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PEELING AND GLUING OF NEW SOUTH WALES EUCALYPTS

BY

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FORESTRY COMMISSION OF NEW SOUTH WALES

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SUMMARY

This paper briefly covers peeling and gluing results for a number of species of New South Wales eucalypts. Exploratory work in the Commission research plymill indicates that some species have properties well suited to plywood production.

Some explanatory notes on log selection, methods of peeling, drying and gluing are given. Indications are also given of what needs to be done to extend present limited information to minimal standards.

INTRODUCTION

The Commission plymill was founded with a grant from the New South Wales Government Rainforest Fund, together with a much larger investment by the Commission. While the original aim of the research was to replace the excellent peeling timbers from rainforests, the results to date also have value for the improved utilization of New South Wales forest resources. Another problem looming up for the plywood industry is the danger of southeast Asian rainforest timbers no longer being available in Australia at some near future date.

The plymill equipment is outlined in the briefest terms and some essential production technical terms are explained. A few explanatory notes on plywood manufacture are also provided to clarify the general results.

SELECTION OF LOGS

As a general rule, the Regions concerned have been requested to select reasonably sound logs for peeling but not necessarily absolutely perfect logs so as to obtain some appreciation of the yields to be gained from logs available as peelers in practical quantities. Where exceptions to this rule have been made either way, the details are noted.

It must be remembered that when eucalypt regrowth timber becomes available in quantity, commercial plymills would probably operate mostly on billets 40 cm diameter under bark at the small end or less. Billets in this range would be more suited to automatic peeling. Furthermore, there would have been less time for these trees to have developed faults such as termite and insect attack. With the increasing efficiency of fire protection, a reduced occurrence of gum veins and pathogen damage permitted by ingress through bark injury can be anticipated. The district and forest details together with log quality, silvicultural and fire history are noted for each species.

EQUIPMENT IN THE PEELING SEQUENCE

The logs prepared in the field were docked to length and manually debarked. They were heated with complete immersion in water in an insulated aluminium tank with thermocouples located at the edge of the final lathe core. The hot billets were peeled on a precision large production model lathe of 1850 mm billet length capacity. For internal use, veneer has not been peeled wider than 1200 mm.

The green veneer was clipped to width on an automatic clipper, checked for quality and thickness and placed in air drying racks which were later transferred to the screen type chamber drier. The sheets were dried finally to a moisture content ranging from 4 to 10% on an oven dry basis depending on the extended gluing requirements.

EXPLANATORY NOTES ON VENEER

The general aim of this plymill is to produce quality veneer. In industry, veneer is dried rapidly while constantly moving through a roller or wire band drier which gives more even drying conditions and usually produces flatter veneer. Thin veneer (e.g. 1.6 mm) is easier to peel than thicker veneer such as 2.5 or 3.2 mm provided the wood quality is there. The Commission plymill peeled 2.6 mm veneer initially and thinner veneer when the peeling quality permitted. The surface finish of the peeled veneer has varied with the species. Certain species have yielded very smooth or perhaps satin smooth faces on the final plywood even without sanding (for example, blue-leaved stringybark).

Some species have produced plywood with a beautiful colour and figure in the rotary peeled veneer. (example Sydney blue gum). Others yield a far less differentiated pattern in the veneer but an attractive colour. (example alpine ash). Those eucalypt species giving attractive veneer suitable to face sheets for rotary fancy would almost always require manual clipping in industry followed by splicing; and these are expensive operations. For plain cover sheets, a considerable proportion of veneer would need to be clipped and spliced and this renders eucalypt veneer uncompetitive when compared with the one piece imported rainforest sheet covers.

When it comes to bond testing results, the thicker the veneers in a piece of plywood then the greater the shear along the plane of the glueline that must be resisted by the glue upon complete wetting. Thus veneer 1.6 mm thick is much easier to glue into plywood that passes the "A" bond, than 3.2 mm veneer.

Some veneer percentage recoveries are given as an indication of veneer yield. These would need to be multiplied by a factor of about 0.85 or lower to convert them to commercial veneer recoveries provided centre material was recoverable in pieces. In commercial practice the waste veneer and at least some of the cores would be used for fuel to provide steam for the veneer driers and hot presses.

EQUIPMENT IN THE GLUING SEQUENCE

Adhesive components were weighed on an electronic balance and mixed with a slotted paddle rotated on an ordinary drill press. Glue was applied with a quality commercial glue spreader made for modern resin glues. The glued sheets were rolled into a prepress with accurate pressure control and were pressed for a recorded period. After this the integral sheet was held for a time and then pressed in a precision hot press heated by oil to yield a panel 1.2 metres by 1.2 metres. Following this, samples were cut out of the cured sheet on a grid pattern and tested according to the requirements of the appropriate glueline specification.

DEFINITIONS AND EXPLANATORY NOTES ON ADHESIVES

Modern plywood adhesives are based on synthetic resins which are fully polymerized in the hot press. The general types of resin are phenol formaldehyde for "A" bonds, melamine reinforced urea formaldehyde for "B" bonds and urea formaldehyde for "C" and "D" bonds. Where a phenol formaldehyde bond is obtainable, it is cheaper than the melamine reinforced urea for a "B" bond.

(a) **Wetting of Veneer.** The adhesive formulation must wet the surface of the veneer completely and must continue to wet it as drying out of the glueline occurs.

(b) **Rate of spread.** This is one of the major parameters of gluing. It is recorded as grams per square metre of double glueline (gm^{-2} DGL). Since it is common in the plywood industry in many parts of the world to define rate of spread as pounds of wet adhesive per 1,000 square feet of glueline, this value is also quoted for the convenience of the industry.

(c) **Open assembly time.** The time elapsing between the lay-up of the glued assembly of veneers until the pack of assemblies is pressed in the pre-press is called the "open assembly time". An excessive "open assembly time" permits the dry veneer to absorb an excessive percentage of the water from the resin mixture and the glueline is then too viscous to wet the interleaved dry veneers, resulting in a faulty glue bond when the plywood is hot pressed. If the open assembly time is too short and insufficient water is absorbed by the veneer, blows can result in the hot press particularly when heavy spreads are used.

(d) **Prepressing.** This operation transfers some of the wet glue to the dry veneers in contact with centres which bear glue on both sides. The pressure may be less or equal to hot press pressure. It is recorded in this paper as kilograms per square centimetre and also as pounds per square inch, once again for the convenience of the industry.

A time function is also involved. Too short a time in the prepress can cause poor bonding in plywood when it is hot pressed. Past a certain time, no further improvement in final bond quality occurs. The Commission plymill commonly uses a prepressing time of ten minutes but this is increased if poor "tack" is detected in veneer assemblies coming from the prepress.

(e) **Tack.** The property of "tack" is essential to confer good handling characteristics upon the assemblies of veneer from the prepress. It is observed by parting the adhering veneer sheets with the fingers. A good tack enables sheets to be handled either manually or mechanically into the hot press. While it is important for manual handling, good tack is essential for mechanical handling.

(f) **Closed assembly time.** This is recorded to measure the intrinsic property of the veneer in drying out the moist glueline rapidly or slowly. Excessively short closed assembly times may lead to "blows" when heavy spreads are required with dense veneers. Excessively long assembly times can permit excessive water removal from the wet glueline by the dry veneer which yields weak bonds in the final plywood. Practical operations in a plymill are greatly assisted by formulation/veneer combinations that permit a wide range of closed assembly times.

(g) **Hot pressing.** In this operation, heat is transferred from platens which also transfer sufficient pressure to flatten the assembly of veneers and to bring the veneer faces carrying a now viscous layer of glue mixture into close contact to give a thin cured glueline. The resin component of the glue is cured and this is a heat energy effect so that either higher temperatures or longer pressing times will increase to a physical limit the degree of cure upon which the quality of the final bond depends. Higher temperatures increase the tendency for "blows".

The Commission's hot press produces a plywood sheet 1.2 m x 1.2 m. In this series of tests, 140° C was generally used as the platen surface temperature. The duration of the hot pressing for sheets of each thickness in the following preliminary tests was selected to be above the minimum for that thickness since the aim of these tests was to establish the quality of the gluebond and not to determine the minimum pressing times required.

(h) **Extractives problems.** In general, eucalypt woods contain extractives. In some cases, the proportional content may be very high (for example in blackbutt), and these extractives can cause minor to disastrous results with phenolic resins. There is also an increase in gluing problems upon veneer ageing due to migration of extractives to the veneer surface and also to chemical changes in those surface films of extractives with time. It is not always practical to use veneer stocks promptly after peeling and this adhesive difficulty related to aging can represent a real problem for a working plymill. Ideally the adhesive formulation should cope with this problem.

(i) **The four bond types of Australian Standards briefly stated.**

(i) **Type "A" Bond.** The plywood has to pass the chisel test after being boiled for 72 hours.

(ii) **Type "B" Bond.** The plywood has to pass the chisel test after being boiled for six hours.

(iii) **Type "C" Bond.** The plywood has to pass the chisel test after being heated in water for three hours at 70° C.

(iv) **Type "D" Bond.** The plywood has to pass the chisel test after being soaked in water for 16 to 24 hours at 15° C to 20 ° C.

JOINT RESEARCH EFFORT ON THE "A" BOND

The Commission has a formal agreement on joint research with Borden Australia whereby Borden developes special phenolic resin formulations which are applied in the Commission plymill with the aim of obtaining an "A" bond with the various eucalypt veneers.

PHENOLIC OVERLAY TESTS ON EUCALYPT PLYWOOD

One of the current main uses of eucalypt plywood is in concrete formwork which requires an overlay film to be permanently applied. One type of overlay is composed of strong paper impregnated with dried uncured phenolic resin. Once again this phenolic formaldehyde resin is affected adversely by certain eucalypt extractives so that considerable research is required to develop commercially acceptable films. An arrangement exists whereby Formica Australia Pty Ltd developes films that are applied in the Commission's plymill in a further combined research exercise. The overlay film has to withstand the six hour boiling at atmospheric pressure as required by the "B" bond plywood specification.

INTERPRETATION OF THE DATA OBTAINED TO DATE

Peeling results to date have been based on a small number of billets numbering up to twenty which might represent only six to ten trees. This is a very small sample upon which to base conclusions for a species. Two studies are planned to determine the number of sample trees and the intensity of sampling required both for a forest and for a full State wide distribution. The initial species to be studied are blackbutt and spotted gum. Blackbutt has been peeled successfully on the North Coast for some years, as has spotted gum to a much lesser extent. Spotted gum from the South Coast will be the first species used for the statistical experiments since the results will add to the marketing knowledge of spotted gum which constitutes a small but increasing resource on the South Coast.

As indicated above, the interpretation of peeling results to date must take full account of the small number of samples involved. However, where a species looks promising and there is an immediate economic possibility, further billets from another compartment, forest or area can be peeled in the Commission plymill and larger tests would be made later in a commercial plymill. The latter type of test could be much more expensive but would be justified if the information could lead to the establishment of a commercial plymill when used in conjunction with similar tests on other species grown in the district. The same constraints of small sample size apply also to gluing results in that firstly the veneer was obtained from only a few trees and at best only a limited number of test sheets have been made for each glue formulation.

The main thrust on gluing work to date has been the search for phenolic formalderhyde formulations to yield an "A" bond with blackbutt veneer. Veneer from other species has been tested for "A" bond results during blackbutt glue testing. Special runs using urea formaldehyde reinforced with melamine formaldehyde or urea formaldehyde alone have been made for some of the species of eucalypt also. In general, eucalypts glue well with urea formaldehyde resins so that this avenue of research is possibly less critical at present. Time is the major constraint on the amount of research carried out in the plymill. In some cases there has been insufficient veneer available for further adhesive experiments. Veneer storage space is also a factor.

It is proposed to carry out additional gluing tests on the species peeled to date so that gluing information adequate for initial marketing appraisal can be published for each species. This will involve peeling fresh billets in most cases. It must be remembered that while glue formulations available at a given point of time may not prove satisfactory, there are better resins and hardeners continually being developed so that continued gluing tests at a later date are warranted until a successful formulation for each species is eventually developed.

In spite of the constraints of limited numbers of samples and of limited testing capacities in the Plywood and Veneer Sub Section, valuable information has been obtained to date. The order in which summarized information appears in this paper is the approximate chronological sequence in which the relevant species were peeled.

OUTLINE OF PEELING AND ADHESIVE TESTS TO DATE

1. ROUND-LEAVED GUM *(E. deanei* Maiden)

The logs were obtained from Olney State Forest from a regrowth stand containing Sydney blue gum (*E. saligna Sm.*). The species is found on the central and north coast of New South Wales and in southern Queensland, at times extending to the tablelands. A medium to large hardwood, the wood texture is rather coarse and the grain is sometimes interlocked (Bootle, 1983). The air dry density is about 960 Kg m^{-3}. The timber is not difficult to work and the heartwood is moderately durable.

(a) Peeling tests

The billets were heated in water to obtain a wood temperature of approximately 60° C, and then peeled to a minimum core of 210 mm when possible. The recovery of green veneer ranged from 25% to 63%. The veneer was of good quality when free of defects due to insect attack or the presence of gum veins. By jointing techniques a proportion of face material would be available.

(b) Adhesive tests

(i) **"A" Bond. High solids resin 7300 M.** Five ply 13 mm thick was glued with the phenolic resin 7300 M which had a viscosity of 28 seconds and a rate of spread of 452 gm^{-2} (91 lb M ft $^{-2}$ DGL). One sample had 22 minutes open assembly time and was prepressed at 12.25 Kg Cm^{-2} for 10 minutes. After prepressing the sheet exhibited very good tack. It withstood 46 minutes closed assembly time and then passed the "A" bond test with an average bond rating of 5.9.

(ii) **"A" Bond. Hardwood phenolic resin HWP 1000.** A sheet of five ply 13 mm thick was glued with the above resin system which had a viscosity of 25 seconds by Ford A Cup and a rate of spread of 450 gm^{-2} DGL (91 lb M ft^{-2} DGL). One sample had a four minute open assembly time, after which it was prepressed at 12.25 Kg Cm^{-2} for 10 minutes. It showed satisfactory tack. It withstood 116 minutes closed assembly time which is several times longer than normal factory practice. The final "A" bond results were reasonable in view of this although slightly below an "A" bond rating. Since the time of these tests in mid 1989, considerable improvements have been made to the HWP 1000 series of resins so that much better bonds can be anticipated when the species is again tested after a proposed future gluing run.

Note that adhesive tests have not been carried out as yet on round leafed gum using urea formaldehyde resins to produce a "C" or "D" bond and a melamine fortified urea resin to yield a "B" bond. A "B" bond is required for formwork but if an "A" bond can be obtained with phenolic resins this is superior and much cheaper to use for formwork.

The plywood formed was strong and sound and of good quality with a smooth surface even without sanding. A phenolic overlay paper was successfully applied to the sheet of plywood and passed the appropriate peeling test after boiling for six hours at room pressure.

Samples of unfaced plywood were belt sanded, lacquered and polished to give a lovely warm pink colour. To have any future as a semi-rotary fancy, the logs would have to produce a proportion of veneer free of defects. This need not necessarily mean full sheets of clear, since several widths of veneer may be joined to produce random matched fancy for which the higher selling price compensates for the extra jointing cost. Such plywood would make attractive wall panelling.

(c) Conclusions

This species peels, dries and glues to yield an "A" bond. It makes excellent plywood with an attractive colour. Veneer pieces with minor defects would be utilized as core veneers. Since this is a fast growing species, further tests would be warranted, particularly on logs from different districts.

2. BLUE-LEAVED STRINGYBARK *(E. agglomerata* Maiden*)*

The logs selected were from trees growing on the middle ridge at Ourimbah State Forest near Wyong as part of a regrowth stand aged 30-40 years. The species is one of the main stringybarks of the central tablelands, central coast and south coast of New South Wales. It is a medium sized hardwood of even and medium textured wood with usually straight grain (Bootle, 1983). Its air dry density is about 880 Kg m^{-3}. The timber is not difficult to work and the heartwood is durable.

(a) Peeling tests

The billets were preheated in hot water to obtain a wood temperature of about 60° C, and then peeled to a minimum core diameter of approximately 210 mm when possible. The recovery of green veneer ranged between 38% to 67%. The sheets of veneer produced were generally of good quality, free of defects. A fair proportion of the sheets would be suited for use as face veneer, being of a uniform pale yellowish brown colour with a silky smooth surface and a tight texture.

(b) Adhesive tests

(i) **"A" Bond phenolic resins.** Tests with phenolic resins were not very successful although most of the veneer was at an excessive moisture content when glued since the Section had the veneer dried elsewhere before its drier was operational. It is possible that the species is subject to gluing problems with phenolics.

(ii) **"B" Bond. Melamine reinforced urea formaldehyde resin CR560.** Five ply 13 mm thick was made in 1988 from stringybark veneer using resin CR560 at a viscosity of 25 seconds and a rate of spread of 480 gm^{-2} DGL (98 lb M ft^{-2}). The plywood showed good tack after prepressing. Short closed assembly times of about 25 minutes were used. The stringybark veneer produced good "B" bond plywood with this formulation.

(iii) **"C" Bond. Urea formaldehyde resin CR3276.** Three ply composed of 2.6 mm veneers was glued up with the above resin system at a viscosity of 27 seconds and a rate of spread of 382 gm^{-2} DGL (77 lb M ft^{-2}). At 17° C, the glueline tolerated a closed assembly time of 1.5 to 3.5 hours to produce an excellent "C" bond with ratings of 8 to 9.

(c) **Conclusions**

The plywood produced with both "B" and "C" bonds was strong and smooth even without sanding. In view of the excellent bond tests for "B" and "C" gluelines, this species certainly has potential for either face or core material with melamine reinforced urea or straight urea formaldehyde adhesives.

3. BROWN BARREL *(E. fastigata* Deane and Maiden*)*

The selected trees were from compartment 2307 in Glenbog State Forest near Bega, where shining gum (*E. nitens* Maiden) was present to some extent with silvertop ash (*E. sieberi* L. Johnson) on the ridges. The species is confined to a relatively narrow zone running almost parallel to the New South Wales coastline with a small extension into the eastern highlands of Victoria. It is a large hardwood with medium and even texture and the grain is often interlocked (Bootle, 1983). Air dry density is about 750 Kg m^{-3}. The timber is slow to dry.

(a) **Peeling tests**

The billets were preheated in water to a wood temperature of approximately 60° C, and then peeled to a minimum core of 210 mm when possible. The recovery of green veneer ranged from 32% to 55%. The veneer produced was smooth, tight, generally uniform in thickness for the several different thicknesses peeled and of good quality. It has a pale brown colour with a slightly open texture.

(b) **Adhesive tests**

(i) **"A" Bond - phenolformaldehyde HWP 1000.** Seven ply brown barrel plywood was assembled in late 1989 from 2.6 mm veneer at 9% moisture content. The adhesive formulation was applied with a viscosity of 35 seconds by modified Ford A Cup and at a spread of 460 gm^{-2} DGL (93 lb M ft^{-2}). A closed assembly of 44 minutes at 25° C was used. The plywood passed the "A" bond test in spite of its moisture content at fabrication being too high at 9% on an oven dry basis. Unfortunately only one sheet was involved in this test.

(ii) **"B" Bond. Melamine reinforced urea formaldehyde CR560 or CR3276.** In three separate glue runs in late 1988, a small number of three or five ply sheets were successfully glued to pass the "B" bond requirements. The glue viscosity ranged from 25 to 27 seconds and the rate of spread varied from 382 gm^{-2} (77 lb M ft^{-2}) to 484 gm^{-2} (96 lb M ft^{-2}). The adhesive formulations gave successful results over a range of closed assembly times from 7 to 223 minutes.

(c) **Conclusions**

On the basis of a single test, brown barrel passed the "A" bond test in spite of being damp, and it also passed the "B" bond test under a range of conditions. Further work will be undertaken on this species.

4. SYDNEY BLUE GUM *(E. saligna* Sm*)*

The trees were from Cumberland State Forest, Sydney, growing on soils derived from Wianamatta shale. The species commonly occurs on the east coast of Australia from Batemans Bay, New South Wales to southern Queensland. It is a large hardwood with moderately coarse and even texture. Grain is straight or slightly interlocked and gum veins are common (Bootle, 1983). Air dry density is about 850 Kg m^{-3}. The timber is easy to dry but tangential surfaces are susceptible to surface checking.

(a) Peeling tests

The billets were preheated in hot water to obtain a wood temperature of approximately 60° C, and then peeled to a minimum core diameter of about 210 mm when possible. The recovery of green veneer ranged from 33% to 59%.

Veneer from Sydney blue gum has both an attractive figure, and colours which can vary from dark pink to red brown with a slight purplish tinge. During the peeling of this species it was observed that the lower part of the tree provided an appreciable number of billets containing various defects. Consequently, both the quality and recovery of green veneer from these butt billets were considerably lower than that obtained from the top part of the tree, which was consistently of a better quality.

(b) Adhesive tests

(i) **High solids resin 7300M for "A" bond.** Five ply 13 mm thick was glued with the phenolic resin 7300M intended for use with moist veneer. The glue formulation had a viscosity of 21 seconds by modified Ford A cup and a rate of spread of 414 gm^{-2} DGL (84 lb M ft^{-2}). Open assembly times were 7 and 14 minutes. The sheets emerging from the prepress showed good tack. The plywood tolerated a long assembly time in the case of one of the two sheets. Both of these sheets passed the "A" bond test successfully.

In a second test run, a similar formulation was used at a viscosity of 28 seconds and a spread of 411 gm^{-2} (88 lb M ft^{-2}); while the dry bond average was low, both sheets passed the "A" bond test. Results would probably have been better with a higher spread.

(ii) **Hardwood phenolic resin HWP 1000 for "A" bond.** One sheet was glued using the HWP 1000 formulation at a viscosity of 25 seconds and a rate of spread of 450 gm^{-2} (91 lb M ft^{-2}). Tack on the sheet from the prepress was satisfactory. Although the closed assembly time of 2 hours was long even for the cold day, the sheet successfully passed both the dry and "A" bonds.

In a second test run with a recent HWP 1000 formulation using an FM 400 hardener, Sydney blue gum veneer more than one-year-old was redried to 6% moisture content on an oven dry basis and glued up with the formulation at a viscosity of 30 seconds and a rate of spread of 429 gm^{-2} (85 lb M ft^{-2} DGL). A single sheet (6/25) passed both dry and "A" bond well.

(iii) **Urea/melamine CR625/3287 resin for "B" Bond.** Ten sheets of plywood of three, five or seven ply construction were glued up using a CR 625/3287 fortified with melamine formaldehyde resin at a viscosity of 21 seconds and a rate of spread of 469 gm^{-2} (93 lb M ft^{-2} DGL). The veneer tolerated closed assembly times of 3 to 4 hours although the day was cool at 23° C. Veneer moisture content was probably 8%.

All sheets passed the dry bond with excellent results and eight out of ten passed the "B" bond with the other two sheets just below a bond rating of 5. A higher moisture content would probably have given an even higher average pass rate. (The "B" bond pass is essential to qualify plywood for formwork quality).

(iv) **Urea resin CR625 for "C" Bond.** Ten sheets of plywood of three, five or seven ply construction were glued up using urea resin CR 625 at a viscosity of 36 seconds and a spread of 416 gm^{-2} (83 lb M ft^{-2} DGL). The sheets emerging from the prepress showed good tack. The plywood tolerated closed assemblies of 2 to 3 hours which can be considered long in spite of the moderate ambient temperature. The dry bond results were very high and all 10 sheets passed the "C" bond wet test with good to excellent results.

(c) **Conclusions**

Sydney blue gum veneer has produced "A" bond plywood with two phenolic formulations, and "B" bond and "C" bond plywood, with flexibility in gluing conditions. The plywood was strong and smooth and had a pink to red colourwith a purplish tinge. Much of the veneer on the faces had an attractive figure. If logs reasonably free of defect were available, there would be the possibility of making jointed sheets for use as faces on rotary random matched fancy plywood suitable for wall panelling. The gluing sample represented here is unfortunately small and comes from one forest only. However, the results justify further tests in both peeling and gluing from a wider area of the natural range of the species.

5. SHINING GUM (*E. nitens* Maiden)

Shining gum (*E. nitens* Maiden) is a large hardwood of the high altitude country on both sides of the Victoria - New South Wales border and also the mountain area of eastern Victoria. Heartwood straw colour with pink or yellow tints. Sapwood is not always easy to distinguish. Texture is medium. Borer holes and associated black stains of "pencil streak" are often present, giving the otherwise attractive timber a very speckly appearance. The air dry density is about 700 Kg m^{-3}. Drying of solid timber needs much care because of collapse and surface checking. Shrinkages are about 5% radial, and 9% tangential. For this initial test, the logs were felled next to the Obliqua Road Construction clearing within Compartment 2360, Glenbog State Forest. This site is considered to be of a high to very high quality; it represents an area which produces some of the best timber in the south-east of the State.

Although this part of the country has suffered severe wildfires over the centuries, the last outbreak in 1952 produced a significant area of even aged regrowth, particularly shining gum. From this regrowth, the logs used in these peeling trials were cut. They are approximately 36-years-old. Since 1952, some selective logging has been carried out in those areas which were less damaged by the fire; this extraction, however, has not affected the growth of the even aged stands.

(a) **Peeling tests**

The major problem with the logs was extremely severe star checking, described as "popping". The veneer sheets had severe defects due to checking in spite of preheating the billets to about 60° C. The green veneer recoveries were low at 29% to 47% even when sheets with splits were included since the cores broke up during peeling operations at diameters in excess of 200 mm.

(b) **Adhesive tests**

(i) **"A" bond. Phenol formaldehyde HWP 1000.** Only one successful test was carried out at the time with a phenolic resin. This test used cover 2.6 mm veneers of shining gum over radiata pine internal plies and this construction has proved far more successful with other veneers such as blackbutt which have gluing problems. The resin was applied at a rate of 450 gm^{-2} DGL (91 lb M ft^{-2}) at a viscosity of 25 seconds. The formulation tolerated a closed assembly of 165 minutes at 14° C to satisfactorily pass the "A" bond.

(ii) **"B" bond. Test with melamine reinforced urea.** Only one sample was tested and it badly failed the wet test.

(c) **Overlay tests**

TA phenolic overlay paper was successfully applied to a sheet of shining gum plywood.

(d) **Conclusions**

Shining gum can be peeled after preheating to give smooth veneer. The tests based on one small test run of fast grown logs have given poor recoveries of veneer and one sample has given an "A" bond pass with phenolic resin. A phenolic overlay passed the "B" bond adhesion test. Since the species grows rapidly and there is a resource present, further work is warranted at a future date. Better peeling recoveries might be possible with larger diameter logs. The phenolic resins currently used in the Commission plymill have evolved considerably since mid 1989 and much improved results would be anticipated.

6. ALPINE ASH *(E. delegatensis* R.T. Bak)

Alpine ash (*Eucalypus delegatensis R.T. Bak*) is a large hardwood of the cold climate areas of Tasmania, eastern Victoria and south-eastern New South Wales. The sapwood is not clearly distinguishable and is about 25 to 50 mm wide in mature trees. Heartwood is a pale pink or pale yellowish brown. Gum veins are common. Air dry density is about 620 kg m^{-3}. Solid timber needs much care in drying because of proneness to collapse and internal checking, as well as surface checking on the tangential surface. Shrinkage is about 4.5% radial and 8% tangential.

The billets were received from a stand of alpine ash situated at a height of 1150 m above sea level in Cpt. 27 Bago State Forest. The area of 1200 ha from which the sample trees were taken, represents a relatively uniform regrowth stand with a few large trees remaining. This area, fairly free of fire, was clearfelled in 1917 and naturally regenerated. In the 1957-58 logging, there was a group selection thinning with most trees around 71 cm diameter being removed.

(a) **Peeling tests**

During the peeling process it was observed that all billets peeled in the range of temperatures between 45° C an 58° C produced a smooth veneer of good quality. Both the tightness and the uniformity of thickness of the 2.6 mm alpine ash veneer were good. The latter ranged from 2.54 mm to 2.74 mm for green veneer. The green veneer recoveries varied from 32% for a billet with a large knot to 60% for this parcel of billets which ranged from 360 to 420 mm in diameter.

(b) **Adhesive tests**

(i) **"A" Bond. High moisture phenol formaldehyde resin 7300 M.** Veneer 2.5 mm thick from an Australian Consolidated Industries (A.C.I.) cold peeling at Tumut at an oven dried moisture content of 8% or less was glued using a formulation with a viscosity of 28 seconds and a rate of spread of 411 gm^{-2} DGL (82 lb M ft^{-2}). The veneer showed good tack out of the prepress and passed both the dry and "A" bonds.

(ii) **"A" Bond. Radiata type phenolic resin SP900.** Commission veneer 2.6 mm thick was obtained from preheated billets and dried to 5% moisture content on an oven dry basis. Composite sheets were glued up using alpine ash faces and three radiata pine veneers for the internal piles. A viscosity of 25 seconds and a rate of spread of 450 gm^{-2} (DGL) (91 lb M ft^{-2}) were used. The formulation tolerated long closed assembly times although the day was cool. The plywood passed both the dry and "A" bonds.

(iii) **"A" Bond. Radiata type phenolic resin SP900.** A test similar to No. (ii) was carried out utilizing a light spread of 409 gm^{-2} D.G.L. (81 lb M ft^{-2}) which once again produced plywood passing both the dry and "A" bonds. A further test repeating this work again produced consistently very good results for both dry and "A" bonds.

(iv) **"B" Bond. Melamine/urea formaldehyde resin WM3294.** Veneer from cold peeling at A.C.I., and from preheating in the Commission plymill was glued at 6 to 8% moisture content using a glue viscosity of 25 seconds and a rate of spread of 434 gm^{-2} D.G.L. (89 lb M ft^{-2}). The resultant plywood passed both the dry and "B" bond tests well in spite of long closed assembly times.

(c) Overlay tests

Overlay phenolic film (Formica #72) was cured onto several sheets during normal hot pressing operations and passed the knife test following "B" bond heating conditions in boiling water.

(d) Conclusions

Alpine ash can be peeled cold to give good quality veneer but the quality is improved by preheating. The finish was smooth on the final plywood sheets even prior to sanding. The veneer was relatively free of knots and with a modest amount of clipping and jointing would yield good faces. The veneer was easy to handle through standard plywood operations and was flat in nature. The veneer glued well to give good "A" bonds with two quite different phenolic resins. It tolerated a range of gluing, closed assembly and hot pressing parameters and still gave good bonding results. The veneer produced good composite plywood with radiata pine veneer which means that both species could be used interchangeably in the one plymill. Alpine ash can also be successfully overlaid with phenolic paper film.

7. SYDNEY PEPPERMINT *(E. piperita)*

Sydney peppermint (*E. piperita* subsp. *piperita*) is a small to medium sized forest tree of the central coast and tablelands of New South Wales. This is a light brown coloured wood, with pink tints, often containing numerous gum veins: generally with interlocked grain and fairly close texture. Air dry density about 766 Kg m^{-3}. Shrinkage is about 9.2% radial, 14% tangential. The logs as received contained 83% to 108% moisture.

The logs were felled within compartment 66, Myall River State Forest No. 296 in the Bulahdelah Management Area at an elevation of 300 m. The sample trees selected were believed to be regrowth from the 1952 or 1968 wildfires following which the area was heavily logged by Hardboards Australia. Since then there has been no major wildfire but only minor ones or hazard reduction burns.

(a) Peeling tests

Billets were peeled at five different wood temperatures and it was observed that all billets with a temperature ranging from 50° C to 78° C produced smooth, good quality veneer. Both the tightness and uniformity of Sydney peppermint veneer were satisfactory. The thickness of green veneer varied between 2.47 mm and 2.77 mm. The recoveries of green veneer ranged from 11% to 49% with an average of 31%. The low recoveries are explained by the small diameter of the billets which ranged from 319 mm to 456 mm and the large core diameters obtained at the time due to a malfunction in the lathe dogging equipment.

(b) **Adhesive tests**

(i) **"A" Bond. High moisture phenolic 7300E.** Sydney peppermint veneer 2.6 mm thick and containing 7% moisture was glued into seven ply using the above resin. The formulation viscosity was 35 seconds and the rate of spread 483 gm^{-2} DGL (98 lb M ft^{-2}). Both sheets passed the "A" bond test well, but it looks as though 90 minutes closed assembly is the limit for this formulation even on a cold day.

(ii) **"A" Bond. Hardwood phenolic HWP 1000.** Two sheets of seven ply were glued from 2.6 mm peppermint veneer at 6% moisture content using the above resin system at a viscosity of 29 seconds and a rate of spread of 496 gm^{-2} D.G.L. (100 lb M ft^{-2}). Both sheets passed the dry test and the "A" bond quite well and tolerated closed assembly times of 75 to 90 minutes at 23° C. It is interesting to note that this thick plywood did not blow at this high rate of glue spread.

Since the date of these tests in October 1989, further improvements have been made to the HWP 1000 series of phenolic resins so that even better bonds may be anticipated. Veneer peeled in July 1989 has been retained in storage and further tests will be carried out to determine if there is a marked or major gluing problem due to ageing of the veneer, as for example happens in the case of blackbutt.

Note that gluing tests have not been carried out as yet using urea formaldehyde resins to give a "C" or "D" bond, or melamine fortified ureas to give a "B" bond. A "B" bond is required for formwork plywood but if an "A" bond can be obtained with phenolic resins this is superior and much cheaper, so that an "A" bond result is very valuable.

(c) **Conclusions**

The plywood made from seven layers of this peppermint was very strong, dense and naturally smooth. Samples of it were belt-sanded, coated with clear lacquer and buffed off with wax polish to give a golden brown colour with a diffuse grain pattern. If logs of the sample quality received could be obtained a proportion of the veneer would make rotary fancy faces. The remainder would be used as core material. Clipping and jointing would be required for much of the face, but the price margin would cover the extra cost. Veneer 1.6 mm thick usually produces material better suited to rotary fancy grade plywood.

The logs selected around 300 mm diameter would be very suitable for a modern automatic lathe set-up. The gum veins present in the sample were fairly small, knots were small and small borer holes were not too frequent. A much larger sample would have to be peeled to determine the average presence of these defects. Billets larger in diameter would give a higher yield percentage of veneer for example, 400 mm diameter billets would still be suitable for peeling on an automatic lathe. In summary, this species peels, dries and glues to yield an "A" bond. It makes excellent plywood of a lovely colour and surface finish. The current results are based on a very small sample of trees, but the findings justify a number of other peelings and the associated glue runs. Certainly the results to date warrant a close look at present silvicultural and utilization practices.

8. SILVERTOP ASH *(E. sieberi* L. Johnson*)*

A large hardwood of the southern and central coast and tablelands of New South Wales, eastern Victoria and northeastern Tasmania. Heartwood pale brown, sometimes pinkish. Sapwood is up to 25 mm wide, not clearly distinguishable from the heartwood. Texture is medium. Grain is often interlocked. Growth rings are noticeable but not prominent. Gum veins, pin-hole borer discolouration and "pencil streak" are common. Air dry density is about 820 Kg m^{-3}. The species is slow in drying and prone to surface checking on the tangential surface. Collapse is significant and reconditioning is desirable. Shrinkage is about 6% radial 10% tangential. The wood is not difficult to work. Heartwood is moderately durable.

The billets were received from compartment 404 Waalimma section, Yambulla State Forest, which was subjected to the 1939 and 1952 fires. Whilst the billets were generally of a good shape, they concealed a great deal of internal defects.

(a) **Peeling tests**

Some of the veneer was smooth and the rest rough since the billets moved on the dogs due to heart breakdown. Recoveries of green veneer ranged from nil to 39% with an average of 11%.

(b) **Adhesive test**

(i) **Phenol formaldehyde HWP 1000H.** Only one sheet of silvertop ash plywood was made with the above formulation. While a couple of glue bonds failed due to excessive moisture content at the time of gluing, the others passed both the dry and "A" bonds.

(c) **Conclusions**

Extensive heart breakdown is a characteristic of silvertop ash from Yambulla State Forest. It would be a complete waste of time to peel such logs. If sound logs are available from other districts, then peeling exercises could be justified at a later date.

9. SPOTTED GUM *(E. maculata* Hook)

A large hardwood of common occurrence on the poorer clay subsoils of the east coast from the Victoria/New South Wales border to the Maryborough district in Queensland. Heartwood is pale to dark brown. Sapwood, to 50 mm wide, is distinctively paler but there may be a zone of intermediate wood. Texture is moderately coarse. Grain is variable; the frequent presence of wavy grain produces an attractive fiddleback figure. Gum veins are common. Air dry density is about 950 Kg m^{-3}. Care in drying is needed to reduce the risk of checking on tangential surfaces. Collapse is slight. Shrinkage is about 4.5% radial, 6% tangential. The moisture content of the billets ranged from 54% to 60% on an oven dry basis.

The billets were received from compartment 106, Boyne State Forest, Coastal Working Circle at Batemans Bay District The area from which the sample trees were taken represents Forest Type 70, namely spotted gum associated with grey ironbark, blackbutt, white stringybark and Sydney peppermint. In 1959-63 and also in 1989, this area was logged. There is no history of major wildfires recorded.

(a) **Peeling tests**

The billets received ranged from 380 mm to 430 mm diameter under bark. The billets were heated using six different temperature ranges. Billets which were heated to temperatures at the edge of the core ranging from 40° C to 70° C produced smooth veneer. Both the tightness and uniformity of thickness of this veneer were satisfactory. Thickness ranged from 2.50 mm to 2.74 mm. The estimated recoveries of green veneer ranged between 40% to 57% with the average 50%. The large core diameters helped to reduce the recoveries.

(b) **Adhesive tests**

(i) **"A" Bond High moisture phenol formaldehyde 7300E.** Two sheets of five ply were glued using the above resin system at a viscosity of 35 seconds and a spread of 480 gm^{-2} D.G.L. (98 lb M ft^{-2}). The tack ex the prepress was good. Both sheets passed the "A" bond although only one passed the dry bond.

(ii) **"A" Bond. Hardwood phenolic resins HWP 1000 G and H series of four tests.** Nine sheets were glued during the four runs of this series. The viscosities ranged from 27 to 35 seconds and the rates of spread from 425 to 480 gm^{-2} D.G.L. (86 to 97 lb M ft^{-2}). Closed assembly times ranged from 15 to 136 minutes. All sheets passed both the dry and "A" bonds.

(c) **Overlay tests.**

Six sheets of plywood were successfully overlaid with a Formica overlay paper during normal hot pressing operations.

(d) **Conclusions**

Spotted gum from the South Coast can be readily peeled into good quality smooth veneer of uniform thickness over a wood temperature range of 40° C to 70° C. The wood colour is much lighter than that from the North Coast. Recoveries in a commercial plymill would probably be comparable with those for other eucalypts in the nominated size ranges.

The veneer was successfully glued into "A" bond plywood with two types of phenol formaldehyde resins. The spotted gum veneer tolerated a range of glue viscosities, spreads, open and closed assembly times and press temperatures. The plywood was successfully overlaid with a phenolic paper. Since the sapwood of spotted gum is susceptible to Lyctus attack, it would have to be dipped in sodium fluoride solution which does not interfere with phenolic adhesives.

Note, another batch of spotted gum logs from Narooma has just been successfully peeled, and adhesive tests will be undertaken on this veneer with the latest of the HWP1000 resin systems. A further batch of logs is due from the Casino district in the near future for peeling tests to give results for comparison with the extended results from the South Coast.

Spotted gum is currently peeled commercially on the North Coast and glued with melamine reinforced urea adhesives to produce considerable quantities of "B" bond plywood.

10. RIVER RED GUM *(E. camaldulensis* Dehnh *syn. E. rostrata)*

This is a medium to large hardwood adjacent to most of the inland rivers on the mainland. The heartwood is red to reddish brown with a distinctly paler sapwood to 40 mm wide. The texture is relatively fine and even. The grain is usually interlocked often producing an attractive ripple or fiddleback figure. Gum veins are common. Air dry density is about 900 Kg m^{-3}. Some collapse occurs. Shrinkage is about 4% radial and 8% tangential. The heartwood is durable while the sapwood is susceptible to Lyctus attack.

The billets peeled in the plymill came from two sources; one shipment came from Millewa SF398. The trees were probably 1890 regrowth. Severe fires in the late seventies caused major damage to the trees which were pole-sized at that time, and the logs probably came from that stock. The only silvicultural treatment they received was an "Intensive Utilization" thinning in 1974-75. The other batch came from Deniliquin State Forest 397. The logs were selected from regrowth commencing in the 1910 to 1920 period. The area was damaged by fire in 1964. This compartment has never had any silvicultural treatment.

(a) **Peeling tests**

River red gum from Millewa peeled well on heating and the best results were obtained when the wood temperature at the edge of the core was 70° C. At 80° C the veneer was also tight and smooth but had a tendency to curl. Recoveries ranged from 6% to 48%, with an average of 20%.

The billets from Deniliquin were peeled at a range of temperatures from 50° C to 80° C to give generally smooth veneer with a few intermediate to rough areas. No relationship could be determined between core temperature and veneer roughness for the small number of samples peeled. The veneer peeled quite satisfactorily in thickness of 2.6, 1.57 and 0.99 mm. Recoveries with the better grade of logs from Deniliquin ranged from 18% to 58% with an average of 33%.

(b) **Adhesive test**

(i) **Hardwood phenol formaldehyde resin HWP1000 FM400.** Seven ply 18 mm thick was glued up with the above resin system using a viscosity of 30 seconds by modified Ford A Cup and a rate of spread of 429 gm^{-2} DGL (87 lb M ft^{-2}). The open assembly time at 18 minutes was typical and the long closed assembly time of 105 minutes was not deleterious to the bond even though the temperature was 18° C. The sheet exhibited good tack on removal from the prepress. This sheet passed both the dry and "A" bond tests. Another batch using river red gum faces with radiata pine core veneers passed the "A" bond very well.

An earlier gluing test using the above resin but with a different hardener gave one sheet passing both the dry and "A" bonds and another sheet just failed the same test.

(c) **Conclusions**

River red gum peeled to give good veneer when the logs were reasonably free of defect. The veneer is a pleasant red to reddish brown and gives indications of drying to a darker, richer brown colour when polished and exposed to light.

Adhesive testing has been confined to the "A" bond only but the species makes very attractive, strong plywood which passes the "A" bond on the extremely limited testing done to date. The plywood has strong appeal when given suitable lacquer coats. Due to the limited volume of logs that would be available, any plywood made would have to comprise only a small part of the output of a working plymill. The obvious product would be rotary fancy in which small blemishes were permitted and marketed as part of the character of the product. The price obtainable should be high since the produce would be of necessity directed at a prestige slot in the market. Veneer not of sufficient quality for rotary fancy would be usable as core material.

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