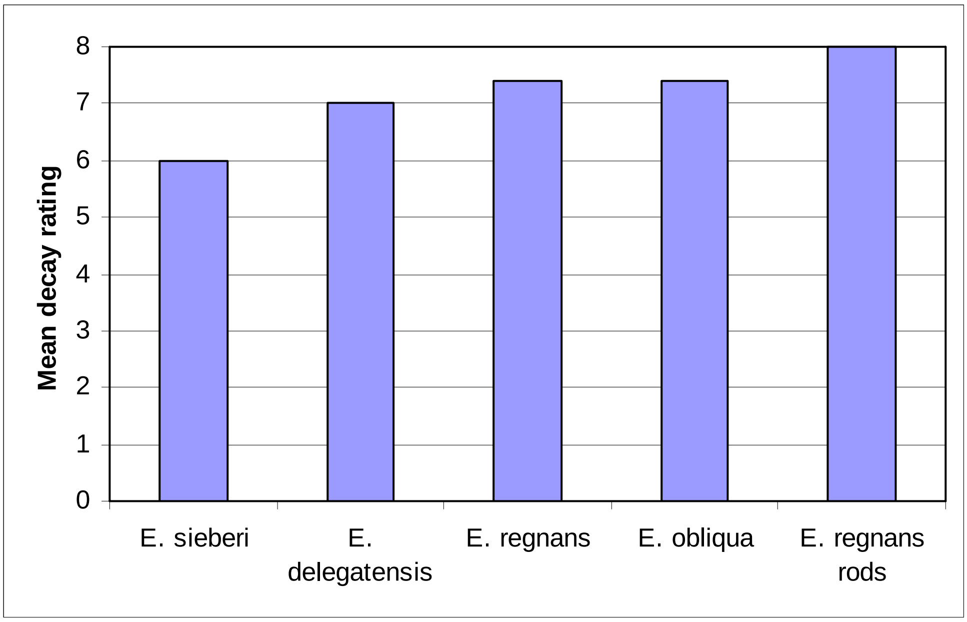


Figure 10. Comparison of mean decay ratings of boron-treated windows after 8 years. All painted cream.

When the ends cut after VPI boron-treatment were resealed by dipping in boron solution, there were nine examples of end grain decay (Figure 11). In comparison, all of the azole LOSP-treated eucalypts (commercial schedule) where ends were cut after treatment but resealed by a three minute dip of the ends in azole were sound. This result suggests that treated seasoned timber (whether treated with boron or LOSP) are better resealed with LOSP rather than boron.

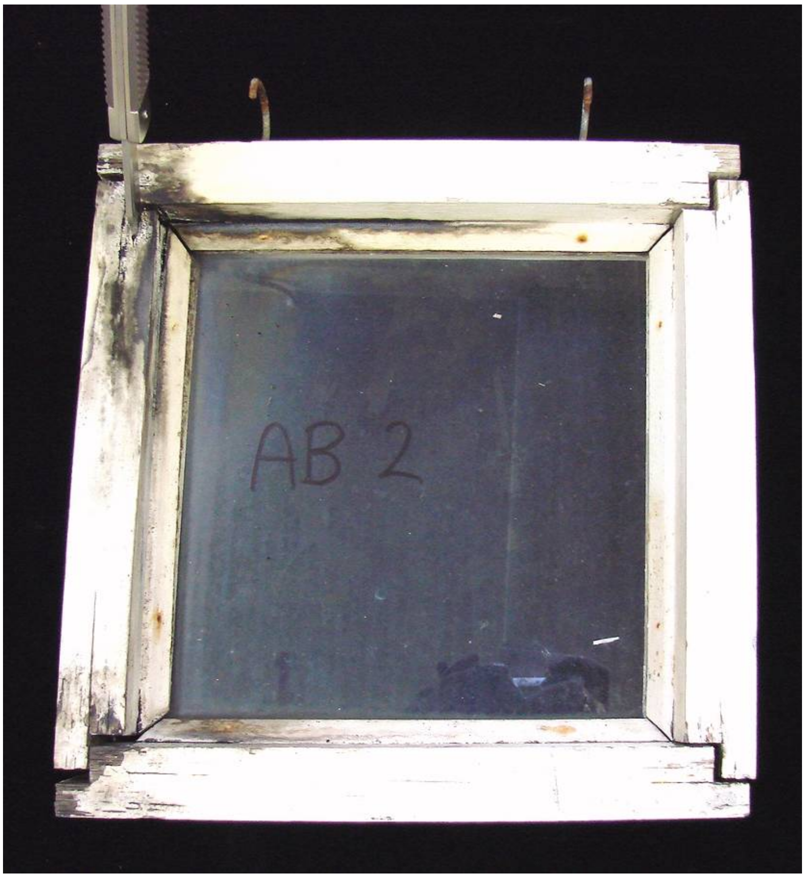


Figure 11. Painted VPI boron-treated *E. delegatensis* window AAB2, with 35+ mm brown rot in both ends of upper left joint (machined seasoned wood dipped in boron after treatment). Other joints without decay.

Untreated *E. regnans* windows that had No-Rot® boron diffusion rods inserted into holes drilled adjacent to the rebates were also protected from decay (Table 5), and were the best performing windows in terms of decay resistance (Table 1). The rods had been replenished after five years' exposure, and the hole sealed with silicone sealant rather than dowel plugs that had fallen out due to window movement.

CONCLUSIONS

This trial has demonstrated that azole LOSP-treated eucalypt windows give almost equal performance to azole-treated *Shorea*, and equal or better performance to untreated *T. plicata*. An advantage of preservative treatment was increased uniformity of performance compared to the naturally durable timber *T. plicata* (where two pieces had decay, moderate or severe). Painting was necessary for the longer term performance of azole LOSP-treated windows. Painting with brown (more heat absorbent during sun exposure) or cream colours gave no difference in performance, although perhaps if windows had been exposed continuously in the sun reduced performance may have occurred in brown windows. TBTN-treated *E. regnans* windows performed much worse than azole-treated windows, as revealed in the eight not six year inspection. Unseasoned *E. obliqua* and *E. regnans* timbers treated with boron by a VPI process used for H1 lyctine control performed as well as azole-treated *E. regnans* (although one *E. regnans* boron-treated window section had moderate decay). Similar *E. delegatensis* VPI boron-treated windows also performed well, except in one window where ends cut after treatment and resealed by dipping dry wood in boron were decayed. Resealing the ends of seasoned VPI boron-treated timber may have been more effectively achieved by dipping in azole LOSP, as there was no end grain decay when this process was used in eucalypts first treated with azole by the commercial or low pressure Bethell schedules. VPI boron treatment of *E. sieberi* was of no benefit compared to untreated *E. sieberi*, which presumably could be remedied by achieving higher boron retentions. End grain sealing of untreated *E. regnans* windows with paint gave no increased protection, although the case may have been different if the water build up in windows had been reduced by properly sealing the glass. The best preservative treatment against decay was with boron preservative rods, which had been inserted into holes drilled near either end of *E. regnans* sections. Note that these rods were replenished after five years (common practice for remedial treatments), but it is not known if this step was necessary for the continued survival of the windows under the test conditions employed. The best location and frequency of holes with rods in larger windows would require further investigation.

ACKNOWLEDGEMENTS

We would like to thank Forest and Wood Products Australia for supporting this research. We also appreciate the assistance of J.L. Gould sawmills Pty Ltd, Eureka Timber Company, Don Real Timber, and Canterbury Windows Pty Ltd for providing timber for the research; Osmose (Australia) Pty Ltd for the LOSP formulations, and Preschem Pty Ltd for the preservative rods.

MATERIALS AND METHODS

Timber sources

The timber species examined and their respective suppliers were: -

- *Eucalyptus regnans* (mountain ash), supplied by J.L. Gould sawmills Pty Ltd, Alexandra, Victoria.
- *E. delegatensis* (alpine ash), supplied by J.L. Gould sawmills Pty Ltd, Alexandra, Victoria.
- *E. obliqua* (messmate), supplied by Eureka Timber Company, South Ballarat, Victoria.
- *E. sieberi* (silvertop ash), supplied by Bob Humphreys c/o Don Real Timber, Beaconsfield, Victoria.
- *Shorea* spp., supplied by Canterbury Windows Pty Ltd. Springvale, Victoria and Bayswood Timber Wholesalers Pty Ltd, Hallam, Victoria.
- *Thuja plicata* (western red cedar), supplied by Canterbury Windows Pty Ltd. Springvale, Victoria.

All timbers were kiln-dried except for the *E. obliqua*, which was air-dried only.

Treatment formulations

Protim Solignum Limited (now part of Osmose) supplied LOSP formulations for timber treatment:

a) A new LOSP formulation (P410WR), developed by Osmose, contained the active ingredient propiconazole (Wocosen tech.) at 0.245 % m/vol, tebuconazole (Preventol A8) at 0.245 % m/vol, and permethrin at 0.26 % m/vol.

b) A commercially available LOSP used for comparison was Timberlife® (235WR), which contains 4.6% m/vol TBTN (active Sn 0.99% m/vol) and permethrin 0.26% m/vol.

Timber preparation

The timber species examined in this study were *E. regnans, E. delegatensis, E. obliqua, E. sieberi, Shorea* spp. and *Thuja plicata*.

Timbers were dressed and docked to produce boards measuring 1000 x 80 x 30 mm. The model window frames were to be constructed using a simple butt join at each corner. Therefore, a 15 mm rebate was cut into both ends of the boards prior to treatment.

LOSP treatment

All kiln-dried boards were divided into groups of 12 for treatment with LOSP formulations. The replicate boards were treated according to the variations shown in Table 6 with either preservative formulation using a range of treatment schedules:

- A commercial schedule involving:
  - an initial vacuum of –60 kPa for 10 minutes

- introduction of preservative under vacuum
- application of a pressure of 50 kPa for 15 minutes
- removal of preservative formulation
- final vacuum of –85 kPa for 20 minutes

- A low pressure Bethell schedule involving:
  - an initial vacuum of –95 kPa for 30 minutes
  - introduction of preservative under vacuum
  - application of a pressure of 150 kPa for 30 minutes
  - removal of preservative formulation
  - final vacuum of –95 kPa for 30 minutes

- A three minute dip

The boards were weighed before and immediately after treatment to determine formulation uptake. They were then stickered for six weeks to allow for the evaporation of residual solvent.

Table 6: Summary of the species/treatment variations included in the model window exposure trial.

Preservative formulation	Untreated	Untreated	Untreated	LOSP (azole)	LOSP (azole)	LOSP (azole)	LOSP (azole)	LOSP (azole)	LOSP (TBTN)	Boron	Untreated
Treatment schedule	-	-	-	Com.	Com.	Com.	LPB	Dip	Com.	VPI	-
Variation	Un-painted	Rebate painted (cream)	Painted (cream)	Painted (cream)	Painted (brown)	Un-painted	Painted (cream)	Painted (cream)	Painted (cream)	Painted (cream)	No-Rot rods, painted (cream)
E. regnans (mountain ash)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
E. delegatensis (alpine ash)			✓	✓						✓	
E. obliqua (messmate)			✓	✓						✓	
E. sieberi (silvertop ash)			✓	✓						✓	
Shorea spp. (meranti)			✓	✓							
Thuja plicata (western red cedar)			✓								

Com. = commercial LOSP schedule, LPB = low pressure Bethell, VPI = vacuum pressure impregnation.

Boron treatment

In addition to the kiln dried timber, 12 green *E. regnans*, *E. delegatensis*, *E. obliqua* and *E. sieberi* boards, measuring 2400 x 90 x 45 mm, were collected immediately after they were cut from the saw log and wrapped in plastic. The green timbers were vacuum pressure treated with boron (Diffusol®) through the Eureka Timber Company. The latter arranged for the timbers to be treated at Beaufort treatment plant, following the procedure generally used to protect sapwood from lyctine borers. After treatment the timbers were air dried and reconditioned. Boards were then dressed and docked to 1000 x 80 x 30 mm.

Window construction

From each metre long board, a 300 mm length and a 270 mm length was docked from opposing ends. The original ends of the cut lengths of LOSP treated boards already had a 15 mm rebate treated in final form. A second 15 mm rebate was cut into the new end (Figure 12). Treated components with a fresh rebate cut into one end were dipped in the appropriate preservative to ensure that the freshly exposed timber surface was properly treated. LOSP-treated boards were dipped for three minutes while boron-treated boards were dipped in diluted Diffusol® for 15 minutes. After dipping the ends, the boards were wiped free of excess preservative formulation and stickered to air dry for one week. Timbers were treated as one metre lengths to produce penetration patterns more similar to those obtained in commercial practice. Smaller windows were made so that they would fit into the space available in the AFS.

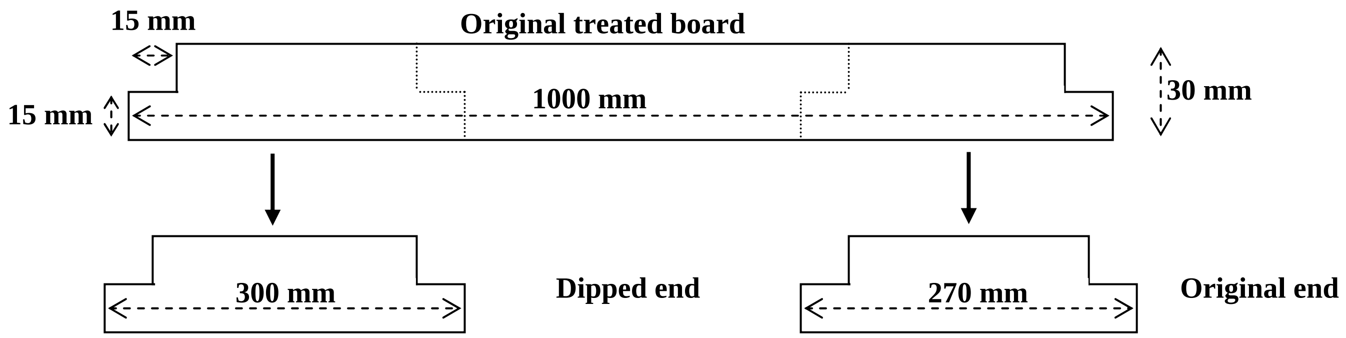


Figure 12. Diagram showing window components cut from original treated board.

The 300 and 270 mm lengths cut from each board were kept together and paired with a set of components that had been cut from a board from the same formulation/treatment schedule combination and that also had a similar preservative uptake. This combination made up one model window frame.

The model window frames were designed so that they could be easily dismantled during inspection. The two 270 mm components were brought together to sit within the rebates of the two 300 mm components (Figure 13).

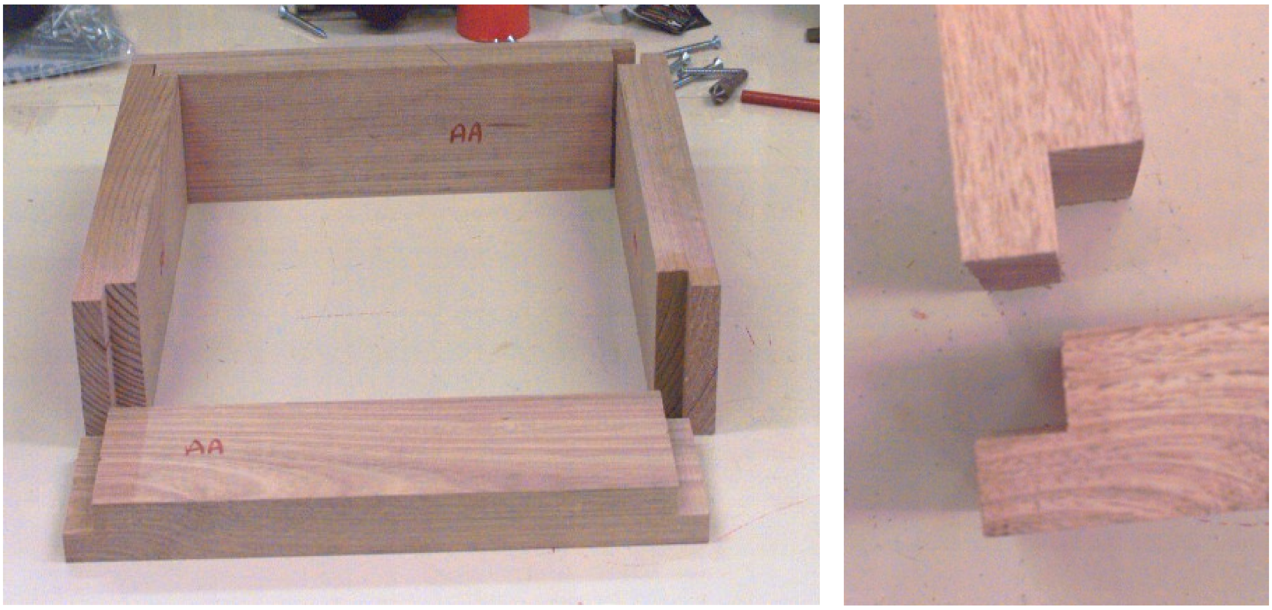


Figure 13. Construction of the model windows showing positioning of 270 mm long components within the rebate of the 300 mm components (left) and a close-up view of the butt join (right).

The components were arranged so that two originally treated rebates came together in one butt joint, two butt joints were made up by an originally treated rebate meeting a dipped rebate and the fourth butt joint consisted of two dipped rebates coming together (Figure 14).

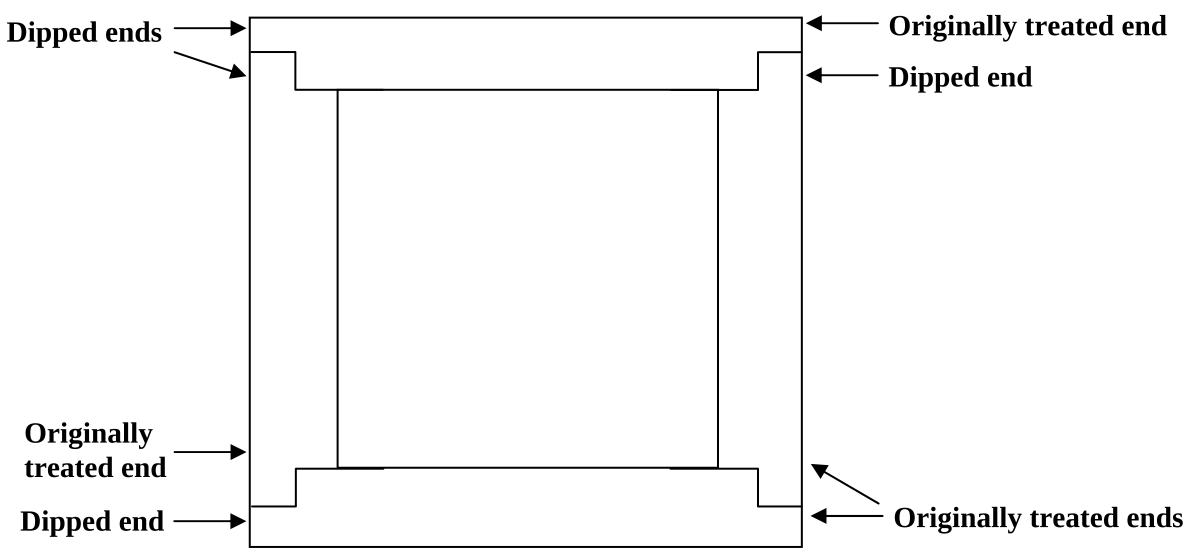
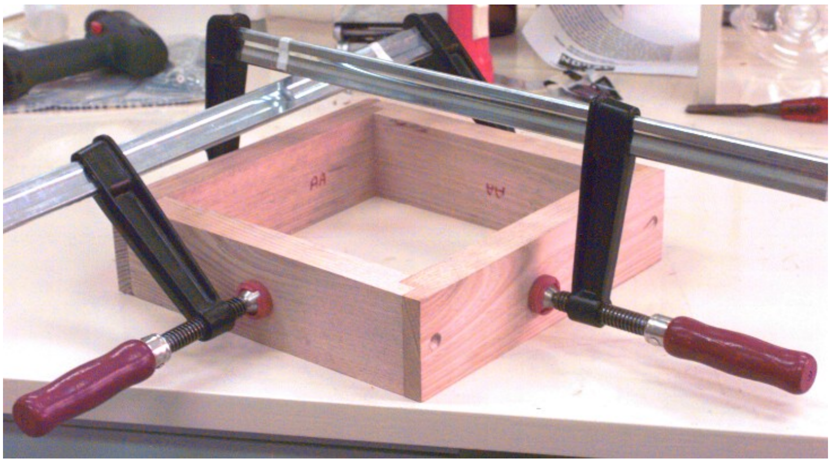


Figure 14. Arrangement of treated rebates with the model window frames.

Once positioned, the window frame was clamped into place and held together with a single screw driven into each of the four butt joints through the overlapping rebate (Figure 15). A metal number tag was placed in the top left corner, above the joint where both ends had been dipped.

(a)



(b)

Figure 15. Arranged components of a model window frame being clamped (a) and a single screw being driven into the overlapping rebate to fix the butt joint (b).

When the window frames were secure, they were glazed with a single piece of glass measuring 238 mm square held in place with TBTN LOSP-treated meranti beading (glass and beading supplied by Canterbury Windows). The beading was not fixed tightly or sealed to the glass, so that water or condensation hitting the glass could flow down the glass and pond inside the beading and come into contact with the test timber.

From the twelve boards in each species/formulation/treatment schedule combination, six model window frames were produced. Most windows were then painted, as indicated in Table 6, using Dulux Weathershield® low sheen acrylic (in either pale cream or mission brown colours). Additionally, multiple groups of six *E. regnans* window frames were constructed so that further variations could be included in the trial. These additional groups involved either LOSP-treated or untreated *E. regnans*:

- Unpainted windows.
- Painting the rebates to seal the end-grain prior to construction and painting the window frame before glass was installed to seal the timber beneath the beading and glass. The *Shorea* beading was also painted on all surfaces before assembly as well.
- Painting window frames after installation of the glass to leave timber beneath the beading and glass exposed, using cream or dark brown coloured paint.

- Installation of Preschem No-Rot® diffusible preservative rods 35 mm back from each rebate. These rods consist of Boron (124g/kg) present as 582g/kg disodium octaborate tetrahydrate and 110g/kg fluorine present as 243g/kg sodium fluoride. These rods were replaced after five years' exposure, and the entrance hole sealed with silicon sealant rather than wooden dowels, as most dowels had dislodged due to timber movement/swelling.

In total, 138 model window frames were included in the exposure trial encompassing 23 variations of six replicates. A summary of the species/treatment type/variation combinations is presented in Table 6.

Exposure

The construction of the model windows was completed in January 2001. Replicates were initially exposed on a roof at the CSIRO Clayton laboratory (Figure 16). This initial exposure period coincided with the summer months in Melbourne, when there would be maximum UV (ultraviolet radiation) exposure and weathering of the paint films. At the end of April the window frames were removed from the roof and exposed in the accelerated field simulator (AFS) at Clayton. Thereafter, window exposure alternated between the AFS for nine months of the year, and roof exposure over the three months of summer.

The AFS is also located at the CSIRO Clayton laboratory. Conditions in the AFS are maintained at 28 ºC and 85 % relative humidity. These are optimal conditions for the promotion of wood decay, particularly soft rot. The model window frames were exposed in the AFS by suspending the frames inside a concrete bin measuring 1.2 x 0.9 x 6.0 metres. The windows were paired so that those made from boards with similar retentions of the same preservative were together. The window of each pair with the higher retention was suspended from the other which, in turn, was itself suspended from a 1200 mm long metal rod that rested on top of the concrete bin. Three pairs of frames were suspended from each metal rod (Figure 1). There were 23 metal rods in total and window frame pairs were randomly distributed throughout this setup. The windows were arranged in order of descending preservative retention so that the effect of any preservative leaching from the treated timber in the top frame onto the bottom frame would be minimised.

Figure 16. Summer exposure of model window frames on the roof of the Clayton laboratory.

A watering system was laid in the base of the concrete bin. Fine mist sprays were connected in series so that 25 parallel groups of three sprays ran the length of the bin. Each line of three sprays was positioned between two racks of windows hanging from the top of the bin, with a set of sprays occurring both before the first frame and after the last. Soil to a depth of 150 mm was placed over this sprinkling system and bark from an old wood yard spread across the top of the soil to provide a source of wood decaying fungal inoculum. The watering system was turned on for about five minutes each week. However, after five years' exposure, an automatic timer was employed to water the windows for one minute each day.

Window inspection

The model windows were inspected annually for three years, again after six years in March 2007, and finally after eight years during March 2009. For the last inspection, each frame was dismantled and individual components probed with a knife to detect decay. Some window sections, especially the bottom sill, were cut in half to aid decay depth determination under the glass and beading (Figure 17). The depth and location of decay was noted (Appendix 1). Specimens were given a performance rating of 8-0 based on the amount of cross-section lost[17] (Table 7). A specimen rated 3 is considered to be unserviceable.

[17] Thornton, J.D., Johnson, G.C. and Nguyen, N-K. (1991). An in-ground natural durability field test of Australian timbers and exotic reference species. VI. Results after approximately 21 years exposure. Material und Organismen 26 (2): 145-155.

Table 7: Decay ratings given to timber samples based on the degree of fungal attack.

Rating	Cross-section lost	Depth of decay (mm) from surface		Description of decay
		Flat surface	End grain	
8	No loss, sound	0	0	No decay
7	Up to 15 %	0-2.5	0-5	Light decay
6	15-30 %	2.5-5.0	5-10	Light-moderate decay
5	30-45 %	5.0-7.5	10-15	Moderate decay
4	45-60 %	7.5-9.0	15-20	Moderate-heavy decay
3	60-75 %	9.0-11.5	20-25	Heavy decay
2	75-90 %	11.5-13.5	25-30	Severe decay
1	90-99 %	13.5-15	30-35	Severe-destroyed
0	100 %	15+	35+	Destroyed

Figure 17. Centre of timber sections cut for inspection, showing 5-6 mm decay and staining under glass edge (removed) and quad beading.

APPENDIX 1. Assessment of model window frames after 8 years.

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end	Right or lower end	Mid length under glass	Worst	Mean
E. regnans untreated painted cream							
MA1	Top	Bottom	35+	35+ BR	30	0	1.5
		Left	20	35+ BR	0	0	
		Right	0	35+ BR	0	0	
		Top	0	0	9 BR	6	
MA2	Bottom	Bottom	35+	35+ BR	10	0	0.0
		Left	35+	35+ BR	11	0	
		Right	35+	35+ BR	28	0	
		Top	35+	35+ BR	14	0	
MA3	Top	Bottom	35+	35+ BR	12	0	1.8
		Left	15	35+ BR	1	0	
		Right	12	35+ BR	0	0	
		Top	0	0	1 BR	7	
MA4	Bottom	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	2	0	
		Right	35+	35+ BR	4	0	
		Top	35+	35+ BR	12	0	
MA5	Top	Bottom	35+	35+ BR	2	0	2.0
		Left	0	35+ BR	0	0	
		Right	10	35+ BR	2	0	
		Top	0	0	0	8	
MA6	Bottom	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	27	0	
		Right	35+	35+ BR	30	0	
		Top	35+	35+ BR	30	0	
E. delegatensis untreated painted cream							
AA1	Top	Bottom	35+	35+ BR	3	0	0.0
		Left	35+	35+ BR	0	0	
		Right	35+	35+ BR	3	0	
		Top	35+	35+ BR	5	0	
AA2	Bottom	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	30	0	
		Right	35+	35+ BR	30	0	
		Top	35+	35+ BR	30	0	
AA3	Top	Bottom	35+	35+ BR	7	0	2.0
		Left	5	35+ BR	1	0	
		Right	0	35+ BR	4	0	
		Top	0	0	0	8	
AA4	Bottom	Bottom	35+	35+ BR	15	0	0.0
		Left	35+	35+ BR	5	0	
		Right	35+	35+ BR	30	0	
		Top	35+	35+ BR	30	0	
AA5	Top	Bottom	35+	35+ BR	16	0	2.0
		Left	0	35+ BR	0	0	
		Right	0	35+ BR	6	0	
		Top	0	0	0	8	
AA6	Bottom	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	1	0	
		Right	35+	35+ BR	30	0	
		Top	35+	35+ BR	10	0	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end	Right or lower end	Mid length under glass	Worst	Mean
E. sieberi untreated painted cream							
SA1	Top	Bottom	0	0	1	7	7.3
		Left	0	0	1 (low end)	7	
		Right	0	0	1 (low end)	7	
		Top	0	0	0	8	
SA2	Bottom	Bottom	35+	35+ BR	3	0	4.8
		Left	0	17 BR	0	4	
		Right	0	5 BR	0	7	
		Top	0	0	0	8	
SA3	Top	Bottom	0	15 BR	2	5	7.0
		Left	0	0	0	8	
		Right	0	4 BR	0	7	
		Top	0	0	0	8	
SA4	Bottom	Bottom	12 BR	13 BR	3 BR	3	5.0
		Left	0	10 BR	0	6	
		Right	0	24 BR	0	3	
		Top	0	0	0	8	
SA5	Top	Bottom	0	0	2 WR	7	6.8
		Left	0	0	2 WR (low end)	7	
		Right	0	11 WR	0	5	
		Top	0	0	0	8	
SA6	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
		Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
E. obliqua untreated painted cream							
MS1	Top	Bottom	0	0	3 BR	7	7.3
		Left	0	5 WR	0	7	
		Right	0	5 WR	0	7	
		Top	0	0	0	8	
MS2	Bottom	Bottom	3	3 BR	3	6	7.0
		Left	0	0	2 WR (low end)	7	
		Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	
MS3	Top	Bottom	0	0	3 WR	7	7.0
		Left	0	0	3 WR (low end)	7	
		Right	0	5 BR	0	7	
		Top	0	0	3 BR	7	
MS4	Bottom	Bottom	0	0	3 WR	7	6.5
		Left	0	0	3 BR (low end)	7	
		Right	0	20 WR	0	4	
		Top	0	0	0	8	
MS5	Top	Bottom	0	0	2 BR	7	7.3
		Left	0	0	4 WR (low end)	7	
		Right	0	0	4 WR (low end)	7	
		Top	0	0	0	8	
MS6	Bottom	Bottom	21 BR	0	2 WR	3	4.5
		Left	0	35+ BR	1 WR	0	
		Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end	Right or lower end	Mid length under glass	Worst	Mean
Shorea spp. untreated painted cream							
M1	Top	Bottom	0	0 dark red wood	1	7	3.5
		Left	35+	35+ WR	30	0	
		Right	0	0 dark red wood	2 BR (low end)	7	
		Top	25	35+ WR	0	0	
M2	Bottom	Bottom	35+ WR	35+ WR	18 WR	0	3.0
		Left	0	16 WR	0	4	
		Right	35+ WR	3 WR	0	0	
		Top	0	0	0	8	
M3	Top	Bottom	35+	35+ WR	6	0	1.3
		Left	35+	35+ WR	18	0	
		Right	15 BR	0	15 BR (20 diam)	5	
		Top	15	35+ WR	11	0	
M4	Bottom	Bottom	35+	35+ BR	30	0	1.5
		Left	17	35+ BR	30	0	
		Right	5	35+ BR	2	0	
		Top	0	0	8 BR	6	
M5	Top	Bottom	35+	25 BR	2	0	1.5
		Left	35+	35+ WR	2	0	
		Right	35+	35+ WR	13	0	
		Top	7 WR	0	0	6	
M6	Bottom	Bottom	35+	35+ WR	30	0	1.0
		Left	14	35+ BR	2	0	
		Right	0	35+ WR	0	0	
		Top	10	10 BR	1	4	
T. plicata untreated painted cream							
WR1	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
WR2	Bottom	Bottom	0	0	1	7	7.3
		Left	0	0	1 (low end)	7	
		Right	0	0	0	8	
		Top	1	0	0	7	
WR3	Top	Bottom	0	5 BR	3	7	7.8
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
WR4	Bottom	Bottom	0	0	12 BR	5	7.3
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
WR5	Top	Bottom	0	0	0	8	5.8
		Left	0	35+ BR	0	0	
		Right	0	0	2 BR	7	
		Top	0	0	0	8	
WR6	Bottom	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end	Right or lower end	Mid length under glass	Worst	Mean
E. regnans untreated and unpainted							
MA7	Top	Bottom	35+	35+ BR	9 (+1 low face)	0	1.8
		Left	0	35+ BR	0	0	
		Right	0	35+ BR	2	0	
		Top	0	5 BR	0	7	
MA8	Bottom	Bottom	35+	35+ BR	9 (+1 low face)	0	1.0
		Left	35+	35+ BR	9 (+1 outer face)	0	
		Right	0	18 BR	2	4	
		Top	35+	10 BR	4 (+5 top face)	0	
MA9	Top	Bottom	35+	35+ BR	30	0	1.0
		Left	0	35+ BR	0	0	
		Right	0	35+ BR	2	0	
		Top	0	20 BR	2 (+4 top face)	4	
MA10	Bottom	Bottom	35+	35+ BR	11 (+2 low face)	0	0.0
		Left	35+	35+ BR	30	0	
		Right	35+	35+ BR	9 (+1 outer face)	0	
		Top	35+	35+ BR	7 (+5 top face)	0	
MA11	Top	Bottom	35+	35+ BR	30	0	0.0
		Left	5	35+ BR	3	0	
		Right	35+	35+ BR	19	0	
		Top	35+	35+ BR	3	0	
MA12	Bottom	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	4 (+4 outer face)	0	
		Right	35+	35+ BR	3 (+1 outer face)	0	
		Top	35+	35+ BR	30	0	
E. regnans No-rot rods painted cream							
MA13	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MA14	Bottom	Bottom	0	0	1	7	7.8
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MA15	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MA16	Bottom	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MA17	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MA18	Bottom	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (for MANLP, dipped end)	Right or lower end (for MANLP, original end	Mid length under glass	Worst	Mean
E. regnans untreated, rebate sealed and painted cream							
MA19	Top	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	13	0	
		Right	35+	35+ BR	30	0	
		Top	10	35+ BR	22	0	
MA20	Bottom	Bottom	35+	35+ BR	4	0	1.5
		Left	0	35+ BR	0	0	
		Right	35+	35+ BR	2	0	
		Top	5	5 BR	0	6	
MA21	Top	Bottom	35+	35+ BR	30	0	0.0
		Left	35+	35+ BR	30	0	
		Right	35+	35+ BR	30	0	
		Top	35+	35+ BR	17	0	
MA22	Bottom	Bottom	35+	35+ BR	7	0	0.0
		Left	35+	35+ BR	30	0	
		Right	35+	35+ BR	0	0	
		Top	35+	35+ BR	2	0	
MA23	Top	Bottom	35+	35+ BR	30	0	0.0
		Left	15	35+ BR	12	0	
		Right	0	35+ BR	30	0	
		Top	30+	20 BR	10	0	
MA24	Bottom	Bottom	35+	35+ BR	14	0	0.0
		Left	35+	35+ BR	0	0	
		Right	35+	35+ BR	2	0	
		Top	35+	35+ BR	10	0	
E. regnans azole LOSP treated, low pressure Bethell, painted cream							
MANLP 1	Top 10.3	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
		Right	0	0	2 BR (low end)	7	
		Top	0	0	0	8	
MANLP 2	Bottom 13.0	Bottom	0	0	2 BR	7	7.5
		Left	0	0	2 BR (low end)	7	
		Right	0	0	0	8	
		Top	0	0	0	8	
MANLP 3	Top 14.5	Bottom	0	0	1 BR	7	7.3
		Left	0	0	2 BR (low end)	7	
		Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MANLP 4	Bottom 17.7	Bottom	0	0	1 BR	7	7.8
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MANLP 5	Top 28.1	Bottom	0	0	2 BR	7	7.8
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MANLP 6	Bottom 37.9	Bottom	0	0	2 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
		Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. delegatensis azole LOSP treated, commercial schedule, painted cream							
AAN1	Top	Bottom	0	0	2 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
	5.5	Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	
AAN2	Bottom	Bottom	0	0	2 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
	9.0	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
AAN3	Top	Bottom	0	0	1 BR	7	7.3
		Left	0	0	2 BR (low end)	7	
	10.1	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
AAN4	Bottom	Bottom	0	0	2 BR	7	7.3
		Left	0	0	2 BR (low end)	7	
	11.2	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
AAN5	Top	Bottom	0	0	1 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
	13.2	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
AAN6	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
	34.5	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
E. sieberi azole LOSP treated, commercial schedule, painted cream							
SAN1	Top	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
	4.7	Right	0	0	2 BR	7	
		Top	0	0	0	8	
SAN2	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	1 BR (low end)	7	
	8.5	Right	0	0	0	8	
		Top	0	0	0	8	
SAN3	Top	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
	9.9	Right	0	0	1 WR (low end)	7	
		Top	0	0	0	8	
SAN4	Bottom	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	13.2	Right	0	0	0	8	
		Top	0	0	0	8	
SAN5	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	21.7	Right	0	0	0	8	
		Top	0	0	0	8	
SAN6	Bottom	Bottom	0	0	1 BR	7	7.8
		Left	0	0	0	8	
	28.8	Right	0	0	0	8	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m³	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. obliqua azole LOSP treated, commercial schedule, painted cream							
MSN1	Top	Bottom	0	0	0	8	7.8
		Left	0	0	0	8	
	7.4	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MSN2	Bottom	Bottom	0	0	1 WR	7	7.5
		Left	0	0	1 WR (low end)	7	
	18.6	Right	0	0	0	8	
		Top	0	0	0	8	
MSN3	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	21.4	Right	0	0	0	8	
		Top	0	0	0	8	
MSN4	Bottom	Bottom	0	0	2 WR	7	7.8
		Left	0	0	0	8	
	23.3	Right	0	0	0	8	
		Top	0	0	0	8	
MSN5	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	25.5	Right	0	0	0	8	
		Top	0	0	0	8	
MSN6	Bottom	Bottom	0	0	1 WR	7	7.8
		Left	0	0	0	8	
	34.8	Right	0	0	0	8	
		Top	0	0	0	8	
Shorea spp. azole LOSP treated, commercial schedule, painted cream							
MN1	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	12.1	Right	0	0	0	8	
		Top	0	0	0	8	
MN2	Bottom	Bottom	0	0	0	8	7.8
		Left	0	0	0	8	
	13.4	Right	0	3 BR	0	7	
		Top	0	0	0	8	
MN3	Top	Bottom	0	0	1 BR	7	7.8
		Left	0	0	0	8	
	15.4	Right	0	0	0	8	
		Top	0	0	0	8	
MN4	Bottom	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	24.7	Right	0	0	0	8	
		Top	0	0	0	8	
MN5	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	33.7	Right	0	0	0	8	
		Top	0	0	0	8	
MN6	Bottom	Bottom	0	0	2 BR	7	7.8
		Left	0	0	0	8	
	34.8	Right	0	0	0	8	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. regnans azole LOSP treated, commercial schedule, painted cream							
MANC1	Top	Bottom	0	0	2 BR	7	7.8
		Left	0	0	0	8	
	5.2	Right	0	0	0	8	
		Top	0	0	0	8	
MANC2	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
	5.5	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MANC3	Top	Bottom	0	0	1 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
	6.0	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MANC4	Bottom	Bottom	0	0	2 BR	7	7.0
		Left	0	0	1 BR (low end)	7	
	6.9	Right	0	0	1 BR (low end)	7	
		Top	0	0	1 BR (left end)	7	
MANC5	Top	Bottom	0	0	1 BR	7	7.3
		Left	0	0	2 BR (low end)	7	
	7.1	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MANC6	Bottom	Bottom	0	0	1 WR	7	7.3
		Left	0	0	1 WR (low end)	7	
	7.1	Right	0	3 WR	2 WR (low end)	7	
		Top	0	0	0	8	
E. regnans azole LOSP treated, commercial schedule, painted brown							
MANC7	Top	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
	7.7	Right	0	0	2 BR (low end)	7	
		Top	0	0	0	8	
MANC8	Bottom	Bottom	0	0	1 BR	7	7.3
		Left	0	0	0	8	
	7.7	Right	0	0	0	8	
		Top	0	0	6 WR (top face)	6	
MANC9	Top	Bottom	0	0	3 BR	7	7.8
		Left	0	0	0	8	
	7.4	Right	0	0	0	8	
		Top	0	0	0	8	
MANC 10	Bottom	Bottom	0	0	4 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
	8.5	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MANC 11	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
	9.6	Right	0	0	0	8	
		Top	0	0	0	8	
MANC 12	Bottom	Bottom	0	0	2 BR	7	7.8
		Left	0	0	0	8	
	10.1	Right	0	0	0	8	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. regnans azole LOSP treated, commercial schedule, unpainted							
MANC 13	Top	Bottom	35+ BR	35+ BR	4 BR+7 low face	0	1.8
		Left	0	35+ BR	0	0	
	11.0	Right	0	35+ BR	0	0	
		Top	0	0	0 +2 BR top face	7	
MANC 14	Bottom	Bottom	35+ BR	35+ BR	2BR+11low face	0	1.3
		Left	0	12 BR	0	5	
	12.1	Right	35+ BR	35+ BR	2BR+9outer face	0	
		Top	35+ BR	35+ BR	0+11BR top face	0	
MANC 15	Top	Bottom	9 BR	0	3 BR&14 to side	5	6.8
		Left	0	0	2 BR (low end)	7	
	12.6	Right	0	5 BR	0	7	
		Top	0	0	0	8	
MANC 16	Bottom	Bottom	0	0	1 BR	7	7.3
		Left	0	0	0	8	
	14.8	Right	0	0	0	8	
		Top	0	0	0+7 BR top face	6	
MANC 17	Top	Bottom	35+ BR	0	2 BR&10 to side	0	4.5
		Left	0	14 BR	0	5	
	17.8	Right	0	13 BR	0	5	
		Top	0	0	0	8	
MANC 18	Bottom	Bottom	0	0	1 BR&12 to side	5	5.3
		Left	0	0	0	8	
	24.4	Right	16 BR	11 BR	0	2	
		Top	0	0	0 +9BR top face	6	
E. regnans azole LOSP dip treated, painted cream							
MAND1	Top	Bottom	0	0	1 BR	7	7.5
		Left	0	0	1 BR (low end)	7	
	2.7	Right	0	0	0	8	
		Top	0	0	0	8	
MAND2	Bottom	Bottom	0	0	1 BR	7	7.3
		Left	0	0	2 BR (low end)	7	
	3.0	Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MAND3	Top	Bottom	0	0	6 BR	6	6.0
		Left	0	0	1 BR (low end)	7	
	3.6	Right	0	21 BR	0	3	
		Top	0	0	0	8	
MAND4	Bottom	Bottom	0	0	3 BR	7	6.8
		Left	0	0	1 BR (low end)	7	
	4.4	Right	6 BR	0	2 BR	6	
		Top	0	0 (3BR top face)	3 BR	7	
MAND5	Top	Bottom	0	0	2 BR	7	7.5
		Left	0	0	0	8	
	4.9	Right	0	0	2 BR (low end)	7	
		Top	0	0	0	8	
MAND6	Bottom	Bottom	0	0	3 BR	7	7.3
		Left	0	0	2 BR (low end)	7	
	5.5	Right	0	0	2 BR (low end)	7	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. regnans TBTN LOSP treated, commercial schedule, painted cream							
MAOC1	Top	Bottom	0	0	1	7	7.3
		Left	0	0	1 (low end)	7	
	7.1	Right	0	0	1 (low end)	7	
		Top	0	0	0	8	
MAOC2	Bottom	Bottom	0	0	3 BR	7	7.3
		Left	0	4 WR	0	7	
	8.5	Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	
MAOC3	Top	Bottom	0	0	1 BR	7	5.5
		Left	23 BR	0	1 BR (low end)	3	
	9.0	Right	0	0	1 BR (low end)	7	
		Top	12 BR	0	1 BR	5	
MAOC4	Bottom	Bottom	35+ BR	0	1 BR	0	0.5
		Left	35+ BR	35+ BR	2	0	
	11.5	Right	26 BR	0	0	2	
		Top	35+ BR	13	7	0	
MAOC5	Top	Bottom	35+ BR	0	11	0	3.8
		Left	0	35+ BR	0	0	
	14.0	Right	0	0	3 BR (low end)	7	
		Top	0	0	0	8	
MAOC6	Bottom	Bottom	0	13 WR	2 WR	5	2.3
		Left	0	19 BR	0	4	
	21.9	Right	35+ BR	0	2 (low end)	0	
		Top	0	35+ BR	2	0	
E. regnans VPI boron treatment of green timber, painted cream							
MAB1	Top	Bottom	0	0	0	8	7.8
		Left	0	0	0	8	
		Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	
MAB2	Bottom	Bottom	0	0	1 WR	7	6.5
		Left	0	0	1 WR (low end)	7	
		Right	12 WR	0	0	5	
		Top	0	3 WR	0	7	
MAB3	Top	Bottom	0	0	1	7	7.3
		Left	0	0	1 (low end)	7	
		Right	0	0	1 (low end)	7	
		Top	0	0	0	8	
MAB4	Bottom	Bottom	0	0	1	7	7.3
		Left	0	0	1 (low end)	7	
		Right	0	0	1 (low end)	7	
		Top	0	0	0	8	
MAB5	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MAB6	Bottom	Bottom	0	0	1	7	7.5
		Left	0	0	0	8	
		Right	0	0	1 (low end)	7	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m³	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. delegatensis VPI boron treatment of green timber, painted cream							
AAB1	Top	Bottom	0	0	1 BR	7	7.3
		Left	0	0	1 WR (low end)	7	
		Right	0	0	1 WR (low end)	7	
		Top	0	0	0	8	
AAB2	Bottom	Bottom	0	0	1 WR	7	3.8
		Left	35+ BR	0	2 BR	0	
		Right	0	0	0	8	
		Top	35+ BR	0	4 BR	0	
AAB3	Top	Bottom	0	0	1 BR	7	7.8
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
AAB4	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	1 WR (low end)	7	
		Right	0	0	0	8	
		Top	0	0	0	8	
AAB5	Top	Bottom	0	0	0	8	8.0
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
AAB6	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	1 BR (low end)	7	
		Right	0	0	0	8	
		Top	0	0	0	8	
E. sieberi VPI boron treatment of green timber, painted cream							
SAB1	Top	Bottom	11 BR	0	2 BR	5	4.5
		Left	0	35+ BR	0	0	
		Right	0	12 BR	0	5	
		Top	0	0	0	8	
SAB2	Bottom	Bottom	0	13 BR	2 BR	5	5.8
		Left	9 BR	0	0	6	
		Right	0	14 BR	0	5	
		Top	5 BR	0	0	7	
SAB3	Top	Bottom	18 BR	17 BR	8 BR	1	4.0
		Left	0	26 BR	0	2	
		Right	0	11 BR	0	5	
		Top	0	0	0	8	
SAB4	Bottom	Bottom	0	5 BR	2 BR	7	6.8
		Left	0	0	2 WR (low end)	7	
		Right	0	15 BR	0	5	
		Top	0	0	0	8	
SAB5	Top	Bottom	0	0	2 BR	7	7.3
		Left	0	0	2 WR (low end)	7	
		Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	
SAB6	Bottom	Bottom	0	0	1 WR	7	7.3
		Left	0	0	1 WR (low end)	7	
		Right	0	0	2 WR (low end)	7	
		Top	0	0	0	8	

Frame no.	Bin position & uptake L/m^3	Specimen in window	Depth of decay mm and rot type			Rating	
			Left or upper end (dipped end)	Right or lower end (original end)	Mid length under glass	Worst	Mean
E. obliqua VPI boron treatment of green timber, painted cream							
MSB1	Top	Bottom	0	0	2 BR	7	7.8
		Left	0	0	0	8	
		Right	0	0	0	8	
		Top	0	0	0	8	
MSB2	Bottom	Bottom	0	0	1 BR	7	7.5
		Left	0	0	0	8	
		Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MSB3	Top	Bottom	0	0	1 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
		Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MSB4	Bottom	Bottom	0	0	1 BR	7	7.3
		Left	0	0	1 BR (low end)	7	
		Right	0	0	1 BR	7	
		Top	0	0	0	8	
MSB5	Top	Bottom	0	0	2 BR	7	7.5
		Left	0	0	0	8	
		Right	0	0	1 BR (low end)	7	
		Top	0	0	0	8	
MSB6	Bottom	Bottom	1 WR	1 WR	1 BR	7	7.0
		Left	0	0	1 WR (low end)	7	
		Right	0	0	1 WR (low end)	7	
		Top	1 WR	0	0	7	

APPENDIX 2. Photographic record of window frames after 8 years of exposure.

Untreated *E. regnans* = Mountain ash (MA) – Painted white

Untreated *E. delegatensis* = Alpine ash (AA) – Painted white

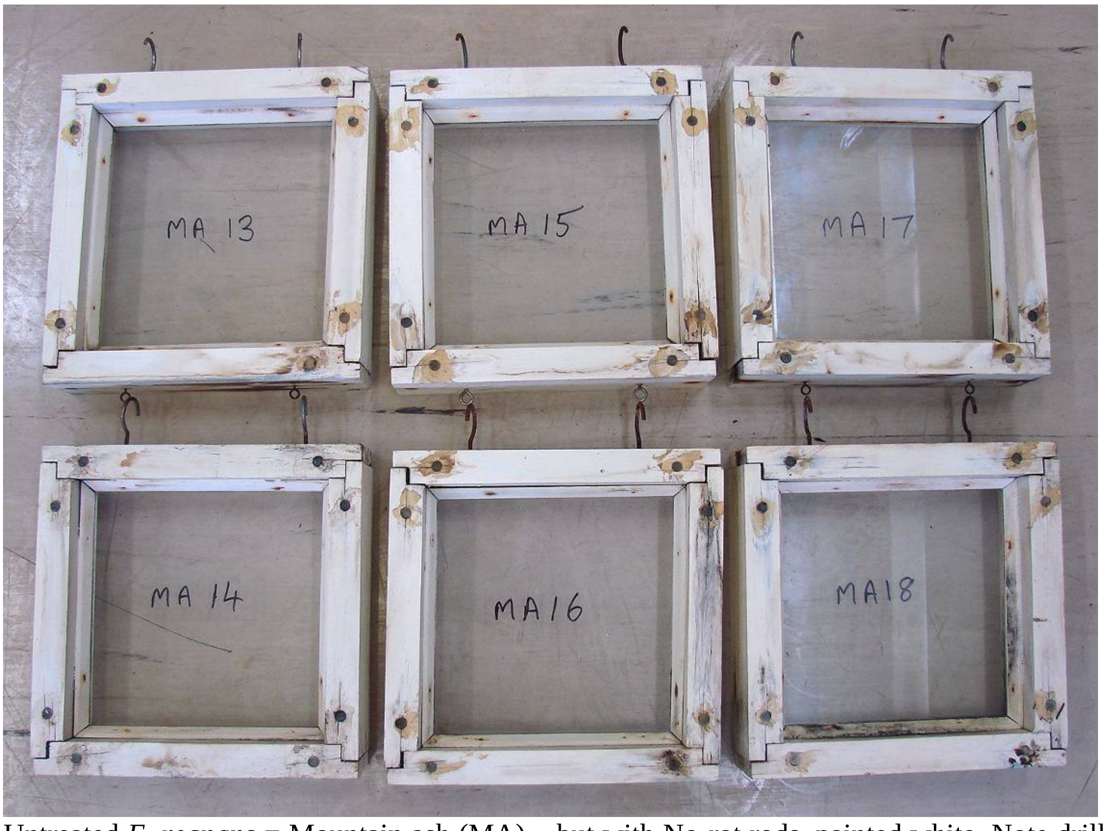
Untreated *E. sieberi* = Silvertop ash (SA) – Painted white

Untreated *E. obliqua* = messmate stringybark (MS) – Painted white

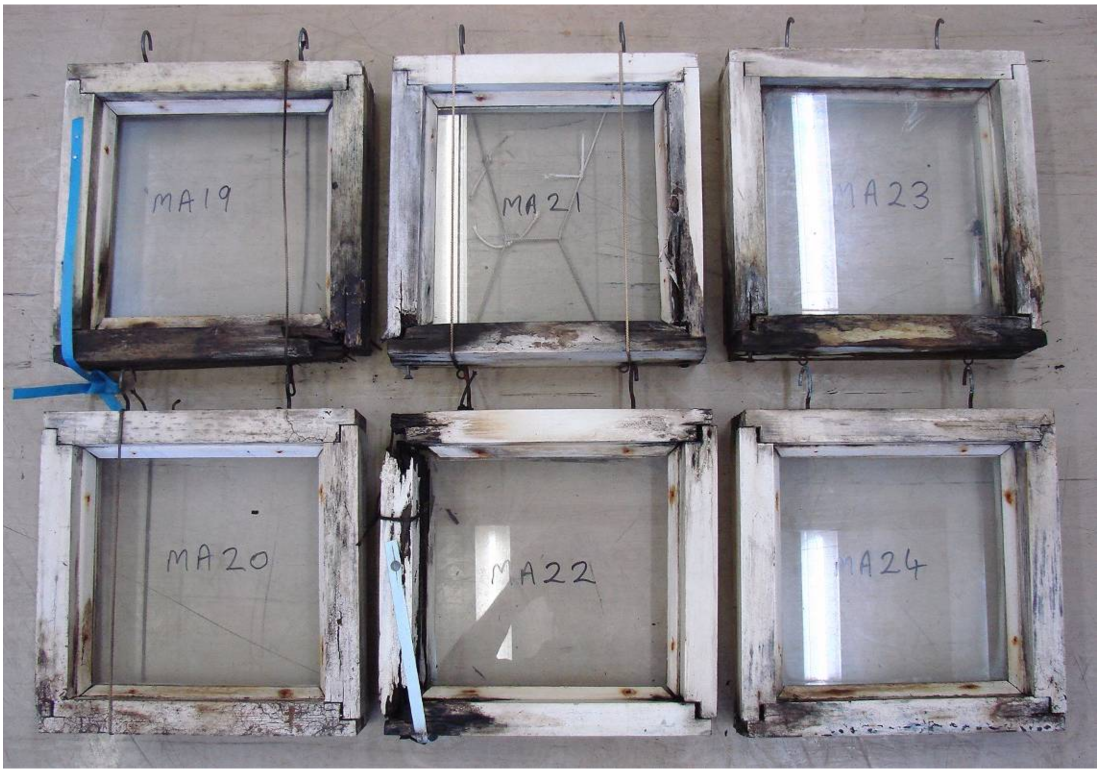
Untreated *Shorea* sp. = meranti (M) – Painted white

Untreated *T. plicata* = western red cedar (WR) – Painted white

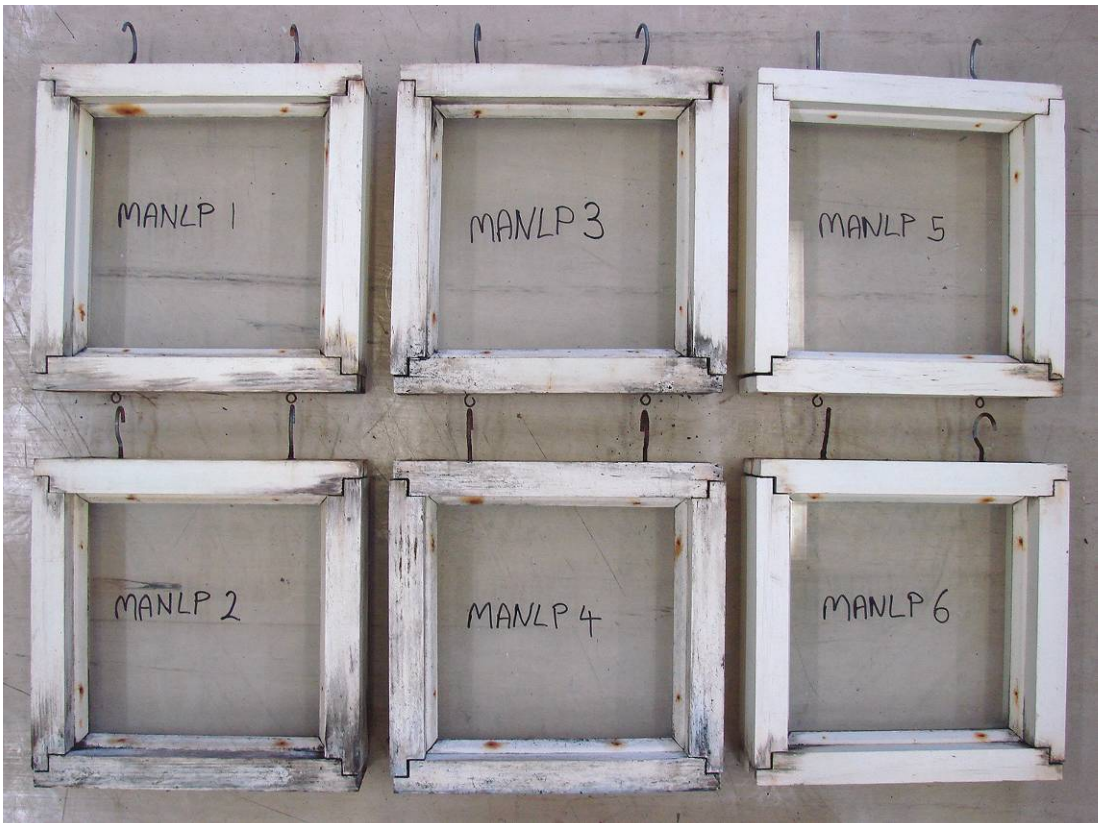
Untreated *E. regnans* = Mountain ash (MA) – Unpainted



Untreated *E. regnans* = Mountain ash (MA) – but with No-rot rods, painted white. Note drill holes with rods near corners sealed with silicone.



Untreated *E. regnans* = Mountain ash (MA) – Endgrain in rebate sealed, painted white.



E. regnans = Mountain ash (MANLP) – Azole LOSP using Low Pressure Bethell schedule, painted white.

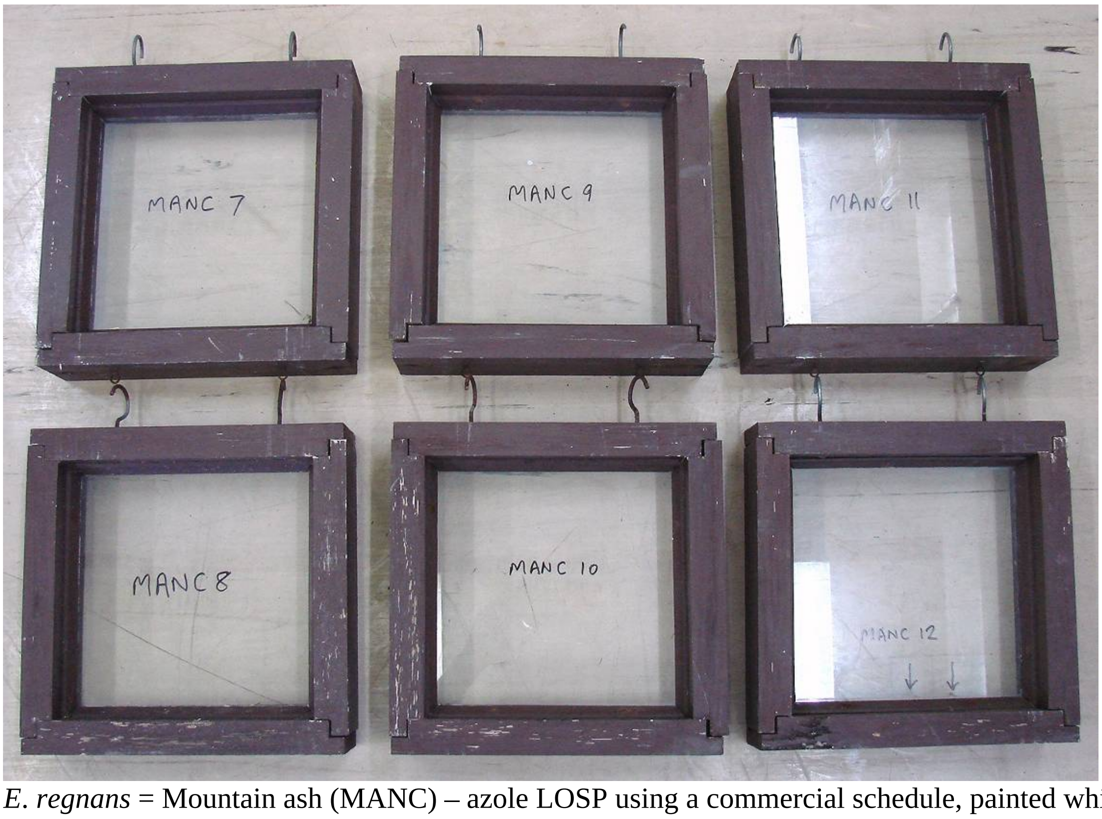
E. delegatensis = Alpine ash (AAN) – azole LOSP using a commercial schedule, painted white.

E. sieberi = Silvertop ash (SAN) – azole LOSP using a commercial schedule, painted white.

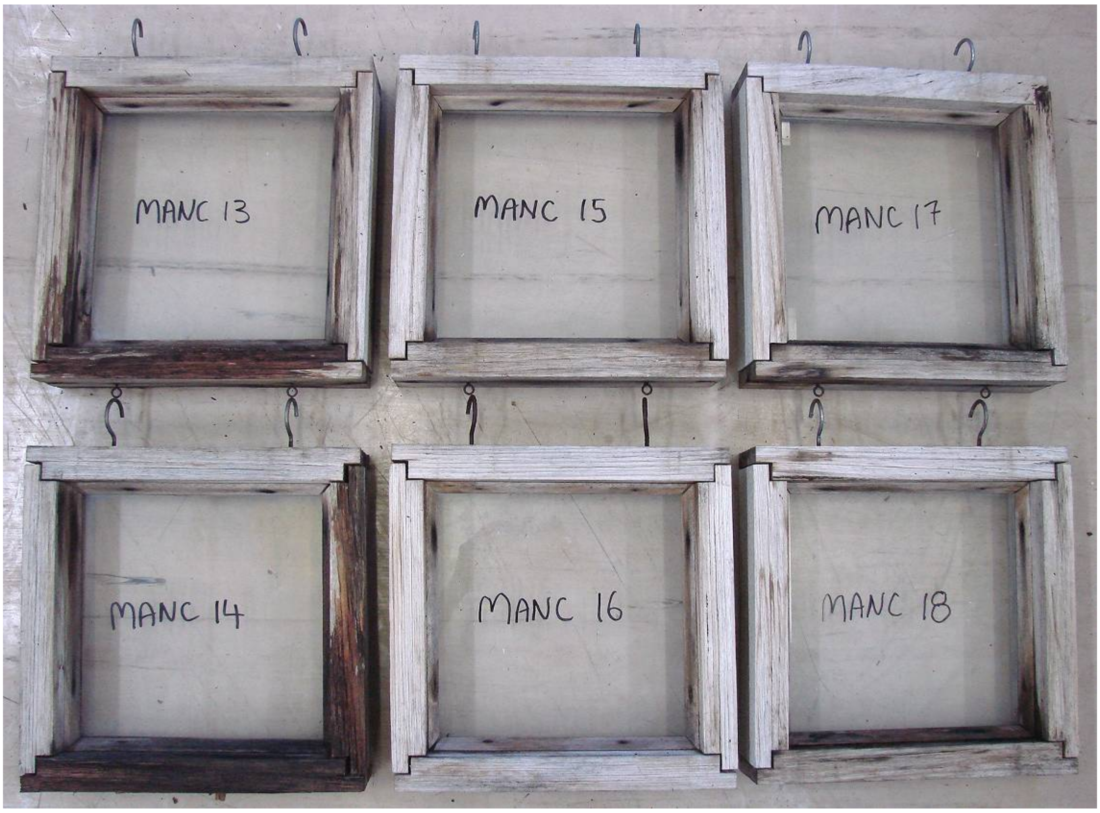
E. obliqua = messmate (MSN) – azole LOSP using a commercial schedule, painted white.

Shorea sp. = meranti (MN) – azole LOSP using a commercial schedule, painted white.

E. *regnans* = Mountain ash (MANC) – azole LOSP using a commercial schedule, painted white.



E. *regnans* = Mountain ash (MANC) – azole LOSP using a commercial schedule, painted white.

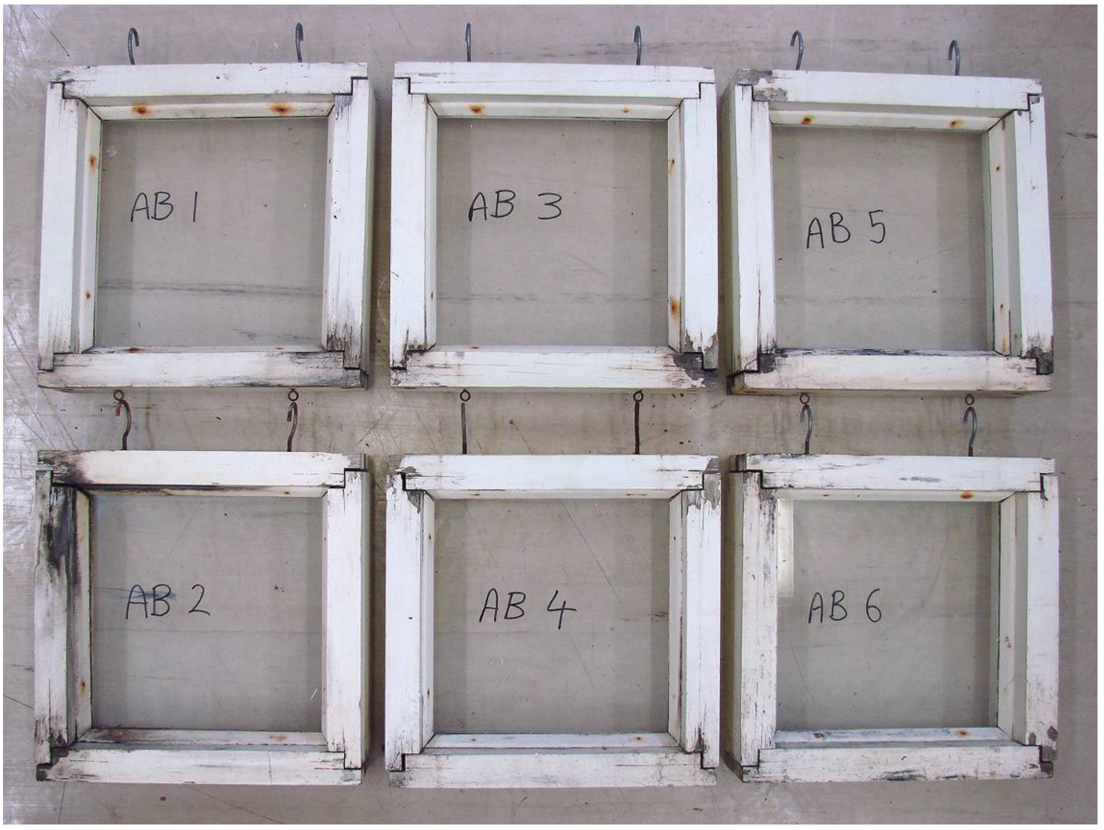


E. *regnans* = Mountain ash (MANC) – azole LOSP using a commercial schedule, unpainted.

E. *regnans* = Mountain ash (MAND) – azole LOSP by 3 minute dip, painted white.

E. regnans = Mountain ash (MAOC) – TBTN LOSP using commercial schedule, painted white.

E. regnans = Mountain ash (MAB) – VPI boron treatment of green timber, painted white.



E. delegatensis = Alpine ash (AB) – VPI boron treatment of green timber, painted white.

E. sieberi = Silvertop ash (SAB) – VPI boron treatment of green timber, painted white.

E. obliqua = messmate stringybark (MSB) – VPI boron treatment of green timber, painted white.

Important Disclaimer