PROCEEDINGS

EIGHTH

FOREST PRODUCTS RESEARCH CONFERENCE

HELD AT

THE DIVISION OF FOREST PRODUCTS,

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION,

MELBOURNE

APRIL 9-13, 1956

DIVISION OF FOREST PRODUCTS
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
MELBOURNE

REPRESENTATION

New Guinea: (Dept. of Forests)	J. B. McAdam, Director.
Queensland: (Dept. of Forestry)	S. G. Jennings, Officer-in-Charge, Forest Products Research Branch. W. J. Smith, V. Balodis) Research Officers.
New South Wales: (Forestry Commission)	W. D. Muir, Assistant Commissioner. E. B. Huddleston, Chief, Division of Wood Technology. R. Humphreys, G. Canaway) Research Officers.
Victoria: (Forests Commission)	F. G. Gerraty, Chairman (Policy Session only) A. W. Shillinglaw, Assistant Chief Inspector. A. L. Benallack, Sales and Marketing Officer. C. J. Irvine, Research Officer.
Tasmania: (Forestry Commission)	A. H. Crane, Commissioner.
South Australia: (Woods and Forests Dept.)	B. H. Bednall, Conservator. J. H. Harding, Investigations and Research Officer.
Western Australia: (Dept. of Forests)	A. C. Harris, Conservator.
Forestry and Timber Bureau:	G. J. Rodger, Director General (Policy Session only) A. G. Hanson, Research Officer.
University of Melbourne:	J. H. Chinner, Senior Lecturer in Forestry.
C.S.I.R.O., Division of Entomology:	F. J. Gay, Principal Research Officer.
C.S.I.R.O., Division of Forest Products:	S. A. Clarke, C. S. Elliot, Dr. H. E. Dadswell and officers.

Chairman - S. A. Clarke

Secretary - A. P. Wymond

CONTENTS

THE CONFERENCE WAS OPENED BY MR. F. G. NICHOLLS, SECRETARY, GENERAL ADMINISTRATION, C.S.I.R.O.

ITEM 1. WOOD STRUCTURE, SILVICULTURAL RELATIONS, WOOD AND BARK EXTRACTIVES

(a) REVIEW BY D.F.P. AND STATES

Dr. Dadswell: Although this item covers a wide range of subjects, it relates particularly to the work of the Wood and Fibre Structure Section, in which Section all these subjects are covered. However, in the discussion, it is expected that the work of the Timber Mechanics Section relating to silvicultural relations will be mentioned.

The investigations of the Wood and Fibre Structure Section are mainly fundamental in nature but, although at times it may be difficult to see any connection, practical problems are not lost sight of. It is our contention that a thorough understanding of the fundamentals is essential for the elucidation of many such problems.

Reference will be made to various aspects of our work under the specific headings of the item, but all our investigations of the past two years cannot be mentioned in the short time available.

(a) Wood Structure

This sub-heading should be more correctly "Anatomy" for in our studies of structure we have found it desirable to investigate the anatomy of bark, root and bud, as well as that of wood. In the main anatomical investigations there is continued concentration on the timbers of the south-west Pacific area. This is essential from the point of view of increasing our knowledge of the timbers of this region, more particularly of New Guinea, and of developing methods for their identification. There is little doubt that Australia will more and more look to the north for supplies of hardwoods for a variety of purposes. The extent of this part of our work may perhaps be gauged from the fact that since the last conference we have examined 356

timber specimens of the New Guinea Forests series, identified 276 for New Guinea Forests Department, and some 1350 for the Land Resources and Regional Survey Section of C.S.I.R.O., which maintain a unit in New Guinea. These determinations have not all been simple, many have involved considerable time and research. On the more fundamental side we are slowly progressing with our study of the anatomy of timbers from this area. Work on the members of the Cunoniaceae (Part IV of the series) and two related but small families, is completed, and results will be published in the next issue of the Australian Journal of Botany. Work on the Flacourtiaceae (Part V) is almost ready for publication. Investigations of the Burseraceae and Sapindaceae are proceeding slowly and it is proposed to continue on Verbenaceae and Combretaceae. The families selected for examination depend mainly on two factors - (i) botanical classification being completed by authorities working on the families concerned, and (ii) adequate material. Help in the supply of the latter may be required from Queensland and perhaps New South Wales in the case of the last two families mentioned.

All the knowledge of anatomy gained by such systematic studies is not readily available unless satisfactory keys are developed. I have referred previously (report of last Conference) to our card-sorting key for families and family groups, and we have discussed the card sorting key for commercial timbers developed for use by students and others. Recently we have made modifications to the latter key and are arranging to have new cards printed. The modifications are in the form of improvements, but they do not invalidate the keys already issued. Revision of the key for New Guinea is first priority since our New Guinea key is completely out of date. We are still waiting for comments from the New Guinea Department of Forests on species that should be included. The Australian set will also be revised making provision to include timbers used in Australia. However, until such time as the revision is complete

we are continuing to distribute the present key, of which some 100 sets are in hand. It is of interest to record that our standard collection has in it 13,358 specimens representing 1323 genera; in addition we have some 4000 authentic New Guinea collection specimens.

A survey has been made of crystalliferous tissue in woody stems, and the results published in "Tropical Woods" in two papers. The first of the series covers druses, raphides, elongated and rod-like crystals, acicular crystals, and crystal sand. The second deals with the rhomboidal, square or diamond shaped crystals that are of commoner occurrence than any of the other types. The lists prepared are of considerable value in timber identification, especially as they include records of many Pacific Island timbers on which nothing has been available previously.

The examination of the anatomy of the bark from various eucalypt species has now been completed and the results published. Investigation of bark from hybrids continues as material comes to hand. It is indeed interesting that bark anatomy has proved useful again and again in providing confirmatory evidence of hybridization. Requests have been made to Forest Services for assistance in obtaining bark specimens of other Myrtaceae. The work on such bark is purely fundamental but of value in family classification.

It was found necessary to have more detailed information available on root wood anatomy and so material from stem and roots of several different genera (including Eucalyptus and Acacia) has been examined. Results indicated that root structure is more likely to differ more markedly in the many roots from the same tree than in larger roots and stem wood. As the roots become smaller the percentage of vessel area per cross section increases greatly and its structure is reminiscent of that of some lianes or climbers.

The step from root anatomy to that of lignotubers in many species of eucalypt was logical and in searching the literature it was evident that knowledge of bud anatomy in Eucalyptus was very

limited. At the present time the investigation is in its early stages but already hitherto unrecorded details of bud anatomy have been recorded.

(b) Silvicultural Relations

(i) Fine Structure and Properties in Young Coniferous Stems. Certain investigations have been continued in this field of work using specimens of Pinus radiata from Queensland and Western Australia, P. elliottii from Queensland, P. taeda from Queensland and U.S.A., and Tsuga heterophylla from U.S.A. The growth patterns in these specimens were naturally not identical. In the hemlock specimens results obtained were as expected, namely, high longitudinal shrinkage near the pith associated with large micellar (fibril) angle but dropping quickly over a number of growth rings from the pith. There was a change in growth rate in one hemlock specimen with growth rings three times the width of those laid down earlier. This was accompanied by a rise in micellar angle (from 17° to 27°) and a slight drop in basic density. Results with P. radiata were similar, conforming to the standard pattern expected; the early wood near the pith showed greater longitudinal shrinkage than the late wood, a result also expected from cell length variations.

In the samples of P. elliottii, the micellar angle was high near the pith (greater than 35°) but there was a general tendency for a decrease in this angle over the succeeding growth rings, although the drop was slow. A higher longitudinal shrinkage in the early wood than in the late wood of the first-formed growth rings was noted. There was no markedly consistent correlation between parent and progeny examined, but neither was there any marked discrepancy. In the actual specimens examined tracheid length started off high (3 mm). Increase in basic density with age was due to increase in that of the late wood.

It is of interest to note that Echols working with this species at Yale School of Forestry reported ("Tropical Woods", 102) a definite correlation for cell length and micellar angle for the late

wood at all levels. He stressed that his results showed that cell length was under rigid genetic control; further that it would be obviously advantageous to breed for high initial cell length (thus supporting our earlier claims).

In the case of P. taeda we examined a 70-year old specimen from U.S.A. This gave results normal for this species, i.e., cell length rise from 2-3 mm over first 20 years (then slow rise to 3.5 mm max.), with slow drop in micellar angle from 50° - 35°. The longitudinal shrinkage near the centre was high with a maximum of 1.5 per cent. The Queensland P. taeda specimen examined gave a length rise from 1.5 mm to 3.5 mm over 17 years, with a drop in angle from 43° to 27°.

I feel I should call your attention to an article by Harold Mitchell, of the U.S. Forest Products Laboratory, published in Tappi, January 1956, 39, p. 26A. He stresses the advantages of silvicultural treatment for quality and quantity of wood to be produced by foresters and also the value of breeding from elite trees. He goes on to say that fibril angle must be given a prominent place in forest genetics work. He can foresee the use of tree breeding techniques to modify cell dimension, and other properties of wood fibres, and even the characteristics of the lignin or the lignin carbohydrate complex responsible for joining cells together. So our interest in lignification is not merely the interest of the fundamental scientist; there may be some most important applications.

(ii) Cell Differentiation and Lignification. The process of differentiation may be divided into the following four phases: (1) cell division, (2) cell enlargement (surface growth), (3) cell wall thickness, (4) lignification. Of these, 2, 3 and 4 are not strictly consecutive as considerable overlapping takes place. In the past few years we have investigated a number of aspects relating to differentiation and growth of wood fibres (cambium parent walls, rate of cell division and fibre length, rate of cell division

and reaction wood development, mechanism of surface growth, structure of pits, bipolar tip growth in differentiating cells, cell wall thickening in compression wood, micellar orientation in secondary wall, particularly as related to compression wood and tension wood). These have been concerned with the first three phases mentioned above. The problem of lignification has to a large extent been neglected until recent months. The study of lignification has recently received great impetus from the biochemical investigations of Freudenberg, Siegel, and von Wacek. The last two workers have shown that plant cells either in segments of plants or in tissue culture can synthesize lignin-like substances from phenolic precursors. Freudenberg has demonstrated that coniferin is hydrolysed to coniferyl alcohol by a glycosidase in the cambium and in the zone centripetally adjacent to it, and a lignin-like compound is synthesized. Such results point to the origin of a lignin precursor either in the cambial zone or elsewhere in the plant being translocated to the cambium.

It will be apparent, however, that while the concept of a centripetally diffusing lignin precursor is an attractive one on the basis of present biochemical studies, such an hypothesis must be consistent with the observed course of lignification as a phase in the differentiation process. Hitherto much of the early botanical observations on lignification have been criticized because the degree of lignification was assessed on the basis of staining reactions. However, these objections are overcome when ultra-violet microscopy is used either alone or in conjunction with staining procedure.

Years ago in the Division we studied lignin distribution in the cell wall by staining techniques and differential solubility methods, and the results obtained have been amply confirmed by the ultra-violet techniques of recent years. Lignification shows an exact parallelism with other phases of differentiation and is influenced by growth conditions and therefore by silvicultural treatment. When we examine lignification in the partially

differentiated xylem it is seen that lignin deposition begins first at the cell corners and thence spreads along the radial intercellular zone, then tangentially, and finally lignification of the secondary wall takes place. The formation of the secondary wall and lignification are independent processes. These observations point to some special property of the corner thickenings and at least indicate that the beginning of lignification depends as much on the state of the tissue as on the adequate supply of precursor.

In primary wood the pattern of lignification is different; it begins in the helical thickenings of the cell wall and the intercellular layer does not lignify. It is thus clear that in primary wood (longitudinal course of differentiation) the pattern of lignification differs markedly from that in secondary wood (transverse course of differentiation). This serves to emphasize the point made that lignification is simply a phase of a much more complex process. It does not seem to be a simple case of diffusion of a precursor, and lignin deposition probably requires the participation of living cytoplasm.

We need to know much more of this process and I think you will agree that it is most important that we do so for lignin and/or lignin complexes are most important in all aspects of timber utilization. Related to this question is the formation of reaction wood which involves changes in lignification.

(iii) Reaction Wood. The development of this type of wood under varying conditions is pretty well appreciated by all delegates. I think it will be agreed that it is bad silvicultural practice to leave, in the plantation or forest, trees which will continue to lay down reaction wood. After an unusual storm or cyclone decisions have to be made as to whether certain trees can be left or should be removed. A 2° lean is sufficient in conifers to cause the formation of compression wood and it is presumably the same in hardwoods. Queensland has had some interesting experience in the recovery of leaning stems.

We have been active over the past two years in the study of both compression wood and tension wood. Examples of the former have been found with a 10 per cent. longitudinal shrinkage, green to oven dry. The micellar angle has been much the same as in first-formed early wood in a conifer stem, but the shrinkage ten times greater. The reason for this is being investigated and some progress has been made.

Most time has been spent on tension wood and details of the fine structure (and variations in it) of tension wood fibres have been worked out. Here the question of degree of lignification assumes great importance. The most troublesome property of tension wood appears to be that of irrecoverable collapse, and this has been correlated with lack of lignification. In the utilization of ash type eucalypts this is a problem. When distinct bands of tension wood are present it is a comparatively easy matter to eliminate early material likely to be troublesome early, but when only what we have termed incipient tension wood is present early segregation is impossible and in fact only after kiln drying and reconditioning does troublesome material makes its presence known (non-recovery of collapse). So far all that is known of such material is that it comes from eccentric logs (most probably derived from leaning trees) and that it is apparently lacking in cell wall lignin when compared with more normal material. We are working on possible methods of detection that can be applied to log cross-sections.

Work on the underlying causes of the formation of reaction wood has continued. A paper on this subject will appear in a forthcoming issue of Australian Journal of Botany.

(c) Wood and Bark Extractives

Under this heading both fundamental and applied investigations are being carried out. On the fundamental side the role of leucoanthocyanins as the possible precursors of tannins is being investigated, particular attention being paid to their possible correlation with the

red colour imparted to the leather by the tannin from the principal tannin resources of Australia, New Guinea and New Zealand. The distribution of leuco-anthocyanins in leaves, bark, cambium and wood has been investigated and it has been suggested by Hillis that in eucalypts at least leuco-anthocyanins originate in the leaves and move with the carbohydrate and other materials down the phloem to the cambium and thence into the sapwood and heartwood.

On the practical side considerable assistance has been given to New Guinea in the establishment of the cutch industry there. The cutch from the mangroves of the Delta region will become an important source of tannin when the teething difficulties of the industry are overcome. Experiments have indicated the value of the cutch as a raw material for adhesive manufacture.

In Australia work has been done on the bark of E. sideroxylon. The French have used this species extensively as a source of tannin. Our idea is to harvest the bark without killing the tree and experiments have shown that this can be done, with the tree regenerating more bark and fixing kino in the bark.

Experiments are planned for the investigation of wood extractives from marri (E. calophylla).

In conclusion, I would like to point out that I have by no means covered all the investigations carried out during the past two years. There have been many individual pieces of work with most interesting results, but these have all been related in general to the overall picture put before you. I suggest that you take the opportunity in the ensuing discussion of asking for enlightenment on any aspect which interests you or that you discuss details with the officers concerned during the course of the conference.

Mr. Boyd: You will know from previous conferences that the Timber Mechanics Section has been doing some work on silvicultural problems and to a degree it is related to the work done by the Wood and Fibre Structure Section. Our present work started from requests

by Queensland to establish whether there is a positive relationship between the mechanical strength properties of parent trees and their progeny. This early investigation was confined to slash and loblolly pine. From the results, we were not able to answer positively whether the properties were transmitted completely, but it could be said that there was no obvious difference in properties between the parent and progeny when certain factors were taken into account. These factors included expected differences which would occur in any such species, differences of strength related to age, strength related to rate of growth and strength related to percentage late wood. The percentage late wood could be affected by seasonal conditions, and rate of growth, which also might be controlled by site or other factors. In view of the somewhat incomplete nature of the conclusions from the Queensland sample, we took the opportunity of extending the investigation to a large sample of P. radiata which we had received from South Australia, which included a number of different age groups and sites. Later on again we extended the sample to include some P. radiata from New Zealand and P. pinaster from Western Australia. The results, taken over all samples, established a very marked relationship between strength and density and another relationship between strength and age (in addition to that due to density change with age) but there was no clearly established relationship between rate of growth and strength. These clearly established relationships accounted for some 90 per cent. of the differences which could be observed in strength properties. However, there were still some differences between trees which were not explained. A sample from Western Australia was selected to try to define more clearly all critical factors concerned. For this purpose we selected some material showing extreme variations of growth rate on the one site. Part of the sample was of trees without special treatment, and part was of trees which had been sprayed with zinc sulphate. The material in this area showed very poor growth until the zinc sulphate treatment was given after which there was a very marked

change in rate of growth. When strength test results from the non-treated and treated material were compared a number of interesting facts developed. Firstly the overall strength of gross specimens of the untreated material was very much less than that of the treated material. However, when we analysed the micro specimens and compared early wood from the treated material with early wood from the untreated material there was no discernible difference in strength. Similarly there was no difference in the strength of the late wood in the two groups of material. In effect therefore, we had in the unthrifty material exactly the same basic strength as in the thrifty material when these were compared respectively in the early wood and late wood bands. The interesting additional fact was that, on appearance, the late wood bands in the unthrifty material were much narrower than in the case of the treated material, which incidentally is now growing much more normally. We haven't the final results of analysis but at this stage it appears that the percentage late wood may be the clue to the strength and age or growth rate relationship. We propose to obtain another sample from the Mundaring area in Western Australia where there are some very suppressed trees which we hope to compare with an earlier sample of reasonably freely growing material from the same vicinity.

Mr. Huddleston: Regarding the card sorting keys, the demand is becoming quite large in New South Wales and we are repeatedly telling people that they cannot have a key unless they undertake a course. Have you considered producing these in greater number and making a charge to cover the cost of producing them ?

Dr. Dadswell: We have found that a certain amount of instruction is necessary before the key can be used intelligently. Without this proviso, which you are also enforcing, we would be handing them out to all and sundry although they were paying for them, and we would not know if they were being used intelligently. We usually only send keys to a firm or school not to individuals, so it remains

the property of the firm or school. Over the past 12 months or so we have not had a very big demand here for the sets.

Mr. Bednall: Concerning Mr. Boyd's remarks on the treated timber from Western Australia. Did he say that the treated timber by and large gave a much greater gross strength value than the untreated, and yet the spring wood and the autumn wood in each sample was the same ?

Mr. Boyd: That is correct, a gross sample cut from the treated material and including several growth rings was substantially stronger than the same size sample cut from the untreated material. However the early wood v. early wood comparison between the two samples showed substantially the same strength for treated and untreated material, similarly the strengths were identical in the late wood v. late wood comparisons. The difference in the gross size specimens is explained by the percentage of late wood.

Mr. Chinner: Is the strength property referred to in the late and early wood micro tensile strength comparisons and the gross strength referred to over several age rings, some different mechanical property ?

Mr. Boyd: That is correct. The micro test specimen is a tensile specimen whereas the compression specimen is used in the gross strength specimen. However, we did establish earlier that comparisons of that type were quite valid, that is, if a strength difference was going to show up in any particular sample in which you took both compression or tension specimens, then you could reasonably expect that the one would mirror the strength properties of the other.

Mr. Kloot: Besides compression we also conducted bending tests and both compression and bending strength showed very much the same effect.

Mr. Jennings: Considering the remarks by Dr. Dadswell it will be as well if I indicate the reasons why we attach so much importance to this work. I propose to use for illustration some

figures we have recently calculated of the financial yields to be obtained from Pinus elliottii (var. elliottii) plantations some 50 miles north of Brisbane.

These are for a 50 year rotation and are the total yields from all thinnings and the final crop without interest considerations but using present day costs of establishment, maintenance, conversion and sawn prices.

Five thinning regimes ranging from a very drastic one to one yielding maximum log volume production were investigated. Three points are of particular note:

(a) The total log volume yields per acre are of the order of 90 to 100,000 super ft Hoppus respectively.

(b) The financial yields range from £1500 to £500 per acre respectively.

(c) The yield of sawn timber is approximately the same from each regime.

This latter fact is of course the principal reason for the variation in financial yields. The lighter the thinning regime the smaller the trees and the lesser proportion of higher grade sawn material in them. It might be said that all this has very little connection with the work under discussion, but I submit that it has. What sort of wood is being grown in the heavier thinning regimes ? So far as we can tell the heaviest will not give less than 4 rings to the inch of wood with a high (over 50 per cent.) of late wood in each annual ring.

Investigations of such properties as basic density, longitudinal shrinkages, etc. show values that are perhaps satisfactory but capable of improvement. To attain the heavy thinning regime in practice we have to materially improve our trees in order that a high proportion of good stems is available to select the final crop. It is to be remembered that the heaviest thinning regime will have a smaller

number of stems to choose from in this connection (probably only 300 instead of 600 in the lighter regimes).

Genetic improvement by single tree selection and seed garden establishment is already well advanced but the judgement of the results of this work has only been based on the external morphological characters and has not yet taken account of the properties of the wood except in a very general way.

The advantage of single tree selection is illustrated in an article by McWilliams and Florence in Australian Forestry (Vol. XIX No.1).

Restricting seed collection to good phenotypes, the following assessment of progeny trials illustrates the benefits obtained:-

Seed Source	Acceptable Stems (suitable for high pruning) per acre	Plus Stems per acre
Routine	72	5
10 best parents	139	35
3 best parents	(144	37
	(144	40
	(138	40

The progeny trials have given us the parents for the seed garden now being established by grafting techniques and I do not need to indicate further the possible benefits of this work.

We must be sure that wood qualities in the selected parents are above average.

The results of the Division's work that I have seen on this material do I think show suggestive differences in certain properties between a group of three elite trees on the one hand and two stems (not phenotypes) from routine operations; e.g., fibre length in the former is generally greater than the latter and longitudinal shrinkage trends from pith to bark are better.

I also refer to recent American work on slash pine by Echols reported recently in "Tropical Woods".

I am not suggesting that all these results are conclusive but they do highlight the necessity and urgency of much more work on the genetic aspects.

We propose to expand our work in this respect in the near future and will supply the Division with duplicate specimens from the chosen parent trees and their progeny as may be desired. We have yet to see any sound reasons why this work should not be accorded a very high priority.

Dr. Wardrop: Mr. Jennings commented that he thought that the fibre and wood properties were possibly under genetic control. I think there are some grounds for this supposition. The properties of wood depend on the properties of the fibres themselves and on the way they are cemented together. In other cells it is known that the characteristics of the cell wall and cell dimensions length are heritable characteristics. This has been shown for example in the endodermis structure in roots. Thus one species with say 9 lamallae in the wall, was crossed with a second species with say 4, and the progeny had about 6 or 7. This is a broad indication that the characteristics of the cell wall, in this case cell wall thickness, which would affect density in wood, is a heritable character.

A second example is that in cotton it has been shown quite definitely that the fineness, which affects both the fibre diameter and cell length, is a heritable character. In view of our earlier work, the more recent work of Echols at Yale, this seems in general agreement with the argument. I wish to emphasize, however, that this relates only to the fibre wall, and not the way the fibres are held together.

With regard to the rate of recovery of leaning stems, recent experiments have given some indication of the rate of transmission down the stem of the recovery process, which is really a measure of compression wood formation. It works out at about 2 to 5 mm an hour, which is roughly the rate of transmission of auxin through the plant cells.

Mr. Jennings: How much these characters are linked with the genes is unknown. We must look for some measure which will give us reasonable assurance that the parent trees selected are going to produce woods of the average or better of the species as we know it. With regard to plantation managed species, you are never going to be able to produce the big trees that you knew in the past in those species, and you are going to have the problem of utilizing a comparatively small tree all the time. Unless we can be certain that our plantations have got the highest value genetically, we will fall down on our job as foresters. One fundamental story that we must have if we are going to improve our strain is the wood structure story. We are in a position where we are establishing a grafted seed garden for the production of all of our seed for Pinus elliottii, and we need to be certain that the thirty odd parents that are represented there are right. We need to know what the quality of those parents is so that we discard the one that is not going to be much good. We are at the stage now where we have to demand some very basic work of our own profession on these matters.

Mr. Harding: The question is going to arise, particularly from a State viewpoint, as to what quality timber we are going to grow on the soils that we have available. The question of soils is going to be a very vexed one in the future, particularly in view of recent work which is making poor soils suitable for agriculture, soils which were previously relegated to forestry because they were no good for anything else.

Mr. Kloot: I think heredity has to be put in its right perspective. Variations in strength within the tree are so large that I wonder whether differences due to heredity will be of very much significance. Further, as has been pointed out, differences between sites are also fairly large. There is no doubt that trees, even taken from the best possible parents, if grown on poor sites are not going to give properties that are much like those of the parents. As a

matter of fact the Western Australian material from Crimwade illustrates that very well. The untreated trees did not show any significant variation in strength from pith to bark. On the other hand with the treated trees (they were treated after 7 years) the properties started to increase immediately following the treatment and followed the normal pattern of strength variation, similar to that shown by the trees from Mundaring in Western Australia and from South Australia. I believe that site quality might well be of far greater significance than heredity.

Mr. Clarke: Forest products people will have to be guided by the foresters in this matter. The foresters will have some idea of the type of country they are going to plant, and the problems which are likely to arise. We would be glad to carry out the testing work in connection with projects of that type, but the initiative will have to be with the foresters as to what amount of work is required on our part.

Mr. Huddleston: We have had a series of resignations from our wood structure section and in the last 2 years we have been concentrating on training new officers and doing routine identification work. We propose shortly to commence a study of the glue line to see whether we can determine any reason for the effect, particularly with the synthetic resin glues, of some timbers bonding satisfactorily and others not. In the field of identification, we are getting a lot of trouble with New Guinea timbers which we are asked to identify and to state their properties and the uses for which they may be suitable. Any information which can be made available in that regard will be very helpful. Another problem that we are experiencing concerns island timbers coming in under the name of a particular timber, but embracing a group of timbers which may range in density from quite low to quite high figures. Buyers will not believe that the particular parcel of timber that has been received is the species ascribed to it by the seller. If we can make any representations to

the various people sending island timbers into Australia to name their timbers in a better way it will certainly help the market as a whole, and make our job of identification very much easier.

Mr. McAdam: Within the next few months we will start making plant collections again and perhaps we can help the departments that are receiving the main bulk of New Guinea timbers by supplying them with a standard set of the main species that are being exported. We are very appreciative of the priority that is being given to the New Guinea timbers at the present time.

THE DRUG PLANT INDUSTRY IN NEW SOUTH WALES*

Duboisia myoporoides

The foliage of Duboisia myoporoides has assumed considerable economic importance in the last two years. This follows a period of about eight years during which it was of little commercial interest, Duboisia leighhardtii being favoured. The reason for the varied commercial fortunes of Duboisia myoporoides leaves lies in the history of the pharmacological use of hyoscine, the major alkaloid of this species. After the 1939-45 war it was generally accepted that anti-histamines would replace hyoscine as drugs useful against motion sickness with the result that the demand for hyoscine fell. The development of the use of hyoscine N butyl bromide as a very effective drug for this purpose (and for other purposes such as peptic ulcers) has lead to a very great increase in the demand for hyoscine and thus for Duboisia myoporoides leaves. This demand is now in excess of 1,000 tons p.a. air dried weight. The price paid for the air dried leaves is between 2/6 and 2/9 per lb. and the business is worth more than £300,000 p.a.

The pharmacological product containing the abovementioned hyoscine derivatives is called "buscopan" and has to date only been marketed in Europe. It is understood that it will be marketed in the United States at a later date.

Most of the leaves exported so far have been collected by a firm at Mitchell Island near Taree. Recently there have been at least three other organizations collecting leaf for export although they are as yet comparatively small.

Because of the lack of a predictable dry season on the north coast of New South Wales it is not possible to air dry Dubosia leaves on a satisfactory production basis. Thermal drying has been found to be the only method of preparing a satisfactory product on a regular production basis. The above firm pioneered this development and originally used a large steam heated manually operated tray dryer.

---

* Prepared by Division of Wood Technology, N.S.W.

Recently they installed a continuous twin conveyor constant rate grass dryer. The tray dryer produced leaf with an unsatisfactory appearance although there was no evidence that the alkaloid content was impaired. The leaves were air dried at about 80°C (maximum) for 20 hr. The continuous dryer produces leaves of good appearance which pass through the machine in about 20 min at a maximum temperature of 60°C. This dryer is very efficient and has greatly reduced drying costs.

A number of enquiries had been received by the Commission requesting information on the effect of time and temperature on the alkaloid content of the leaves. No information was available from literature and a small experiment was designed to supply the data having in mind the importance of keeping the supply of the leaves from all sources at a high quality level so that competing hyoscine sources including synthetic production from furan, would not disrupt the industry. Results of this work are summarized as follows:

Drying Temp. °C	1 hr	17 hr
60	3.1% total alkaloid	3.0% total alkaloid
80	3.1% " "	3.1% " "
90	2.9% " "	3.0% " "
120	2.7% " "	1.3% " "
Air dried leaves	3.2% total alkaloids	

It can be seen that the alkaloids are not very heat sensitive, fluctuations which occur in the alkaloid content of supplies, therefore, mainly arise from natural factors.

Rutin. The sale of rutin is continuing at about the same rate as that reported to the last Forest Products Conference, some 23,000 lb having been shipped to U.S.A. from June, 1955, to the present time. However, because production was keyed to maximum demand there was, at one factory, a building up of stocks which lead to cessation in production. This situation is regarded as temporary by the manufacturer

concerned, and he is now building up stocks of dry Eucalyptus macrorrhyncha leaf for another production period.

The price of the rutin as produced now stands at about 28/- per lb packed ex factory.

So as to ensure that the operators would be in a competitive position to continue to market their product when Saphora japonica flowers became available again certain unknown factors associated with the industry have been investigated. These are briefly dealt with below.

1. Seasonal Variation of Rutin Content in Eucalyptus macrorrhyncha Leaf

A weekly examination of the mature leaves of one tree did not reveal any seasonal variation excepting for a small increase in the summer months arising undoubtedly from the mature leaves being generally younger during that period than mature leaves obtained when the tree was dormant in winter.

Weekly examination of leaf meal from the Tumut factory showed a general rise in rutin content in the spring and early summer followed by a sharp fall in late summer and autumn. This drop coincides with the flowering period of the species. An examination of leaf:flower ratios revealed that the decline in the leaf content of the meal due to the incorporation of flowers, etc. could completely account for the decline.

2. Rutin Content of Regrowth

The rutin content of regrowth leaves were found to be in no way different from that of the mature tree. The exploitation of regrowth, however, is limited to that which is three years of age or over because of the high twig:leaf ratio in the young material. Regrowth, of course, has the advantage that there is no flowering season problem.

3. Variation of Rutin Content with the Age of Leaf

Two separate examinations, one on single leaves and the other on 10 leaf samples, show a steep decline in rutin content as the leaf matures. Subsequently it falls off rather slowly. Table 1 gives the

result of the single leaf study while Table 2 gives the results of the 10 leaf sample study on five trees.

TABLE 1

VARIATION OF RUTIN CONTENT WITH AGE OF LEAF
(examination of single leaves)

Position of Leaf	Weight of Leaf Air Dry g	% Rutin (Air Dry Leaf Basis)
Growing tips	0.0610	28.9
1st leaf	0.0685	29.4
2nd "	0.1851	23.8
3rd "	0.2162	12.7
4th "	0.2854	13.9
5th "	0.2406	13.6
6th "	0.1229	12.0
7th "	0.2026	14.2
8th "	0.1008	11.7
* 9th "	0.2775	9.5
*10th "	0.2124	10.4

* Both the 9th and 10th leaves were on the main stem and their auxiliary buds had given rise to lateral branchlets. Estimated age of 10th leaf is 3 months.

TABLE 2

VARIATION OF RUTIN CONTENT WITH AGE OF LEAF
(examination of 10 leaf samples from 5 trees)*

Leaf Age	Sample Tree No. 401	402	403	404	405
	% Rutin (oven dry leaf)				
1 year	10.0	10.0	9.0	11.6	9.4
2 years	8.6	10.0	8.5	9.8	7.2
3 years				7.9	

*Samples were taken while the trees were dormant. Mature leaves were taken from previous season's growth and labelled 1 year old. Leaves labelled 2 years old were grown during the season preceding the one year old leaf, while leaves labelled 3 years old were grown the season before that. All are, therefore, not quite as old as stated.

4. Best Method of Extraction of Rutin

It has been decided that extraction with water at 100°C at atmospheric pressure is the most satisfactory method of extracting rutin from the leaf because:-

(i) Plant cost is kept at a minimum.

(ii) Operating costs are low.

(iii) A fairly pure product can be obtained with a little care in manufacture because not many contaminating materials are extracted with it.

The leaching time must be kept as short as possible because prolonged boiling of the extracted solution results in lower yields. The results of this work are shown in Figure 1.

5. Thermal Drying

Both temperature and time affect the yield of rutin. The results of experiments carried out so far are shown in Table 3.

TABLE 3

THE EFFECT OF DRYING TEMPERATURES (AND THE DURATION OF DRYING) ON THE RUTIN CONTENT OF E. MACRORRHYNCHA LEAF

	% Rutin $3H_2O$ (o.d. leaf basis)	
Green leaf	10.3	
Air dry leaf	10.1	
Temperature of Drying	Duration of Drying	
	½ hr	17 hr
110	10.3	9.3
130	9.7	7.0
150	8.2	Nil

6. Survey of Species for Rutin Content

A sample of leaves from the two Eucalyptus youmani trees growing near Glen Innes gave the extremely high figure of 23 per cent. rutin (oven dry leaf basis). Thirty other Eucalyptus species have been given a preliminary examination. None appear to contain commercial quantities of rutin.

Discussion:

Mr. Huddleston: You have a preprint on this item, in which we have mentioned a number of points which we feel are of particular interest. Duboisia myoporoides is virtually a weed on the north coast of New South Wales, and most of the exportable leaf is coming from diary farms at the present time. As artificial drying of the leaves is necessary to produce a satisfactory product, we have done a little work on the effect of temperature on the alkaloid content, and the results are summarized in the preprint.

With regard to rutin, at the present time we produce almost the total world supply, and production from other sources such as tobacco leaf waste proved to be uneconomical. The Americans found that they could produce it reasonably cheaply from buckwheat, but the difficulty here is that buckwheat is an agricultural crop and takes up agricultural land, also the rutin content is very closely allied to the time at which the crop is harvested. There are also very serious handling difficulties. In the meantime the flowers of Saphora japonica from China became readily available on the American market and the buckwheat industry died out. When America stopped importing from China, the material which had been known to exist in the leaves of Eucalyptus macrorrhyncha for many years was produced and has been produced ever since, for the American market, which is, as far as we can gather, the only substantial market for this material. The same of course applies to Duboisia myoporoides leaves, the total output of which is exported to either Germany or Switzerland.

Mr. Humphreys: E. macrorrhyncha regrowth was reported to contain no rutin a few years ago, but we have now definitely shown that that is not the case. The rutin content of E. macrorrhyncha regrowth is the same as the original tree. Also the rutin content of E. youmani leaves has again become rather prominent in our considerations because we have had two samples which have shown well over 20 per cent. on a dry leaf basis. Our Division of Resources has only recently carried

out a survey in the Glen Innes district indicating that there is a considerable quantity of E. youmani in that district which would be suitable for exploitation.

I would also like to point out the value of these drugs as exports. Dried Duboisia leaves should net the country £300,000 per year if they continue to be exploited at the rate of 1000 tons per annum, which is the expected rate, and the rutin industry is converting otherwise useless leaves into £30,000 a year.

ITEM 1 (c)

UTILIZATION OF BARK TANNINS

1. Pinus Radiata Bark Tannin

Counter current extractions have been carried out using plain water at two temperature levels, viz. 95°C and 60°C. Extraction at 95°C throughout the system gave a 100 per cent. yield of extractives based on the official analysis of a fresh bark. Extraction at 60°C throughout the system gave poor yields of extractives and the final extract contained more non-tannin than tannin, indicating that the non-tans are more soluble than the tans and that an adverse ratio of tans to non-tans would accompany poor yields.

The head liquor of the 95°C extraction contained 11.9 per cent. solids, whilst that of the 60°C extraction contained 8.9 per cent. solids. The head liquor of the 95°C extraction precipitated cold water insolubles on standing. It was necessary, therefore, to sulphite with a mixture of equal quantities of sodium sulphite, hepta hydrate and sodium bisulphite. The amount of sulphite mixture used was 6 per cent. of the weight of total solids. The use of this mixture gave a liquor which deposited no solids after two months' standing. The head liquor of the 60°C extraction contained very little insoluble matter so that the accumulated liquors were evaporated without sulphiting.

Although Anderson had reported that preliminary tests indicated that tannin from Pinus radiata bark was satisfactory for tanning leather, no actual tanning trials which simulated tannery conditions had been carried out by him up to the end of 1955. Information supplied by the New Zealand Leather and Shoe Research Association indicated that tannin from New Zealand P. radiata bark gave a complete tan to sole leather but one which was dark red in colour and thus unacceptable to the trade. This organization concluded that the possibility of producing a practical tanning material from pine bark extract which could be successfully blended with mimosa appeared quite definite. On the other hand, there was no indication that a tannin could be produced which when used alone would give a commercially acceptable leather.

Because of these facts and as a result of a discussion at the Division of Forest Products in August last, arrangements were made to test an extract made at the Division of Wood Technology, Sydney, at a Melbourne leather laboratory. The extract was prepared in a 5 stage counter-current system using 2 per cent. sulphite (based on bark weight) and evaporated in a climbing film evaporatory. An analysis of the solid extract according to the official method of the Leather Trades Chemists Association gave the following results:

Total solids	88.5 per cent.
Tans	57.7 " "
Non-tans	30.8 " "
Insolubles	negligible
Moisture	11.5 per cent.

An interim report has now been received from this laboratory, the essential observations contained in which are outlined below.

(a) Penetration into Hide

The rate of penetration of Pinus radiata bark tannin into the hide is quite satisfactory. At the end of tanning all pieces of hide were fully penetrated and no difference could be detected between any of the mixtures used. These mixtures were:

(1) Mimosa/myrabolan 90/10
(2) Mimosa/myrabolan/radiata 60/10/30
(3) Mimosa/myrabolan/radiata 30/10/60

(b) Colour of Leather

Pinus radiata bark tannin produces a deep red colour leather which under present day circumstances is a serious disadvantage.

(c) Sludge Formation

Tan liquors containing P. radiata tannin formed excessive deposits of sludge with consequent loss of tannin from solution. The deposits are compact and adhesive and are therefore a most serious defect.

(d) Conclusions

P. radiata tannin extract in the form tested is unlikely to find much commercial application in the Australian tanning industry. It is quite possible that the properties of the extract could be appreciably modified, for example by using a much higher degree of sulphiting.

It must be emphasized that this was an interim report. However, the prospects of the use of the bark for leather tannage in the near future are remote. A decision on future work will be made when the final report is available.

2. Use of P. radiata Tannin in Adhesives

From the above it is clear that other uses must be found for this tannin. For this reason work has commenced on the production of a resol from the solid extract according to the method reported by Knowles and White for Mimosa tannin (1). Also, its use in adhesives is being investigated. Samples of finely ground bark have been placed in the hands of phenolic adhesive manufacturers to test its possibilities as an extender for their products.

3. Eucalyptus crebra Bark

The use of the bark of this species as a phenolic adhesive extender is being investigated. The bark was put through a Van Gelder grinder using a $\frac{5}{8}$ in. screen and then sieved. It was possible in this way to separate most of the fibre from the corky bark and kino. The fairly fibre free material was then ground in a Raymond laboratory mill to pass a 200 mesh screen, and samples given to phenolic adhesive manufacturers to test as an extender for their products.

Work has commenced on the preparation of a resol from the mechanically separated kino of this bark.

Reference

(1) Knowles and White - Adhesives and Resins 2 No. 10, 1954; and 2 No. 11, 1954.

Discussion

Mr. Humphreys introduced the item.

Mr. Harding: South Australia is carrying out some work on tannin extractions on radiata bark. We hope within the next 6 months or so to be able to give you the results from the South Australian Department of Chemistry's work on tannin production from radiata bark, plus some practical application of the tannin to leather under conditions of normal commercial practice. An Adelaide firm is going to carry out those tests for us. The general opinion, in South Australia, at this stage is that it is not an unpromising project and from our viewpoint it would be a very important one.

Mr. Humphreys: We have done some work on the distribution of tannin in the bark, and did find quite a wide variation, particularly from our Jenolan State Forest. Before that we had done quite a large number of spot tests from various places and we found that tannin content of young smooth bark in general was low; whereas the tannin content of rough bark was much higher. We also examined 16 samples obtained at various intervals of time from Tumut mill, the average of those was over 20 per cent. and the spread was from about 14 per cent. up to about 28 per cent., so there is a very wide variation in the tannin content. Our survey at Jenolan was unable to show any useful measure for predicting what the tannin content would be, although there was a correlation between diameter and tannin content also a positive correlation of tannin content with the height of the samples on the tree.

ITEM 2. TIMBER MECHANICS, TIMBER ENGINEERING, CREEP

(a) REVIEW

Mr. Boyd: The title, "Timber Mechanics", might be defined as the study of the effects of forces applied to the material "timber". Originally, most of the work of the Timber Mechanics Laboratory was directed specifically towards this end. It was concerned chiefly with

the clear material and its testing in bending, compression, shear, hardness, tension and impact loading. These effects were studied particularly in loading of short duration during which there was no obvious change in the reaction of the material "timber", i.e. it was in a steady state condition. However studies were made also of the effect of long duration loading.

(a) Short Duration Loading Tests

This timber mechanics study was directed towards obtaining the basic knowledge of the qualities of the important Australian species. At first this work progressed somewhat slowly because of the type of sampling then practised. Later, with changed sampling methods, a considerable speed-up occurred so that now it can be said we know the mechanical properties of most of the more important Australian species with a reasonable degree of precision. You will recall from earlier sessions of this conference that our sampling was so directed as to obtain values of the important structural properties with a degree of precision economically appropriate to the structural use of the species being examined.

(b) Long Duration Loading Studies

Over the earlier years of testing in our laboratory it became increasingly clear that a knowledge of the effect of long-duration loading on mechanical properties was of considerable importance, particularly in beams, and a study of this factor was therefore commenced. Later, due to a rearrangement of staff, it became convenient to transfer this work to the Timber Physics Section. Subsequently the study of long-duration loading or creep has been developed and extended considerably by the Timber Physics Section and this will be discussed by Mr. Kingston. However, with the exception of the study of beams, most of their work again has been confined to tests of timber as a material of construction rather than on structural units.

(c) Growth Stresses

One other aspect of timber mechanics which has been studied in more recent years is tree growth stresses. This of course, is the study of the forces which develop in a living tree and their effect on the utilization of timber. This work has been discussed before this conference on an earlier occasion, and all planned work has now been completed and most of it reported.

Thus it is seen that most work, described generally above, which could be properly described under the title "Timber Mechanics", and which is still controlled by this Section, has been completed; and therefore perhaps the title of the Section is somewhat outmoded. In fact, gradually our work has developed towards the study of structural components and structures, i.e. towards timber engineering.

CURRENT LONG-DURATION LOADING STUDIES

An investigation on long-duration loading of structural units was commenced in the Timber Mechanics Section about the same time as the other creep studies was transferred to Timber Physics. A little work was done on model columns and a considerable effort was applied to an experiment to determine the effects of long-duration loading on structural joints made with split-ring connectors.

(a) Split-Ring Connector Joints

Work on split-ring connector joints has continued for some 9 years to the present day, but work according to the original plan is now substantially complete, and the data has been analysed preparatory to reporting. It should be realized here, however, that the experiment was somewhat restricted in nature, in that it dealt only with joints in tension and containing only one split-ring or shear-plate connector, in timber loaded parallel to the grain. Only one size of connector was studied. Thus we have no information under these conditions of specimens loaded at right angles to the grain, of the capacity of the larger 4 in. split rings and shear plates of multiple connector joints or of the effect of live loads and wind

loads applied in addition to continuous dead load. Therefore even though considerable work has been done, many gaps still exist.

(b) Columns

Columns, of course, are a very important structural component, both in the pure sense as props, and also in the sense of compression members in trussed constructions, and as combined bending and compression units, particularly in structures such as roof trusses. Our early exploratory work on columns has recently been developed very considerably. At the time of publication of our Handbook of Structural Timber Design, it was necessary to provide guidance to designers of columns, and certain recommendations were made. As a result of our early work on creep in beams, it was felt that some corresponding allowance for long-duration deflection should be made in column design. Though overseas authorities recognized that stresses should be less for long-duration loading, no allowance for deflection due to the long-duration loading was provided in design codes. As a consequence, our recommendations were at variance with overseas practice, and received much criticism because they appeared to be very conservative. It seemed appropriate, therefore, that specific study be given to this matter.

Over the last 4½ years, 327 model columns have been set up under constant loads equal to 50 per cent., 60 per cent. or 70 per cent. of the expected short-duration failure load. The three species, Douglas fir, mountain ash and yellow stringybark, were represented with moisture conditions green, set up green and allowed to dry, and initially dry. Various eccentricities of loading, representative of the grade or quality of the structural timber, and various ratios of length to thickness were also represented. The project is a long-term one, and the complete picture is not yet clear though certain trends are now emerging. Most of the specimens requiring initially green material have now been tested, and attention is now being given to dry material. In view of the lack of guidance in this matter from

data available elsewhere in the world, the indications of trends now becoming apparent and the importance of the data sought, it is proposed that this work be continued to completion.

SCANTLING INVESTIGATIONS

In making available to engineers and architects the data collected from short-duration loading of clear material, a deficiency exists with respect to the effect of blemishes in commercially available timber, i.e. what variation of clear specimen strength should be made for grade. Experimental work in this field has proved extremely difficult to interpret because of the very great variability in strength caused by blemishes in their various combinations, degrees of severity and position. In connection with overseas timber, particularly softwoods, considerable work has been done in assessing appropriate strength reduction factors for grade. In the absence of any substantial test data of our own, it has been necessary to base our grade factors for Australian timbers on this overseas data. This approach, of course, is subject to certain criticism particuly directed to the difference in blemishes in hardwoods and softwoods and their consequent effects on strength. Also the high shrinkage and collapse of hardwoods, particularly in some of our eucalypts, and the free-splitting characteristics of some, further complicate proper assessment.

Because of a claim that grading practices, as used in Australia at present, were uneconomical and unreal in relation to utilization of jarrah scantling, an investigation has been undertaken in Western Australia with a view to determining the effects of characteristic blemishes in this material. The first planned work is now almost complete and is being analysed. It is hoped that we will have sufficient data to publish findings in this investigation at an early date. There are no immediate plans for extending a similar study to other species, but it may be desirable, if substantial differences from present practice in jarrah are indicated, to check the validity of the application of grade reduction factors to some other species.

METHODS OF MAKING JOINTS

Joints are a very important consideration in timber engineering. They may be made with several components and their efficiency varies correspondingly. For example, with nailed joints it is possible to develop an overall efficiency of the structure with respect to maximum strength of the timber of 6 per cent. to 8 per cent. only. The efficiency of screws is of the same order. Bolts may increase the efficiency up to the order of 20 per cent., and similar efficiency is obtainable with toothed plate connectors. Split-ring connectors, however, double this efficiency, and until quite recently were the most efficient jointing medium widely used for large structures. However, with the development of glues, particularly those of the water-resistant type, joints approaching 100 per cent. efficiency have become possible.

(a) Nailed Joints

Despite their relative inefficiency, and because of their simplicity, nailed joints are important. Consequently a considerable amount of effort has been applied by this laboratory to their study. So far investigations have been confined to one species and one type of nail. Testing has included variation of nail size but has been limited to green timber, though specimens have been prepared in which nails were driven green but the joint will be tested after the timber has dried out.

These tests are necessary because originally recommendations were based on overseas practice. In view of the relatively high density of our hardwoods, criticism could be levelled that such recommendations were conservative, and results to date seem to indicate that this in fact is true. However, it would seem desirable that testing be extended to at least one other hardwood species and possibly also to a softwood species in view of the fact that softwoods will become of increasing structural importance in the near future. Further, it would appear desirable that long-duration loading tests be undertaken at least on a reasonably substantial exploratory basis.

(b) Bolts

Except for secondary structures in which efficiency of joint design is not important, bolts are not likely to be widely used without connectors of split-ring or toothed type. The large amount of research necessary to study the characteristics of these fasteners in Australian species would therefore not appear to be warranted at this stage.

(c) Split-Ring Connectors

Split-ring connectors have been dealt with earlier and some guidance for adjustment or confirmation of our earlier recommendations on safe working loads should be available from data already collected. However, it would be desirable as opportunity offers to extend the work somewhat in the general directions indicated earlier. Nevertheless as a major effort it is doubtful whether this should have as high a priority as a study of glues in the fabrication of engineering structures.

(d) Toothed Plate Connectors

These are unsuitable generally for hardwoods. However later when softwoods of exotic type become important structurally, it may be necessary to undertake tests.

(e) Glued Joints

Glued joints in engineering are important in a variety of large structures, including the familiar glued laminated arch type of construction or similarly constructed deep beams, in built-up beams of solid material and plywood or hardboard, and in framed structures such as roof trusses. In the first two classes of structures mentioned, the stress distribution in the glue line is comparatively simple although the effect of long-duration loading on such structures is by no means fully understood.

In framed structures, glued joints appear to hold many attractions from the point of view of efficiency, simplicity and economy. However the stress distribution in such joints is complicated and the effect of long-duration loading is somewhat difficult to assess.

From the point of view of more efficient use of our limited resources, it would seem highly desirable that studies be concentrated on this particular problem. So far a few exploratory tests only have been made and a few specimen beams constructed. However it is intended to extend this work and to develop the study further.

LOAD DISTRIBUTION IN STRUCTURAL SYSTEMS

To some degree in the past, it has been necessary to estimate the performance and consequent stress apparent in a structure consisting of a number of interconnected elements. Examples include a wooden floor supported on joists and bearers, or the wall of a house consisting of studs, lining and weather cladding. It will be clear that being able to design a member to produce a given resistance to loading is not sufficient, and it is necessary to know precisely the loading likely to occur in the member. Thus it is probable that greatest efficiency in design in the future will be attained only after a thorough study of the load distribution in such systems. A little work of this nature has already been done and as opportunity offers in the future it may be necessary to direct some of the work of the Section towards this end.

POLE STRENGTH INVESTIGATIONS

Poles are simple engineering structures which in the past have received quite inadequate consideration in design. This has led to wasteful approaches varying among different authorities throughout Australia and indeed throughout the world. It was evident, because of new species coming into use, that pole using authorities must make a new approach to design - an approach they were ill equipped to make. Because it became evident to us after analysis that very considerable savings could be made with efficient design, it was felt that research should be undertaken by this Division to provide pole using authorities with sound and acceptable design data. However it was found impracticable to carry the considerable cost of this research on the funds available. Accordingly a committee, representative of

pole-using authorities and the pole supply authorities, was organized with a view to their sponsoring a pole strength investigation.

The committee hoped to raise sufficient funds to cover a substantial part of the costs associated with the actual testing. They were successful in this, as over £17,000 has been promised and already half has been received. In addition, the Victorian Forests Commission promised supply of poles required from that State. The value of this Victorian Forests Commission donation has been assessed at approximately £2000. I regret to say that there has been no formal statement of similar support from the other States.

It has been decided that the support is sufficient for the investigation to make a solid beginning, and in fact testing is now under way. Initial teething problems have been overcome and the work is proceeding satisfactorily. As a result of the work on the Victorian species, it is hoped that the size of sample required to produce data on species from other States with sufficient accuracy, will be capable of reduction. Thus it should be possible, in spite of the increased transport charges per pole unit, to supply species on a rate comparable with the Victorian species. We will be glad to hear if the other States will support us in a similar way.

Mr. Kingston: Since the last Forest Products Research Conference, the emphasis of the creep studies has continued to be largely directed to the engineering aspects, in order to collect data sufficient to enable adequate allowance to be made for the increased deformation and reduced strength of timber under dead loads. Attention has also been given to the effect of moisture content, temperature and stress on these properties.

In addition to these studies, an investigation is being made of the possibility of speeding up creep testing. One possible way of doing this is to use an elevated temperature. For wood, the temperatures which can be used are very limited if chemical decomposition is to be avoided. However, it is hoped that the available range may be

sufficient for the purpose. The difficulty in achieving a speeding up of the work by this means lies in the interpretation of the results at higher temperatures and for shorter times in such a way as to predict what will happen at lower temperatures over longer periods of time. To enable this to be done, certain conditions must be fulfilled. It is impossible to go into these in the time available but they involve a detailed knowledge of the effect of temperature over as wide a time scale as possible and, to extend the time scale, much shorter times are being included by means of vibration studies of the elastic and damping properties of wood. From measurements of these at various temperatures, assessments of the elastic after-effect and plastic flow occurring during these very short times can be made.

A study is also being made of the relation between creep and relaxation to see if the one can be predicted from the other and hence, the effect of any combination of time effects of stress from either. In linear material (that is, one in which the principle of superposition applies) such prediction can be made by calculation and has been made for wood on the assumption of linearity. Comparison has been made with experimental results and in bending differences of up to 8 per cent. have been found particularly in green normal wood and in compression wood but in shear superposition tests showed no significant departure from the principle except during the first few hours under load. The departure in the case of bending in compression wood appears to be due mainly to the irrecoverable component.

A study of the increase in deformation under dead loading has been continued for all types of stresses and the work on specimens under shear greatly extended. In bending, tests have been extended to blackbutt, as previously most of the work was done on mountain ash, and little was known of the differences between species in rheological properties. Blackbutt was selected as being one of our most important structural timbers. Initially green blackbutt allowed to dry out during test appears to be generally similar in behaviour to mountain

ash, deflecting to 3 to 6 times the initial value in periods of 12 to 18 months. Tests are being carried out both indoors and in the open; the latter for the detection of the effects of weather and of solar radiation temperatures on the compression face. The last are probably important as rapid increases have been found in deflection each summer and, especially in summer, the rate of increase of deformation in the day-time has been found to be 2 to 3 times as great as at night. Beams are also being tested green and dry. The green beams are protected by polythene envelopes and, in some cases, these in turn are wrapped around with building paper to protect the envelopes from juvenile delinquents who seem to be very prevalent in the Highett district. This envelope, together with the water between it and the beam, may considerably reduce the temperature due to solar radiation and this probably accounts for a much slower deflection observed in this case than in exposed inivially green beams drying out during test.

On account of the increases in deflection during hot periods, which I have already mentioned, it is possible that a beam, which appears to have ceased deflecting continuously after 2 or 3 years, may eventually increase in deflection to a dangerous extent or be weakened by a succession of summer periods over the economic life of the structure. Exposed beams may ultimately fail due to this cause at stresses which appear to be safe for a period of a few years or which could safely be carried indefinitely by beams protected from solar radiation. For this reason, it has been felt desirable to test a number of beams over longer periods, if possible up to the economic life of a timber structure or for at least 20 years, and such tests have now been set up both indoors and out of doors in mountain ash and similar outdoor tests are in progress on blackbutt.

It was hoped to include spotted gum in all these tests but so far this has not been possible. Tests on this species may, however, be carried out later, as may bending tests on a softwood.

A large number of electrical resistance strain gauges have been mounted across the depth of a beam to see whether any redistribution of stress occurs over the cross-section under dead loads. Such redistributions have been reported by Dietz of the Massachusetts Institute of Technology, but so far no departure from linear distribution has been found in our tests. It was at first thought that this may be due to the slow rate of creep at the temperatures available and the room containing the tests is now heated continuously to 35°C to speed up the flow but still no departure from linearity has been detected. However, evidence has been obtained of non-linear distribution of stress in our outdoor tests but this could be due to a difference in the temperatures on the top and bottom faces of the beams. A departure from linearity, if occurring, could be quite important, as it would change the stress in the extreme fibre and so possibly necessitate an alteration in the design stress.

Recovery in beams after unloading has been found to be such that the deflection due to elastic after-effect is about equal to that due to irrecoverable flow. Also, under dead loads a markedly increased tendency to buckle laterally has been detected, presumably due to the greatly increased deflection.

Tests are also in progress on tension and compression members but the effect of continued loading on deformation has generally been found to be less than for beams, increasing to 2 to 3-fold in a year to 18 months. Proportional increases in deformation are roughly the same for green and dry specimens. Some of the reduction in increase in deformation as compared with beams, may be due to the lack of increased temperatures due to solar radiation, as the specimens are being tested in air-conditioned cabinets, whereas most of the beam data for periods of this duration have been obtained on beams set up out of doors. Tests now in progress should resolve this.

One trouble which occurs with these tests is that of obtaining sufficiently well matched material in the sizes required.

To overcome the scatter of the results due to poor matching, in tests to investigate the effect of stress, some tension tests are now being carried out on tapered specimens, the strain being read at various points along the tapered cross-section by means of electrical resistance strain gauges. In this way, the scatter was reduced and it was found that tests could be carried out at various temperatures by placing metal heater strips on either side of the specimen.

Shear tests show similar effects to bending with increases in deformation to as much as $1\frac{1}{2}$ times to twice the initial values in 2 months. It was found that the irrecoverable part of this increased deformation was considerably affected by temperature but the recoverable portion appeared to be little affected.

The effect of temperature on beams and on shear specimens is being studied under controlled conditions but it is too early yet to give specific results of these tests. However, over the range of testing there appears to be a marked effect due to temperature, the rate of increase of deformation increasing with increase of temperature.

One of the most important aspects of creep is the reduction in strength which occurs under dead loads with all types of stress. Many failures have occurred in tests under various types of stress at twice the design load and a few even at design load. Some of the latter were accounted for by defects not detected when the tests were started but a few remain unexplained and hence, further study proved essential. As very low safety factors for accidental overload, etc. are allowed for wood (1.25), the reduction of strength under dead loading must obviously be allowed for with reasonable precision. The effect of this would be even more serious if the reduction were affected by temperature and moisture content as it may quite well be.

Tests are being done to determine the time to failure at various stresses. The work will be extended to cover various temperatures and moisture contents. This study is being made in a

testing machine provided with a load maintainer and means of recording time to failure. Up to the present, no direct tests have been made on the effect of defects on strength reduction under dead loads, but some work on this aspect will be necessary to complete the data.

Discussion

Mr. Bednall: Is there any reason why you should not include softwoods species in your pole test, if you have not already done so ?

Mr. Boyd: We hope that we might undertake some softwood tests, providing there is sufficient interest, and we know the F.M.G. are interested as far as S.A. is concerned. However it is not one of the species we have immediately planned for as we want at this stage to concentrate on the more readily available material from Victoria. Thus we can determine the minimum size sample required for testing interstate species and keep costs to a minimum. We propose, even with the Victorian species, to make analyses as we go along so that we will not at any stage test an excessively big sample. We hope later to review the whole project and to bring in some of the interested forestry people from other States. It is possible that we might be able to obtain a large amount of information from overseas on softwoods, particularly from South Africa, which included radiata in their pole test. Despite species differences the American and Canadian work will also give some good leads but we may find it desirable to supplement their data.

Mr. Bednall: Mr. Boyd has made no mention at all of any work on railway sleepers as far as timber mechanics is concerned. In my opinion there is excessive waste in specifications used by various railways departments. I think it is important to consider if work should be done on it, especially in regard to the optimum size of sleeper to be used. For instance, we know that people think that radiata ought to be about 8 in. in depth before they put it onto the ground, whereas $4\frac{1}{2}$ in. sleepers might be quite satisfactory.

Mr. Clarke: The required thickness depends to a very large extent on the condition of the road bed and the practices of the particular railway departments. The type of ballast used is most important, also the way in which the rails are packed and the amount of maintenance. If there is not very much maintenance given and the ballast is not kept packed tightly under the sleepers near the rail seat, then you get the sleepers riding in the centre of the track, and run the risk of breaking their backs.

Mr. Boyd: Such construction and maintenance practices are largely a matter of economics to be balanced against sleeper cost and it is a question of discussion with the railway departments concerned to ascertain the practical approach, and to see whether economically they can make a move towards a smaller sleeper. One thing which is clear from the pole-using authorities is that the engineering aspect of this problem has not been critically examined at least for many years, and I think possibly the same might be said of some of the railway practices. There may be some value in inviting the railways authorities to discuss this problem and I recommend Mr. Bednall to consider doing that.

Mr. Clarke: We have at the moment a request from F.A.O. at Bangkok asking for information on our sizes of sleepers. They are hoping to get some uniformity throughout the region in sleeper sizes. I think that is rather optimistic because railways sizes will vary enormously in different places.

Mr. Harris: The requirement in Western Australia for our 3 ft 6 in. gauge at present is a 7 ft sleeper, but the railways are taking a percentage, not a fixed one, of 6 ft 6 in. sleepers. That is partly to meet our suggestion because, in our sleeper mills, quite frequently a sleeper cut from a 7 ft log turns out to be defective to some extent, but you can produce a 6 ft 6 in. sleeper. The whole question of 7 ft versus 6 ft 6 in. sleepers is still under consideration, and there does seem to be some case for revision.

I have the impression that there is an increasing number of 6 ft 6 in. sleepers being accepted.

Mr. Huddleston: There has been some interest in New South Wales in recent years in sleeper sizes, because a few years ago a New Zealand firm sold New South Wales Railways some Pinus radiata sleepers. The sizes supplied were 10 x 5, 9 x 5 and 9 x $4\frac{1}{2}$, and they have been creosoted and are going into some of the secondary lines. The Railways are watching them very carefully so that I think we will hear in the next few years from the N.S.W. Railways Department as to the behaviour of the radiata sleepers in various sizes. The last report I had from the Chief Technical Officer was that the sleepers were very satisfactory.

Mr. Smith: Has Mr. Kingston noticed any difference in results between the model beams and larger specimens ?

Mr. Kingston: There are so many factors coming in that it is difficult to say. One of the troubles with our small specimens is the difficulty of making them dry out at the same rate as the bigger ones. No matter what coating we use it seems impossible, and in any case you have a different moisture gradient so that we cannot compare there. We have done nothing in "green". There may be a few preliminary dry results.

Mr. Armstrong: The models we tested under controlled conditions do show somewhat similar results to the larger sizes, but we have not really done sufficient there between small and large specimens to answer that thoroughly.

Mr. Jennings: We agree with Mr. Boyd that further work is necessary on the connectors. We have recently had a design done by a prominent firm for a 100 ft fire tower, but I think it will probably be impossible to use that design because the sections specified for the columns particularly will be impossible to obtain. In Queensland at the moment, it is almost impossible to obtain an 8 x 8 section clear of heart and sap, and the column specifications of the tower

call for four 35 ft lengths of this section. They are going to be very difficult to obtain.

We do agree that the question of glue as a jointing medium should receive priority, so much so that we have already started some pilot tests to ascertain whether we can glue some of our denser hardwoods. These tests cover three species and three glues at the moment. The specimens are being prepared for a glue block shear test and we hope to have results in a few months.

In regard to the poles, we are quite prepared to supply whatever you need. We have deferred officially advising you of that and are waiting on your preliminary work. You can take it we will be prepared to contribute the material required.

Mr. Boyd: I would like to express thanks on behalf of the Pole Strength Joint Research Committee for that offer. I am sure it will be appreciated.

Mr. Huddleston: In New South Wales we still have some timbers for which we have no strength values. We are testing some of those timbers ourselves, on a chance sampling basis, and there are others which remain to be tested. We are still waiting for some complete list of mechanical properties of Australian species. I know that we can obtain these figures by writing to D.F.P. for them, and in many cases we have tested N.S.W. timbers and have our own test figures available, but as far as the engineering profession is concerned those figures are not available. We give them a grouping of timbers and figures which apply to a group, but where a special application requires knowledge of a particular timber, the figures are difficult to obtain, and I feel that we, and possibly the Division of Forest Products, should be aiming to produce some publication where those figures can be listed and made available.

In the field of timber design we get a large number of enquiries from engineers and builders with regard to the method to be used in calculating particular timber members. Occasionally we

produce a typical design to illustrate a point, but usually it is a matter of telling the engineers the figures which should be used and methods which should be applied in deriving the design.

We have been concerned with the use of sodium fluoride for treatment of veneers, particularly insofar as the effect of sodium fluoride on glued joints made with resin glue is concerned. That work has occupied a considerable amount of time and we have shown in the last 2 or 3 years that resin glues are quite satisfactory with sodium fluoride impregnated veneers.

Mr. Boyd: With regard to the information available on species, I am pleased to say that that is almost cleared up; we have a publication prepared, which should shortly be going to press. It covers all the data on species work which we have produced in this Section and includes also some obtained by the Division of Wood Technology in New South Wales - 100 species in all. However, the publication giving figures for particular species is generally not the sort of publication that should fall into the hands of the designing engineer, he would be quite an exceptional man who could use it properly. The proper use of it will have to be pointed out in a letter or personal guidance, because the question of reduction factors on strength is one which cannot be covered by a general statement applicable to all these species and possible uses. The new edition of the Handbook when produced will provide more information which will give designers guidance. The difficulty of design is in knowing how to design a particular member for a given service. We hope to have the Handbook in a form which will more readily provide that information directly to properly trained designers. Rewriting is proceeding slowly at the present time.

Mr. Huddleston: When will copies of the Handbook be available ? If they are not generally available, is it possible to obtain a limited number of copies for special purposes ? For example students of the Faculty of Architecture at the Sydney University are

required to equip themselves with the Handbook of Structural Timber Design, but no bookshop in Sydney can supply it.

Mr. Boyd: I understand that the supply has just run out, and all I can say is, we will work on it and get it out as quickly as possible. If odd copies were available, perhaps the students could use them in groups. We cannot supply any copies.

Mr. Clarke: This book is not issued by the Division, the work is prepared by the Division and it is printed by the Government Printer. It was distributed through the Tait Book Co. and sold as a commercial book, hence we hold no stocks. Head Office held reserve stocks and they issued those to the booksellers from time to time. However, they now inform us that supplies have run out.

Mr. Huddleston: Can Mr. Boyd give us any indication when the new edition will be available ?

Mr. Boyd: I am afraid not, at this stage.

Note: The matter was referred to the Policy Session.

Mr. Huddleston: With regard to Mr. Boyd's programme, I would like to see more concentration on a definite line of action, such as the modification of the Handbook of Structural Timber Design, and a definite attempt made to press the Standards Association into the preparation of a code of timber design. The Standards Association have produced a code for structural steel and a code for concrete, and we feel that there is a great need for a code for timber. The way to overcome many difficulties which are facing engineers and designers is to get a code of structural timber design prepared by the Standards Association, and as such it would be accepted by all concerned. I feel that we should make a concentrated effort in this direction.

Mr. Clarke: We are in the process of reorganizing our work on timber mechanics, and we are getting away from tests on material to work of a timber engineering nature. There is no doubt that before we can get very far with the suggested code, we will have to finish the Handbook of Structural Timber Design. However the code will be

much wider than the Handbook coverage. As far as this Division is concerned, we are prepared to do what is possible but, at the moment, I cannot see our being able to embark on any extensive new work such as involved in preparation of a design code.

Mr. Huddleston: It is my opinion that in the field of timber mechanics and timber engineering, there is no more important job to do than the preparation of the timber structural code. However, I do realize that before you can go ahead with the preparation of the code, you have got to finalize the Handbook of Structural Timber Design and use that as the basis. I feel that you should not be planning to extent the work in timber engineering before that code is prepared, and that applies to ourselves and any other State in a position to help.

Mr. Clarke: I feel that the Standards Association should take a lot more responsibility in preparation of such codes than it has taken.

Mr. Boyd: The basis of our programme is substantially directed towards providing essential information to designers in some form or other. The question of who prepares the code is another matter again, but our first responsibility must be to provide basic information and that is our aim. If we can publish that research information in a Handbook, then I think our prime function has been met.

Mr. Jennings: I feel that an Interim Code should first be issued, because we have the very grave problem of reconciling all the widely differing views of local authorities on the code.

Mr. Huddleston: In Mr. Kingston's discussion, he said he proposed at a later stage to use spotted gum as a higher strength timber than blackbutt. In New South Wales we believe that blackbutt is, if anything, better than spotted gum, and certainly New South Wales spotted gum on the whole is no better than blackbutt. I would suggest, if the work is to be extended in the higher group timbers, ironbark or one of the "A" group timbers should be used rather than spotted gum.

Mr. Kingston: It may be better then if we go on to another species, but it may be better to test Queensland spotted gum rather than ironbark. Ironbark would not represent a very high proportion of structural timber in New South Wales.

ITEM 3. WOOD LIQUID RELATIONS, SHRINKAGE, DENSITY, MOISTURE MEASUREMENT

(a) REVIEW

Mr. Kingston: In the sorption field, in addition to measurements being made of such properties as shrinkage and intersection point, a basic scientific study is being undertaken of the phenomena associated with the sorption of water and other materials in wood and its constituents, to provide an increased understanding of these characteristics of the material. This work is considered to be of considerable importance because of the fact that these characteristics form a very central feature in many aspects of both the processing and use of wood.

When measurements were being made to determine the thermal properties of wood, it was noticed that the specific heat of wood could not be determined by treating it purely as a mixture of dry wood and water using the formula generally adopted but that the use of this formula gave rise to considerably too low values. This observation led to a study of the effect of temperature on the heat of wetting of wood and the confirmation of the departure from the mixture law by measurements based on an entirely independent method. This confirmation has been very satisfactorily established. The study of the heat of wetting is really an investigation into the variation with moisture content of the binding energy of water to the wood. In addition to whole wood, a study has been made of its main constituents, cellulose, hemicelluloses, and lignin. In the case of lignin unexplained differences have been obtained both as regards the rate and the amount of heat evolved between results for different types of lignin. This is being studied further to find the reasons

for the differences, as it is hoped that the results may throw light on the physical and chemical nature of the differences between different types of lignin. The importance of this cannot be fully determined until further data has been obtained.

Another line of work which is very closely related to this is the study of the temperature dependence of equilibrium moisture content. It also should throw light on the bonding of water to wood and help to confirm the results obtained from the heat of wetting studies. So far, the isotherms, that is curves showing the relation between equilibrium moisture content and relative humidity have been determined both adsorbing and desorbing at 10, 25, 40 and 55°C and the work is being extended to a lower temperature to investigate the influence of temperature on the state of the sorbed water at low temperatures and to widen the temperature range over which the variation of equilibrium moisture content with temperature can be studied. As far as is known, no work has yet been done anywhere on sorption by wood at sub-zero temperatures. The results of this may be of interest in connection with the freeze drying experiments which I will mention in a few moments. The determination of the sorption isotherms is now being extended to the various constituents of wood mentioned earlier.

A freeze-drying experiment was carried out at -70°C to investigate the loss of moisture at this temperature. A steady drying rate was found to be present down to about 19 per cent. moisture content in drying from the waterlogged state. Below this, the drying rate fell rapidly. A new technique is now being developed to investigate the significance of the change in drying rate at this particular moisture content. We hope that it may be possible by means of this technique to elucidate further the capillary structure of wood and the influence of this structure on sorption.

Measurements are still being made to determine the shrinkage and density of Australian and Pacific Island timbers and a report is

being prepared covering work on 196 Australian grown species. In many of these the work is additional to that previously carried out, as it was felt that, in some cases, the geographical range had not been adequately covered and in others that the sample was too small. However, the report includes a number of new species which had not been tested at all until the last decade.

At present an assessment is being made of the results achieved by the enormous amount of work which has been carried out during the last quarter of a century at this laboratory in this field to determine what gaps still exist in our knowledge and to what extent the geographical range of the more important species have been adequately covered. The accuracy to be attained will, of course depend upon the importance of the species concerned and regard will be taken of this in deciding whether or not further work remains to be done. When the next stage of this work is commenced, we will probably be very glad of co-operation from the Forest Services in obtaining suitable test material. A further report is about to be issued on the shrinkage and density of Pinus radiata of South Australian origin. This material comes from two localities including two age groups from one and four age groups from the other. The work has included a study of the variation in properties across the diameter of the tree for 13 trees with eccentric pith. In general, an increase in density and shrinkage from pith to bark was noticeable.

A study of the shrinkage and density of some hybrid species has also been made. One hybrid tested so far is derived from Eucalyptus robertsoni and Eucalyptus rossii and another from Eucalyptus elaeophora and Eucalyptus maculosa. In all cases, the material was derived from the Capital Territory. The properties of the hybrid from E. robertsoni and E. rossii have been found generally to be intermediate between those of the parent species, but in the other case, the hybrid tends to show slightly greater collapse and normal shrinkage than either parent.

In the course of the work on shrinkage, it has been noticed that a number of species have an unusually low intersection point. For instance, 4 or 5 of the New Guinea species already tested showed this peculiarity and in three cases, the intersection point was below 20 per cent. moisture content. The intersection points of Casuarina leuhmanni, Eucalyptus abergiana, Sterculia quadrifida and Podopetalum ormondi are also below 20 per cent. Some other species, such as Acacia cambageii and Gmelina leichhardtii also gave low values. However, only one tree of each of these species has been tested and it is not yet known how general the phenomenon is.

At the last conference, it was reported that detailed surveys had been made of the properties of one building board and one insulating board. Since that time, however, a broad survey has been made of the majority of local and imported boards, all except a few of the newer ones to reach the market having been covered. This work included:

1. Determination of shrinkage on repeated cycling.
2. Water absorption during complete immersion.
3. Density.
4. Inter-comparison of equilibrium moisture contents.

A report on this work is now in preparation.

An investigation has been made into the general reliability of species correction data for resistance type moisture meters as compiled in the past with a view to planning future work. This showed a need to extend work on many species already tested by testing at higher moisture contents and in some cases extending the sampling for work at lower moisture contents.

Brush box has been collected from seven Queensland districts and three New South Wales districts and tests have commenced to determine moisture meter correction data for this species.

In connection with the use of moisture meters on impregnated timber, it is proposed to test several types of meters on selected

timbers treated with certain preservatives. The meters to be used are -

1. Electrical resistance type.
2. Dielectric constant type.
3. Surface hair hygrometer.
4. Hair hygrometer located in a hole.

It appears unlikely that the resistance type will be of use and it is being tested only to obtain an idea of the likely magnitude of the errors.

The species and chemicals for these tests are:

Klinki pine Douglas fir	soaked in salt water..
Pinus radiata Pinus taeda	dipped in sodium pentachlorphenate + borax. $\frac{1}{2}$, 1 and 2 x standard concentration.
White cheesewood Yellow carabeen White birch	borax, $\frac{1}{2}$, 1, 2 standard concentration (0.2 per cent. in the core).

All material has been ordered and most of it is in hand. The tests on klinki pine and Douglas fir are now about to start.

Discussion:

Mr. Jennings: In regard to electrical properties there has been some recent work done at the University of Queensland on high voltage high frequency discharges through wooden crossarm sections in which you may be interested at some future date. They will be publishing this work, it was carried out as a result of a grant by the electrical authorities in Queensland.

Mr. Smith: We have noticed in a few trees an apparent increase in longitudinal shrinkage in material in the one growth ring from butt to top of the tree. After discussion with Dr. Wardrop I think perhaps that might be related to the increase in proportion of early wood in the ring as you go up the stem, and I was wondering whether anyone had done anything along these lines.

Dr. Dadswell: You will have a variation of fibre length in any one growth ring from butt to top of a tree. It will increase to a maximum somewhere between 25 ft and 50 ft up the tree depending on the species, and I think you would have a variation in longitudinal shrinkage in those separated parts, early wood and late wood, with height in tree, but there you would have the highest at the bottom, decreasing and possibly increasing again.

Mr. Huddleston: With regard to future work in New South Wales we have found a rather pressing need for more information about equilibrium moisture content. Some years ago, there was a survey carried out, initiated by the Division of Forest Products, in the capital cities of the Commonwealth. That carried on for a period of three or four years and as a result of that survey we obtained a good idea of the equilibrium moisture content in the capital cities over that period. At the same time a survey in various country towns in New South Wales gave us a good indication of the equilibrium moisture content there. However I am by no means convinced that the period over which the survey took place was long enough to tell us the full story of moisture variation. There are a lot of areas in the State where no tests have been taken and we are continually running up against the problem as to what is the correct moisture content to dry to for those areas. In addition, sawmillers or timber merchants often claim that they cannot dry down to a certain moisture content in their particular area. In each case it involves testing to determine whether that can be done and with variations similar to those which we have experienced during the last 12 or 18 months in New South Wales, I think our data is completely wrong anyway. I would like to see a continuing test set up in each capital city where we have a laboratory capable of doing it. Let us put down the number of samples and weigh them, say, once a week and keep that running as a definite record of the moisture variation which we are getting in those particular locations. In addition, we are planning to extend

the survey in New South Wales to try and get more information within the State itself as to the prevailing conditions of equilibrium moisture content, particularly in the larger towns.

Mr. Clarke: I think that suggestion for permanent tests in the capital cities is an excellent one. Mr. Wright has some proposals regarding the e.m.c. survey, which will be discussed later under seasoning.

ITEM 4. SEASONING

(a) REVIEW

Mr. Wright: The work of the Seasoning Section is again reviewed under three main headings - (1) industry assistance; (2) applied research studies, and (3) basic or fundamental research studies.

1. INDUSTRY ASSISTANCE

This covers a fairly wide range of activities and includes general advisory work for industry, plant visits, kiln design and plant layout, waste disposal, and work of a training and educational nature.

(a) General Advisory Work

Under this heading is the majority of our direct technical enquiries or requests for assistance of a short term nature. Enquiries of this type average between 2000 and 2,500 per annum. As the time spent on an individual enquiry may range from minutes to hours, obviously they occupy a significant proportion of the time of the technical officer and assistant staff. No spectacular developments are expected from these activities - although occasionally they result in a development of value to industry generally - but over a period of years their influence on standards of industrial technology must be considerable.

(b) Plant Visits and Plant Layout

Local and interstate visits to examine, test and report on seasoning processes and equipment are averaging between 100 and 150 per annum; about 10 per cent. of these visits are interstate. Over

the past 12 months two were made to South Australia, four to Tasmania, three to New South Wales, one to Queensland and one is being made to Western Australia next month. One New Zealand and two New Guinea visits were also made.

Work on plant layout is sporadic but averages about 12 or 13 requests for layouts per annum. This is time consuming work because the best solution is not always the first apparent. We feel more than justified in continuing it, however, because despite some outstanding exceptions, much of the Australian timber industry needs example and precept to ensure adoption of modern technological developments.

(c) Kiln Design

Since the previous conference emphasis has been given to kiln design specifically to suit (i) plantation pine material, and (ii) rotary peeled veneers.

For the pine kilns we are providing high heat capacity at a high temperature level, high circulation rates and appropriate venting for the large volume of moisture evaporated. The value of superheated steam drying for this material does not appear, as yet, to be fully resolved, so we are designing pine kilns as "all purpose" units capable of performance under either superheated steam, or orthodox air-water vapour atmospheres. Increasing attention is also being given to anti-corrosion measures in these units.

The screened veneer kiln was developed to meet the need for an efficient kiln of moderate capacity and low capital cost for conditions where a mechanical drier is unsatisfactory or excessive in cost. The principal feature is, as some of you know, a specially developed screen to ensure suitable head resistance within the drying system to enable the fast and economic vertical finger racking method of veneer handling to be used. Features include high heat capacity to ensure drying at high dry bulb temperature, high fan capacity to ensure minimum "across sheet" drying differentials, and a special triple vent arrangement for heat economy.

Field studies of importance were also made on mechanical driers of American and European origin - a Moore unit in New Guinea, and Schilde units in New Guinea and South Australia - and on screened driers, the latter in Western Australia and Tasmania. The studies confirmed the basic nature of veneer drying principles first recognized, as far as we know, during earlier work in the Section.

Work on predriers was continued, mainly in performance testing and in providing guidance in operation. Some overseas interest is being shown in these units. An application by a private firm for patent rights on the predrier was successfully opposed for the benefit of industry on the basis of original and prior development.

In the field of general kiln design, considerable attention has been given to rationalizing design to give interchangeability of manual and automatic control systems with minimum disturbance; and to improving door and door handling equipment. Further fan power charts were also prepared, and further steam-fuel relationships, particularly for oil fired boilers, were determined.

In terms of statistics our kiln design work is requiring the preparation of some 450 drawings per annum. In accordance with our Commonwealth-State policy, designs were issued to some 40 commercial firms, or other organizations, in all Australian States. A number of requests from New Zealand, the U.S.A., Japan, Austria and South Africa for kiln designs were also handled.

Despite gradual improvements over a number of years we feel the forced circulation kiln as at present constructed is still a comparatively inefficient piece of equipment. A recent re-examination of our designs has indicated directions in which we think a great deal of improvement can be made, particularly in the structural, venting and air distribution features. I shall not enlarge on this at this stage, but will be glad to comment further if required.

(d) Wood Waste Disposal

Considerable progress has been made in our understanding of the more critical factors of McCashney waste wood burner design; this applies particularly to grate area and combustion space.

An outstanding problem in this field is to determine maximum capacity limits, with and without waste edgings as a disposal load. Our present proved load limit approximates $\frac{3}{4}$ ton of sawdust and $\frac{1}{2}$ ton edgings per hour, both on an oven dry basis. There is need for capacities at least double this, but we are uncertain whether the cyclone principle remains sufficiently effective at diameters greater than 14 ft to ensure no "throw" of small particle material. We have designed a unit having an assessed capacity approximating 40 - 50 tons of green mill waste per day for South Africa - this unit is 15 ft 6 in. in diameter - but the drawing was issued with reservations and no guarantee as to performance. Pressure of other work has prevented us from doing essential field studies on these units, but we are hopeful that the staff problem involved will resolve itself in the near future.

We can also report the development of a portable steel "knock-down" unit in all sizes and these are now commercially available.

The McCashney unit has apparently become favourably known in South Africa, judging from the requests we have received for designs. Requests also came from New Zealand, New Guinea, Sarawak, Singapore and the United Kingdom.

(e) Seasoning Correspondence Course

This continues as an extremely active project - we average 2 to 3 lessons daily for correction - and although somewhat of a burden, it is apparently an essential activity judging from the response to it by industry. Enrolments are at the rate of about 60 per annum, with about 40 students completing the Preliminary Course and about 12 the Kiln Operator's Course every year. We are receiving an increasing number of requests from New Zealand, New Guinea, Ceylon

and Far East Countries for enrolment, and have had to make a policy that only in very special circumstances will other than Australian students be accepted.

(f) Other Training and Educational Activities

Our programme in this field has been, and is, also heavy. In recent months trainees from two of our Australian States, New Zealand, the Philippines, Sarawak, North Borneo and Burma have been received in the Section. This, however, is again accepted as an essential activity and a contribution to technical development in our own and other countries.

In addition, our officers have participated in the usual lecture series to Melbourne University forestry students, Australian School of Forestry students, Victorian School of Forestry students, Melbourne Technical College Building Science students, Supply and Management students, technical teachers from the Victorian Teacher's Training School, and others from the Teacher's Training College.

Two major lecture series were also given as seasoning classes, one in South Australia in co-operation with the Timber Development Association; and the other at Tumut, New South Wales in co-operation with the New South Wales Division of Wood Technology.

2. APPLIED RESEARCH STUDIES

Our applied research work can best be subdivided into field and laboratory studies.

(a) Field Studies

Most of this is new work since the previous Research Conference, and relates mainly to air drying, the protection of round and large sawn timbers in storage, and the e.m.c. of timber products.

(i) Air Drying Studies. These studies were designed to determine optimum stack spacing for high, multi-packet air drying stacks erected by fork lift trucks. Fork lift truck stacking and handling is now so widely used that the answer to this must be of economic importance to industry. Criteria are drying rate, uniformity of drying

and cost of drying. Spacings of 1 ft, 2 ft, 4 ft and 6 ft have been statistically arranged in the air drying yards of five co-operating commercial firms. This study is still in progress - it was started about 9 months ago - but already is showing that common yard practice for this type of stacking is bad, and must be changed to ensure greatest output through a given yard area.

(ii) Protection of Round and Large Sawn Timbers. Storage conditions for round and large size sawn timbers in Australia are usually of the most primitive nature, and losses from exposure have always been comparatively high. In the case of mill logs, this must affect sawn recovery and production rate. Degrade hazard is especially high in sawmill log yards, pole and pile storage depots, and at mining centres where large stocks of large sized sawn timbers invariably have to be held because of remoteness from points of supply.

This study has been designed, therefore, to determine the value and cost of applied protective coatings sprayed on these timber surfaces - the most simple method would probably be from a knapsack spray. The alternative American approach is usually by log pond but this is unlikely to be practicable as a general practice in Australia.

The study has been extended to include points of felling as well as storage yards, as there is reason to believe actual felling techniques significantly influence subsequent degrade.

The Victorian Forests Commission and local sawmillers are co-operating in the part of the study concerned with round timbers, and are specially interested in it. Consolidated Zinc Pty. Ltd., of Broken Hill, is also specially concerned in the matter of large sawn sizes.

(iii) E.M.C. Studies. In general, little information is available on e.m.c. reached by many timber products under service conditions. Such data are of importance in connection with drying programmes, in assessing durability or decay hazards, and to indicate degrade hazards from shrinkage or distortion.

With the co-operation of the Melbourne Harbour Trust, the Victorian Housing Commission, the Country Roads Board and a manufacturer of agricultural implements, moisture meter electrodes have been installed and readings commenced in wharf installations, bridges, the timber components of agricultural implements, and housing. In the case of the latter, 4 timber and 4 brick veneer houses are under test, with 12 measuring points in each house. They include roof timbers, studs, plates, subfloor timbers, weatherboards and flooring; and will include joinery and furniture. The electrodes were installed as permanent fittings during construction and have been wired back to readily accessible measuring boxes so that the tests can be continued after occupation.

The P.M.G. Department has also expressed interest in the study being extended to poles, and the Harbour Trust wants it extended to some of its floating installations.

An interesting feature of e.m.c. studies in railway sleepers is that in Melbourne's environs core moisture contents rarely appear to drop below 30 per cent. even towards the end of summer in old sleepers in exposed, well-drained sites.

With the co-operation of the Australian National Antarctic Research Expedition, e.m.c. samples of a hardwood (mountain ash) and a softwood (radiata pine) were installed on the Antarctic mainland for exposure under indoor and sheltered outdoor conditions; arrangements provide for weekly readings. Following recent discussions with the New Guinea Forest Department we also expect to have e.m.c. installations soon at Lae, Port Moresby and Bulolo.

A limited study was also made for the W.A. Forests Department to determine the cause of an empirically established correction found necessary to add to oven dry determinations on exposed radiata pine fire hazard sticks to enable correct moisture correlation with actual fire hazard.

Equilibrium moisture content conditions for wood for temperatures up to 400°F were also evaluated and charted.

(b) Applied Laboratory Studies

In this category falls our work on vapour drying, veneer drying, kiln schedules, an examination of the redrying characteristics of pressure-treated preservatized radiata pine, and other miscellaneous drying studies.

(i) Vapour Drying. We have by no means discarded the possibility that, under certain conditions, vapour drying could become accepted as a desirable and economic technique for seasoning large sized timber for the relatively impervious hardwoods of low durability - as well as large sized softwoods - as a prerequisite for pressure preservation treatments. Studies on railway sleeper sizes of jarrah, karri, mountain ash, messmate stringybark and peppermint were completed. Results from 10 hr vapour drying were good and compared favourably with air dried material taking at least 6 months to reach the same stage of surface zone moisture content. For example, 10 hr vapour drying was effective in redrying the surface (or treatment) zone moisture content of mountain ash sleepers (i.e. to a depth of from $\frac{3}{4}$ in. to 1 in.) from 100 per cent. to 30 per cent. with a drop in the average moisture content of the sleeper as a whole of about 30 per cent. In the same drying time, the treatment zone for jarrah sleepers dropped in moisture content from 85 per cent. to about 25 per cent. The work showed that a combined drying and preservative treatment can be given in well under 24 hr.

A separate paper on this work has been prepared and will be discussed later.

(ii) Veneer Drying. Although the influence of temperature on collapse susceptibility and intensity has been known for some time, recent work has, we believe, made a contribution to veneer production technology in recognizing and demonstrating the influence of log heating temperature on dried veneer quality, independent of that caused

by peeling procedure. This work is showing that, in the case of the "ash" eucalypts at least, dried veneer quality can be seriously impaired by heating logs at temperatures in excess of 110°F, and possibly also by leaving veneer stock block piled while hot from the lathe. For example, for veneer peeled cold, and after heating at 140°F gross shrinkage in the latter ranged from 15 to 30 per cent. more than in the cold peeled material; this probably represents additional collapse. Because of differential early and late wood effects it undoubtedly causes localized stresses in veneer sheets, with consequent effect on distortion.

In field studies, the commercial application of laboratory developed veneer drying schedules was also confirmed with radiata pine and ramin at commercial plants.

(iii) Kiln Schedule Studies. Work in this field was directed to a major study on backsawn karri at the request of a West Australian sawmiller; standard schedule studies on yellow stringybark and on coigue, a South African Nothofagus; studies on superheated steam drying for radiata pine, and studies on what we are calling "difficult" or "unseasonable" Tasmanian alpine ash. This latter study and those on coigue have demonstrated the harm done by reconditioning or steaming before the entire core moisture content of the sawn material has dropped below 25 per cent. or so - even though the average may be as low as 15 - 18 per cent. An excessively high moisture gradient condition is not uncommon in a proportion of the sawn timber of these species during drying.

The work is explaining, in part, the cause of much industry trouble and loss with these troublesome species - and is an aspect we have determined as being distinct from the tension wood problem. At the stage in drying mentioned, the timber has been exposed to temperatures not less than the critical 110°F or so - mentioned previously in connection with the veneer work on the eucalypts - for a considerable period, with probably significant effect on cell wall constituents.

At the moisture content condition mentioned above - a core above 25 to 30 per cent. - it is still in a critical condition with respect to collapse. While in this labile condition the susceptible proportion of given charges is then being subjected to a fairly prolonged high temperature treatment by reconditioning. This then, has disastrous effects on the intensity and permanence of collapse and ensures poor response to reconditioning.

This particular question of non-recovering collapse in some of the Tasmanian eucalypts is a major problem, and as already indicated in previous reviews, will undoubtedly involve several aspects of forest products research before it is solved.

(iv) The Redrying of Radiata Pine Pressure Treated with Water-Borne Preservatives. A co-operative study with the Preservation Section was made to determine whether pressure impregnation with water-borne preservatives influences the subsequent drying characteristics of radiata pine. Kiln dried Australian and New Zealand grown radiata pine in 1 in., 2 in., thicknesses was treated by the Lowry and "full cell" processes, using two proprietary water-borne preservatives, zinc chloride and water in the case of the Australian material; and three proprietary water-borne preservatives and water in the case of the New Zealand grown material.

With the Australian material, which increased in moisture content to the order of 150 per cent. during pressure treatment, a retardation in drying rate of up to 20 per cent. was observed in the salt treated material compared with untreated controls, or those pressure impregnated with water. The retardation was most pronounced in material air dried rather than kiln dried after treatment. Data from the study on the New Zealand grown material has not yet been analysed. I should point out that these interim conclusions are at variance with conclusions reached in New Zealand.

(v) Miscellaneous Drying Studies. A limited, and as yet incomplete, study of the value of end slotting in preventing or reducing end splitting in railway sleepers in service was also commenced. It is possible deliberate end slotting with a chain saw or other suitable equipment for a distance of 6 or 9 in. in from the ends of sleepers could reduce tension stress concentrations during drying either in the stack or in the track, and so reduce end splitting.

A determination of the conditions causing board crushing at sticker positions in timber stacks during reconditioning was completed.

3. FUNDAMENTAL STUDIES

Work on collapse and recovery has been pursued with considerable vigour since the last Research Conference as a major fundamental study. Broadly, the work has proceeded under the following headings: (a) the mechanics of collapse and recovery; (b) the influence of cell wall composition and morphology; (c) the pattern and development of collapse, and (d) the influence of chemical and other pretreatments.

The work has thus been designed to establish experimentally the acceptibility of the several theories for collapse; to determine the factors which cause certain material to be collapse susceptible; to determine how wood reacts to collapse-inducing forces and the reconditioning treatment; to determine why certain pretreatments intensify collapse; and to determine whether any particular pretreatments can prevent the formation of collapse-inducing forces and so prevent the occurrence of collapse. This work is the subject of a separate paper.

Discussion:

Mr. Jennings: Referring to the question of equilibrium moisture content, we have been dissatisfied with the information that is available at the moment in Queensland and we are proposing to do some work on that. We will be happy to collaborate in any work the Division may establish in Queensland. We have taken preliminary

action to investigate possible relationships between climatic data and equilibrium moisture content along the lines that Dr. Ellwood did some years ago.

The overall position regarding seasoning in Queensland is still not good although it is improving. There has been quite a development in the construction of the screen drier in private industry, particularly in the north.

Mr. Huddleston: Our work has been primarily directed towards improving seasoning practices and we have concentrated over the last 2 to 3 years on the seasoning of brush box and an attempt to have the light weight eucalypts occurring along the New England tablelands used in a more rational way. That involves air drying or kiln drying and reconditioning.

The Main Roads Board was interested in developing a new type of bridge consisting of a number of poles laid side by side and covered over with a bituminous surface. This makes a very quick and cheap bridge to build and it has subsequently proved to be very satisfactory in actual use. They were concerned as to what might happen to the poles covered by the asphalt deck, so we had some electrodes fitted into the poles when the bridge was built and we have been taking readings for the last 3 or 4 years. We now find the timber down to about 18 per cent. moisture content and still drying out so that it appears that they will be quite safe from subsequent decay.

I mentioned previously that we have been concerned with the data which we have for equilibrium moisture contents throughout the State. We have designed but have never used, an instrument which we hope will give us a reading of moisture content from the movement of a timber element. It consists of a $\frac{1}{2}$ in. square of Queensland maple cut across the grain and a magnifying arrangement to show the movement. We hope to place about 50 of these in forest offices and obtain from them some indication of the variation of e.m.c.

Dr. Ellwood: Some 5 years ago we attempted to draw lines of equal e.m.c. throughout Australia. This was based on specimens set out many years ago in capital cities, in an attempt made to tie in these moisture contents to atmospheric conditions. Although the report was put out about 5 years ago, we have not had any opportunity of verifying any of the extrapolations made. I was wondering if either Queensland or New South Wales could give us any indication as to whether they have used those maps and whether they have found whether there is any distinct variation from the forecasted equilibrium moisture contents.

Mr. Jennings: The map has been of general assistance to us, but the variations that we suspect were too local to show up on the map of Australia, which is one reason why we were proposing to do a very much similar study in Queensland to perhaps get more detail. Whether the correlation can be established with satisfactory precision we'll have to find out.

Mr. Huddleston: We do consult the map when we have to determine what the equilibrium moisture content is for a particular town, but we do find that our predicted e.m.c. does not always agree with the measured results from timber which has been in the town and we feel there are some other factors influencing it which have not been taken into account in the existing data.

Mr. McAdam: Mr. Colwell recently discussed the possibility of establishing two or three points for the measurement of equilibrium moisture content in New Guinea. It is very desirable that all these test samples should be exposed under similar conditions. Meteorological instruments are exposed in standard Stevenson screens, and I think this should be considered before the tests are established.

Mr. Huddleston: Perhaps Mr. Wright should prepare a working plan for the capital city work, and in preparing that he might have in mind the possible expansion in the States to other centres in

accordance with that working plan. We could prepare supplementary working plans for any variation which we propose within our own areas.

Mr. Wright: I had that in mind, and in doing so to select sites which might enable Dr. Ellwood's regression equations to be further checked. This would involve selecting sites where meteorological data is reliable and where suitable measuring personnel or measuring equipment is available, as part of an overall or assisted project for all States.

Note: The subject of e.m.c. measurements was discussed subsequently at the specialist level. A working plan is to be prepared by D.F.P. for circulation to the States.

CURRENT RESEARCH ON COLLAPSE*

1. Introduction

The phenomenon of "collapse" has been investigated ever since it was first recognized by the pioneer of timber seasoning research, Harry D. Tiemann, in 1913. The Division of Forest Products, since its inception in 1928, has been particularly prominent in the research on this subject.

Apart from the purely ad hoc solution of day-to-day problems, research on collapse has a twofold aim: to understand the phenomenon from a fundamental point of view, and to evolve improved practices in the applied field. Both these aspects are at present actively pursued in this Division.

2. Fundamental Research

Most workers today accept the theory, originally proposed by Tiemann in 1915, that collapse is primarily induced by liquid-tension forces acting in the virtually free water in the lumen of completely filled fibres. There are two approaches open for investigation: (i) examination of the nature of the collapse-inducing forces in their relation to the wood structure and to externally imposed physical variables, and (ii) study of the physical and chemical reaction of the wood substances to these forces.

The liquid-tension theory depends mainly on the magnitude of surface tension forces and on the cohesive strength of water. Reduction of surface tension in small specimens by using wetting agents or replacing water by another liquid has resulted in decreased collapse intensity. The cohesive strength of water depends on the presence or absence of nuclei of a critical size depending on the liquid tension induced. Current experiments have already shown that collapse in small specimens filled with de-nucelated water is slightly greater than in controls filled with air-saturated water.

---

* Prepared by Division of Forest Products.

These results support the liquid-tension theory; further work is planned to investigate whether bubble formation can be artificially induced in wood.

The effect of drying stresses has been claimed by some workers to be primarily responsible for collapse, but this has never been generally accepted. Recent results show, however, that the intensity of collapse in a given specimen depends on its shape and on the direction of cutting as well as on the magnitude of the moisture gradient. A severe moisture gradient tends to decrease collapse due to the stabilizing effect of the rapidly hardening outer case.

The intensity of collapse under given external conditions depends, however, largely on the reaction of the wood substance. High temperatures applied to moist wood cause degradation and increase collapse during subsequent drying. The exposure time is important: a high temperature for a short time may not cause as much damage as a lower one for a longer time. Experiments are proceeding to investigate the reasons for this behaviour; preliminary results show that prolonged exposure to moderate or high temperatures is associated with changes in the pH of wood. Other tests are aimed at determining whether any particular constituent of wood is responsible for observed collapse behaviour. It has been found that extraction treatments which remove lignin and non-cellulosic polysaccharides from green wood result in more severe and less recoverable collapse during subsequent drying.

3. Applied Research

One outstanding post-war development on collapse was the recognition of the importance of wood temperature, and consequently of the wet bulb temperature of the drying atmosphere. Considerable progress was also made through better understanding of the interaction between temperature and drying time, already mentioned above in connection with fundamental research. On the basis of research results, it is now recognized that collapse susceptible timber should be dried (above fibre saturation point) at temperatures not higher than 100° to 110°F with the

maximum drying potential consistent with the avoidance of checking. In addition, the research findings were instrumental in the development of the predrier and the veneer screen drier designed by officers of the Division of Forest Products.

Current research on the value of low temperature in the preheating of veneer peeler logs, as well as the damage induced in green veneer prevented from cooling by block-stacking after peeling, will undoubtedly result in improvements in veneer production and dried veneer quality.

Work on means for field identification of collapse susceptibility in logs by sampling techniques yielded encouraging results in the form of a recently tested method which involves drying of disc segments or smaller specimens, taken from the log, to determine collapse susceptibility. The research on the relation between chemical behaviour and collapse, mentioned above, might possibly result in a more rapid identification method based on a chemical test.

A method has also been developed for field determination of the correct reconditioning point during drying by measuring core moisture contents with sheathed nails driven into the timber to a suitable depth.

4. Outlook

The current research work is aimed ultimately to establish whether a method exists to prevent collapse altogether from occurring during drying. It would also be of great interest to elucidate the relation between the response to reconditioning and the viscoelastic and chemical properties of the cell wall, and experiments are being initiated to investigate this problem.

In the meantime it is, however, very probable that better understanding of the physical and chemical basis of collapse behaviour will result in progressive improvement of methods for the treatment of collapse-susceptible timber.

Note: The above item was prepared and introduced by Mr. W. G. Kauman - there was no discussion.

VAPOUR DRYING AND PRESERVATION OF HARDWOOD SLEEPERS*

There are many advantages in being able to reduce the moisture content of green timber rapidly to a value suitable for preservative treatment. Vapour drying provides a means of accomplishing this, and since the process may be carried out in a suitably designed preserving cylinder it deserves special consideration.

Where preservative treatment is contemplated, there are several advantages in favour of combined vapour drying of green material and pressure impregnation in the one cylinder. Decay is prevented in low durability species prior to treatment; lower interest charges result from a substantial reduction in stocks of timber held; space requirements are less and air seasoning defects and resultant wastage are avoided; plant handling costs are reduced as stacking for air drying is eliminated. Against this, the costs of treatment and transport to and from a central depot would be greater and there is the risk of possible damage to the timber during the rapid drying process.

A laboratory investigation of the vapour drying and high pressure impregnation of sleeper size material cut from five species of eucalypt has recently been completed.

This work was undertaken to determine whether a combined vapour drying - high pressure impregnation process was suitable for Australian hardwoods with regard to drying rate, drying degrade and moisture distribution in relation to treatability, retention and distribution of preservative.

Procedure

The species used were E. marginata, E. diversicolor, E. obliqua, E. regnans and E. australiana. Their collapse susceptibility ranged from low to very high, and treatability at high pressure when partly air dried from satisfactory to erratic. The size of the drying cylinder limited each charge to a single half-length 10 in. by 6 in. sleeper. The material was kept green till ready for drying. One

---

* Prepared by Division of Forest Products.

half-length of each sleeper was dried and cut to determine moisture distribution; the other half was dried as closely as possible to the same conditions and transferred to the preservative cylinder immediately after drying. While the apparatus available made it impossible to carry out the complete process in the one cylinder, the procedure adopted was aimed at making conditions similar. Mineral turpentine and perchlorethylene were selected as drying fluids to give a wide range in boiling point (250-360°F). The cylinder was operated at atmospheric pressure and drying times were 5 and 10 hr. The dried material was treated with furnace oil containing 3 per cent. pentachlorphenol at a temperature of 160°F and at a pressure of 1000 lb/sq.in. for 1 hr. After this treatment the preservative retention approximated refusal point.

Results

Initial green moisture contents ranged from 55 per cent. for E. diversicolor to approximately 100 per cent. for E. regnans and E. australiana. After 5 hr drying with perchlorethylene, the reductions in average moisture content and the moisture content in the outer case (to a depth of $\frac{5}{8}$ in.) were 6 per cent. and 20 per cent. respectively for E. marginata and 15 per cent. and 35 per cent. for E. australiana. Reductions in moisture content after 10 hr drying with mineral turpentine were 16 per cent. and 37 per cent. respectively for E. diversicolor and 38 per cent. and 73 per cent. for E. regnans.

The average preservative retention after 5 hr drying with perchlorethylene ranged from 1.5-3.5 lb/cu.ft. for all species except E. regnans for which it was 6 lb/cu.ft. After 10 hr drying with mineral turpentine, the retention for E. regnans was 10 lb/cu.ft. and ranged from 5-7 lb/cu.ft. for the other species. It appears that, except for E. regnans, 5 hr drying from the green condition with either drying fluid is not sufficient to give satisfactory preservative loadings.

As far as is known, the drying fluid acts only as a heat transfer medium and has no chemical effect. Therefore, the increased retention obtained with mineral turpentine is probably due to the differences in moisture content and distribution. Whether differences in drying degrade and different drying temperatures affected retention was difficult to determine. Even after 10 hr drying with mineral turpentine, the depth of penetration of preservative on the radial edges of E. marginata and E. diversicolor was not greater than $\frac{1}{4}$ in.

Degrade

The type of degrade which occurred during vapour drying of green sleeper size material differed greatly from that normally observed in similar air dried material. The characteristic end splitting and deep surface checks which often occur during air seasoning, in species such as E. diversicolor, E. obliqua, E. regnans and E. australiana, were not present. Instead, fine ray checking at the ends and numerous fine surface checks on the backsawn faces were observed. In addition, a multitude of fine internal checks developed just under the surface - their length depending on the species and time of drying. However, on subsequent air drying, these internal checks closed up in both the untreated and preserved material. The amount of collapse which occurs was only very slight. Immediately after drying, the case is in a highly set condition because of the very steep moisture gradient. A steaming treatment at the end of the drying cycle appeared to provide a greater relief of set than did the more usual vacuum treatment. An exception to the general degrade behaviour pattern was observed in sleepers cut from small trees of E. australiana, where severe checking occurred on the heart face.

A limited amount of work was done on commercial grade "gummy" E. marginata 9 in. by 5 in. sleepers. These had been partly air dried to approximately 50 per cent. moisture content compared with initial green moisture contents of 70-80 per cent. Where initial

air drying defects were present these were generally accentuated by the vapour drying treatment. In such cases, the fine multiple internal checking near the faces, characteristic of vapour dried green eucalypts, did not tend to occur.

Sleepers subjected to a high pressure treatment in the green condition and matched material dried with perchlorethylene for periods of 5 and 10 hr before treating were block-stacked for 3 months. During this time very little change was observed in the vapour dried, treated material, but in the green, treated material severe end checking and surface checking developed particularly in the E. australiana and E. obliqua.

During vapour drying air is excluded from the cylinder and the steam evaporated from the timber is displaced by the heavier vapour but temperatures are sufficiently high to produce some permanent reduction in strength, possibly through hydrolysis. In general, cylinder temperatures during drying ranged from 200-250°F.

Special Value of Treatment

The shortage of naturally durable sleeper timbers is resulting in increased utilization of material formerly rejected because of low decay resistance and free splitting tendencies. It has been shown that end splitting with resultant spike kill is the most important single cause of mechanical breakdown of sleepers in service.

The work carried out in this experiment suggests that the defects which normally develop in air seasoning might be minimized and that a real reduction in mechanical wastage is effected by use of this process. While it is too early to draw definite conclusions in this respect, the results tend to support observations made by workers in the U.S.A. on refractory species such as oak.

The work done shows that several species of green hardwood sleepers can be vapour dried to a suitable moisture content for preservative treatment in approximately 10 hr with very little degrade, that a high pressure impregnation treatment can be used immediately after drying and that satisfactory preservative loadings are obtained.

Recommended Future Work

Extension of this work to include full length sleepers of these and other species, and the installation of vapour dried and treated sleepers in the track for service trials is recommended. This would necessitate the installation of a larger and somewhat better controlled vapour drying plant. Work in this field could be of great importance and have a considerable influence on the measures taken for future sleeper supply.

Note: The above item was prepared by Mr. F. Christensen and introduced by Mr. Wright.

Discussion:

Mr. Wright: We do think there are possibilities still for vapour drying, as I mentioned in my review, for the large sizes of timbers. We did find that about 10 hr vapour drying under either mineral turpentine or perchlorethylene was effective in achieving sufficient drying to enable effective penetration by preservative liquids in subsequent 1 or 2 hr treatment. This applied particularly to E. regnans which almost reached suitable drying conditions in about 5 hr vapour drying. It does look as though a combined drying and treating procedure can be given in under 24 hr from the green condition, so I feel that there are avenues worth looking at in respect to accelerated seasoning for the sleeper sizes on an economic basis.

On the aspect of degrade it appears that our findings are in accord with those of the Americans in that the type of degrade appears to combat subsequent exposure better than air drying does, whereas the checking occurring during the air drying of sleepers of our impervious hardwoods occurs more or less as large isolated checks on the surface and fairly large end splits, and these subsequently extend during exposure in the track. Under vapour drying conditions we get a more or less intricate network of very fine checks at the ends, multiple fine checking under the surface, and these do not tend

to open up in exposure but, in fact, seem to help penetration of preservative liquids. We have now reached the stage where service tests are desirable. I think the time must come in Australia when we shall have to face these accelerated drying techniques.

Mr. Bednall: Are there any patent rights or other protection covering vapour drying ?

Mr. Wright: I suspect that there are certain patent rights in Australia, but what the existing position is I am not quite sure. I think I have seen some reference in the Journal of Patents.

Mr. Huddleston: We had a search put through some time ago and could not find any reference, although one firm claims to hold a patent.

Mr. Bednall: Have we reached the stage where automatic control is likely to become standard in the installation of kilns; also could Mr. Wright say more on the kiln circulation experiments ?

Mr. Wright: There is a gradual increase in the installation of automatic control. This is partly because labour is increasing in cost, partly because heat is increasing in cost and with automatic control one can control the loss of heat from vents considerably. The loss from vents which are uncontrolled or under manual operation can amount to six times as much as they should lose. Even under theoretically perfect conditions the heat loss from vents is about one sixth of the total used in a kiln so that one can see that control of vents by automatic operation can be important, apart from all other considerations. There is thus an increasing trend to install automatic control.

With regard to the kiln circulation experiments, we do want to do some work on higher air circulations in kilns. There is a trend today to move away from the 200 or 300 ft/min up to as much as 600 or 700 ft/min and the Canadians are showing that the drying rate and uniformity of drying is increasing quite spectacularly with

some species at least, at circulation rates up around 600 or 700 ft/min - species which would be more or less like radiata pine.

Mr. Huddleston: Mr. Wright referred to the effect of high temperatures on timber in the green state on the subsequent reconditioning after collapse. As you know the boric acid treatment involves a 4 hr steaming followed immediately by a cold quench and we are a little concerned that that 4 hr steaming may affect subsequent reconditioning of the timber with collapse susceptible species.

Mr. Gottstein: I think it would be reasonably safe to say that in other than a highly collapse susceptible species the effect would be very limited but that 4 hr steaming would probably be sufficient to give some slight increase in collapse in highly susceptible species, especially if the temperature is 212°F. It may be of the order of ½ or 1 per cent. in a highly collapse susceptible species but that is only a guess.

Mr. Kauman: We have found that boiling for about 2 hr or periods of that order did not have a very significant effect upon subsequent collapse. I doubt whether any increase in collapse would be of any practical significance.

ITEM 5. PRESERVATION

(a) REVIEW

Mr. Tamblyn: This review of the work of the Preservation Section will attempt to give a broad outline of current activities and to indicate the more important work planned for the near future. It will not be possible to cover in detail some aspects on which we would like the opinion of the conference. On these particular aspects I propose therefore to comment very briefly so that officers of the Section may later elaborate them for your consideration.

General Developments

Before reviewing the Section's work, it may be opportune to survey recent important developments in the preservation field in Australia. There is now every indication of the imminent birth of a

conventional preservation industry in at least three States. In Victoria two commercial pole treating plants are being erected to pressure creosote poles for the State Electricity Commission and the P.M.G.'s Department. Two similar plants are being constructed in New South Wales. In South Australia the pressure plant to treat pine sleepers and poles has been designed and tenders for its construction are being called. There is much talk of other plants among which may be mentioned a pressure plant in Port Moresby to treat building timbers, a pole plant at Cairns and a Tanalith plant either in Melbourne or Adelaide. High pressure treatments are not being overlooked as Victorian Railways have purchased a site for their proposed plant to treat eucalypt rail sleepers while Tasmanian Railways have indicated their intention to proceed with a sleeper plant. Two other high pressure plants are also proposed in Melbourne to treat crossarms, sawn fencing timbers, window joinery, etc. In addition, mention should be made of the boro-fluoride-arsenic diffusion process which this Division has developed for treatment of klinki pine building timber in New Guinea. Already almost half a million super ft of timber has been treated by this process.

These many developments since the last conference are most gratifying to all preservation workers in Australia who have laboured to this end for so many years.

Returning how to our technical activities, I will try to summarize these under three headings (1) field work, (2) laboratory work, (3) future work.

1. Field Work

Sleeper Tests. Since the last conference, most sleeper tests which were proposed or for which material was then being treated, have now been installed in various localities in four States - Victoria, Tasmania, South Australia and West Australia. In total, these tests have involved almost 4000 sleepers the majority of which have been eucalypts treated at high pressures of up to 1000 lb/sq.in. After

this very considerable experience we are still convinced that high pressure treatment is technically and economically desirable for sleepers of most eucalypt species. The earliest tests of high pressure treated sleepers have now been in service for about 18 months and already show a marked difference between the high pressure treated groups which are still oily on the surface and the low pressure treatments which now appear almost clean.

While we have spent much time in the treatment of eucalypt sleepers we have not overlooked the importance of radiata pine as a sleeper material. In the recently installed Victorian tests there are 420 radiata pine sleepers, variously treated for direct comparison with treated eucalypts. In addition there are 100 New Zealand grown pine sleepers for comparison with Australian grown material. In South Australia a new test has just been installed of 540 pine sleepers supplied by the Woods and Forests Department in three sizes - cross-sections of 8 x 5, 8 x 6 and 9 x 5 in. We treated these sleepers with four preservatives, including a 30:70 creosote:furnace oil mixture to determine whether this relatively low creosote content would be effective. Reduction of creosote content is most important in South Australia where the Railways can import furnace oil for less than 1/- per gallon, but will probably pay almost three times as much for creosote oil. Because of this we have included pentachlorphenol in furnace oil as one of the test preservatives.

Crossarm Tests. Following our survey of causes of failure of crossarms in Australia, the P.M.G.'s Department is now satisfied that a longer life from the crossarm will be an economically desirable accompaniment to pressure treatment of poles.

As mechanical deterioration is important in crossarms we have confined attention to treatments using preservative oils, applied to the prebored arm at high pressure. The main problem at present is to obtain a reasonably clean treatment which will enable linesmen to handle and install arms without objection. As installation requires

almost continuous handling this is a very different case from poles which are handled mechanically except for a short period during actual installation.

Creosote-fuel oil mixtures have not proved promising and we have tried pentachlorphenol in various oils as an alternative. So far we have not been able to obtain an entirely clean treatment but a trial installation of 100 arms treated with pentachlorphenol-furnace oil has led to the conclusion that linesmen would probably handle this treatment provided protective clothing was made available. However, as protective clothing involves considerable cost the P.M.C. has not yet reached a decision on commercial treatment.

Fence Post Tests. Our fence post bulletin was issued about 6 months ago and about 20,000 copies have now been distributed. It has met with an excellent reception despite the fact that preservative oils as recommended are relatively expensive.

In Victoria we have tried to popularize the treated round fence posts by demonstration at many country shows and on farmers' properties. For example, during the last quarter we arranged eight demonstrations during which our portable plant treated almost 3,000 posts including radiata pine and four different eucalypts. Oil retentions per post were about $\frac{1}{3}$ - $\frac{1}{2}$ gallon for eucalypts and $\frac{1}{2}$ - 1 gallon for pine. This higher absorption, which is necessary for pine, clearly shows the need for a cheap, well fixed water-borne preservative to reduce chemical costs to a minimum. That such a preservative can give good results is proved by our West Australian tests where, after 25 years service, the zinc chloride-arsenic treatment, has given almost as good protection as creosote oil.

On this subject of fence post treatments, Mr. Dale has some later comments to make, particularly from the aspect that the State Services should assist in popularizing the small round post by commencing or sponsoring treatments in selected areas.

Cooling Towers. In many countries today, preservative treatment of cooling tower timbers is exciting considerable interest. This is largely because modern forced draught towers have greatly accentuated slat decay, apparently because the water is more highly oxygenated than in older type atmospheric towers. Fungi causing slat decay, or "soft rot" as it is now called, are not normal wood destroyers and are tolerant to at least some preservatives of otherwise good repute. Use of durable timbers may not be a solution, as at least in the case of redwood, the toxic extractives are too readily leached.

We have this problem in Victoria involving towers to the value of over a million pounds, which, in some cases, are showing severe deterioration within the first two years. There are three aspects to the problem.

(a) To find the best preservative treatment for new towers.

(b) To find means of retarding deterioration in towers already erected.

(c) To find an alternative timber to redwood which is costly to import and difficult to treat.

We are working on this partly in the field where some tests are already installed and partly in the laboratory where we are attempting to isolate the causal fungi and test their resistance to preservatives. We would be glad to know of any towers in other States where rapid breakdown of slats is occurring so that material can be obtained for laboratory examination.

Small Specimen Tests. The large scale test, involving several thousand specimens and many different preservatives, mentioned at the last conference, has not yet been installed. However, treatment of specimens is now ready to commence and we are at present trying to finalize on installation sites. For the Mastotermes site we have investigated several possibilities and are now hopeful of obtaining two or three suitable areas in Darwin with the assistance of the Forest Officer for the Northern Territory.

We have recently installed in Victoria two tests of small treated specimens for the Swedish and Finnish Forest Products Laboratories who are anxious to test some preservatives under conditions of high termite hazard.

This subject of evaluation of preservatives will be further discussed under laboratory tests. There are some points relating to field and laboratory tests on which we would like discussion by the conference and at the conclusion of this review, Mr. DaCosta will raise one matter of considerable importance relating to standardization of tests and uniformity in our recommendations when specifying a particular preservative for a given use.

Surveys. Recently the Divisions of Forest Products and Entomology co-operated in a survey of termite problems in the Adelaide area with particular reference to prevention of attack in Housing Trust Buildings. Both Mr. Gay and I were impressed by the severity of the hazard in many areas and by the fact that the conventional construction of brick and brick veneer houses in Adelaide is a major obstacle to effective eradicative treatment. We concluded that termite shields applied to buildings with low foundations and no sub-floor access cannot be considered reliable and are now inclined to favour soil poisoning treatments in such cases.

2. Laboratory Work

Diffusion Treatments. This matter is fully covered in a preprint which will be discussed later in the conference. There is no need to enlarge upon it here, except to remark that the whole subject of preservative treatment of building timbers requires careful thought, firstly to ensure that unnecessary treatments are not made and secondly to decide which are the cheapest treatments which will be reasonably effective. We should reach some decision on this before proprietary preservative interests decide the matter for us.

Evaluation of Wood Preservatives. In its many ramifications this is the most important current project of the Section.

In addition to extensive field and service tests, it involves laboratory leaching and volatilization tests, tests of toxicity to fungi and termites (the latter being done for us by Mr. Gay), corrosion tests and various other technical, practical and economic considerations.

In this work we are coming to regard laboratory evaluation as more important than field tests, which in the past have been accorded a degree of importance detrimental to rapid progress in understanding preservative mechanisms. While we fully admit the confirmatory importance of field tests, laboratory characterization will often yield more information in one year than many field tests do in 20 years. In particular, laboratory tests are designed to find the reasons why a preservative succeeds or fails while field tests rarely provide this information.

Our leaching tests in water of varying pH are now almost complete and we will shortly be looking at mechanisms of fixation in the wood, and the effect of timber species and wood constituents on fixation. On the mycological side soil-jar wood block tests have been standardized to give rapid and consistent toxicity assays, the value of which should increase greatly as our experience in interpretation grows.

Preservative Treatments for Plywood. At the last conference mention was made of tests with green karri and mountain ash veneer treated with six different preservatives by a momentary dipping technique. These tests have now been completed and we have built up a detailed picture of the decay and termite resistance of plywood treated by this very simple method. Nail corrosion tests have also been made on treated plywood held at high humidities for about 12 months.

In these tests sodium pentaborate at about 0.35 lb/cu.ft. was the outstanding preservative against decay. Mr. Gay has also shown that it was an excellent termiticide except against the species Nasutitermes exitiosus which in our limited tests with inorganic salts was completely controlled only by arsenic. Undoubtedly a boron-arsenic preservative of the type used for treatment of klinki pine timber in

New Guinea would be very effective for plywood if it could be used without health hazard. If treatment of exterior plywood with an all purpose preservative becomes important further work may be necessary to obtain a fixed salt compatible with phenolic resin glues and with the lowest possible health hazard. We would be glad of discussion on this matter.

Preservative Treatment of External Joinery. A limited survey in Victoria has shown that a considerable amount of decay is occurring in window sills and window frames constructed of ash eucalypts or oregon. As a result of this survey we have done some work on dip treatments of external joinery in water repellent pentachlorphenol solutions. However, we are by no means convinced that such treatment is sufficiently effective when it is remembered that a window should last the life of a house - possibly up to 100 years. Dr. Ellwood wishes to raise this matter for further discussion later in the conference.

The Toxicity of Various Preservatives to Lyctus. This test to determine the toxic threshold for various preservatives is now nearing completion. Specimens have not yet been chemically analysed so that at present all results are based on the nominal preservative retentions. They are thus comparative rather than precise.

Results showed emergence with boric acid up to a nominal retention of 0.1 per cent. but slight activity occurred up to 0.2 per cent. With arsenic pentoxide there was no activity above 0.04 per cent. indicating that arsenic in this form is about 5 times as toxic as boric acid. The threshold concentration for Tanalith U was about 0.05 per cent. and about twice this figure for the Boliden BIS salt. Zinc sulphate was relatively non toxic. If further details are required on these tests, Mr. Rosel will be glad to furnish them.

Effect of Blue Stain on the Strength Properties of Radiata Pine. Last year a survey was made of fungi causing blue stain in radiata pine. In material collected from four States 84 per cent. of

the isolations of the causal fungus were Diplodea pinea, though several other fungi were also isolated. In all five fungi were used for laboratory production of blue stained radiata pine specimens which were later tested for loss of strength by the Timber Mechanics Section. These tests showed no significant loss in toughness or modulus of rupture irrespective of whether the stained specimens were tested green or at 12 per cent. moisture content. We are at present extending this work to determine whether Diplodea pinea is the common staining fungus generally throughout Australia and whether in repeat tests there is still no indication of strength loss. In these latter tests we will include the Ceratostomella species which English workers claim causes appreciable reduction in toughness.

Other Work. Time does not permit further review of laboratory work which includes Lyctus susceptibility tests on Queensland timbers, prevention of Lyctus attack by superficial treatment with contact insecticides, the collection and taxonomy of wood destroying fungi, the toxicity of extractives from durable timbers, laboratory production of fruit bodies of wood destroying fungi, studies on the absorption and penetration of preservatives in refractory timbers, the effect of water borne preservatives on the drying rate of treated timber, the decay resistance of Australian timbers in laboratory tests and several other miscellaneous projects.

3. Future Work

I do not propose here to give in any detail our programme of future work but will merely select some of the fields in which the conference may be interested.

Field Tests. Five new tests are planned -

(a) A test of high pressure treated rail sleepers in Queensland in co-operation with the Queensland Forest Service.

(b) A similar test of high pressure treated sleepers in N.S.W. at the request of the N.S.W. Railways.

(c) A pole test in North Queensland in Mastotermes country at the request of the P.M.G.'s Department.

(d) The small specimen test of some 30 preservatives which was mentioned at the previous conference. This test will be installed at four sites including one in New Guinea and one in a Mastotermes area.

(e) A stake test of various durable Australian timbers to check laboratory ratings against field results.

Fence Post Investigations. The development of a fixed water borne preservative (or the selection of an existing formula) for treatment of round posts is planned for the very near future. We may also investigate double diffusion treatments.

Evaluation of Preservatives. Work on many aspects is planned. On the chemical side we hope to learn something of the mechanism of fixation of water-borne preservatives in wood; on the mycological side we have a detailed programme of laboratory tests designed to investigate the toxicity of single salts and mixtures, to locate the most tolerant fungi and to determine whether their tolerance increases with acclimatization. Termite tests are also planned in co-operation with the Division of Entomology. In this connection a project which will commence shortly will compare the termiticidal properties of the various metal-arsenic preservatives at present available (such as Tanalith C, Celcure A and the Boliden salts).

Durability Studies. In addition to continued work on the laboratory rating of the decay resistance of various timbers, we are commencing a new project to study the reasons for durability by extracting the toxic material and proving its toxicity by decay tests on the extracted material and on sawdust to which the isolated toxic has been introduced.

Wooden House Stumps. It may be of interest to mention briefly that we have been surveying causes of failure of wooden house stumps in the Melbourne area. Our future work here will probably be

in co-operation with the Commonwealth Building Research Station, in an effort to design a composite stump with a concrete base and wooden top somewhat similar to the jack stud construction used in New Zealand.

Mr. Dale: The Division cannot keep up the level of extension work dealing with fence post treatment as it wants to get on to more work on the water solubles. However, we do feel that the States could profitably carry on this work by carrying out some semi-commercial fence post treatments, preferably as part of their plantation activities. We can give them every assistance - the portable plant which is available for demonstration purposes has proved itself thoroughly reliable and effective - even outsiders have used this, and there is a manufacturer in Melbourne who is interested in making this unit, particularly if he can make more than one at a time. We believe that they should sell for about £300. We have also designed a very simple fixed version which has only two controls, a valve and a switch. Both that plant and the portable unit will work as well on water solubles as they will with the oily preservatives. However, we think it would be best to start with creosote because it is already well known in service and well known to most farmers. The change to water solubles should involve no difficulty, particularly if there is a corresponding reduction in price of the finished article when the change is made. The possible sites that come to mind when we are thinking of such an operation are the brown mallet stands in Western Australia which with the tan bark off, are already half-way to fence posts and, more particularly, the pine plantations. The objection may be raised that barking of pines is a problem in those small sizes - we admit that - but the Victorian Forests Commission have done some very useful work on chemical debarking of pines and there are a number of machines which have given good results barking small pine thinnings. The Melbourne and Metropolitan Board of Works have practically finished a low pressure treatment plant with a 12 ft x 6 ft diameter cylinder at their Werribee Sewerage Farm where they have a considerable annual

requirement for fencing. Their initial programme contemplates treating 15,000 posts and an indefinite number of split rails per annum.

Mr. Bednall: South Australia would like to have first use of the portable plant. The utilization of round wood will be a very important matter for us in the future, not only because of the utilization of that type of pine, but also because of the difficulty and expense of posts of any kind in South Australia. We have had small creosoted posts in our fence lines now for some years with very satisfactory results, all the posts we have tried are quite good and we are anxious to make a feature of it in South Australia in the near future.

Mr. Clarke: We would be willing to give staff help in the early stages, but we would hope that after we had had somebody with the initial stages of treatment with the plant that the States themselves could carry on.

Mr. Huddleston: There is a proposal to put in some fencing on the main Western Highway. The general scheme is that we would provide small eucalypt and possibly some pine posts. Timbrol would provide the creosote for treatment and the treatment would be carried out by the Forestry Commission - we hope with the aid of your portable plant. After the fence is erected Timbrol are prepared to give it publicity with a view to selling creosote.

Mr. Dale: We would like to see such an operation go further than the installation of demonstration fences. We would like to see the State Departments selling treated posts from their plantations not only to popularize treated posts but also to get an idea of the local reaction to the local sales market for treated posts. We have a fair amount of demonstration fence at present but I think that when you get to the stage of semi-commercial operation that it becomes important.

A short discussion on barking pine posts followed, and Victoria agreed to supply South Australia with details of chemical barking using sodium arsenite.

Dr. Ellwood: The fairly rapid deterioration of window sills, made from hardwood, and also to some extent from oregon, is becoming a problem in Victoria. I would like to find out what the position is in other States with respect to the possible future supplies of relatively durable joinery timbers for exterior use, or if supplies are diminishing to a stage where relatively non-durable timbers have to be used for these purposes, whether the States would be interested in us doing some work on superficial treatments. The object of superficial treatment is primarily to protect end grain - our surveys show that the trouble starts at end grain around joints. If we can get some degree of penetration there, we get some degree of protection, by incorporating a fungicide we get fungal protection, and using a water repellent we cut down the water uptake into those critical joints. We have done some work on the water uptake of materials treated with a number of water repellents and found that they are quite effective, they will cut down the water uptake to about half that achieved by an untreated piece of wood. We would like some comment from the States on this subject.

Mr. Tamblyn: I feel that it might be better to go for pressure preservative treatment of non-durable window joinery so that we could reasonably guarantee a life of up to 100 years for a treated window frame. I am afraid that these water repellent dip treatments might prove effective only for a limited period, and the service obtained would not be as good as from pressure treated joinery. We might even consider, whether in some later issue of the standard dealing with window joinery, only pressure treated timber or naturally durable species should be permitted.

Mr. Huddleston: In New South Wales the great bulk of our window joinery is in Douglas fir and we normally use durable tallowwood window sills but Sydney blue gum, which is not a durable timber, has been used extensively for sills. We have not seen any great incidence of decay in window joinery, except in cases where the joints have been wrongly made and I feel that if we were to advocate the compulsory impregnation of window joinery material, we would be adding unnecessarily to the cost of houses. In N.S.W. there is no serious problem there, except in the case where the workmanship is faulty.

Mr. Jennings: Most of the external window joinery in Queensland has been northern silky oak, which has quite a good durability rating but supply of that is becoming difficult and there is already pressure to use substitutes. We have temporarily recommended the 24 hr cold soak of the completed mill work in penta-chlorphenol and oil. With pressure treatment I feel that there would be an unnecessary amount of capital investment, and the dip treatments have been attractive to us from the point of view that they are quite a simple thing for the joinery manufacturer to do and not particularly costly. We calculated that they might add 2/- to the cost of the completed casement. We would be quite interested for the Division to do some work particularly along the dip line; we have already started trial experimental work ourselves on that aspect. In regard to sills we have no particular problem there, they are normally made from durable hardwoods.

Mr. Irvine: I think that if there is trouble with ash joinery, it is more a matter of manufacture either in method of jointing or in incorrect moisture content, leading to open joints rather than the absolute durability of the timber.

Dr. Ellwood: Durability of the timber is only one factor concerned. There are plenty of cases around Melbourne where non-durable timbers have behaved satisfactorily, simply because of good manufacture and good maintenance, but good joints are not always made today, and are

not primed with heavy red lead as they used to be. The question of species arises in regard to the relative ability of the species to pick up moisture in the joints. One of the reasons for the better behaviour of oregon, I believe, is the fact that it does not absorb moisture nearly as readily as certain other timbers, particularly the ash type timbers and pine. The dip treatment is a means of correcting, to some extent, the insufficiencies of manufacture and also coping to some degree with the lack of durability.

Mr. Jennings: The major factor is, as Dr. Ellwood has said, the deterioration in the standard of joinery manufacture. That is particularly hard to remedy and it would be easier to introduce the dip treatment.

Mr. Crane: I think there are two changes - one is the change in the style of architecture, and the other is a definite deterioration in the standard of manufacture of external joinery. The use of unseasoned wood and consequent opening of the joint is very common. Ash type joinery is regarded as second rate simply because of this movement between its wet and dry conditions.

Mr. Smith: With reference to the use of Baltic deals for window joinery, we have had a lot of cases in Queensland, particularly in prefabricated imported houses, where extensive replacements have been necessary in houses that have been erected for no more than 3 years.

Mr. Huddleston: We have seen the same in a number of prefabricated houses, but in every case I have seen it was due to faulty construction, joints that have not been properly made so that it is no time before decay takes place.

Mr. Smith: No matter what you do to maintain protection from moisture, I don't think any paint has been devised yet that will remain completely impervious to moisture. Also it is almost impossible to control maintenance. As paintwork deteriorates you must get greater movement, even in an originally well constructed joint.

Durable species, or a non-durable species treated with a suitable fungicide is the answer to the problem, rather than trying to improve methods of manufacture.

Dr. Stamm: You might be interested in practices in the United States. We have been making most of our window frames from ponderosa pine which is of low durability, and about 10 years ago they started the dip treatment - practically every manufacturer uses it now. It is such a short dip that a lot of people would wonder whether it was effective at all, but they claim that it is effective, even the 3 min dips, of course I think our average hazard conditions in the United States are a little less than yours here, so that may partially account for the fact that the 3 min dip has been very satisfactory.

Dr. Ellwood: It seems that there is a definite interest in this dip treatment and we will give all assistance we can to the States. We will be going ahead on our own tests and if there is anything anyone wants done we would be pleased to hear from them or have any ideas submitted to us on the subject. At the moment we cannot give first hand experience on our species - all I can refer to is American work on dipping of ponderosa pine, tests which have been exposed now for 12 years. Samples given this superficial treatment are showing no signs of deterioration in that time, without paint cover.

Mr. Clarke: All that we would have to say is that we would advocate this treatment for non-durable timbers and that we are sure it would extend the life of the joinery. I do not think there is any obligation on us to say just how long it would extend it.

Mr. Tamblyn: At least one company is interested in establishing high pressure treatment plants wherever they can get sufficient work to do. I think we might encourage the establishment of these plants by recommending treatments of some timbers such as external joinery, fence posts, plinths, etc. If we began to recommend it, proprietary interests would fairly rapidly enter the field and provide the facilities. We would then have, at very little extra cost,

a treated window frame which has a reasonable chance of lasting the life of the house. The other way we have the dip treated window frame that probably costs nearly as much and for which we can guarantee 12 years life - it might be 20 or 30 years but I would be almost certain in my own mind that it will not last 70. Pressure treatment has a chance of doing that.

Mr. Clarke: I think there is one point that we have to keep in mind, and that is a number of people here have drawn attention to the fact that they do not consider the expense is justified. We have to be particularly careful in encouraging treating companies or people with proprietary preservatives to do treatment which is not fully justified - otherwise we are going to be in exactly the same position as they are in New Zealand where a colossal amount of money is being wasted today because proprietary preservative firms have frightened everybody into treatment. As a result the cost of a house has gone up considerably.

Mr. Huddleston: We believe that treatment should be used where it is necessary, but that we should discourage it unless it is economically justified.

Mr. DaCosta: We are devoting a lot of attention to evaluation of preservatives and now that commercial treating plants are being established in Australia it is a field in which we are all going to be asked a lot of questions in the future. We therefore thought that we might take some steps towards co-ordinating our research work and also our advisory activities in this field. A chemical firm recently approached the Division and asked us to carry out tests on residual tar from oil distillation. We agreed to do so under certain conditions and in the course of subsequent correspondence with them they mentioned that they had also supplied samples to the Division of Wood Technology, who are doing laboratory tests. That is a good idea in that two tests are better than one, but where a commercial firm is concerned it is obviously desirable that we should keep in touch with one another.

In the past our use of laboratory and field tests of preservatives has been largely to demonstrate that such and such a preservative was highly effective in a given list - or perhaps to indicate which of two preservatives is likely to be better for a given use. But now, especially with commercial treatments becoming available in Australia, we are going to be asked what is the minimum retention of a preservative for a certain use, or for a specification, or for a legal standard. These questions are very difficult to answer from laboratory tests but there is no other type of test that would be quick enough to give us an answer. But to answer them from laboratory tests we do need to calibrate our laboratory test techniques by correlation with field tests, particularly with service tests. Whenever any service test or field test is set up, samples of the preservative used should be reserved, also samples of the timber, so that laboratory tests can be made. We have got along fairly well in the past with informal co-operation, and it may be that the time is not yet ripe for setting up any more formal, more positive means of co-ordination, but I think inevitably, that time must come.

We thought it might be desirable to set up a Preservative Committee, firstly to keep each other informed of current and proposed work; secondly to arrange these co-ordinated services, beyond the laboratory tests; and thirdly to provide a means of discussing this question of minimum approved retentions. Such a committee would be able to offer advice to people on this question of minimum retentions, such people as commercial treatment plant operators, and others such as the Standards Association or anyone else who has to draw up a definite official standard for preservatives.

Mr. Clarke: This is a very important point. The position in New Zealand is chaotic as there are several different Government authorities advocating different retentions of material. I think that we can profit by their difficulties.

Mr. Huddleston: Several conferences back it was decided that any work aimed at the determination of concentration for a particular purpose would be left to this Division. This has been done and has worked very satisfactorily. Legal approval is the responsibility of each individual State administering an act and no Committee could take away or assume the responsibility of determining what those States are going to do. If we confirm these arrangements and adhere to them we cannot do better.

Mr. Jennings: I am in accordance with Mr. Huddleston's views on the matter and the previous arrangement would be entirely satisfactory to us. We would be very glad if, from the point of view of technical guidance and the determination of toxic limits, the Division would continue the arrangement that was agreed upon at previous conferences.

Mr. Clarke: Where the States are carrying out any field test on their own account we would be glad to have samples of the preservative and the timber.

Mr. DaCosta: We would feel much happier about correlating our laboratory results, where we would actually use the same batch of preservative, the same solution, in our laboratory tests as was used in the stake tests.

Mr. Jennings: We have established stake tests since the last conference and also have some interest in laboratory scale pressure tests, perhaps also vacuum. Apart from that we have no immediate plans this financial year. We have been trying to concentrate on field control in our established preservation plants and that is taking up a lot of the time of our laboratory staff. We are carrying out an extensive campaign on maintenance of standard of treatment. We have found that this is essential because we have had two or three cases where standard of treatment had been varied with rather disastrous results.

Mr. Huddleston: The New South Wales work is covered by the preprints which are to be discussed later.

Mr. Crane: There is no doubt that the Tasmanian Railway Department will put in the high pressure plant. It means a lot to them, particularly as they are only getting about 12 years life from a sleeper. We are interested in the hop pole work which you are doing.

Mr. Dale: Though we have not done any hop pole treatments as yet it is projected that we do some for one of the major breweries who run their own research farm, and have their own research officer. They are very keen to get hop pole treatments started because they get very short lives from the hop poles they use at present. We have a series of tests projected to determine whether the preservatives will have any effect on the vines.

Mr. Bednall: We have kept in touch with the various projects mentioned by Mr. Tamblyn as far as they affect us. We have in addition our own tests of small round posts at the various forest reserves. We also run a standard pentachlorphenol dipping plant at our flitch mill at Mount Gambier. He has also mentioned the pressure plant to be installed at Mount Gambier to treat initially about 50,000 sleepers a year.

Note: Mr. Harding then raised the question of providing a publication to be given to householders to enable them to treat their own termite infestations. This was particularly desirable in South Australia as the Woods and Forests Department received many enquiries.

There was considerable discussion on this subject, and it was pointed out that the type of construction generally adopted in South Australia made any treatment particularly difficult. It was felt that it would be preferable to recommend enquiries to one or two reputable pest treatment firms. Mr. Harding felt that this was not satisfactory, and Mr. Gay agreed to supply some interim notes which could be duplicated and handed out. Mr. Gay pointed out that it was hoped to produce a detailed booklet on the subject in the near future.

Mr. McAdam: We have been making some progress with preservation in New Guinea as a result of the co-operation between the Division of Forest Products and Commonwealth-New Guinea timbers. What seems to be a fairly successful commercial operation in diffusion treatment with klinki pine is being used in New Guinea now to enable us to use the lower quality top logs for the production of house construction timbers. It may sound a bit luxurious to be building houses out of klinki pine but that is what is happening in Port Moresby at the present time. We have been short of sawn timber in the Port Moresby area and this diffusion treatment has enabled us to get what we think is a satisfactory product for use on the coast without going into expensive high pressure equipment. It is important from our point of view in the valley where the pine is to have something of that kind to use our lower grade logs but I think if pulping operations are established the bulk of the timber that is at present being put into second or third grade building scantlings will probably go into the pulping operations and the need for preservation will die out in the valley. There has been some talk of the establishment of a pressure plant in Port Moresby but at the moment it is only talk. I have nothing detailed on it and I am waiting for further activities before I can report any progress.

We are hoping to put in the graveyard test at Lae in co-operation with the Division of Forest Products as soon as the material is available.

MOMENTARY DIP-DIFFUSION TREATMENTS FOR JOINERY AND BUILDING TIMBERS*

1. Introduction

When the momentary cold dip boron treatment for Lyctus-immunization of green veneer was released by the Division in 1949, it very rapidly and successfully supplanted the old hot steeping process. At that time the merits of a similar cold dip-diffusion treatment for green sawn timber were fully realized, but the practical obstacle to success was believed to be the difficulty in formulating the very concentrated boron solutions necessary for treatment of scantling size timber. Australian practice for Lyctus immunization of sawn timber has therefore relied on tank steeping treatments involving heating and cooling of the wood for at least several hours in contact with dilute solutions of either boric acid or borax.

While the tank process has proved a valuable and reliable Lyctus treatment for rain forest timbers, it does not give maximum protection against decay and termites and has not proved economically attractive for wide adoption in the treatment of susceptible eucalypt sapwood. Although plant is cheaper than that required for pressure treatments, and the whole process has many advantages in cheapness and simplicity of operation, the small operator is still faced with considerable capital outlay in providing large treatment, mixing and storage tanks and the necessary facilities for heating either the timber or the solution. Also a degree of skill is necessary in routine analysis of solutions to maintain full treating strength. In its present form the boron process would not provide an ideal answer to any future need for preservative treatment of radiata pine building timber in South Australia where protection against termites would probably rank at least as high as immunization against Anobium.

These shortcomings of the present tank treatment could be overlooked if no simpler, cheaper and more effective treatment were

---

* Prepared by the Division of Forest Products. (N. Tamblyn).

available. However, it appears likely that they could be largely eliminated by perfecting momentary dip treatments which would be very cheap and simple to apply and which would permit the use of more complex preservatives without any technical difficulty in control of solution strength.

The purpose of this paper is to survey current information on dip-diffusion treatments and to invite the fullest discussion by the Conference on lines of future work.

2. Developments in New Zealand

During the last few years, Harrow and co-workers in New Zealand have investigated momentary dip-diffusion treatments for green radiata pine and tawa, using a highly concentrated solution containing a mixture of boric acid and borax. This mixture probably forms sodium pentaborate which has much higher solubility in water than either boric acid or borax alone, and can be heated to obtain higher concentrations if necessary.

The theoretical equation for formation of pentaborate requires that approximately equal weights of boric acid and borax (1:1.03) be used, but New Zealand workers have shown that more concentrated solutions can be obtained by considerably increasing the amount of borax. The mixture which Harrow now recommends contains weights of boric acid and borax in the ratio of 1:1.54 and has a solubility at 30°C of about 27 per cent. H_3BO_3 equivalent on a w/w basis. This is probably a supersaturated solution as heating is necessary when preparing the solution.

Using this mixture, the safe diffusion period in solid stacks recommended in New Zealand to obtain a core retention of not less than 0.2 per cent. boric acid, varies from about 3 weeks for 1 in. radiata pine boards to about 4 months for 2 in. tawa stock.

3. Dip-Diffusion Tests of Eucalypt Sapwood with Concentrated Sodium Pentaborate Solutions

Last year a limited test was completed at this Division to determine the effectiveness of cold dip-diffusion treatments for Lyctus

immunization of eucalypt sapwood using a borax-boric acid solution containing about 22 per cent. boric acid equivalent.

Test boards were cut $1\frac{1}{8}$ - $1\frac{1}{2}$ in. thick from two small trees each of messmate stringybark (E. obliqua) and narrow leaved peppermint (E. australiana). These boards were all cut parallel with the full sapwood running off to wane and the grain direction ranging from quarter to almost back cut. Sapwood thickness ranged mainly from $\frac{3}{4}$ - 1 in. but in occasional boards was either slightly narrower or wider. Boards were dipped green (moisture contents ranging from 70-106 per cent.) at solution temperatures of 70-72°F and were block stacked at the same constant temperature. After the block stacking period they were stripped out to air dry for 4 weeks.

Core specimens for analysis were then cut as a $\frac{1}{4}$ in. square strip of sapwood on the heartwood boundary as far away as possible from the surfaces of the wood. Each core specimen was analysed separately for percentage boric acid based on the oven dry weight of the wood.

In the results given below the quite considerable blank titration from analysis of matched untreated wood specimens has been subtracted.

Eucalypt Sapwood Diffusion Tests

Showing mean percentage H_3BO_3 in the core based on O.D. weight of wood.
(Figures in brackets are lowest individual values obtained)

Timber	Dipping Period min	Per cent. H_3BO_3 after block stacking for:		
		6 days	14 days	25 days
Messmate stringybark	1	0.09 (0.07)	0.19 (0.17)	0.28 (0.16)
	25	0.27 (0.15)	0.20 (0.11)	0.25 (0.15)
	225	0.15 (0.11)	0.24 (0.16)	0.55 (0.34)
Peppermint	1	0.12 (0.05)	0.20 (0.12)	0.23 (0.17)
	25	0.14 (0.07)	0.20 (0.12)	0.43 (0.36)
	225	0.22 (0.09)	0.44 (0.16)	0.55 (0.17)

(Each mean was the average of 4 boards representing 2 trees)

These results indicate that the 6 day diffusion period was too short but that both the 14 and 25 day periods have probably resulted in practical immunity for all specimens. It may be argued that the 0.20 per cent. core retention figure specified in tank treatments has not been fully met even in the 25 day period. However in attempting to decide the practical value of these results the following points merit consideration.

(i) All specimens showed complete sapwood penetration by the turmeric test.

(ii) The core specimen represented only about 6 per cent. of the total sapwood volume and the remaining 94 per cent. was certainly more heavily treated.

(iii) After the 14 and 25 day diffusion period the lowest individual core retentions were very close to the accepted toxicity threshold of 0.14 per cent. which has never been accurately determined by wood analysis and is probably too high. A safety factor is probably unnecessary for a core specimen, and some relaxation of our standard should at least be considered.

(iv) Despite high starch content no treated specimens have shown attack by Lyctus after 14 months storage in the laboratory.

(v) Stronger solutions and longer block stacking periods are quite practicable.

(vi) A 1 min dip followed by 3-4 weeks block stacking should at least give a high measure of protection to eucalypt sapwood which is at present rarely treated. It appears that sapwood up to about 1 in. in depth on any sawn timber, and of any depth on quarter or half quartered boards up to about $1\frac{1}{4}$ in. thick, could be successfully treated in less than 1 month. In practice this would include a large proportion of sawn eucalypt material.

4. Dip-Diffusion Treatments for Klinki Pine

Almost concurrently with the above tests on eucalypt sapwood, an urgent problem arose in connection with preservative treating of klinki pine building timber in New Guinea.

Pressure treatments with klinki pine from 6 different logs were initially unpromising as penetration of the heartwood was often irregular and unsatisfactory. Attention was therefore turned to dip-diffusion treatments and an effort made to develop a preservative solution of high concentration which would diffuse readily and would be more toxic to termites than boron compounds alone. The most promising mixture appeared to be one giving a highly concentrated solution of borofluoride and pentaborate to which an arsenic compound could be added without difficulty.

The first cold solution used contained 43 per cent. total salts and had the following formula (by weight).

Boric acid	(H_3BO_3)	26.0 per cent.
Sodium fluoride	(NaF)	7.0 " "
Sodium arsenate	($Na_2HAsO_4.7H_2O$)	5.0 " "
Sodium dichromate	($Na_2Cr_2O_7.2H_2O$)	5.0 " "
Water		57.0 " "

The high solubility of the boric acid probably depends on the following reactions giving borofluoride and pentaborate

$$14H_3BO_3 + 8NaF \rightarrow 2NaBF_4 + 3Na_2B_4O_7 + 21H_2O$$

(boric acid) (borofluoride) (borax)

$$6H_3BO_3 + Na_2B_4O_7 \rightarrow Na_2B_{10}O_{16} + 9H_2O$$

(pentaborate)

Combining these two equations the probable reaction may be represented as -

$$32H_3BO_3 + 8NaF \rightarrow 2NaBF_4 + 3Na_2B_{10}O_{16} + 48H_2O$$

Later the formula was modified slightly by addition of a small quantity of borax to stabilize the solution against precipitation during use. This solution has been used successfully in laboratory dipping tests with klinki pine heartwood and has the advantage of being slightly acid in reaction but completely non-corrosive to ferrous metals. An application for patent has been lodged covering solutions of this type.

In laboratory dip-diffusion tests, rough sawn klinki pine heartwood material from 6 trees was used at green moisture contents ranging mainly from 30-40 per cent.

Boards $1\frac{1}{2}$ in. thick, which were dipped singly for 1 min and then drained, absorbed about 0.616 lb/cu.ft. total dry salt and were completely penetrated after 2-3 weeks block stacking as judged by the turmeric test for boron. Similar green heartwood material $2\frac{3}{4}$ in. square treated as above absorbed about 0.3 lb/cu.ft. dry salt in a momentary dip. After 52 days block stacking this material was analysed for boric acid and arsenic content in consecutive zones from the outside to the core. Average results as percentage, based on the O.D. weight of the wood were as follows (after subtraction for untreated wood blanks).

	Per cent. H_3BO_3	Per cent. As_2O_3
Zone 1 (0 - $\frac{1}{4}$ in.)	0.99	0.17
2 ($\frac{1}{4}$ - $\frac{1}{2}$ in.)	0.42	0.01
3 ($\frac{1}{2}$ - $\frac{7}{8}$ in.)	0.28	trace
Core (1 in. square)	0.20	trace

These results have been satisfactorily duplicated in experimental and semi-commercial treatments at Bulolo, though at first there was some trouble due to drying of the timber either before or after dipping. This trouble has been obviated by ensuring that all material is dipped without delay after sawing and is covered in the stacks during the diffusion period. Because of the low moisture content of the heartwood such precautions are probably more necessary with klinki pine

than with most other timbers, though our experience is not yet sufficient to judge the minimum degree of care necessary for timber at normal green moisture content.

Commercial treatments are now being made at Bulolo and a specification has been prepared in which the turmeric test for boron is used as the basis for acceptance of treated timber. The specification states "In a satisfactory treatment, a colorimetric test as specified, for the presence of boron, should show complete penetration in timber up to 1 in. in thickness and substantially complete penetration in 2 in. material. In thicker sizes complete penetration should not be expected but such timber may be safely used provided the minimum depth of penetration is $\frac{1}{2}$ in. and provided any untreated wood exposed in subsequent cutting or machining is coated with a preservative in light oil solvent as later specified".

The specification also draws attention to the need for precautions to avoid leaching of preservative during storage of the timber or construction of a building and requires that all timber used in positions liable to rain wetting shall be protected as soon as possible with a well maintained paint system. Use in contact with the ground is prohibited.

5. Future Work

In judging the klinki pine treatment, it should be remembered that it was developed at short notice in response to an urgent requirement for which conventional pressure treatments did not appear promising. It does not claim to be the best which can be developed, and further work, if undertaken, will almost certainly show various ways in which it can be improved, and possibly further avenues for its use.

In the present formula the boron compounds diffuse more rapidly than the arsenic, due to their higher concentration in the solution and to the greater mobility of the monovalent boron-containing ion. In the wood, this results in a higher concentration gradient for

the arsenic, which in the present New Guinea treatments is probably an effective preservative only to a depth of $\frac{1}{4}$ - $\frac{3}{8}$ in. While this is a very effective envelope, deeper penetration could be obtained by increasing the arsenic content of the solution and the diffusion period. While the former remedy presents no difficulties the latter is more or less impracticable as a very considerable increase in diffusion period would be necessary to produce a worthwhile result.

Increase in the arsenic content of the solution can be achieved by the following formula (per cent. by weight).

Boric acid	(H_3BO_3)	22.0 per cent.
Sodium fluoride	(NaF)	6.0 " "
Sodium arsenate	($Na_2HAsO_4.7H_2O$)	20.0 " "
Sodium dichromate	($Na_2Cr_2O_7.2H_2O$)	12.0 " "
Water		40.0 " "

This gives a cold solution containing 60 per cent. total solids which we are proposing to test for green karri rail sleepers required by the South Australian Railways for service in dry areas, where Powellized sleepers have previously given good results. A block stacking period of 2-3 months will probably be necessary for these sleepers.

If fixation of salts became necessary, the dichromate could be omitted in the above solution and the first treatment followed after an interval of a week or more by a second dip in a copper sulphate-dichromate solution. Probably this need not greatly extend the block stacking period as the less mobile copper ion, applied after a short interval, could not immediately precipitate salts which had already diffused below the surface.

In considering future work we should not lose sight of the fact that treatment of radiata pine building timber may become common practice in the next few years, particularly if the European house borer (Hylotrupes bajulus) becomes established in Australia. Its desirability obviously depends on the cost of treatment, and diffusion treatments should be cheaper than pressure treatment with proprietory preservatives.

Discussion

Mr. Tamblyn: I would like to make some comments relevant to possible treatments of building timber in South Australia. South Australia, with radiata pine as its main building material is a special case, and I can see vendors of proprietary preservatives becoming established there and persuading the building industry that treatment of radiata pine for building timber is economically justified. The arguments they might present would be that building construction methods in South Australia are traditional and unalterable, that termite damage is severe and radiata is a highly susceptible timber, that Anobium is a further hazard and that borers such as Hylotrupes not yet established here will almost certainly become established in the future, and I think that they could make a case that might be considered good by architects and builders. We might thus see in South Australia within the next few years the same scene enacted that has occurred in New Zealand where treatment of Pinus radiata building timber has become common practice. This being so I think we would be remiss in permitting a treatment costing perhaps 25/- per hundred super ft when momentary dip diffusion treatment can do practically the same job for 6/- or 8/- per hundred super ft. Therefore we have to decide whether we should forestall what I believe to be the natural development by introducing momentary dip diffusion treatment even though we may argue that it is doubtful whether the money is justifiably spent or not. We should move in this direction as a counter to the what I think inevitable development of the more costly treatment which once it starts we will have difficulty in preventing or perhaps then in introducing our treatment. I suggest that we may have to introduce our treatment as a defence against the proprietary preservative treatments.

Mr. Huddleston: We are opposed to introduction of any universal preservative treatment for radiata. In economic considerations, if we look forward to the year 2000 we will have

coming out of our plantations something of the order of 200 million super ft per annum sawn. On the basis of ordinary tank type boric acid treatment with the present cost somewhere about 15/- that timber is going to be subject to an annual charge of £1½ million. Or if we go to half that figure with the momentary dip treatment it is still going to be £¾ million per annum and it is our belief that we should go to considerable trouble to save that annual expenditure.

It might be better to consider soil poisoning with eradication of termites inside the barrier surrounding a house and the renewal of that barrier from year to year. I think it would be a cheaper proposition than treating all the timber in the houses and would be something that the householder could do - once he is suitably instructed in it - so that there would be no actual cost save the small cost of chemicals say once every 5 years and the labour of digging out a trench, puddling the soil and replacing it. If you look at the South Australian problem on a straight out economic basis and assume that we can get treatment - the momentary dip process - for a sum of say 10/-, this would mean an increase of £50 or £60 per house in initial capital expenditure. Therefore it is a question of whether it may be better to leave the timber without treatment and pay the 5 or 6 guineas to the pest control firms and let them have the trouble of keeping the termites out. On the same lines if a householder is adequately instructed as to how to deal with these pests he can probably save himself that annual cost. I feel that whilst the momentary dip treatment with the subsequent diffusion of the chemical is going to be well worthwhile where we must treat, I think we must be very careful in recommending universal treatment of timber for building purposes at this stage.

Mr. Jennings: The preprint contains the disturbing suggestion that the present standard of the boric acid treatment be relaxed. Unless there is very definite experimental evidence that a lower toxicity level is acceptable we cannot agree to this. Our

evaluation of the preservative problem in Queensland is not concerned with normal constructional material used in protected situations except for protection against Lyctus attack, and possibly in the future for protection against Hylotrupes. The present need is for preservation against fungal attack and certain insects attack in external situations, particularly in the heavy engineering timbers. This applies particularly to the northern areas where we lack durable material for that purpose. We have some doubts as to whether the proposed diffusion treatment will provide any economic advantages over the existing tank method. There are questions of extra handling which I do not think have been adequately investigated. We have an existing industry with a capacity of almost 40 million super ft a year in tank treatment of various types and it is perfectly able to do all we need in regard to protection against Lyctus.

Mr. Bednall: I think we may be losing sight of the point that Mr. Tamblyn is not eager to make treatment compulsory, he is merely trying to forestall a compulsory and necessary treatment at a later date. If we do not adopt Mr. Tamblyn's suggestion are we going to be forced into a worse situation ? At the moment all radiata used in our Departmental houses is treated up to floor level.

Mr. Huddleston: At one stage in New South Wales Ordinance 71 required all joists and bearers to be brushed with creosote. We were inclined to scoff at this brush coating as having no value, but recently in several cases of termite attack and decay in houses due to faulty underfloor ventilation we have found without exception that where a brush coating of creosote had been applied to the joists that they had withstood the attack from the surface protection afforded, so we now feel that brush coating may have some value in this regard. We normally use hardwood for joists and bearers but some imported oregon is used and there is a tendency in some districts now cutting pine to follow the European practice of using pine throughout the whole building. This could lead to an increase in

termite attack, but the usual practice in country districts where there is severe termite hazard is to provide ant caps and to provide at least 15 in. between the ground and the lowest timber to give opportunity of inspection.

Mr. Tamblyn: Mr. Huddleston suggests that it would not be economic to do diffusion treatments because termite troubles can be solved more cheaply. I rather doubt that. In our recent survey we tried to obtain some statistics on the incidence of termite attack in houses in the Adelaide area and arrived at the conclusion that 4 per cent. of all houses in Adelaide are treated annually to eradicate termites. That would indicate that in about 25 years on the average every house would have some termite problem. The costs of eradicative treatment were about £30 for the initial treatment and about £6 per annum to maintain the guarantee. So that in a period of 20 years the cost could be £30 plus twenty times £6 which would be at least £150 without interest charges. For pretreatment of houses, the figure quoted for private houses was about £2.10.0 a square though it was indicated that where a number of houses in one area required treatment, it could probably be reduced to 30/-. This means that it would often cost £30 for the initial treatment of a 12 square house. There is no guarantee that this initial pretreatment would last the life of the house, in fact it seems unlikely that it would. At some stage there would thus almost certainly be a further charge for eradicative treatment. Assuming that an average 12 square house has about 8,000 super ft of timber in it and assuming that momentary dip diffusion treatments of all timber in the house could be done for 8/- per 100 super ft the total cost would be £32. If you assume 10/- the total cost would be £40. If there are 10,000 super ft of timber in the house and it cost 10/- to treat, the initial cost would still only be £50. I can see people interested in selling proprietary preservatives making considerable capital out of these figures, pointing out that there is a potential cost of £100-£150 or more during the life of the house in Adelaide in keeping termites out. If their treatment cost

even that much they would still have a bargaining point by developing the theme that Anobium, Hylotrupes, and also decay are further hazards. I think they would persuade a lot of people that treatment is economically desirable even though the cost is far in excess of dip diffusion treatments.

With regard to Mr. Jennings' comments on relaxation of the boric acid content, we have suggested it only for eucalypt sapwood. In this case I would suggest that we might relax to say 0.15 per cent. in that $\frac{1}{4}$ in. square section in the middle of the piece. The chances of any attack developing are very remote, and the relaxation would allow the momentary dip diffusion treatment of eucalypt sapwood to be practically possible with minimum block stacking. At least in Victoria we have not been able to persuade anybody to use tank treatments despite 10 years of successful use in other States, the reason being that the capital outlay and the inconvenience and costs of treatment do not appeal in a case where the public are already more or less resigned to a small amount of damage in trim and other decorative woodwork. Victorian sawmillers feel that if the public are not very vocal on this matter that it is unnecessary to take costly steps to correct it. However, almost all we have talked to have said that if momentary dip diffusion treatments were approved they would consider it more favourably, largely because of the very little capital outlay, and the fact that we believe the cost to be much lower than tank treatment. We were certainly not suggesting that there should be relaxation of the 0.2 per cent. for scrubwood timbers, or for that matter for any tank treatment where that percentage can be readily obtained.

Mr. Jennings also suggested that, if it became necessary to combat decay and termites, it would not be difficult with the present tank set-up to do so. I suggest however that it would be much easier to do it by momentary dip treatments because a complex preservative can be used without the difficulties of solution

analysis which are inevitable in the tank treatment. If you have, for example, a complex preservative containing boron, arsenic and some other compound it becomes technically difficult to keep the solution in a tank at constant strength unless analysis of all components in the preservative is frequently made. In the momentary dip diffusion treatment there is no need for analysis at all. The preservative is merely made according to formula and cannot become unbalanced as every few hours the tank is recharged with fresh solution.

Mr. Clarke: None of us will disagree with the idea of complete immunization of scrub timbers where you have large quantities of sapwood and where the timbers are used for purposes where any borer attack would be deleterious, but there is a very large preservation field other than this, and preservation of timber all over the world has not been on the basis of complete immunization. It has been on the basis of getting a protective layer of treated material, so it is possible to get occasional attack in treated timbers. For many treatment purposes I do not think that our standard should be complete immunization.

Mr. Jennings: My remarks about the relaxation of standard have been concerned with protection against Lyctus. Furthermore I think that the place of eucalypt sapwood in timber building construction in Queensland has been underestimated. I suppose nearly half of the treated capacity in Queensland at the moment is concerned with the treatment of spotted gum sapwood for use in normal building operations. One of the reasons why we have had to concentrate our staff on to control of the existing treatment plants has been their relaxation of standards and consequent trouble.

Mr. Clarke: If the dip treatment is properly carried out, I cannot see any danger to the house and I am quite certain that the amount of Lyctus attack that you could get in the house would be ever so much less than is at the present time accepted in the houses in Victoria. The facts are that with an instantaneous dip treatment of eucalypt sapwood you can get all the protection you need for ordinary building purposes.

Mr. Tamblyn: If you look at the first table in the preprint, you will see that in the 14-25 day lips the minimum boric acid content was either above or right on the lethal threshold of 0.14 per cent. The section analysed represents only 6 per cent. of the cross section, so that at the very worst, there might be an occasional piece falling below the threshold in that very small core in the centre of the sapwood. I cannot see that that very occasional piece should be allowed to condemn the very simple dip diffusion process that has promise of being adopted in Victoria where tank treatments have not been favoured.

Mr. Jennings: We have to do everything to protect the reputation of the treatment that has statutory approval. There is reasonable evidence that the toxicity level can be dropped, but I would require more evidence than has been presented to date.

Mr. Huddleston: The 0.2 per cent. set some years ago was set not as a minimum threshold figure but as a legal minimum to provide sufficient safety to ensure that we would not have borer attack in any treated timber. It was recognized in the discussion that 0.14 per cent. was the required amount but it was thought that it would be unsafe to set 0.14 as a minimum.

In New South Wales we could not maintain a prosecution if there were 0.14 per cent. of boric acid in the core of the piece, except from the point of view that the treating firm had not obtained the legal minimum. There is ample evidence which could be brought against us to say that you would not get Lyctus attack with that concentration anyway.

Mr. Tamblyn: What I want to know is how the conference would feel about our introducing this treatment in Victoria with a minimum loading of say 0.15 in the core. If we approve it in Victoria there may be attempts to introduce it in N.S.W. and Queensland - or at least to require that the lower loading be accepted generally. I would not like to feel that we had precipitated trouble.

Note: Discussion on this point is continued under Item 5 (c).

ITEM 5 (c)

IMMUNIZATION OF BROWN BARREL BY MOMENTARY DIP IN CONCENTRATED BORAX-BORIC ACID SOLUTION AND BLOCK STACKING*

Considerable success has been achieved in New Zealand in immunizing Lyctus susceptible timber by a brief dip of the green timber in a concentrated solution of borax-boric acid followed by a period of block stacking to allow the boron to diffuse into the timber (1), (2), (3).

The method was applied to backsawn 3 in. x 1 in. boards of brown barrel (Eucalyptus fastigata) consisting mostly of sapwood. The boards were end coated and dipped for 30 sec in a warm (45°C) solution of borax-boric acid (58.7 per cent. H_3BO_3 w/v). After draining for 1 min the boards were block stacked under conditions preventing evaporation. Short lengths were cut from the boards at intervals and tested with boron spot test reagent. After 30 days the concentration in the centre of the boards appeared satisfactory.

The boards had picked up approximately 0.25 oz. of H_3BO_3 per sq. ft. of surface area. A typical sample had a boron concentration ranging from 1.44 per cent. H_3BO_3 at the surface to 0.33 per cent H_3BO_3 at the centre.

A board similarly treated with solution containing 53.5 per cent. H_3BO_3 w/v and allowed to diffuse for 60 days, contained 1.18 per cent. H_3BO_3 at the surface and 0.46 per cent. H_3BO_3 at the centre.

It is considered that this process offers a possible alternative to the methods of immunization at present in use. It would be necessary in practice to balance the use of a concentrated solution and a short period of block stacking on the one hand against the use of a more dilute solution followed by a longer period of block stacking.

Bibliography

(1) Harrow, K. M. - New Zealand Journal of Science and Technology. 32, 32 (1951).

(2) Harrow, K. M. - ibid 33 471 (1952).

(3) Harrow, K. M. - ibid 36 56 (1954).

* Prepared by Division of Wood Technology, N.S.W.

Discussion

Mr. Canaway introduced the paper.

Mr. Huddleston: This work was initiated because a sawmiller in the Tumbarumba district who has a green chain suggested that it would be very simple if he could treat his timber by putting it through a dip process. The information obtained from the small investigation carried out has been sent to that sawmiller, who states that if he has to strip the timber for a month or 6 weeks, he is not interested as it is going to cost him too much in capital outlay and there would be too much handling around the yard. Another mill interested has adopted exactly the same attitude. The cost would work out at approximately 8/- per hundred super ft, comprising 3/- for chemical costs, 1/- interest on capital tied up, the remainder being allowance for handling and overhead. As compared to the cost of 8/- for the momentary dip, tank treatment for the treatment of spotted gum sapwood is estimated to cost something under 5/-, this figure being derived by the plant accountant, and representing just under 2/- for chemicals, the remainder being allowance for plant maintenance and handling.

We would approve of a dip plus diffusion treatment in N.S.W. at present on the same basis as we approve of a tank treatment, in other words the core of the sapwood shall have 0.2 per cent. of boric acid. The 0.2 per cent. has already been pointed out as being in accordance with the decision made by this conference but I think that with the experience we have had over the years we could afford to allow some relaxation in that, possibly 0.15 per cent. would be quite a satisfactory figure to adopt. If 0.15 per cent. is a satisfactory figure it should be adopted not only for diffusion treatments but for tank treatments also.

Mr. Jennings: We would of course approve of the dip treatment, provided it met with present legal requirements. I am not satisfied that relaxation of the standard from 0.2 per cent. is

desirable. In regard to the cost factor, there are a very large number of firms in Queensland dealing with eucalypt sapwood and their average cost for tank treatments would not exceed 8/-. The standard charge made is 12/3 which has not been altered much since it was first made in 1946. Some competition from other methods of preservation would I think very swiftly bring that price down. I repeat that we are not objecting to the treatment as such but we are objecting to the proposal to relax the standard.

Mr. Clarke: The possibility of bringing the standard down from 0.2 to 0.15 per cent. will probably come forward at our next conference when results of our tests at present in hand should be available.

Mr. Tamblyn: It seems likely that there is some difference in the respective techniques which we have used in these tests. Our material was block stacked for the period stated and it is then allowed to air dry for one month before analysis. In the New South Wales treatments it seems likely that sampling for analysis was done immediately after the diffusion treatment, in which case the shorter times which we found approximately effective are probably explained by the air seasoning period given before sampling. If followed by air seasoning I do think that a diffusion period of 14 days would probably be effective for sapwood of Victorian timbers. As to the costs of treatment, Mr. Huddleston has selected a case, where, with everything in favour one operator has been able to reduce costs to 5/-; but if one considers the plant and manipulations necessary in the two treatments there surely is no argument. In the case of tank treatment a man has first to supply himself with a plant cost probably £2000 or £3000, he has to provide steam and some technical assistance to keep his solution strengths correct. In the momentary diffusion process his equipment costs virtually nothing because all he needs is a very small dipping tank - he does not have to analyse his solutions and he has no steam costs - there are virtually

no costs except chemical and the interest charge on the block stacked material for a period of a fortnight. In most cases the interest charge would also obtain in the tank treatment, because many plants hold their timber for a period of 2 or 3 weeks before treatment. In the momentary dip that would not be permissible, so that I believe the timber would be prepared ready for sale at no longer period by momentary dip than by tank treatment. I am quite certain that there would be some saving both in steam and equipment costs and in technical control of the solution strength.

Mr. Clarke: Summing up there does not seem to be any objection to our encouraging the use of dip treatments in Victoria and Tasmania for eucalypt sapwood - possibly even stating our percentage requirement. The position seems to be adequately covered in the two States where you have Acts and can insist on a certain percentage of preservative in the centre of the timber.

ITEM 5 (d) PRESERVATION OF FENCE POSTS BY SAP DISPLACEMENT*

The treatment of natural round fence posts by sap displacement with water soluble preservative mentioned at the last Forest Products Research Conference has been continued.

The preservative used was copperized chromated zinc chloride (20 per cent. sodium dichromate, 7 per cent. cupric chloride, 73 per cent. zinc chloride) at the rate of 1 lb/cu.ft. Since only the sapwood absorbs the preservative the actual rates would be higher than this amount. It was found that freshly barked posts could be treated with this quantity as a 10 per cent. solution in 1-2 days in normal weather conditions, but in very humid weather about one week was required. It was also found that the posts could be held in a green condition suitable for treatment for about 6 weeks by storing them unbarked with the butts in water.

Sections 1 in. wide were cut at 1 ft intervals along the length of one post. The sapwood was separated into inner, middle and

---

* Prepared by Division of Wood Technology, N.S.W.

outer concentric zones in each section and analysed. It was found that the copper and chromium were fixed in the lower 2 ft of the post, while the zinc occurred over the whole length, the concentration being highest at the butt. It was also found that the concentration of preservative was highest in the outer shell of the sapwood, as might be expected.

A former member of the Division has installed about 1000 posts of treated Eucalyptus dives on his property at Moss Vale and so far they have shown reasonable durability. Treated posts installed 2 years ago are still sound whilst untreated sapwood on controls is rotting off. The cost of preservative for a natural round post cut from his own property was about 1/3 as against a cost of 6/- for a post of a durable species imported from another district.

Treated posts and controls of spotted gum (Eucalyptus maculata) were cut into 6 in. sections and buried around a termite mound to test the termite resistance using the technique developed by C.S.I.R.O. Division of Entomology. After 2 years the treated sections are mostly unattacked. A few sections from the tops of posts are showing slight attack. All controls are showing bad attack.

It has also been found that sodium pentachlorphenate at the rate of $\frac{1}{2}$ lb/cu.ft. can be introduced into spotted gum (Eucalyptus maculata) by sap displacement.

Discussion

Mr. Canaway introduced the paper.

Dr. Ellwood: Is it proposed that D.W.T. work with water-borne preservatives - other than the copper chromated zinc chloride ?

Mr. Huddleston: Yes, we have also been working with sodium pentachlorphenate which gives an interesting effect. We have obtained quite good movement into the sapwood by sap displacement, and there is a subsequent reaction taking place in the timber whereby the sodium pentachlorphenate is converted to pentachlorphenol. The change from the sodium salt to the phenol is quite discernable when cutting the timber, and can be traced readily.

Dr. Ellwood: We are inclined to believe that the copper chromated zinc chloride is not as well fixed as might be thought from its constitution. We are concerned that such a salt might gain precedence with respect to certain others which might be more suitable for fence post treatments. Results of American service tests have shown quite often that the chromated zinc chloride is not very much more permanent than the zinc chloride itself.

Mr. Tamblyn: In our leaching tests we were able to remove almost all the preservative quite readily in the case of chromated zinc chloride and copperized chromated zinc chloride in the first hundred hours.

Mr. Huddleston: The reason for using the copper chromated zinc chloride was the fact that the original work from overseas was based on that salt, and it was a case of reproducing the results that were reported.

Dr. Ellwood: We have been doing some work on a similar type of treatment, that is a modified Boucherie treatment, where the solution, in this case an Ascu type was applied to the butt of a growing tree, the attempt being to get it right up through the length of the tree, We analysed the timber for arsenic and copper, and there was a very marked fall in the concentration of both up the length of the tree, so that it looks as though the effective length of treatment by this method would be limited.

ITEM 5 (e) PRESSURE TREATMENT OF TIMBERS WITH PRESERVATIVES IN NEW SOUTH WALES *

The pressure treatment of timber with preservatives has not yet been carried out commercially in this State, although the Forestry Commission operates a cylinder in which timber is treated for Government and semi-Government bodies on a non-profit basis.

This pressure plant, located at the Commission's Putney yard does not operate continuously. During the past 4 years a total of 111 charges have been treated with creosote, the most important

* Prepared by the Division of Wood Technology, N.S.W.

jobs being some 20,000 Pinus radiata sleepers for the N.S.W. Government Railways, and about 300 poles for such bodies as the P.M.G., Overseas Telecommunications Commission and the Sydney County Council.

As the aim of the Commission's operations in this field has been to promote the use of treated timber and to supply such treatment to the various authorities, chiefly for experimental purposes, it is apparent that the use of impregnated timbers has only been considered as an economic proposition during the last few years, due to the difficulty of obtaining adequate supplies of the more durable species.

Recently a firm with experience of pressure impregnation in the United Kingdom and in New Zealand has commenced the installation of preservation cylinders and associated equipment at Wauchope and Grafton in New South Wales as well as one plant in Victoria and another in Tasmania. These plants which will use creosote or pentachlorphenol will have 70 ft x 6 ft cylinders, capable of operating at pressures up to 200 lb/sq.in., and it is expected that the Wauchope, N.S.W. plant will be operating in July, 1956, provided that adequate supplies of seasoned poles are available by that date. In addition, the company proposes to install several other plants throughout Australia; these will include 40 ft x 4 ft 6 in. cylinders operating at 1000 lb/sq.in. and smaller 56 ft x 3 ft 6 in. plants operating at 200 lb/sq.in. for the treatment of timbers for housing, cooling towers, and other situations where a clean finish is desirable.

Thus the development of large scale treatment facilities is under way, while the demand for preservation has already been initiated by the P.M.G. Department in their recent call for the supply of treated poles, a move which they expect to result in a saving of £80 million over a period of some 40 years.

No discussion.

METHYL BROMIDE FUMIGATION OF TIMBER INFESTED WITH SIRICID WOOD WASPS*

Fumigation work with methyl bromide was reported at the fifth and sixth Forest Products Research Conferences. As a result of this work the Commonwealth Department of Health has insisted on the fumigation with methyl bromide of timber suspected of containing Sirex wasps. The recommended gas concentration is 3 lb of gas per 1000 cu.ft. and this type of fumigation has become fairly common in Australia.

In England, following many requests from a wide range of industries the effectiveness of methyl bromide against test insects placed in selected positions within large stacks of sawn timber was investigated jointly by the Forest Products Research and the Pest Infestation Laboratories, Department of Scientific and Industrial Research (1).

Sirex larvae were impossible to obtain so larvae of a closely related alder wood wasp, Xiphydria camelus were used, together with larvae of Lyctus brunneus and Anobium punctatum. The gas concentration was 3 lb/1000 cu.ft. These tests were inconclusive but the subsequent direct exposure of Sirex larvae to the gas lead these workers to the view that this insect was probably more than 10 times as resistant as the Lyctus adults used in the original Australian tests at this Division. The British workers did not therefore recommend fumigation with methyl bromide as a means of controlling these wasps.

These results lead the Division to obtain Pinus radiata logs heavily attacked with Sirex noctilio from New Zealand. For reasons connected with quarantine requirements it was not possible to design an entirely satisfactory experiment. Details of the work are given below.

Six bark-free logs (3 ft 6 in. long, 5 in. diameter) were received. The logs were rather spongy in places due to fungal deterioration. They were fumigated by placing them under a plastic sheet with other articles being treated by the Quarantine Authorities.

---

* Prepared by the Division of Wood Technology, N.S.W.

The gas concentration aimed at was 3 lb/1000 cu.ft. and the time of exposure was 24 hr. Two fumigations were carried out, one involving two logs, the other the remaining four. A 6 in. long sample was taken from one end of each of the two logs (A) and (B) prior to the fumigation and the insects present in these samples were counted. The gas concentration at the beginning and end of the first fumigation was checked and was found to be 2.4 lb/1000 cu.ft. at the beginning, decreasing to 0.7 lb/1000 cu.ft. after 24 hr. The results of the fumigation are shown in the following table.

Log	Approx. Length	Larvae Dead	Pupae Dead	Adult Dead	Larvae Alive	Pupae Alive
		1st Fumigation				
A	3 ft 6 in.	33	32			
B	3 ft 6 in.	16	75	5		
		2nd Fumigation				
C	4 ft	26	68	1		
D	4 ft 6 in.	26	132	7		
E	4 ft	29	117	6		
H	4 ft	15	63	17		
		Control				
6 in. from end of A					10	13
6 in. from end of B					7	19

It can be seen from these results that the gas was effective in killing all Sirex larvae in the logs. The temperature during fumigation varied between 65°F and 80°F and the insects were removed from the logs and examined five days after the exposures.

These results directly contradict the findings of the British workers and it is considered that more work requires to be done on this problem.

Reference

(1) Fisher, R. C. - "Sirex Wood Wasp Problem", Timber and Machine Wood-working 63, September, 1955.

Discussion

Mr. Huddleston: Recent work by Fisher in England threw some doubt on the efficiency of methyl bromide fumigation, and in order to check the results obtained in previous work, we obtained from New Zealand 6 logs containing Sirex noctilio. We cut 6 in. off the end of two of the logs and found plenty of live Sirex larvae in these pieces. We sent the two logs out to be fumigated, together with the other four logs. After the logs were cut up we found plenty of dead larvae and dead pupas, none were found alive.

Subsequent to that work we supervised the fumigation of a house for Hylotrupes. We obtained some of the effected timber from the house before fumigation, and by cutting up portion of that we found that the insect was very much alive. These samples were again placed in the house at various points for testing purposes, and subsequently were taken out and cut up, when it was found that the insects present in the timber were all dead. We cannot understand why the results obtained by Fisher showed that Sirex larvae are particularly resistant to methyl bromide, when all our previous work and the latest confirmatory work shows that methyl bromide is particularly effective for fumigation of timber, but we feel quite confident, as a result of the work that has been done, that fumigation with methyl bromide in the concentrations recommended - that is 3 lb/1000 cu.ft. - is quite effective for Sirex and other treatments.

Mr. Clarke: I think that this is a matter in which we ought to have some co-ordination throughout the Empire. The place to carry out Sirex work is in New Zealand where there is ample material available. We should try at the coming Commonwealth Forestry Conference to arrange some organization whereby we can get work carried out in the place where the insect is available. It should not be necessary for New South Wales Forestry Commission to have to import Sirex.

Mr. Jennings: I think it would be desirable if, rather than bring any more Hylotrupes into the country, we sent some test material to South Africa.

ITEM 5 (g) ANOBIUM, ERNOBIUS AND HYLOTRUPES IN NEW SOUTH WALES*

1. Anobium punctatum, de Geer

Anobium has been a pest for many years wherever softwoods are extensively used for building purposes. To date this insect has been of minor importance in Australia when compared to the degree and extent of attack known in such countries as New Zealand, South Africa and in Europe generally.

Pinus radiata, a susceptible timber, is now being used more extensively in New South Wales for building purposes and this could finally result in an even greater spread of the insect. Although attack by Anobium usually goes unnoticed for some years due to the long life cycle and the appearance of relatively few exit holes in exposed places, infestation may actually be initiated a very short time after milling. Development of the insect seems to be favoured by moist, temperate conditions and this at least suggests that there may be certain geographical boundaries to the areas where attack is liable to occur.

Reports from responsible firms in the pest control field indicate that Anobium attack is increasing in the Sydney area. The Commission intends to investigate these reports and in addition is particularly interested in the results of work discussed at the last Forest Products Research Conference on the susceptibility of Pinus radiata to attack by Anobium.

2. Ernobius mollis, Linn.

At the last Forest Products Research Conference it was reported that the Division of Forest Products had received requests for advice on the control of this insect. Mr. Gay also reported that Ernobius was attacking Pinus radiata off-cuts in the Canberra area. Several cases have come to the notice of this Commission in recent months and it is possible that this insect may become much more important in New South Wales due to the increasing use of Pinus radiata.

* Prepared by the Division of Wood Technology, N.S.W.

Comparatively little is known of the insect at the present time but it has been found attacking under the bark of fire damaged Pinus pinaster in the forest as well as along bark edgings of P. radiata timber in mill yards and homes. Bark inclusions around knots are also liable to infestation.

Investigations have just been commenced by the Commission to determine the effectiveness of an existing sap-stain dip against Ernobius. This dip which consists of sodium pentachlorphenate and borax in water is now widely used to prevent sap-stain in Pinus radiata.

3. Hylotrupes bajulus - The House Longhorn Beetle

This beetle originally came from Europe where attack has been common for many years and where large numbers of buildings are infested. The beetle was introduced into South Africa comparatively recently but by 1941 the incidence of attack was so great as to cause the introduction of legislation making compulsory the pre-treatment of susceptible building timbers with preservatives.

The insect has been present in Queensland since 1951 and many pre-fabricated houses of both French and Italian origin have been found to be infested. Late in 1955 the beetle was found emerging from Rumanian white wood (Abies alba) in a home at Collaroy in New South Wales. The infested home was fumigated under plastic P.V.C. sheeting 6/1000 in. thick using methyl bromide at a concentration of 4 lb/1000 cu.ft.

Three shipments of Rumanian white wood arrived in Sydney at the same time as the infested timber arrived and efforts are now being made to trace the rest of the timber, although this will be a difficult and lengthy task. Many pre-fabricated houses of European origin have also been imported into the State and erected in various places. These may also be infested and the Commission is at the present time discussing the question of inspection with the Commonwealth Department of Health.

The presence of Hylotrupes bajulus in Sydney is viewed with great concern by this Commission since this city has approximately the same latitude (34° south) as Cape Town and Port Elizabeth in South Africa and in these latter cities conditions for the development of the beetle are extremely favourable.

Discussion

Mr. Huddleston: We have been experiencing trouble with Monterey pine due to Ernobius mollis, a bark beetle, which is reported to carry over from the green timber in bark and is able to continue its attack until the bark is completely destroyed. We have had some cases where there was no apparent attack in the timber at the time it was sawn, but the attack has occurred subsequent to use. In all those cases the timber has been air dried prior to use. It is quite a serious problem where it is occurring because according to the literature and our evidence it will continue to work in the bark region until such bark is destroyed. In the case of included bark around a knot, it is to be assumed that eventually the bark will be destroyed and the knot will fall out. In one case which we saw that had actually happened.

We are carrying out some investigations to see if the antisap-stain dip would give any protection. We are doubtful because the concentration of chemical is so low that we feel that it might not be sufficient to control the insect. If that is so we may have to insist on the kiln drying of the timber, or if there is an infestation taking place in dry timber, some other means of control will have to be taken in New South Wales because the indications are that it can become a serious pest as it has in New Zealand.

We are also worried about the possibilities of Anobium, we have not seen any Anobium attack in Pinus radiata in New South Wales but there are reports from South Australia and New Zealand. Because of the fact that firms will shortly be selling general preservative treatment, we are going to investigate Anobium more thoroughly and try to assess the magnitude of the problem so that we will be in a position to give any advice which we consider appropriate, when that position arises.

The most serious problem with regard to insect attack in Monterey pine is the introduction in the last few years of

Hylotrupes. When this was reported at the last conference by Queensland we took a note of it and kept a watch for it. In March 1955, suspected Hylotrupes, was discovered in a house at Dee Why. The matter was reported to Commonwealth Quarantine who were not prepared to do anything until the identification of the insect was placed beyond doubt. We kept samples until we got emergence and then were able to positively identify the insect. When we reported it, then, Commonwealth Quarantine very quickly arranged for the whole house to be fumigated with methyl bromide. In the last 2 weeks we have detected, also at Dee Why, another house containing Hylotrupes attack in weatherboards - the disturbing feature is that the house was painted last June and there are flight holes in the weatherboards which have been painted over, indicating that there was an emergence of borers before June, and there are subsequent emergences through the paint, indicating that they have also come out since last June. We do not know what Commonwealth Quarantine are going to do about the second house, but the incident imposes quite a heavy obligation on all concerned to see what can be done about the particular insect.

In South Africa it has been found necessary to introduce legislation requiring the preservation of all building timber. The information which we have to hand indicates that a survey carried out in South Africa has shown a 55 per cent. incidence of attack in houses examined and in many cases the attack had advanced to the stage where complete replacement of roof structures was necessary. If we get to that situation in New South Wales we must assume that it will become necessary to treat all pine. In addition, in Sydney, practically all our buildings are roofed with oregon framing and oregon has been shown in South Africa as being susceptible to Hylotrupes attack, so the potential cost of Hylotrupes getting loose in Sydney in existing buildings is very great. We have suggested to Commonwealth Quarantine that they, in conjunction with ourselves, should carry out a survey of all prefabricated houses imported into New South Wales, the Housing

Commission alone have over 800, and also houses built from timber in the same shipment as those from which the houses at Dee Why were built and in which Hylotrupes attack has been found. That is a major job and we believe that the Commonwealth Quarantine Authorities are now discussing with Commonwealth Treasury as to whether they are going to get the necessary money to carry out the work. The position is that if they cannot give us very substantial assistance, with regard to finance and staff, the work cannot be done because we cannot get the finances or the staff.

Mr. Bednall: With regard to Anobium in Pinus radiata we had an investigation made by an entomologist from the Waite Institute of a house in Mt. Burr and we found that several houses had been attacked by Anobium.

Mr. Tamblyn: In a paper given at the last Forest Products Conference, we informed the conference that we were doing co-operative tests with the D.S.I.R. in New Zealand and had collected 28 different trees, from various States, South Australia, Victoria and the Australian Capital Territory, and that these had been forwarded to D.S.I.R. and had been artificially innoculated with Anobium by Harrow. In addition to the Australian material some New Zealand material was added to the test over there. After innoculation, half the specimens were returned to the Division and the other half were retained by Harrow. When Harrow was here a few months ago, he said that there had been very light emergence already in New Zealand but at that time our specimens were not showing any exit holes. However, over the Xmas period, the normal Anobium flight period here, a few holes have appeared 2 years after innoculation. The test is not yet sufficiently advanced for us to form any conclusions as to the degree of susceptibility of the Australian material.

Summing up we have no more evidence than we had at the last conference - we knew then that radiata was susceptible - but by the time the next conference comes around we should have clear data of susceptibility of the radiata which we have now in test.

Mr. Harding: At Mt. Burr where several houses were in trouble with Anobium we found that the attack seemed to favour areas where there was a high moisture content, due perhaps to creepers on the walls, drainage outlets or leaking pipes. It appears that the measures taken in South Australia of opening up the areas and reducing the moisture content and the humidity present in the localized attack areas were quite effective.

Mr. Tamblyn: In South Australia, the method of building construction would favour Anobium attack in flooring in brick houses. The ventilation is not very good, the floors can be fairly close to the ground and the minimum humidity conditions, that is not less than 50 per cent. relative humidity for successful hatching of eggs would probably be obtained. I think that the hazard in typical houses in Adelaide would be quite high in the flooring members at least.

Mr. Harding: We have received specimens from some of the timber firms in which Ernobius has been operating through the wood itself but in every case there has been bark, and we had assumed that the Ernobius had been operating on the included bark and had just incidentally passed into the wood. I understand that Ernobius has also been found in the pith.

Mr. Huddleston: We have only seen Ernobius working in association with bark, either included bark or bark strips left on the wood. The emergence holes often pass through the timber, the beetle seems to take the longest way out.

Mr. Jennings: At the last conference we did report the presence of Hylotrupes in pre-cut houses imported from France. We had to wait some time for positive identification by the Commonwealth Entomological Bureau. The matter appeared to us to be of such grave importance, that we commenced a critical inspection of all State owned houses in which imported material from whatever source was present. There were three substantial contracts involved, one from France, an Italian project using Rumanian timber, and a Dutch contract using

Swedish material of a fairly high grade. There are approximately 3000 houses involved and we have not yet completed the inspection, but we have completed the inspection of the French contract of 800 odd houses, in which there is positively identified attack in 10 per cent. of the houses. The date of import was approximately 1951 and in view of the life cycle we should expect to get greater emergence next summer. We have recommended to Cabinet that we should incur an expenditure of up to £80,000 on fumigation of every house with methyl bromide. The inspection, though it has been critical, cannot cover things like cupboard studs with any degree of certainty and we are by no means sure that the 10 per cent. is the limit of the infestation, so we feel that if we are going to undertake any eradication treatment that it should be done to every house. The only other imports of material which would be subject to infestation were some prefabricated houses fortunately imported at the time of the Sirex scare which were all given a methyl bromide treatment on landing in Brisbane. We expect to be starting treatment soon, probably in the form of a contract with a reputable firm under supervision. The treatment we anticipate will cost us between £40 and £50 per house and there are likely to be at least 2000 involved.

Mr. Irvine: Some of the prefabricated houses that were fumigated or heat treated for Sirex here in Victoria have been inspected 18 months after erection, and there have been no signs of any borer activity. However, from what Mr. Jennings has said, I feel that houses may have come to Victoria from the same contractor who supplied the Queensland houses, and I am afraid we will have to carry out at least a representative inspection of those houses.

Mr. Jennings: Most of the attack that we have located has been in either flooring members or roofing members. This does not indicate that there is preferential location, but that these are the parts that can be given critical examination. There is some possibility that our roof temperatures are high enough to cause death

shortly after emergence. The position is sufficiently serious to warrant a commencement of inspection in the southern States. I cannot but feel that you probably have Hylotrupes infestation here too. It has quite a long life cycle and whether that would be accelerated by local conditions is problematical but we know that in South Africa the life cycle was virtually cut in half after establishment.

Mr. Huddleston: Hylotrupes attack so far discovered in New South Wales occurred in imported junk from Rumania in sizes ranging from 4 x 1 up to 12 x 2. In the initial house it was discovered in 4 x 2 studs and in the second house in 6 x 1 weatherboards. The workings show as hair-line tunnels and they require careful scrutiny to detect them.

Mr. Jennings: I think that it could have escaped even quarantine notice at the time of import.

Mr. Harding: Might I suggest that New South Wales and Queensland might be able to supply South Australia, Victoria and Western Australia with some samples of the workings of the Hylotrupes so that we could show our local quarantine officers what to look for.

Mr. Jennings: We could do that. There is an article in the Queensland Agricultural Journal which we will send you in the meantime.

Mr. Huddleston: There is a very good South African publication which gives illustrations and descriptions of the attack, and the insect. We have prepared some ronoed information with photographs from this and would be very happy to make copies of that material available to anyone who wanted it. We are now in the course of providing the same information to all pest control firms in New South Wales with a request that they inform us if they see any incidence of the insect.

Mr. Gay: There is one point of guidance, this insect is a cerambycid and all cerambycid tunnels are oval in cross-section. That is a simple point to look for, you can be suspicious of any tunnel with an oval cross-section.

Mr. Huddleston: With regard to further action, the position in New South Wales is that even if we were able to find the staff and the money to carry out the inspection, we would probably have considerable difficulty in meeting the cost of treatment and eradication. We feel that it is in the nature of a national problem and it should be taken up on a Commonwealth basis. I would like to see representation made, possibly through C.S.I.R.O., to the Commonwealth authorities to afford assistance in that direction.

Mr. Clarke: The first thing to do is to define the extent of the problem before we make any approach, therefore we should have an inspection made in the various States to see just how widespread the infestation is.

Mr. Huddleston: The only way to find out is to carry out detailed inspections of every house. In New South Wales there are 830 Housing Commission houses concerned, and if we were to carry out an inspection on those, using say four officers, it would be at least 12 months before we could cover them all. We have traced the sales on that 150,000 super ft of Rumanian timber and find it was sold in parcels of 10, 5, 20, 200 super ft through suburban timber merchants. I feel that we must try to trace some of that timber in use to see whether there is any further incidence of attack. That in itself is going to be quite a major job - apart from inspecting the prefabricated houses.

Mr. Jennings: Our method of inspection was to select carpenters from the Housing Commission's maintenance staff, and give them some preliminary training on recognition. They were under the supervision of an entomologist and were equipped with hammer and chisel; they check every board, if the chisel goes in, they check further. There is no surface indication.

Mr. Crane: Would such an inspection be adequate, or would it need to be repeated ?

Mr. Jennings: It would need to be repeated. We invisage that we will do this treatment and inspect again 2 years later. We propose to maintain fairly constant supervision over the whole project.

Note: This subject was referred to the Policy Session as to subsequent action.

ITEM 5 (h) TREATMENT OF VENEER WITH SODIUM FLUORIDE FOR USE WITH WITH PHENOLIC GLUES *

At the last Forest Products Research Conference, the Commission reported that laboratory trials using phenolic film glue with sodium fluoride treated veneer had given satisfactory results in both boiling water tests and weathering. It was stated that factory trials would be carried out in the near future.

A number of factory trials have now been carried out. The species used were yellow carabeen (Sloanea woollsii), white birch (Schizomeria ovata), and blush tulip oak (Tarrietia actinophylla). The veneer was dipped by the Division and had been air seasoned prior to dipping which caused a certain amount of cracking due to the fragile nature of the dry veneer. Panels, 6 ft x 3 ft of various constructions, were pressed from this treated veneer and subsequently tested. No difficulties were experienced in pressing. At the same time as these panels were pressed, control panels using the same veneer, but not immunized, were prepared. Adhesion tests, dry and after 6 hr boiling, showed no significant differences between treated and control panels. Exposure tests at the three locations normally used by the Division were carried out and again no significant differences were noted between treated and untreated panels. In several cases, delaminations occurred in untreated control panels whereas corresponding treated panels were not affected. The panels made from blush tulip oak were generally less satisfactory than the others, and this species, because of its high shrinkage, is not recommended as a face veneer for waterproof plywood directly exposed to the weather. It is, subject to its normal

* Prepared by Division of Wood Technology, N.S.W.

properties as a timber, suitable for internal construction and in those applications where sun checking is not likely. Yellow carabeen panels showed variable results with respect to sun checking, the timber from the extreme outer zone of the log as would be expected appearing to be more satisfactory. White birch showed good resistance in all cases to sun checking and this timber should prove an excellent substitute for coachwood in marine ply.

It was concluded from these tests, that the fluoride immunization process was suitable for use in commercial manufacture. Following these tests, treatment of New South Wales brush wood veneers with sodium fluoride was commenced at a veneer plant in the Wauchope area.

No trouble has been experienced in operating the fluoride dip although plant control is not as simple as with boric acid and borax. The treated veneer, which in this plant is air dried, has in all cases been bright, clean and free of stain. This treated veneer has been regularly used by a Sydney plant using film glue and no process troubles have been encountered with it. This veneer plant has now changed over entirely to the use of fluoride immunization for all its veneer production, and thus fluoride treated veneer is in fairly widespread and satisfactory use in plants in Sydney where it is being glued in most cases with urea formaldehyde. Earlier tests have shown there was no trouble to be expected in using urea glues with this material.

This work is now considered to be substantially completed and it has resulted in considerably widening the raw material base of the waterproof plywood industry in New South Wales. We believe that ultimately, sodium fluoride will replace the use of borax and boric acid in those veneer plants which produce for the open market. Fluoride appears to have an advantage over borax and boric acid in two respects: (a) as compared with boric acid, sodium fluoride is a more powerful fungicide and the treated veneer, therefore, tends to

stay brighter when air dried; (b) as compared with borax it has the advantage that alkaline staining of some timbers does not occur.

Discussion

Mr. Humphreys introduced the item.

Mr. Tamblyn: In Victoria, hot-press plywood manufacturers are facing the difficulty of being unable to buy suitable veneer which is either immune to Lyctus or is not treated with boron. We have approached the Queensland Forest Service suggesting that treatment with sodium fluoride in Queensland would supply the need here in Victoria but to date we have not been able to persuade them that sodium fluoride can be used without considerable health hazard. Would Mr. Jennings explain why it is impossible for Victoria to buy sodium fluoride treated veneer from Queensland, despite the fact that some producers there are willing to do the treatment ?

Mr. Jennings: For good and sufficient reasons, the Board has not been prepared to approve of sodium fluoride under the Queensland act. Those reasons are that it is unwilling to over-ride our Health Authorities' advice, which was that unless there was a pressing economic reason for the use of it, they did not see that it was warranted. That is our attitude and we cannot see any sound reason for changing it at present. In those circumstances it is desirable that I indicate to you the extent of our powers under the act; if we approve a treatment, that treatment can be used by any person for any purpose whatever, provided that he registers his plant and his brand. He can then sell it as immunized against Lyctus, provided he maintains the requirements of the approved treatment. The powers of that act do not extend beyond the border; it is open to any person in Queensland to treat with sodium fluoride and sell it outside Queensland. He can sell it in Queensland but he could not describe it as a preservative treatment under the act. They can sell it in Victoria or New South Wales, and if certain manufacturers want to obtain material with sodium fluoride they can make their own arrangements with the North Queensland manufacturers to do that.

Mr. Tamblyn: That covers the position excellently - which we did not fully understand from correspondence. It appears that I can now inform Victorian interests that they can order sodium fluoride treated veneer from Queensland, and that the Queensland Forest Service will raise no objection - provided the material is treated solely for use outside of Queensland.

ITEM 5 (j) TERMITE INVESTIGATIONS

Mr. Gay: I propose to mention three aspects of the work that is being carried out in our Canberra laboratory. Firstly we have continued our investigations of soil treatments, where we are testing various insecticides against three species of termites in three diffierent localities. Tests with Nasutitermes exidiosus in the immediate vicinity of Canberra, Coptotermes lacteus in the Braywood area of N.S.W. some 40 miles from Canberra, and Coptotermes frenchi and acinaciformis, a mixed complex of those two species, in the Riverina area of N.S.W. These tests have been in for varying periods of time - some from 1947 and others as recently as last year. We are testing quite a variety of materials and we hope ultimately to be able to get some figures on the comparative efficiency of the various chemicals which might be used for soil poisoning, and the persistence of these chemicals under conditions of complete exposure to sunshine, rainfall, general leaching and other destructive agencies.

Possibly the most important aspect of our laboratory testing is a survey of the natural resistance of commercial timbers. In this work we have been helped considerably by the supply of test samples from the various State Forest Departments. This project has been going for some years and is at last reaching finality with the timbers that have been selected for test to date. The following is a list of the timbers on which tests have either been completed or are nearing completion. For Eucalyptus acmenioides, maculata, microcorys, pilularis and Tristania conferta we have completed tests

with Nasutitermes exidiosus and with Coptotermes lacteus. For the second group of timbers, Eucalyptus crebra, grandis, miorantha, paniculata and tereticornis, we have completed all the Nasutitermes tests and are about half way through the Coptotermes tests. A third small group, Eucalyptus resinifera, siderophloia and marginata, have been tested against both species. The final group includes six eucalypts - E. rostrata, saligna, propinqua, punctata, eugenioides, and sieberiana - for which we are half way through the Nasutitermes tests. For each of these timbers we are testing specimens from 48 trees. In connection with the test I would be interested to hear from the States as to whether there are any other commercial species which they feel should be subjected to the same type of exhaustive test to determine the range of susceptibility within the species.

We are also carrying out a survey of the termite resistance of plastics. I mention this as you may have at times some need for plastic piping for field purposes for temporary water supply, and you might be interested to have the results of the investigation we are carrying out. In recent months there has been some publicity given to the use of thin plastic films, notably polyethylene film, in building construction. Claims have been made that these are efficient damp course materials, and are also proof against termites. All our tests so far have shown these films to be completely inadequate as termite barriers.

The third aspect of laboratory testing that I want to mention is an investigation of the actual nature of natural resistance in timbers. Natural resistance can conceivably result from one of two things: it can result from what you might call a presence factor or an absence factor, and we are assuming for the time being that it is the result of a presence factor. In other words it is the result of the presence in the timber of some material or materials which are toxic or repellent to the termites. Some work along these lines was carried out by the Division some years ago in conjunction with the School of

Organic Chemistry in Sydney. This work was on the cypress pine, Callitris glauca. Unfortunately those results are no longer available, but the position has been re-opened and we have decided that this is a field of considerable interest which is worthy of some detailed study. We are conducting our first survey on black bean, which we chose deliberately because we wanted to start off with a timber which was toxic to termites, and this timber is the most toxic we have ever tested in our laboratory colonies. We have also, in this work, the co-operation of chemists from the School of Organic Chemistry in the N.S.W. University of Technology who are kindly providing us with the extractives. We propose to test the extractives on extracted sawdust at various stages, and so far we have tested total methanol extract put into E. regnans sawdust. This total methanol extract has been shown to be quite toxic but at the same time the extracted black bean sawdust still retains an appreciable amount of toxicity, indicating that all the toxic material has not been removed from the wood by methanol extraction. This work is continuing and we are now waiting for a further series of extracts to be supplied.

The third field of activity in Canberra is related to field testing. We have for some years been carrying out co-operative field tests on timber treatments in conjunction with the Division of Forest Products. These are very nearly complete now, but we are not going to get very much useful information from them. We also have some field tests of plastics which are corroborative to the laboratory tests that we are carrying out. For a long time, those of us concerned with advisory work have been reluctant to recommend surface treatments for protection against termite attack, because of the dangers inherent in subsequent cutting of surface timber and checking, exposing untreated wood and allowing the termites ingress. However within recent years evidence has been growing to suggest that these surface treatments are not quite as bad as we imagined and that they might offer some reasonable scope for investigation. We have two

tests running at the present time which bear on this subject. We were approached by a large German chemical manufacturer to investigate the anti-termitic effect of a complex organic mixture which they have prepared, and which they felt was very useful as a surface treating material. Although we indicated that we were not very keen on surface treatments and would not normally recommend such treatments we thought that this was a good opportunity to clear up this matter once and for all. The tests have been in now for just about 2 years; the first examination took place about September of last year when 90 per cent. showed some degree of attack within 12 months and more than 50 per cent. were removed as completely destroyed within the 12 months. It was a very striking failure of surface treated material placed in direct contact with the soil. We have, in conjunction with the Division of Wood Technology in Sydney, started a test to check on how surface treatments behave when they are not actually in contact with the soil.

Note: Mr. Gay then gave details on the blackboard of the method adopted for this test. Following this there was some general discussion on this method and on some other points raised by Mr. Gay.

The Chairman then reviewed items discussed under the heading of Preservation, and asked if there were any further points to be raised.

Mr. Tamblyn: In connection with Item 5 (b), we gave some thought as to whether the first cold solution formula given should be patented, and we decided that it might be desirable to file an application for provisional patent while we developed further the idea of using sodium fluoride as a solubilizing agent for boric acid, and also, while we considered whether diffusion treatments using this type of formula would have further application. We now intend to proceed with the lodging of the full specification so that the use of this

type of diffusion mixture can be controlled and its mis-use prevented. It should certainly not be used except for timber that is sufficiently green for diffusion to occur, the block stacking periods must be sufficiently long for penetration to occur, and the process should never be used where there is any considerable leaching hazard.

Note: A short discussion on decay in cooling towers took place after Mr. Smith had raised the question of the use of durable hardwoods in cooling towers.

Mr. Bednall: Is it right that the S.E.C. are proposing to use radiata for cooling towers ?

Mr. Tamblyn: In Victoria, it is proposed that if radiata pine of sufficiently good quality is available it will be used in cooling towers. This introduces the difficulty of its treatment and the resolution to use radiata is contingent on treating facilities being available so that the slats can be impregnated in a fixed water-borne preservative of the copper-chrome-arsenic type. I have no doubt that when such facilities are available and if radiata is also available that it would be economically preferable to redwood. The evidence we have seems to suggest that the soft rot fungi are well controlled by preservatives with a high copper content. There is so far no real evidence that creosote is highly effective. The fixed water-borne preservative would be cheaper and cleaner to use.

Mr. Huddleston: There was a proposal in New South Wales to use creosoted radiata slats in two towers being erected, but the contractor was unable to obtain the fine slats, clear of knots and other defects which they regarded as being detrimental.

Mr. Bednall: We are not in the least anxious that radiata should be used in cooling towers; firstly because of reluctance to expose radiata to moist conditions for an indefinite period; and secondly because of the high specification required which, in our case, would disorganize our milling set up. We have opposed its use as a cooling tower timber on more than one occasion.

Mr. Clarke: The quantity of timber required per annum for cooling towers is appreciable and it is a serious problem as far as overseas funds are concerned. Redwood is extremely expensive.

Mr. Tamblyn: I believe it is approximately £30 per 100 super ft now. The S.E.C. sent an officer to New Zealand to investigate radiata supplies and both N.Z. Forest Products and Tasman Pulp and Paper Company indicated that if a premium price could be obtained for clear radiata they would be very interested in its supply, so that the problem of obtaining radiata supplies for cooling towers is probably not an insuperable one.

Mr. Smith: Has anyone tried to find a hardwood that would be an acceptable substitute ?

Mr. Clarke: There were some objections to hardwood - one was weight and the other was the possibility of shrinkage and swelling. Some of these towers have to be shut down for periods, particularly over the summer months. We are rather worried as to what might happen to hardwood under those conditions.

Mr. Turnbull: I would like to add a few remarks in relation to this cooling tower subject. There are several types of towers as the conference is probably aware. The use of redwood is principally in the Marley tower in which sections are designed in relation to the weight of redwood and its mechanical properties, so that the question of substitution is more complex in that type of tower than in others. If you substitute some other species which is heavier, you upset the loadings on the tower and consequently you upset the dimensions of the components. The components in this tower all fit together rather like a mecanno set, so that there are constructional problems involved in any dimensional change. With some other types of towers that condition does not apply. I would say that we are facing up to a difficult problem to find alternatives to redwood for the Marley tower but the field might be more open in relation to other towers. It is true that attempts are being made to

get radiata supply for the Marley tower in the S.E.C. installations, but the officer of S.E.C. who tried to get the supply ran into considerable difficulties and the token quantities that were put in were in themselves difficult to find. I think it is a use which should have the attention of the States concerned in marketing large quantities of radiata and I think they should get some of their material into some towers or into some components of the tower in order to obtain some service information on its use.

Mr. Huddleston: It must be kept in mind that if we are going to find a substitute it is a question of a very considerable quantity of timber.

Mr. Turnbull: About 300,000 super ft per tower is quite a normal quantity.

ITEM 6. SAWMILLING

(a) REVIEW

Mr. Turnbull: The broad objective of our projects on sawmilling is to promote greater efficiency in production. When this industry is examined it is difficult to find remarkable changes having been made in this century. There are some gradual improvements but nothing resembling the spectacular modern advances in the processing of other materials. Sawn timber continues to be offered for sale in practically the same state of preparation as it was when Australian sawmilling was founded and is apt to be regarded as a roughly cut material and its quality is probably lower on the average than formerly because of the types of trees that can now be made available for sawmilling. Competing materials, on the other hand, are being offered in forms of increasing attractiveness and their properties are improving in reliability. The appeal of cheapness which used to overcome many disadvantages of timber is disappearing under today's conditions, and consequently the need is greater today than ever before for production practices to be improved. It is desirable for the sawmilling industry to increase its man-day output from its average of

around 400 super ft/man/day and progress towards rates attained elsewhere in the world. Although we may never attain the 8000 super ft/man/day as do large sawmills in North America, this is so different from our own rate that serious consideration must be given to adopting such improvements in technique as can be found to suit local conditions.

As there is no service bureau able to assist the industry in production planning, and possibly not sufficient continuity of demand for such service for one to be established in the near future, the Utilization Section of D.F.P. has undertaken sawmill designing for firms who ash for assistance in planning new sawmills or in improving existing sawmills. To date each plan has been treated individually to cover specific conditions described by our client. Some conditions have been common to several plants, but too many features differ between sites, raw material and desired products to have allowed us to prepare one design for very wide applicability. We have not been able to cover the subject of sawmill design with a series of planned experiments as is common in other aspects of forest products research. Studies have been undertaken to collect performance data on various types and sizes of machines used in sawmilling. Further broad contacts with the industry have allowed us to study the merits of certain arrangements of machines and of sawing patterns. This knowledge we have applied when preparing designs. We propose to continue to collect factual data on sawmilling in order to improve our service.

The Forest Products Newsletter is being used for release of notes on equipment. The scope of these will be extended as opportunity permits. Their purpose is to bring to attention machines or practices whose wider adoption might improve efficiency. The interest in log edgers, log gangsaws, a highly mechanized carriage-and-saw headrig and an automatic docker for waste are fairly marked at present.

Our immediate recommendations are directed towards the promotion of headsawing instead of breaking-down; the balancing of the distribution of material between machines; the elimination of

double handling and of wasteful cutting; and specialization of cutting at mechanically-controlled rates, in place of general mixed cutting physically controlled by a large crew at breast benches.

The dispersion of the industry makes contact difficult with the majority. The division of supply among 3200 sawmills, many of which are limited to log allocations that can be easily converted while minimum plant is operated intermittently results in few being particularly concerned with improving the rate of production. This factor has so marked an influence on cost of production, on price and therefore on the current and future status of timber in industry that one is prompted to ask whether forestry authorities might consider the licensing of sawmills to approved designs instead of allocating logs in volumes lower than that necessary to provide incentives to improve conversion techniques.

Saws. During our contacts with sawmillers we have noted diversity of opinion regarding the merits of saw-teeth of various shapes, but have not been able to find scientifically based local data on sawing. Overseas literature reveals that scientific study of the subject can be expected to yield results of practical value. We have commenced studies on saws in the field and in the laboratory. Mr. Jones will summarize our studies on circular saws, and Mr. McKenzie our work on chain saws.

Mr. Jones: Mr. Turnbull has in general terms indicated the necessity for research into problems connected with wood cutting. One of Australia's principal wood cutting tools is the circular saw, and we will now look briefly at how we in the Division of Forest Products are attacking circular sawing problems.

The Division's first attempt to come to grips with sawing problems was made when an experimental sawbench of unique design was constructed. This was the flywheel experimental sawbench in which a known amount of energy was extracted from a flywheel to make each cut. This known amount of energy was fixed and cutting efficiencies were

compared by comparing the weights of wood removed from the specimens by sawing. An efficient saw extracted more wood for the same amount of energy than a less efficient saw.

Some of the difficulties experienced with this sawbench were enumerated at the last conference, and there is no need to repeat them here. Mention was also made of work that was being especially planned to minimize the effects of these disadvantages and to determine if the equipment were capable of supplying sufficient accurate and reliable experimental data. A full report of this work and the results obtained has been written, and the conclusion, after this exhaustive study, is that the flywheel experimental sawbench cannot supply sufficiently accurate experimental data, nor can it conveniently supply measurements on saw horsepower, shaft torque, saw speed, feed speed or feed power.

Quite recently, consideration has been given to the design of new equipment on which sawing studies can be conducted. We have three alternatives before us:

(1) The construction of a special machine for experimental work.

(2) The modification of an existing breast bench in the Division's sawmill so that the bench can be operated on both experimental and service duties.

(3) The use for sawing studies of a single circular breaking-down unit with carriage that is now under construction in the Division's sawmill. There are some disadvantages attending the use of this type of machine for experimental work, and this equipment would not normally have been chosen for experimental purposes. However, as the unit is at present under construction for service duties in our sawmill, it is both convenient and wise to see what use can be made of it before either of the first two alternatives is pursued.

It is intended to install a torque meter on the saw shaft of the machine, and to put a tension measuring instrument on the

carriage cable. The electrical impulses from these two instruments will be taken to a cathode ray oscilloscope and the traces photographed with a moving film camera. The saw speed and carriage speed will be indicated on tachometer dials, and, if necessary, the dials can be photographed to give a permanent record of the speeds.

If the equipment proves satisfactory, these instruments can be made permanent and others added, but if it is necessary to build another machine, the instruments can just as easily be transferred to the new one.

Whether the breaking-down unit is used directly as a research machine or not, it will probably be used indirectly, because when it is constructed we will have in the Division the fundamentals of a complete sawmill - a breaking-down saw, a No.1 bench and a docker. This sawmill is likely to be very useful for some of the applied studies we shall be conducting.

While speaking of equipment, we can mention the fact that a large amount of sawing research is more conveniently conducted with a single tooth or a group of teeth. In connection with his work on chain saws, Mr. McKenzie has had a pendulum dynamometer constructed on which this sort of work can be done. He will be describing this machine a little later on, and he will also describe the sort of work he intends to do on it. This machine can obviously be used to study any type of cutting edge of any type of tool and will therefore be of universal value, not only for chain sawing work, but also for circular sawing and other wood-cutting problems.

Having dealt with our activities with regard to equipment, we now come to a consideration of the topics that need investigation. Right from the very beginning we have been aware of certain problems that seem to need studying. In the flywheel experimental sawbench days, for example, such topics as the effect of wood density and feed speed on the power and energy consumption of saws were studied; but we have been finding it difficult to decide what topics will yield

information of direct importance to sawmillers and what topics are of academic interest only. We need to expand our thinking past the four walls of the laboratory and make some sort of a survey of the industry to determine its prime difficulties.

And so, with this object in view, a mill study programme was commenced to supply us with information on the conditions and problems existing in Victorian sawmills. As a means of contact, and as a sort of alibi for going into mills, we decided to make simple power measurements on the motors of the No.1 benches. This mill study work has already been instrumental in showing up a number of matters that could well be studied in the laboratory and has proved itself very profitable.

However, it is still desirable to supplement and/or modify ideas gained from these studies with suggestions direct from men in close contact with the industry. Mr. Clarke has stimulated some suggestions by circulating a report on work done in overseas laboratories, and possibly other suggestions will be forthcoming from that source. We are hoping that discussion here will indicate the lines of work that are considered of first importance. The following topics are already under our notice and are suggested as profitable avenues of research. The work can be divided into two groups, fundamental studies and applied studies.

A. Fundamental Studies

Two lines of work are being considered.

(1) A study of the effect the cutting process has on wood material is suggested. Many wood cutting peculiarities are closely bound up with the properties of the wood. For example, different tooth shapes are necessary for hardwoods and for softwoods. Again, it is well known that the denser summer wood of some species tends to deflect saw blades and cause "snaking" in cuts. If one can determine how the wood, when it is being cut, reacts to the instrument cutting it, this should lead to a clearer understanding of how to design the instrument.

(2) The behaviour of a circular saw depends largely on the stability of the blade. Bad circular saw behaviour is nearly always evidenced by lack of stability, and those handling circular saws instinctively use stability as a measure of a saw's ability to handle a particular job. It is well known that tooth bluntness adversely affects saw stability. The effect may be due to excess heating at the rim, to the higher forces imposed on the blade, or to some other effect. Also tensioning, speed of rotation and feed speed influence a blade's stability. It is felt that if stability is closely analysed a better understanding of the fundamentals of circular saw design will result.

Neither of these lines of work has been pursued very much elsewhere. The first-mentioned project would receive priority because the results can be universally applied to all types of woodcutting tools. The second is only useful for circular saws.

While it is desirable to have fundamental and applied work proceeding together in a complementary manner, the fundamental research must take second place until the applied research is established, because this is more likely to produce immediate results for the sawmiller.

A summary of some suggested applied research follows.

B. Applied Research

(1) It is felt that we need to determine the optimum tooth designs for various classes of timbers sawn in Australia. This work would embrace, for example, the effects on sawing efficiency of hook angle, clearance angle, bevel angles, gullet volume and shape, amount of set, etc. A study of the relative desirabilities of swage and spring setting is also suggested.

(2) We would like to know something more definite about the saw gauges necessary for various saw diameters, saw speeds

and classes of work. Studies like these would at first be confined to the circular saw, but enquiries regarding frame saws are increasing in frequency and we may eventually be obliged to repeat much of the above on frame saw blades.

(3) The speed of a saw, especially a circular saw, is known to significantly affect its operating efficiency, but we cannot be sure that we yet know the best saw speeds for the various cutting conditions. This matter needs investigation.

(4) The sawmill study work mentioned above is showing that the feed speed of machines not only influences the quantity of material cut in a given time, but also has a significant effect on the operating efficiency of the machine itself. It seems that there are optimum feed speeds for various cutting conditions. A more detailed investigation of the influence of feed speed on efficiency is needed.

(5) It has been suggested that a study be made of the use of saw packings to determine the best type of packing for various purposes and where it should be placed.

(6) A study of the methods and equipment used to sharpen saws has been proposed with a view to streamlining the operation and improving its efficiency. Further, in view of the decreasing number of skilled saw doctors, the question of whether or not it is possible to apply a standard tensioning technique to circular saws, by rolling, for example, has been raised.

(7) It has been obvious for some time that the lack of positive data on the power requirements of machines in sawmills needs to be remedied. The sawmill study work that we are now doing should help to make up this deficiency. The scope of the power measurements made in these studies has

recently been widened and the work should now provide figures from which the power requirements of most types of machines in Victorian sawmills can be forecast fairly reliably. It may be possible for similar work to be done in other States so that it covers a larger field of Australian conditions. We conduct this power work with a robust portable three-phase recording wattmeter which is wired through current transformers to the input leads of the motor. The chart of the meter gives a permanent record of the time taken for each cut, and the power and the energy consumed in the cut. The length of each flitch is measured to the nearest 3 in. and the depth of cut to the nearest $\frac{1}{4}$ in. Only cuts which are uniform in depth along their length and which are free of all complicating peculiarities are recorded. A density specimen is taken from each flitch in which recorded cuts are made.

We are just now working on the results of the first of these improved power studies and the results look quite promising. We are at first concentrating on No.1 benches because these are the most convenient to work on, but there seems no reason why similar work cannot be done on other sawmill machines.

The proposals so far discussed have dealt largely with the saw blade and the machine. We now come to a group of suggested topics involving the techniques employed in using the machines.

(8) A significant source of waste with the conventional twin circular and No.1 bench conbination is the making of face cuts on the No.1. It has been suggested that twin circular breaking-down techniques should be studied to determine if more accurate cutting, eliminating the necessity for face cuts, is possible.

(9) Closely allied with this work would be a study of breaking-down machines and methods. The aim would be to find the machines and techniques that give the maximum recovery of clear material for various Australian conditions. Two log types that need special attention with regard to breaking-down procedures are the hardwood logs that give trouble with spring, and the small plantation conifer logs.

(10) It has been suggested that work should be done on bench gauges to secure more accurate sawing on No.1 benches.

(11) For some applications accuracy in docking is important. An example is the manufacture of case components. It has been suggested that we might determine how docking accuracy can be improved.

Owing to the strict log quotas to which many sawmills are limited, few sawmillers can be interested in methods that will allow them to cut more logs. But all sawmillers will be keen to learn of improvements that will enable them to produce more timber at a lower cost from the same log quota. It is felt that most of the lines of work mentioned above can contribute to such an improvement, but we would appreciate suggestions on which of these are so important that they should be tackled first, and if there are others we have not mentioned that are also important.

Mr. McKenzie: Early in our chain saw work, it became apparent that there were two important factors in operating efficiency to be investigated, particularly concerning the chain. These were firstly the need for accurate sharpening, and secondly some modification of overseas sharpening schedules to suit Australian conditions.

Having developed a suitable standard sharpening procedure, we have attempted to disseminate information as widely as possible

without attempting direct contact with saw users. The means used have been Newsletter articles, a wall-chart and a film setting out step-by-step the best maintenance and sharpening practice.

With regard to chain modifications, early field experiments indicated that hook angle and raker clearance were the two most important modifications involved. More precise laboratory work was commenced to investigate their effects when cutting timbers over a wide density range. These experiments showed that raker clearance, while less important, should be as small as possible, and a value of 0.010 in. serves most purposes. Hook angle has a great effect on saw efficiency, and should be as great as possible. The available power of the saw, the weight put on the saw, and the proportion of felling done, are important factors controlling the desirable hook angle. These factors are difficult to evaluate for practical cutting conditions, so that the recommendations being formulated can only be approximate, to be modified for specific sawing conditions by trial.

Experiments were carried out on gouge type chains, with the similar aim of deciding which of various patterns were best, and what modification might be necessary for Australian conditions. The simplicity in construction and maintenance of these chains, compared with scratch types, weigh heavily in their favour. It was found that well manufactured and sharpened chains cut quite satisfactorily in Australian timbers. Certain patterns were outstanding, and the modifications desirable for Australian timbers were determined, the conclusions being published in our Newsletter and in an article in the Australian Timber Journal.

The foregoing work revealed the desirability of more accurate control of cutting conditions, to simplify the investigation of many sawing factors. Of 25 factors affecting sawing, it is possible to investigate 18 with a single tooth testing machine. This led to the design and construction of a pendulum type testing machine. A set of teeth are attached to a rotating head on the pendulum arm and

swing in turn through a wood specimen. The tangential force, corresponding to the main cutting force of a saw, is measured as with an Izod machine, by the reduction of the pendulum swing after striking. A new innovation yet to be fully tested, will be an attempt to measure the radial force, enabling the feed force to be calculated. The feed force has most importance in the type of sawing where the feed force is constant, and the feed rate variable, as in many cross-cutting operations, and hand feed rip sawing. It is expected that the relation between the radial and tangential forces will vary during the blunting process, within and between steels and woods. One of the difficulties in single tooth work is to control the degree of sharpness, and take account of blunting, so that a study of these aspects will be a necessary preliminary to a study of the more important of the 18 factors awaiting investigation.

In Australia and the tropics a great variety of species is sawn, and to investigate the various sawing properties of each species individually is obviously a formidable and long term task. If the sawing properties could be related to some other property subject to standard test, a valuable short cut would be achieved. Very little attempt has been made anywhere to do this. I have done a small amount of work with saw teeth in a standard static testing machine, attempting to relate the cutting forces (in separate experiments) to hardness, and to shear strength. The latter property indicated some promise, and also some experimental problems which, due to pressure of other work, have not been tackled.

Discussion

Mr. Jennings: We think that if you were to concentrate on the last-mentioned work by Mr. Jones that it would offer the most immediate benefit to the industry. It is our opinion that productivity per man-hour can be raised very substantially by proper breakdown techniques and machines. It is obvious that the figures quoted by Mr. Turnbull for the No.1 bench are primarily due to poor

breaking-down technique. In Queensland we have been able virtually to eliminate the No.2 bench by proper attention to this matter, and the effect on those mills has been a raising of a productivity level from somewhere about 40 super ft to about 65 super ft per man-hour. I would call the conference's attention to the new breaking-down carriage at Hyne and Son's at Maryborough. It is the most significant advance we have seen for a long time and some rough production checks that we have recently done there indicate man-hour production rates of over 120 super ft/man/hr.

It would probably be desirable in the future for us to approve the type of plant that is installed for production from our plantation species.

Mr. Huddleston: I agree that the most important job is the question of break-down pattern and method of break-down. We can materially increase the recovery and increase the production per man-hour by giving proper attention to this matter. Next, the determination of power requirements for circular saws according to the depth of the cut, the species of timber and the rate of feed is urgently needed. If we can get these figures a lot of improvement can be made to sawmills without a great deal of effort. As far as the individual States are concerned, we have found that a lot of good can be done by putting men into the sawmill just to watch their method of breaking-down and we have dealt with many complaints of low recovery and poor quality timber by giving instruction in breaking-down pattern and order of cutting and have substantially increased both their output and their recovery.

Mr. Benallack: There is no doubt that an improvement in the break-down technique would increase the man-day output of mills and result in a considerable saving in timber. A tremendous amount of timber has probably been wasted in face cutting due to bad breaking-down technique. The break-down equipment is mostly very inaccurate equipment, crudely designed in most cases, and most inefficient, and results in

the No.1 bench virtually having to fashion the timber before it can produce finished sizes. The biggest improvement that could be made in sawmilling today would be improvement in the break-down technique and equipment.

Mr. Harding: Which States actually issue sawmill licences, or register sawmills ?

Mr. Jennings: Queensland does.

Mr. Huddleston: New South Wales does.

Mr. Benallack: Victoria does not register sawmills.

Mr. Crane: We register and must also approve sawmills on Crown land. On private land it is merely registration.

Mr. Harris: We only register them, there is no actual licensing of sawmills except that they cannot mill on Crown lands without our approval.

Mr. McAdam: We have no Statutory registration in New Guinea but most of the cutting in New Guinea is done on permits issued under the forestry ordinance.

Mr. Harding: Would Mr. Turnbull enlarge on the point he made concerning incentives.

Mr. Turnbull: I did not mean to infer wage incentives, I rather meant that if a mill were established and given a certain volume of logs per annum, and the capacity of its equipment was greater than necessary to cut that volume of logs, there was no inducement in that mill to cut the volume in a shorter time, as it would simply mean that they would have more idle time. Therefore once a forest authority has approved installation of machines, it should take some positive action to see that that equipment is worked as efficiently as possible.

Mr. McAdam: We in New Guinea realize that we have not an efficient industry at all - it is just an industry that built itself up since the war on whatever equipment it could gather. It is only in recent years that operators there have been able to get better

class equipment, or have been in a position to afford new equipment. We are trying to develop a bigger industry by the issuing of permits which look to a life in the vicinity of 20 years for any new mill that is operated. We are hoping in that way to give the millers an amount of raw material which will enable them to think in terms of efficient sawmilling. We are interested in efficiency of sawmill equipment and matters of saw design, tooth design, speed, and power for machines, and want to assist the industry in New Guinea with the best available information as to the design of more efficient sawmills.

MECHANICAL SAWING OF RAILWAY SLEEPERS IN NEW SOUTH WALES*

Since the second World War strenuous efforts have been made by the New South Wales Government Railways to obtain sufficient sleepers for its needs. This fact, coupled with the considerable export demand, has gradually resulted in the use of mechanical methods for sleeper production being widely practised.

From 1945 onwards the Forestry Commission designed and the Railways built, mobile sawmills which produced mainly sleepers but also other sizes of sawn timber. The Railways Department also acquired and modified mobile mills from the Army in an effort to obtain more sleepers.

In 1950 mobile circular swing saws began to be adapted to the sawing of sleepers on the flat forest country adjacent to the Murray River. The timber cut was Murray River red gum for the Victorian and New South Wales Railways and both departments permitted the production of "roundbacks" for use on second-class country lines. From the red gum forests along the Murray these small mobile saws have spread into the central west, the north west and more recently to the northern tablelands on Girard State Forest, some 30 miles east of Tenterfield. There seems to be a reluctance on the part of the operators of these small machines to work the coastal timbers due to the terrain and to the possibility of time lost be wet weather.

Recently two new inovations in mobile mills have been put into practice in the Kempsey area. One is an auxiliary to the Combatine Timber Co. and the other has been developed by Mr. D. Hargan and is situated at Willawarren, some 25 miles west of Kempsey. Their operation will be described later.

The advent of these saws in the forest areas of New South Wales has greatly increased the utilization of timber formerly regarded as of little value and which formed a potential fire hazard on the forest floor as well as preventing the growth of young stock. From the forest

---

* Prepared by Division of Wood Technology, N.S.W.

management point of view mechanical conversion is ideal for these saws move into an area only after the sawmill, the casemaker and the other timber industries have been supplied and in this way very little is left but the tops of the trees.

Mechanical Methods Used

The type of mobile mills used are described generally by the fact that with one type the log is moved to the mill and with the second the mill is moved to the log. In the first type, the mills are large and stationary, the log moving through the mill in the conventional manner except in the case of the Hargan type in which the whole mill runs on rails over the log. With the second type the sleeper billets are cut into 8 ft lengths and generally snigged to a dump with a tractor or a truck. The dump is a flat cleared area and is large enough for the mobile saw to operate on a number of billets. With this type of operation the sleeper cutters usually work in pairs with one doing the sawing and the other marking billets, rolling them and removing the sawn-off slabs and sleepers. Marking out is done in the usual way using chalked string. The billet is chocked into position so that the two cuts are vertical and the two sides are sawn off. The billet is rolled over and if it is a "two-billeter" the other two slabs are marked and sawn off in the same way. The two sleepers are then sawn apart. Where the heart cannot be used or where the billet is large it is broken down into halves, thirds, or quarters and the sleepers are then sawn out of the flitches. Where the billet is too large for the saw to straddle it is split into two by running the saw in from each end.

Types of Machinery Used (see photographs)

Apart from the ordinary sawmill which cuts sleepers occasionally the large mills are as follows:

1. The Forestry Commission mobile mill owned and operated by the Railways Department at Telegraph Point.
2. The Royal Australian Engineers mill, owned and operated by the Railways Department at Wauchope.

3. Combatine Timber Co.'s mill at Kempsey.
4. Hargan's mill at Willawarren, via Kempsey.
5. Jamieson's sleeper grooving mill at Bril Bril State Forest, near Wauchope.

The first two mills have been described elsewhere and will not be dealt with here.

Combatine Timber Co.'s Mill

This was designed and manufactured by A. Anderson of Kempsey as an auxiliary unit to cope with logs not suited to his normal set-up. As shown in the photographs it consists of twin saws, the space between which can be varied. These saws swing from an overhead framework. The log is chocked on a carriage, the saw is set to the desired width and the log sent through. Flitch and edges are then sent through the rest of the mill for squaring in the normal fashion. Two 25 h.p. electric motors drive the saws which vary from 36 in. - 48 in. diameter. It is of interest to note that these saws rotate upwards into the logs instead of downwards.

Hargan's Mill

This consists of two steel-framed arches on steel rails, the arches being connected by stays. On the top of each arch a 20 h.p. electric motor, an arm and a saw is mounted to form a set-up similar to the normal swing saw, except that the saws are set at an angle of 45° on opposite sides of the vertical plane giving an angle of 90° between the two saws.

These saws can be moved laterally on the top of the arches one sawing and the other dragging as the whole frame which straddles the log runs from end to end and returns on steel rails. The saw height can be adjusted by raising or lowering the sides of the arch as required. Both saws are operated from a platform at one end by one operator. The output of this mill is sporadic but it is claimed that 60 sleepers were cut in 4 hr.

Jamieson's Sleeper Grooving Machine

This machine is situated at Bril Bril State Forest, Wauchope, New South Wales, and was built for and patented by Mr. J. Jamieson of Sydney.

As can be seen in the photographs, the unit consists of a carriage way, an adjustable saw platform and a reversible clutch mechanism. The unit can handle very large girth logs but as yet its output of sleepers has been restricted to experimental runs.

The carriage way comprises a horizontal rectangular frame suitably braced with cross members with a pair of rails mounted longitudinally thereon. A pair of vertical guide posts joined at their upper ends by a transverse member is centrally secured to the horizontal frame, one on each side of the rails. A horizontally disposed platform is mounted between the guide posts. The platform is moved up and down between the guide posts by means of a pair of rods provided with a square thread suspended from each side of the transverse member. Each rod passes through a correspondingly internally threaded block secured to the platform and slidable in a channel in each of the vertical posts. The threaded rods are rotated through bevel gearing by a reversible electric motor mounted on the upper transverse member.

A pair of circular saws 42 in. diameter are mounted side by side on the underside of the platform on the same transverse axis with the blades parallel to the longitudinal axis of the horizontal frame. The saws are spaced apart a distance equivalent to the width of the sleeper, in practice about 9 in. Each saw is driven by independent electric motors respectively mounted on the platform.

The log supporting means comprises a rectangular trolley provided with flanged wheels adapted to run on the rails. Pairs of rollers are fitted at each end of the trolley, the axis of the rollers support the log in a central position relative to the two saw blades. When mounted on the rollers the log is self centering. A pair of hydraulic rams are mounted on the trolley so as to raise or lower the log from or onto the rollers when required.

The rollers are secured, one to each end of a shaft. The shaft is connected to the pinion shaft of a worm and pinion reduction gear box fixed to the trolley. A handle is attached to the worm shaft of the reduction gear box so that rotation of the handle causes the rollers to rotate and consequently the log.

In operation a log, cut to the required length, is rolled onto the log supporting trolley with the hydraulic rams in the raised position. The log is then lowered onto the rollers by lowering the rams. The trolley is moved along the carriage way until the front end of the log is adjacent the saw blades which have been lowered into a position wherein the blades extend into the log a distance equal to the depth of one or more sleepers depending on the amount of timber available in the log. The log is then passed under the saws at the rate of one foot per second. When the cut has been completed the movement of the trolley is reversed and the log passed back under the saws at the rate of two feet per second. The trolley is then stopped and the log rotated about its longitudinal axis and another groove is cut into the log in the same way as described above. The process is repeated until grooves have been cut into the log around the circumference thereof. The rams then raise the log off the rollers. A second log is then moved into position on the trolley pushing the first log off in the process.

Smaller Mills

The smaller mills are many and varied in their design and are usually standard swing saws which have been altered to suit the owner.

They consist essentially of a pulley driven circular saw, powered by a two or four stroke motor mounted on the end of a long arm. The motor is mounted on a carriage with two wheels, so that a sleeper billet can be straddled by the machine. In some cases, the saw is driven by a shaft through the arm. There must be a clutch of some type in the drive to stop the drive on the saw, and the saw blade should be able to operate in either the vertical or horizontal planes. Mostly the saws

are operated by a handle on an extension of the sawing arm past the saw blade. In this position the sawdust and flying chips are avoided, but it is dangerous for the saw tends to pull itself towards the operator.

The carriage used is generally modified to form an "H" shape with the wheels attached to stub axles on the bottom of the uprights. The cross bar has a collar around each upright and can thus be raised or lowered to suit the type of log being sawn.

The larger saws have a carriage in the shape of an "A", with the top arm in the form of a spindle, with a cable attached so the lower arm and motor may be raised or lowered.

Saw blades used vary from 20 in. to 44 in. and are similar to normal bench saws. Regular sharpening is important. The saws most commonly in use are as follows:

1. New Record. This saw is produced by the New Record Machinery Co., Melbourne. It is powered by a $7\frac{1}{2}$ h.p. J.A.P. motor and has a tubular steel frame. It is fitted with a clutch drive and self propelling gear is available. In this case, as with all proprietary types, the special carriage must be made up.

2. Mott Swing Saw. Manufactured by C. Mott of Ballarat it also incorporates the J.A.P. motor. It is similar to the New Record in many respects and has a V belt drive.

3. Mobilico. This saw is generally fitted with a B.S.A. motor and is driven by a shaft through the saw arm. The model illustrated in the photograph was converted locally and the saw blade cannot be swung to another angle.

4. Hargan. The Hargan saw is equipped with a B.S.A. two-stroke motor and has a patent gimbal ring and saddle for turning the saw blade angle. It is belt driven. The carriage on this saw enables it to straddle a log up to 6 ft girth.

5. Ford 10. This is a Law saw distributed by Wm. Adams and Co., and incorporates a Ford 10 h.p. motor.

6. Large Sleeper Saws. These saws have all been specially made up by various firms and are designed to operate on logs up to 18 ft girth. These are all belt driven and usually have a J.A.P. twin cylinder motor, although one has a Ronaldson and Tippet 8 h.p. motor. As mentioned above, the motor and saw can be raised up to 5 ft using a spindle, and they are operated from in front of the saw.

Auxiliary Equipment

Auxiliary equipment attached to these mobile mills and swing saws include tractors, "blitz" trucks, winches, gulleting machines and chain saws.

Cost of Equipment

The costs of the larger mills are unobtainable with any degree of accuracy but for the small swing saw types the units range from £400 upwards, to which must be added the costs of the auxiliary gear mentioned above bringing the total capital cost of equipment to between £2,000 - £3,000.

Output

The output of the large mobile mills vary somewhat due to timber supply, operation and demand but when operating on a normal continuous schedule the Forestry mill averaged between 7,000 - 8,000 super ft of sawn timber per day which included 200 sleepers.

Reports from Forestry officers on the production figures of the swing saws shows that the average weekly quotas for the western areas are higher than those working on the highlands. It should be pointed out here that "round backs" are not acceptable on the eastern lines of N.S.W. and this fact tends to cut down the production rate in the east because the Railways specify that all the timbers cut for these areas must be square edged. However, a two man unit in the western areas can cut between 160 - 200 sleepers per week whilst in the Tenterfield area the figure drops to 125 - 150 per week.

From Deniliquin, Mathoura and Barham districts on the Murray River, approximately 35,000 sleepers are produced per annum by

mobile power saws which, allowing for a recovery of 54 per cent. represents 2,500,000 super ft log measure.

Economic Aspect

Each mill set-up varies with location, type of timber, ability of the operators and requires careful consideration on the part of potential sleeper cutters before starting out.

However, the Commission's foresters report that whereas the hewer would handle only free splitting trees carrying a large number of sleepers the saw operator can afford to take anything that will make a sleeper.

Future Development

Future expansion of the swing saw cutting of railway sleepers in N.S.W. must take place on the tablelands and coastal areas. It will depend upon the ability of the operators to find sufficient level areas to warrant operation and to overcome problems posed by the rougher terrain and the wetter conditions that exist in these areas.

Acknowledgements

Acknowledgements are made to Acting District Forester Fraser, Forbes, Foresters J. Crumpton, Inverell, and J. P. Hauser, Mathoura, for information and photographs kindly supplied by them.

Mr. Canaway introduced the item and also showed a number of slides illustrating equipment described in the paper.

There was no discussion.

MONTEREY PINE - RECENT DEVELOPMENTS IN CONVERSION TECHNIQUES IN NEW SOUTH WALES*

Until very recently the sawing of Pinus radiata from plantations in New South Wales was directed almost exclusively to the conversion of first thinnings to cases. As was to be expected, the poor quality of timber resulting from small logs and poor conversion techniques earned for radiata a name which did not enhance its reputation.

In the last three or four years, with larger logs becoming available, a concerted campaign has been launched to sell and develop Pinus radiata for floorings, weatherboards, linings and other dressed material under the name of Monterey Pine, and concurrently with such campaign action has been taken to improve the conversion techniques adopted by the Monterey Pine sawmillers.

In the case of two large mills, namely Monterey Pine at Tumut and National Sawmills at Gilmore, where it was possible to give the mills an initial quota of 6,000,000 super ft of logs per annum with an undertaking of increasing supply to a stated programme, the Commission insisted on approving of the mill design and general plant lay-out. In each of these cases an area of land has been acquired by the Commission of sufficient area to provide for the eventual establishment of a group of integrated industries, and such land has been leased to the company concerned under suitable conditions. Unfortunately, Monterey Pine Pty. Ltd. have not followed their original approved design and cannot at present be pointed to as an example of an efficient pine sawmilling industry. It is expected, however, that they will improve and will eventually install a mill and an auxiliary plant to the design approved by the Commission.

In the case of National Sawmills at Gilmore the mill is being installed strictly to the approved design and incorporates two production lines, one a Stenner band mill and the other consisting of a Swedish rack followed by the necessary breaking down saws to handle

---

* Prepared by the Division of Wood Technology, N.S.W.

the flitches from the rack bench. The two production lines can either be operated each as a separate line or can be married within the mill according to the type of product required from the mill.

In addition to the two large mills another sawmiller had his quota temporarily increased from 2,000,000 to 4,000,000 logs per annum for a period of five years on the condition that he modifies his mill as approved by the Commission. Subsequently, he submitted plans developed in consultation with the Division of Wood Technology for a mill with a twin edger feeding into two ordinary breast benches which in turn feed into three radial arms. This mill is in the course of construction but unfortunately the miller is particularly slow.

The Commission requires that every pine mill no matter what its size, shall dip the sawn product immediately after it is sawn, and further requires that a mill having a quota in excess of 1,500,000 super ft of logs per annum shall install timber drying kilns and dry the product of the mill. In accordance with these directions a number of mills are installing kilns and with two exceptions all mills have installed anti-sap stain dips using in those dips the New Zealand formula of 4 lb of sodium pentachlorphenate and 12 lb of borax to 100 gal of water.

In its recommendations for the use of Monterey Pine the Commission has recommended that it only be used in places where seasoning before use is essential and the particular development has been in floorings, weatherboards, linings and an increasing percentage in cabinet work. Whilst the Commission recommends that at this stage it be not used for building scantling unless the scantling is seasoned before use, an increasing tendency is noticed to use it green for such purposes. It is felt that this is likely to undo the work already done in building up a reputation for the timber and that opportunity should be taken in the developments of Monterey Pine to develop the very desirable practice of seasoning all building scantling.

In parallel with the above developments the Commission has reached a policy decision which in effect means that additional mills to cut Monterey Pine shall not be established if the quota available can be added to that already available to the existing mill to build its quota up to an economic level. The exact minimum quota for an economic production has not yet been determined but from all information available it appears that something of the order of 6,000,000 to 8,000,000 super ft/annum is required to warrant the establishment of mills and efficient sawmilling machinery.

Discussion

Mr. Huddleston: New South Wales pine plantations can increase log quotas to sawmills, particularly in Tumut and Batlow where there are two possibilities of establishing sawmills with a quota of between 6 to 8 million super ft of log per annum. The Commission has called for applications from people interested in erecting a mill either to a design laid down by the Commission or to an alternative design to be approved by the Commission. The design was to be suitable for cutting the quota in the sizes which were available and of being capable of expansion to cut 30 million super ft of log per annum. We accepted the application of Monterey Pine Pty. Ltd. on a design which was capable of modification in accordance with the design prepared by Mr. Turnbull. We did lay down there that kilns had to be installed and all timber had to be dried in accordance with specifications of the Standards Association as applying to the products concerned - that the products had to be milled to the finished state at the mill and that all timber sawn had to be dipped in antisap-stain dip that would produce clean timber. We have entered into an arrangement with that company to give them an increasing quota up to the end of 15 years which will be 15 million super ft of timber per annum. Another company was offered an increased quota subject to their erecting a mill to plans to be approved by the Commission. Their design combines a British Stenner bandmill with Swedish Ari machinery.

When it starts to operate at Gilmore near Tumut in about July 1956, it will be a complete unit with kilns, planers and dry storage facilities. Almost immediately following the completion of the sawmill a plywood factory will be erected to take Monterey pine and produce plywood. In the interim the company have put a lathe at their Kunama mill and are producing veneers experimentally so that they will have the necessary experience when they go into production of plywood at Gilmore. Each of these two units has been designed as part of a group of integrated industries.

The Commission has retained ownership of adjoining land. Our agreement with the companies requires them to either install new industries when the Commission judges that they are warranted, or to relinquish their right to allow the industries to be established making use of the materials which they cannot use, either coming out of their sawmills or coming out of the forest. Concurrently with these developments the Commission has determined that there will be no new pine licences granted from plantations until all existing sawmills are built up to the economic quota of between 6 and 8 million super ft/annum. There is a prospect of a third development on similar lines taking place in the Orange-Bathurst district in the near future and the Commission will deal with it in exactly the same way.

Mr. Jennings: This is particularly interesting to us and we would welcome an opportunity to visit the last mill described. At Imbil, Hyne and Son have decided on Ari equipment which will be installed very shortly.

Mr. Harding: Mr. Bednall doubted the economics of 4 million super with a twin edger - he may not have realized that the eventual scheme was to bring the intake up to somewhere around 30 million, but his comment was that somewhere between 40 and 50 million would be the amount required, from South Australian experience, for the installation of a mill of that type. He also wished to comment on the use of green radiata as scantlings, and he feels that if they are

not used green, there would be considerable difficulty associated with the twisting and bowing in putting the timber in place, therefore it is highly preferable to use the timber green.

Mr. Huddleston: We are discouraging the use of Monterey pine for scantling in New South Wales unless it is seasoned and any likely twisting has taken place before use. We do know that it is possible to use Monterey pine green - put it in the job and fix it green and keep it straight. Our opinion is that using Monterey pine green as building scantling at the present time could damn it for very many years. When we get to the larger trees, and we are able to cut away from the pith and avoid the distortion associated with the centre of the tree - we feel that we will be on very much safer grounds, but until we do get to that stage we would rather see it seasoned, sold as boards, and not suffer from the disadvantage of twist or possible twisting in the job. We are endeavouring to associate the name Monterey pine with a superior grade of pine which is not sold green and is not sold with blue stain.

With regard to the question of economics of kiln drying and dipping the Commission does realize that the 1½ million super ft log is the absolute minimum required for the operation of a kiln but in my discussion I stated that the Commission's policy was to build up the quota of all these mills as and when the forests were capable of doing so, and it was on that basis that these mills are established. If they are prepared to do so they will eventually become quite large mills; but the Commission at this stage is insisting on the installation of kilns. On the question of twin-edgers Mr. Turnbull and I looked at this problem very carefully and I consider that with the prospect of developing increasing quotas, taking into mind the type and size of log that was available, that the twin-edger was the most adaptable machine that could be used at the present time. It will not be economic until such a time as the quota gets up to possibly 20 or 30 million where the logs can be sorted into a range of sizes suitable for the log edger, leaving the bigger and the smaller to go through alternate breaking-down methods.

ITEM 7. VENEER, PLYWOOD, ADHESIVES

(a) REVIEW

Mr. Gottstein: Since the latter part of 1954 direct work in this field has been drastically reduced and restricted to trade assistance, completion or continuation of a limited number of existing projects and to work for which specific requests have been made.

Enquiries from the trade have been numerous, particularly in regard to adhesives and their application. Such requests have usually been made by visitors to the Division or by letter. In a few cases local visits have been necessary. By special arrangement visits were made recently to New Zealand, Tasmania and New Guinea to study problems involving veneer handling equipment and drying.

Lectures and demonstrations of peeling, gluing and testing techniques have been given to forestry students and other visitors. Several students, both from industry and under the Colombo Plan, have received specialized training in the veneer and gluing field. U Yin Pe, a Colombo Plan junior fellow, is with us at present.

Advice and assistance has been given for conformity tests to A.S.A. Specifications for plywood, including orders for highly moisture resistant plywood for munitions requirements. Examination of glue failures in a damaged aircraft was undertaken for the Department of Civil Aviation. Several complaints were received of failures of joints in waterproof phenolic bonded material and boron treated veneers. All possible assistance was given and limited experiments showed that phenolic washes at about 10 per cent. concentration markedly reduced the deleterious effect of boron.

Assistance with the preparation of test material which required gluing was given to other Sections where required. Specialized laboratory investigation of sawdust-resin bonded blocks for termite baits for the Division of Entomology was undertaken. A wide range of adhesives was tested and recommendations made.

In carrying out peeling studies on several species it was found that the micrometer settings, which provide for horizontal nosebar adjustment on the lathe, did not give an accurate indication of the relative nosebar and knife positions during peeling operations. In addition, similar micrometer settings when repeated during experiments did not necessarily give the same veneer quality. A careful examination and adjustment of all components and linkages failed to correct matters. This caused considerable delays and led finally to the setting up of measuring stations which permit check readings to be made during peeling. These stations showed that some 0.010 in. of horizontal nosebar movement relative to the knife occurred when the load was applied and that, in addition, the amount of relative movement at each end of the lathe varied up to about 0.004 in. Feed screws and pitch settings were carefully recalibrated in order to obtain highest possible accuracy in observations. The closer control has given considerable assistance in determining critical settings at different peeling temperatures in several species. The use of the test stations has made the peeling settings accurately reproducible and particular peeling conditions can be established in a minimum time.

It seems possible that devices of this type might prove of value in a number of commercial lathes where some of the guess work might be taken out of peeling operations with consequent improvement in quality and uniformity.

The lathe calibration, development of fittings and adjustments required a fair amount of time with the limited staff available, but peeling work has been carried out on several species including Celtis philippinensis, Spondias dulcis, Ptero cymbium beccari, Hernandia ovigera and Hekakoro from New Guinea. Australian grown material has included Pinus radiata, P. ponderosa, Balanops australiana, Eucalyptus obliqua and E. gigantea. The results are being analysed, and surface and peeling check evaluations are being made.

As an illustration lathe settings determined for Pinus radiata can be given. Pitch has been found to be non-critical between 91° and 96°, vertical nosebar setting between 0.000-0.050 in. is not critical with a nosebar ground at 75°. Optimum horizontal nosebar setting was 0.050-0.052 at a height of 0.015 in., while effective peeling range for good quality veneer was 0.045 to 0.052 at a height of 0.015 in.

In the peeling of ash type eucalypts, the close control proved of special value and peeler block temperatures could be reduced by some 30°F to 100°F without affecting green veneer quality.

This reduction in peeling temperature has made it possible to take advantage of the fact that peeling temperatures in some species have a highly significant effect on drying behaviour as already pointed out by Messrs. Wright and Kauman. The heating studies in the laboratory have shown that this effect can be almost as important as the drying schedule. Previous attempts to analyse this effect with any accuracy have almost certainly been confused by temperature gradients in the peeler blocks and the fact that temperature effects appear to be more or less linearly time dependent, as shown by Kauman.

Trials of heating log segments an inch or so long show that it is possible to pre-determine which logs are especially heat and collapse sensitive so that their use for veneers can be avoided if necessary. The method may also be useful in applications other than veneering.

The position with ash eucalypt veneer is that the severe end curling at splits has almost been eliminated by improved control of heating and drying schedules and that by the selection of normal material reconditioning of veneers can probably be omitted. This should improve recovery and reduce handling costs and damage. Therefore while the ash group certainly does not present ideal veneer material, it should be possible to produce satisfactory medium density, light coloured plywood provided log quality is adequate.

It is interesting to note that wood temperatures in the vicinity of 100°F, apart from being a desirable maximum in peeling ash group eucalypts, also appear as a maximum in the kiln drying of veneers and in solid timber predrying during the critical stages.

In the adhesives field minor laboratory investigations have been made testing the bonding of a variety of finishes for wood with a number of glues. Finishes have included metals, linoleums etc. The increasing number of types of adhesives available locally also requires some laboratory tests. More recently trials have also been undertaken to determine adhesion between wood and hardboard of both tempered and standard types.

Marked differences between tempered and standard, sanded and unsanded and smooth face and screen side with different adhesives have been observed. In the weatherometer resorcinol and synthetic rubber adhesives have been outstanding on tempered hardboard.

In co-operation with our Preservation Section limited gluing trials on arsenic and zinc chloride treated veneers have been undertaken. W.A. karri and Pinus radiata have been used but assessment of gluing strengths and reliability with a limited number of samples in the weatherometer has presented some difficulty. Some work has been carried out on resonance testing of the weatherometer specimens in conjunction with our Division of Building Research and the results are very promising.

For several years attention has been drawn to the properties of tannins as possible adhesives both in the particle board and wood gluing fields. Recently it has become apparent that mangrove tannin or cutch might become available at relatively low cost in the Australian area from a plant installed in New Guinea.

In anticipation of this a co-operative investigation was initiated with our Division of Industrial Chemistry to explore the behaviour of mangrove tannins as a plywood adhesive.

Up to the present time the tannins used in the experiments have been supplied from Borneo where similar mangrove

species occur. The adhesives prepared by the Division of Industrial Chemistry have been based on a sulphite cook to give viscosity control and a syrup at a uniform solids content of about 40 per cent. Reasonably good dry bond strength and adequate spreading qualities have been achieved and pot life has been satisfactory. However, wet tests carried out for H.M.R. and waterproof shear strength showed very high losses in strength, with H.M.R. shear strengths barely passing, and boil strengths slightly below specification requirements.

Modifications were therefore undertaken using additions of phenol formaldehyde, urea formaldehyde, polyvinyl formal and natural latex. Phenol formaldehyde and urea formaldehyde additives generally gave improvements, roughly in proportion to the quantities added but it remained difficult to get good H.M.R. bonds or waterproof requirements with small additions.

Results from the addition of polyvinyl acetate, however, have been much more promising and, in a series of tests carried out last January on coachwood veneers, addition of 10 per cent. resulted in shear tests showing a fair pass for H.M.R. shear and a poor pass on boiling. Against this, hoop pine just passed H.M.R. requirements but failed badly in boil tests. In both species dry tests were exceptionally good and only a little below figures for straight phenolic and good U.F. joints.

The low figures for wet tests on hoop pine were rather surprising and have not yet been explained satisfactorily. Such results emphasize the desirability of studies to determine the importance of the several factors affecting bonds on various species and types of adhesive. Since January staff changes led to a transfer of the adhesives preparation work to this Division and the work has been continued here. The method of preparation of the adhesive has been modified and in scout tests on Borneo material a great improvement has been obtained on coachwood veneer. In both boil and H.M.R. shears figures of about 300 lb have been obtained consistently with slight

wood failure, while the dry test has given 400-500 lb with considerable wood failure. This work is being continued and it is hoped that effective results will also be obtained with other species and that all specification requirements may be met with this low cost material.

Discussion

Mr. Jennings: We will endeavour to take over as much of this work as possible if you have to close it down. We have purchased some equipment over recent years to strengthen our plywood and adhesives side.

Mr. Humphries: We have concentrated on the use of the natural polyphenols to extend phenol formaldehyde adhesives and so make them sufficiently cheap to compete with urea. Owing to the fact that tests of our Pinus radiata tannins on leather have been unsatisfactory we have endeavoured to use this material as a phenol formaldehyde extender, also we have endeavoured to repeat the work of Knowles and White with mimosa tannin. We have not been able to do this, the radiata tannin appears to be far too reactive to make a resol. We have endeavoured to make a resol from Eucalyptus crebra kino for use in adhesives, but it also appears to be too reactive. However we have only just started the work and I think we will continue it as time permits. The use of a bark as an extender - Eucalyptus crebra and other barks, including radiata, of high tannin content, is a much more promising and immediate contribution to this field. One firm maintains that it can use a sufficiently finely divided bark, with a high phenolic content, up to 100 per cent. extension but they have not done so yet.

Mr. Harding: With regard to the suggestion that a research association should carry out this work, or alternatively that financial assistance should be found to allow the work to continue, I would suggest an approach to the glue manufacturers, who would, I feel, be quite helpful in that direction.

ITEM 7 (b)

USE OF FLOUR FOR EXTENSION OF UREA FORMALDEHYDE GLUES*

At the last Forest Products Research Conference, some results were presented by the Commission of testing carried out on flour extended urea resin glued plywood, which showed that a falling off in moisture resistance appeared to occur with time. It was not considered that the reduction in strength would be serious, however, providing flour extensions of less than 100 per cent. were used. During the intervening period further work has been carried out by the Commission, on the use of flour for extending urea resin.

The question was of particular interest to our industry as ply mills had reported some difficulties and variable results obtained with baker's flour which they normally used. Sydney flour mills had also shown interest in developing special grades of flour for use by the industry. A detailed report on this work is being issued but the following summary of the results obtained should be useful. Tests were carried out on five flours which were judged to be representative of those available to the industry in New South Wales and included types which flour millers considered would be possibly very suitable for the industry. It was concluded from the work that the most suitable flour is a low protein content one, having a low extensibility and coarsely dressed. This is in close agreement with results obtained earlier at the Division of Forest Products. Aspects which were investigated for each flour were:-

(a) Glue line strength.
(b) Gelation time or "pot life".
(c) Flow time of glue mixes, without the addition of hardener.
(d) Ease of mixing.

All flours were tested at a 75 per cent. rate of extension.

Glue line strength provided the most interesting information. All flour mixes and the unextended resin gave glue joints

---

* Prepared by the Division of Wood Technology, N.S.W.

of equal strength when tested a few weeks after setting. However, considerable variation occurred when glue joints were stored for 12 months and then tested. One set of specimens was stored under warm dry conditions and the other in a cool moist atmosphere. Under the above conditions the only glue joints which did not lose strength were those made with the softest flour. All other samples lost strength to a very significant degree in a cool moist atmosphere. In the warm dry atmosphere all other samples lost strength with the exception of one other flour having similar properties to the first one mentioned. The average results obtained are quoted in the table below:-

Tested After	Resin Alone lb	Flour A lb	Flour B lb	Flour C lb	Flour D lb	Flour E lb
1 week	1060	1040	1000	1130	1080	1120
12 months (moist)	760	920	760	720	620	1010
12 months (dry)	850	1030	890	980	860	1010

All flours used at 75 per cent. extensions.

The effect on gelation time was measured for each flour. Gelation time was longest for those flours which had the softest properties, i.e. flours A and E. The actual gelation time appeared to vary more with some types of flour than others. It appears that with flours the initial mixing conditions can exert quite a marked influence on the propert es of the final mixture. This affects the pot life and the flow time of the mixture. This is in line with phenomena experienced in the baking industry, where manipulation procedures are important. Flours which give the longest pot life are probably the most desirable and these seem to be the soft flours.

The flow time (viscosity) of glue mixes was measured with some difficulty and there was a marked variation in flow time

between the various types of flour. As would be expected, the strong flours gave the thickest mixtures and hence are less desirable in the plywood plant. Again a variation in flow time was noted depending on the mixing procedure followed before the flow time was measured. This effect was most marked with the stronger flours.

Although in plywood plants differences in the lumping characteristics of various types of flour are noticed, no success was achieved in endeavouring to appraise this aspect in laboratory tests. A standard mixing procedure which simulates that used industrially was used, but no significant difference in the mixing properties of the various flours was observed. From this it is concluded, and this is borne out by experience in the field, that mixing troubles are usually caused by faulty mixers rather than by the flour itself.

The conclusions following from this work are that from all points of view in plywood making the soft so called "industrial" flours are the most suitable.

Further glue line strength results will be available in the future from the specimens aging two years. Meantime the effect of high protein flour on strength should be borne in mind. It is of interest to record that practically all cold press plants using urea resin in New South Wales have settled on an extension of 75-80 per cent. as giving the most consistent results in practice. A few faulty batches of ply soon offset any slight saving in glue line costs using higher extensions.

Discussion

Mr. Humphreys: This work is a continuation of the work previously reported. It has been stimulated by the interest in this particular matter by Sydney flour mills, also by reports from plywood mills that they were having varying results with bakers' flour when used as an extender for urea formaldehyde resins. The tests outlined were carried out using five flours which were obtained from Sydney flour mills. The flours have varying properties and were tested firstly

by themselves and then admixed with urea formaldehyde resins at the rate of 75 per cent. extension. This extension was considered to be the one which is mostly used at the present time. The panels were pressed at about 150 lb/sq.in. (cold setting) and after testing were left for 12 months under two conditions, one warm and moist and the other cold and dry, but neither of which were very specific, being different locations in our building in Sydney. All samples lost strength on standing for 12 months, excepting those using flours A and D, which are both soft flours compared with the others. The tests are being continued, and more samples will be tested in another 12 months time.

Mr. Plomley: We have not carried out tests on glue shear strength with flour-resin mixes - we have been interested mainly in the effect of flour on the flow properties of the glue mixes, and from this point of view we found that the soft flours, particularly both bakers' and biscuit flours from Victoria, were all most suitable for glue extension, whereas the higher protein and higher baking strength flours of New South Wales and Queensland were less suitable.

Mr. Gottstein: It is possible that the higher protein flours might give superior results under hot pressing conditions in contrast with cold setting.

ITEM 8. WASTE UTILIZATION

(a) REVIEW

Mr. Turnbull: Industry evidently expects the Division of Forest Products to have the answer to all waste problems, we receive many enquiries each year for advice on uses of sawdust, offcuts, bark, logging waste, etc., and I am afraid we are not able to help them to the extent they expect.

Efforts to lessen waste are being continued by promoting good sawing practices in the sawmilling industry. Attention of enquirers is directed to the general uses of sawdust and possible outlets for wood in small dimensions. Dealers are put in touch with

suppliers of sawdust, and suppliers in touch with dealers. Apparently in the Melbourne area practically all dry or semi-dry sawdust is collected at present.

A survey was conducted several years ago to ascertain the amount and distribution of sawdust. Some 51,000 tons/month are produced, of which 46,000 tons are not used, dispersion being a major obstacle to development of utilization. Practically all manufacturing processes concerning which we have information require larger quantities of woody material in one locality than are procurable as waste from the sawmilling industry as scattered as at present. We have encouraged the greater use of sawdust as a fuel for generation of steam for power and processing, and notable advances in some places have taken place or are being planned. Some of the gain is, however, being offset by a possibly greater use of purchased electricity or generation of power by reciprocating engines driven by liquid fuel. Attention is drawn to the suitability of dutch ovens, step grates and spreader stokers for firing sawdust, shavings and hogged fuel, and we have considered preparing technical descriptions of these for issue in the Newsletter.

Briquetting of wood waste is a subject of recurring interest, and relevant information has been given to many firms and individuals. A number of contacts have led us to believe that they have intended to commence briquetting, but none has actually commenced as far as we know. The need for a large tonnage daily of dry sawdust, and the high cost of plant appear to be the main deterrents. We have encouraged the manufacture of wood flour.

Sawdust-resin and sawdust-blood mixtures have been investigated by hot-pressing techniques for suitability for board making. The influence of proportions of binder on strength and other properties has been determined. Several firms have examined the economics of production and more than one has, we understand, negotiated with firms overseas for rights on some patented processes.

These have not yet resulted in a foreign process being used in Australia. There appears to be enough information forthcoming from patentees of processes overseas to permit manufacturing if economics of local manufacturing can be shown to be favourable, and there is no urgent need for further technical data.

Sawdusts have been pulped for hardboard, and boards meeting requirements of a British standard for hardboards have been produced in the laboratory.

We have endeavoured to keep ourselves informed on developments elsewhere in the world on waste reduction. As processing by any procedure at present known is expensive, the Utilization Section has turned attention to uses that involve no processing and have possibilities for using sawdust near the source of supply, e.g. grape packing and soil improvement. Mr. W. M. McKenzie will outline the progress of our investigations on these subjects.

Mr. McKenzie: A potentially valuable, but not extensive, use for sawdust is as a packing for grapes.

About 4 years ago, when the cost of Portuguese granulated cork reached £200 or more, packers were anxious to try sawdust. Sawdust of particular species and special shape has been used successfully for years in North America, therefore in two seasons experimental packs were made up using sawdust from various common species and various types of saw, and sent to Sydney and Singapore for scientific and trade examination. These trials showed that coarser fractions of sawdust from light coloured species with cuboid shaped particles were technically satisfactory and held a good chance of trade acceptance. Small commercial consignments were suggested to establish such materials on the market, but the matter has not been carried this far. This was mainly due, I think, to discouragement by the Department of Commerce and Agriculture as it was then.

General acceptance of sawdust as a soil improver would use up all the sawdust and chipped wood from the sawmills in

horticultural areas. The Department of National Development maps show considerable overlapping of horticultural and timber areas, and considering the withdrawal of sawmills from the bush it appears that a large number of sawmills fall in this category.

The practice of mulching orchards is common in North America, and appears likely to be adopted widely in Australia, judging from the few private experiments, and experiments of the Victorian Department of Agriculture. The latter gave spectacular results compared with the usual order of response in horticultural research, and were attributed to improved soil moisture content. If eventually only 16 per cent. of Australian orchard areas were mulched with wood fragments, this would absorb all the sawdust and chippable waste produced in this country. However, the Agricultural Department likes to confirm its results over a period of years, and educate by demonstration so that this eventuality is still distant. The profit will also not be great because as yet the value placed on organic materials by orchardists is small.

Vegetable and flower growers, including home gardeners, make intense use of the soil, so that their demand for organic materials is high and the price for recognized materials such as animal manmure also high - e.g. £8/ton in Melbourne. With these short rotation crops, it is inevitable that a mulch is soon mixed with the soil. It is now well known that in the case of woody materials, the result is a huge demand for nitrogen and other nutrient elements lasting for years if remedial steps are not taken, and precluding crop growth. It is also well known that if nitrogen and other elements are brought to an adequate level in the soil by heavy applications, no harm ensues after a few months. But these heavy applications are costly, and it appears that the nitrogen tied up in the wood decay is not released for the plants for many months. This then is the disability of wood waste which must be overcome if it is to attract users.

Our first approach was an attempt, by preliminary chemical treatment, to increase the initial rate of decomposition of wood incorporated in the soil, thus shortening the period before nitrogen would be released. It seemed possible that a light hydrolysis treatment would have a trigger effect making the wood much more susceptible to attack. Field experiments with treated materials showed a hastened decay, but no trigger effect. A high degree of hydrolysis would be necessary to shorten the decay period sufficiently, and the costs of processing are too high as shown by our pilot-scale cooks of sawdust for the field trials. Chemical treatment is mentioned again later.

The field trials suggested that factors other than nitrogen supply also affect the rate of decay under field conditions, and it was decided to investigate some of these factors in the laboratory, with the aim of arriving at a procedure to minimize the necessary nitrogen applications. An experiment is proceeding to study the effect on nitrogen uptake and on soil fauna characteristics of wood species, extraction by water and alcohol, proportion of wood in the soil, liming, and soil type. The sawdust-soil mixtures are incubating at 78°F and the loss of nitrate-nitrogen is being followed. Results to date show differences due to wood species, extraction and liming, but no simple effects, there being interactions between these factors, and interpretation must await a complete analysis.

Parallel with the above work Mr. Plomley has been isolating the organisms responsible for breakdown of wood in soil and at the surface, and studying the factors affecting their activity in pure cultures. He has found that a dilute alkali treatment makes wood susceptible to attack by some fungi which normally do not decompose it actively. Studying nutritional requirements, he found that increasing the concentration of certain inorganic salts also increases their activity. Comparison of his results with those of the sawdust-soil incubation studies should be very interesting. His work is also of interest in relation to the deterioration of timber in cooling towers.

Mr. Humphreys: We have one or two other utilization fields which I think should be reported. The stringybark mattress filling industry is proceeding very satisfactorily, the two factories concerned are both still small but nevertheless very prosperous. The stringybark fibre work has reached the stage where we find that we can ret the bark, provided it is reasonably fresh, but as it gets older the retting becomes more difficult. We have had one euqniry for its industrial use but nothing has come of that yet.

As far as Mr. McKenzie's work is concerned we have confined ourselves to observing the effects of sawdust when used in various agricultural situations. We can report that one farmer is using sawdust and general wood litter in his cow bails and making up the nitrogen deficiency that way. He is the only person in New South Wales that we know of who is doing that. Orchard utilization is fairly well established in N.S.W. - the main trouble with utilization of sawdust for mulching is that the cost of sawdust distributed in that way is very high. Our work on the pH of various species is still only in the exploratory stage. While we do not know what causes the acidity of various species, we have found that some species are much more acidic than others; in white stringybark, for instance, we obtained a pH of 2.9 on one sample, that is the sort of material that may be used in the Sydney area as a mulching material.

The reasons for the failure of Vencor veneer were largely technical. The boards supplied by Vencor Veneer were very heavy, being composed of sawdust from blackbutt, which is much heavier than anything produced in Europe. In addition it had no voids, so it was particularly dense. Warping problems also occurred, and I think those two things largely led to the cessation of production of this material, there was also a tendency to use too much starch extender in the urea adhesive, which possibly led to further difficulties with warping.

We are very pleased to report to the conference another development, namely the production of charcoal from mill off-cuts.

There is a small plant working in the Carrogon district and it has produced a very satisfactory charcoal of reproducible quality for which Imperial Chemical Industries at Botany pay a premium price. As a result of that plant's successful working, I.C.I. has stimulated the production of charcoal from off-cuts at two large tableland mills - one at Oberon and the other at Mongo - and we expect that these plants will shortly be producing charcoal of reproducible density and activity from the light weight eucalypts both mills produce. I.C.I. for their new finish plant require about 900 tons a year, these two mills together should be able to produce that amount. The species being used are E. fastigata and E. dalrympleyana. They are using a small scale retort system to produce the charcoal, using fuel oil to heat the retort.

Discussion

Mr. Harris: I consider that it would be wise for each State to make a survey of potential charcoal markets. There is a tremendous possibility for this development, in America for instance, there is a heavy demand for charcoal for use in barbecues, cafes, dining cars of trains, etc. so much so that the last remaining charcoal iron furnace in Tennessee has stopped using charcoal for its process and is selling the charcoal at a colossal price, in 28 lb paper bags. In N.S.W. there are many possibilities that have not been explored for the use of charcoal, some industries are using anthracite for purposes for which I think charcoal would be cheaper and better. The carbon bisulphide industry is always looking for good charcoal at a cheaper price, and the need for cheaper carbon bisulphide in the Australian chemical industry is very great. In some States the demand would not be very large at the present moment but particularly in Victoria and N.S.W., I should think that a proper survey would be very interesting. Wundowie is now using about 10,000 tons of charcoal a year and the cost of production of that charcoal is about £8 per ton. If charcoal can be produced for £8 to £10 a ton, there are big possibilities for

it, as the chemical industry in N.S.W. is paying between £20 and £30. The cheapening of cost depends on mass production of the charcoal in amounts of not less than about 2,000 tons per year.

Wundowie is proposing to increase its charcoal iron production to 100 tons a day, which would be treble the present production. In order to produce the extra charcoal, they are proposing to put in vertical continuous retorts. Another possible use for charcoal is for making electrodes for aluminium production.

Mr. Clarke: With regard to Mr. Humphrey's statement concerning core board, I found in Germany that it was generally recognized that you had to produce chipboard very carefully in well designed plants with good plant control. Cheap and improvised plants have virtually gone right out. Well produced board was regarded more favourably by the furniture manufacturers than solid core stock, which it was displacing.

Concerning charcoal; in Japan, charcoal is used very extensively for many purposes, and the Japanese are particularly good at its manufacture. They grade their charcoal by a scratch method using pencils of different alloys of gradually increasing hardness. The hardness number of the charcoal sample being that of the last pencil to mark the charcoal. They were also working on a method of electrical resistance, using a machine something like an electrical moisture meter, to determine the degree of burning of the wood and the quality of the charcoal.

Mr. Huddleston: With regard to Mr. Harris' statement I feel that we will never be able to produce charcoal in N.S.W. at the centres where it is required at anything like £8 to £10 a ton. We have to cart our wood or alternatively our charcoal long distances and the freight alone would put us well above these figures. It is already possible to buy charcoal in Sydney at about 15/- for a 15 lb bag.

Dr. Stamm: To our knowledge the trend in the United States is towards the simplest possible portable type of charcoal

production unit to take to the woods, where they are burning part of the wood as fuel, there is no separate heating compartment. They are really going back to the old-fashioned method, and that appears to be the most promising method of making charcoal which does not have to meet rigorous specifications.

ITEM 9. EXTENSION WORK

(a) STANDARDS

Mr. Turnbull: Grading is in need of development to aid marketing, to rationalize utilization and to improve timber's reputation for reliability. Through the issue of standard grading rules for the main sawn timber products, and standard specifications for manufactured products, most of the foundation for sound practice is believed to have been prepared. A notable step in promoting the adoption of standards was taken in February 1956 at a conference in Sydney (to be referred to in more detail under agenda item 9 (c)) where the attention of a large number of builders, architects, sawmillers, timber merchants and representatives of government and semi-government bodies was drawn to the scope of existing standards, and demonstrations given of the application of standard grading rules to our main timbers. Emphasis was placed on the joint interests of the timber and building industries in selecting the right grade for the right purpose.

The Division of Forest Products has actively supported the Standards Association from the inception of its work on timber. As regards programming, we have indicated the range of specifications that would cover the major products, the priority favoured for each item, and the interests that might be invited to join committees. Divisional staff has served on the Timber Industry Committee and its executive, and in Victoria has undertaken chairmanship of the Sectional Committee on Wood Technology, Utilization, Packaging, and Plywood and Adhesives. A great deal of preliminary data and, in a number of cases, pre-committee draft specifications have been

prepared. Field investigations in anticipation of or in response to requests from committees have been carried out.

The work has proceeded as rapidly as the procedures of the Standards Association will allow. The standard specifications are believed to be realistic. During the year in Victoria revision has been undertaken of the grading rules for flooring and other milled products of the hardwoods of south east Australia so that these will cover the current needs of the trade. The interim rules for sawn timber have been revised so that they can be issued as standards consistent with those for milled products. Committee drafts have been completed for Engineering Structural Timber, Wood Blocks for Parquetry Flooring, and A Code for Laying Parquetry. A draft specification for ladders was reviewed.

Grading rules for stumps, sole plates and fence posts have been drafted and after acceptance by the Victorian Housing Committee submitted for ratification as Australian standards.

The continuation of collaboration with the S.A.A. is proposed. Action is needed in ever State to develop grading practices in the timber trade.

Discussion

Mr. Huddleston: I would agree with Mr. Turnbull that as far as timber specifications are concerned the range is reasonably well covered, but I did discuss earlier, steps which may be taken towards the production of the codes for timber construction, one on the method of building construction and the other on engineering construction. There is an urgent need to get both those codes published. I feel that we should endeavour to provide a draft code to the Standards Association fairly quickly.

With regard to the code for architectural building practices or domestic building construction, there have been some rather interesting developments following the grading course in Sydney. The Housing Commission are showing quite an interest in the standard

specifications and the application of such specifications to their work and they suggested to the Standards Association that it would be a good idea if the Association could publish a code for domestic building construction. We are hoping that the Housing Commission will do quite a lot of work for the draft code on the domestic building side.

Mr. Clarke: We are quite in accordance with the idea of the codes being prepared but as far as our Division is concerned I cannot see any hope of our giving any appreciable assistance towards it at the moment. I would not be prepared to ask either the Timber Mechanics or Utilization Sections to take on more work at the present time.

Mr. Jennings: We might do some work on the standards for plywood. The question of testing is included in the present standards and has given rise to some dissatisfaction.

ITEM 9 (b). EXHIBITIONS, DEMONSTRATIONS, ETC.

Mr. Wymond: This Division has had some experience now of providing portable exhibits for country shows. We entered this field a year or so back in an endeavour to publicize fence post preservation and so far have visited approximately 12 shows. Although we do not intend to carry on with this work, some of our experiences may be of interest to the States.

We found that to enable us to set up and pull down the exhibit in the shortest possible time, it was necessary to have the material all ready assembled in cases which could be merely opened up on folding tables. One of these cases deals particularly with fence post preservation and we could make it available to any of the States should they desire it.

The second point I would like to make is that it is essential to man any exhibit which is put into a show. On several occasions we were located adjacent to the State Department of Agriculture exhibit which was not manned on at least one occasion. We found that people merely glanced at the subject matter and walked

away, whereas I am quite sure had there been an officer there, many would have stayed to discuss the subject exhibited. Our exhibits were manned continuously and we found that besides dealing with enquirers concerning post preservation, we dealt with many other aspects of forest products work.

Mr. Huddleston: I would like to confirm Mr. Wymond's statement that it is no good placing an exhibit in a show unless it is manned. We have found exactly the same thing, with one or two men there to answer enquiries, the people come around, and you not only get enquiries about the exhibit in question but about all sorts of matters in timber utilization.

We have recently adopted a practice which is proving very satisfactory, that is to make up quite a major portable exhibit which is made available to a district forester, with authority to show it at local shows. The first really concentrated effort in that direction was carried out this year in the Glen Innes district. An exhibit showing use of the highland eucalypts for cabinet and joinery timber was prepared and made available to the district forester and he has succeeded in showing it at most of the major shows within his district.

ITEM 9 (c). SEASONING AND GRADING COURSES PROPOSED FOR NEW SOUTH WALES*

Towards the latter part of last year following the successful seasoning course at Adelaide, the Division of Forest Products ran a similar course at Tumut in New South Wales. The course was very well received and immediately following its conclusion a request was made and has been repeated since, for a similar course to be arranged on the north coast.

In addition to the seasoning course, complaints of rejection of timber by builders, timber merchants and others in New South Wales led the Forestry Commission to suggest to the Sawmillers' Association that a course in timber grading and timber utilization

* Prepared by Division of Wood Technology, N.S.W.

should be run in Sydney and such a course was conducted from the 27th February to the 3rd March with very successful results. The Division of Forest assisted very greatly with that course, providing Messrs. Turnbull and Wright as lecturers and very kindly duplicating the lectures so that they could be made available to those attending. Mr. Clarke was good enough to travel to Sydney for the purpose of delivering a final lecture to the course.

At the time it was organized, the Commission visualized similar courses would be conducted, firstly in the large markets of Newcastle and Port Kembla and later on a smaller scale and with slightly different emphasis in the larger country towns. Recommendations have now been made to the Commission that a seasoning course be held at Coff's Harbour, possibly during August, the actual date being subject to C.S.I.R.O. being able to provide the lecturers as they did at Tumut. In addition, it is proposed that a grading course be conducted at Newcastle on the basis of one afternoon and one evening lectures per week commencing about mid-May and terminating about 11th June, and also that the Newcastle course shall be followed by one at Port Kembla commencing about the 18th June and terminating in July. The sawmillers are rather anxious that a full week's course following the Sydney pattern should be conducted in or around Canberra and a suggested date for such a course is for late September. In these latter courses the Commission is prepared to provide the whole of the lectures but would be extremely grateful for any assistance which could be given by the Division of Forest Products by way of lecturers.

Discussion:

Mr. Huddleston: Reference has already been made to the very successful grading course which was held in New South Wales earlier this year. When that course was organized, we proposed to extend it to other centres, and it is now proposed to run a similar course at Newcastle, followed by another one at Port Kembla and

later in the year one at Canberra or Queenbeyan. In the Newcastle course, rather than occupy a full week, it is intended to occupy one day per week for a period of 5 weeks. The lectures will be on an afternoon and evening the same day. As far as these three courses are concerned the Commission would be prepared to provide the necessary lectures, using the notes prepared for the Sydney course. But we feel that it would be better for everyone if D.F.P. could be associated with such courses in the provision of lectures and other assistance.

At the time of the seasoning course at Tumut last year, requests were received that it be repeated on the North Coast of New South Wales, and we would like assistance from D.F.P. in providing a further course, possibly during August, at Coff's Harbour, so that we can now cover the northern part of the State.

Note: This matter was referred to the Policy Session after some discussion.

ITEM 9 (d). F.A.O. COMMITTEES

Mr. Clarke: Last year F.A.O. held the third Session of the Asia Pacific Commission in Tokyo and a number of matters of interest to us were discussed there. Of particular interest were the decisions to set up a Forest Products Research Committee and a Forestry Committee for the Asia Pacific Region, both being answerable directly to the Commission. The Forest Products Committee is in course of being set up and I have been nominated by Australia as the Chairman. It is proposed that the Secretary will come from Malaya. We hope that the committee will be able to co-ordinate research throughout the Asian Pacific region. Initially we are going to encourage the preparation of Programmes of Work for all countries of the region, so that we can see what work is being carried out, and the committee will be used to advise F.A.O. on work that might be carried out in the region.

There are a number of matters in progress at the present time - there is a draft set of grading rules for logs, which should reach the stage of being a proof issue for critical review. This proof issue has been circulated and will come up for discussion again at the fourth Session of the Asia-Pacific Commission, which is expected to be held in Bandong in Indonesia in January next year.

There is also a move to get a standard list of trade names for the region, but attempts so far have not proved successful because too many names were included and also because there was an attempt to get one standard common name for the whole of the area for the one timber. That proved to be absolutely impossible and there was considerable doubt as to whether it was desirable. It has been decided now that a check list is the real requirement so that it is possible, by looking up this list, to trace any name which is likely to be used in the region.

There is also a recommendation that we should have a list of all methods of measuring logs in the region and that information should be collated and published, that is already on the move. Grading rules for sawn timber are in course of preparation at the present time, they are general grading rules, recommended for adoption by all countries, on the understanding that if a country has adequate grading rules of its own for its own particular timber, then its position is covered, but that if it is looking for a set of grading rules to adopt, it should adopt these standard rules as much as possible.

UNESCO is making a survey in connection with the use of timber for sleepers and telephone poles and we have received a request through the regional office of F.A.O. in Bangkok for information on the size of sleepers used in Australia. We are getting that together and will supply it to them.

There is to be a World Eucalypt Conference held in Rome in October of this year, and this Division has been asked to provide

papers on the utilization side, which we are doing. Mr. Rodger is also preparing a paper on the overall position of eucalypts. We hope to have one of our officers, Mr. Boyd, who will be overseas at that time, at that conference.

There is also to be a conference on hardboard, insulating board and chipboard or particle board, to be held in Geneva in January. There are requests out now for papers, and I have been asked to supply a short paper of a few hundred words on the hardboard and insulating board position in Oceania. The three main producers in Australia have also been asked to contribute papers to this conference. The conference is to be a review of all the knowledge known regarding these materials.

Mr. Smith: What is the position regarding the preparation of grading rules for south-east Pacific timbers by the F.A.O. Committee ?

Mr. Turnbull: These rules are prepared mainly as an aid to countries that have not developed practices of their own, and there is no suggestion that the rules for logs or for sawn timber should be introduced into Australia to supersede anything that we have done. In fact I think the terms of reference of the committee was to deal with hardwoods other than teak, excluding New Zealand, Australia and Japan.

Mr. Smith: Our interest is in being able to advise industry just what type of material they can expect in import shipments. We are able to inform them in regard to material coming from Malaya but the position regarding grading in Borneo and some other places is obscure.

ITEM 10. HARDBOARDS, PULP AND PAPER

(a) FIBREBOARD STATISTICS

Mr. Hanson: We have prepared the following tables showing the statistics for both hardboard and soft fibreboard. We included plywood in the per capita availability as we felt it provided an interesting comparison.

TABLE 1

AVAILABILITY OF HARD FIBREBOARD

(Figures in thousands of square feet)

Year	Production	Imports	Exports	Availability
1946/47	21,448	1,000	634	21,814
1947/48	37,181	-	1,358	35,823
1948/49	51.287	5,900	1,164	56,023
1949/50	70,491	19,265	1,423	88,333
1950/51	71,727	44,655	1,855	114,527
1951/52	90,195	71,457	1,428	160,224
1952/53	111,030	1,394	1,643	110,781
1953/54	160,403	1,124	3,643	157,884
1954/55	177,663	4,382	3,364	178,681

TABLE 2

AVAILABILITY OF SOFT FIBREBOARD

(Figures in thousands of square feet)

Year	Production	Imports	Exports	Availability
1946/47	32,000	1,000	-	33,000
1947/48	28,800	-	2,600	26,200
1948/49	26,500	3,400	1,000	28,900
1949/50	23,200	8,300	200	31,300
1950/51	31,300	2,300	200	33,400
1951/52	31,424	8,623	873	39,174
1952/53	21,167	497	48	21,616
1953/54	22,079	1,553	443	23,189
1954/55	24,917	2,222	260	26,879

TABLE 3

PER CAPITA AVAILABILITY PER ANNUM

(Figures in square feet)

State	Hard Fibreboard			Plywood		
	1953/54	1954/55	July-Dec.* 1955	1953/54	1954/55	July-Dec.* 1955
N.S.W.	17.9	19.7	23.4	19.6	23.7	29.0
Vic.	19.1	22.1	26.4	15.8	20.1	22.8
Q'ld.	15.5	16.8	20.6	26.8	27.8	30.9
S.A.	14.4	16.2	17.4	18.1	23.7	35.7
W.A.	7.8	8.2	8.4	20.8	24.7	29.2
Tas.	34.4	43.6	50.4	9.3	7.3	12.9
N.T.	39.8	38.2	68.8	n.a.	n.a.	n.a.
C'th.	17.5	19.7	23.2	19.2	22.8	27.6

* Annual basis.

ITEM 10 (b). HARDBOARDS

Mr. Turnbull: As early as 1930, only 4 years after the production of hardboards had been initiated in U.S.A. by the commercial application of the Masonite process, the Division of Forest Products sent 3 Australian timbers to U.S.A. and arranged for them to be tested for suitability for manufacturing into insulating boards and hardboards. The preliminary tests showed that there was no insurmountable technical obstacle to production of insulating and hardboards from the timbers. Information was collected on the status of the industry and the economics of manufacture. Production in Australia was regarded as an economic rather than a technical problem. Available data were published in a C.S.I.R. Pamphlet which had some influence in attracting investors to support the Masonite Corporation in starting production in due course in Australia.

Hardboard manufacturing commenced in 1938 in New South Wales at the rate of approximately 20 million sq. ft./annum. Mason's explosion process was used under licence from the Masonite Corporation of U.S.A., and a mixture of local eucalypts became the raw materials.

In 1939 the manufacture of insulating boards was commenced by the Colonial Sugar Refining Co., at Pyrmont, Sydney, at the rate of about 30 million sq.ft./annum. The raw material was bagasse, the waste fibre from sugar processing. The process included attrition grinding, forming on a vacuum cylinder, and drying, and the plant was engineered by the U.S. Wallboard Machinery Co.

These two companies continued for over 10 years to be the only local manufacturers of fibre boards, and they maintained their initial rates of production up to about 1946. Throughout the World War II supplies of hardboard were inadequate and had to be rationed.

While these conditions prevailed the Division started investigating the influence of processing variables on the properties of fibre boards and found experimentally conditions under which forest waste, sawmill waste and sawdust of both hardwood and softwood

could be converted into hardboards having strength and other properties generally similar to commercial boards. Some comparisons were made between the techniques of wet-pressing and dry-pressing, and the effect on strength of manipulating the press in various ways. The influence of temperature and pressure variations on strength and moisture resistance were investigated. Several laboratory reports were written.

The investigations were continuing when changes took place rapidly in the industry in Australia. The Masonite Corporation trebled its production capacity, the Colonial Sugar Refining Co. added hardboard manufacturing equipment to its factory in 1948, and the Burnie Board and Timber Co. started manufacturing hardboard in Tasmania in 1951. The total established capacity appeared likely to saturate or even over-supply the market. Each firm was however financially successful, and market development resulted in them selling their capacity outputs. The availability in 1954-5 was 26 million sq.ft. of insulating board and 182 million sq.ft. of hardboard (the latter including 4 million sq.ft. of imported board). The manufacturers had engaged technical staff that were able to study processing variables, to devise means of plant control and to improve and diversify their products. Continuation of research in D.F.P. accordingly seemed unnecessary unless the firms concerned requested it.

At the present time further expansion of the industry is being planned in Australia and manufacturing is expected to spread soon to Victoria, Queensland and South Australia. The actual processes to be used and scale of manufacturing have not been disclosed but no doubt full consideration will be given to the respective merits of technological developments that have taken place in board production processes in recent years.

The prospective manufacturer can obtain plant and technical guidance from the supplier of well tried equipment. The three manufacturers established at present in Australia use different

processes, and in the projected expansion of the industry other processes could conceivably be adopted. There are the following to choose from:

Chipping	Chipping	Chipping	Chipping	Chipping
	Preheating		Preheating	Cooking
Explosive pulping	Attrition grinding	Attrition grinding while steaming	Attrition grinding	Semi-dry grinding
Wet forming	Wet forming	Wet forming	Wet forming	Felting
Dewatering	Dewatering	Dewatering	Dewatering and drying	
Wet pressing	Wet pressing	Wet pressing	Dry pressing	Dry pressing

The economics of production favour large plants, the minimum likely to have prospect of success needs to produce approximately 20 million sq.ft./annum of hardboard 3/16 in. thick. This involves investment around £1 million and requires approximately 5.5 million super ft of green wood per annum plus fuel and power. The retail value of output would be over £650,000 per annum. The very interesting and important fact from the viewpoint of the forester and wood technologist is that the type of hardboard that this plant would produce is sold today at the lowest price of any sheet material in Australia. It is a plant that can utilize wood of practically any species in practically any original form and undersell competitive industries, including plywood, that are selective as regards their raw material.

It may be of interest therefore to consider how far this industry might develop. Some optimism towards the success of further expansion might be justified when Australia's production and consumption are compared with those of other countries.

Country	Production			Consumption		
	Insulating Board ½ in.	Hardboard 3/16 in.	Total	Insulating Board ½ in.	Hardboard 3/16 in.	Total
	sq.ft. per capita					
Sweden	36	108	144	16	47	63
Norway	34	41	75	25	32	57
Finland	53	40	93	28	8	36
Canada	31	10	41	31	10	41
New Zealand	14	19	33	14	19	33
U.S.A.	17	8	25	18	8	26
Australia	2	21	23	2	21	23

It will be noted that Australia is doing pretty well in marketing hardboard compared with Finland, Canada, U.S.A. and New Zealand, but with them Australia is considerably below Sweden and Norway. The use of insulating board in Australia is far below that in the other countries in the list, but of course climatic conditions may have some influence on prospects.

At present Australian board factories operate only in New South Wales and Tasmania. The latest information available from the Forestry and Timber Bureau on production, imports, exports and interstate distribution shows that hardboards have been available in the respective States as follow:

	Million sq.ft. per annum 3/16 in. basis	Sq. ft. per capita
N.S.W.	69	19.6
Vic.	55	21.9
Q'ld.	22	16.3
S.A.	13	16.0
W.A.	5	7.6
Tas.	14	44.4
N.T.	1	37.5
Total:	179	20.7

The high rate of consumption in Tasmania is believed to have been due partly to scarcity of plywood following the destruction by fire of the local plywood factory. But the rate does not exceed that of Sweden. It appears that further market development in every other State is a possibility. The demands in Victoria and Queensland at present rate of consumption both exceed the output of the minimum factory and no doubt this situation has stimulated the Masonite Corporation to plan for production in Eildon, Victoria, and the Burnie Board and Timber Co. to plan for production in South Queensland. A third project, by a subsidiary of Softwood Products Pty. Ltd., to produce both hardboard and insulating board in South Australia is understood to have been encouraged by the prospect of expanding markets in South Australia and Western Victoria for hardboard, and the opinion that a wood-based insulating board would be superior to one made from bagasse and open the way for market promotion of insulating board throughout Australia.

Consumption in Western Australia has not yet reached the output of a minimum plant, consequently manufacturing in that State is not likely to be attractive to investors at present. Establishment of manufacturing in that State seems likely to be deferred until the local consumption can be increased.

The prospect of small plants competing in the market has declined as the established manufacturers have consolidated their positions and written off considerable percentages of their initial expenses. Market conditions have justified the expansion which has lowered their costs and strengthened them to meet challenge from competitors.

Note: A general discussion on the new hardboard and insulating board plants followed.

Mr. Clarke: There is an interesting point in the case of the establishment of a plant in Victoria which reflects the desirability or otherwise of doing work on hardboard manufacture. Throughout the world today there are a number of laboratories set up to carry out work on the study of hardboard manufacture from various timbers. I feel that that work is virtually wasted because it does not form the major reasons for the selection of a site of a plant. As Mr. Turnbull has pointed out you can make hardboard from practically anything; having decided to make hardboard, you nearly always decide where you have the particular set of conditions best suited for making it. Then, having decided on your site, you decide on the process you are going to use. That is what happened in Victoria where the Eildon township was available, and Masonite bought it. They were then virtually forced into a dry felting process, because effluent would be a major problem there. There were other reasons why they would be interested in a dry felting, one being that this is one method of producing a two-faced board and there is no two-faced board produced in Australia. Therefore these were the deciding factors, not any research work that would be carried out in a laboratory on the pulping properties of various timbers for making hardboard.

ITEM 10 (a). PULP AND PAPER

Mr. Watson: Pulping investigations on the Araucaria sp. and on timber of the mangrove association from New Guinea have continued. The investigations on the Araucaria sp. have been extended to veneer waste and core-logs.

All the Araucaria wood examined, no matter what its origin, pulped readily by the sulphate process giving good yields of high quality pulp which gave paper with a very high tearing resistance. Other pulping processes were examined but in no instance did they give pulps with the high tearing resistance of the sulphate pulp.

The trees of the mangrove association all pulped readily by the sulphate process but the denser species formed a rather weak

paper. The lower density species, particularly Camptostemon schultzii and Excoecaria spp. gave pulps with strength properties similar to those of the eucalypts pulped commercially in Australia. Preliminary work has also indicated the possibility of producing good grade cold soda and groundwood pulps from these two species.

We have been watching with interest some recently developed pulping processes which offer possibilities of utilizing timber not used previously for pulp and papermaking or which enable mills to be operated on a smaller scale than is possible with some modern pulping procedures.

A great deal of interest has been shown in the cold soda process. The chips are soaked in cold sodium hydroxide solution and then defibred mechanically to give a pulp which may be used for newsprint production, board or lower grades of paper. The process operates best with hardwoods.

The chemi-groundwood process has been operated for some time on a commercial scale. In this process the billets are treated with cooking liquor and then ground in the conventional grinders used for groundwood production. A higher grade pulp is obtained and power consumed during grinding is reduced substantially.

The conventional sulphite process has been adopted to give a high pulp yield by reducing the amount of cooking chemicals. The cooked chips are defibred mechanically and used to replace some of the chemical pulp when making newsprint.

Mr. Clarke: N.Z. Forest Products arranged for tests of New Zealand Pinus radiata to be carried out by Courtaulds, who informed us that they had previously carried out some tests on Pinus radiata in Australia and they described the raw material that they had as several logs 6 in. in diameter containing about 40 per cent. heartwood - I do not know where they got it from, but they were probably small suppressed trees.

They used a pre-hydrolysis process, followed by the sulphate process, but they obtained a low pulp yield and found the pulp was hard to process; the colour was poor and they were not impressed by the results they got there. They therefore tried the New Zealand material which consisted only of about 10 per cent. heartwood. They came to the conclusion that using the sulphite process, Pinus radiata behaves very much like spruce, providing that heartwood is not greater than about 10 per cent., and that it can be satisfactorily cooked by the sulphite process up to about 25 per cent. heartwood, but above that they ran into some difficulties, which they might or might not be able to overcome. Whey they tested heartwood alone they found that it had the disadvantage that it took roughly three times the quantity of chlorine to bleach the pulp, and they also got a lower yield of rayon pulp.

They looked into the question of costs of production with such a plant and came to the conclusion that to put in a plant on its own then to get the costs down to present overseas prices of rayon pulps the capacity would have to be greater than 200 tons a day. It would be possible to run a smaller plant in conjunction with some existing plant. They pointed out also that at the present time it would be very difficult to market an output of 200 tons a day high alpha pulp.

Mr. Crane: I have had some contact with an English manufacturer, during the past year or so on a proposition for rayon. They had small samples only of our obliqua and regnans, but they have pulped almost every e calypt that grows in Algeria and the Mediterranean and have recently, in association with other interests, established an alpha pulp mill in South Africa. The negotiations broke down again on market; to be economical they must have a big output, at least 50,000 tons a year, and their markets outside of Australia are just not there.

Mr. Hanson: This question of small pulpwood is very important to Australian forestry, we can provide any amount of pulpwood, but we cannot provide it in the concentration which the pulp mills seem to want, unless there is any process of using say 10 million super ft a year. I think it is one which should be investigated; perhaps it could be used for newsprint.

Mr. Clarke: Groundwood must be produced close to the place where it is turned into newsprint. It is most unsatisfactory to dry groundwood and then wet it again to use it.

ITEM 11 (a). DETECTION OF FLAWS IN TIMBER BY NON-DESTRUCTIVE MEANS*

Work has been carried out by the Commission for some time on methods of detecting flaws such as pipe inside timber, generally arising through termite attack. This work has two objectives:

(a) Development of a technique useful in forestry operations.

(b) Development of a technique useful in the examination of poles, piling and structural timbers generally.

Work has been directed along two lines:-

(a) Sonic methods of detection.

(b) Use of gamma radiation transmitted through the material to be examined.

Two typical problems which it is hoped to solve are:-

(i) Measurement of pipe in standing trees in the forest.

(ii) Measurement of termite damage in transmission line poles.

At present pipe is assessed largely by eye, supplemented by sounding the tree with an axe. This method is notoriously incorrect because of the difficulty of determining the extent of pipe. This has been proved on many occasions where assessed merchantable volumes have been compared with the final merchantable yield from a plot. In the case of poles, termite damage at the butt is usually assessed by sounding and drilling. The use of X-ray technique for this purpose has been developed by the Sydney County Council and whilst this method

* Prepared by Division of Wood Technology, N.S.W.

is accurate a costly mobile X-ray laboratory must be brought to the site and a trench dug near the pole. In an endeavour to eliminate the use of X-ray photography for this work, we have investigated the use of an image intensifier tube to enable direct visual examination to be made. The results of this were not at all promising as insufficient contrast was obtained.

The method developed by the Commission consists in placing a source of gamma radiation on one side of the tree, or pole, to be examined. A relatively weak source is used and to date we have used radon sources of 5 to 20 mc. strength. Gamma radiation is emitted in all directions and some passes through the tree. The amount of radiation emerging at different points around the tree on the diametral plane is measured using a geiger tube carried on an arm, swinging at a fixed radius to the source of radiation. The geiger tube is attached by a cable to a rate meter. If the tree is solid there will be a gradual fall in rate as the diameter is approached. If the tree contains pipe two minima will be observed on either side of the diameter. The size of the pipe is measured directly, since it is the distance of the geiger tube from the tree at the points where a rate equal to the diameter rate is obtained. This method has been applied, to blackbutt of diameter classes ranging from 18 in. to 48 in. and in 80 per cent. of cases pipe was correctly measured to within an inch. In the other cases errors ranged up to 50 per cent. and in one case a hard plug of mud was registered as solid timber. Where the external indications of the tree are considered in addition, errors of this kind would not occur. In the case mentioned, the presence of the termite nest (Coptotermes) was obvious but the instrument's readings alone were relied on. Mud in the pipe causes an under estimation of pipe size but although this was thought, initially, to constitute a grave difficulty, practical experience has shown that it is of little consequence. Nearly all of the pipes measured in the blackbutt experiment carried

mud. A serious difficulty is extremely wet mud which accumulates in the butt of large, over-mature trees attacked by Porotermes spp. This can be avoided, in practically all cases, by measuring the pipe about 6 ft from the ground.

The speed of measuring is important and using the above technique, 5 min per tree is required. It is believed that this time is tolerable for plot assessment work particularly where growth studies are being carried out. It is also worth while where large numbers of possible duffer logs in a compartment are to be measured. In strip assessment work times of this order are far too long. The practice of plot assessment, however, is increasing and strip surveys are not used as widely as in the past.

In order to increase speed of assessment an alternative technique has been used. This consists of a caliper-like apparatus with the source mounted at the end of one leg and a geiger tube mounted at the end of the other. To use this device it is placed across the diameter of the tree and a reading taken. With the source held steady against the tree the calipers are moved so that the tube moves down and around the tree to an oblique position. A reading is again taken and compared with the diameter reading. The ratio of the two readings gives an estimate of the soundness of the log. This method is speedy and whilst not as accurate quantitatively as the swinging arm method it is more suitable in a rapid survey.

The above methods have been developed for use in standing trees. They are suitable also with slight modifications to the examination of poles in the ground and before erection. In this way the technique can be used to detect termite damage and various flaws found in poles such as doze.

Certain precautions must be taken to limit the daily exposure since radio-active radiations constitute a health hazard. Because weak sources are used the radiation hazard is not high. A few simple precautions are necessary such as keeping the source shielded when not in use and only approaching close to the source when

absolutely necessary. The source must not be lost and therefore it must be in the personal care of someone who understands the hazards associated with radio-active substances. So far two people have been required to operate the device in the field but it is felt that, using an instrument properly engineered for the purpose, one operator would be sufficient.

We intend to try the device in the near future for the examination of wharf structures to detect Limnoria damage which at present requires the use of a diver. It is immediately useful as a supplementary tool in ordinary pole inspection. This particularly applies to high tension lines where poles are valuable, because once the diameter reading for a pole is obtained, immediately after installation, any change in the measured rate provides a valuable indication of possible alterations inside it. This may be decay or attack by termites. Where no change occurs and other visual indications are satisfactory it may be assumed that the pole is in a satisfactory condition. In the checking of reticulation power poles the instrument is best applied for check determinations on poles condemned by ordinary inspection.

It is hoped that this device will find a useful permanent place in forestry technique. It is relatively cheap, sensitive, robust and light to carry. The hazards associated with its use are minor and well understood.

With regard to our sonic methods of pipe assessment we propose to incorporate this device in the same instrument as the one described above. In this case both methods would be available providing a check on the indications of each. This is particularly useful as the sonic method, whilst not quantitatively accurate, is a satisfactory way of separating logs which are quite solid from those which are not. Once this separation has been made the interpretation of the radiation measurement is made much more certain.

Note: The above item was introduced by Mr. Canaway; there was no discussion.

ITEM 11 (b)

EXPERIMENTS AIMED AT CONTROLLING THE SPREAD OF MISTLETOE *

Although not directly a forest products matter, it was considered that recent work on mistletoe being carried out in New South Wales may be of interest to representatives of the State Forestry Services present.

Observations on the incidence and spread of mistletoe (family Loranthaceae) have been made in the files of the New South Wales Forestry Commission over the last 20 years. Two questionnaire type surveys were made through field staff in 1940 and 1947 and the results seemed to indicate that mistletoe was essentially a pest of opened-up areas rather than of forest stands.

No critical measurements have been made of the damage caused by mistletoe but observations over the last 10 years suggest that heavy infestation will kill trees and also that the pest seems to be spreading in certain localities.

Damage can also take the form of lowered vitality in infested trees, malformation due to broken branches or finally, death. Infected trees rarely if ever shake off the parasite.

Seed production of mistletoe is prolific and it is common to find "pockets" of mistletoe infested trees within timber stands comparatively free of the parasite. These isolated "pockets" appear to coalesce over the years so that a large area may eventually be mistletoe infested.

There is no unanimity on the methods by which mistletoe seed has spread but clearly birds play an important part and there is little likelihood of control based on vector suppression.

Importance of the Mistletoe Problem

As indicated above forest authorities have taken the view that mistletoe is not a serious pest of silviculture. This view may have to be altered if spread of the pest continues at its present rate. The Department of Main Roads in New South Wales which has the responsibility of providing scenic improvements to roads is notably concerned with

---

* Prepared by Division of Wood Technology, N.S.W.

mistletoe damage. Graziers are concerned because of the loss of shade trees in opened-up and particularly vulnerable areas. Water Boards controlling catchment areas are also concerned because light tree cover must be maintained in some areas and this encourages the spread of mistletoe.

Control Measures

Lopping infested branches is only of value in the case of isolated trees. It is quite useful with fruit trees and can be combined with normal pruning operations. Control by means of "hormone" (2,4D sprays) was suggested by this Commission in 1949 and the method is described for practical application in a Division of Wood Technology leaflet. Injection of the hormones into the butt of infested trees was suggested by C.S.I.R.O. Division of Plant Industry working in conjunction with the Forestry and Timber Bureau and Forestry School at Canberra in 1951. Both these chemical treatments have attracted attention particularly of Main Roads authorities in the various States and of graziers. Both methods have been applied only to eucalypts.

Present Position

The spray technique suffers from the obvious disadvantage that it is difficult to apply to tall trees. The injection technique is still under test but seems to have the disadvantage that considerable accuracy is required in dosage and mistletoe suppression takes a long time (12 months or more) before any marked effect is discernible.

It seems logical to pursue investigations of the injection technique rather than the spray method because of the wider application of the former. On the other hand, certain fundamental problems involving tree physiology must be faced in this method. Addition of hormones to a tree often results in local hypertrophy and bark splitting. This is not permissible in forest and plantation trees. Side effects such as excessive flowering, "brooming" of young growth and bursting of adventitious buds, are also noticed quite often. These may be over-dose symptoms and not necessarily harmful but they should be closely studied.

Finally, there is the question of resistance to hormone action which is noticed on occasion but may be a function of the physiological age of the tree or mistletoe. The effect of hormones on wilga, kurrajong and buddah - all subject to heavy mistletoe attack - is not known with certainty but experiments are in progress to determine it.

Note: The above item was introduced by Mr. Huddleston; there was no discussion.

ITEM 11 (c). BATTERY SEPARATORS

Mr. Hanson: Our only purpose in requesting this item was to try to get some information on requests that were made at the last conference. Mr. L. N. Clarke of D.F.P. did a lot of work on suitable timbers for battery separators and came to the conclusion that radiata was satisfactory but it needed commercial tests to prove it. We asked N.S.W. Commission if they would undertake it and they said they would, but we have not been able to find out if this work is progressing. I understood that there was trouble in obtaining flitches of suitable size, but that these were obtained from New Zealand.

Wooden separators are still being used as much as every, in spite of synthetics. We conducted a survey towards the end of last year to see to what extent synthetics had taken over, and the impression we gained was that although they were being used, they were not as satisfactory as at first thought and had done no more than cover the natural expansion in the market due to increased use of batteries. As far as we can see, wooden separators are going to be used for a considerable time yet, which raises the problem of supply of material - most of it is coming from New Guinea at the moment.

Mr. McAdam: We have no objection to sending battery separators to Australia, providing it is economical. We are hoping that some of the output from the sawmilling industry at Wau will come to Australia for this nationally required battery separator use;

but we consider that it can only be induced to Australia by the industry paying a price that will make it as profitable at least for them to supply material for battery separators, as for other markets they can find. Much of the timber that we are supplying to Australia for battery separators has been coming from a small concession which is owned by one of the main suppliers of manufactured battery separators in Australia, a Sydney manufacturer. He has only a few month's supply left, but he is prepared to go into fairly rough country and we are at the present time trying to arrange a further concession of fairly inaccessible forest. I think, that as a result of the efforts we are now making, we will get a continuing supply in the nature of a million super ft or more of first class timber into the hands of this supplier.

Note: The matter of a further test being arranged was to be discussed between Messrs. Hanson and Huddleston.

ITEM 12. BRITISH COMMONWEALTH FORESTRY CONFERENCE

(a) CORRESPONDING COMMITTEES

Progress was reported by Mr. Clarke, there was no discussion.

ITEM 12 (b) (i). 1957 CONFERENCE - PRE-CONFERENCE

Dr. Dadswell: At the last British Commonwealth Forestry Conference there was a Pre-Conference Session of Forest Products delegates from all over the Commonwealth and the idea is to have a similar Forest Products Pre-Conference here in Australia, before the next main Conference. The Pre-Conference will be held in Melbourne from August 12th to 16th, meeting in the Division. On Sunday, August 18th, it has been suggested that a Pre-Conference party of Forest Products delegates and any foresters who are interested, go to Tasmania on the morning plane to Wynyard. If it can be arranged, they would visit the forests near Burnie from which A.P.P.M. draw

their supplies, or possibly see the plywood mill at Somerset. On Monday the delegates would visit the A.P.P.M. pulp and paper mills, also the sawmills and the hardboard plant. Tuesday, August 20th, the party would go by bus from Burnie to Hobart, looking at some plantations on the way. On Wednesday, August 21st, there would be a visit to the Australian Newsprint Mills - staying on the Wednesday night in Hobart. On Thursday, August 22nd, there would probably be a visit to the areas from which Newsprint Mills draw their supplies. Thursday night would be spent in Hobart and the party would arrive back in Melbourne just before mid-day on the Friday. That afternoon would be spent finalizing the report to be presented to the main conference.

Mr. Clarke: With regard to the form which the Pre-Conference should take, I think the general feeling overseas was that they did not think that the Pre-Conference was a suitable occasion to have highly specialized papers and that it would be far better to have a general review of forest products research in Australia. We could get their considered opinion on our method of attacking our research here. We would have the benefit then of their experience in much the same way as the foresters do.

They thought also that we might bring up some items of special interest, such as Sirex and perhaps Hylotrupes. Where we are bringing those up it would be necessary to get information out in good time so that people coming from overseas could be briefed on any technical aspects which might come up in the discussion. In addition to that the feeling was that we might also make the conference cover fundamental research in forest products.

I think you are all aware of the forest products items that are proposed for the main conference. Firstly there will be reports and discussions on our Corresponding Committees, reports and discussion on Translation Exchange, and the question of what has happened to our "Terms Used in Forest Products Research" which was supposed to be finalized and published at the last conference. Then

exchange of reports, methods of desimination of results of research, and United Nations Committees would also be discussed. It would also be interesting to know something about research associations - there is a new Timber Development Research Association in England and they are putting up a laboratory not very far from Princes Risborough. They have been given a grant by the Government, and I think the way that scheme is going to work out might be of interest to us all.

We agreed that it should be a conference of forest products workers, we should not have people from industry. We discussed discussed the method of reporting the conference and it was unanimously decided that we should work on the basis of summaries.

Those are some of the main points that came up in overseas discussion and they more or less summarize the general feelings about the Pre-Conference.

ITEM 13 (b) (ii). 1957 CONFERENCE - MAIN CONFERENCE

Dr. Dadswell: It is proposed that several sessions be given over to the forest products side in the main conference. For example, on Friday, 20th September, when the main conference is in Canberra, there may be a session devoted to developments in pulping. Two papers are suggested - one on pulping of hardwoods, and the other on softwoods. Two of the Australian companies have been suggested for the paper on hardwoods and New Zealand for the paper on softwood.

The next session - "Forest Utilization" - could be split into three parts -

(a) Small logs.

(b) Less valuable species (which in previous conferences was referred to under the heading of Secondary Timbers); and

(c) Preservative treatment.

It was suggested that Great Britain might be asked to supply the main paper for "Small Logs"; New South Wales the paper for "Less Valuable Species"; and this Division the paper on

"Preservative Treatment". Papers for the main conference have to be prepared and circulated ahead of time and at the main conference they will be taken as read, but the authors, if present, will be asked to speak to them for a short time. There is nothing against more than one country, or individual, submitting a paper on any of those subjects; for example, under the heading of "Small Logs", there would be no reason why South Australia or some other State could not also supply a paper. Another subject is titled "Grading and the Utilization Officer", and it has been suggested that the paper for that come from New Zealand. "Tree Growth Characteristics and their Influence on Wood Structural Properties" was suggested as a subject for the main conference, and that will be presented from this Division.

There are other subjects at the main conference of interest to forest products people. One of them is the influence of markets on silvicultural practice, that will probably be prepared by Mr. Grenning of Queensland, and another which is of general interest is "Forest Insect Control, Quarantine and Other Protective Measures". It has been suggested that Dr. Harrison of Commonwealth Quarantine should present a paper on that subject, and that we also might get the entomologists of the State Forest Service in New Zealand to prepare a paper. Some of the States might also be interested.

That summarizes the items of interest to forest products people and which will be presented at the Main Conference, also the suggestions as to who will present the papers.

Mr. Clarke: We will keep you as fully in touch as possible with the progress of the arrangements. We would like to see all the States represented at the Forest Products Pre-Conference, although there may be some clashing with other conference activities, but the people on the utilization side should be able to attend.

Note: After some further discussion and the referring of some matters of policy re conduct of the Forest Products Research Conference to the Policy Session, the conference was closed.