PROCEEDINGS

SIXTH

FOREST PRODUCTS RESEARCH CONFERENCE

HELD AT

THE DIVISION OF FOREST PRODUCTS

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION.

MELBOURNE

NOVEMBER 17-21, 1952

DIVISION OF FOREST PRODUCTS
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
MELBOURNE

CONTENTS

REPRESENTATION

State Forest Departments

Queensland:	Mr. V. Grenning	(Director)
	" S. G. Jennings	Forest Products Research Branch.
	" K. V. Cokley	
	" G. F. Littler	
New South Wales:	" E. B. Huddleston.	Chief, Division of Wood Technology.
Victoria:	" A. L. Benallack	(Sales and Marketing)
	" C. J. Irvine	(Research Officer)
Tasmania:	" F. A. Noar	
South Australia:	" J. Thomas	Acting Conservator

Commonwealth Departments

New Guinea:	" J. B. McAdam	Director of Forests
Forestry and Timber Bureau:	" L. F. Hammond	Research Officers, Division of Imports, Exports, Statistics and Programming.
	" J. B. Campbell	
Department of Works:	" R. E. Banks	Building Research Liaison Service.
	Miss A. Dicker	
C.S.I.R.O.	Mr. F. J. Gay	Division of Entomology
	Dr. J. S. Fitzgerald	Division of Industrial Chemistry.
	Mr. S. A. Clarke and Officers	Division of Forest Products
University of Melbourne	Mr. J. H. Chinner	Senior Lecturer in Forestry.

Chairman: Mr. S. A. Clarke, Division of Forest Products

OPENING OF CONFERENCE BY DR. F. W. G. WHITE, CHIEF EXECUTIVE OFFICER, C.S.I.R.O.

Dr. White was introduced by the Chairman, Mr. S. A. Clarke, Chief of the Division of Forest Products.

Dr. White: I very much appreciate this opportunity of being with you today to initiate this first session of the Sixth Forest Products Research Conference. These Conferences began in 1946 and, while I believe it was the intention at first to use them to co-ordinate the activities of the Division of Forest Products with those of the Division of Wood Technology and Victorian Forestry Commission, the scope was widened almost immediately until now there is representation from very wide interests in forest products and to some extent forestry. All organizations concerned with forest products work are represented at this Conference, unfortunately with the exception of Western Australian Forests Department. On behalf of the Executive of C.S.I.R.O. I wish to welcome you all to this Conference and I hope that the usual spirit of hearty co-operation will prevail.

I would like to express a special welcome to Dr. Ramaswamy from Bangalore, who is with us today. His presence reminds me that during the past year we have had an influx of visitors to Australia interested in forest products. We had forty members of the Eucalypt Study Tour, representing many different countries; and just recently Mr. G. Hunt, ex-Director of the U.S.A. Forest Products Laboratory at Madison. We find these visitors have a very stimulating effect on workers in this country and really need such visits if our own work is to be successful.

I wish to apologize for the absence of Dr. Clunies Ross here this afternoon but this is an unfortunate week for him in that he has various Conferences with Chiefs of certain Divisions leading up to a meeting of the Advisory Council later in the week.

Before opening the Conference I would like to say that these

discussions are of very great value to the Division of Forest Products. I think we can claim that work in the field of forest products research, not only in this Division but elsewhere, has been rather more successful than in other fields chosen for study. I think the Division has studied many problems of considerable economic importance in this country and has chosen wisely in maintaining a balance between fundamental and applied problems. This balance is not easy to maintain and can only be maintained by the interests of the individual workers in such a Division. I believe that scientific work will only prosper if a group of individuals can be assembled who have expert interests in various aspects of science pertaining to the problems you are studying.

It is no use expecting a Division such as Forest Products to change vitally and materially its field of work at short notice. Such changes must be planned and I think Mr. Clarke must welcome these discussions as they must help him to plan for adequate and sensible objectives in this Division's research. I hope that this Conference may hold the same meaning for the other interests represented.

In C.S.I.R.O., and particularly in this Division, we have always welcomed the entry into the field of research of other bodies with similar and related objectives. There is no doubt that this country is so large that one institution located at one place cannot hope to cope adequately with all problems of an industrial and applied nature. We find it quite impossible to extend our own facilities into the four corners of the Commonwealth. We have tried to do this in the case of one or two of our Divisions but problems of scientific management become very difficult. The same problems would appear if C.S.I.R.O. attempted, in a field such as forest products, to set up laboratories to deal with all the fundamental and applied work. It is for this reason that we very much favour and encourage the growth of sister laboratories in organizations other than our own.

It is quite evident from the programme of this Conference

that it is your intention to integrate the work of this Division with that which your organizations are doing and intend to do in the future.

I have given very serious thought recently as to how the results of research can most effectively be brought into use in industry. We feel that industry does not take up the results of work as readily, quickly and enthusiastically as they might, in spite of our best endeavours with information officers, and with booklets describing results as simply as possible. Having given a great deal of thought to the matter and having seen what happens in other countries of the world, and particularly in the United States, I feel there is only one answer to the problem. Unless those engaged in industry are willing to take some part in the initiation, direction and management of research we will never achieve the optimum in the research field. In the United States industrialists are always thinking of research as a means of bettering their production, cheapening their production or creating new types of production. It is for this reason that the U.S. has advanced so rapidly in the industrial field compared with other countries.

I know that forest products covers a very wide field and that different bodies cover different interests but I still feel that this interest by industry must be obtained if we are to have the results of our research used effectively.

On behalf of the Executive and members of this Division I would like to welcome you to this, the Sixth Forest Products Research Conference, and I hope that you will have much interesting and profitable discussion.

ITEM 1 - REPORT ON BRITISH COMMONWEALTH FORESTRY CONFERENCE

On behalf of members of the Conference Mr. Clarke welcomed Dr. Ramaswamy, Chief Forest Officer, Forest Research Laboratory, Bangalore, who is spending 4 or 5 months at the Division under the Colombo Plan. He also welcomed Mr. Hodder who has been working at the Division for some months. Mr. Hodder is from New Zealand Forest

Products Limited.

Mr. Clarke: Prior to the 1947 British Commonwealth Forestry Conference, forest products research was not dealt with as a separate item. A number of items dealing with forest products were included in the main Forestry Conference. At the 1947 Conference a definite effort was made to provide for separate discussions on forest products research throughout the British Empire and separate sittings were arranged. A Standing Committee on Forest Products Research was set up and in the five yearly intervals between Conferences all matters of interest are dealt with by this Committee. Four Corresponding Committees were formed covering (a) Timber Mechanics; (b) Composite Wood; (c) Terms and Definitions and (d) Preservation.

A recommendation was also made that specialist conferences should be held from time to time and preliminary steps were taken to hold such a conference on timber mechanics. This was held in Ottawa and Madison in 1948.

It was also decided that at the 1952 Conference a pre-Conference on Forest Products should be held. This was done and at the pre-Conference all countries of the British Empire, with the exception of New Zealand, South Africa and India, were represented. There was also a representative of the Commonwealth Forestry Bureau, Oxford and a delegation of three from the Forest Products Research Laboratory, Madison.

To give greater continuity of operations it was decided to elect a permanent Chairman of the Standing Committee with executive power to take any action necessary between Conferences, in correspondence with other members of the Standing Committee.

The work of the Corresponding Committees was reviewed and generally these were found satisfactory, with the exception of the Preservation Sub-Committee which was widened to include wood deterioration.

Two new Committees were formed, one on Seasoning, with

Australia as convening country, and the other on Fundamental Research, this latter Committee consisting of the officers in charge of the various laboratories.

A very wide range of technical papers was presented at the Conference and many matters of interest to Australia were discussed. It is hoped to have the Report of the Conference before long and copies for the State Forest Services have been requested.

As these minutes are very detailed, the work of the Conference need not be mentioned further here.

Australia and New Zealand will be the hosts for the next Conference which will be held in 1957.

ITEM 3 - NOMENCLATURE

(a) Australian Species

Mr. Turnbull: The current Australian Standard No.O.2 "Nomenclature of Australian Timbers", has been in need of revision for some time. We hope to standardize the names of many more timbers without increasing unduly the diversity of names in the Australian field. A lot of background work has been done. A list of Australian genera has been prepared, their present names listed and a preliminary choice made of the best name to promote for each. The second step has been to list the names for the species within quite a number of genera and we have now circulated lists for three of the genera - Acacia, Elaoecarpus and Callitris - to Forest Departments, Government Botanists and other interested bodies, inviting comment. Not all have been returned yet. Each list is circulated in duplicate and return of one is requested with corrections, suggestions, etc. We will try and prepare a consolidated statement from the returns for submission to the Standards Association as a revision of the Australian Standard.

Mr. Jennings: We have Mr. Turnbull's draft under consideration. We would question in regard to the Acacias whether it is desirable to include all species. Many are only of minor economic importance. We are in agreement regarding the Elaoecarpus, but do not agree with the

Callitris proposals. We are happy to carry out any further work required.

Mr. Turnbull: These three genera were really a test of the system. When we started we had only the commercial timbers in mind but the late C. T. White felt if all species names were standardized botanists might be assisted also. All those included at present will not appear in the final Standard. States are asked to indicate those timbers which they consider of commercial importance.

Mr. Huddleston: I recall that at a previous Conference we decided to include all timbers and plants likely to have economic importance in forest products. Many plants are likely to assume economic importance because of their derivatives. I admit this will make the list bulky and it may be necessary to subdivide it but I think it is desirable.

(b) Imported Timbers

Mr. Hammond: It was hoped to have the final list ready before this Conference but this was not possible. I will however give a brief outline of progress made.

Following the recommendation in 1948 a preliminary draft was prepared and sent to Queensland Forest Service, Division of Wood Technology and Division of Forest Products for comment and suggestions. When this draft was returned a further draft was prepared but it was obvious that it was still not as comprehensive as possible. As it seemed likely that several New Guinea timbers were likely to come on to the Australian market, the list was also sent to Mr. McAdam for suggestions and these were incorporated. The list was then ready for submission to the Standards Association. This was submitted in May 1952, with a request that the Timber Industry Committee of New South Wales should give consideration to its issue as a publication under the Australian Standards Association. It was explained to the Standards Association that this list was prepared by the Forestry and Timber Bureau with the help and assistance of all interested

Departments and in August 1952 the Standards Association had prepared a draft list which followed substantially the form prepared by the Forestry and Timber Bureau but they had subdivided the list into three parts as in the old publication, whereas the Forestry and Timber Bureau wished to have it published in one part only plus an index. A Postal Ballot has been arranged for the acceptance or otherwise of this Standard as proposed by the Standards Association which closes today. As far as the Forestry and Timber Bureau is concerned it is hoped that a negative vote is recorded and it is thought that when the reasons for the one list plus index suggestion of the Bureau is better understood by the Standards Association that this will be accepted. Further discussion on the proposal will be necessary but it is hoped that something definite will be achieved within the next month or two.

Mr. Turnbull: I have had quite a few discussions with the Forestry and Timber Bureau regarding this list and I agree that it would be simpler to have one list, plus an index to include standard common names, other common names and botanical names, with numbers referring back to the list.

ITEM 4 - BUILDING BOARDS, BINDER BOARDS ETC.

(a) CONSUMPTION FIGURES OF HARD AND SOFT FIBRE BOARDS

The following consumption figures were presented by Mr. Campbell.

Per Capita Figures of Hard and Soft Fibreboard Availability 1950/51 and 1951/52

Hard fibreboard sq.ft. 3/16 in. basis		
State	1950/51 sq.ft.	1951/52 sq.ft.
New South Wales	13.4	17.99
Victoria	15.4	18.1
Queensland	16.6	16.0
South Australia	12.0	18.95
Western Australia	7.7	10.9
Tasmania	15.6	31.6
Northern Territory	18.4	24.5
Commonwealth	13.9	17.8

Soft fibreboard sq.ft. 1/2 in. basis		
State	1950/51 sq.ft.	1951/52 sq.ft.
New South Wales	4.5	4.9
Victoria	3.7	3.9
Queensland	3.55	2.25
South Australia	5.45	9.3
Western Australia	1.7	3.6
Tasmania	4.7	6.9
Northern Territory	-	-
Commonwealth	4.0	4.6

Availability of Hard Fibreboard - 3/16 in.
1950/51 - 1951/52

	New South Wales		Victoria	
	1950/51	1951/52	1950/51	1951/52
Distribution	34,928,887	35,706,618	15,579,496	19,055,792
Imports	8,892,236	24,741,876	18,764,687	22,450,325
Availability	43,821,123	60,448,494	34,344,183	41,506,117
Exported	1,915,544	1,412,160	-	-

	Queensland		South Australia	
	1950/51	1951/52	1950/51	1951/52
Distribution	8,753,583	7,432,815	5,714,243	6,119,798
Imports	11,067,107	12,119,160	2,829,572	7,713,702
Availability	19,820,690	19,551,975	8,543,815	13,833,500
Exported	16,256	16,000	-	-

	Western Australia		Tasmania	
	1950/51	1951/52	1950/51	1951/52
Distribution	2,952,741	2,027,680	2,951,900	9,680,340
Imports	1,467,899	4,409,961	1,633,097	21,895
Availability	4,420,640	6,437,641	4,584,997	9,720,235
Exported	-	-	-	-

	Northern Territory		Commonwealth	
	1950/51	1951/52	1950/51	1951/52
Distribution	277,824	380,690	71,140,674	80,403,723
Imports	-	-	44,654,598	71,456,915
Availability	277,824	380,690	115,795,272	151,860,638
Exported	-	-	1,931,800	1,428,160

Availability of Soft Fibreboard - 1/2 in.
1950/51 - 1951/52

	New South Wales		Victoria	
	1950/51	1951/52	1950/51	1951/52
Distribution	14,023,447	12,702,000	7,204,727	7,469,000
Imports	695,428	3,840,011	1,012,785	1,377,886
Availability	14,718,875	16,542,011	8,217,512	8,846,886
Exported	-	-	-	-

	Queensland		South Australia	
	1950/51	1951/52	1950/51	1951/52
Distribution	4,096,714	2,405,000	3,654,222	4,815,000
Imports	137,856	339,686	228,142	1,974,139
Availability	4,234,570	2,744,686	3,882,364	6,789,139
Exported	257,362	873,000	-	-

	Western Australia		Tasmania	
	1950/51	1951/52	1950/51	1951/52
Distribution	900,450	1,633,000	1,210,018	1,503,000
Imports	73,213	472,160	182,857	619,122
Availability	973,663	2,105,160	1,392,875	2,122,122
Exported	-	-	-	-

	Northern Territory		Commonwealth	
	1950/51	1951/52	1950/51	1951/52
Distribution	-	-	31,089,578	30,527,000
Imports	-	-	2,330,281	8,622,994
Availability	-	-	33,419,859	39,149,994
Exported	-	-	257,362	873,000

ITEM 4 (b) - PROPERTIES OF *PINUS RADIATA* AND *E.CREBRA* BARK SAWDUST BOARDS *

Pinus radiata bark and sawdust and *E. crebra* bark with mixed hardwood sawdust have been examined.

Useful boards can be made with these mixtures, the most satisfactory conditions in both cases being as previously reported for *Callitris glauca* (300 lb./sq.in., 130°C. and 6 min. pressing time).

The most important variable to be examined so far is the moisture content of the mixture before pressing. An important improvement in the previously reported properties of the board has been made by adjusting the moisture content of the mixture to 17.5 per cent. which seems to be the optimum. However, with *Pinus radiata* mixtures, up to 25 per cent. moisture content can be used provided the boards are allowed to mature.

The work carried out with *Callitris glauca* bark and sawdust indicated that the properties of boards produced from these mixtures varied in some way with the moisture content of the mixture before pressing. Probably because of the presence of large amounts of sandarac resin in this material, which together with the tannin-formaldehyde resin formed during the reaction, gave a board with a very high resin content, these boards proved extremely difficult to press satisfactorily from mixtures with moisture contents other than those reported. Neither repressing, breathing, wire mesh nor any other technique tried was, for various reasons, successful in stopping the boards from splitting on the release of pressure within the range 13 per cent. - 30 per cent. H_2O. *Pinus radiata* and *E. crebra* however, proved to be more satisfactory in this respect and mixtures of all moisture contents could be examined. This proved to be extremely valuable in that it showed that the moisture content of the mixture before pressing is the most important variable to be investigated so far. The close correlation between variation in modulus of rupture

---

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

and water absorption undoubtedly shows that there has been a substantial improvement in the distribution of the resin leading to the formation of a board which has definite commercial possibilities. A much improved appearance has resulted, both with regard to the uniformity of the surface and the lack of porosity.

The improvement in the properties of the board with the increased moisture content of the mixture is probably due to the increased availability and distribution of those materials in the bark which react with formaldehyde. It is suggested that as the reaction takes place in aqueous solutions under the conditions of pressing, the maximum resin distribution and content is reached under those conditions which will dissolve the greatest amount of the tannin materials but which do not allow materials when dissolved to flow out of the mixture when pressure is applied. Under these conditions the sawdust absorbs the water soluble material before it has time to react with formaldehyde or before the mixture is hot enough for the formaldehyde to form its monomer. This thorough distribution of one of the raw materials of the adhesive together with the fact that the other constituent is gaseous is apparently the primary cause of the improvement in the properties resulting from increasing the moisture content up to 25 per cent. After this figure is reached free water together with the dissolved material is squeezed from the mixture on pressing. A decline in the board's properties can then be expected and is, in fact, found (see Fig.1 and 7).

The improvement in the modulus of rupture of boards made from mixtures having a moisture content higher than 17.5 per cent. on standing 4 weeks for Pinus radiata and 3 weeks for E. crebra, checks with a similar observation made in the Progress Report dealing with Callitris glauca. When these boards are resoaked their modulus of rupture probably reverts to something like their original figures. One such board was so treated giving this result.

Boards made with sawdust wetted just prior to pressing

appear to be better than boards made with sawdust of the same moisture content but which is drying out. This may be due to the uneven drying of the sawdust as a whole, that is, some particles are very wet and some almost air dry. Also when finely ground bark is mixed with freshly wet sawdust, it adheres to the latter, giving a fairly uniform distribution of the tannin bearing bark powder.

The methods used to press mixtures with water contents 17.5 per cent. to 25 per cent. are unsatisfactory for commercial production. Methods usually resorted to such as wire gauze, breathing etc., were not successful. The pressing operation should, it appears, proceed as follows:-

(a) The tannin, dissolved in the water contained in the mixture, should be pressed on to the sawdust so that it is well distributed. This should occur before the mixture is hot enough for appreciable quantities of formaldehyde vapour to be available. The pressure used at this stage need only be great enough to accomplish this.

(b) The mixture must then be heated sufficiently to make para-formaldehyde break down completely to formaldehyde. Sufficient water should be available for the reaction required to form the adhesive to take place in aqueous solutions. This should preferably be done at 300 lb./sq.in.

(c) As soon as the reaction has been completed sufficiently, some method of releasing the gases without injuring the board is necessary.

Some sawdust must be used to make a satisfactory board. It appears that the lack of fibrous material in the Pinus radiata bark powder causes the board to lose strength. Enough resin appears to be formed in both Pinus radiata and E. orebra mixtures with as low as 20 per cent. bark to make a board with useful strength properties. The moisture absorption of these boards was fairly high. Higher bark contents up to 80 per cent. showed an improving modulus of rupture and

a decrease in moisture absorption more marked in the case of Pinus radiata than E. crebra. The fairly good moisture absorption properties are probably caused by a good distribution of the water resistant adhesive formed in the process together with the closely packed nature of the board as indicated by the high density. It is clear that for certain uses, barks with a good tannin content can be used to as low as 20 per cent. in the bark sawdust mixture. Also not much advantage can be gained by making boards with more than 50 per cent. to 60 per cent. bark.

Neither temperature nor pressure cause a great deal of difference in the modulus of rupture of the boards when the minimum conditions required for the reaction are met.

Mr. Huddleston: Primarily the purpose of this paper was to discuss some of the factors influencing the properties of the boards and to endeavour to obtain from the Conference some indication of any likely utilization in this field. You will recall that at our last Conference reference was made to a board being manufactured in Newcastle by a firm making floor boards from sawdust. Unfortunately, owing to financial stringency it has not been possible to sell that board in competition with solid flooring material and this firm is now out of production. For similar reasons we have not found any interest in the manufacture of hardboard. We therefore feel that any work we can do in this field or in any field connected with hardwood board manufacture is work for the future and hence at the present time has a purely academic interest; but we are endeavouring to determine some of the factors which influence the properties of these boards.

Mr. Wright: I have a feeling that the use of the native bark in a finely ground form as a binder may work very well on a laboratory scale, but I suspect great difficulty will be found in getting comparable or reproducible results on a commercial basis.

Is the uniformity of tannin within the bark system sufficiently good to ensure that one would get reproducible

adhesive properties from different commercial parcels of powdered bark if these were from different areas, particularly at different seasons of the year ?

To ensure uniformity of board quality on a commercial scale with tannin formaldehyde as the binder, I would not be surprised if one had to go to the trouble of setting up plant to manufacture a standardized tannin formaldehyde syrup. In such a case it is very probable that the cost of manufacture would not be greatly different from that of manufacturing a urea or cresol formaldehyde syrup, so that it is doubtful if anything would be gained economically. A disadvantage of the tannin formaldehydes is that they are dark in colour. We were disappointed to find that even when we started with a light coloured particle material, it was not possible to get other than a dark coloured board.

Mr. Huddleston: I have no definite evidence which will allow me to answer this question satisfactorily. The laboratory scale manufacture of boards from Pinus radiata and from E. crebra has been based on the production of a quantity of tannin-formaldehyde resin which would require an amount of 8 per cent. tannin in the bark used. From a survey carried out, we found in practically all samples that the tannin content is above this limit, hence the average material available would have tannin in excess of that which can be used by the formaldehyde. If you want to increase the hardness of your boards, or their strength, in most cases you can do so by adding paraformaldehyde.

Mr. Turnbull: Were any of the gum types of stringybark types investigated ?

Mr. Huddleston: Yes, we have handled quite a number of barks, but, while some of them have made satisfactory boards, each one of them introduces problems of its own. There is the problem of grinding to get a suitable material for pressing. For that reason we have concentrated on Pinus radiata, and we have included E. crebra to assist us in the investigation. Those are species where

bark and sawdust are likely to be available in the one species in sufficient quantities to warrant utilization.

Mr. McAdam: In these experiments for building boards, I understand that young mangrove saplings are not very satisfactory tannin-producing barks, and that the tannin content increases considerably with age. Unless some work has been done on this type of young sapling growth it is possible that you might get a low content of tannin.

Mr. Huddleston: So far as we can determine from our investigations, tannin does not run true to form. What applies to one species does not apply to another.

Mr. Hodder: From the standpoint of strength quality, it does seem to me, Mr. Chairman, on the basis of the figures given here that strength properties seem to be rather low. The minimum standard for a hardboard in America and in Great Britain is about 6000 lb./sq.in. I presume quite a considerable amount of work has been done in endeavouring to improve strength. The other point is the question of percentage of bark and sawdust in these boards. It would be interesting to have any information on this particular point and whether there is an optimum figure for the quantity of ground bark to be added to the sawdust.

Mr. Huddleston: As I said previously in reply to Mr. Wright, in most cases the addition of paraformaldehyde would give greater hardness and greater strength. If you want a board of high strength and hardness you can make it out of pure bark; that is if you want something approaching the texture of, say, masonite or compressed wood. In Pinus radiata you can use about 50 per cent. sawdust and 50 per cent. bark. That could be altered again if you had a bark which contained a higher percentage of tannin than that which we get in our plantations. We have made boards from some of the eucalypts in which the tannin occurs in the timber and not in the bark, and in that case we get a better product out of the timber sawdust alone.

Mr. Kloot: I think Mr. Hodder is mistaken in quoting 6000 lb./sq.in. as the specification limit for modulus of rupture. From memory, the figure in the British specification is nearer 3000 lb./sq.in. I know of only one hardboard that could pass 6000 lb./sq.in., whereas all the makes we have tested would pass the lower figure.

ITEM 4 (c) - EXPERIMENTAL WORK (STATUS OF INVESTIGATIONS ON PULP BOARDS, MECHANICAL PROPERTIES, AND BINDER PRODUCTS)

Mr. Turnbull: In the past year work on pulped fibreboards has included pressing experiments with commercial wallboard pulps, production of hardboards from E. regnans and E. sieberiana, some trials of sizing and the testing of equipment. Pulp supplied by courtesy of a New Zealand company was used in studying the effect of variations of temperature and pressure on the properties of dry-pressed hardboards. By using a short pressing cycle without breathing, boards having a modulus of rupture in excess of commercial hardboards have been produced. Over a range of temperatures in the vicinity of 250°C. and pressures near 1400 lb./sq.in. a correlation was found between modulus of rupture and temperature, but not between modulus of rupture and pressure. Elevation of the temperature improved moisture resistance to a degree that conformed with the requirements of the British standard. It has been found that bonding is affected by the lignin present. Paper pulp practically free from lignin could not be converted into good hardboards by either the wet pressing or dry pressing techniques, the resulting products being soft and prone to separate when flexed. Material rich in lignin such as coconut fibre and powder pressed satisfactorily, could tolerate temperatures above those used for wood pulp and gave a hard product.

Hardboards comparable with commercial products were readily produced from E. regnans and E. sieberiana under various conditions. These species tended to yield a high proportion of fines in their pulps which lengthened the draining time and introduced some difficulties during pressing. A study of the pressing characteristics

of different fractions was intended, but time has not allowed fractionization and completion of the proposed work. There was no striking difference in the two species. The hardwood pulps were used in a short series of experiments on sizing. By using a wax size a water resistance equal to that of commercial hardboards was obtained with 1/2 per cent. wax size compared with the 3 per cent. required with the conventional rosin-alum size.

In view of the expansion of the fibreboard industry that has taken place by following more or less conventional techniques, preliminary consideration has been given to alternative production methods that might be investigated. The literature on the gelatinization of wood has been reviewed and work started on the preparation of this material. We have made it from Pinus radiata and E. regnans and combined it with raw sawdust to produce some boards that look reasonably promising. The gelatinized wood has been made by prolonged ball milling of sawdusts and has reached the stage when we must find a way of evaluating the gelatinized pulp. It is too slow for testing in any of the recognized freeness testing apparatus. Differences in its swelling characteristics at different stages of preparation have been observed, and these are being examined as a possible means of determining the degree of gelatinization. The van Gelder mill is not proving satisfactory because even with a constant setting a uniform product is difficult to produce from run to run. We are endeavouring to control the feed rate of solids and the flow of water. We hope that a Bauer laboratory mill which is on order will give us consistent results when it comes to hand.

ITEM 4 (c) contd. - WASTE LIGNO-CELLULOSE BINDER PRODUCTS *

This Division's most recent work in this field has been aimed principally at assessing the possibilities of the following combinations to make either a hardboard or coreboard.

(i) Waste veneer with synthetic resin.

(ii) Bagasse with synthetic resin.

* Prepared by Officers of the Division of Forest Products.

(iii) Coir fibre dust with synthetic resin.

(iv) Cocomut fibre with synthetic resin.

In addition, a study was made of the following possible binders, namely,

(v) Xanthorrhoea resin.

(vi) Decayed heart material from the "ash" eucalypt species.

The principal results of these studies may be summarized as follows.

(i) Waste veneer with synthetic resin combinations

The first aspects covered in this study involved a determination of the most satisfactory type of "chip" required, of a method for producing it, and of the type of milling plate necessary to give the desired final chip properties.

From this work followed studies of the variables affected by the combination of the relatively large particle material with urea-cresol and tannin-formaldehyde resin to give core board panels about 5/8 in. thick; the variables included the effect of pressure, temperature, resin proportion, etc.

In the later stages of this work techniques for pressing all core board components (namely, the loose chip material, the cross banding and the face veneers) in the one operation were developed. This consisted of placing the chips and veneer, which had previously been coated with the hot setting resin, into a suitable form and pressing at a temperature of 280°F. at relatively low pressure for about 20 min. The shorter chunky softwood chips produce a more homogeneous core than the longer spiky hardwood chips.

(ii) Bagasse-resin board

At the request of a Queensland sugar producing company with a considerable excess of bagasse, studies were made of the possibilities of using a bagasse-resin combination to make a hardboard. Some 40 trial boards were made up, constitution and press conditions being varied on the basis of the successive mechanical and physical test

results obtained.

General requirements were that the board have two smooth faces and that, for economic reasons, not more than 2 per cent. of the synthetic resin be required as the binder.

The study demonstrated that with bagasse moisture contents greater than about 7 per cent. in the absence of a backing screen, severe "burning" took place; on the other hand with the bagasse moisture content too low the mechanical properties suffered, possibly because of the influence on plasticity and flow characteristics of both the bagasse and resin.

It was found that with the bagasse graded with a 14 B.S.S. mesh, with a moisture content at about 5 per cent. and with a cresylic resin proportion of 7 per cent., a board pressed at about 410°F. gave close optimum properties; even so, they were appreciably inferior in both strength and stability to standard Australian hardboard. With the resin proportion held at 2 per cent. as specified, the best combination gave values of modulus of rupture and water absorption* no better than 2500 lb./sq.in. and 87 per cent. respectively.

(iii) Coir fibre dust - resin combinations

At the request of the Department of Industry, Ceylon, studies were made to determine the value of coir fibre dust as a raw material for hardboard manufacture by the dry process. Some 60 test samples were prepared and tested.

With the material as received, although relatively high resin proportions (up to 10 per cent. of cresol resin) and pressure up to 500 lb./sq.in. gave good appearance, mechanical properties remained very low. During this phase of the work it was found that the raw material had included in it a fairly high proportion of a gravelly substance.

In subsequent studies as much as possible of the "foreign" material was removed, and the influence of adding a proportion of

* Because of the limited size of experimental sheets, water absorption samples were 2 in.x $1\frac{1}{2}$ in., with unprotected edges and soaked for 48 hr. at room temperature.

coir fibre (up to 20 per cent. by weight) was examined. Best results were with 10 per cent. of cresol resin pressed to 400°F., and at 500 lb./sq.in. to give a modulus of rupture of 3000 lb./sq.in. With 5 per cent. of resin the modulus of rupture dropped to about 1500 lb./sq.in. These values were some 25 per cent. better than was obtained without the fibre additive. The properties of board hot pressed with a urea formaldehyde resin as the binder were found to be markedly inferior to those hot pressed with the cresol formaldehyde resin.

Tests with rubber latex and casein-rubber latex showed that unless the proportion of rubber latex was greater than 80 per cent., edge splitting and warping of test samples occurred during drying. It was also shown that, in the absence of hot pressing facilities, urea formaldehyde as the binder was the most promising of the cold setting binders for pressing at higher pressure (e.g. 900 lb./sq.in.).

(iv) Coconut fibre-resin combinations

Some limited studies on the suitability of coconut fibre and coconut fibre-resin combinations for hardboard production by a dry process were also made. The results demonstrated that the coconut fibre alone with pressure up to 500 lb./sq.in. and temperature at 400°F., and despite the addition of some 2 per cent. hexamine or paraformaldehyde, did not give values for modulus of rupture better than 1000 lb./sq.in., nor water absorption properties better than 100 per cent.

Boards made with 10 per cent. of the cresol-formaldehyde resin increased the modulus of rupture to 3000 lb./sq.in. and improved the water absorption to 53 per cent., the surface also becoming hard and smooth.

(v) Xanthorrhoea resin as a binder

Forty sample boards were made to test the suitability of the resin of the "red" variety of xanthorrhoea as a binder for sawdust boards or products.

The results indicated that the accroides resin produced only a low quality hardboard. With 10 per cent. of the resin and hardwood

sawdust at a moisture content of 10 per cent., a modulus of rupture of 1350 lb./sq.in. and a water absorption of 40 per cent., were obtained. By comparison, cresol formaldehyde as a binder, with the constitution of the board mix and the pressing technique otherwise identical, gave values from 4500 to 5000 lb./sq.in., and a slightly lower water absorption. With softwood sawdust and the accroides resin, test results gave modulus of rupture at 920 lb./sq.in. and water absorption at 110 per cent., these being appreciably inferior to those obtained with the hardwood sawdust. The best test values obtained for strength and water absorption were with 20 per cent. of the accroides resin as the binder for a hardwood sawdust, modulus of rupture of 1720 lb./sq.in., and water absorption 27 per cent.

(vi) Decayed heartwood as a binder

A limited study of the value of decayed heartwood material (obtained from the heart of over-mature "ash" type eucalypts) as a binder for sawdust-based hardboard and briquettes to be made by a dry process, was made. To convert the wet decayed heartwood material to a form in which it could be used as a binder, it had first to be dried and then ground to pass through a 72 B.S.S. mesh.

Approximately 20 boards were made at constant pressing conditions of 500 lb./sq.in., and a temperature of approximately 400°F. Because analysis of the decayed heart material showed it to contain a high proportion of lignin, the effect of adding 1 to 2 per cent. of paraformaldehyde and hexamine was also examined. The binder content used varied from 5 to 30 per cent.

The general appearance of the board produced was good, but even with 30 per cent. binder the modulus of rupture was low, no board exceeding 500 lb./sq.in. The general level of results for water absorption was poor, although increased amounts of the binder affected a slight improvement. No indication of any improvement in strength and water absorption by the addition of hexamine or paraformaldehyde was obtained.

It is thought that the powdered decayed heart material

has less satisfactory flow characteristics than a synthetic powdered resin and, therefore, may require higher pressures to ensure adequate distribution of the binder particle in the case of briquettes. For this latter purpose, moisture content control was found to be very critical; if above approximately 5 per cent. extensive "burning" occurred and some internal "blowing" of the briquette.

Discussion:

Mr. Grenning: Does the Division of Forest Products believe that the manufacture of veneer waste resin coreboard is economically attractive ?

Mr. Wright: Over the last several months there has been a recession in all commercial activity, so that one is loth to reply categorically with respect to present circumstances. However, we believe that the commercial manufacture of waste-wood coreboard should compete satisfactorily with solid coreboard in price.

Mr. Jennings: What is the minimum economic size of a dry process coreboard plant ?

Mr. Wright: It is generally considered to be around 10 tons per day- say 10,000 sq.ft. of 3/4 in. thick board per day - although it is likely in some circumstances that a daily production rate of about 5 tons would be economical.

Mr. Clarke: An advantage of the veneer waste type of coreboard is that it provides an open textured composition in the core, so that it is possible to obtain reasonably low and medium density boards from it.

Dr. Fitzgerald: Resins used for these boards are either those which would impregnate the material or more fully condensed resins which do not penetrate the wood but which are more viscous. It is difficult to spread these resins over a large surface.

Mr. Wright: Commercially the use of liquid resins has been accepted and is usual. In the Division powdered resin has been used for convenience, but recently an effort has been made to develop

techniques with liquid resins on a small scale. One of the difficulties of using powdered resins is that there is a tendency to segregation.

Mr. Turnbull: With regard to economical factors, these materials have hit the market at the worst possible time as the furniture trade has been one of the first to feel the effect of capital restrictions. As far as production costs are concerned, I think it would be worthwhile to examine the possibilities of producing the material concerned in plants at present producing plywood. In this way it might be possible to combine the production of veneer waste coreboard with plywood. Perhaps it would be possible to install a system of part-time work in such plants.

Mr. Gordon: There are many difficulties involved in such an arrangement, and I consider that this would result in increased overhead costs. I doubt if any of the plywood hot presses in Australia has daylights wider than 3 in. so that unless a special pre-forming process is installed only very thin boards could be produced in existing plywood presses.

Dr. Fitzgerald: Returning to the more technical aspects, if water soluble resins are used a fair proportion of the resin would be wasted as far as bonding is concerned as it would impregnate the particles. With viscous resins too much would be left between the particles of wood unless high pressure was used, and the same could be said for solid resins. Only sufficient resin is required to bond the particles where they touch, however impregnation would increase the stability and water resistance of the board.

Mr. Clarke and Mr. Huddleston referred to the value of the work in this field, as the product would serve a useful purpose and at the same time provide an avenue of waste-wood utilization.

ITEM 4(c) contd. - MECHANICAL PROPERTIES OF FIBREBOARDS

Mr. Kloot: It is my intention to report very briefly our investigations on the mechanical properties of fibre building boards of local and overseas manufacture. I do not think details of the work

will be of any great interest to this Conference, although I will be happy to supply them to anyone interested.

We have sampled and tested a large number of makes of board available on the local market. Our aim has been to obtain a background of information on the properties of fibreboards in general with the ultimate object of assisting such bodies as the Standards Association in the formulation of standard specifications for this type of material. In all we have sampled approximately 330 sheets representing 30 different makes of board, 20 of which were hardboards, the remainder insulating boards. In addition we have sampled for comparative purposes asbestos-cement, fibrous plaster and plaster board.

On material conditioned at 65 per cent. relative humidity we have obtained average values and variability figures for bending strength and stiffness, tensile and compression strength, hardness, puncture resistance and lateral nail holding power. The physical properties of density, weight per 100 sq.ft., and thickness were incidentally measured. The effect of soaking in water for 24 hr. was observed on bending, tension and puncture specimens, and also on lateral nail pulling resistance.

Altogether some 15,000 individual tests have been made, including a number of minor investigations to study the effect of various factors, particularly on the methods of test. As far as the mechanical testing is concerned the project, as originally planned, has been completed, and a report of the results is now in preparation.

Mr. Cokley: How do the Australian boards compare with imported boards ?

Mr. Kloot: There are very few Australian boards available for comparison. I would say they are in the upper grade as far as their strength properties are concerned.

Mr. Kingston: In connection with the various imported boards Mr. Kloot has been examining, we have done some tests on each of the types on the swelling during soaking tests and moisture pick-

up. This information is available to anyone interested.

ITEM 5 - BATTERY SEPARATOR VENEER SUPPLY POSITION

Mr. Campbell: In recent months there has been a great change in the battery separator supply position. This had come about by -

(i) pressure by battery manufacturers to obtain battery separator veneers from whatever source possible with the result that by the end of 1951 the battery trade as a whole was fairly well stocked;

(ii) 1952 saw a considerable fall in the demand for separators;

(iii) local demand for batteries decreased in 1952. Production of kauri separators was increased because of the depression in the kauri plywood industry.

The position was aggravated by the issue of licences by the Department of Trade and Customs without reference to the Forestry and Timber Bureau. Some licences have been cancelled and the Customs Department has been informed that no licences should be issued for other than Port Orford cedar.

Beech was imported from Europe to avoid dollar expenditure but battery manufacturers who intended to use it were informed that it would probably not be suitable and this has proved the case.

Mr. Kingston: We did some tests on one or two Nothofagus species which proved unsuitable. In general pored species are unsuitable because they soften readily in acid. This has been our experience with most pored timbers, except possibly yellow carabeen. A white deposit forms on yellow carabeen separators and we are not sure yet whether this is deleterious. It has been said that sassafras is satisfactory for separators but we have not carried out any tests because of the shortage of that species.

Reports from overseas indicate that beech is not favoured for separators. I think the reduction in demand for separator veneers

may be due to some extent to the fact that overseas the present trend is to switch from wooden to plastic and micro-porous rubber separators. At least one firm in Australia is manufacturing micro-porous rubber separators.

Mr. McAdam: Is there any forecast of probable future demand ?

Mr. Campbell: Although we are getting ample kauri at present from New Guinea and other areas due to the slump in the plywood trade, if the trade does improve I know it will be desired to keep the supply of kauri for separators up so that acute shortages, such as there have been in the last few years, can be avoided.

Mr. Kingston: Two or three of the larger Sydney companies thought that the present reduction in demand was due to the fact that people had overstocked and were reducing stocks. They expect an increase in demand shortly.

ITEM 6 - RAILWAY SLEEPERS

(a) Grading

Mr. Turnbull: At the last Conference the Division of Forest Products was asked to prepare a Working Plan for field investigations on sleepers. This was written and distributed. It included a form for field use on the punch card system. We were subsequently advised that punched cards are unsuitable when observations run into thousands, but that the Powers or Hollerith types of card are satisfactory. We were strongly advised to divide the field card from the computation card. A field form was devised with headings arranged to facilitate transfer of data to computation cards. Several thousand forms have been distributed to the States but we have not had any progress reports of the field work yet.

Mr. Jennings: The survey is in progress in Queensland by district officers and we expect to get reasonable results within two or three months.

Mr. Huddleston: We propose to commence the survey in New

South Wales in the very near future.

(b) High Pressure Treatment

Mr. Tack: The high pressure treating cylinder has now been operating quite successfully for a little over one year, and a large number of sleepers, crossarms, and other specimens have been treated with creosote oil and creosote plus fuel oil mixtures. A total of some 30 eucalypt species has now been treated.

Sleepers have been treated for the Western Australian and Commonwealth Railways, species being jarrah, karri and marri. In the sleepers treated for the Western Australian Railways some 150 sleepers (50 each of jarrah, karri and marri) were treated with creosote oil using a schedule of 10-15 min. initial vacuum, followed by a pressure period of 45-60 min. at 1000 lb./sq.in. at 150°F. with no final vacuum. The mean absorptions obtained were 12.9 lb./cu.ft. for jarrah, 6.7 for karri, and 8.3 for marri, and the results confirmed the trends observed in the earlier treatment of small specimens. In particular, very variable absorption obtained with jarrah was again noticed, the minimum absorption being 1.7, and the maximum 25.3 lb./cu.ft. However, results were considered quite satisfactory, having regard to the short treatment cycle used. These sleepers form part of a comparative test in which open tank treated sleepers will be included for service tests in Western Australia.

For the Commonwealth Railways 50 karri sleepers were treated in two batches, half with creosote oil and half with a creosote/diesel fuel oil (30:70) mixture. Preliminary air drying of approximately 7-1/2 months gave a moisture content on the surface of about 20 per cent., with 35 per cent. at a depth of 1 in. These sleepers were also treated at 1000 lb./sq.in. at 150°F. using an initial vacuum of 10 min. The mean absorption for all treatments was 4.8 lb./cu.ft., which was somewhat below a satisfactory figure. Variations in the treatment schedule, including extension of the pressure period to 2 hr., slightly increased absorption, and

preliminary steaming in the treatment cylinder, followed by the usual pressure cycle, raised the absorption by approximately 1/2 lb./cu.ft. Slightly increased checking, however, occurred with this preliminary steaming. Incising increased the absorption by 1.5 lb./cu.ft. to a mean figure of 6.3 lb., and it appears likely that in practice this absorption would be satisfactory. End penetration averaged 5 to 8 in. with a side penetration of 0.75 in. in the incised sleepers. These sleepers will be installed in the Leigh Creek line, together with untreated karri sleepers in two localities.

The plan for the treatment of some 2-1/2 thousand eucalypt sleepers for the Victorian Railways has now been finalized and almost 2/3rds of our requirements have been received and randomized. Half of these sleepers will be incised, at least on the upper and lower faces, with the expectation of assisting penetration of the preservative and of improving resistance to splitting of the ends during service. As a conventional roller-type incising machine was not available, a hydraulic machine has been built in the Division for this purpose. Half the sleepers will also be pre-bored and adzed (where necessary) before treatment. In this test the species to be used are mountain ash (E. regnans), messmate stringybark (E. obliqua), peppermint (E. australiana), and white stringybark (E. eugenioides), 4 species of low durability which should become increasingly available for sleeper work in the next 25 years in Victoria.

The ten preservative treatments to be used are as follows:-

1. Creosote oil at 200 lb./sq.in.
2. " " " 1000 " "
3. " " plus fuel oil 40:60 at 1000 lb./sq.in.
4. " " plus coal tar 40:60 " 1000 " "
5. Pentachlorphenol 3 per cent. in a heavy furnace oil.
6. A water soluble salt with a bituminous surface coat.
   (This salt will probably be Wolman salts, etc. and/or C.Z.C.).

7. A water soluble salt without a surface coat.
8. Crude naphthenic acid plus fuel oil 70:30.
9. Untreated, plus toxic surface coat such as creolatum, pentagrease, or crude copper naphthenate.
10. Untreated controls.

The sleepers will be installed at 2 sites in each of 3 localities, the 3 localities being the metropolitan area, a high rainfall area in Gippsland, and a low rainfall area in northeast Victoria.

In addition to the eucalypts, a small number of Pinus radiata sleepers treated with representative preservatives at 200 lb./sq.in. will also be installed.

At the last Conference it was decided that some sleepers should not be end coated and in fact approximately 10 per cent. are uncoated.

We found that the decision to dock 3 in. from the ends was a good one. We have had some sleepers air drying for about 10 months and some for 3 months and after docking 3 in. from the end the moisture content at the ends of both batches of sleepers is comparable.

We have not as yet had material from thinnings. Each species has been chosen from at least four different localities so that the range of trees likely to be available during the next 25 years is adequately covered.

The life of an untreated sleeper will probably be between 8 and 14 years.

ITEM 6 contd. - FIELD SURVEY OF MOISTURE CONTENTS IN RAILWAY SLEEPERS *

Mr. Wright: A limited field survey to determine whether the average moisture content of railway sleepers in service tended to level out at a mean value or not, and the extent to which moisture gradients develop in situ, was commenced during early 1951. The influence of site was naturally included in the study,

* Prepared by Officers of the Division of Forest Products.

although this initial study was limited to the Melbourne metropolitan and urban area.

Five test sites were selected, including situations with exposed banks, in cuttings, and near and under bridges.

Successive moisture content readings were obtained by a technique using a moisture meter calibrated from 8 to 40 per cent. and with permanent electrodes imbedded in the sleeper to depths of 1/2 in. and 2-1/2 in. The longer electrodes were protected for 2 in. of their depth with polyvinyl chloride sleeves. The sleeper species were white and yellow stringybark and red gum.

The following general summary of results was obtained.

(a) At site 1, where two groups of sleepers were selected which had been in position from 5 to 10 years, (one group in a well drained site and the other in a poorly drained position), the sleeper core value showed virtually no moisture content variation from about 40 per cent. and greater over a period of 18 months, (i.e. from February of one year to August of the next). The case moisture content value averaged 22 per cent. in mid-summer (February) and 28 per cent. in winter (August).

(b) At site 2, three sets of test sleepers were selected, one in a well drained shallow cutting, one in a badly drained cutting, and the other in an exposed position near a bridge. These track sections had been relayed early in 1950. Practically all core moisture content values were above 40 per cent. over the period of study, although case readings fluctuated from about 20 per cent. in the first late summer to 35 to 40 per cent. in winter, but dropped again to about 18 per cent. in the following mid-spring.

(c) At site 3, the test groups were located on an exposed but well drained bank. Most of the sleepers were from 10 to 20 years old.

The core readings, generally, remained in the 30 to 40 per cent. moisture content range, although they did show some evidence of slight seasonal fluctuation. End differences were somewhat more marked (i.e. moisture changes at 6 in. and 12 in. distances from the sleeper

ends). The case moisture content readings were much as at site 2, i.e. a fluctuation from about 18 to 20 per cent. in mid-summer to 35 per cent. or more in mid-winter.

(d) At site 4, it was understood the sleepers were from 15 to 20 years old, and at site 5 at least 20 years old.

Again a range of varying site conditions was provided. Even in the case of long time exposure specimens the core moisture content value averaged around 35 to 40 per cent. irrespective of season, although the case values showed a seasonal variation from as low as 14 per cent. in summer to 35 per cent. or so in winter.

It would appear that, at least for sites near Melbourne, or in rainfall areas similar to Melbourne, little would be gained by endeavouring fully to season sleepers before locating in track. Some partial controlled seasoning of surface zones, particularly if the sleepers are to be preservative treated, would appear to be all that is necessary. This raises the question as to whether or not a chemical salt might not assist in improving weathering resistance, particularly with respect to surface checking and end checking in such areas. Leaching of the salt might be a weakness.

Mr. McAdam: Has any work been done on mangrove sleepers ?

Mr. Tack: The preservation work on the mangroves has been completed and the results forwarded to Mr. McAdam. Results on the mechanical, physical and seasoning aspects are still awaited but it is hoped before the end of the year to give a comprehensive report on the material. Four or 5 untreated mangrove sleepers are already in the track and 5 treated sleepers in 2 groups, one group treated with creosote and the other with fuel oil.

Mr. DaCosta: The accelerated laboratory decay tests on mangrove will be completed by the end of this year. At the moment the material does not look at all durable.

Mr. Tack: Mangrove material was impregnated to 12 to 15 lb./cu.ft. As regards service records, we have never been able to

get extensive accurate service life figures from the Victorian Railways. They have no identification tag or date system for sleepers. We do hope to get such a system operating next year in co-operation with the Victorian Railways at Nowa Nowa. They are cutting silvertop ash and have offered to co-operate to the extent of installing tagged sleepers so that we will probably have some thousands of sleepers for which we will have accurate installation dates.

Mr. Tamblyn: The Western Australian Railways use a system of drilled holes in 21 positions as a dating system. Once the code is learnt the dates are easy to ascertain. South Australia use a system of dated nails which are easy to read but are liable to be knocked out and lost.

One of our difficulties is that we do not know the main cause of failure of sleepers outside Victoria. It would be of great help to us if the State Forest Services could give consideration to making a small survey of causes of failure in typical areas in their own State. Queensland are already doing this. If all States followed suit it would be of great help to this Division in pin-pointing the type of failure to be contended with.

Mr. Huddleston: We have endeavoured to get this information from the New South Wales Railways but it seems their policy is to re-sleeper main lines every time they re-rail. These sleepers are then put into secondary tracks and sidings. Failures then occur in side tracks where it is impossible to obtain installation data.

Mr. Grenning: I would be interested to know the state at which a sleeper is deemed to have "failed". Is it when the sleeper is removed by a pick or when it has to be shovelled out ?

Mr. Jennings: In Queensland we find sleeper failure depends largely on position in track. Sleepers are replaced much more frequently on curves. The Railway Department does not use any form of rail plate, just dog spikes, and we think that the use of a rail plate would extend the service life of sleepers.

Mr. Clarke: The main requirement is to compare the life of sleepers of different species so that ultimately the Railways' expenditure on sleepers is reduced. We would like some lead as to what experimental work is required by the States. We have a request from South Australia for an investigation on the shape and size of treated Pinus radiata sleepers; we are already engaged on the Victorian test.

Mr. Tack: We have been approached by Tasmania for some tests on their low durability eucalypts. These will be treated and put in the track.

Mr. Huddleston: There is not likely to be any request from the New South Wales Railways or Forest Commission for tests on sleepers but because of recent alteration in the timber supply position, the Railways have raised the grade of sleepers they will accept. The Standards Association Interim Specification for Sleepers has just been published and the Division is more likely to be approached by private bodies who want the Railways to accept sleepers as long as they comply with the Specification. They will probably require interpretation of defects.

Mr. Gordon: I think consideration should be given by Forestry Departments to perpetuating supplies of the more durable sleeper species.

Mr. Thomas: We have had radiata sleepers in service for more than 30 years and they have performed quite satisfactorily. Providing we have radiata available we will not have to use durable eucalypts except to a limited extent such as through the Adelaide hills.

Mr. Dale: The Victorian Railways have on order 400,000 sleepers made to the French pattern in steel. So far they have not been able to obtain these but with trade conditions as they are I think we should expect some competition from steel sleepers. The initial cost is high but the service life justifies this.

Mr. Clarke: The Canadian Forest Products Laboratory has been working on laminated sleepers with hardwood tops. Costs are too

high at the moment but they expect that by the time results are available the cost of sleepers will justify the additional expense of lamination.

Mr. Turnbull: I think it would be advantageous if laminated sleepers could be included in the Standards Association tests.

ITEM 6 contd. - MECHANICAL FAILURE OF RAIL SLEEPERS

Mr. Dale: The work of the Division of Forest Products on mechanical failure may be summarized as follows:

(i) Surface Coatings and Special Treatments

The proposed field test at Highett will go in as soon as all-weather access to the site is available, probably early next year.

A recent inspection of surface treated sleepers in the main north-east line showed that a creosote oil spray is effective in preventing weathering of the sleepers, but until the results are analysed, we cannot say whether it is effective in controlling end splitting or spike kill.

The service test of pressure treated sleepers now being prepared will give us further information, as ten different treatments are to be used, including surface coating of untreated sleepers and surface coating of sleepers treated with a water-borne salt.

(ii) Track Temperatures

Some further readings of track temperatures confirming the earlier results, have been made using a 6-point recorder.

(iii) Moisture Contents in Service

The surface and core moisture contents of a number of sleepers in the track around Melbourne have been measured at intervals. This work is covered in a paper by our Seasoning Section.

(iv) Rail Fastenings

The report on the lateral shear strength of rail spike fastenings has been published, but little interest has been shown in our attempts to have a track test of the shear plate spike fastening installed. However, we have hopes that at least one State will put in a small test.

Mr. Jennings: The Conference may be interested in similar

Queensland tests commenced in 1950. Hot and cold tank creosote oil treated sleepers have been in the track 2 years and the first inspection was made in October 1952. All the sleepers are in reasonable condition, the treated sleepers generally in better condition. There is no spike failure but sapwood is shelling off untreated controls. Rail cut is negligible and end splitting of rail seat very slight. In some untreated sleepers fungal fruiting bodies are developing in the sapwood. Species used have been the less durable Queensland species plus some standard species. From general observation it would seem that the main trouble in Queensland is due to spike kill.

Mr. Dale: Ten lower durability eucalypts were used in the 1941 tests with red gum controls.

Mr. Gordon: Have galvanized spikes or spikes of other metals or alloys been tested to see if they have any advantage over steel spikes ? Galvanizing is very effective in protecting timber connectors.

Mr. Tamblyn: Western Australian Forests Department have in test some galvanized spikes and claim that the results are promising. However, as they could only retard the breakdown of the area around the spike, it is difficult to see that they could make a major contribution to the mechanical life of a sleeper if splitting were the main cause of failure.

Mr. Clarke: Perhaps galvanized spikes could be incorporated in the Queensland tests.

Mr. Jennings: It is proposed in Queensland to adopt a shear plate in which case the tolerance of the spike would have to be very fine.

Mr. Tamblyn: We should be careful not to generalize too much on tests completed. The 1941 Victorian tests indicate some benefit from spraying, whereas in the Western Australian test on jarrah sleepers which are surface coated, there is no practical benefit apparent after 13 years. Jarrah is more resistant to

weathering than some ash eucalypts and results may vary with this factor.

With low durability timbers surface coatings may help prevent decay, but have no beneficial effect with timbers of greater durability.

With regard to spikes, in the Victorian test we have not observed much difference in the spike holding capacity of treated or untreated sleepers.

Mr. Jennings: I do not know whether the Queensland Railways would consider the installation of a high pressure cylinder an economic proposition. The evidence in Queensland is that oil treatment is retarding weathering. Desirability of treatment varies with track loading. Little used lines do not show nearly as much spike kill as the main lines.

Mr. Huddleston: We notice in durable timbers that if the timber is exposed to weather and contains iron spikes, after a considerable period the timber around the spike completely rots away. For this reason I think it well worth while carrying out investigations on galvanized spike or some method to prevent deterioration of timber due to presence of iron.

Mr. Clarke: The galvanized spike may not give the lead we want as to the cause of breakdown because of the presence of zinc also. I suggest that we have a number of dog spikes tested in different metals to find out more about the breakdown around the dog spike. This may be a chemical or a biological breakdown.

Mr. Tamblyn: It may also be a temperature breakdown. It does not require very high temperatures to cause charring if a long period is involved.

Mr. Gay: To what extent are termites or other insects responsible for sleeper failure ?

Mr. Huddleston: In New South Wales in maintained tracks there is practically no damage due to termites or other insects.

Mr. Tamblyn: I think this depends on how often the track

is used (i.e. the volume of traffic) and type of ballast. Untreated Pinus radiata sleepers in metal ballast on the Pinnaroo line were not attacked at all, whereas karri in Western Australia in gravel ballast is liable to attack.

Mr. Clarke: I think also that railway engineers use termite resistant timbers where attack is likely.

ITEM 7 (a) - LABORATORY AND FIELD EVALUATION OF PRESERVATIVES

Mr. DaCosta: The purpose of this item is not so much to present an account of work in progress as to discuss future work, and to provide a basis for co-operative work in this field by the various organizations interested.

With regard to work in progress in the Division, we are now conducting two lines of laboratory work on the properties of wood preservatives; firstly, an investigation of water soluble preservatives in which we are measuring their toxicity to wood destroying fungi in agar medium and in wood, their resistance to leaching under various conditions, and the permanence of their protective effect. Secondly, we are working on different types of copper naphthenate and are measuring their relative toxicity and permanence as amongst themselves, and as compared with similar types of preservative such as creosote, pentachlorphenol, and naphthenic acids. Anyone who is interested in these lines of work can obtain more information on them by discussion with officers of the Preservation Section.

As regards future work, we feel that the most urgent need at the moment is to set up a co-operative programme of investigation on the effectiveness of different preservatives. At the moment there is very little factual evidence available in Australia as to the service life to be expected from different preservatives under stated conditions, or as regards the relative effectiveness of different preservatives under various conditions of exposure. This lack of factual information is a continuous source of embarrassment when it comes to making recommendations to timber users, particularly

where new preservatives such as pentachlorphenol, or unusual conditions of exposure such as mining timbers, vat timbers, or cooling towers, are concerned.

Information as to the service life to be expected could be obtained mainly from service tests, although small specimen graveyard tests give a fair indication, but information on the relative effectiveness of various preservatives can be obtained either from service tests, graveyard tests, or laboratory tests. We suggest that the urgent need at the moment is for the setting up of well designed, accurate graveyard tests. These tests will indicate to what extent overseas results can be applied in Australia and to what extent the locality of exposure influences the performance of the preservatives. They will also enable us to see to what extent the results of our various laboratory investigations indicate field performance. This cannot be done at present as there are no field tests of sufficient sensitivity and reproducibility for a satisfactory comparison. If these field tests are done on small specimens, sufficient results would be available in 10-15 years to provide a good background for recommendations and for future work on preservatives. This Division has suggested the setting up of a large small specimen graveyard test covering most of the preservatives likely to be used in Australia in the near future, and a preliminary outline of this test was circulated to some of you earlier this year. We would like to know to what extent the various States are interested in this type of test and are prepared to co-operate in its setting up. We suggest that the collection and treatment of material could be carried out by the Division, and the installation, maintenance, and inspection of the various graveyard sites could be done by the State organizations in whose area they are located.

The present plan calls for the installation of 1000 to 1800 stakes in each locality - either on one site of approximately 1/3rd acre, or on two sites of 1/6th acre each. These sites would have

to be kept free from fire, vandalism, stock, and excessive weed growth, and would have to be inspected at intervals of 1 to 2 years.

In view of the large number of preservatives to be tested, we suggest limiting the test to 4 sites, as follows:-

Site 1	- New Guinea	- High decay and leaching hazard, probably no termites.
Site 2	- Darwin or Queensland	- Mastotermes areas with a moderate decay hazard.
Site 3	- New South Wales	- Decay and termite hazard.
Site 4	- Victoria	- Decay, probably no termites.

The working plan for this test has not been finalized and we would welcome suggestions from the various State organizations regarding preservatives which should be included, or alternative test sites. These detailed comments could, if necessary be obtained by correspondence. What we are mainly concerned with is to get some agreement on the possibility of providing and maintaining test sites and on co-operation in installing and inspecting tests.

Mr. Cokley: In Queensland the collection of material for a small specimen graveyard test is well under way. Eleven species of timber and preservatives such as pentachlorphenol, copper naphthenate, and zinc naphthenate, have been collected. Potential test sites have been investigated and advice is now awaited from Mr. DaCosta as to the most suitable site and other details regarding exposure to continue with the project. Difficulty has been met in obtaining quantities of Tanalith from the supplier as they are not interested in supplying small quantities of this preservative.

A concurrent laboratory evaluation of preservatives has been planned using veneer strips as suggested by Mr. DaCosta. This may give a quicker result in the comparison of the effectiveness of various preservatives. It was, however, agreed that stake tests are essential to make a comparison of the effectiveness of the preservatives under natural conditions.

In the standardization of inspection of stakes, I suggest

that difficulties may arise with the differences of opinions of different inspectors when condemning stakes.

Mr. DaCosta: The use of veneer strips gives a rapid evaluation of the preservatives tested, but comparative results would be regarded with suspicion, as they may not correspond to service results. Therefore, stake tests are more important and should go in first. As regards inspections, estimates of remaining life of stakes will vary but the actual results of inspections recorded by different people are closely correlated and quite reproducible.

Mr. Tamblyn: The test is to evaluate preservatives in the field and comparatively any inspector could quite easily determine the order of effectiveness for his particular locality. For more detailed study, however, data would have to be precise.

Mr. Cokley: Trouble has been met with in the past where two inspectors on the same project have differed quite considerably, and I feel a standard of inspection is desirable.

Mr. Huddleston: I agree with Mr. Tamblyn that in a test evaluating various preservatives, differences of opinion of inspectors to various degrees of deterioration would still lead to the same results; that certain preservatives are more efficient than others. However, I suggest that inspections be carried out by trained officers and that specimens be described and reported accurately, so that any variations in estimation can be evened out.

The New South Wales Forestry Commission would show every interest in any graveyard test conducted by the Division, and would be glad to co-operate, but would not be conducting any tests of their own.

Mr. Tack: In the standardization of inspections it would be desirable to have inspecting officers trained by preceding inspection officers, and to standardize inspections by a Conference of inspecting officers from all States.

Mr. McAdam: A graveyard site has been selected in the Botanical Gardens at Lae and a number of New Guinea timbers have already

been placed in the site. The decay hazard at the site is very high and already fungal fruiting bodies have appeared on some of the stakes. Matched samples of the timbers have been sent to New Zealand to be treated with Tanalith and will be introduced into the graveyard site when returned, together with the untreated specimens.

Mr. DaCosta: Have any Australian timbers been included in the test for a comparison in durability ?

Mr. McAdam: No Australian timbers have been included, and the test is only between treated and untreated New Guinea timbers. In inspection methods certain pressure should be used on the test stakes during inspection, as some timbers are of lower strength value and more likely to rot.

Mr. Clarke: The subject of failure point was discussed at the British Forestry Conference in Canada, when it was stated that quite a number of laboratories had tried the method of applying a definite test load to stakes to determine their failure point. The conclusion arrived at was that this action was not justified, because to overcome the difficulty of variation from stake to stake it is necessary to make the test load a small percentage of the initial load which could be carried, say 10 per cent.

Mr. Wright: Would a photographic record be of assistance in inspection for selected specimens, or would the cost be too great ?

Mr. Beesley: Photographic records were taken at the recent inspection of poles at Benalla and were of limited value. There was not sufficient definition to be able to get a true indication of the deterioration of the timber; also it was impossible to get an indication of the condition below the surface.

Mr. Turnbull: Is there any standard method to determine softening of wood ?

Mr. Clarke: Since deterioration of timber does not occur in regular dimensions, it would be very difficult to determine softening of wood by any standard method. It has been normal

practice to measure softening of wood by means of a pen-knife.

Mr. McAdam: In the inspection of specimens at graveyard sites it would be desirable to have one trained officer from the Division to visit all sites in company with inspectors of the State where the sites are located, so that some sort of standardization in the inspection of timber specimens can be brought about.

ITEM 7 (b) - PHYSIOLOGICAL EFFECTS OF PRESERVATIVES

Mr. Tack: Since the last Forest Products Conference the most interesting feature relating to this item is the very large amount of information published by Australian organizations. In particular, I would like to draw Delegates' attention to a very comprehensive review by J. B. Martin of the Commonwealth Department of Health, Adelaide, published in November, 1951, namely "Pesticides - A Review of their Uses, Properties, and Hazards". This is a valuable publication, well indexed and with an excellent bibliography.

In addition to this publication, recent articles in the New Zealand Journal of Agriculture, July 1952, "Health Aspects of Plant Therapeutants" is of interest. Other articles dealing with the toxicology of insecticides have appeared in the South Australian Journal of Agriculture and Commonwealth Health Department publications. Recent text-books - "D.D.T. and Newer Persistent Insecticides" by T. F. West and "Chemical Control of Insects" by West, Hardy and Ford, also contain much valuable information.

It is recommended that co-operation with the Defence Research Laboratories be continued in this project and that all States should keep in contact regarding publications dealing with insecticides and their industrial hazards

No discussion.

ITEM 7 (c) - FENCE POSTS

Mr. Dale: Since the last Conference two new tests have been installed, the New South Wales test has been inspected and reported, and

the Benalla and Western Australian tests have been inspected. The first of the new tests installed at Highett was put in under the worst possible conditions in fencing and area, for our test work. Round posts were given 24 hr. cold soak treatments in the middle of winter in copper naphthenate, 5 per cent. pentachlorphenol in diesel fuel, and 50:50 creosote and diesel fuel oil.

Preservative pick-ups were very low, total pick-ups ranging from 1-9 lb. It will be most interesting to see if any benefit is derived from these treatments.

The second test, set up in conjunction with the Victorian Department of Agriculture at the Potato Research Station at Toolangi, should give us a lot of information. A total of 270 round and split posts were treated with 5 per cent. pentachlorphenol and creosote plus oil by cold soaking, and with creosote and copperized chromated zinc chloride by hot and cold bath.

Pick-ups of preservative ranged from 1-1/2 to 17 lb./cu.ft. of oil type, and 0.1 to 0.95 lb. of dry salt for different test groups. The fire-killed ash, with spongy sapwood, picked up most preservative in each treatment. All the posts were top sprayed with 5 per cent. pentachlorphenol after installation.

The Clarencetown inspection confirmed the value of creosote hot and cold bath treatment and gave us an expectation of 20 years' life for the zinc chloride plus arsenic treatment. This is quite good when we allow for the lower cost of treatment.

The Benalla inspection also confirmed the value of hot and cold bath creosote treatment, but gives a slightly better rating to zinc chloride plus arsenic in preventing termite attack of exposed truewood in split posts.

It is obvious that we are not having any success in promoting hot and cold bath treatment of fence posts. Of the dozens of enquiries we receive, very few, if any, carry out this treatment - they simply haven't the time or labour to spare.

The hot and cold bath treatments at Toolangi, made by good labor under good supervision, were costly and tedious. If hot and cold bath treatment is to be "sold" it must be greatly simplified, e.g. by automatic temperature control, and greater stress laid on the use of small, easily handled round posts for the same job.

Personally, I think it better to recommend a 24 hr. soak in 5 per cent. pentachlorphenol, preferably on a hot summer afternoon, to get some temperature effect, than to advise hot and cold bath treatment, which must have a man's attention nearly all the time.

Mr. Benallack: What was the cost of the treatment of fence posts at Toolangi ?

Mr. Tack: It is difficult to assess the cost because the work was not done full-time. It would work out to approximately 6d. to 1/6d. per post for the creosote used, to which must be added the cost of the labour involved.

Mr. Huddleston: Are there any records on the performance of pentachlorphenol and creosote over a number of years ?

Mr. Tack: The pentachlorphenol treatment only dates back to about 1936.

Mr. Tamblyn: So far, in its first 15 years of test, pentachlorphenol in heavy oil was comparable in performance with creosote.

Mr. Huddleston: I do not consider that cold soak treatment should be recommended in preference to the hot and cold bath process.

Mr. Tamblyn: It is not intended that the cold soak process should replace standard treatments, but having regard to the difficulty of persuading farmers to treat by the hot and cold bath process it would be better to recommend the cold soak treatment, than have no treatment at all. There was no doubt that cold soak treatments would result in worthwhile increase in life.

Mr. Huddleston: In New South Wales no other treatment except the hot and cold bath for timber - in the natural round - has

been recommended. It is generally accepted that 5 per cent. pentachlorphenol was equivalent to creosote.

Mr. Clarke: The cold soak treatment is considered only as an improvement for the farmer to apply on his property. It has yet to be proved from a sales point of view.

Mr. Huddleston: If a treatment is to be sold, whether to a farmer for his own use or to be applied to marketable timber, it would have to be reasonably sound. In some areas it has been found that concrete fence posts prove cheaper than timber fence posts. The question of competition in these circumstances requires sound economics.

Mr. Dale: With treatment of fence posts, small posts in the round could replace split fence posts of larger dimensions.

Mr. Clarke: More demonstrations as to the performances of preservative treated fence posts would be the answer.

Mr. Gordon: I suggest that State Forestry organizations might make it their policy to use treated posts for enclosures of plantations, nurseries, etc. and set up demonstrations of preservative treated fence posts as often as possible to convince the public of its effectiveness.

Mr. Beesley: The State Forestry organizations as well as other major bodies are extremely interested in the setting up of demonstrations.

Mr. Tamblyn: I suggest that a draft recommendation be drawn up for a cold soak treatment method for fence posts and sent to the New South Wales and Queensland Forestry Departments for approval. If agreement could be reached, a great deal might be achieved in overcoming the main difficulty of getting any but a simple recommendation accepted by farmers.

Mr. Cokley: There is always the difficulty of inducing the trade to accept something which has proved itself from a technical angle, and in this respect farmers are more conservative than others.

Mr. Jennings: The price factor is a consideration in Queensland where we could not consider treating non-durable timber as posts of durable species are available at £10 - £15 per 100, or when steel fence posts could be obtained at competitive prices.

Mr. Clarke: Preservative treatment would apply only where durable species are not available, as they present no problem.

ITEM 7 (d) - THE STERILIZATION OF TIMBER BY FUMIGATION *

It has been shown that the toxic gas methyl bromide is apparently unique among gases in that it will penetrate deeply into timber under atmospheric pressures (1) and that it can be used to sterilize even large stacks of block stacked timber, either in fumigation chambers or in situ under suitable covers, using a gas concentration of 2 lb./1000 cu.ft. for 24 hr., if the atmospheric temperature is above 60°F. Below this temperature the dose should be increased by 0.5 lb./1000 cu.ft. for each 5°F. below 60°F. The gas is a general insecticide and also appears to be a promising fungicide and will penetrate hardwoods apparently just as readily as it does softwoods. Suitable chambers can be made from timber framed rooms, either lined with gas proof materials such as Sisalkraft, or heavily coated with bituminous paint, and from rooms constructed with waterproof plywood. Suitable covers for fumigation in situ can be made from 4 gauge polyvinyl chloride sheeting preferably fabric-backed to give greater wear, from Neoprene sheeting and from polyvinylidene chloride sheeting. It is advisable to use a fan to stir up the gas for the first half hour of the fumigation period to prevent it from layering (one ordinary office fan per 50,000 cu.ft. will be sufficient), and to test the chamber or covers thoroughly with a halide detector lamp to detect sources of gas leakage, since the remarkable activity of the gas causes it to escape rapidly and completely if there is any leak. The gas is toxic to humans and the usual precautions for toxic gas fumigations should therefore be adopted.

---

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

Lyctus and Tristaria sp. beetles were selected as the biological test material in most of the experiments carried out by this Division, since they are easy to handle, but the gas has also been found to be effective against Sawfly larvae (Tenthridinidae).

Since it is a general insecticide and has been used extensively overseas against termites, ants, wheat weevils and the other insects and micro-organisms commonly found in grain stores, ships' holds, and soil, this gas provides a particularly effective alternative to the usual method of sterilizing timber by heat. Recent work at this Division has shown that the gas is also effective against many fungi, 2 lb./1000 cu.ft. killing Ceratostomella and Penicillium sp., while higher concentrations, e.g. 6 lb./1000 cu.ft. for 24 hr. is effective against Poria, Trametes Aspergillus, and Lentimus sp., and higher concentrations (or longer exposure time) is also effective against Lenzites and Trichoderma sp.

The penetrative power of methyl bromide is in strong contrast to that of other commonly used toxic gases such as formaldehyde and carbon bisulphide, which penetrate timber in a radial direction to a depth of not more than 3 mm. (2).

It is possible that other gases, e.g. ethylene dibromide, are also capable of penetrating timber and it is intended to test such gases as they become available.

References

1. Burden, J., and McMullen, M. J., Aust. J. of Sci. 14, 57-58, 1951.

2. Vanine, S. I., and Vladimarskaya, N. N., Acta Inst. Bot. Acad. Sci. USSR Ser. 4, I, 205-22, 1933.

Discussion:

Mr. Gay: Ethylene dibromide has been found to be cheaper (1/6th the value of methyl bromide) and equally effective as methyl bromide. There seems to be a possibility of adopting its use in the the near future as a fumigant.

Mr. Huddleston: It has been mentioned as a possible alternative fumigant. Formalin has been used as an alternative fumigant against moulds. The timber was treated by releasing formalin into the air stream of kilns during the drying of timber.

Mr. DaCosta: Is there a residual effect following on the use of methyl bromide?

Mr. Huddleston: I could not answer that question, as we have not done any work on the residual effect of methyl bromide. However methyl bromide has been found to be more effective as a fumigant than other gases tested.

Mr. Gordon: Does methyl bromide kill fungal spores ?

Mr. Huddleston: Yes, it does.

ITEM 7 (e) - SUPPLY OF BORIC ACID AND BORAX

Mr. Hammond: The importation of boron compounds for timber immunization has been kept under review, and has been the subject of enquiry and correspondence from time to time.

In September 1952, the Department of Trade and Customs was informed of estimated requirements for the year 1952/53, viz. - Queensland 460 tons and New South Wales 170 tons, and was asked if consideration could be given to the following requests:-

(i) Allocation of sufficient dollars for importation of the above quantities specifically for timber immunization.

(ii) Any dollar allocation for borax and boric acid for timber immunization to be made interchangeable.

(iii) Issue of licences on a 6 monthly basis in lieu of the present quarterly basis.

(iv) Permanent removal of duty on borax and boric acid.

In their reply the Department of Trade and Customs said that a dollar allocation had been regularly provided for the importation of borax and boric acid from dollar areas, and at present no applications for licences are awaiting attention. The Department further stated that for some time part of the allocation provided for boric acid had not been fully expended each quarter, and they could not therefore see that 6 monthly licences in lieu of present quarterly ones were warranted.

Personal representations were made to the Department of Trade and Customs in Canberra, pointing out that the fall in demand for timber was probably the reason why there had been no difficulty in securing adequate supplies of boron products, but with a revival of the industry the requests made might still be warranted.

There appear to be practical difficulties in a special allocation of borax and boric acid for timber immunization as long as these products are imported by general importers on behalf of sawmillers as well as other interests, but it is thought that this difficulty can be overcome if the trade is sufficiently interested to take out a licence or licences.

The Department of Trade and Customs is averse to departing from the general procedure of issuing licences on a quarterly basis. It is probable that with the difficulty there has been at times in obtaining supply, general importers may have given priority to other users of this material from their total importation. This of course would be avoided if separate licences were taken out on behalf of sawmillers as suggested above.

Boron products are imported under 449A(1) free from the United Kingdom and 12-1/2 per cent. from other countries. As the United Kingdom has in recent years been unable fully to supply the boron requirements of Australia, imports have been obtained from other countries and with the consent of the United Kingdom they have

been coming in free and will continue to come in free until 31st December 1952, under By-law 449A(2). Although this arrangement cannot be made permanent, the Department of Trade and Customs has asked for a further extension of the arrangement for another 12 months. Advice has not yet been received of the result, but it is anticipated that the rebate will continue.

Mr. Jennings: It is general practice in Queensland for individual firms to take out licences. They indicated their requirements and the licences were checked by the Department of Trade and Customs in Brisbane. The Department of Trade and Customs does not issue the licences. There was a decision made some time ago that there would be an allocation of dollars for boron products and there has been no evidence that any change has taken place. The position at the present time is that everyone has had adequate supplies and there is no point in making an issue of the matter.

Mr. Cokley: When the application form has been completed it is returned to the importer (Swift's, Hardies, or H. M. Russell) who work through the Sydney office; and then sent to the Division of Import Procurement. At the same time the Division of Import Procurement is advised of estimates for the year, and estimates for new firms are given by the Forestry Department. Estimates are based on experimental work and surveys. The licence is then sent to America and each individual shipment is sent back addressed to the sawmiller himself, who has to pay directly through the importer for the material supplied. Anything up to 3 months is taken from the time the application is granted.

Mr. Huddleston: That is not the practice in New South Wales. No applications for licences are made, which are issued by the Department. That applies to everyone buying in New South Wales. No difficulty is encountered on this score.

Mr. Cokley: On my last visit to Sydney I spent quite a lot of time with Swift's manager and saw quite a lot of applications

from New South Wales firms. These were based on similar conditions. The position in Queensland at one stage was so bad that there was a Conference of this Department with sawmillers' and importers' representatives and subsequent discussion with the local Customs Chief. On the question of stocks, one thing to be fixed is the matter of supply. The quarterly allocation has proved to be unsatisfactory.

ITEM 7 (f) - METHODS OF ANALYSIS OF BORON COMPOUNDS IN PRESERVATIVE TREATED TIMBERS *

The matter of methods of analysis, the advantages and disadvantages of existing methods have been discussed at previous conferences and resulted in the appointment of a sub-committee comprising Mr. Christensen (Division of Forest Products, C.S.I.R.O.), Mr. Fogl, Division of Wood Technology, N.S.W. Forestry Commission and Mr. Cokley, representing the Queensland Forest Service. After examining all available data the committee (1) concluded that some modification was necessary and work was allocated as follows:-

1. Division of Forest Products was to examine methods of a high degree of accuracy. Due to other factors, however, including the departure of Mr. Christensen on an overseas scholarship, the Division does not appear to have been able to carry this project to its conclusion.
2. Division of Wood Technology. This Division would continue the development of a simple reflux extraction method with a view to overcoming existing disadvantages.
3. The Queensland Forest Service would continue with the development of colorimetric methods. Concurrently therewith work would continue upon the development of what was termed the Char method, both as an independent method and as an integral part of colorimetric techniques.

Since that Conference and as reported therein, it was confirmed that colorimetric methods were sensitive to temperature

* Prepared by Forest Products Research Branch, Queensland.

and that accordingly control was necessary. To this end an electric water bath was ordered from a chemical supplier, but unfortunately delivery has not yet taken place. As a result no further investigation was possible on this phase.

Work was then concentrated upon three phases -

(a) Selection and test of a Basic Reference Method.

(b) Improvement and tests of the Char Method.

(c) A detailed study of reproducibility of the Double Indicator and a comparison thereof with the Bromthymol Blue Method and Char Method.

(a) Basic Method

Although the development of a highly accurate basic reference method has been left to the Division of Forest Products, it was found necessary to establish a basic reference to which other methods could be compared. The validity of results so obtained would ultimately depend then upon the relationship existing between the basic reference method and that finally developed by the Division. After examination of a large number of references and tests of some, selection was eventually made of the method given by Piper under the title "Dodd's Method".

In such use a variation was tested, viz., the use of sodium hydroxide in place of barium hydroxide as prescribed in Dodd's Method. At the same time, checks were made of reproducibility using both alkalis. Such tests proved satisfactory (Table 1) and results agreed to within 0.01 per cent., i.e. the method was for normal purposes completely satisfactory as a basic method and accordingly adoption thereof was made. I would point out, however, that its use would not be generally practicable as a maximum daily output of six samples per analyst appears the limit.

TABLE 1

Results Using Dodd's Method

Standard concentration	Alkali	
% H_3BO_3 on O.D. wt.	$Ba(OH)_2$ N/20	NaOH N/20
0.00	0.00	0.00
0.10	0.10	0.10
0.20	0.21	0.20
0.30	0.31	0.30

(b) Improvements in Char Method

As previously pointed out the Char Method was intended both as a "plant control" system and more importantly was to form the basis of colorimetric methods. Improvement in techniques was initially examined using standard samples previously prepared and finally by comparison over a large range of samples with Dodd's Method. Results to date have been statistically examined and the most suitable equation connecting the two methods is given by -

$$D = .9557C + .0763$$

This holds up to concentrations of 0.8 per cent. Further work up to 2 per cent. concentration is in hand, but due to staff shortages and demands of industry, it has not been possible to complete this investigation. Results given by the method show that there is a loss of 0.07 per cent. and further work will attempt to remove this constant.

However, comparison up to the range 0.8 per cent. gave satisfactory results and the method now finds application as a classification method. Samples at or near the minimum of 0.20 per cent. are then examined by the Double Indicator Method. The entire analysis can be completed in 30 min. individually, or alternatively one operator can comfortably test 25-30 samples per day compared with a rate of 12-15 by the Double Indicator Method. Comparison results between Dodd's and this Char Method are shown in Table 2.

TABLE 2

Comparison Results between Char and Dodd's Method

Char Method	Dodd's Method	Error D - C
0.13	0.18	+ 0.05
0.26	0.21	- 0.05
0.46	0.54	+ 0.08
0.05	0.01	- 0.04
0.74	0.74	0.00
0.30	.43	+ .13

(c) Double Indicator Methods, etc.

As the Double Indicator Method is the present standard and is used in cases of dispute, it was necessary that the accuracy of the method and reproducibility be determined. Such check was made using three operators who were experienced in the existing methods. Operators A and B used the Double Indicator (methyl red and phenolphthalein) and operator C used potentiometric titrations which were taken as the standard of comparison. A minimum of duplicates was done on each sample, each of which consisted of a bulk ground to a standard mesh, mixed, etc., and stored under aseptic conditions with respect to boron and moisture. To ensure that all results were representative, inclusion was made of species.

After analysis all results were statistically examined and it was found that standard deviations obtained were as shown in Table 3.

TABLE 3

Deviations Obtained by the Double Indicator Method

Operator	Mean deviation	Maximum deviation
A	$\pm$ 0.05	0.14
B	$\pm$ 0.05	0.10
Between operators	$\pm$ 0.03	0.07

Subsequent to this, a comparison was made of results obtained over a large range of samples analysed in two laboratories (Division of Wood Technology and Queensland Forest Service) using the Bromthymol Blue and Double Indicator Methods. Correlation between the two indicated that similar results applied to the single Indicator Method. In conclusion a further range was analysed by the Double Indicator Method and Dodd's Method. This range was the same as that used in the correlation of the Char Method and gave not only the relation between each and the standard, but also the relation between each other. It is of interest to note that some divergence from results using Dodd's Method appears to be given in higher ranges when the correction factors for the Double Indicator are used. Before this can be definitely concluded however, further work in the doubtful region is necessary and has been delayed only through staff shortages and the demands of industry.

Summarizing it may be said that a suitable reference method has been found to which other methods can be compared. In the Char Method a convenient and rapid method exists for the classification of samples, but further work is required to eliminate the constant of 0.07 per cent. at present found. With reference to the existing standard analysis techniques, their errors have been determined and can now be allowed for in accurate determinations.

References

1. Division of Forest Products. Proceedings of the Fifth Annual Forest Products Research Conference, p.72.

2. Piper, C. S. Soil and Plant Analysis. University of Adelaide Press, 1944. p.315.

Mr. Cokley: Shortage of staff has caused this work to be curtailed, and activity has been concentrated on plant control. At the previous Conference it was decided to aim for a short, quick method of analysis. For legal analysis, the method described in this paper is not sufficiently accurate, but we are relying on the Division of Forest Products to provide a legal method.

ITEM 7 (g) - RECENT WORK ON PLANT CONTROL METHODS OF DETERMINING BORON IN TIMBER AND BORAX TREATMENT SOLUTIONS *

PART A

THE DETECTION OF BORON IN TREATED TIMBER

The practice of impregnating starch containing sapwoods with boric acid or borax to render them immune to attack by the powder post borer (Lyctus brunneus Steph.) has brought about the need for some rapid and simple field method of determining whether such timber has been satisfactorily treated. The most suitable test would be a direct spot test whereby a pronounced colour change would occur on timber containing the required amount of boron when some chemical reagent was applied to it.

In New South Wales the Timber Marketing Act of 1945 requires that such treated timber shall contain 0.2 per cent. boric acid in the core, based on the oven dry weight of the wood.

Curcumin (tumeric) is a well known reagent often used for the detection of boron (1), with which it reacts, forming a red coloured intermediate. However, if an alcoholic solution of curcumin is sprayed or dropped on treated timber containing about 0.2 per cent. boric acid, no colour reaction can be detected. If the timber is first acidified by spraying with hydrochloric acid before applying the curcumin solution, a light reddish colour can often be seen, which will turn blue-black when a drop of alkali is placed upon it. Experience in our laboratories has shown that with this technique the colour development is not only very erratic but also is not sensitive enough for our purpose.

In recent years it has been reported (2) (3) that it is possible to obtain intense and consistent colour development with solutions of boron to which curcumin has been added, if oxalic or salicylic acid is added to the hydrochloric acid.

Investigations into the use of these reagents resulted in

---

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

the development of a satisfactory spot test for the detection of boron in timber. Two reagents are required, the first being an alcoholic solution of curcumin, the second being an alcoholic solution of hydrochloric and salicylic acids. The details of their preparation are as follows -

Solution A is prepared by refluxing 2 gm. of tumeric powder with 100 ml. of 95 per cent. alcohol for 1 hr. The solution is then cooled and filtered.

Solution B is prepared by mixing 80 ml. of 95 per cent. alcohol and 20 ml. of 30 per cent. hydrochloric acid, then saturating this mixture with salicylic acid.

The test is carried out in the following manner -

1. The surface of the timber is first planed or rasped to facilitate the penetration of the test reagent.
2. Two drops of solution A are then applied to the prepared surface, and allowed to dry for a few minutes.
3. Two drops of solution B are then applied to the surface. As this second solution dries a brown to red stain will develop on the timber.

It has been found that the intensity of the colour produced varies with the boron content of the timber in such a way that it is possible not only to detect treated timber but also to determine whether or not it has been satisfactorily treated. It was found that the colour varies from a distinct brown stain on timber containing about 0.1 per cent. boric acid to a very definite homogeneous bright red stain on timber containing approximately 0.2 per cent. boric acid (the amount required for satisfactory treatment in N.S.W.). Experience has shown that the intensity of the red stain increased with the concentration of boron in the timber, so that with timber containing excessive amounts of boron e.g., 0.8 per cent., a very intense dark maroon stain is developed. This stain should not be confused with the dark brownish red stain developed on slightly untreated timber. It can be distinguished from the latter by its

greater intensity and more homogeneous nature. On dry timber each of the solutions takes about 2 min. to dry, i.e., the stain is fully developed in about 5 min. from the commencement of the test. With wet samples from a freshly treated charge the stain took up to 30 min. to develop but it was found that the process could be hastened by the following method:

Allow several drops of the curcumin solution to soak into the timber for several minutes, then touch it with a lighted match. The alcohol will burn, leaving a relatively dry spot. Repeat this procedure with the alcoholic acid solution. As this second solution burns the stain will develop.

The only other compounds which are known to turn curcumin red-brown are (1) those of iron '''', molybdenum, titanium, niobium, tantalum, and zirconium. Since these are either not found in timber or are present only in very small amounts, this spot test can be regarded as being specific for boron. The test can be made more specific due to the fact that the red-brown rosocyanine stain produced by boron in the presence of tumeric will turn greenish-black if treated with alkali and that the original red colour can then be restored by acid. This is not so with the stain produced by iron '''', molybdenum etc.

This spot test has been used by this Division for many months now, and has also been used successfully by commercial treatment plant operators and timber inspectors without any anomalies being reported. It has been found that the curcumin solution deteriorates about 2 months after its preparation but that the salicylic-hydrochloric acid solution will keep indefinitely. The most convenient method of using the solutions is from a glass dropping bottle TK pattern with ground in slotted stopper, and a capacity of about 60 ml.

References

1. Feigl, F., "Qualitative Analysis by Spot Tests" - 3rd. Eng.Ed. (Elsevier Pub. Co. New York, 1946).
2. Russell, J. J., Natl. Res. Counc. Can., Atomic Energy Project. Div. Res. MC 47, NAC No. 1596 (1947).
3. Mitchell, F., Mikrochemie ver Mikrochim. Acta, 29, 63-72 (1941).

PART B

THE DEVELOPMENT OF A PLANT CONTROL METHOD OF DETERMINING BORAX IN TREATMENT SOLUTIONS

The impregnation of timber with boron to render it immune to attack by Lyctus has been mainly achieved in the past by treating it with a solution of boric acid. However, borax solutions are also used and because of its non-corrosive effect on steel, it is finding increased favour for this purpose. Since the treatment solution must be maintained at a certain concentration (usually 3 per cent.) it is necessary to have a simple and rapid method of determining its concentration.

With boric acid solutions this can be done by a simple crystallization method but tests in these laboratories have shown that this method is not reliable when applied directly to the determination of borax.

However, if a 100 ml. aliquot of the borax solution is made acid by the addition of 1.5 ml. of 98 per cent. sulphuric acid, it can be regarded as a boric acid solution, and its strength determined by the crystallization method. Multiplication of the result by the factor 1.54 gives the strength of the solution in terms of borax.

An alternative method is to titrate a large aliquot of the treatment solution with 0.1 N hydrochloric acid, using methyl orange-indigo carmine screened with titanium dioxide, or bromthymol blue as the indicator. Over the range 1-4 per cent. the results are found to differ from the true concentrations of the test solutions by not more than approximately $\pm$ 0.2 per cent. borax.

Since the method involves only the simplest of titrations with large aliquots and easily detected end points, it is considered that no difficulty should be encountered in its use by treatment plant operators, and that the method is sufficiently accurate to enable them to keep their solutions adjusted approximately to the required strength.

It is most important to use the titanium dioxide

correctly. It must be stressed that only a small amount (0.01 g.) of this pigment be used for each titration. This amount is sufficient to suppress interference by the natural reddish colour of well used treatment solutions, but excess of the pigment will depress the intensity of the indicator colour change.

The only complaint so far received from commercial plant operators using this method was one from a firm on the north coast who treat a large variety of scrubwood species and who reported that the methyl orange-indigo carmine was decolorized when it was added to their treatment solution. Laboratory studies showed that bromthymol blue was not affected by this particular solution and that it gave results comparable in accuracy to those obtained with the mixed indicator.

Attempts have been made by this Division to estimate the strength of borax solutions by measuring the height of a boron-tartrate complex precipitated from the treatment solution contained in a 50 ml. burette. Although some success was obtained with pure solutions of borax, the results were erratic with treatment solutions due to co-precipitation of the various timber extracts.

The presence of these extractives precludes the use of a simple hydrometric method of estimating the concentrations of treatment solutions, and the pronounced reddish-black colour of these solutions also precludes the use of a method based on comparison against colorimetric standards.

There are several ion-exchange resins available for the decolorizing solutions (e.g. "Decolorite", a Permutit product) or for the removal of boric acid or borax from solution (e.g. Dowex 50 and Amberlite IR-100 AG) but our experience has been that such columns are quickly blocked by the fine suspensions found in treatment solutions and that the use of such columns is not practicable.

It would appear, therefore, that treatment plant operators will be confined to using either the crystallization or the titrimetric

method outlined above. Both are relatively simple, and reasonably accurate and it is considered that little difficulty should be encountered with their use.

Discussion:

Mr. Noar: Is frequent testing of timber necessary ? Is the turmeric colour test acceptable under the New South Wales Timber Marketing Act, and are tests carried out regularly ?

Mr. Huddleston: In New South Wales the colour test is not sufficient legal evidence. Before prosecution of an offender under the Act is considered, an analytical report is obtained. There are 18 inspectors operating on behalf of timber buyers and another 2 inspectors are engaged on routine inspections under the Act. Sellers and others concerned are not obliged to replace brands worn off timber. The timber may be sold before analytical reports are obtained.

Mr. Jennings: The turmeric indicator method has been used in Queensland since 1946 and is considered satisfactory. We are considering inclusion of this method in the regulations. Until recently we depended on plant operators to supply timber samples for analysis, but now require our own district officers to take all necessary samples.

Mr. Cokley: Referring to the turmeric test, the colour reaction is affected by the concentration of the turmeric. However, this difficulty may be overcome by the use of a saturated solution. We found it preferable to leach the turmeric to remove boron impurities which may be present but this method is a big advance in control. In our analytical procedures both borax and boric acid are estimated as boric acid using clarification for solutions, and as decided in 1947, we have dropped the crystallization method which was too dependent on the accuracy of the operator.

Miss Wilson: No work on boron estimation has been done at the Division since Mr. Christensen left.

Mr. Cokley: There is still need for a highly accurate method for legal purposes.

Mr. Huddleston: The present analytical method is sufficiently accurate as the Act requires a boric acid content of 0.2 per cent., which gives a good safety margin where plants are working under close control. In court, the onus is on the Department to prove that Lyctus attack is possible at lower concentrations.

Mr. Cokley: If a figure of 0.14 per cent. boric acid was obtained would you prosecute in New South Wales ?

Mr. Huddleston: A figure of 0.14 per cent. would not cause a court action but would warrant a warning.

Mr. Cokley: What figure below 0.2 per cent. would result in prosecution ?

Mr. Huddleston: A sample containing 0.1 per cent. or less would be used in a prosecution. If we considered that a plant was treating inefficiently we would take a large number of samples and select one with a very low concentration on which to launch prosecution.

Mr. Jennings: Is work continuing at the Division of Forest Products to develop a highly accurate method for analysis of boric acid suitable for use in legal cases ? Also, is the Division working on the redetermination of the minimum lethal concentration for boric acid ?

Mr. Tamblyn: Mr. Christensen looked at existing methods of analysis before going abroad, but did not succeed in improving those already used by Queensland and New South Wales. With respect to the minimum toxic concentration of boric acid, we have not yet commenced work, as until very recently we were unable to secure timber suitable for the tests.

Mr. Tack: Has any timber been attacked by Lyctus after treatment with boric acid in Queensland and New South Wales ?

Mr. Huddleston: No.

Mr. Jennings: No - except for one possible doubtful case.

ITEM 7 (h) - THE DETECTION AND DETERMINATION OF SODIUM FLUORIDE IN TREATED TIMBER AND IN TREATMENT SOLUTIONS *

The proposal to use sodium fluoride for the immunization of timber against Lyctus attack has made it necessary to develop a method of determining fluorine in treated timber suitable for routine laboratory work.

The usual method of determining fluorine by titration with thorium nitrate is not regarded as being suitable since the colour change at the end point is not particularly pronounced, and it takes some experience on the part of the operator to match the end points of duplicate samples. In addition the thorium nitrate solution is not stable, and the indicators used do not change colour at the true end point of the reaction, thus necessitating the frequent construction of calibration curves.

At this stage it is interesting to note the opinion of F. E. McKenna who recently completed a comprehensive review (1) of fluorine analysis covering the literature from 1816 to 1950. He states "No universal scheme can be set forth for the analysis of fluorine-containing materials. The amount of fluoride as well as the matrix must determine the analytical methods to be considered. In all cases the proficiency of the analyst with the method or technique adopted is of major importance, and all analysts are not equally adaptable to all of the techniques suggested in the laboratory". In our opinion the above statement was influenced by the vagueness of the end points associated with the titrimetric methods of determining fluorine.

Hence, because of their simplicity and adaptability to rapid routine work it was thought that colorimetric methods would be the most suitable for this purpose. A search of the literature revealed that of the comparatively few colorimetric methods proposed only one was regarded as being suitable for use with the concentrations of fluorine expected in treated timber. This was the method of Monnier

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

et al, (2) based on the diminution of the colour of a ferri-sulphosalicylic acid complex upon the addition of fluorine. It has been found that the method will determine 0.1 per cent. fluorine in timber (based on the oven dried weight of the sample) the maximum error being ± 0.01 per cent. fluorine.

The extraction of the fluorine from the timber is achieved by ashing the finely ground sample with alkali at not more than 500°C. then steam distilling the ash with syrupy phosphoric acid at 200°C. ± 5°. The size and design of the distillation apparatus is critical and the one used by this Division consists of a 150 ml. Kjeldhal type flask with a side arm connected to a vertical Vigreaux tube the upper extremity of which is bent over sharply to fit into vertical Allihn's condenser. The design of the apparatus precludes any pockets wherein refluxing of the distillate can occur, and prevents entrainment of the phosphoric acid. The apparatus can be cleaned after each distillation without being dismantled and each distillation takes about 20 min. A full description of the apparatus, the distillation technique, and details of the colorimetric method of analysis are given in a progress report issued by this Division (3).

Unsuccessful attempts have been made to extract fluorine from timber by leaching methods, and it is considered that at present the above distillation step cannot be avoided, due to the great reactivity of the fluoride ion with some elements commonly found in timber, e.g. iron. However it is worth noting that a recent report stated that fluorine can be determined, in the presence of foreign ions, by polarographic methods, but so far this has only been used for determination of microgram quantities of fluorine.

In conclusion it is considered that the method used by this Division is simple, reasonably rapid and accurate, and, most important that it is objective, thus lending itself to reproducible results and hence is suitable for routine laboratory work. Little progress in the development of a plant control method of determining the strength of

fluoride treatment solutions has been made and suggestions in this regard would be greatly appreciated.

References

1. McKenna, F. E., Nucleonics 9 (2), 51-58, 1951.

2. Monnier, D., Ruscone, Y., and Wenger, P., Helv. Chim. Acta. 29, 521-5, 1946.

3. McMullen, M. J. and Downes, K., D.W.T. Sub-Project P.15-1. "The Determination of Fluorine in Treated Timber and Treatment Solutions". Progress Report No.1.

Mr. Huddleston: A satisfactory spot test for the estimation of sodium fluoride in treated timber is expected from present developmental work. The laboratory control method is established.

In reply to questions: Caustic soda is used for ashing, and I do not think fluorine could be estimated without first ashing.

ITEM 7 (i) - INVESTIGATIONS INTO THE EFFECT OF SODIUM FLUORIDE ON CONCRETE, VARIOUS METALS AND WOOD GLUES*

The possible future use of sodium fluoride for the immunization of timber against Lyctus attack has rendered it imperative to investigate the effects of this compound on the various materials which would come in contact with either the treatment solution or the treated timber. The materials selected for study were concrete, steel, galvanized iron, copper, brass, and animal, casein, urea-formaldehyde and tego glues. The tests were designed to determine (a) the extent of weight loss and surface corrosion of concrete and metals resulting from repeated treatment with sodium fluoride, (b) the glue shear values of ply panels and timber test pieces prepared from fluoride treated veneers and timber, and (c) the weathering qualities of tego bonded fluoride-treated ply panels.

The concrete and metals were immersed in a 1 per cent. sodium fluoride solution and boiled daily for 3 hr. The weights of

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

the test materials were recorded weekly and the treatment was continued for 5 months. The results showed that no loss of weight and no apparent deterioration of the concrete occurred, that brass and copper were also not unduly corroded (loss of weight 0.1 - 0.2 per cent.) but that galvanized iron and mild steel were corroded (1-3 per cent. and 4-7 per cent. loss in weight respectively). These last two materials showed extensive pitting. With regard to adhesives, urea formaldehyde, animal, and casein glues were found to behave satisfactorily when used to bond solid timber containing approximately 0.4 per cent. fluorine in the case. The boiling and other tests of the tego bonded ply panels were all satisfactory with the exception of the weathering tests. Since some of the weathering test controls became delaminated these tests were regarded as unsatisfactory and will be repeated, since investigations revealed that the tego resin used was of inferior quality.

However, in view of the behaviour of some of the treated test panels during the weathering tests, and the good results of the boiling and other tests, it is thought that sodium fluoride treated veneers can be satisfactorily bonded with tego resins.

The situation with regard to mild steel is not clear.

The samples of steel used in our experiments were corroded, but in a peculiarly localized fashion, the pitting being extensive only in several places on one face of only one of the two samples. According to reports in the literature sodium fluoride is not corrosive to steel and in fact is used to prevent corrosion in boilers. A clue to this conflicting evidence may be found in the work of Chapman (1) who found that dilute solutions of potassium fluoride will attack iron but the attack ceases if the strength of the solution is increased above 0.8N i.e. above about 4.6 per cent. KF.

We have not as yet been able to determine whether similar conditions hold in the case of sodium fluoride, but it is intended to investigate this matter further. Another point worthy of consideration is that silicofluorides are strongly corrosive to steel and iron, and

that the presence of these in some commercial sodium fluoride may be causing the corrosion observed in these tests.

Reference

(1) Chapman, A. W., J. Chem. Soc. 1930, p.1546.

Discussion:

Mr. Huddleston: I have nothing to add to this paper, except to say that it is proposed to carry out further work with regard to the corrosion of iron. As indicated in the paper, pitting of mild steel occurs in quite an unusual way, and we feel there may be some explanation for this.

Mr. Tamblyn: Is New South Wales prepared to approve the use of sodium fluoride as an alternative to boron components ?

Mr. Huddleston: Applications for the use of sodium fluoride are granted subject to the Timber Marketing Act. Its use, however, is not recommended because plant control of the process would require the services of a qualified chemist.

Mr. Jennings: In Queensland, following a report received from the Health Authorities, it was felt that treatment by sodium fluoride would not be justified. Safety of the operators depends on the effecient control of the machinery concerned, and it would be quite impossible to police this control.

Mr. Clarke: Referring to the use of sodium fluoride treated veneers for plywood, the position is very difficult, owing to the danger involved during sanding.

Mr. Gordon: There is another method which could be used and that is to use treated veneers for the centre plies, and untreated veneers for the outer plies. The problem would then be to get suitable veneer which does not require immunization for use as face plies.

Mr. Huddleston: It is a difficult situation, and I think we would still need to use treated veneer for the outer as well as the inner plies.

Mr. Jennings: I consider it would be impracticable to

segregate at the green clipper veneers which would be used for outer and inner plies.

ITEM 7 (j) - STANDARD SPECIFICATION FOR TREATMENT - SAMPLING PROCEDURE*

Although entitled Standard Specification for Treatment - Sampling Procedure, the purpose of this paper is to discuss briefly the wider aspects of quality control in the preservative treatment of timber, indicate the problems encountered by this Department and the methods attempted to overcome these, together with the results obtained. In considering the matter it is convenient to divide the subject into three phases as they occur in practice. These may be listed as -

(1) Control in relation to plant efficiency.

(2) Control under legislation.

(3) Control in relation to a pre-determined standard of treatment.

Each of these is both independent and yet interdependent, the one to the other, and while it is obvious that quality control is necessary, we find in practice that a satisfactory system has as yet not been determined. As a result it is probable that much valuable data has been lost upon treatment. In this discussion it is intended to restrict the scope to the material undergoing treatment and not to other factors such as treatment schedules.

1. Control in Relation to Plant Efficiency

When a firm commences treatment in this State, the initial treatments have been, with few exceptions only, under direct supervision of an officer of the Preservation Section. Care is taken to ensure that the operator in charge of the plant is reasonably conversant with the factors of treatment, is satisfactory in solution analysis, is familiar with schedules and during initial runs is checked in all of these phases. On such occasions a number of samples of timber are taken representative of the species undergoing treatment with a minimum of 50 per cent. of the most refractory species and at

* Prepared by Forest Products Research Branch, Queensland.

the same time distributed through the stack. For successive charges a similar requirement is made and so on until this officer is satisfied that the plant is achieving the desired result. Periodically samples are requested from the firm so that a check determination can be made; alternatively samples are submitted by the firm on their own initiative for check. In these latter cases normally six samples are requested but in practice we find firms sending single samples as representative of a charge.

To ensure that the plant operates on a standard of treatment such that maximum efficiency, maximum economy and at the same time satisfactory treatment is obtained, the optimum arrangement is for firms to submit a continuous sample representative of charges to a qualified analyst, which in this State in practice means the Department. To do so however would mean that the chemical laboratory would be fully engaged upon such check service and would be unable to completely fulfillits function to industry. This will be seen from the fact that at present treatment plants operating in Queensland are as follows:-

Veneer treatment	19
Sawn timber, operating	24
Sawn timber, constructed, not yet operating	9
Sawn timber, not operating	1
	53

Upon the conservative arbitrary basis of four samples per week from veneer mills and four samples per week for sawn timber, the weekly samples requiring analysis would be a total of 208, or put alternatively would require the full time of two analysts, which would be impracticable.

In an attempt to overcome this difficulty this Department has worked and is working along the following lines.

(a) Maintenance of adequate treatment plant recordsby firms.

(b) Periodic "snap" inspection and sampling of treated material.

(c) Determination of a statistical index of efficiency within the plant.

Of these (a) and (b) are normal practice and will not be further discussed. In the case of (c) results are as yet too incomplete to predict the final efficacy of this index but in compiling such index we are doing the following:

(i) For each plant the determination of mean core concentration and deviation of analytical results.

(ii) Determination over all plants of mean concentrations and deviations.

In both items the coefficient of variation will be used as the criterion.

From these determinations it is hoped that firms can be placed upon an efficiency rating which, combined with knowledge of the firms concerned, will serve as a basis upon which stricter control can be exercised.

Several tentative assumptions have necessarily been made. These as far as possible are being checked by reference to the records referred to in (a) above. Such assumptions are -

(i) For each plant the species groups are constant.

(ii) For each plant the treatment process is constant.

(iii) For each plant administrative control by the firm is of a constant standard.

To date the study has shown a range of efficiency as determined on (i) above as can be seen from the following:

Firm	Product	Mean * core	Standard deviation	Coefficient of variation %
1	sawn timber	0.68	0.38	56
2	" "	0.33	0.09	27
3	veneer	0.61	0.11	18
4	"	0.58	0.32	55

* Required legal core minimum in any sample is 0.20 per cent. (as boric acid on the O.D. weight).

2. Legal Control

This phase may be best summarized as a combination of plant efficiency and the control under a predetermined standard. It not only embraces the treatment at any individual plant but extends to material which in many cases originates from several sources. Control of this to date has been the rigid requirement of any sample containing 0.20 per cent. as boric acid in any section.

However, in many cases it is not possible to sample the material in stack and often small sections cut from the ends of boards are all that is available. Although this type raises the possible error of end-penetration with results higher than further along the length conclusions can be drawn only on such determinations.

3. Control to a Predetermined Standard

For some time discussion has been proceeding by the appointed Committee upon the draft specification prepared by the Division of Wood Technology. Of this draft the most important sections are those dealing with minimum concentrations and techniques of sampling. Upon these rest the effectiveness of the entire standard and the reliability of results obtained. It is desired that the latter section upon sampling technique should be fully analysed as hereunder.

Number of Samples

Dealing with the simplest case where a single charge of one species is to be sampled the number of samples is a function of the average (determined either experimentally or statistically) for the species and the deviations obtained. In addition it is directly affected by the minimum required standard and the accuracy of the analytical technique. In an effort to determine this figure results available from commercial firms were examined statistically as follows:-

(a) Random selection was made of charges where average results varied in the range of 0.20 per cent. to 1 per cent. using one species in each charge. For each the mean core concentration, and the standard deviation was determined. Concurrently therewith was

determined the overall average of treatment covering a range of 786 samples.

Typical results of such examinations are shown in Table 1.

TABLE 1

Charge	Species	No. of samples	Mean %	Standard deviation %
1	Pink poplar	21	1.11 (0.21-2.10)	0.70
2	Brown tulip oak	15	0.47 (0.22-0.75)	0.17
3	Brown tulip oak	17	0.22 (0.12-0.30)	0.047

Results were not sufficiently constant to derive any satisfactory conclusions but the following features were indicated -

(i) A minimum number is necessary irrespective of the size of the charge.

(ii) There appears to be a reduction in the amount of variation experienced as the species progress from the easily treated to the more refractory.

(iii) Results from any one charge were too variable to allow a rigid specification.

(iv) An overall treatment mean for Queensland plants was found to be 0.52 per cent. It had been found in a consumption survey that the following general relationships existed :

Relation between minimum core and mean core - 1.95

Relation between mean core and mean cross section - 2.08

(b) Individual species were examined from standard treatments with a view to determination of samples for species. Typical determinations are shown in Table 2.

TABLE 2

Treatment Results of Species

Charge No.	No. of samples	S.ft. of charge	Mean concentration of core	Standard deviation	Coefficient of variation %
Brown Tulip Oak					
1	15	4500	0.47	0.25	53
2	16	4500	0.49	0.23	47
3	23	4500	0.75	0.41	55
4	7	6000	0.28	0.17	60
5	6	6000	0.59	0.14	20
6	6	6000	0.59	0.27	46
7	5	6000	0.38	0.06	16
8	6	6000	0.29	0.12	41
White Cheesewood					
1	7	6000	0.46	0.43	93
2	6	6000	0.53	0.52	98
3	21	2000	1.30	1.00	77
4	12	5000	0.47	0.23	49
5	8	5000	0.52	0.17	33

Here again it was found that the material results were too variable to determine any rigid specification but it was again reasonably evident that a minimum number irrespective of charge size would be necessary.

In commenting upon this variability it is pointed out that in practice for even one species there are the factors of variable percentage of "sapwood", varying angles of cut and varying moisture content, each of which has been found to play some part in the pick-up concentrations obtained.

A further aspect which must be considered is the accuracy of

analysis. As the minimum standard concentration is approached the degree of such accuracy has an important bearing upon the number of samples which must be taken to ensure that results have significance. Whilst this can be reduced by the use of a standard method of known error, such error should be allowed for in the sampling requirements. A lengthy control check of the two existing methods, viz., the Double Indicator and the Bromthymol Blue Methods, gave results as shown in Table 3.

TABLE 3

Deviations in Analytical Methods

Operator	Mean deviation	Maximum deviation
A	± 0.05	0.14
B	± 0.05	0.10
Between operators	± 0.03	0.07

One further point which affects the sampling is the relationship between minimum core concentration and the average core concentration in a charge. The contention has been made that should the average result be in excess of 0.20 per cent. then the minimum core should not fall below 0.16 per cent. This is not the complete picture and in practice it has been found that there is a relation between them of 1 : 2 approximately.

This feature is also shown by the figures cited for the charge of Brown Tulip Oak at Hardy's in Sydney where a mean of 0.22 per cent. gave a minimum of 0.12 per cent. The reasonable accuracy and dependability of this ratio is shown by the fact that by its use was determined the consumption ratio per 100 s.ft. for Queensland and that of New South Wales. Moreover calculations based upon this figure and treatment plant data have been within 5 per cent.

of consumption requirement of preservatives in this State. Making this assumption then the average result to give a minimum of 0.16 per cent. in any one sample would need to be of the order of 0.30 per cent. and it would not be sufficient to simply specify 0.20 per cent.

Summarizing it can be seen that the determination of a minimum sample number which will meet even the majority of cases if difficult and probably can best be met by an initially arbitrary assessment. It has been found sufficient by the Division of Wood Technology to select samples to the degree prescribed in the specification based upon our experience but on the result of the mathematical examinations I feel that further samples should be prescribed. However I would suggest that such a figure could be best determined by an examination by the Mathematical Section of the Division of data from all sources.

Concerning the other main aspect discussed above, viz., plant efficiency, the views of Conference delegates upon their experience in other states would be appreciated. In particular, the practices followed by the Division of Wood Technology where a similar problem presumably arises would be of assistance.

Acknowledgement

It is desired to acknowledge the assistance given by the Departmental Biometrician (Mr. B. Adkins) and Mr. Rees in carrying out the mathematical examinations associated with these matters.

Discussion:

Mr. Jennings: Queensland Forest Service is concerned about the effect of sampling procedure on the boron content of a treated charge. Unless the method of sampling is standardized, different results might be obtained from the one charge. I suggest that a Committee be set up to report on a standardized sampling procedure.

Mr. Huddleston: If this is to be a standard specification there will be a sub-committee set up by the Standards Association.

If it is only to be for quality control in the treating plant then it should be a sub-committee of this Conference.

Mr. Jennings: We can only have quality control by constant sampling, since there is so much variability in the treating plants. To what extent should we sample ?

Mr. Huddleston: In Standard Specifications the minimum concentration is laid down. The method of sampling is usually included as an Appendix and is not in the Specification.

Mr. Clarke: Should it be tackled now or left until the Standards Association set up a Committee ? Is more information needed for the Standards Committee ?

Mr. Tamblyn: This Division can only help academically.

Mr. Clarke: Do you think we should leave it to the statisticians ?

Mr. Jennings: Yes - our staff will look into it.

ITEM 7 (k) - STANDARD SPECIFICATION FOR LYCTUS IMMUNIZED TIMBER

Mr. Turnbull: At the last Conference a Committee consisting of Messrs. Fogl, Cokley, Tack, and myself was formed to prepare a draft standard. The first draft has been prepared and has been reviewed by the Queensland Forest Service and New South Wales Forestry Commissions. We can now prepare a final draft. What is the following step - is this to be a Standards Association document, or a Departmental document for incorporation in the State Acts ?

Mr. Clarke: Is the draft in a form acceptable to the Standards Association ?

Mr. Turnbull: I think it is. It is divided into sections covering what preservatives and how much of them must be present in treated timber; the method of sampling; testing procedure and the branding of examined material.

Mr. Clarke: How does this method of testing sections tie up with the previous item 7 (j) ?

Mr. Jennings: Sampling procedure involves so many variables that it cannot be made an Australian standard.

Mr. Huddleston: I think some Standards Association Specifications refer to a Standard for treated timber.

Mr. Jennings: Should this be done before sampling procedure has been established ?

Mr. Turnbull: Mr. Cokley considers more samples than those set out in our draft are needed. It could be used as an interim Standard.

Mr. Turnbull then outlined the Standards Association procedure of having a drafting committee to prepare a draft standard, a reviewing committee to comment and a postal ballot on the redrafted (interim) Standard. Before an Australian Standard was approved a proof issue was made available for 3 months or more, for public comment.

Mr. Clarke: Could we submit this to the Standards Association as a first draft - do we all agree ?

Mr. Jennings: Yes, I agree.

Mr. Irvine: In some Standards Lyctus susceptible timber is indicated by an asterisk. How is immunized timber affected in these Standards ?

Mr. Turnbull: The questions of susceptibility rating will be discussed under a later item.

Mr. Clarke: Can we have this ready to send forward to the Standards Association meeting on Thursday afternoon ?

ITEM 7 (1) - GLUE LINE TESTS

Mr. Gordon: The present position on 200 test panels with a treated glue line is as follows: 150 sheets are in use in the Veneer and Gluing Laboratory (D.F.P.) and the remainder are still in Queensland being held in storage by the Queensland Forest Service, and provide a good control for plywood left in store. Fifty sheets have been treated with benzene hexachloride at the rate of 1 lb./1000 sq.ft. of

single glue line. These were held in Queensland for 3 months between manufacture and arrival at the Division of Forest Products. There has been no attack in the treated panels after nearly 2 years. The second lot treated at the rate of 1/4 lb. benzene hexachloride per 1000 sq.ft. of single glue line and further controls were made up 12 months ago. There is no attack visible in the treated panels, but in recent weeks some attack has occurred in the control panels of this batch held in Queensland and slight attack is now occurring in the panels installed at the Division of Forest Products.

The principal question now in this treatment is: For how long will benzene hexachloride confer immunity ?

It should be mentioned that in Melbourne, Lyctus beetles totalling several hundreds have been released into the wall cavities behind the panels over periods when available so that every opportunity for attack to develop has been given.

Mr. Tamblyn: I would like to add that the small panel test treated with benzene hexachloride and DDT in casein and urea glue lines is now nearly 7 years old and still shows no attack. We might now decide whether or not this type of treatment should be approved.

Mr. Jennings: I personally would prefer to see the benzene hexachloride treatment continue for a few more years. We should make no recommendation yet.

Mr. Tamblyn: There is no point in holding out if there is any practical advantage in making a recommendation now.

Mr. Huddleston: We have seen a lot of plywood lacking in glue, a and where there is no glue, can there be any protection from a glue-line treatment ?

Mr. Clarke: The question of determining the presence of benzene hexachloride must arise.

Mr. Gordon: The chlorine test may be used to determine the presence of benzene hexachloride but may be vitiated by the presence of sodium chloride impurities in the glue.

Mr. Huddleston: We have approved benzene hexachloride in New South Wales. We use the chlorine test but must have a blank of untreated wood of the same species so as to be able to determine the presence of the additional chlorine.

Mr. Clarke: The general feeling is that it is a little early to recommend benzene hexachloride.

Mr. Huddleston: We should have a commercial test on a restricted scale as a trial. In normal manufacture some pieces of plywood may be "starved" for glue.

Mr. Jennings: Only case quality plywood would be suitable for such a restrictive test, so that if any damage occurs there will be no great loss.

Mr. Irvine: Is benzene hexachloride treatment cheaper than borax treatment ?

Mr. Gordon: Benzene hexachloride works out at about 1½d./100 sq.ft. of plywood, and costs less than the momentary dip treatment.

Mr. Tamblyn: Why not add benzene hexachloride to all casein glues used in Australia. It would greatly reduce borer attack and might give some protection against termites.

Mr. Wright: Could not benzene hexachloride to be used for this purpose be given an additive so that its presence is easily recognized - for example, by adding a dye ?

Mr. Jennings: You might get the dye without the benzene hexachloride.

Mr. Wright: It would be necessary to legislate for the manufacturer to include the additive.

Mr. Jennings: Can you add benzene hexachloride to urea glues and phenolics ?

Mr. Gordon: Yes, we successfully included benzene hexachloride and DDT in cold set urea glues in our original laboratory tests but have not investigated hot pressed urea

formaldehyde glues. Liquid phenolic glues have been used overseas but under the hot alkaline conditions the benzene hexachloride has broken down.

With regard to a suggestion from I.C.I. that benzene hexachloride might be included in the glue line of plywood to make it resistant to termite attack, it should be noted that in Australia 80 per cent. of the plywood is used for furniture. It would therefore seem unnecessary to apply termite proofing methods unless all the other wooden components of houses etc. were effectively termite proofed.

Mr. Gay: Benzene hexachloride is compatible with urea formaldehyde glues but you cannot get enough benzene hexachloride into the glue line to confer immunity from termite attack. There is just not enough glue in plywood. With wallboards the position may be different.

ITEM 8 (a) - CYPRESS PINE JEWEL BEETLE INVESTIGATIONS

Deleted from Agenda.

ITEM 8 (b) - LYCTUS SUSCEPTIBILITY GRADINGS

Mr. Tamblyn: This issue has been raised many times in the past without agreement being reached. At the last Conference a Sub-committee reached a decision which, however, has not proved acceptable and has been the subject of correspondence between this Division and the Queensland and New South Wales Forest Services. As a result of this correspondence a new proposal has been made and is submitted to the Conference for approval.

The position over the last few years has been as follows:-

Conference 1950 - Agreed to resistant, rarely susceptible, and susceptible.

D.F.P. 1951 - Disliked the term resistant and counter-proposed immune, rarely attacked, and susceptible.

Q.F.S. 1951 - Considered that a review of the Conference decision was necessary and suggested that for practical trade purposes two gradings only were necessary as used in their Pamphlets 1 and 2 -

C - commercially non-susceptible

S - commercially susceptible

For scientific papers and more detailed records the following gradings were recommended -

0 - immune

1 - slight (practically immune)

2 - light (not uncommon)

3 - moderate

4 - heavy

New proposal - As already agreed to in correspondence by Mr. Huddleston.

(1) To be used where a simple "Yes - No" grading is required.

NS - not susceptible commercially.

S - susceptible commercially.

(2) For more detailed classification -

I - immune for all practical purposes.

SS - slightly susceptible

MS - moderately susceptible

HS - highly susceptible

In the discussion which followed, Mr. Jennings indicated that Queensland would agree to the new proposal for the sake of uniformity. Mr. Huddleston thought only three grades were necessary. Mr. Tamblyn considered that two different systems were necessary, 1 (above) allows a Yes - No classification, while 2 (above) allows more detailed classification.

Mr. Huddleston pointed out that the question to be answered

was does or does not the timber need treatment; the more gradients used, the more difficult it was to answer this question.

After considerable discussion, the item was deferred.

When brought up again, the Chairman requested that the matter be finalized.

Mr. Huddleston said that at the 1950 Conference a group of three grades was adopted. The Division of Forest Products and the Division of Wood Technology followed these three grades but changed the names of the grades. He suggested that we adhere to the use of these three grades.

Motion: Moved by Mr. Huddleston, seconded by Mr. Elliot that we adopt the grades as recommended at the 1950 Conference.

The motion was carried on voices, Mr. Beesley dissenting on behalf of Mr. Tamblyn who was absent.

ITEM 8 (c) - LYCTUS NUTRITIONAL STUDIES

Mr. Gay: This is a brief resume of the work done prior to the 1951 Conference. Lyctus larvae have completed their development on the following synthetic diet - starch, casein, sucrose, yeast, and cholesterol. The life cycle under these conditions was completed in approximately the same time as in normal wood.

During the past year, various diet ingredients were removed in an effort to detect the essential nutrients for normal larval development.

Removal of yeast (vitamin B complex) prevented normal development. The removal of casein and salt mixture had little effect. It was considered that the small protein and salt requirements were available elsewhere (in the yeast). The removal of sucrose, however, greatly reduced the number of larvae completing their life cycle. Those larvae which did complete their life cycle took longer to do so but were quite normally developed.

Sucrose was then replaced by xylose, lactose, maltose, dextrose, raffinose, galactose, mannose, and mannitol, all being satisfactory except galactose which appeared to affect the larval development adversely.

It is a fact that some timbers not giving the normal starch reaction could support Lyctus attack. This aspect of larval nutrition was investigated by sutstituting amylopectin and amylose for starch in the dietary mixture. It was found that with amylopectin instead of starch the life cycle occupied 2-1/2 months, whereas with amylose it was 8-9 months. In view of these results it must be realized that susceptibility is not necessarily dependent on the presence of natural starch in wood since starch breakdown products are suitable as substitutes.

A further extension of the investigation has been directed to the fact that eggs laid in apparently susceptible sapwood developed only to the stage of young larvae, which soon died, suggesting the presence of some toxic factor in the wood. The timbers concerned were Melicope australasica and Cryptocarya glaucescens. A methanol extract of each of these timbers was added to the basic diet and found to be toxic.

Subsequently, Dr. Price of C.S.I.R.O., Alkaloids Investigations, fractionated an extract from Melicope sp. (not australasica) and obtained three alkaloids - melicopine, melicopidine, and melicopicine. These were added to the basic diet in quantities up to four times the normal concentration in the wood, but had no deleterious effect on larval development. It is evident that even if these alkaloids are present in M. australasica they are not responsible for suppressing larval development.

Petroleum ether and methylene chloride extracts of M. australasica were non-toxic. The ethanol insoluble fraction of a methanol extract was non-toxic, but the ethanol soluble fraction proved toxic to young larvae.

In conclusion, I should like to refer to tests done with 2 per cent. chlordane emulsion as a contact insecticide. The timber specimens were allowed to dry for 24 hr. after momentary dipping in the emulsion. They were then inoculated with Lyctus beetles, which all

died within 24 hr. A re-inoculation carried out 4 weeks later showed that the chlordane was still toxic to Lyctus beetles.

Mr. Turnbull: Is chlordane generally acceptable ?

Mr. Gay: If the hazard is not high. At present there is a large scale spraying operation with chlordane in a Sydney suburb.

Mr. Clarke: What would be its practical application ?

Mr. Gay: The spraying of timber off-saw, or treatment of timber during air drying in timber yards to give temporary protection.

Mr. Turnbull: Is it expensive ?

Mr. Gay: I have not the exact price, but consider it is in the vicinity of 39/- a pint. It can be very considerably broken down from the 50 per cent. strength at which it is marketed. Due to its dollar source of supply, its availability at present is restricted.

Mr. Tamblyn: In concluding the discussion, I should like to express appreciation of the work done on the nutritional aspect of the Lyctus problem and we all look forward to reading further on the subject when Mr. Gay has prepared his report. It is important that this work should continue.

ITEM 8 (d) - ANOBIUM INVESTIGATIONS

Mr. Tamblyn: Briefly, the work done on Anobium since the 1950 Conference is as follows: - The Pinus radiata susceptibility test attempted in 1950 in co-operation with the New Zealand D.S.I.R. was a failure. As a result of this, work was carried out by Mr. Rosel to develop and standardize a technique which would give good oviposition. This was achieved and it is now proposed to carry out, under controlled laboratory conditions, a Pinus radiata susceptibility test using 20 trees from about 15 different localities throughout New South Wales, Victoria, Tasmania, and New Zealand. Ten trees of New Zealand white pine, together with 5 each of Scots pine and spruce, are to be used as controls.

In all cases 3 specimens will be cut from each tree, representing the outer, middle and inner sapwood zones.

ITEM 9 - STATISTICAL SURVEY OF DAMAGE BY BORERS, TERMITES AND DECAY IN AUSTRALIAN BUILDINGS

Mr. Beesley: At the last Conference it was resolved that this survey should include new houses, especially in regard to the incidence of termite attack. Although the number of returns received has not been as great as expected, due in particular to a restriction in the activities of the Department of Works, some 250 forms have been received since the last Conference.

The position at the moment is as follows:-
Borer attack is reported in 43 per cent. of houses.
Termite " " " " 5.5 " " " " .
(60 per cent. of the houses in this group have been built since 1941).
Decay is reported in 3 per cent. of houses.
Negative returns were received from 48.5 per cent.

Due to the curtailment of the functions of many of the Departments supplying these returns, it is to be expected that information will be coming forward at a reduced rate in future. Nevertheless, it is felt that this type of survey will ultimately provide a basis for an authoritative statement on the incidence of borers, termites, and decay in Australian buildings.

Mr. Gay: I consider the figure of 43 per cent. for borer attack is low. Judging on our Canberra experience, I would say that in houses erected in the last 5 or 6 years, 90 per cent. are infested by borer.

Mr. Irvine: I think in Melbourne the actual figure would be nearer 100 per cent.

Mr. Beesley: In a Victorian Housing Estate of 98 houses, 95 had reported attack by borer.

ITEM 10 - REGISTRATION AND LICENSING OF PEST DESTROYERS IN NEW SOUTH WALES

Introduction: Mr. E. B. Huddleston.

Mr. Huddleston gave a brief resume of the technique and practices used by the pest exterminating firms operating in Sydney.

Reference was made to the tendency of a number of firms to exaggerate unduly the potential damage from incidence of borer, particularly Lyctus, and to quote extravagantly high charges for treatment. As a result of this, Mr. Huddleston reported that a number of the more reputable firms have recently formed an Association to keep mal-practices in check, and that Association has approached the Minister seeking legislation for the purpose.

Proposals for legislation have been drafted by the Commission for submission to the Minister. Under the proposed legislation it will be necessary to obtain a licence before any individual can practise as a pest exterminator, and in the near future it will be necessary for aspirants in this field to qualify by written examination before going into business.

A syllabus of instruction is proposed and an Examining Committee will operate as at present under the Local Government Acts. An examination will be held yearly and those successful will get their licences. Licences would be lost by individuals, if mal-practice is proved, not by the firms they represent.

Mr. Irvine: The position in Victoria was discussed with the Crown Law Authorities a number of years ago. The difficulty of policing any legislation introduced was stressed by this Authority and it was decided that there was ample legislation available by which any aggrieved person could recover damages.

ITEM 11 - TERMITE INVESTIGATIONS

Mr. Gay: I shall give you a brief summary of the work of the Division of Entomology since last Conference. It can be divided into laboratory and field tests.

(a) Laboratory tests

Nasutitermes has quite different digestive processes and food preferences from Coptotermes. All the tests in Canberra have been with N. exitiosus and C. lacteus, and the principal tests were:

(i) Plantation-grown conifers from Queensland and New South Wales. Pinus taeda, Pinus patula, Pinus caribaea, and Pinus radiata were tested, but none of these species showed resistance to termite attack.

(ii) Malayan timbers for the Malayan Forest Service. Betis, Membatu, and Nyatch, showed useful to high resistance. The results of this test are to be published in full in the "Malayan Forester".

(iii) Further tests of the natural resistance of Australian commercial timbers. Tests of 50 trees of each of the following six species are in progress :- E. crebra, E. paniculata, E. microntha, E. grandis, E. tereticornis, and Syncarpia laurifolia. Syncarpia is showing up well so far.

(iv) Preservative materials and treatments. Dieldrin in quite low concentrations has high preservative value. To some extent this test was nullified, since the carrier used had some residual toxic effect. However, the test will be repeated and aldrin and chlordane will also be studied.

We have also tested, for L. G. Farben "Termiten-Basileum", which consists of a mixture of chlorinated hydrocarbons. We objected to their brush method of application and insisted on pressure impregnation. The brush treated specimens had only low resistance to termite attack, but the pressure impregnation was comparatively effective.

(v) Miscellaneous laboratory tests included samples of impregnated rubber compounds to be used for cable coverings for the P.M.G.'s Department. Two per cent. pentachlorphenol in the rubber is sufficient to ensure a high degree of termite resistance.

Plastic covered cables (polyvinyl chloride and chloride and polythene) are not immune from attack and some plastics have very low resistance.

Tests of treated English plywoods have also been made. These plywoods are being manufactured with a view to export in large quantities to colonial areas, notably Africa. Benzene hexachloride has been added to the glue line in both the crude and the pure gamma isomer form. Benzene hexachloride up to 4.8 per cent. in the glue line has not been successful in resisting termite attack. Subsequently, the glue line was "plastic treated", that is, the veneers were smeared with phenol formaldehyde and then glued up. This was also unsuccessful. In general, superficial treatments have not been successful.

(vi) Coptotermes acinaciformis tests. This is the species of No.1 economic importance. Our first problem was to adopt the existing testing technique, and this was done successfully. The next problem was to equate the results of C. lacteus tests (Canberra species) with C. acinaciformis of Queensland. The results of the Queensland tests have shown that both species have similar food preferences but that C. acinaciformis is 2-3 times as "hungry" as C. lacteus.

Whilst in Queensland we tried to adapt our technique to Mastotermes darwiniensis but lacked test material. Since then we have attempted to develop a laboratory method of using Mastotermes with material sent to Canberra from the Katherine Experimental Station, N.T.

(b) Field Activities

Soil poisoning tests have been in progress in the Canberra area for 4 years.

At the recent examination a few months ago, we found that 5 per cent. pentachlorphenol, creosote, 5 per cent. sodium arsenite, and 5 per cent. sodium pentachlorphenate are beginning to break down at the end of 4 years. This may be due to a "wash" effect, giving a superficial layer of untreated soil on the top of the treated soil. This "wash" could have taken place from the termite mound or from the surrounding country. We have now modified our technique to eliminate the effect of "wash" and during the next 12 months will know whether the apparent failure of the soil poisoning treatments is really a breakdown of the treatment or is only a "wash" effect.

We have installed a soil test in the Riverina at Griffith, and have included chlordane (2 per cent. emulsion) for the first time. This test has been set up so as to eliminate the effects of "wash".

Miscellaneous

I wish to draw your attention to the advance copy of "Australian Termites" - by Ratcliffe, Gay, and Greaves - which is complementary to Hill's monograph.

"Australian Termites" is divided into two main sections. The first deals with biological aspects; the second section is a "working-man's guide" to the various common species of commercial importance. There is an appendix on collecting termites - by which we hope to increase our own collection - and another on control and eradication. The book is being distributed by the Tait Book Company and is now available.

Finally, I wish to draw the attention of the Conference to the potential hazard presented by termites in living trees in new housing areas. In Canberra, where there is a considerable amount of building in progress, there is one area of 80 acres with 35 trees (stags) of E. rubida. On this area crates of prefabricated houses had been stacked and, after a period of only 3 weeks some crates were found to be heavily infested with termites. An adjacent tree was pushed over and was found to contain a large nest of C. frenchi.

Subsequently, each of the other trees on the area was examined and pushed over with a bulldozer, and each was found to be inhabited by a colony of C. frenchi having a radius of potential damage of 80-100 yards from the tree.

Mr. Beesley: Several manufacturers of plastics have sought the Division's advice on the addition of materials such as pentachlorphenol to plastics for the protection of P.M.G. cables. So far we have no information on the manufacture of such products.

Mr. Tack: Is it a fact that polyvinyl chloride coated cables are no longer regarded as termite proof ?

Mr. Gay: Polyvinyl chloride was attacked in Queensland.

Mr. Tack: What is the termite resistance of boric acid treated plywood ?

Mr. Gay: We have tested some Pinus radiata and matai plywood from New Zealand, treated with boric acid (at a higher concentration than would be required for Lyctus control) and found it gave useful protection.

Incidentally, our method of laboratory testing has aroused interest in several countries and we have received requests for details of it from Great Britain, South Africa, and other countries, as well as numerous requests for tests.

Mr. Clarke: If C. acinaciformis is 2 or 3 times as voracious as C. lacteus, how are you going to determine the minimum concentration of preservatives required for termite protection ?

Mr. Gay: I think that the concentration required to prevent termite attack would be 2 or 3 times the value of the threshold concentration for C. lacteus. Next year we hope to go to Queensland again and will endeavour to determine how much more preservative is needed to stop C. acinaciformis than to prevent C. lacteus attack.

Mr. Tack: Commercially, soil poisoning treatments are usually made beneath a building. The Canberra tests have been made under the worst possible conditions.

Mr. Gay: Yes, our tests can be expected to give only the minimum life of soil poisoning treatments.

Mr. Tack: How does this evaluate water solubles, such as sodium arsenite, which when used commercially, i.e. applied to soil protected from the weather by the superstructure, are not subject to water "washing"?

Mr. Gay: We have purposely avoided testing under these conditions because of the additional work of erecting a structure to shed water.

Mr. DaCosta: Are any brush treatments successful ?

Mr. Gay: We are not happy to test brush treatments because the method is unreliable and recommendations for brush treatments are not desirable because of this.

Mr. Clarke: There is a problem in testing brush treatments. In tests the material is handled carefully; in service it may be treated roughly and the surface coating broken.

Mr. Gay: I agree.

Mr. Tack: We are often asked for the best method of eradicating termites from a building. Arsenic dust is our best treatment but the request usually comes after the floor is lifted, in addition, arsenic is dangerous for the average householder to handle.

Mr. Gay: We still recommend arsenic dust treatments. We have examined nearly all other possible compounds and have found none to wholly replace arsenic. The efficiency of the treatment is invalidated if there has been extensive distu bance before it is made.

Mr. Tamblyn: In your soil poisoning tests are the specimens surrounded by preservative ? In practice, house stumps, for instance, often pass through the zone of treated soil. We need to know the depth for treatment.

Mr. Gay: In the first year of our soil poisoning tests the specimens were placed on the bottom of the trench and the treated

soil was packed around them. There was plenty of attack through the bottom of the samples. You must have treated soil beneath the specimens as attack can occur at a considerable depth; attack at 2 ft. 6 in. is not uncommon in Canberra.

Mr. Tack: If durable stumps such as red gum, concrete, or masonry are used, it is only possible for termite attack to come up through a cavity or crevice in them. The depth of soil treatment is not so important under such conditions.

Mr. Jennings: It is interesting to point out that in the Downs country and at Townsville, attack has come from as deep as 5 ft. It was Mastotermes at Townsville.

ITEM 12 - CROSSARM SURVEY

Mr. Beesley: The field work in this survey of the causes of service failure of crossarms, throughout Australia, is now almost complete. In Western Australia almost 900 arms were examined; over 1000 arms have been inspected in Victoria, about 1300 in New South Wales, over 2000 in Queensland, and between 400 and 500 in Tasmania. As soon as this Conference is over the recovered arms collected in South Australia are to be inspected.

Pressure of work, and other assignments, have hindered the preparation of reports in this project, but at the present time the results of the Victorian survey are being analysed by the Section of Mathematical Statistics; an interim report on the results of the New South Wales survey has already been submitted to the New South Wales Division of Wood Technology, and the figures for Queensland and Tasmania have not been analysed.

Nevertheless, useful results have come out of the survey and have already been applied. The Sectional Committee on Wood Technology, Victorian Section of the Standards Association of Australia, has prepared a new draft specification for crossarms, which has been based largely on the recommendations made as a result of the survey of recovered crossarms. It is anticipated that this new specification will replace the existing P.M.G. specification, and will be

generally used in Eastern Australia. The three most important changes are the wider range of permissible species, the greater leniency with regard to defects such as gum veins and pinholes, etc., and the absence of reference to inclination of growth rings.

Without going into the details of the results of the recovered crossarm survey and their application, one or two points are worth mentioning:-

(i) There was a noticeable similarity in the appearance of the recovered arms in Victoria, where the ash type eucalypt timbers predominated, and those in Queensland, where the ironbarks and spotted gum were most common.

(ii) Accurate data on the service life of recovered crossarms was only available in a few instances, but "circumstantial evidence" indicates that the average service life, regardless of species or State, is between 25 and 35 years.

(iii) The proportion of arms removed from service whilst still in good condition amounted to about 20 per cent. of all arms recovered, and indicated considerable wastage. Even without preservative treatment the bulk of these arms were fit for re-use.

(iv) During the survey, as opportunity offered, various aspects of timber utilization and wood technology were discussed with engineers, technicians and field staff of the P.M.G.'s Department. Most of these officers expressed regret at their lack of training in wood technology, and many were able to give instances of where better knowledge would have enabled them to conserve useful timber. The conspicuous absence of trained specialists in wood technology, in a Department otherwise well-endowed with specialist-engineers and technicians, is to be regretted, and this Division, together with the State Forest Services, is urged to consider ways of keeping this Department and other large scale users of timber informed of the progress of knowledge in the use of timber.

(v) In Tasmania, a number of the fittings had been in black

iron, and it was noticed that corrosion or decay of the wood around these fittings, particularly combiner bolts, was severe, so that sometimes only a hollow shell of seemingly sound wood remained.

(vi) The percentage of "not condemned" arms recovered from different depots varied considerably, being as low as 2 or 3 per cent. at some depots, and up to nearly 50 per cent. at others. This could be due either to different standards of inspection and recovery or else to modernization in the area, such as replacement of aerial routes by subterranean cables.

Mr. Turnbull: The crossarm survey has been of great benefit to the Standards Association in drafting a specification for crossarms, which the P.M.G. engineers have readily accepted.

Mr. Clarke: I am apprehensive at the elimination of specified direction of cutting for crossarms.

Mr. Irvine: It is recognized that the arms examined were recovered from service. Neither the Railways nor the P.M.G. seemed unduly concerned at the omission of this clause.

Mr. Beesley: Figures for New South Wales and Victoria show that the proportion of arms cut in various ring directions is almost randomized.

Mr. Huddleston: Was the survey conducted on arms recovered from trunk lines only ?

Mr. Beesley: Yes - the standard of maintenance on the trunk lines is very much higher than on subscriber routes and the majority of the arms recovered came from trunk lines.

Mr. Jennings: Nearly all the arms recovered in Queensland came from trunk lines.

ITEM 13(a) - SEASONING PRACTICE IN NORTH QUEENSLAND*

During 1951, visits were made to North Queensland sawmilling centres by officers of the Department to obtain information on the engineering and seasoning aspects and also to render assistance wherever

---

* Prepared by Forest Products Research Branch, Queensland.

possible on any timber or plywood and veneer problems.

Generally speaking, only the larger mills were making any endeavours to season timber either by kiln or air seasoning matters, the smaller millers finding a ready output for their unseasoned material either to other millers, timber merchants, or timber using industries. It was noted that the veneer and plywood industry was increasing in importance and that there were a number of newly established firms as well as a number in course of construction.

From the observations made, it was obvious that there is considerable room for improvement in the drying technique for both sawn timbers and veneers. It would seem that many millers having been accustomed to the handling of species such as pine, maple and silky oak, for which timbers they were able from experience to adopt "rule of thumb" drying techniques, are now meeting difficulties when called upon to handle other species of whose characteristics they are unaware. The position pertaining in the post-war years to the demand for timber greatly exceeding the supply, has not assisted the efforts of technical officers of the Department in instilling the need for more efficient methods into the sawmillers' minds.

In the Cairns area, eight ply or sawmills were visited. The veneer and plywood mills appeared to be relying almost entirely on air racking for their veneer drying and using kilns for redrying. Under the conditions of temperature and humidity in this area, it is very doubtful whether E.M.C. would ever be much below 15 per cent., and it is possible that gluing failures in plywood are not unrelated to moisture content of the veneers at time of gluing. Redrying kilns in use were not of good design, but millers stated that they were quite happy about the results being obtained. No apparent effort to control kiln conditions was noted.

The timber drying kilns appeared to be in reasonable condition, but in some cases the millers had departed from the original kiln design, particularly as regards fan speeds, thereby

impairing kiln efficiency. Other deficiencies noted were lack of dummy ceilings and also baffles between tops of stack and dummy ceilings. In more cases than not, the operators had no knowledge of timber drying and worked on time schedules even with green off-saw material. Wet and dry bulb thermometers were conspicuous by their absence.

On the Atherton Tableland, two millers at least were endeavouring to adopt sound seasoning practice both in timber and veneer drying. One of these two firms had recently constructed a kiln for veneer drying and plywood redrying, but circulation and moisture content checks indicated that drying was very uneven. Following advice on this point, the firm is to modify the kiln and construct an additional unit on the lines recommended by the Division of Forest Products for veneer drying.

This same firm has two C.S.I.R.O. design timber drying kilns both in good condition and has partially completed a further kiln of similar design.

In another mill on the Tableland, the operator has a sound knowledge of timber drying, keeps careful control, and records of kiln conditions, but is handicapped by the fact that kilns are not in particularly good condition. The worst defect was that fan speeds are far too low allowing for uneven circulation in the kilns. This mill is, at the moment, building two more cross shaft internal fan kilns, and is proposing the installation of a kiln for the drying of sliced veneer.

Another veneer mill had been supplied with plans for the construction of a cross shaft progressive veneer drier, but at the time of the inspection no action had been taken to install the unit. The owner was quite happy, however, to bundle his veneer and truck it some 40 miles to a more suitable air drying area. This additional handling appeared to have an adverse effect on the veneer quality.

In the Innisfail-Tully area, advances are being made in the veneer and plywood industry, some five mills having been established here in recent years. In two of these mills, advantage has been taken of the

technical information available both from the Division of Forest Products and this Department on the drying of veneers and these millers are installing cross shaft progressive kilns both for veneer drying and plywood redrying. In two other mills, it was noted that kiln design was extremely poor with the kilns being quite unable to cope with the production, quite apart from the fact that uneven drying with resultant severe degrade was apparent. It would seem that the designers of these units had little knowledge of the principles involved. In the other mill visited in this area, a fan and boiler had been purchased against the advice of officers of this Department and a tunnel kiln is in course of erection. It is felt that satisfactory results will only be obtained if considerable modifications are made to this unit.

In Townsville the only kilns in operation were two cross shaft internal fan units employed on plywood redrying. These kilns appeared to be operating reasonably well, but required a considerable amount of maintenance. Other millers in this area are quite content to rely on air drying for their requirements in seasoned timber.

In Mackay, one firm has three kilns in operation. These kilns are in good condition and are being operated intelligently. A further mill in this area is installing two kilns, each to take approximately 20,000 s.ft. (on 1 in. basis) per charge.

It will be noted from the above that some millers are becoming more aware of the need for a dry product from their mills and are taking necessary steps to effect this condition. It is hoped that their action will be a forerunner of similar action by other mills in the North Queensland area.

ITEM 13(b) - AIR SEASONING OBSERVATIONS ON BORIC TREATED AND UNTREATED SCRUBWOODS OF SOUTH EAST QUEENSLAND*

As practically no information was available on the air seasoning of boric acid treated and untreated scrubwoods of South Queensland, the opportunity was taken to compare the drying rates of a number of these species in conjunction with work being undertaken

* Prepared by Forest Products Research Branch, Queensland.

by the Preservation Section.

As only a small quantity of each species was available, the observations were carried out on a model stack basis, using 4 in.x 1 in. sample boards.

Four samples of each of the following species were used:-

Southern Silky Oak	(Orites excelsa)
Sour Cherry	(Eugenia corynantha)
White Birch	(Schizomeria ovata)
Grey Persimmon	(Diospyros pentamera)
White Walnut	(Cryptocarya obovata)
Tamarind	(Diploglottis cunninghamii)
Pink Poplar	(Euroschimus falcatus)
Bollywood	(Litsea reticulata)
Yellow Carabeen	(Sloanea woollsii)
Brown Tulip Oak	(Argyrodendron trifoliatum)
Bonewood	(Emmenospermum alphitonioides)
Rose Mahogany	(Dysoxylum fraseranum)
Blush Tulip Oak	(Argyrodendron actinophyllum)
Red Apple	(Eugenia brachyandra)
Rose Walnut	(Endiandra discolor)
Silky Ash	(Ehretia acuminata)

Two sample boards of each species were boric acid treated by the hot immersion process and then stripped out in a model stack under cover. The two remaining samples of each species were stripped out, untreated, in a model stack similar to the first one.

These sample boards were weighed and examined for degrade weekly for 65 days on the treated samples and 56 days on the untreated, after which time pressure of more urgent work prevented further observations for many months.

After the untreated samples had been seasoning for 35 days and the treated samples for 27 days, a period of wet weather set in. As the two sets of boards were within 2 per cent. of each other in

moisture content, it has been assumed that the wet season caused a similar rise in moisture content in each series.

The attached graph shows the mean drying rates of 32 sample boards in each of the two series, after correction by the Department's Biometrician for the increase caused by the wet weather. It will be seen that, notwithstanding an average rise of approximately 20 per cent. on the initial moisture content during treatment, the drying times of the treated and untreated samples were practically identical. Most noticeable is the rapid drop in moisture content in the treated samples down to about 20 per cent.

This rapid drying of the treated material may be caused partly by the leaching out of soluble solids from the wood during hot and cold boric acid treatment, allowing freer passage of moisture, and partly by incomplete penetration resulting in a very great increase in case moisture content and only a small rise in core moisture content.

While it is unfortunately true that much of the value of this experiment is lost because of the premature cessation of observations, there is sufficient data to show that there is no appreciable loss of time in seasoning boric acid treated scrubwoods.

All boards were examined for degrade after seasoning, and it was found that the treated samples compared more than favourably with the untreated ones.

The table set out below shows the actual uncorrected rates of drying.

Drying rate of boric acid treated samples		Drying rate of untreated sample boards	
Days	M.C.%	Days	M.C.%
0	90.8	0	70.2
6	52.8	7	55.3
13	37.9	14	37.6
20	26.4	21	28.7
27 rain	20.1	28	22.3
34	19.3	35 rain	18.4
48	18.8	42	18.1
65	14.6	56	18.0

ITEM 13(c) - SOME AIR SEASONING AND BASIC DENSITY OBSERVATIONS ON SOFTWOOD PLANTATION SPECIES *

Sample boards of a number of exotic softwood species were dried at the Forestry Experimental Yard, Brisbane, between June and September, 1949. Although the work was carried out only on a model stack basis and with a small number of samples, the indications were that all species would dry very rapidly under cover and degrade apart from blue stain would be negligible.

The sample boards were obtained from logs of the following species which had been grown in the Arboretum, Beerwah:-

Species	No. of logs	Centre Girths O.B.	Age
Pinus caribaea	3	31 in., 33 in., 32 in.	20 yr.
Pinus luchensis	2	35 in., 30 in.	16½ "
Callitris cupressiformis	2	34 in., 31 in.	18½ "
Pinus canariensis	2	31 in., 26 in.	18½ "
Pinus patula	2	30 in., 33 in.	20 "
Pinus longifolia	2	31 in., 36 in.	18½ "
Pinus insularis	2	32 in., 34 in.	19 "
Pinus palustris	2	29 in., 30 in.	18½ "
Pinus taeda	2	31 in., 35 in.	20 "
Pinus pinaster	1	31 in.	19 "

Sample boards of 5/8 in., 1 in., 1-1/2 in. and 2 in. material were obtained from each log and after preparation were stripped with 3/4 in. strips on top of the air drying stack containing the remainder of the material sawn from the logs.

All samples were weighed and measured for shrinkage at weekly intervals for approximately 3 months.

The times of drying of all species to various moisture content levels are given below:-

---

* Prepared by Forest Products Research Branch, Queensland.

Moisture content	20%	18%	17%	15%
5/8 in. thick boards	15 days			30 days
1 in. " "	30 "			55 "
1-1/2 in. " "	47 "		55 days	
2 in. " "	55 "	61 days		

Under conditions obtaining at the Forestry Experimental Yard there did not appear to be any really significant differences between times taken for each species to dry to various moisture content levels even though there were considerable differences in initial moisture content between species. (Range 143 per cent. for P. canariensis to 44 per cent. for P. taeda).

Of the 1-1/2 in. and 2 in. thick material, only the 1-1/2 in. thick boards of P. insularis dried below 15 per cent. moisture content within the study period of 89 days.

Shrinkage figures to 15 per cent. moisture content are tabulated below:-

	Back Sawn			Quarter Sawn		
	Av.	Max.	Min.	Av.	Max.	Min.
Pinus caribaea	2.65	3.35	2.00	3.20	3.90	1.90
Pinus luchensis	3.01	4.35	1.90	3.15	3.90	2.25
Callitris cupressiformis	2.39	2.80	2.05	2.12	2.70	1.60
Pinus canariensis	2.78	3.60	1.65	2.12	2.82	1.35
Pinus patula	3.50	4.25	2.44	3.40	3.97	2.70
Pinus longifolia	2.51	3.40	1.40	2.45	3.40	1.30
Pinus insularis	3.00	3.85	2.10	2.94	3.13	2.85
Pinus palustris	4.04	4.75	3.50	3.60	4.00	2.80
Pinus taeda	3.85	4.70	2.45	4.12	5.00	2.75
Pinus pinaster	2.95	4.50	1.25	3.73	4.70	1.95

Density

From the same logs a number of samples were taken for density purposes and the basic density figures obtained are given below:-

	Basic Density (lb./cu.ft.)			
	Av.	Max.	Min.	
Pinus canariensis	25.1	34.1	20.4	
Pinus caribaea	26.7	35.4	20.1	
Pinus insularis	27.7	32.7	20.7	
Pinus luchensis	27.8	35.3	22.6	
Pinus patula	29.5	43.4	19.9	
Pinus taeda	30.1	37.0	18.9	
Pinus palustris	30.7	40.5	22.2	
Pinus longifolia	32.5	41.4	23.8	
Pinus pinaster	40.9	46.5	35.0	(Compression wood present)
Callitris cupressiformis	25.7	39.2	21.5	

These figures have more significance when they are compared with the figures for Hoop Pine:-

Virgin growth - 29 lb./cu.ft. (Ranges 23-34 lb.).

Plantation grown (8 yr. old) - 26.5 lb./cu.ft. (Ranges 21.8 - 31.2 lb.).

Discussion:

Mr. Wright: The type of field work referred to in these papers is most important, particularly Item 13(a). The repercussions of poor seasoning practice at some plants in North Queensland was noticed recently as far abroad as Western Australia, when a number of crates of veneer received from North Queensland by a furniture manufacturer in Perth was opened in my presence. This material had been invoiced and charged as fully dried material. The pattern of moisture distribution in individual sheets of veneer taken from within several of the freshly opened crates showed moisture contents exceeding fibre saturation point, and was such that rain wetting could be discounted. On the other hand

the moisture distribution was consistent with the despatch of the material ex the manufacturer's veneer mill in the wet condition. This, naturally, had caused not only loss of good will, but also actual monetary loss to both parties concerned.

Mr. Grenning: It is the intention of our Research Branch to impress on the Queensland industry, and particularly on the veneer manufacturing plants, the need for applying correct drying practice. It is also my intention to accelerate field work in North Queensland with the object of preventing the unsatisfactory circumstances referred to previously. The economic conditions existing in post war years have been a contributing factor to some forms of malpractice.

Mr. Gordon: Urea formaldehyde glues appear to be increasingly favoured by plywood manufacturers. Since these glues are more sensitive to high moisture content of veneers, it will be necessary for them to exercise more care in drying veneers and installation of artificial drying must follow to ensure satisfactory moisture contents and eliminate gluing troubles likely to occur with air dried veneers.

ITEM 13(d) - VAPOUR DRYING - A SUMMARY OF RESEARCH STUDIES*

Some 3 years ago laboratory studies of the vapour drying process were commenced at this Division. The object of the studies was to determine whether the process had technical application to Australian native timbers, and, if possible, whether it would be of value to the Australian timber industry.

SUMMARY OF RESULTS

1. VAPOUR DRYING JOINERY QUALITY TIMBERS

(A) THE IMPERVIOUS SPECIES

(i) From the Green Condition: Tasmanian alpine ash and myrtle beech demonstrate to a marked degree the refractory drying characteristics of this group of impervious collapse susceptible species. Both are temperature sensitive in the green condition, and the former, particularly, is highly collapse susceptible. The "ash" eucalypts, incidentally form some 25 per cent. of the total sawn timber production

* Prepared by Division of Forest Products.

in Australia.

For these reasons it was considered that timber from these two species would provide a reasonably severe test of the possibilities of using vapour drying as a seasoning process, for impervious species generally, from the green condition.

Initial experimental work early demonstrated that 1 in. thick alpine ash could be very rapidly dried (in from 4 to 10 hr.) from the green condition to about 12 per cent. moisture content by any of the vapour drying agents at atmospheric pressure, but only with extremely severe checking, honeycombing and collapse. It is worth noting that the normal kiln drying time for this class of material from the green condition approximates some 15 days or so (i.e. 360 hr. or more).

As indicated previously, reduction in working pressure tended to improve drying quality during vapour drying, but it was not until a drying technique was evolved which involved the use of (a) a relatively low boiling point drying agent, (perchlorethylene), (b) low working (of the order of 28 in. vacuum) and (c) careful heat input control to the working fluid evaporator to ensure a low wood temperature (not greater than approximately 150°F.), that satisfactorily dried quality with a minimum of collapse was obtained.

With this condition good final quality was obtained for both species, the vapour drying time in the case of the 1 in. thick Tasmanian alpine ash, from the green condition to a moisture content of 12 per cent., being only a little more than 4-1/2 days (111 hr.).

It should be noted that similar material of this species degraded severely when kiln dried under conditions to give a drying time of 5 days; similarly, when kiln dried at conditions ensuring a wood temperature (150°F.) which gave a good drying quality with vapour drying, severe degrade again developed in the kiln dried material.

(ii) From the Partly Air Dried Condition: Little difficulty was experienced in satisfactorily vapour drying 1 in. thick Victorian mountain ash from the partly air dried condition (25 per cent. moisture

content) to a final value of 10 per cent. in the very rapid time of 5 hr.

This result was obtained with perchlorethylene, at atmospheric pressure, as the drying agent. Final drying quality was good and comparable with that obtained from matched material which was partly air dried and then kiln dried to a similar final moisture content in some 35 hr., i.e., 7 times as long.

The results obtained with mineral turpentine as the drying vapour were not quite as good as those obtained with perchlorethylene.

(B) THE PERVIOUS SPECIES

No difficulty whatever was found in vapour drying, free from degrade, 1 in. or 2 in. thick radiata pine from the green condition to a moisture content of 12 per cent. The 1 in. thick stock was vapour dried in from 4-1/2 to 5 hr., and the 2 in. thick stock in approximately 12 hr.; these drying times are only some 5 to 10 per cent. of the time usually regarded as normal in a modern forced circulation internal fan kiln for material of this nature.

In drying, no checking developed in either backsawn or quartersawn stock; the timber surface did, however, darken somewhat with the higher temperature used (of the order of 350°F. towards the latter stages of drying).

No special process modification was found necessary, the highest boiling point agent (Stanvac K9) examined being found satisfactory even at atmospheric pressure.

(C) THE SEMI-PERVIOUS SPECIES (Rain Forest Types)

A scout survey of the drying behaviour of some twenty-two New South Wales and Queensland rain forest species (including silky oak, coachwood, sassafras, rose alder, tulip oak, yellow carabeen, white birch, etc.) demonstrated that, by satisfactorily modifying drying technique, all the species examined could be vapour dried, free of degrade, from the green condition to low final moisture contents.

It was found that the species examined could be divided into four main groups with respect to tolerance to temperature and

pressure conditions. The following range of vapour drying schedules was found to provide sufficient elasticity to enable good drying quality to be obtained in all cases -

(i) A drier temperature of between 260° and 340°F. at atmospheric pressure.

(ii) A drier temperature of between 200° and 240°F. at atmospheric pressure.

(iii) A drier temperature of 180°F. at a vacuum of 25 to 27 in.

(iv) A drier temperature of 150°F. at a vacuum of 25 to 27 in.

The study showed that 1 in. thick timbers of the more permeable species may be dried at temperatures greater than 220°F. in from 3-1/2 to 6 hr., whereas temperature control at 180° to 150°F. and drying times from about 30 to about 100 hr. are required for material from the low permeable species.

2. PREDRYING LARGE SECTION TIMBERS FOR PRESERVATION PURPOSES

The following combined drying and preservation studies were carried out in association with Preservation Section.

(A) IMPERVIOUS SPECIES

The work on this phase of the study was carried out on green, half length 8 in.x 4 in. messmate stringybark railway sleepers. With Stanvac K9 at atmospheric pressure, vapour drying from an initial average moisture content of 80 per cent. to an average of 43 per cent. was obtained in 7 hr.; and with perchlorethylene, vapour drying from a similar green moisture content to an average of 57 per cent. required 11 hr.

The drying quality obtained was rated as satisfactory for the purpose required and, in fact, somewhat better than normally obtained in partially air dried material of similar type. Although appreciable surface checking occurred, the checks were fairly fine (not greater than about 1/32 in. in width) and of no great length. The radial end checks which occurred extended in for about 1 in. This form of checking was not regarded as undesirable, as it facilitated

subsequent preservative impregnation.

A preservative treatment with creosote at a pressure of 1000 lb./sq.in. to refusal point (taking approximately 45 min.), was found to give good penetration to a depth of 1 in. from the surface, although practically no creosote could be seen 1-1/2 in. from the surface. The loading obtained approximated 9 lb./cu.ft.

(B) PERVIOUS SPECIES

A reasonably comprehensive study on 9 in.x 6 in. green, short length radiata pine railway sleeper sections, vapour dried with mineral turpentine at atmospheric pressure, demonstrated the following:

(i) A vapour drying time of 6-1/2 to 7 hr. (including a 1 hr. cylinder heating period, and a 1/2 hr. final vacuum period) is effective in drying green radiata pine sleepers (cut from small logs) from an average moisture content of 95 per cent. (sapwood at approximately 160 per cent. and heartwood at approximately 40 per cent.) to an average value of 65 per cent.

(ii) At this latter moisture content (65 per cent.) the surface zones of the sleepers appeared to be in a suitable condition, with respect to moisture content, to ensure satisfactory creosote penetration and absorption by the "empty cell" (rueping) process, i.e. satisfactory creosote loadings were obtained in the test sleeper lengths at average moisture contents appreciably in excess of fibre saturation point.

(iii) Little difference in creosote loading was obtained by continuing the vapour drying to give an average sleeper moisture content of 35 per cent.

(iv) No significant difference in creosote retention resulted by varying initial air pressure between 25 lb./sq.in. and 50 lb./sq.in.

(v) Creosote pressure treatments, within the range 100 lb./sq.in. and 200 lb./sq.in., for periods ranging from 2 hr. to 1 hr., gave satisfactory loadings; typical loadings obtained ranged from 7.4 lb. creosote/cu.ft. with 100 lb./sq.in. pressure for 2 hr. and 7.9 lb./cu.ft. with 150 lb./sq.in. treating pressure for 1 hr., to 10 lb./cu.ft. from a treating pressure of 200 lb./sq.in. for 2 hr.

(vi) In each case sapwood was completely penetrated; where heartwood was exposed at the surface penetration ranged from 1/4 to 1/2 in.

At the time these studies were made the high pressure cylinder was not available, so that the influence of pressure greater than 200 lb./sq.in. was not examined.

The results of this study indicated that, by a vapour drying and low pressure preservative treatment, (assuming the drying and treatment could be carried out in the one cylinder) green radiata pine sleepers may be vapour dried and preservative treated in an overall time of some 9 to 10 hr., allowing 6-1/2 to 7 hr. for the drying and some 2 hr. for the preservation treating cycle; this time does not include cylinder loading and unloading times.

THE COMMERCIAL APPLICATION OF VAPOUR DRYING

(A) AS A SEASONING PROCESS FOR JOINERY QUALITY TIMBER

As far as is known, the vapour drying process has not, as yet, been commercially used as a recognized seasoning process for joinery quality timbers. The studies referred to above have shown, however, that on a laboratory scale at least, the basic process can be satisfactorily modified so that even refractory and collapse susceptible species (in thicknesses up to at least 1 in.) can be vapour dried to give good final seasoning quality.

The work has also shown that the process gives a considerably accelerated drying rate compared with kiln drying with orthodox drying schedules. Within the scope of the experimental work, it was shown that, with refractory drying species, a reduction in drying time to about 30 per cent. of that required for kiln drying (to equivalent quality) was obtained. For pervious timbers of the pine type, drying time was reduced to some 5 per cent. to 10 per cent. of that required for kiln drying.

At this stage it would appear that the potentialities of the process have more application to the rapid drying of the fairly pervious timbers than the refractory species.

Despite the very definite attraction offered by the speed of drying, however, some aspects of the process are less attractive, and in certain directions the laboratory studies have indicated that, for transition to large scale commercial operation, considerable further work on plant engineering, control and operation would be needed to ensure fully efficient performance. Some of the engineering and process difficulties to be solved include (i) a means of effectively ensuring equilibrium moisture content control within the drying cylinder; (ii) a means of ensuring vapour distribution within the cylinder which will give uniform temperature and drying conditions throughout the drying charge; (iii) the prevention of working fluid retention of pervious (or semi-pervious) timbers when high vacua are an integral part of the process.

In addition, it must be recognized that plant design and equipment require to be sufficiently good to prevent excessive working vapour loss through the system; furthermore, that the provision of high vacuum with commercial equipment is likely to be expensive.

On the laboratory scale at which the work was carried out it was not possible to assess the comparative economics of the process as compared with that of accelerated drying by other processes.

(B) AS A PREDRYING PROCESS FOR PRESERVATION PURPOSES

Promising results were obtained in the partial drying of both impervious and pervious timbers of large cross section by vapour drying as a means of moisture conditioning the timber to a level satisfactory for preservative impregnation.

It was for this purpose that the process was originally developed in the U.S.A. where it has now been in operation on a commercial basis for several years.

Should a preservation industry develop in Australia which will involve the drying and preservation of appreciable quantities of sleepers, poles, piles or other large section timbers, it would appear that close consideration would need to be given to the claims of combined vapour drying and preservative method. However, the

possibility of a Boultonizing (or boiling-in-oil) method for predrying the timber should not be overlooked.

No discussion.

ITEM 13(e) - DRYING AND SELECTION OF TIMBER FROM SMALL PLANTATION PINE LOGS FOR CORESTOCK*

Following complaints received from South Australia regarding warping difficulties occurring in core stock made from young plantation grown Pinus radiata (i.e. 4 in. to 8 in. diameter), an investigation was undertaken.

A preliminary visit to the Mt. Gambier area showed that the method of assembly was based on the deep sawing of 4 in. and 6 in. wide boards which had previously been glued into blocks of suitable dimensions with a casein adhesive. Indications were that the drying procedure for the 1 in. thick boards was most unsatisfactory. Arrangements were therefore made to secure a batch of green rough sawn boards (as used by the plant) for laboratory trials at the Division.

The batch received was divided into two portions, one of which was dried to a uniform moisture content of about 12 per cent. using a standard drying schedule for pine while the remainder was dried under the severest conditions obtainable in the laboratory kilns, the final moisture content with final conditions of 200°F. D.B.T. with 70°F. W.B.D., was fairly uniform and between 3 and 4 per cent.

Two blocks using fifteen pieces each of material at 12 per cent. and two blocks using material at the low moisture contents were then assembled with a heavy spread of casein glue as used in the plant.

After allowing the glue to set for three days the blocks were then band sawn into core boards. The behaviour of the panels sawn from the 12 per cent. material was found to be significantly different from that of 3 to 4 per cent. material. The major difference was that as the panels were sawn from the block (i.e. at cutting), those from the 12 per cent. block remained nearly flat

* Prepared by the Division of Forest Products.

while those from the 3-4 per cent. block showed considerable tendencies to buckling in both the longitudinal and transverse directions in the outermost panels. The outer panels presented a convex surface towards the core of the block and this was attributed to the squeeze out of the glue, resulting in surface absorption and very severe compression set on the surface of the block.

It should be noted that, in addition, the pick up of moisture from the glue lines appeared to result in a general compression set near the glue lines, and that this tended to be more severe near the core of the block. This caused panels not affected by the surface compression set (due to squeeze out of glue) to "dish" the opposite way to the outermost panels, i.e. concave to the core of the original block.

The panels were exposed to the air for several hours after cutting and the extent of buckling in the low moisture content panels was reduced considerably as moisture equilization occurred.

All panels were then strip stacked and subjected to two complete cycles (each of 1 week duration) of high humidity (100°F. D.B.T. and 5°F. W.B.D.) and low humidity (130°F. D.B.T. and 25°F. W.B.D.). At the end of this period there was no significant difference in the amount of buckling present in the panels from the 12 per cent. and the 3 - 4 per cent. moisture content material. The panels, however, did retain an appreciable amount of cup (up to 3/16 in.) and also a small amount of bow in some cases.

This indicated that there is little difference in the final behaviour of coreboard (with respect to warping) made up from material within the moisture content range 4 to 12 per cent. provided all component material is at the one average moisture content and that proper moisture content equilization and stress relief are undertaken.

The tendency of several panels to retain a small amount of bow was not explained, and it was decided to determine how much longitudinal shrinkage occurred in these panels with changes in

moisture content. The movements were surprisingly large (shrinkage ratio of 1:10 for longitudinal to transverse shrinkage as compared to normal wood which has a ratio in the order of 1:100). It was, therefore, decided to secure a second batch of material from the same area so that more accurate observations could be made on individual boards before assembly into corestock. As the initial work had indicated that the block assembly method did not appear to involve any particular variable of its own, a better selection of material type was made by cutting 1-1/2 in. and 2 in.x 1 in. boards from the 6 in.x 1 in. stock and gluing these edge to edge in accordance with common manufacturing practice.

The boards as received were carefully sorted into material near pith and material remote from the pith so as to obtain representative samples for observation purposes. On drying, all were found to have undergone an unusually high longitudinal shrinkage, the average being about 0.07 per cent. of initial length for a 5 per cent. moisture change. This material was sawn into 1-1/2 in. and 2 in. wide strips 1 in. in thickness for making observations. It was found that when subjected to changes in moisture content a considerable tendency to distortion was present. Spiral grain, of course, showed the usual tendency to wind, but, in addition to this there was a pronounced bow or spring present in many of the boards when the moisture content was low. This was apparently due to the presence of differential longitudinal shrinkage in the cross section, the tendency to greater shrinkage being always on the core side, so that the warp occurred in the opposite direction to that produced by growth stresses.

The material, after completion of measurements, was sorted to produce six panels as follows (i) one panel of narrow, near backsawn sections, each sawn to contain material as close to the pith as possible (within the limits of the material available), but glued to give unbalanced construction (with respect to grain direction); (ii) one panel as for (i) but glued to give balanced construction;

(iii) one panel of narrow, near quartersawn sections, each sawn from material as remote from the pith as possible, but glued to give unbalanced construction; (iv) one panel as for (iii) but glued to give balanced construction; (v) one panel of wide sections of backsawn material as remote from the pith as possible, but glued to give balanced construction, and (vi) as for (v) but glued to give unbalanced construction.

The panels were tested for dimensional stability by exposing them to a range of humidities to give a moisture content from approximately 20 per cent. to 5 per cent. Very marked differences in behaviour were observed. Irrespective of whether from near the pith or sapwood, the panels of backsawn material of unbalanced construction bowed badly, a bow of approximately 1 in 60 occurring as the worst case. The balanced construction, in both pith and sapwood panels of backsawn material, was reasonably satisfactory, the bow being 1 in 200 in the worst case. The panels made from quartersawn stock, irrespective of whether balanced or unbalanced with regard to grain direction, showed best behaviour, the bow being less than 1 in 600 in both panels.

Preliminary examination of the data obtained has shown that longitudinal movement in panels assembled from strips sawn at an average distance of 1-3/8 in. from the pith of the logs used, is about 50 per cent. greater than that in panels assembled from strips sawn at an average distance of 2-1/2 in. from the pith (the latter distance was the greatest which could be obtained from the small plantation logs available). To enable an examination to be made of the influence of cross banding in compensating for inferior core board assembly methods (by offering restraint to movement), the core boards referred to above were cross banded and a second series of observations, similar in nature to those previously made on the unbanded boards, has been commenced.

Discussion:

Mr. Irvine: Has the influence of pith eccentricity in relation to distortion been explored ?

Mr. Clarke: Eccentricity in South Australian plantation grown radiata pine is unlikely.

Messrs. Grenning and Jennings expressed interest in the results of the work on corestock from small pines and asked that copies of any published literature or reports on the subject be made available to them.

In reply to an enquiry with respect to the influence of sloping grain, Mr. Wright referred to the effects of variation in fibril inclination within the tracheid and the complementary change in tracheid length with increasing distance from pith as being a factor affecting distortion, the intensity of distortion also being further influenced by the extent of spiral grain also present.

ITEM 13(f) -TRENDS IN KILN DRYING PRACTICE AND KILN DESIGN

Mr. Wright: For some time officers of the Seasoning Section have observed a gradual but definite trend in commercial policy with respect to seasoning practices. Whereas, previously, drying costs appeared to be the principal criterion which determined the size of plant and type of seasoning employed by industry, for some appreciable time the impression has been received that industry is regarding this factor (i.e. operating costs) as of lesser importance compared with speed of turnover. This outlook is, of course, largely affected by the need to conserve on capital investments in stock by accelerating turnover.

A good example of this trend is in respect to the practice of partial air drying prior to kiln drying. As you well know, where climate is suitable, the combined air and kiln drying process gives reasonable turnover at reasonable cost. Increasingly, however, industry seems concerned in avoiding the capital investment of air drying stocks, and indeed, to put capital into such items as predriers or kilns for

drying from the green condition. This, of course, may only be a temporary outlook caused by present economic conditions, or it may develop into a more definite trend.

On the matter of predriers it may be of interest to mention that designs have been finalized for further predriers for Tasmania, namely, four units each to hold 160,000 s.ft. It is likely that additional units will also be installed later at another plant. One predrier has been in operation in Victoria for an appreciable period. The Tasmanian units are designed to operate at a fairly low constant temperature of, say, 100 to 110°F. throughout, except, of course, for the incidental temperature drop through drying stacks. The important features of design are to ensure uniformity in drying conditions in a chamber some 80 ft. long by 70 ft. wide. Consideration is at present being given to the type of control gear necessary to achieve this.

So far as kiln operating practice is concerned, it is believed, too, that in the case of the more pervious species (such as radiata pine) a trend towards the use of much higher temperatures in kiln drying than currently used, is likely. The principal object is, of course, to reduce drying time. It is believed that the drying quality of some of the reasonably pervious softwoods will not suffer significantly by higher temperature drying conditions.

The influence of this on kiln design will be to require the provision of greater heating surfaces, and, it is probable, greater air circulation rates, than is now generally used. The thermal insulation of kilns may also become of much more importance.

These trends will also be influenced by an increasing tendency to the use of straddle and fork trucks and the handling of seasoning stacks in packaged units, as this gives an increasing tendency to wide and higher kiln stacks.

In the field of veneer drying the value of high temperature and high air circulation with low relative humidity (low wet bulb temperature) to give as rapid drying as possible has

already been demonstrated. A recent brief study at a commercial plant during which veneers of the refractory "ash" eucalypts were dried in press platens at a temperature of some 300°F. in a period of 4 min. indicated, at least, that plate type drying of this class of material might well be technically attractive both with respect to quality and drying time.

An aspect of veneer drying which requires careful study, although possibly this should be done by industry itself, is the method of veneer handling and stacking to be used for drying. Are we sure that of the flat tray and finger racking methods, one is better than the other ? Are the economics of one markedly different from those of the other, due regard being paid to species influence as well as handling time and veneer degrade ?

On the equipment and instrumentation side, reference should be made to the value of the so-called "flash" type boilers. In some States a certified boiler attendant is not required for the operation of this equipment and it can well be that considerable labour and operating savings can be made with the use of this type of heating unit where the application is suitable. On the instrumentation side it is also believed that there will be an increasing tendency towards automatic control, partly because of increasing labour charges. It is of interest to note that this Division recently designed, on request from industry, the first inter-locked automatic vent and humidity spray control system.

Further studies of air circulation effects in kilns are to be undertaken.

Mr. Jennings: Work in kiln design is important to industry and we are seriously considering undertaking the preparation of kiln designs for the industry in Queensland. I believe that it is only by developing experience in this field and by providing this service, that my staff can effectively cope with the problem of improving seasoning practice.

Mr. Wright: This Division already has staff on this work, and this staff has a considerable backlog of experience, a sound knowledge of the needs of the industry and a continuing interest in developmental designs which aim at the continuing improvement of standard and special purpose driers for both timber and veneer. Recent and past experience has shown that there are, at present, no industrial consultants who have a sufficiently sound knowledge of the practice of timber seasoning and of the requirements of kiln design, to provide a designing service for industry. I believe this Division would, therefore, need to continue work in this field at least for some time longer. The Queensland research staff it was proposed to put on to this work might well fill a pressing need by continuing with field work on the seasoning and sawmilling side rather than by working at the drawing board.

Mr. Jennings: I consider it important that we commence work in the field of kiln design, particularly in regard to veneer drying.

Mr. Clarke: You realize that if one or two States develop their own design staffs, it may become desirable for the Division to vacate this field of work and concentrate on problems of interest to all States. It would be difficult then for individual States to develop new designs and improve old designs with the help of Australian wide experience. It would also lead to considerable overlap in State activities.

Mr. Jennings: I realize that but I still feel that it is necessary for us to make this move because of the great need for improvement in plywood practice in Queensland.

ITEM 14(a) -PLYWOOD ADHESIVES IN QUEENSLAND*

The purpose of this paper is not to set out in detail all aspects of the industry in Queensland, but rather to indicate to Conference what developments have occurred and are occurring, together with possible trends along which we feel the adhesive field will develop in the future in this State. The transition for practical

* Prepared by Forest Products Research Branch, Queensland.

purposes may be said to have commenced at the beginning of 1951, for, till then, the adhesive field was based upon lactic casein and soya bean, the advantages, disadvantages and properties of which are familiar to delegates. In addition, there was a small quantity of cold pressed urea (one mill), hot pressed urea (two mills), and phenolic resin applied as "Tego Film" (two mills). This transition was due to a number of factors, the principal of which are:-

(a) Economics

Suppliers of casein were not eager to maintain lactic acid casein due to the low price paid by plywood firms (slightly in excess of £100) when compared to other markets such as food products, plastics, or many similar fields where the value is shown by an export price of approximately £300. This was met to some extent by frequent price increases to plymills until casein is now of the order of £160 per ton. This figure combined with other raw materials, redrying costs, etc., meant that the manufacturing costs of plywood were increasing at a rate not matched by a corresponding rate of increase in the price of plywood.

(b) Availability and Quality

The major supplies of casein for Queensland were derived from a Melbourne firm and a Queensland firm for soya bean, which has remained reasonably stable in view of the fact that it is an imported material. Due to variable seasonal conditions, supplies fluctuated, a position aggravated by the price factor cited in paragraph (a). To this was added the conversion by some casein processors to either Rennet or Hydrochloric acid casein, each of which required variation in formulation and in the case of the former could not be regarded as a satisfactory substitute for lactic casein. Considered from the aspect of quality, this variability of supplies, cumulative with the spasmodic shortages in lime, silicates, etc., did not tend to produce a good article, in fact it meant that no glue room could work to a standard formulation, but were frequently required to experiment with consequent effect upon production. In several cases mills did not examine this

aspect to any extent as it was a "sellers' market" and to use a phrase "as long as it stuck till it left the mill it was plywood". In general mills did attempt to maintain a standard reasonably commensurate with that of the raw materials.

It will be seen that the industry was now somewhat dissatisfied with the casein position and were prepared to accept a substitute which would satisfy the following conditions:-

(a) Availability with independence of seasonal variations.

(b) Economic glueline cost.

(c) It must be "cold-pressed" and should be capable of being used with existing equipment or alternatively with the minimum of alteration.

(d) It should not require elaborate preparation or specialist staff.

(e) It should be of local production.

Of the alternatives, the synthetics offered most promise, and of these urea formaldehyde resins compared most closely with the above conditions. It was manufactured locally by several firms, i.e. there was competitive supply, the glueline cost, although in excess of casein, was not greatly excessive and could be varied by addition of extenders. Finally, it could be used with only minor modification of equipment.

A major plymill converted to urea resins completely and found that they had eliminated the worry of casein, that their product was of a higher quality and that their redrying costs were significantly reduced, in fact the firm found that the period of air drying between gluing and final processing was sufficient when using satisfactorily air dried veneers. Using the formulations for both casein and urea formaldehyde followed by this firm, the product after gluing was of the order of 30 per cent. and 20 per cent. moisture content respectively, i.e. for the urea there was an increase of the order of 6 per cent. only. In this regard a number of firms had the impression that no redrying was required, a fact with which this Department cannot agree unless the original veneers are glued at an

initial moisture content between 8-10 per cent., i.e. conditions attainable under Queensland conditions only by kiln drying.

Interest grew and the present position now, as far as is known to this Department, may be summarized as follows:-

Classification of Plants Producing Veneer and Plywood

Rotary veneer only	5	
Sliced veneer only	1	
Plywood mills -		
(a) Cold press		15
(b) Hot and cold press		4
Total:	6	19

Classification of Adhesives used in Plymills

	Number of mills	
	Total Production	Part Production
Wet mix casein) Soya bean)	7	4
Dry mix prepared caseins	3	3
Urea resins		
(a) cold	3	2
(b) hot	2	-
Hot press phenolic resin-tego	2	-
Other adhesives	Nil	Nil

Of those using casein or prepared caseins only, a further four mills have shown a definite interest in ureas and it is now anticipated that, of these, three will be converted this current year. Of the remainder, it is felt that a further five will convert within the next two years, assuming the casein trend continues and no difficulties arise in the supply of urea resins. Most mills, which have converted, have taken the opportunity of modernizing their gluing equipment. Rubber covered, doctor roll controlled spreaders are being used with grooving ranging from 16-20 pitch depending on what the mill conditions are. Spreads are obtained of the order of 80-90 lb. of mix per thousand square feet of double glue line (M.D.G.L.), as compared

with wet mix casein spreads of the order of 140-150 lb.

As could be anticipated problems have arisen which are being examined. Of these the bigger proportion are directly related to our climate and include such factors as storage life of resins, setting times, gluing of veneers which have been air dried in areas such as Cairns with E.M.C's of 16-20 per cent. The department is co-operating with manufacturers and the plywood industry and associated organizations to overcome these and it is felt that solutions to them will be obtained.

One item which does require examination is the use of flours for extension purposes. To date no specification has been prepared to enable millers to purchase thereto and in several instances, it has been found that considerable variation occurs in flours which have been bought upon normal flour requirements, e.g., gluten content. In practice in Queensland the glue manufacturer tests a flour with his resin and advises the plymills accordingly.

(c) Prepared Caseins

In addition to the ureas discussed above it will be seen that a number of mills are using prepared casein glues of a proprietary brand to supplement their own stocks, and in several cases using such exclusively.

As final comment, I will point out that the position of phenolic resins is fluctuating, supplies are up and down, but I feel that the two firms employing "Tego" will not change whilst material can be imported. Should the importation become difficult, their only alternatives would appear to be urea resins or preferably liquid phenolics of local production.

Discussion:

Mr. Huddleston: The swing to urea formaldehyde glues is not confined to Queensland. There is interest in New South Wales in urea formaldehyde extended with wheat flour, with the result that the maximum use of extenders and lack of control in the glue room is

causing glue failure. Malpractice does not appear to be confined to the lower grade manufacturers. I feel that the tendency is to extend the glue far too much, there is then no margin left for error due to high temperature etc.

Mr. Jennings: There is a great tendency in Queensland to extend with wheaten flour, and Queensland flour is much more variable than southern flours. If urea formaldehyde is to be used there must be some form of efficient technical control. The problem is largely one of education of the trade.

Mr. Gordon: There is no shortage of casein at the present time - stocks in Melbourne total 300 tons. If urea glues are going to be used at high extensions the only feasible method is to use the hot press. Manufacturers tend to keep the glue line down to a price rather than the quality up to a standard. Until manufacturers are affected financially nothing will be done in this regard.

ITEM 14(b) - PLYWOOD ADHESIVES BASED ON FRESH WHOLE BLOOD*

At a number of centres in New South Wales, abattoirs exist in close proximity to plywood plants. In most cases fresh whole blood is readily available and cold setting adhesives using it would be commercially attractive.

The blood protein adhesives have several interesting properties but their generally objectionable nature and putrefaction problems are difficulties in their successful use. Also most blood glues are considered to lose strength on aging. The blood glues have a certain water resistance, particularly the hot setting types. However, their low resistance to bacterial and fungal rotting rules them out as water resistant adhesives.

Subject to the above disadvantages blood glues can find use in the lower grades of general purpose plywood.

In order to achieve easy utilization of blood in the plywood plants mentioned a cold setting adhesive similar in working properties to normal casein is required.

---

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

It was considered that taking advantage of the high reactivity of the proteins in the fresh whole blood a cold setting adhesive could probably be developed.

Our most successful adhesive formulae are based on fresh whole blood with a small addition of hydrochloric or lactic casein.

Two successful formulae are given below.

(a)	Liquid whole blood	100	pts. by weight
	Lactic casein	12	" " "
	Hydrated lime	6	" " "
	Water	12	" " "
(b)	Liquid whole blood	100	" " "
	Lactic casein	5	" " "
	Sodium silicate	50	" " "
	Hydrated lime	5	" " "
	Ammonium hydroxide	3	" " "
	Water	10	" " "

Both formulae were used on plywood and solid wood joints at 21°C.

The following average results may be noted.

Solid wood joints:-

Alpine ash.

formula (a) failing load 900 lb./20 per cent.

formula (b) " " 800 lb./60 " "

Plywood

Species - Borneo Cedar:

Both formula (a) and (b) give boil proof joints when tested after boiling 6 hr. in water. However the low resistance of these adhesives to fungal etc. attack and the problem of "aging" makes them quite unsuited for the waterproof plywood field.

Costs

The costs of the two mixed adhesives shown above are interesting when compared to a normal casein lime silicate mixture as used in a plywood factory.

Taking the cost of the casein mixture as 10.00 the cost of formula (a) is 6.00 and of formula (b) is 7.1.

These costs are based on the price for blood purchased in small quantities from the Homebush abattoirs. The price for larger quantities in Sydney would be lower. (Actual price not known - would depend on quantity and would be specially negotiated on a contract basis). The price for country abattoirs would vary and in all cases it is believed the price would be much lower than the metropolitan price where facilities for by-product use of the blood are much greater.

Storage and Handling of the Blood

So far the procedure followed has been to procure fresh blood at the abattoirs and add about 1 per cent. of sodium oxalate. This delays coagulation and the blood has then been stored at 5°C. for one week without any difficulty. After this period the blood will no longer clot on addition of calcium ions and it must then be discarded.

Summing up it may be said that glue formulae giving satisfactory cold setting strengths have been prepared. A range of working lives is possible and the most suited mixtures will be tested by further laboratory work.

The cost of the glues is lower than conventional casein as used at present.

Disadvantages are the uncertain aging effect and the noxious character of liquid blood.

It is hoped to try out the adhesive in a commercial trial in the near future.

Discussion:

Mr. Gordon: This question is largely an economic problem. Whilst theoretically there are a number of plywood plants near abbatoirs, the enquiries we have made have shown that there is no interest by abbatoirs in providing blood for glue making.

Mr. Huddleston: Once a successful formula is made available attampts will be made by several firms near small country abbatoirs to use it.

Mr. Clarke: I agree that this work will have application especially where blood is freely available from country abbatoirs which have no equipment for drying blood for fertilizer.

ITEM 14(o) -DURABILITY OF PHENOLIC FILM BONDS ON IMMUNIZED TIMBER

Mr. Huddleston: The question of using veneers treated with boric acid and borax has been raised from time to time and it has been stated that veneers so treated cannot be used with Tego bonds. We obtained information about 2 years ago which suggested that veneers treated with a 2 per cent. or 3 per cent. solution of boric acid in a momentary dip can be satisfactorily bonded with phenol or cresol formaldehyde. Samples were taken and plywood manufactured from them. These have been subjected to weathering tests and results to date have been quite satisfactory. The bond seems to stand up to severe weathering and degrade is no more severe than that which occurred in control panels manufactured from untreated veneers. It does appear that we have to recast our ideas as to the use of borax and boric acid treated veneers for hot press plywood. It appears to us that provided the concentration of the treatment solution is not too high, boric acid or borax can be used to treat veneers which are subsequently to be glued up into Tego bonded or similar plywood.

Mr. Gordon: We have carried out various experiments and, whilst we have had satisfactory bonds, we have also had unsatisfactory ones. I think there is sufficient doubt about the quality of adhesion to make the proposal suspect. Our experiments were carried out with different concentrations of boric acid in veneers, and with the relatively low concentration of less than 0.5 per cent. of boron in the veneer, satisfactory adhesion was obtained, both dry and after boiling. The difficulty is to ensure that there is sufficient boron radical in the veneer to prevent Lyctus attack and at the same time not have too much to interfere with the effective bonding, especially as most "Tego" glued plywood is intended for exposure.

Mr. Huddleston: Even if the figure of 0.5 per cent. concentration is accepted there is still a fairly wide margin of 0.2 per cent. - 0.5 per cent. If it can be shown that plywood with a concentration below 0.5 per cent. can be satisfactorily glued, there

is the possibility of giving the veneers a double dip, firstly in boric acid at 2 per cent. followed by block stacking overnight and a water dip in the morning to wash the boric acid from the face of the veneers. There are two Sydney plywood firms who will be willing to carry out practical experiments when this is feasible. This method is reliable as long as the manufacturer is prepared to exercise suitable control. Where boric acid fails to bond with these glues, failure is apparent by examination of the glue line.

Mr. Gordon: We have had satisfactory bonds under dry conditions which have failed on weathering or boiling.

Mr. Clarke: A dye could be added to the water to ensure that all surfaces receive the water treatment. Can Dr. Fitzgerald suggest any reason for unsatisfactory wet strength when treated veneers are used ?

Dr. Fitzgerald: Polyvinyl alcohol reacts with borate to form a compound stable when dry but which is unstable in the presence of water. Something similar may occur with phenolic resin.

Mr. Huddleston: We are continuing to expose samples to weather to determine whether plywood manufactured from boric acid treated veneers will stand up as well as plywood from untreated veneers. We hope also to determine ways of reducing the boric acid on the surface of the veneer to give satisfactory bonds.

Mr. Jennings: We are interested, not so much in the phenolics, as in the ureas and we have done some testing in conjunction with the manufacturers on boric acid and borax treated timber. While in general we have no significant results to report, we did notice that one particular formula from Monsanto showed a very significant decrease in shear strength with both boric acid and borax. Their other formula showed no significant difference as compared to casein standard.

Mr. Gordon: While boric acid and borax seriously affect gluing with phenolic resin glues, our experience with urea has usually been satisfactory. One firm stated that with hot pressing they experienced

trouble with borax treated veneer whereas they had no difficulties with boric acid treated. Some firms running test batches with urea glue did initially have trouble by releasing the clamps too soon. This trouble has been overcome by insistence that at least 6 hr. be allowed for clamping.

With many North Queensland species bad alkali staining becomes evident in casein glued plywood if the bundles are left clamped overnight. The use of urea glues overcomes this and manufacturers with sufficient clamps for a full day's production often leave plywood clamped overnight, saving money by eliminating overtime work necessary to release clamps and strip out casein glued plywood between 8 and 10 p.m. to minimize glue staining.

ITEM 14(d) -COLD STORAGE OF CASEIN FOR GLUE MANUFACTURE*

The object of this experiment is to determine whether casein for use in plywood glues can be stored satisfactorily at low temperatures in the freshly precipitated, undried condition. If this is possible an additional quantity of casein could be made available to plywood manufacturers; dairy produce factories in districts where there is no casein drying plant, but with cold storage facilities, would be able to manufacture and store casein for local plywood mills.

Through the co-operation of the Dairy Research Section approximately 50 lb. samples of lactic, hydrochloric acid and rennet casein in the undried condition were obtained. Half of each, packed in glass jars and in cartons, was placed in cold storage at 15°F. and the remainder at -1°F. Samples have been taken for testing at approximately four weekly intervals over a period of 4 months, and the experiment is to be continued for at least 6 months.

When testing, the casein is first passed through an 1/8 in. sieve. Moisture determinations are made and glue mixes are prepared according to the usual D.F.P. Laboratory formulae, allowance being made for the water already in the casein. It has been noted that the casein dissolves more slowly than usual, but since the particle size

* Prepared by Division of Forest Products.

is larger than usual, this is not regarded as significant. Test panels are prepared using 1/16 in. hoop pine and coachwood veneers.

The casein was tested before being placed in cold store. The glue shear strength of standard specimens cut from the test panels is shown in Table 1.

TABLE 1

Type of casein	Glue shear strength (lb./sq.in.) and percentage wood failure *			
	Hoop pine		Coachwood	
	Tested dry	Tested wet ø	Tested dry	Tested wet
Lactic	311 - 80	201 - 54	404 - 87	177 - 5
Hydrochloric acid	262 - 67	168 - 50	456 - 98	198 - 23
Rennet	235 - 57	132 - 6	375 - 49	153 - 4

* Average for 12 specimens.
ø Tested wet after soaking in cold water for 24 hr.

During the first 2 months storage no decline in glue shear strength was apparent, but tests made after 3 months show that the wet strength is lower in some instances (Table 2). One cannot say at the moment whether this decrease in wet strength is due to changes in the casein as a result of prolonged storage, particularly as the panels with low wet strength had excessively high glue spreads. Gluing tests made in the ensuing months will show whether or not the effect is real.

TABLE 2

Results of Test after 3 Months Storage

Type of casein	Storage temp. °F.	Glue shear strength (lb./sq.in.) and percentage wood failure			
		Hoop pine		Coachwood	
		Tested dry	Tested wet	Tested dry	Tested wet
Lactic	- 1	317 - 55	124 - 1	495 - 93	90 - 0
	15	315 - 60	128 - 3	406 - 85	44 - 0
Hydro-chloric acid	- 1	246 - 40	172 - 23	418 - 56	172 - 6
	15	275 - 43	181 - 10	397 - 95	141 - 3
Rennet	- 1	237 - 13	136 - 1	412 - 21	157 - 6
	15	178 - 5	57 - 0	285 - 13	57 - 0

Discussion:

Mr. Plomley: Since this report was written storage tests have been under way for 6 months. A decrease in wet strength was noted in tests made after 3 months storage, but the latest results are quite satisfactory. As far as gluing properties are concerned there has been no deterioration in the casein stored at 15°F. and at -1°F. over the period of 6 months.

Mr. Gordon: This work was carried out at the request of a plywood firm who had difficulty in obtaining casein. When the tests were partly completed the need was not so urgent as supplies of casein were more plentiful, but we are finishing the investigation in case supplies are difficult to obtain in future.

ITEM 14(e) - WHEATEN FLOUR AS AN EXTENDER FOR UREA FORMALDEHYDE GLUES

Mr. Plomley: The object of this investigation was to determine the effect of wheaten flour extenders on viscosity and pot life of a cold press urea resin glue. The experimental work has only recently been completed so that we are not yet able to report the full results.

The flours used were obtained from Victoria and New South Wales and represented a fairly wide range of flour types as regards gluten content and baking strength.

Firstly, suspensions of flour in water were prepared and examined in a Stormer viscometer at 25°C. over a period of 3 hr. from the time of mixing. All showed a decrease in viscosity with time, the decrease being most marked in the first hour but continuing throughout the period of observation.

The most striking characteristic of the suspensions was the wide range of viscosity which varied from 7.2 to 333.5 poises, the lowest viscosity being obtained with a Victorian biscuit flour and the highest with a strong flour of New South Wales origin.

When a commercial urea formaldehyde resin was extended 100 per cent. with each of the different flour samples, the mixes behaved in a similar way. Viscosity of the mixes ranged from 3.1 to

220.4 poises and it was apparent that the most viscous mixes would not be satisfactory in a mechanical glue spreader. The mixes decreased in viscosity over a period of 1 to 2 hr., but the decrease was not as marked as in the flour-water suspensions and was least in mixes of low viscosity.

The addition of extender increased the pot life of the glue mixes very greatly. The life of the unextended resin at 25°C. was about 46 min.; the life of the flour extended resin at the same temperature varied from 4-1/2 to 9 hr.

The results indicate that low baking quality and low protein flours would be best for extension as they do not increase viscosity too much when used in the proportions generally recommended, and also because the changes in viscosity that occur with time and with mixing are not too large. The increase in pot life with flour extension may be important in warm climates.

Mr. Jennings: The only difficulty I foresee in using urea formaldehyde is that of extension, particularly with Queensland flours. It would be almost impossible to obtain a consistent standard of flour from any Queensland mill and therefore another variable would be introduced into plant control. Coconut shell flour or sander dust may have more consistent properties as an extender. Shelf life seems to to quite satisfactory now, and we are not particularly interested in the possibility of the shelf life of urea resins being increased.

Mr. Plomley: Victorian and New South Wales flour millers endeavour to standardize their product and the physical properties of a particular grade are reasonably constant. The lower baking quality flours are probably less variable than the higher quality ones.

Mr. Gordon: Millers might be glad to have an additional market for lower quality flour and possibly would be prepared to produce a standard blend for glue extension.

As regards shelf life, the flour extender tends to settle out on standing and, if part only of a tin of resin is used, the user may get mainly resin from the top portion and mainly flour from the bottom portion.

ITEM 14/f) - PROTEIN GELATION

Mr. Higgins: The protein investigations which were reported at the last Conference have been continued along two main lines, aiming at elucidating the mechanisms of protein gelation in alkaline systems and the coagulation of protein systems by means of enzymes. Alkaline gelation has practical applications in gluing and other industrial fields, such as paper coatings, and enzyme clotting is used in the production of casein for plastics and in cheese production, and it is also a phenomenon of considerable interest in the fields of physiology and medicine. The study of alkaline gelation was concerned initially with the effects of concentration of constituents, time and pH on the rheological properties of the system. Later work has been directed towards determining the chemical and physico-chemical changes which take place during the gelation process. In enzyme coagulation, certain analogies may be readily drawn between the clotting of milk and of blood, but we have been mainly concerned with the action of rennet in clotting milk and casein solutions. The problem can be resolved into two parts: the changes produced by the action of the enzyme in transforming casein to paracasein, and the action of calcium ions upon the paracasein to form a clot. Both of these problems have received extensive attention. In the early stages of the protein gelation studies, viscometric methods were used to a large extent. These have now been supplemented by various methods and techniques, and in particular very considerable use has been made of spectrophotometry in both chemical and physical aspects of the work. Various associated problems have arisen in the course of these investigations, and limited digressions have been permitted where these seemed to be of special interest. The reaction of proteins and amino acids with diazonium compounds has been studied by spectrophotometric means, and may lead, inter alia, to a method of determining amino groups. A novel kinetic treatment has also been developed in connection with these studies, with the mathematical assistance of Mr. E. J. Williams,

and it is hoped that this may be applicable to the study of molecular structure.

Future work on this project should attempt to link the basic results more closely with practical operations.

ITEM 15 - VENEER PLYWOOD ETC.

(a) Glued Laminated Structural Members

Mr. Huddleston: During the last 5 or 6 years there has been a pronounced growth in the use of glued laminated structural members, particularly in the Sydney Metropolitan area. Two consulting engineers are engaged full time on this type of structure, and many satisfactory buildings have been erected. One particularly suitable type of roof for a factory building consists of a series of arches spaced from 15-20 ft. apart with a curved roof over one 15 ft. section and a pitch roof between the two sections of curved roof. Windows are set in the arched framework. It is quite attractive and dispenses with boxed guttering which is a common cause of complaint in saw tooth roofs. Photographs illustrating this type of construction are on the Division of Wood Technology's files and may be inspected by those interested. Mr. Huddleston also offered to show some of the buildings already erected to anyone who may be visiting Sydney. Cost of such construction is only 40-50 per cent. of equivalent steel structure produced from Australian steel and 70 per cent. of the cost of conventional timber framed structure.

Casein glue is being used but one of the engineers does not believe in glues and provides sufficient bolts to provide the shear requirements.

The difference in cost was mainly due to lower labour cost brought about by the lighter weight of laminated constructions which could be assembled on the ground and raised to position whereas steel structures have to be assembled in situ.

Mr. Gordon: The expanded use of laminated members might be expected now that resorcinol formaldehyde resin glues are available in

Australia. These should be satisfactory under severe exposure conditions. Recently in this Division we have made up, for the Department of Civil Aviation, 8 laminated masts 18 ft. long x 6 in.x 6 in., two of which were for test and the other six were for installations of distance measuring equipment at aerodromes throughout Australian territories. Approximately 200 masts will be required and to date approximately 20 masts have been delivered by a Sydney firm - 6 have been installed, one on Cocos Island, which should prove a good exposure test.

Mr. Cooper: Would laminated beams, made under normal engineering conditions, and used for bridge construction, stand up to the elements ?

Mr. Gordon: Laminated beams should be satisfactory for such a purpose provided that they are either made from durable timbers or suitably treated, and provided a suitable glue is used.

(b) Silviculture and Veneer Quality

Mr. Gordon: At the last Conference it was reported that Veneer and Gluing Section was investigating the quality of plantation grown pines - it was then obvious that material available was knotty. Although theoretically trees were supposed to be pruned at 5 in. or 6 in. in diameter, most seemed to be pruned at 8 in. or 10 in. diameter. There was relatively little clear veneer outside the pruned knots. It appears that better veneer can be obtained when the rate of growth is slow and I think we should give attention to the effect of rates of growth on veneer quality. Co-operation from the State Forest Services would be required in obtaining test material.

Mr. McAdam: I may be able to supply some fast grown kamarere from New Guinea in the near future.

Mr. Gordon: With the pines much better veneer is obtained when peeling sapwood than when peeling heartwood. Some silvicultural treatment might be designed to produce a higher percentage of sapwood for veneer, or perhaps in tree selection consideration should be given to trees with the maximum amount of sapwood.

Mr. Clarke: Slow grown New Zealand radiata pine has less heartwood.

Mr. Cooper: The opposite would seem to apply with South Australian radiata pine.

ITEM 16 - GROWTH STUDIES

Mr. Boyd: At the last Conference, a request was made that we continue studies of the effect of growth stresses on utilization of timber. Accordingly a series of experiments has been carried out in respect to the end cracking of veneer logs. Data from simple experiments have been integrated with a view to illustrating the composite effect in causing cracking.

I have previously illustrated to you the stress distribution in a log. Generally primary longitudinal stresses are the most critical. In veneer logs we are concerned with cracking across the ends, and the transverse stresses responsible. However, in the earlier discussion it was shown that distortion at the end of a log is induced by the relief of longitudinal stresses. The result of this end curvature is to stretch the timber transversely and to produce corresponding tensions which tend to open up cracks along radial planes, the greatest transverse tension being across the centre of the log.

In analysing the various significant causes, it has been found convenient to discuss six separate factors. These have been set out in the diagram and for each stage an attempt is made to show the stress distribution within the body of the log and the corresponding deformation at that cross-cut. The sketches at the right hand side are half end cross sections, on which the transverse stresses which tend to cause cracking along radial lines are shown.

1. The Initial Stress Distribution within a Log

At the last Conference the initial stress distribution, particularly in the longitudinal direction, was discussed in some detail. Generally this consists of tension of the order of 1000 lb./sq.in. at the periphery, changing to increasing compression ranging to 2000 lb./sq.in.

or more near the centre line of the log. On cross cutting the log the strain relief which occurs tends to distort the end in a dome shape. As a consequence the length of any line across the end is increased and tensions are therefore developed. These have been illustrated diagrammatically on the half end cross section.

2. Effect of Time

The stress distribution and distortion referred to in section (1) represent the conditions existing immediately a tree is felled and cross cut. Sometime after cross cutting an additional effect becomes apparent. Some of the restraint holding the balance of forces within the log appears to be reduced, with a consequent reduction in the actual stresses near the end of the log, and a corresponding increase in the distortion on the end face. This extra stretching across the end face produces further increments of transverse tension across a radial plane as illustrated again at the right. It will be noted that the longitudinal strain relieved as a result of this time effect may correspond with a longitudinal stress of the order of 500 to 1000 lb./sq.in.

3. The Effect of Heating on Transverse Stresses

This factor might be considered in three stages -

(a) tangential expansion

(b) radial contraction

(c) reduced modulus of elasticity.

Both (a) and (b) tend to increase the transverse tensions as illustrated again in the diagram. The effect of the reduced modulus of elasticity is to increase the distortion in the transverse plane corresponding to any stress existing in that plane. As will be discussed later, this increases the probability of cracking.

4. The Effect of Heating on Longitudinal Stresses

Two factors again are significant.

(a) the loss of restraint, and

(b) reduced modulus of elasticity.

The plasticizing effect of heat tends to reduce the restraint of less stressed zones of the log on the more highly stressed zones. As a consequence some of the stress in the highly stressed zone is relieved, with a corresponding tendency to increase the distortion on the end face, and thus increase the tensions across that face as shown again in the diagram. The effect of heat in reducing the modulus of elasticity again effects this somewhat, in that for a given force retained in the log the amount of distortion will be greater than in the corresponding cold log.

5. Reduction of Strength

As a result of heating a very considerable reduction in strength across the grain occurs. As with most of the other effects discussed, this varies largely with temperature.

6. No Increase of Deformation to Failure

It should be noted in connection with all the effects discussed above that, though heat apparently plasticizes wood, when the actual deflection to failure in tension of timber tested cold, is compared with that of timber which is heated to a temperature of the order of 200°F., no appreciable increase occurs. This is a particularly important factor to note as plasticizing - in relation to deformation of timber to the point of failure - produces no offset to the many disadvantages of heating as illustrated in the five factors discussed above.

I have listed various factors producing effects on the longitudinal section. Because of the longitudinal stress, secondary effects are induced on the transverse plane. However all these effects interact in a complex manner, and possibly the problem has been over-simplified. Nevertheless such treatment increases the possibility of being able to reduce the bad effects of present practice.

Mr. Higgins: (1) Are computations made on the assumption that the wood is really elastic ?

(2) Regarding computations on the effect of heating, do they assume the wood is raised to a uniform temperature right through ?

Mr. Boyd: A series of experiments has been presented in an integrated form. Tests have not been made on actual logs but on small specimens, so that the confounding effect of a temperature gradient across the log is eliminated. In this way, an attempt has been made to show very approximately the way in which separate factors affect the reaction of the log on heating. Change in modulus of elasticity has been measured, and its effect included in the discussion, but the illustrations are not intended to be true to scale. Generally the same remarks apply to the other effects, the diagrams showing qualitatively only, the type of accumulative effect which occurs.

Mr. Pearson: In reply to a doubt raised by another delegate it is pointed out that test specimens in compression do show increased deflection per unit load at increasing temperatures, but a similar increase does not occur in tension.

Mr. Boyd: That is so. The relevant stress in relation to cracking of veneer logs is tension at right angles to the grain.

Mr. Cooper: From Mr. Boyd's treatment it appears that heating through the central portion of ends of logs may reduce the cracking which otherwise occurs. High frequency heating appears to offer possibilities, and Madison has done some research on it.

Mr. Clarke: Madison has now discontinued research into high frequency heating of veneer logs, because of the relatively high cost of heating. At present they are experimenting with a method of electrical heating immediately ahead of the knife, but this, too, appears to be costly.

Mr. Gordon: To overcome degrade resulting from splitting during heating, the roller pressure bar has been introduced in America. It has been used with Douglas fir and effects an improvement of quality of veneer which can be cut from cold logs.

ITEM 16 contd.

Mr. Kloot: At the last Conference I expressed the doubt that we had reached the stage where a new Working Plan could be prepared for the investigation of the effects of silvicultural

treatment on the properties of timber. Since then we have received unexpected requests for assistance in this field, and today our investigations, although still rather limited in scope, appear to be yielding promising results.

In test methods no new technique has been developed, but rather we have re-employed some well known methods. You will recall that we developed a testing machine capable of testing specimens 3/1000 in. thick, and it was hoped that this would prove the ideal tool for the investigation. However, a serious drawback in technique involved the testing of a tremendous number of specimens, far more than was considered practicable. To cite an example, in an investigation at present in hand we have some 70 or more trees to test. To examine them thoroughly would have required the testing of something like 100,000 micro specimens. With a single testing machine this would have taken at least 5 years. We have been able to make much more rapid progress by using small compression specimens with cross-sections about 3/8 in. and 5/8 in. square. This does not mean that we have discarded the micro testing machine but rather we are now intending to use it in conjunction with the compression specimens. We are in fact completing the design of a new micro testing machine which we hope to have in service fairly soon. The first machine on which we have carried out several thousand tests is no longer serviceable. With the compression specimens we can study rapidly variation of properties within a tree. The micro tester will enable us to study the variation within individual growth rings.

Now I would like to give you a brief resume of the work we have been doing and a general summary of the results to date. It would take far too long to discuss all the points in detail, so I will cover the ground in a very general way.

Our work has been confined to the 3 pines - loblolly, slash and radiata. In regard to the first two the Queensland Forest Service has spent some time in studying the transmission of external characteristics from parent to progeny with, I believe, some success. However, before establishing clones from elite trees they were concerned

with the possibility that an elite tree might not necessarily have desirable mechanical properties, and that undesirable properties might be transmitted to the progeny. They asked for our assistance on this aspect and after planning a suitable set of investigations we received from them some 74 trees of Pinus taeda and Pinus caribaea. Our objects first were to establish whether there was any evidence of heredity as far as strength properties were concerned, and, if such could be found, to decide which of a number of elite trees were suitable for the establishment of clones. We tackled this problem in two ways. First we cut from the logs supplied sub-standard size test specimens and submitted those to our normal testing procedure. This was in an endeavour to obtain results as quickly as possible. As it turned out the results were quite inconclusive, but they pointed the need for an intensive investigation of the effects of such factors as rate of growth, percentage summerwood and so on.

Although a lot of work has been done on these aspects overseas there appears to be a lot of conflicting evidence. Turnbull of South Africa favours age as being the prime factor affecting density and hence strength. Kraemar in the States adduces evidence to show that rings per inch (or rate of growth) has a strong influence on bending strength and that the importance of density for the prediction of strength properties is over-rated. Therefore, although we were covering ground that had already been covered by other investigators, we felt fully justified.

With the slash and loblolly pines we cut small compression specimens from pith to bark in each log. Furthermore, we determined the percentage latewood and the density on each individual ring. Without going into detail I can say that the correlations between density and compression strength were in general considerably higher than 0.9 and higher in many cases than have previously been obtained by other investigators. Also, although we did strike quite a lot of difficulty in measuring percentage latewood we obtained correlations with density in general in excess of 0.9. In addition,

we found that density, together with strength and percentage summerwood, showed a general increase with age up to about 20 to 23 years.

Summarizing the position, therefore, it would appear that as these trees grew from their first to their twentieth year their percentage summerwood increased and with it their density and strength properties. It would appear that the properties of the earlywood and latewood bands did not change in this period, and that all the change was brought about simply by the changes in percentage summerwood. This, however, is an over-simplification of the position but it would take too long to go into details here.

I have mentioned a general trend of increasing summerwood percentage with age. Actually, the percentage summerwood from year to year varies considerably about the general trend. We have endeavoured to correlate this variation with rainfall data but, except in a very general way, have not met with much success. The reason is fairly clear in that from the rainfall figures we can get practically no estimate of the amount of water that runs off. While these investigations were in progress we had the opportunity of carrying out similar studies on radiata pine from South Australia. With this species we have noticed the same effects of percentage summerwood on density and strength although the relationships are, of course, different for the different species.

One of the difficulties that we have struck in all this work on the pines is the influence of such things as compression wood, resin content and heartwood. I list these three together simply on the basis that each is capable of upsetting the relationship between strength and density as obtained on normal wood.

Our investigations are not yet complete but the results appear to be falling into a pattern. However, it might be premature to indicate at this stage just what this pattern is or what it means. I must point out that our work to date has been confined, in the case of Pinus taeda and Pinus caribaea, to trees not older than 23 years, and in the case of Pinus radiata, to trees not older than 40 years.

It is intended to extend the work to older trees and also to hardwoods in the near future.

Mr. Grenning: We are particularly interested in this project, as it costs just as much to grow a good tree as a bad tree, we are anxious to grow only good trees. We are in process of establishing improved parent trees which are proving to be acceptable although they have only been studied from an external point of view. We have no knowledge of the timber qualities so we are asking for your assistance and advice concerning the parent trees which are going to provide the whole of our stocks in a few years. We are concerned with the elimination of any undesirable qualities in timber and whether you can discover any amongst those which we have selected, so that we can weed them out as early as possible. We would be very interested to receive information on this point.

Mr. Chinner: Has Mr. Kloot in his studies noticed any divergent rate of growth, that is, any sudden change in the growth ?

Mr. Kloot: The work we have been doing has been on material which in all cases started off at a very high rate of growth and has gradually diminished. In none of the specimens we have examined has there been a sudden spurt of growth; that is an aspect on which we will concentrate our attention in the future. Referring to Mr. Grenning's earlier remarks concerning undesirable properties, so far I have not noticed any objectionable features, but this is a subject to which the Wood Structure Section has given some attention.

ITEM 16 contd.

Dr. Dadswell: First of all I will summarize briefly some of the work which has been done in the Wood Structure Section in carrying out these growth studies, which have been mainly fundamental in character. We have endeavoured first of all to relate both the macroscopic and the sub-microscopic structure of the wood laid down to the conditions of growth to which the tree has been exposed. In the second place, we want to try and find out what is happening in

relation to (a) the development of cells from the cambium, (b) cell extension and cell wall formation, and (c) the deposition of lignin. The last is of importance in pulp and paper studies. The region of differentiation is the production line in the growing tree, or the production line of the "factory" of the tree, and the products are to be used in industry either as wood or in the form of separated fibres. Therefore, the knowledge of the effect of external influences on the production line is extremely important.

From the pattern of the wood laid down it is possible to obtain information of value on the influence of external agencies. The whole history of the tree is set out in the wood for us to read if the right techniques can be found to interpret this history.

It will be seen, therefore, that the changes in structure that take place throughout one or more growing seasons in a number of species, including Pinus radiata, taeda and caribaea, has been one line of investigation. For the last 16 months we have had collections of Pinus radiata made at Macedon, Victoria, and the wood specimens have been examined. So far our observations have not been completely analysed, but we do know there is only a short period of dormancy and that period may be as short as one or two weeks. Whether there is more than one peak in the growth rate throughout the growing season investigated has still to be determined. Growth rings near the centre of the stems are very indistinct, or complicated by false rings (some due to snow), but later growth rings are distinct and there is no difficulty in distinguishing those of particular years in material from the Macedon area.

Queensland material of Pinus taeda and caribaea has been coming forward for about 11 months now, but we have no conclusions to report from the observations made. That work is progressing as fast as possible, but we are waiting for the full range of material. It should also be recorded that specimens have been collected at regular intervals from North Queensland. So far as these species are concerned,

we have been interested in determining relationships of certain anatomical features, such as parenchyma bands to the growing season. However, we ran into great difficulties with this North Queensland material, even with what we considered to be the simplest timber - red cedar. It was most troublesome to match up the growth rings from stem to stem, and even within the one stem. In other species these difficulties would be multiplied considerably, and therefore the work has been put aside for the present. We will be handicapped in this part of our work in the immediate future because Mr. Amos, who planned and carried out the investigations, is leaving this Division, having been transferred to Merbein.

On the sub-microscopic side, some of you are aware of results reported at the last conference. We had investigated, as you know, the sub-microscopic structure of the wood in relation to certain properties and variations in growth and conditions. At out last Conference it was pointed out that our method of approach was to investigate variation in cell length and micellar orientation through successive growth rings of a number of conifer stems. In the youthful period of the tree's life, the cell length is increasing and does not reach an approximate constant value until after 12-25 years, depending on the species; for instance, in the case of Pinus radiata the time is 12-15 years. With increasing cell length there is a decrease in micellar angle according to the relationship first proposed by Preston. These short cells have a large angle of micellar orientation in the middle layer of the secondary wall, and long cells have a small angle. With the change in the angle in the middle layer of the secondary wall there is a change in certain properties of the timber, and that was shown by Mr. Bisset at our last Conference. Although it is this angle which influences the change in properties, because of Preston's relationship, we can use the cell length as an index. The work was extended to selected stems in which growth rate at a later period of the tree's life had been changed considerably as a result of changes in growing conditions.

The accelerated growth rate was due to silvicultural treatment in some cases, and in other cases to development of compression wood. In all cases examined the increased growth rate was accompanied by a decrease in cell length and corresponding change in properties. Thus it appeared that sudden changes in growth rate could alter the properties of the material. Recent work has shown how rapid growth rate influences the type of cell division occurring in the cambium with resulting shorter average cell length. Therefore it may be said that growth conditions have a marked influence on cell division, cell length and cell wall structure; and the structure of the cell wall influences the properties. To carry the story a little further, it was mentioned at the last Conference that we had evidence that in any one species the initial cell length is not always the same, and it has been observed that the length in one stem may be as high as twice the length in another stem. It was obvious because of this relationship that it might be desirable to start with a plantation of trees with a high initial cell length because of the possibility of less trouble with the wood from the early growth rings in conversion and utilization, and because the longer cells are desirable from the pulping point of view. With this in mind attempts have been made with the Commonwealth Forestry and Timber Bureau to develop strains of Pinus radiata with high initial cell length.

The work is in its infancy, but already some 2000 trees have been sampled and the promising ones (from the point of view of cell length) have been selected as parents for vegetative reproduction. The tree itself is not damaged; we take a twig from the first year's growth and determine tracheid length from the wood 6 in. back from the growing tip, and those which show a high tracheid length (1.5 or 1.6 mm.) are selected for parent trees. We also take samples from trees which show a lower initial length. We can, I think, select very early, on the basis of our knowledge of cell structure and its influence on properties, the strain that should give the best type of material for

utilization. Obviously other factors will have to be taken into consideration, such as tree form, rate of growth, etc., but I want to emphasize that all factors should be considered. Depending on the material which is likely to be required in 15-20 years time, it may be quite useless having a strain of good form and good growth characteristics if the cell wall structure is not just what it should be to give the best properties. We should be careful, therefore, in our selection during the early stages. I might mention one example: some Pinus ponderosa from Canberra, aged 17 years. There was one area of this which was clear-felled, and shipped to box manufacturers in Sydney. These manufacturers complained bitterly that the box shooks had twisted and turned. In the samples which we examined we found that 7 growth rings were covered. In the initial growth ring the micellar angle in the middle layer of the secondary wall was at 60° - we expect 30-35° in normal wood, and for the 7th growth ring it had dropped only to 50°. This explains why the manufacturers had had some trouble. Another factor influencing the properties of wood is spiral grain, and we are planning work in this direction because it is felt there may be some relationship between the severity of spiral grain and growth conditions.

Mr. Gordon: Referring to statements concerning the growing volume of timber in Queensland, what are the current end uses of timber at the present time, and what will be the end uses when the plantations which are being established are utilized. I estimate that approximately 2 million tons of timber per annum go to sawn products and approximately 0.15 million tons into chemical products, pulp, paper and fibreboard. The question is, in 15, 20 or 30 years time by how much will that proportion be changed. Undoubtedly the trend will be towards more trees for chemical or mechanical disintegration and utilization for fibre boards and for pulp and paper.

It appears to me that we are tending to direct our efforts and studies towards growing timber with the best properties on the assumption that the best properties are the highest strength and density.

I believe that quantity and cheapness are perhaps more important in the long run. In Australia imported softwoods have been used for construction, but at present hardwoods are being used. The hardwoods are stronger and heavier. If the cost of hardwoods were not less than the imported softwoods, the use of softwoods may have been continued. They are easier to handle, easier to work, and possibly cheaper in the long run. I feel that consideration should be given to this aspect, rather than to put every effort into developing woods of highest strength qualities.

Mr. Grenning: I may have been misunderstood. Our policy is to grow timbers of the highest quality in such a way that the highest possible quantity might be produced. In this way the production of 100 trees could be as high as the production of 500 trees of lesser quality. I do not know what form utilization will take in the years to come, nor what use might be given to timber in that period, mechanical or otherwise, but I feel that the highest grade timber for one purpose will prove to be equally effective for other purposes.

Mr. Turnbull: Referring to Mr. Gordon's question concerning end uses, with this work on wood structure and wood elements should go a study of tree form, in order to influence the development of the most suitable timber.

Mr. Cooper: I agree with Mr. Grenning that the basic strength of the material does not matter; if it is not strong enough for a particular purpose, it can be used in greater quantity. Is the length of initial cells uniform throughout the tree, and if not, by what means could repetitive types be obtained?

Dr. Wardrop: My experience has shown that a tree with high tracheid length in the branch tips also has high tracheid length in the wood of the stem. In a plantation of a given age the tip length could be used as an indication of length throughout the tree. This has been established by a system of measurements.

ITEM 17(a) - SAWMILL ENGINEERING - NORTH QUEENSLAND*

During 1951 some time was spent in North Queensland by an officer of the Engineering Section and it is proposed to present here a brief general impression of sawmill engineering practices.

1. Mill Equipment

(a) Breakdown units There has been an early trend to band-mills in the larger softwood mills with smaller mills finding particular virtue in the frame-saw. However with the increasing trend from softwoods to hardwoods and large to small logs (often due to log preference to auxiliary plymills) both these units have suffered a production loss.

Increase in breakdown capacity has been achieved in a number of instances by the use of two frames or subsidiary equipment (either a rack or Canadian bench).

To date the Canadian bench has not been very popular although mills carrying this unit are quite satisfied. Interest is increasing however and a number of new installations were seen.

(b) No.1 bench. Apart from the bandmill units which normally employ edgers and band resaws the No.1 is the key mill unit. The frame gives the No.1 a heavier task and large diameter (60 in.) saws often have to be used to handle some of the larger flitches produced. In a number of instances there was no direct outlet for the sawn product of No.1 and consequently it served only as an intermediate breakdown bench between the frame and No.2.

(c) No.2 bench. No.2 benches are used extensively but in general they bear a far larger share of the sawn production than is required for balance between benches. Feed speeds are generally not high (120 ft./min.) and consequently as a bench employed mainly on repetition cutting their performance is not spectacular. In one case a radial arm No.2 has been employed and gives quite good service.

---

* Prepared by Forest Products Research Branch, Queensland.

(d) Dockers. Pendulum type dockers are used throughout, but little, if any, mechanical assistance is provided. In some cases material not requiring docking is stacked directly on trucks by the bench tailerouts. The economy of such an operation is open to question in a number of cases.

2. Layout

Very few mills present a smooth flow pattern, the general impression being that an initially small mill has been added to with little thought as to the final plan.

The most interesting layout noted is presented in the diagram.

3. Log and Product Handling

Wooden derrick cranes are used extensively in the log yard giving quite reasonable log storage and sorting facilities. One miller proposes the installation of an overhead logging wire which should allow of greater storage and easier sorting than the crane.

Sawn material is generally sold green off-saw in all but the larger mills involving very little handling. Where further processing is to be done either a truck or transfer is used.

One very impressive example of good mechanical handling was noticed in one timber yard which employed a 5 ton capacity travelling gantry crane of 60 ft. span. The proprietor estimated that such a unit and 12 men is equivalent to 22 men under normal conditions.

4. Waste Disposal

Steam plant utilizes the waste in a number of instances. In general, however, it creates a problem and considerable interest was shown in McCashney incinerators.

Discussion:

Mr. Littler: Conditions in mills in North Queensland are similar to those in South Queensland. Further mechanization needed in Queensland mills of low efficiency should not be reflected in higher prices.

Mr. Jennings: If man-hour production is to be increased the general efficiency of mill operation must be raised by mechanization etc. The average figure for Queensland is 42 solid sawn per man-hour.

ITEM 17(b) - SAWMILL STUDIES - THE CONVERSION OF HARDWOOD THINNINGS*

Introduction

As mentioned at the previous conference, a mill study was conducted in hardwood thinnings over the 48-49 Christmas vacation period. The statistical analysis of the study data is now almost complete and it is proposed to present briefly the more important aspects of the work.

Purpose of Study

The large stands of small hardwood logs in Queensland prompted the Department to examine the market possibilities of such timber. Consequently a study was designed to determine the influence of species and girth on -

(a) production rate and recovery

(b) quality of sawn product

the data to be later applied in the determination of equitable stumpages for hardwood thinnings.

Sample Description

Full details are given in the following table:

Species	Nett Hoppus	Defect allow-ance s.ft.	Girth distribution (No.of logs)						Total
			18 to 23.9"	24 to 29.9"	30 to 35.9"	36 to 41.9"	42 to 47.9"	48 to 53.9"	
Turpentine	15611	39	12	38	52	43	11	1	157
Ironbark	20926	36	5	35	59	63	28	3	193
Grey Gum	19629	452	8	23	39	58	39	11	178
Messmate	28522	252	4	38	75	79	40	3	239
Brush Box	17507	25	4	52	74	42	19	2	193
Red Mahogany	21171	4	1	42	85	50	23	3	-
Spotted Gum	24143	45	2	31	52	68	43	16	212
Total:	147509	853	36	259	436	403	203	39	1376

* Prepared by Forest Products Research Branch, Queensland.

Average girth	35.6 in.
Average net Hoppus	107.2
Average length	16.5

Sawmill Type

The mill had a capacity of 8-9000 s.ft. nett Hoppus per day in thinnings, employing a knee type Canadian feeding to two three-man No.1 benches and two dockers. There was no lack of power in the mill and feed speeds up to 250 ft./min. in 4 in. cuts were quite common. Sawdust was removed by scraper chain with offcuts cut to firewood lengths by the dockers.

Study Procedure

The No.1 benches only were timed by individual logs, the others being timed on a total time basis. Then the time per log is calculated from the equation $T = \frac{a}{A}(A + B)$

where a = direct time on a log

A = total direct time for the study

B = total time for study.

The No.1 bench then determines the influence of any particular log on production time.

Individual log tallies were of course recorded.

Results

(a) Production Rate

The average production rate was quite reasonable for a Queensland sawmill being 160.8 man-min. per 100 S.F.S.S. or 37.3 S.F.S.S. per man-hr.

Graph 1 presents the average results with the extreme species range of ironbark and grey gum.

The best estimate of production rate for a log of any species is given by $T = 0.7716H + 12.0784$

where T = total time man-min.

H = gross Hoppus of the log.

The average production rate for 230 normal hardwood logs

milled for comparison purposes was 144.3 man-min. per 100 S.F.S.S. or 41.6 S.F.S.S. per man-hr.

(b) Recovery

Graph 2 presents the average results with the extreme species range of ironbark and grey gum.

Average recovery was 56.5 per cent. on net Hoppus with the best estimate of recovery for a log of any species being given by

$R = 0.6393H - 9.6746$,

where R = recovery (S.F.S.S.)

H = gross Hoppus of the log.

Recovery from the 230 normal hardwood logs was 61.4 per cent. on a net Hoppus basis.

(c) Quality of Product

As expected, sapwood was the major influence in degrade. Where in normal hardwood the product was predominantly either specially select or 1st grade, the grade in thinnings was either 1st or 2nd grade.

The following table summarizes the overall results for the study; the R1 column indicating a board having susceptible sapwood, but when treated, will yield a 1st grade board, and R2 indicating a 2nd grade board after treatment.

Species	Sawn volume					
	Select %	1st %	R1 %	2nd %	R2 %	Reject %
Turpentine	14.0	57.6		27.3		1.1
Ironbark	18.9	59.9		20.6		0.5
Grey Gum	9.6	55.2		32.4		2.8
Messmate	8.2	50.5		40.5		0.8
Brush Box	10.9	63.6		23.8		1.8
Red Mahogany	14.6	21.4	26.4	20.9	15.0	1.7
Spotted Gum	6.2	21.4	28.8	10.8	31.6	1.2

The influence of girth on grade for each species has yet to be examined.

Mr. Littler: These mill studies were to determine (a) variation in recovery with log size, and (b) man-hour production rate, and were made on a total daily mill output basis. The statistical work has been discussed with Mr. E. J. Williams.

Discussion:

Mr. Grenning: The purpose of the study, which was done on logs milled from cut-over bush which required thinning, was to determine a stumpage figure and how far the Forest Service could compel thinnings cutting.

Mr. Clarke: If greater efficiency is desired, initial capital outlays must be raised. To increase capital outlay, millers must be sure of definite and increased log allocations.

Mr. Huddleston: I agree that this is the crux of the matter and that it is necessary for installed horse power available to the mill to be increased. I consider an allocation of the order of 8,000,000 s.ft. of logs is necessary to warrant full mechanization and utilization of horse power. In the experimental area of pine at Tumut, tenders have been invited for the installation and operation of a sawmill. Logs will be supplied under a special licence granted on a yearly basis with practical certainty of a 15 year life. Allocation to be 6,000,000 HLV for first year rising to 15,000,000 HLV at 15 years.

Mr. Turnbull: Because of the great number of variables there is a tremendous field of work to be covered and more investigations are needed. I hope that Mr. Littler will be encouraged to continue with the sawmill engineering work in Queensland. I agree that the problem of man-hour production is due in a large part to the low input to mills, and the future of milling is bound up with official ideas as to the desirable size of mills. Further mechanization will not be effective unless existing machines can be operated full time. E.S.T.I.S. is a valuable medium for discussions in milling, but licensing procedure is still the important factor.

Mr. McAdam: Is there a point at which the curve of log volume against efficiency levels off ?

Mr. Turnbull: The optimum figure is in the range 8-10,000,000 HLV input, and the typical mill under these conditions should consist of

(a) break-down rig
(b) No.1 breast bench
(c) re-saw bench
(d) recovery bench, with necessary dockers and additional mechanical handling.

Mr. Huddleston: In some areas in New South Wales the Commission is issuing licences to form mills in one area each to cut 1,000,000 HLV where it would have been more advisable to issue a licence to one mill only to cut the full quota.

ITEM 18(a) - USE OF STRINGYBARK IN FIBROUS PLASTER*

At the present time, sisal or a mixture of sisal and coir is used in the manufacture of fibrous plaster sheets. Both these fibres are expensive and must be imported. It is very desirable, therefore, to replace them with a cheaper, locally grown and readily available fibre. Such a fibre is that obtained from the bark of white stringybark (E. eugenioides).

Tests carried out by the Division of Wood Technology in conjunction with a fibrous plaster manufacturer, have shown that stringybark fibre is entirely satisfactory, either on its own, or mixed with an equal amount of sisal. Stringybark fibre is not as strong as sisal, and therefore a slightly larger amount of this fibre must be used in order to obtain a board of equal strength (13 oz. of fibre/sq.yd. of 7/16 in. board.).

Transverse bending tests on fibrous plaster sheets show that there is a large variation in strength between different samples taken even from the one large sheet, so that difference in proof load for stringybark and sisal fibrous plaster samples are not significant.

---

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

Transverse Bending Test

Fibre	Sheet thickness	Proof load lb.	Deflection	Made by	Tested by	Proof load thickness = 7/16 in. lb.
Sisal	.369	76	0.9 in. at 62 lb.	Narrabeen Plaster Works	D.W.T.	83
"	.375	63.5	0.8 in. at 49 lb.	"	"	69
"	0.407	77	0.93 in.	"	"	80
"	0.396	57	1.00 in.	"	"	60
Sisal and Stringy-bark	0.463	95	1.00 in. at 75 lb.	Narrabeen Plaster Works	D.W.T.	92
"	0.410	69	3/8 in.	"	P.W.D.	69
Stringy-bark	0.318	56.5	1/4 in.	D.W.T.	"	71
"	0.432	53	1/8 in.	Narrabeen Plaster Works	"	53
"	0.468	54	0.6 in.	"	D.W.T.	52

An important advantage of fibrous plaster sheets made with stringybark fibre is the fact that they are less flexible, and consequently will not sag as readily if used in ceilings. At the same time such sheets do not face-crack.

The fibre is easily prepared by retting the bark. This process takes from 3 to 5 weeks, depending on the thickness of the bark, and on the temperature. Tannins, which would strongly discolour fibrous plaster, are leached out during the retting. The process is completed when the fibres can be pulled apart easily, without being broken. The bark is then washed several times, dried, and teased in the conventional teasing machine.

So far, white stringybark is the only stringybark suitable for fibrous plaster. All the other stringybarks will be investigated in the near future.

Mr. Huddleston: The use of stringybark fibres for the manufacture of plaster sheets according to specification has proved to be satisfactory. These fibres can be used either wholly, or mixed with an equal quantity of sisal. It is anticipated that the demand for these plaster sheets would increase considerably.

Mr. Thomas: In South Australia Pinus radiata wood wool has been used for the same purpose, but owing to high cost, its use was discontinued.

ITEM 18(b) -DEVELOPMENTS IN PAPER BARK UTILIZATION*

In the 6 months ended December 1951, Australia purchased from abroad cork and cork manufactures to a total cost of £484,000. Work at D.W.T. shows that a substantial part of this expenditure might have been saved by utilization of the bark of the paper-barked tea tree (Melaleuca leucadendron) as a cork substitute.

Below is summarized the evidence on which this claim is based.

Since there is a considerable difference in both bark and tissue structure, as compared with Quercus suber, which effects its utilization, a brief description of the bark is appended.

The cork from paper-bark has been compared chemically with Spanish cork and since it appears possible to extend the application of cork as a chemical raw material a note on the chemical aspect has been added.

The Structure

The structure of the outer bark is a layered formation which accounts for the characteristic appearance of the tree. These layers are monocellular layers of cork, produced by phellogens whose life is short compared with that of the tree - about a dozen layers of cork are produced by each phellogen. In young unweathered bark can be seen a layer of parenchyma between each layer of cork, but when the bark is old this tissue has very considerably degenerated which results in increased weathering. After the formation of about a

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

dozen of these alternate layers of cork and parenchyma the old phellogen is replaced by a new one forming in the phloem. The phloem which is thus cut off is crushed by the increasing pressures and a thin layer of phloem fibres is added to the layers described above.

As a result of this structure, therefore, with the exception of gaskets and the like, no mechanical uses of paper bark are possible, and even the use of paper-bark for manufacture of cork flour for use in linoleum is speculative.

Fortunately the physical properties of these three tissues are so different that their mechanical separation is not difficult.

The Chemistry

In the chemical examination of paper bark two aspects have been considered:

(1) The investigation of the gross chemical features of paper bark by analogy with Spanish cork.

(2) An examination of the extractives which make up about 20 per cent. of this bark, with a view to finding out what they are and determining whether or not they are the sole cause of the bond formed in this material on lightly heating and pressing.

With respect to the first, paper-bark has been compared to cork for acid resistance. For this purpose, both tissues were subjected to Klason lignin treatments (i.e. 72 per cent. $H_2 SO_4$ etc.). Calculating on an extractive-free basis, the percent. of material insoluble by this treatment was -

cork - 80 per cent.
paper-bark - 81 " " .

Probably the best way of comparing suberized tissues is by suberin extraction and determination.

A method, after F. Zetzche in Klien's Handbuch der Pfanzenanalyse (1932) and more recently quoted by others, has been used for this purpose. The method suffers from a number of inherent disadvantages. The authors do not mention in their experimental

details just how these were overcome.

The method involves saponification of the polyestolide, suberin with 3 per cent. alc. KOH for 6 hr. under reflux. The products of saponification are collected and weighed.

The method used here was as above and a correction was made to the weight of acids obtained by multiplying this value by a factor K.

$$K = \frac{\text{E. Weight of Suberin acids} - \text{M.W.}_{H_2O}}{\text{E. W. Suberin acids}}$$

The mean equivalent weight of the acids from suberin was found to be EW = 273.5 g. and the corrected value for suberin to be close to 50.0 per cent. for paper-bark.

After suberin extraction and washing with alcohol a residue remains of which 71 per cent. is the water soluble potassium salt of an acid.

The literature indicates that cork is about 45 per cent. suberin. The Sap. number for cork has not yet been determined and does not appear to be quoted.

If chopped-up paper-bark is heated to a temperature not less than about 180°C. at 2-3 lb./sq.in., a quite remarkable change in mechanical properties is observed. A block of material, in which the pieces adhere together quite strongly is formed having a density of 0.2 g./c.c. or better and a conductivity constant of about 0.7×10^{-4} C.G.S. units.

The bond formed is waterproof and to some extent solvent proof. It appears from work done by Schmidt and others (1), that this bond may not be due entirely to the flow of molten extractives in the bark, although this, no doubt, contributes to a considerable extent. We have observed that treatment of the bark with HCl in a manner likely to hydrolyse a considerable amount of the associated carbohydrate, yields, on washing and drying, a material which apparently polymerizes and which softens on heating.

The amount of extractives from paper-bark is considerably

greater than from cork and it seems likely that their variety is greater too.

The first of these extractives to be isolated in a pure crystalline state were two triterpenes which, whilst they have not been identified at D.W.T., have recently been reported by White in Western Australia to be betulic acid and a new triterpene which he calls "Melaleucic acid". It is interesting to note that these compounds bear only a family similarity to the triterpenes, carin and friedelin of cork and that, as we have observed, triterpenes frequently occur in suberized tissues, a fact which may ultimately be of some value to plant physiologists in studies on single tissues.

With regard to the other extractives, none has so far been crystallized. They appear to be chiefly acidic and the mixture is apparently fairly complex. However, it seems likely that both the extractives and the saponification products of paper-bark will bear a general similarity to those of cork since such a parallel has already been drawn between such different species as the birch, Betula verricosa, and the cork oak, Quercus suber.

If such is the case, the possibility exists for extending the application of paper-bark into the field of chemical raw materials (2).

Utilization

It is clear from the structure of paper bark that its utilization is limited to those forms which do not require the mechanical properties of the bark of Quercus suber such as cork bottle stoppers. Also the bark must be made free of woody fibres. This can be done by -

(a) Mechanical disintegration of the dry bark followed by air separation.

(b) Mechanical disintegration of the dry bark followed by water separation.

Industrially, the former is probably preferable because expensive drying of the end product is not required.

A small manufacturer in Sydney is using a dry method of separation. He has designed a disintegrator specially for the job and

claims to get higher ultimate yields of corky material than would be obtained by using a hammermill. This manufacturer must obtain flakes which are quite large and are almost completely free of woody fibres because they are used as a filling for infants' mattresses and pillows. This filling has very considerable advantages over chaff (the usual material used) and has been highly recommended by local infant welfare authorities. The mattresses and pillows can be washed and even boiled.

Various methods of making insulating materials have been investigated.

(1) Loose Chopped Dry Bark

Air dried paper bark was chopped with a chaffcutter into approximately 1/2 in. strips and tested for its insulating value both in a guarded hot plate apparatus and in a domestic hot water heater. The conductivity constant was shown to be 1.03×10^{-4} C.G.S. units. The bench test on the domestic hot water heater was conducted for 6 months and from the data obtained from the manufacturer conducting the test it seems that the bark proved to be a better insulator than slag wool.

(2) Fibre-Free Dry Bark (plus 40 mesh)

Dried paper bark was disintegrated in a hammermill, sieved, and the material which stayed on 40 mesh was tested for conductivity. The value for k was found to be equal to 0.65×10^{-4} C.G.S. units. Owing to the low yield of this material, however, it would be difficult to exploit commercially unless a satisfactory price could be obtained for the flour. Also, the light flaky nature of the material may lead to production difficulties.

(3) Resin Bonded Chopped Paper Blocks

Various attempts were made to manufacture a low density block using chopped bark and various adhesives. It has proved to be impossible, however, to make an insulating block by this method which is of sufficiently low density to have a low enough conductivity to make it attractive for commercial use. Some of

the conductivities obtained for blocks of various densities are as follows:

Specimen No.	Density g./c.c.	Cond. k x 10^{-4} C.G.S.
A	0.21	1.01
B	0.30	1.01
C	0.18	0.84
D	0.27	1.05
E	0.24	0.92
F	0.24	1.04

In an attempt to improve blocks made in this way, various admixtures of cork from Quercus suber were made. These were, however, unsatisfactory; the difficulty of obtaining a light density board being the main trouble in all cases.

(4) Thermally Bonded Blocks

Owing to the tendency of flakes of paper bark to layer under pressure, efforts to use the extrusion baking process used in the manufacture of insulating blocks from conventional cork resulted in the making of blocks with densities which are too high. Various admixtures of paper bark and cork did very little to modify this difficulty, with the result that it seems to be impossible to utilize existing plant for the manufacture of insulating blocks from paper bark. It has been found that the pressure should be of the order of 2 to 3 lb./sq.in. and that the material should be heated for about 1 hr. at a temperature between 400 to 600°F. Small blocks which have a fairly satisfactory mechanical strength and density of about 0.2 g./c.c. or better can be made using these conditions. The conductivity of a large block made under conditions similar to these gave a conductivity constant of 0.68 x 10^{-4} C.G.S. units.

The Forestry Commission's field research staff have carried out some valuable work on the rate and cost of stripping the bark. Included amongst their conclusions are the following points of interest:-

(1) Irrespective of size classes represented a total bark yield of 4000 lb./acre can be expected from a fully stocked area. Of this yield 80-90 per cent. is available from the lower half of the stems.

(2) Cost of stripping trees of D.B.H. 13.5 in. plus is approximately half that for trees less than 7.5 in. D.B.H. Cost of stripping increases rapidly above 10 ft. from the ground.

(3) Following from 1 and 2 above it will be uneconomic, possibly to strip any trees less than 7.5 in. D.B.H. and to strip any tree higher than could be reached from the ground.

No further work has been done since the last Forest Products Conference on the use of the bark for making gaskets excepting various endeavours to interest manufacturers in the process.

Lack of reliable information concerning the function of cork flour or indeed its necessity in linoleum, has inhibited extension work in this direction. If the function of cork flour in linoleum relies upon the mechanical properties conferred on the bark of Quercus suber by virtue of its structure, then the addition of the flour made from paper bark would not necessarily be of any value. Tests conducted at Michael Nairn's, Sydney, on an industrial scale, were marred by lack of control in the factory. However, it did appear that the linoleum made using paper bark flour as one of its ingredients was in no way distinguishable from linoleum made using the company's usual formula. Whether or not this formula contained any cork flour was difficult to ascertain, and as the company itself did not seem to be more than superficially interested in obtaining supplies of paper bark flour, this line of extension has been temporarily dropped.

References

1. Schmidt, M., Monatschefte 31 347 (1910).

2. Guillemonat, A., Bull. Soc. Chim., (S) 9, 589 (1942).

Mr. Huddleston: Since the last Conference a market for paper bark has been firmly established, and includes uses such as bedding, pillows, cushions, and insulating material. The United States has been supplied with approximately 1000 tons for insulation purposes.

Discussion:

Dr. Chattaway: Is the bark stripped from the living tree ?

Mr. Huddleston: Yes.

Mr. Chinner: Is the tree injured by stripping ?

Mr. Huddleston: No, the tree recovers quite well after stripping and the bark is subsequently much improved. Regeneration results in a growth of bark approximately 1/4 in. to 1/2 in. thick per annum.

Mr. McAdam: How is the stripping carried out ?

Mr. Huddleston: The stripping is done with a brush hook, and it is possible to cut the bark down to within a few layers of the cambium, where it then becomes too tight to strip. Trees which were stripped in 1940, when restripped recently, gave an improved yield of higher grade bark.

ITEM 18(c) - SURVEY OF TANNIN CONTENT OF BARK OF PLANTATION GROWN PINUS RADIATA AT JENOLAN S.F.*

The world shortage of vegetable tanning materials has, over the past two decades, become increasingly acute. A large part of the world is dependent on wattle extract from South Africa and quebracho from South America. In the latter case supplies are continually diminishing because quebracho cannot be profitably exploited unless the trees are at least 80 to 100 years old.

In some countries tanning materials are available but economic considerations prevent their proper exploitation, e.g., valonia in Turkey and black wattle in Australia. It seems at present that, as labour costs increase generally, other materials will become prohibitive in price and so disappear from the market, e.g. myrobalans in India, where the nuts are collected by hand and the price is

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

continually rising with labour costs.

In this country the only company making tanning extract is Industrial Extracts Pty. Ltd. The wood and bark of wandoo (E. redunca) is extracted to manufacture "Myrtan" extract. This extract and small supplies of wattle and mallet barks from local sources constitute about 20 per cent. of the tanning agents used. Thus, of the total amount consumed, Australia imports 80 per cent.

In the continental countries such as France, Germany, Poland and the U.S.S.R. the extraction of pine bark is carried out quite extensively. Turkey (1) also has built up a fairly large industry from the barks of Pinus brutia and Pinus nigra which produce extracts of high quality.

A comprehensive survey has been carried out in the U.S.A. by Snow on the possibilities of exploiting P. echinata, P. taeda, and P. virginiana from the Tennessee Valley (2). Snow considers that loblolly and shortleaf barks are commercial propositions at 4.5 per cent. and 5.4 per cent. tannins respectively, these trees having a bark volume averaging 18 per cent. for sawlogs and 24 per cent. for pulp logs. Virginia pine is considered uneconomic at 3.7 per cent. tannin and 13 per cent. bark volume.

Pine bark is an attractive source of tannin since it can be regarded as a by-product of the already profitable timber industry for which plantations of these trees have been established. In Australia P. radiata is grown extensively in plantations and increasing quantities of waste bark are becoming available for exploitation.

In 1949 Anderson (3) obtained about 25 per cent. tannin in an analysis of a sample of P. radiata bark from South Australia. He stated that the leather samples prepared from the aqueous infusion were of good quality and indicated that the pine may be a valuable tanning agent.

During 1950 a bulk sample received from Green Hills S. F. analysed 27.2 per cent. tannin. Also five fresh bark samples from South Australia were analysed. These gave an average tannin content of 20 per cent., the values ranging from 15 to 28 per cent.

These results suggested that a preliminary examination of barks from New South Wales would be worthwhile, so a collection of samples was carried out in different localities. The samples were taken from thinnings and were removed at about the centre of the mill log. Some samples received obviously had been taken from logs exposed to weather for some time so the results obtained can be regarded as conservative. Twenty-five bark samples from ten State Forests were analysed and gave an average tannin content of 14.2 per cent. From th these figures it can be seen that the bark of P. radiata could rank high as a potential source of vegetable tanning material.

Preliminary work suggested that tannin content decreased as the height from which the sample is taken increased. If confirmed, this could limit the height at which it would be economically sound to take bark extraction.

Survey of Tannin Content of Bark

In the investigations at Jenolan S.F. factors considered included the effect of age, G.B.H., and site quality upon the tannin content, as well as the variation with height of sampling.

Initially, it was decided to examine the relationship between tannin content and the amount of tannin formaldehyde resin yielded by an aqueous extract of the bark, the object being to evolve a shorter method of tannin analysis for this species. This resulted in a working formula for estimating tan content from the amount of resin formed.

Sampling of the Forest

Bark samples used were collected by removing the bark between 3 ft. and 4 ft. 6 in., between 15 ft. and 16 ft. 6 in., (Tannin A, Table 1) and between 30 ft. and 31 ft. 6 in. from the ground (Tannin B, Table 1) and between 10 ft. and 11 ft. 6 in. from the top of the tree (Tannin C, Table 1).

Planting was commenced at Jenolan in 1929 and discontinued for several years after 1935, so for the purposes of this work trees

were selected from the plantings for the years 1929 to 1935 inclusive. Eight trees were selected from each year's planting, the samples being taken proportionately from the various site qualities. Trees to be sampled were pre-selected on a map to prevent favouritism.

From the eight samples for each year one was selected for up the tree sampling, this limit was imposed because of the necessity of felling the tree. As each sample was taken records were made of the year of planting, G.B.H., and site quality.

Shorter Method of Analysis (4)

A method was worked out whereby the amount of tannin formaldehyde resin yielded was determined and the tannin-formaldehyde expressed as a percentage of the bark.

Concurrent analysis were carried out on 29 barks to determine the tannin content and the tannin formaldehyde. A regression of tan content on tannin formaldehyde was then obtained by standard methods. The correlation coefficient was found to be 0.963. An analysis was carried out to demonstrate the significance of the regression, t_b for the regression was 19.06. Where X, is tannin formaldehyde percentage and Y, the tannin content an entirely satisfactory estimate of tannin could be obtained from the equation $Y = 0.7593X-3.45$.

Analysis of Bark Samples

All barks were dried in air immediately after collection and then ground in a Wiley mill to pass a 1 mm. screen. The 29 barks used in evaluating the shorter method were analysed by the official method of the Society of Leather Trades Chemists, and the remainder by the shorter tannin formaldehyde method. In all 77 samples were analysed.

Results of Survey

The collected results are shown in the accompanying table. The average tannin content for the 56 butt bark samples was 16.4 per cent. The results were examined statistically by the

Biometrician, Department of Agriculture, and no significant effect was shown for any of the variables studied except the pronounced drop in tan content with increase of height of sampling.

Discussion of Results

Perhaps the most significant result of the survey was the fact that there was no variation of tannin content with age. This of course can be applied only to the age groups included, but it seems that there is no accumulation of tannin and the important consideration would then be bark yield.

Although the drop in tannin content with increased height of sampling is very definite the C results are not insignificant. Another point is the fact that for an average 70 to 80 ft. high P. radiata the bark from the top 20 ft. would be only a small percentage of the total bark.

Conclusion

This survey has indicated that the bark of plantation grown P. radiata could be a valuable source of vegetable tannin. If a satisfactory extraction method can be evolved it should find a use in leather manufacture, failing this a definite possibility exists for its use in building boards and adhesives.

References

1. Seligsberger. "Turkish Pine Bark and its Extracts". Der Gerber 103, 57-8, (1937).
2. Snow E. A. "Pine Bark as a Source of Tannin".
3. Anderson H. Private Communication, (October, 1949).
4. Martin, P. D.W.T. Project C.6, Sub-Project C.6-4, Progress Report No.1

TABLE 1

Sample No.	Tannin Formal.	Tannin	G.B.H.	Tannin A	Tannin B	Tannin C
29/1	34.3	25.7	48			
29/2	33.5	19.5	54			
29/3	22.9	13.9	44			
29/4	31.2	19.3	42	17.4	16.7	6.0
29/5	23.0	14.0	42			
29/6	27.4	17.3	33			
29/7	28.1	17.9	52			
29/8	33.4	21.9	49			
30/1	24.2	14.9	36			
30/2	22.6	13.7	34			
30/3	26.8	16.9	44			
30/4	24.2	14.9	37			
30/5	28.8	17.1	45	14.2	12.7	8.1
30/6	20.7	12.2	31			
30/7	22.2	13.4	35			
30/8	26.6	16.8	38			
31/1	26.8	16.8	37			
31/2	22.5	13.6	33			
31/3	24.7	16.0	38	13.9	15.9	11.0
31/4	30.7	19.9	37			
31/5	30.0	19.4	35			
31/6	25.2	15.7	40			
31/7	21.6	12.9	31			
31/8	23.4	14.5	44			
32/1	28.9	18.5	45			
32/2	36.1	24.0	31½			
32/3	27.8	17.7	41			
32/4	23.2	14.1	32			
32/5	22.9	14.2	27	11.3	8.3	7.9
32/6	25.5	15.9	38			
32/7	27.6	17.5	38			
32/8	22.9	13.9	31½			
33/1	22.4	13.6	33			
33/2	26.4	16.6	28			
33/3	19.2	11.8	37			
33/4	21.5	12.7	28			
33/5	22.8	14.0	31			
33/6	23.1	13.5	38½	12.6	9.2	5.1
33/7	23.5	14.4	35			
33/8	19.2	11.1	23			

Table 1 (contd.)

Sample No.	Tannin Formal.	Tannin	G.B.H.	Tannin A.	Tannin B.	Tannin C.
34/1	25.3	15.8	35			
34/2	26.5	16.7	33			
34/3	30.5	19.5	35			
34/4	28.7	16.7	37			
34/5	27.5	17.4	33			
34/6	32.0	20.8	31			
34/7	26.0	16.3	35			
34/8	23.8	13.8	27	12.9	11.0	11.0
35/1	26.5	16.6	27			
35/2	26.3	16.6	27½			
35/3	24.9	15.6	34			
35/4	28.9	18.5	33			
35/5	22.4	13.3	21½			
35/6	21.6	13.0	28			
35/7	32.8	23.7	28½	16.4	9.4	7.7
35/8	29.8	19.5	33			

Mr. Huddleston: From observations made on the bark of Pinus radiata this species is regarded as a potential source of tannin supply. It has been tried out for the manufacture of leather with satisfactory results.

Discussion:

Mr. Hodder: Similar results to these given in the report were obtained from investigations at New Zealand Forest Products. There have been some experiments for extraction on a commercial scale but these presented a difficulty in getting satisfactory yields on a large scale. It is obvious that a much more efficient method was necessary.

Mr. Huddleston: A Sydney firm is co-operating in trials with radiata bark, and they do not anticipate any difficulty.

Mr. Bland: While I appreciate the value of the present rapid method of analysis, the use of the standard method is to be preferred, in order to give an indication of the ratio of tans to non-tans which is important.

Mr. Huddleston: I agree that it is necessary to use the standard method in some cases.

ITEM 19(a) - BOX TESTING ACTIVITIES

Mr. Huddleston: The box testing system referred to is installed in our laboratory. It has been in operation for 12 or 18 months, but lack of staff has prevented any research in box testing. We have one or two enquiries in that field, and to meet these specific requests the work that has been done has been at the expense of other activities.

Mr. Clarke: We were approached by one of the boxmaking firms asking if we would be prepared to undertake box testing activities again. Boxmakers have been faced with difficulties which might result in the wooden box going out of existence except for a number of minor purposes. My reply was that in accordance with the policy of the C.S.I.R.O. we were not prepared to meet their request unless they were prepared to find the money; I said that probably £1000 would be necessary. Ultimately I was informed that most of this sum had been raised and that they expected to receive the balance shortly.

ITEM 19(b) - PROPERTIES OF TIMBERS OF SOME LESSER KNOWN ACACIAS

Mr. Huddleston: I am sorry I have not got a paper on this subject. Following some incidental tests on some of our acacias, it that worthwhile results could be obtained more or less from an ad hoc study of acacias commonly growing in New South Wales, and for that purpose samples have been collected from 5 trees of each species over quite a wide range, and certain tests carried out, including impact strengths. We hope shortly to be able to plan a wide investigation to determine in more detail the properties of these particular species.

ITEM 19(c) - EXPERIMENTAL TURPENTINING OF PLANTATION GROWN PINUS CARIBAEA*

Large plantations of Pinus caribaea have been and are being established by the Forestry Commission of New South Wales, primarily for timber, pulp, and plywood manufacture. Pinus caribaea is one of the main

---

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

naval stores producing species in the United States, and the possibility of obtaining turpentine and rosin from those trees which will be removed in the final thinning, without reducing significantly their value as timber, was investigated in this experiment.

The important methods of turpentining, practised in other countries, were tried out. In particular, the yields from three types of faces, French (original face 3-1/2 in. wide x 1-1/2 in. high; new face of 1/2 in. made at each chipping; 4 in. of old face freshened), American (peaked streak, 5/8 in. high, 1/2 in. deep, face 9 in. wide), New American (slant streak, bark chipped, 1/2 in. high, face 9 in. wide) were compared, and the increase in yield due to acid stimulation (40 per cent. sulphuric acid), the influence of the side of the tree on the yield, the variation in yield due to cutting two faces per tree, and the reduction in the rate of growth of turpentined trees were investigated.

The experiment was carried out on a stand of 20 year old trees (average D.B.H. 9 in.), at Banyabba State Forest. The chipping was done by the resident forest foreman. Close supervision of the work was not possible as Banyabba is 500 miles from Sydney, and consequently the experiment was not carried out exactly as planned; e.g. there was very little, if any, difference between the American and the New American face. The depth of the streak of the American face never exceeded 1/4 in., and some woody tissue was always removed when cutting the New American face. Also, the height of the streaks varied from 1/4 in. to 1/2 in., so that the increase in the height of the faces during a season varied from the expected 16 in. to as low as 8 in. Nevertheless, useful results were obtained. The experiment was commenced in 1946, and carried on for 5 years.

Results

Type of Face

The French face gave considerably less gum than the other two types, but, as is to be expected, there was no significant difference

between the yields from the American face and the New American face.

Year	Average weight per face of gum produced		
	New American g./face	American g./face	French g./face
1946-47	2570	2420	1950
1947-48	1530	2000	1850
1949-50	1470	1550	698
1950-51	1420	1210	754
Mean	1750	1800	1310

The Effect of Acid

The experiment has shown that acid stimulation increases gum yields, but apparently only during the first chipping season.

Year	Average weight per face of gum produced					
	New + Acid g./face	New g./face	Amer. + Acid g./face	Amer g./face	French + Acid g./face	French g./face
1946-47	3170	1970	3010	1820	2110	1790
1947-48	1530	1520	2130	1860	2220	1480
1949-50	1650	1300	1560	1530	759	637
1950-51	1340	1490	1240	1170	783	724
Mean	1920	1570	1990	1600	1470	1160

There is no satisfactory explanation for the general, large reduction in yield after the first season, apart from the possibility that the experiment was carried out less carefully. The cause of the lowering of the yield over the years, and in particular the ineffectiveness of acid stimulation after the first season, will be investigated in further experiments.

Number of Faces per Tree

When two faces per tree were cut instead of one, the yield per tree was greater, but the yield per face less.

Direction of Face

Although daily gum production varies with average daily temperature, no greater quantity of gum was produced from faces on that side of the trees which received the maximum amount of sunlight (i.e. the north side) than from faces on the opposite side.

The Effect of Turpentining on the Growth Rate of Pinus caribaea

The experiment proved conclusively that turpentining reduces rate of growth. The more intensive treatments (acid stimulation, two faces per tree) affected growth rate to a greater extent. The growth rate may be reduced by more than one third, and, although this fact does not seem to have been appreciated by workers overseas, it is obviously of very great importance and will be investigated more fully in future experiments.

Comparison of Yields with Those Obtained Elsewhere

The yields of gum obtained in this experiment were only about one half to two thirds of those obtained for similar treatments, in other countries. However, if one keeps in mind that the average height of the streaks was only between 1/4 in. and 1/2 in. and that the D.B.H. of the trees involved was in the range of 9-10.5 in. (overseas this range is considered the lower limit, below which it is unprofitable to chip for turpentine), the yields are quite encouraging.

Cost of Gum Production

On the basis of the results obtained in this experiment, the yield of gum from the most promising type of face, New American, acid stimulated, will have to be increased by at least 50 per cent. or the amount of work involved in obtaining gum reduced by an equivalent amount, in order to make turpentining operations profitable. To determine whether this is possible, a new experiment has been commenced. In the experiment the trees will be chipped bi-weekly, instead of weekly, larger trees on a better site will be used, and 2,4-D stimulation will be compared with acid stimulation. It is expected that at the next Forest Products Research Conference preliminary results will be to hand.

Mr. Huddleston: At the last Conference I think we reported the work being done at Banyabba. Commencing in 1946 we have been turpentining a number of the finest trees at Banyabba in Northern New South Wales. These tests were completed last year and as a result of the information obtained from them we have now organized another series of tests to follow on the information gained from the first tests. It does appear, however, that on the production of turpentine and with our labour costs we need to increase production by 50 per cent. or alternatively reduce our costs by that amount in order to make it an economic possibility.

ITEM 19(d) - PULPING OF TROPICAL WOODS

Mr. A. J. Watson: During the past 12 months we have been carrying out some work in the Division on New Guinea mangrove species to determine their chemical, physical and paper-making characteristics. Klinki pine has been examined in the same manner and the investigation has been extended to cover a number of trees, both natural and plantation grown, in order to obtain results which will be representative of the species. An investigation of hoop pine is also being made along similar lines. So far the latter portion of this investigation is not sufficiently advanced to enable definite conclusions to be drawn, but the preliminary studies have served to give a general indication of the pulping properties of the mangroves and klinki pine.

The mangroves examined were Excoecaria (1 sample), Campostemon schultzii (2 samples), Sonneratia (1 sample) and Bruguiera gymnorrhiza (1 sample). The chemical composition of all species was similar to that of other hardwoods. The chips cooked readily by the sulphate process, using 17-20 per cent. total alkali to give yields of approximately 50 per cent. Excoecaria yielded the best grade of pulp, producing paper a little superior to that given by a commercial regnans kraft pulp. The pulp from Campostemon schultzii was only slightly inferior to that of Excoecaria but Bruguiera gave a coarse sheet with low tensile and bursting strength, but with satisfactory tearing strength.

The strength properties could be related to the fibre structure of each species. With the exception of Bruguiera, which had a fibre about 1.6 mm. long, all fibre lengths were approximately 1 mm. The fibres of Bruguiera were also much thicker-walled, this factor being largely responsible for the coarse sheets and the high tearing resistance. Klinki pine had a similar chemical composition to the usual northern hemisphere pulp woods. It pulped readily by the sulphate process, giving yields of about 50 per cent. The pulp produced a good grade of paper, similar to commercial long-fibred pulps, in burst and tensile, but with a much higher tearing strength. This latter property could be attributable to the length (6 mm.) and the thin walls of the klinki pine tracheids.

ITEM 19(e) - VOLATILE OIL INDUSTRY

Mr. Hammond: In view of the long experience and intimate knowledge of the volatile oil industry possessed by Mr. A. R. Penfold, Director, Museum of Applied Arts and Sciences, he was asked for a brief statement -

1. Indicating the present quantitative production and production trends of essential oils of different types in the various States.
2. On any experimental or other silvicultural development work being carried out in connection with oil bearing species.

The following information was furnished in reply:-

"1. The last few months has seen a very great change come over the essential oil industry in Australia. In all centres production has been very severely curtailed and in some cases has been suspended until next year. The main reason for this is that the export market, which takes about 70 per cent. of the oil produced in Australia, has slumped badly, and at present little or no oil is being shipped overseas. There are three reasons for this slump. Firstly, the fact that many countries have cut their imports due to the prevailing economic situation. Secondly, the figures for the last two years indicate that most countries are probably carrying a fair stock. Thirdly,

the competition for Eucalyptus oil during the boom of 1951 and the early part of 1952 forced prices to such a high level that it became uneconomical for other countries to buy our oil.

The situation will probably improve early next year when several large firms intend to begin production again, but a big improvement is not likely until May when the overseas buyers begin to place their orders, and even then the situation will depend upon the size of the overseas stocks and the price the overseas firms are willing to pay. Going on previous experience it will probably be 1954 before production will reach the figures attained in 1950-51 and 1951-52.

The exact production figures for Australian essential oils are impossible to obtain as there is no check on private distillers operating on other than Crown lands. However, we have access to certain sources of information which enables us to give a very reliable estimate of the production of the various States.

The annual production of Eucalyptus oil in the various States for the last 5 years is given below. For 1951-52 only the Australian figures are given as the export figures for the various States are not yet available. No Eucalyptus oil is produced in Tasmania, Northern Territory or Western Australia.

1947-48	New South Wales	1,016,000 lb
	Victoria	898,000 "
	South Australia	35,000 "
1948-49	New South Wales	594,000 "
	Victoria	605,000 "
	South Australia	35,000 "
1949-50	New South Wales	432,000 "
	Victoria	672,000 "
	South Australia	35,000 "
1950-51	New South Wales	848,000 "
	Victoria	805,000 "
	South Australia	60,000 "
1951-52	Australia	1,705,000 "

Queensland, up to about 1948, produced a fair amount of Eucalyptus citriodora oil, but production has now practically ceased.

It is extremely difficult to determine the relative proportions of industrial and medicinal oil produced, but it would be roughly about 60 per cent. medicinal and 40 per cent. industrial oil.

Several minor essential oils are produced in Australia, the main five being Tea Tree oil (Melaleuca alternifolia) from New South Wales, Sandalwood oil (Eucarya spicata) from Western Australia, Lavender oil from Tasmania, Leptospermum citratum oil from New South Wales and Queensland, and Backhousia citriodora oil from Queensland.

Tea Tree Oil

Production has just recommenced after a lapse of two years when the distillation areas were badly hit by floods and bushfires. No production figures are available.

Sandalwood Oil

Production probably of the order of 20,000 to 30,000 lb. per annum. Areas are now limited.

Lavender Oil

Produced by one firm and production figures are therefore confidential.

Leptospermum citratum

Now little distilled as price cannot compete with oil from the Kenya plantations established with Australian seed.

Backhousia citriodora

Small amounts only.

2. With regard to experimental work, this Museum is the only institution carrying out any intensive research on oil bearing species. We have three experimental plantations near Sydney where we are investigating such subjects as the inheritance of

oil yield and constitution in Eucalypts and allied genera, the breeding systems of the various species, the physiology of oil production, the effect of various manurial treatments, etc.

However, we are not in a position to carry out any extensive silvicultural work, as we have no control over the various forest areas where the oil trees occur. We consider also that this type of work is primarily the province of the various Forestry Commissions, and the fact that no work of this type is at present being carried out is very disturbing, particularly as the next few years can be regarded as the most critical years for the oil industry since it was established in 1852.

Although this Institution has tried repeatedly to prevent the export of the seed of our three most valuable oil species - E. australiana, E. dives type and E. dives var. C. - we now find that plantations of these three species have been commenced in several countries overseas.

This means that overseas countries will now be able to compete with our finest quality oils, and with lower production costs will be able to deprive us of our overseas markets. In fact, unless efforts are made to improve our forest management, distillation practice, etc., and by selection and breeding to produce high yielding species giving first class oils, Eucalyptus oil, once a typically Australian oil, will take its place beside wattle bark and Leptospermum citratum oil. We have the genetical work well in hand, but there is a pressing need for the various Forestry Commissions to take an active interest in the silvicultural aspects of oil yielding species.

In conclusion, I would like to emphasize again that these problems are urgent, and in order to be of any use to the industry, should be proceeded with as soon and as rapidly as possible."

Mr. Huddleston: With regard to silvicultural work, in New South Wales the Forestry Commission has arranged for the planting of high yielding species, but owing to the prevailing economic conditions we have not been able to sample these areas or carry on the work as we would have liked.

ITEM 19(f) -COLLECTION OF MATERIAL

Mr. Turnbull: This Division cannot carry out research unless experimental material continues to come forward. While we are very appreciative of deliveries received from the Forest Services so far, collection is still a difficult problem and with the trend towards a wider geographical range of sampling it is not likely to become simpler. The cost of maintaining a member of the Division's staff in the field is prohibitive and we hope for assistance from every State. When we request material from a Forest Service we try to look ahead and estimate future requirements as well as immediate requirements. The number of species and number of individual samples required for Mr. DaCosta's work on systematic durability determinations and Mr. Cooper's work on mechanical testing is very large and collection is a serious problem. Mr. DaCosta cannot start his work until he has the last of his material delivered and we would appreciate continued co-operation from the States in collection of material.

Mr. Cooper: I have reviewed our species testing projects and find that over the last 20 years we have received about 1000 trees for testing under these projects. Distribution is 350 from Victoria, 300 from Queensland, 100 each from Tasmania and New South Wales and 60 each from South Australia and Western Australia.

The number of species totalled 94 - 45 from Victoria, 26 from Queensland, 10 from New South Wales, 9 from Tasmania, 3 from Western Australia and 1 from South Australia. The new idea for species sampling is to sample by district and this has been done as a trial in Victoria. For this method of sampling it is essential to have the closest co-operation from district foresters and the question now

arises as to what area we should tackle next.

Mr. Huddleston: The collecting problem is a very real problem in New South Wales. We have difficulty in getting material for our own forest products research and have found that the only satisfactory method of collecting is to use our own officers.

Mr. Jennings: Queensland will co-operate in the same way as we have in the past.

Mr. Thomas: Mr. Turnbull can be assured of South Australia's co-operation.

Mr. Benallack: Similarly for Victoria.

Mr. Noar: It is difficult at times to get material in the time required but we will co-operate to the best of our ability.

Mr. Turnbull: I will take up the question of New South Wales collections with Mr. Huddleston outside the Conference.

ITEM 19(g) - EDUCATION IN WOOD TECHNOLOGY

Mr. Clarke: At the last Conference I was asked to take up the question of education in Forest Products with the Education authorities. I reported the position at that time and it has now progressed a little further. I have had discussions with Mr. Chinner and with the Forestry and Timber Bureau, and I understand there is under consideration the possibility of having a Forest Utilization course at the Commonwealth Forestry School at Canberra.

During my recent visit to Canada, I was impressed with the training being given at the University of British Columbia, where the final degree is a degree of Applied Science. It is a very good course indeed. There is an eager demand for the men trained there. In Quebec, there is a new surveying and forest engineering school being established at Laval University at a cost of about £2 million. It is magnificently equipped.

Mr. Huddleston: The Wood Technology course at the Sydney University has been extended and this is now a compulsory subject for training in forestry. The course is reasonably well attended and a

correspondence course is almost ready and should be available next year. As a matter of interest, many of you may remember Mr. Shambier, who was with us for very many years. He was due to retire and a collection was taken up amongst the staff for the purpose of a presentation to him. Before the presentation was made he died, and we had on hand some £20 which had been collected. Following discussions as to what should be done with the money a suggestion was made that it should be given as a prize for Wood Technology, and some of our good friends came to light and built the amount up to £100. This became the Shambier Memorial Prize for Wood Technology.

Mr. Chinner: I am afraid, Mr. Clarke, that my report is rather a negligible one. Following the proposals you put forward 2 years ago I placed the wishes of the Conference before the Standing Committee on Forestry at the Melbourne University. The members of this committee expressed themselves as being in complete agreement on the establishment of a wood technology course in conjunction with the forestry course at the University, but as the basic forestry - that is to say, the training of officers for the field side of forestry rather than the wood technology side - still lacked the necessary staff, the Committee felt that it should first see an adequate staff firmly established before seeking to provide a course in wood technology. Since then, for financial and other reasons, it has not been possible to proceed further, and there has been no further discussion on the subject of a wood technology course.

Mr. Clarke: I was interested to learn that the University of British Columbia had had a number of Chairs endowed by the industry, including one in wood technology.

ITEM 19(i)-BUILDING RESEARCH LIAISON SERVICE

Mr. Banks: When I had the privilege of addressing the Fourth Forest Products Research Conference in October, 1949, I described rather fully the objectives we had set for the work of the Building Research Liaison Service. Briefly, these are to foster within the

building industry an active interest in building research and to encourage and assist the industry to make use of the results of research.

In 1950, my assistant - Mr. W. P. Brown - told you of some of the activities we have started and of the progress then being made. I am glad to have this opportunity of giving you an up-to-date picture of our activities, and I hope also to receive from you helpful criticisms and suggestions which may enable us to do our work more effectively.

Our endeavours to develop closer working relations with architects and builders through their professional and trade organizations have not progressed as far as we would have hoped, mainly due to our failure to have full time officers appointed to act as our Liaison Service field men in the various State Capital cities. This measure has been strongly recommended by our Building Research and Development Advisory Committee, but putting it into effect must wait upon the exigencies of the financial position. I am quite satisfied that continuity of contact is essential if worthwhile progress is to be made in the field.

Nevertheless, we have been able to keep in regular contact with some of our friends in the building industry and have received their friendly support when the need has arisen.

Mr. Brown spoke to you in 1950 about the Building Research Exhibition, which was the first of its kind ever to be held in Australia and which opened at the Sydney Technical College in September, 1950. It then proceeded to Melbourne, Adelaide, Perth and Hobart, finishing up in Brisbane in July, 1951. In each State, the exhibition was opened by a Minister of the Crown and was well attended by a total of some 13,300 persons in all States. The arrangements made in each State were carried through in close collaboration with organizations in the building industry. As you are aware, the exhibition included a comprehensive exhibit on Forest Products research, and we appreciated your co-operation in making the modifications to this exhibit which were necessary to take into account the problems most important in each particular State.

It is of course difficult to assess the full effect of such an exhibition but, so far as we were able to judge, it stimulated considerable interest and must inevitably have resulted in the education of quite a number of people in the industry.

Again, because of lack of suitable staff, the amount of field development work we have been able to do has been limited. We were glad of the chance to take part in the field project on 9/16 in. flooring conducted by the Division of Forest Products at Stawell last year and intend to make good use of the interesting results obtained from that trial. There has been growing interest in the use of lightweight timber roof trusses for domestic buildings designed by the C.E.B.S. from both large and small builders and from public authorities. These trusses are being used on a project I inspected recently in Tasmania. They are fabricated in the builder's yard in Burnie and then transported to Rosebery, taken direct from the rail truck to the site and erected into position. The firm has taken out figures for comparative times which reveal appreciable savings in time on the site in the use of these trusses as compared with the normal method of cutting and erecting rafter type roof construction. It is well known that the use of the trusses makes possible a considerable saving in scantling timbers.

In the discussion which followed my remarks at the 1949 Conference, reference was made to the value of lectures as a means for arousing interest and giving information to builders and others. During recent months, we have commenced a programme of talks with slides and films to meetings of various Builders' Associations as well as to the personnel of large building organizations, including our own Department of Works, and have been impressed by the evident interest with which these have been received.

We are proposing to continue this programme of talks at about half-yearly intervals, and I believe that they will do a great deal to encourage builders to make known their problems to the research bodies and to take notice of the results of research.

As a further means of keeping the subject before builders, we have been running a series of short 'simple language' articles on building research topics in the building journals circulating in all States. Several of these have dealt with timber problems including correct stacking - practice for air-drying - prevention of decay - prevention of termite damage in brick buildings - protection against bush fires - light timber roof trusses. We would appreciate suggestions for subjects to be included in this series.

Another event of interest has been the participation of the building research bodies in the exhibition held last week in the Brisbane City Hall in conjunction with the Annual Architectural Convention. The Queensland Forest Service and the Division of Forest Products co-operated in providing the material for the Forest Products Section of the Building Research exhibit.

In my remarks to the 1949 Conference, I referred to the large number of individuals in the building industry who have to be educated in research including some 30,000 professional people, builders and contractors and, at that time, some 80,000 building operatives. I know that this latter figure had increased to more than 90,000 by June, 1952. It is clear that we are working in a very large field and that a great deal of ingenuity must be used in making the best possible use of our limited resources. We have been most encouraged by the response of technical education authorities who are using publications issued by the research bodies for text book and reference purposes in courses of architectural and building construction. For example, nearly 3,000 copies of each issue of "Notes on the Science of Building" are distributed by instructors to selected students for their own personal reference. Instances have been reported to us of apprentices joining issue with their employers on some methods of carrying out work on the basis of information given in these Notes, the upshot being that the employer has been very glad to modify his practice.

I look forward to a continuation of our present co-operation with the Forest Products research bodies.

ITEM 19(i) - HAND SAMPLES OF TIMBER

Dr. Dadswell: The Division receives many requests for hand samples from all over Australia. We have helped where we can and indicated that State Forest Services also sell sets of hand samples. Should not Education Departments in the various States obtain specimens direct from State Forestry Departments for distribution to their schools ?

Mr. Jennings: In Queensland a small stock of timber is kept at the Rocklea yards for this purpose. A charge is made, depending on the use for which it is required. There has not been a great call on this material of recent years.

Mr. Huddleston: We have a carpenter employed full time preparing standard sets of 25 hand samples. The charge is 10/- plus postage. A larger set of 50 timbers is sold for 22/6 plus postage. The samples are 6 in.x 3 in.x 1/2 in. and are labelled with the name of the timber and other details.

Mr. Noar: In Tasmania the hand sample position is unsatisfactory. We do endeavour to supply samples but have very few commercial species. The lesser species are not being cut and there is a problem in having them prepared by a local miller. The samples are generally free but in some cases a charge of 1/- per sample is made.

Mr. Irvine: In Victoria we have in the past supplied 6 in.x 3 in.x 1/2 in. samples free but we do not generally supply them to individual pupils - rather we prefer to supply them to schools.

Mr. Thomas: We supply samples free.

Mr. McAdam: We do have a limited number of hand samples and it depends on the enquiry as to whether we charge or not.

Dr. Dadswell: Should D.F.P. vacate the field completely ?

Mr. Clarke: We should cease this service except in the case of technical people who want the samples for special purposes.

ITEM 19(j) -WORK ON REVISION OF THE IDENTIFICATION OF THE GENUS EUCALYPTUS

Dr. Dadswell: The original Bulletins are out of print and over the last 3 or 4 years we have been trying to complete a revision and we hope in the near future to have the Bulletin completed. In the meantime, the macroscopic identification work is being written up for publication in the News Letter.

ITEM 19(k) - COPIES OF CONTACT CORRESPONDENCE TO STATES

Mr. Elliot: Five or 6 years ago an agreement was made with the Division of Wood Technology to send copies of correspondence from New South Wales enquirers when they contained anything of an unusual or special interest. With the Queensland Forest Service it was agreed to send copies of all answers to enquiries. I would like to know whether this is still satisfactory.

Mr. Jennings: I think it necessary that we should have only copies of correspondence covering policy matters.

Mr. Huddleston: The present system is satisfactory.

ITEM 20 - COLLABORATION AND CO-ORDINATION

Mr. Elliot: Now that Queensland have an engineer on their staff would they like us to drop out of the kiln design work in Queensland ?

Mr. Jennings: The amount of kiln design work our engineer can do is limited at the present time. We could undertake a lot of the general seasoning work but could not undertake initial designs. I shall discuss the matter with Mr. Wright outside the Conference.

Mr. Huddleston: In New South Wales we take note of requirements and supply details of handling methods, layout, etc. but refer kiln design queries to Division of Forest Products and we would like to continue in this way.

Mr. McAdam: I could not cope with kiln design work in New Guinea and must rely completely on the Division for this.

ITEM 21 - FUTU

Mr. J ferences continue
on a more or le: tter the
personal contac i those of the
Division of For: -ordination of
activities.

Mr. C: om various States,
suggested March ; Conference and
this was agreed fitted in with
the E.S.T.I.S. (

GENERAL FORM OF

Mr. C: we have tried to
cram too much i

Mr. H the next Conference
should be of 3-

Mr. E: tates were very
good but I think that this Division could have presented more of such summaries.

Mr. Jennings: This is the only criticism I have of the whole Conference - I would have liked to have known ahead what Divisional officers were going to present. I could have sufficient numbers of papers run off for the next Conference for distribution to delegates.

Mr. Huddleston: This could also be done in New South Wales. Will the summaries be published in the proceedings ?

After discussion it was decided that they should be included in the proceedings.

Dr. Ramaswamy thanked the Conference for the opportunity of being present.

Mr. Grenning moved a vote of thanks to the Chairman for his very able conduction of the Conference. He said it was the first occasion he had attended the Forest Products Research Conference but he hoped it would be an example to other Directors and Commissioners to attend.

ITEM 21 - FUTURE CONFERENCES

Mr. Jennings: I would like to have the Conferences continue on a more or less annual basis and I think that the better the personal contact of officers from Forest Services with those of the Division of Forest Products, the better will be the co-ordination of activities.

Mr. Clarke, after expressions of opinion from various States, suggested March or April, 1954 as the date of the next Conference and this was agreed to with the proviso that it should be fitted in with the E.S.T.I.S. Conference.

GENERAL FORM OF THE CONFERENCE

Mr. Clarke: I think that at this Conference we have tried to cram too much into the 2-1/2 days allotted.

Mr. Huddleston: I agree and I suggest that the next Conference should be of 3-1/2 days duration.

Mr. Elliot: The summaries prepared by the States were very good but I think that this Division could have presented more of such summaries.

Mr. Jennings: This is the only criticism I have of the whole Conference - I would have liked to have known ahead what Divisional officers were going to present. I could have sufficient numbers of papers run off for the next Conference for distribution to delegates.

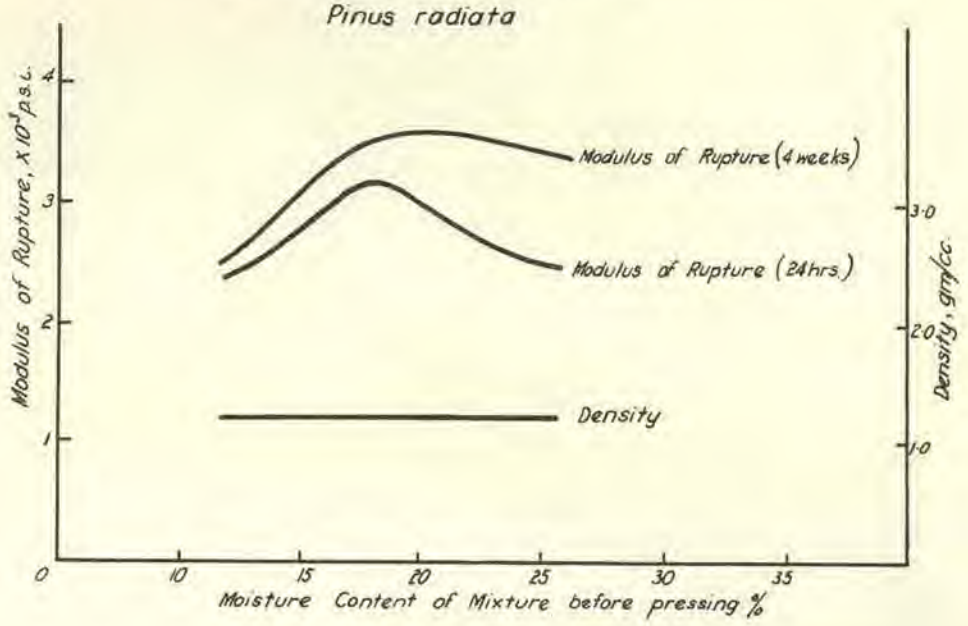
Mr. Huddleston: This could also be done in New South Wales. Will the summaries be published in the proceedings ?

After discussion it was decided that they should be included in the proceedings.

Dr. Ramaswamy thanked the Conference for the opportunity of being present.

Mr. Grenning moved a vote of thanks to the Chairman for his very able conduction of the Conference. He said it was the first occasion he had attended the Forest Products Research Conference but he hoped it would be an example to other Directors and Commissioners to attend.

Fig.1 Effect of Moisture Content of Mixture before pressing on the Properties of the Board



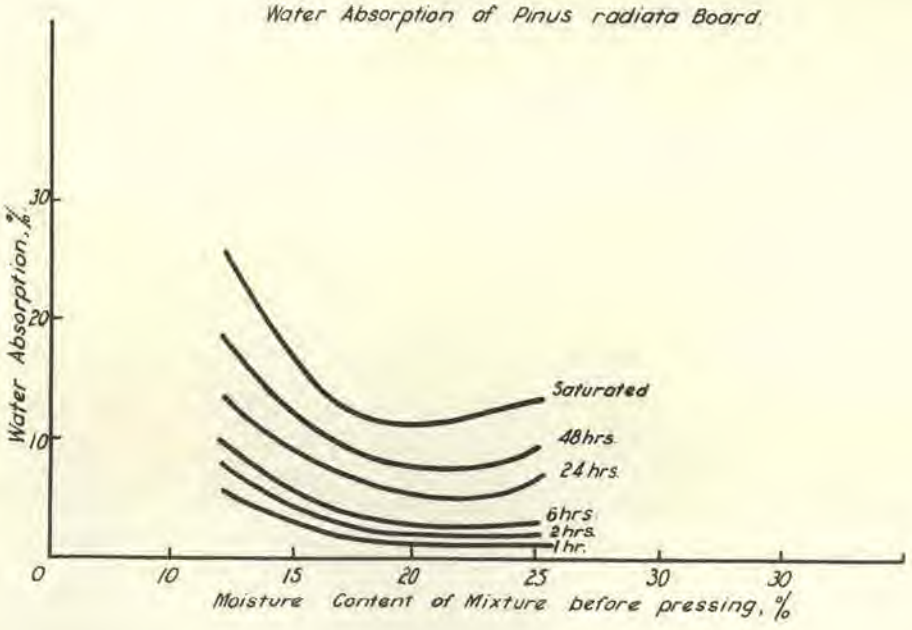
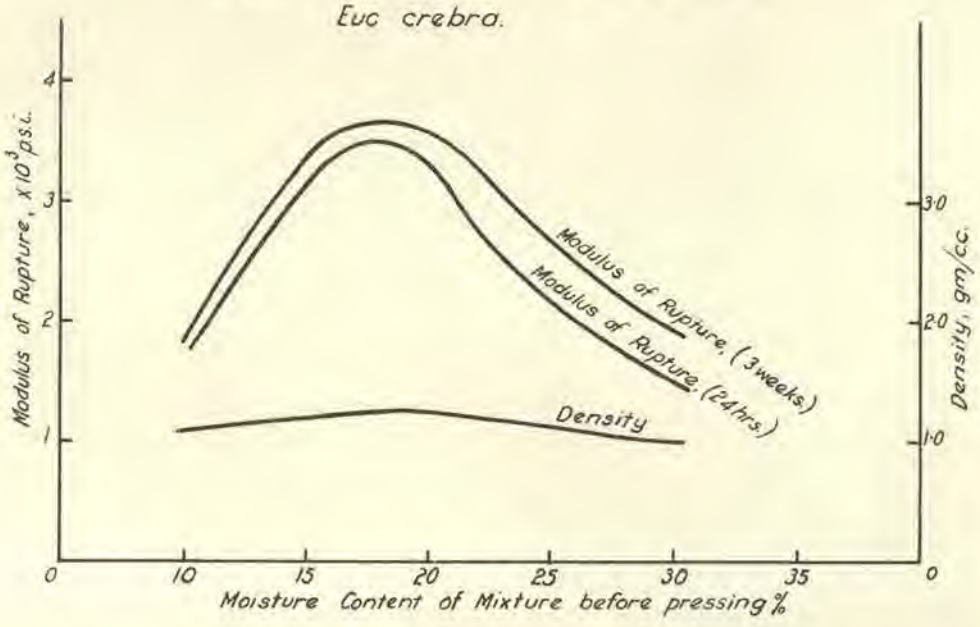
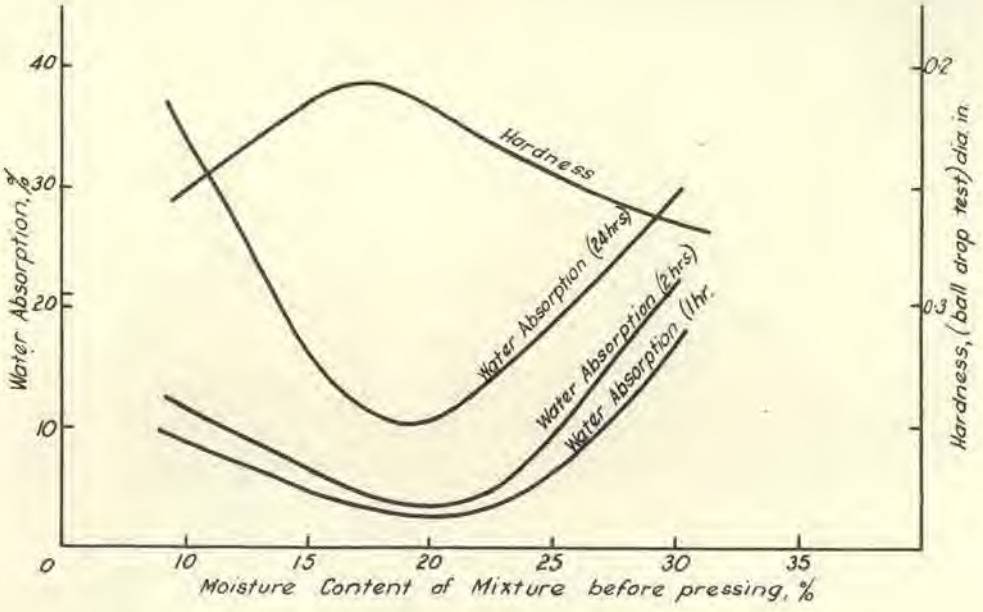
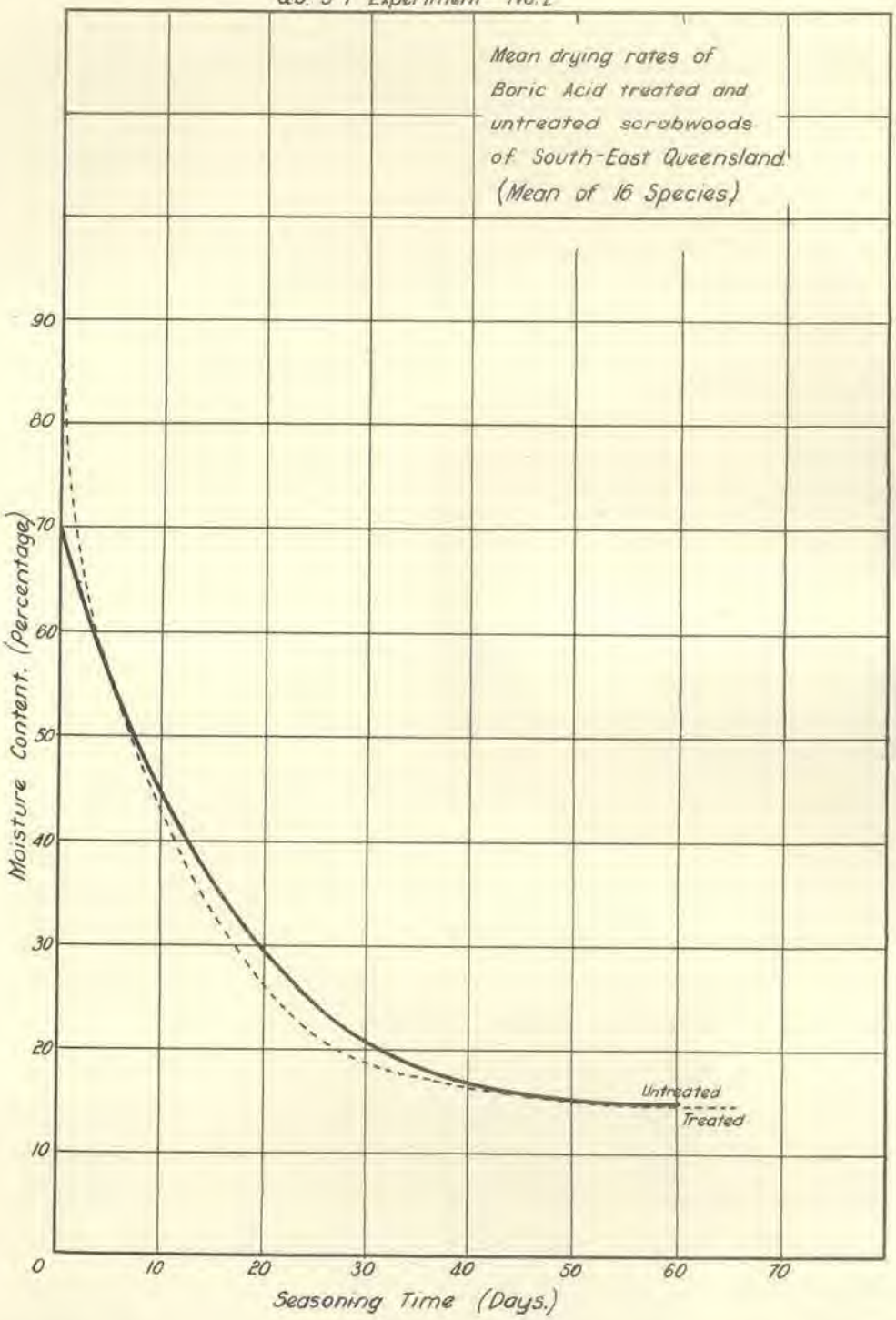


Fig. VII. Effect of Moisture Content of Mixture before pressing on the Properties of the Board

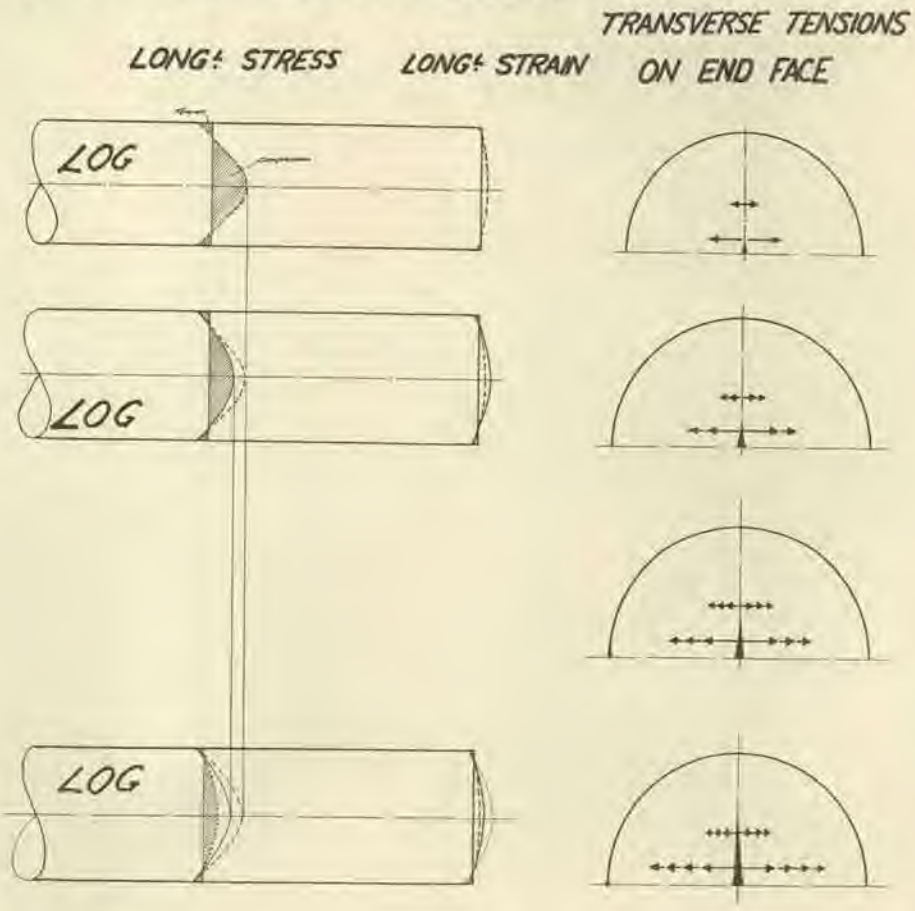




Q.S. 5-1 Experiment No. 2



END SPLITTING OF VENEER LOGS



1. INITIAL STRESS DISTRIBUTION
   ON END OF LOG AFTER ELASTIC RECOVERY

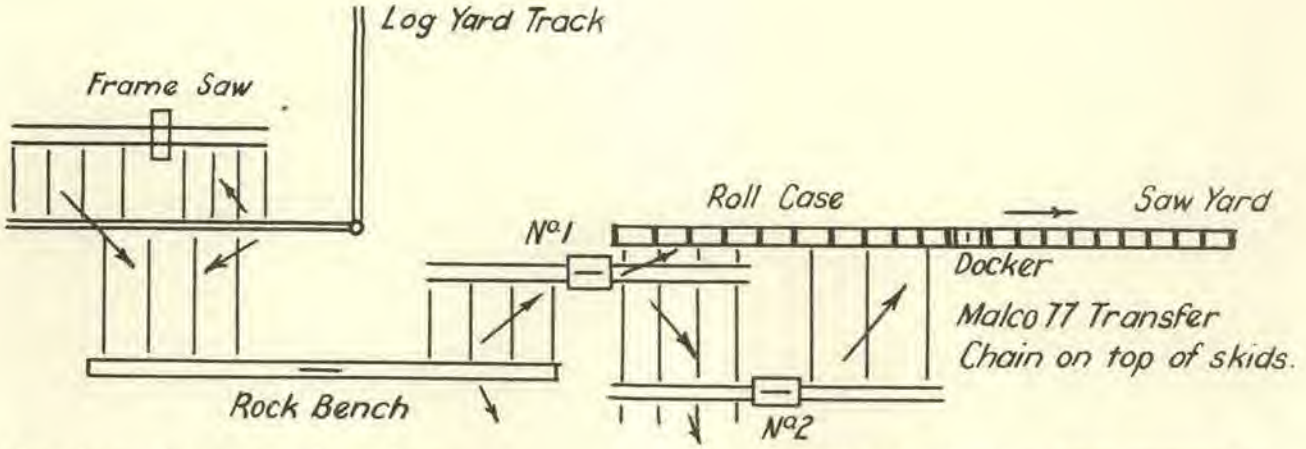
2. EFFECT OF TIME —
   ON STRESS DISTRIBUTION

3. EFFECT OF HEATING
   ON <u>TRANSVERSE STRESSES</u>
   (a) TANGENTIAL EXPANSION
   (b) RADIAL CONTRACTION
   (c) REDUCED MOD. OF ELASTICITY

4. EFFECT OF HEATING
   ON <u>LONGITUDINAL STRESSES</u>
   (a) LOSS OF RESTRAINT
   (b) REDUCED MODULUS OF ELASTICITY (LONGITUDINAL)

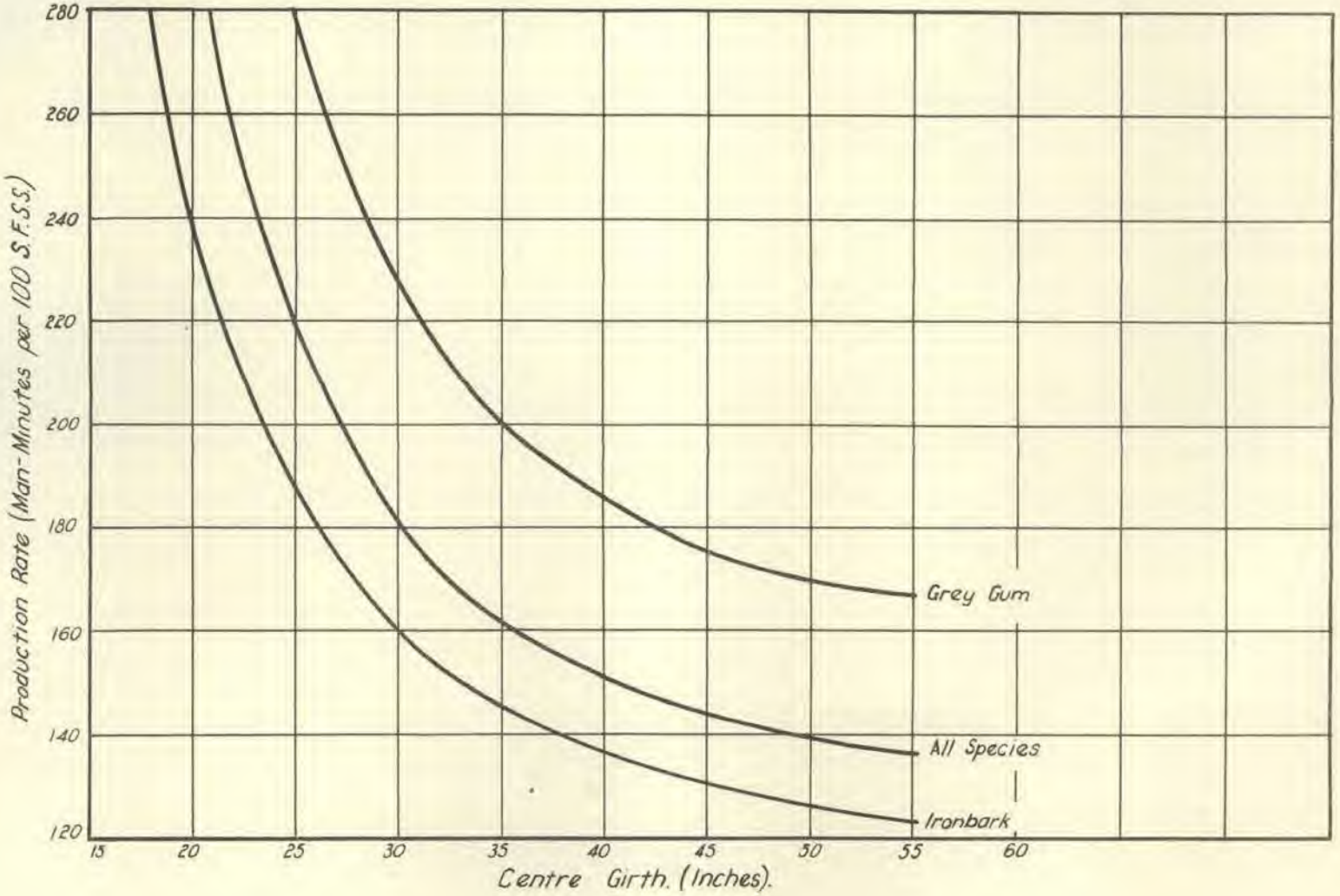
5. REDUCTION OF STRENGTH

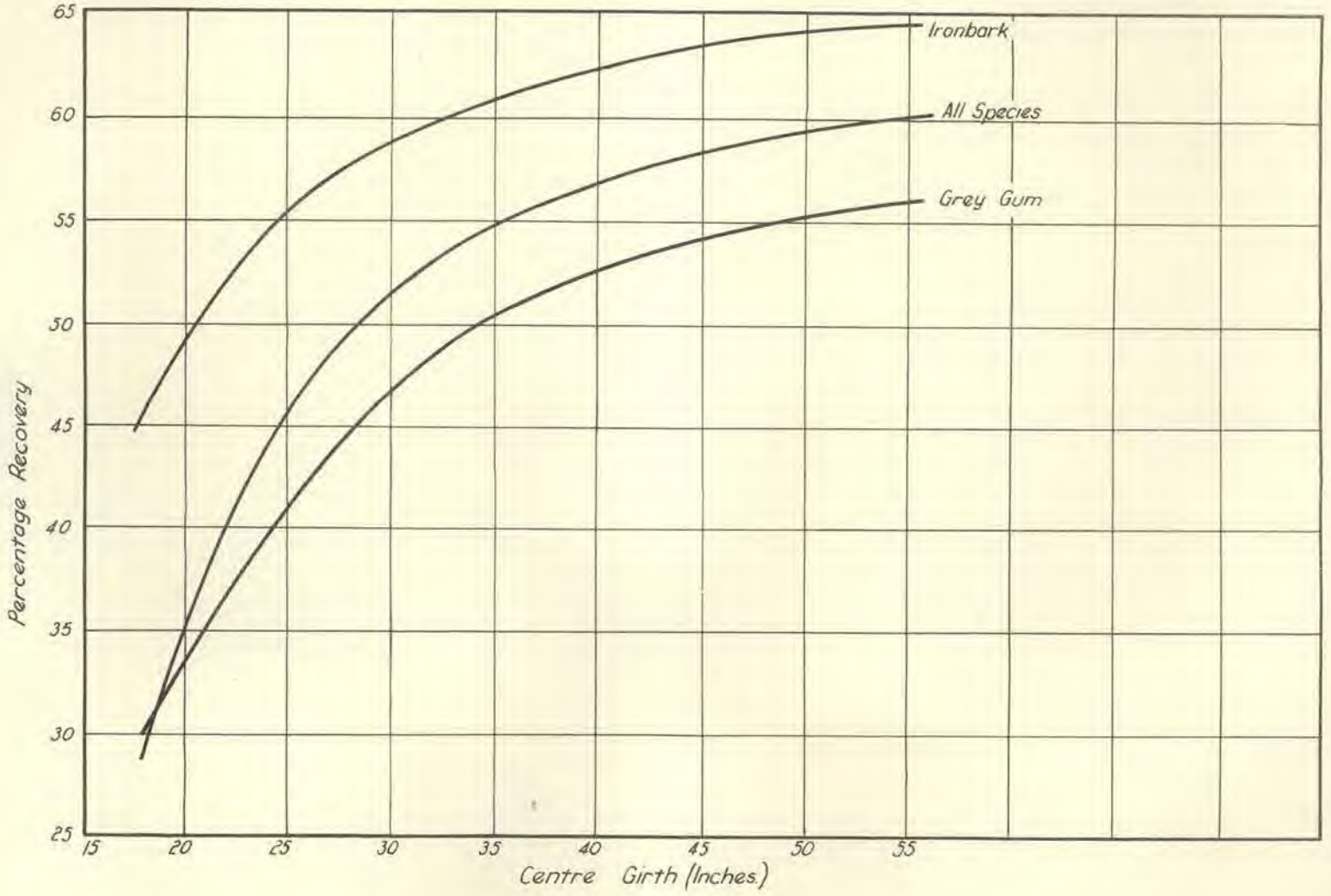
6. NO INCREASE OF DEFLECTION TO FAILURE



A further 3 breast benches and one band resaw are fed from this break down unit.

Note: 12 rolls and transfer chain driven by the one 2HP motor with Dog Clutch control by the Docker.


Production Rate (Man-Minutes per 100 S.F.S.S.)
280
260
240
220
200
180
160
140
120
15
20
25
30
35
40
45
50
55
60
Centre Girth. (Inches).
Grey Gum
All Species
Ironbark


Ironbark
All Species
Grey Gum
Percentage Recovery
65
60
55
50
45
40
35
30
25
15
20
25
30
35
40
45
50
55
Centre Girth (Inches.)