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THE DIVISION OF FOREST PRODUCTS.

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION.

MELBOURNE

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MELBOURNE

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REPRESENTATION

New Guinea: (Dept. of Forests)

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Queensland: (Dept. of Forestry) V. Grenning, Director

S. G. Jennings, Officer-in-Charge, Forest Products Research Branch

B. Adkins, Biometrician

New South Wales: (Forestry Commission) E. B. Huddleston, Chief, Division of Wood Technology

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Victoria: (Forests Commission) A. L. Benallack, Sales and Marketing Officer

C. Irvine, Research Officer

Tasmania: (Forestry Commission)

A. H. Crane, Commissioner

Western Australia: (Dept. of Forests)

B. J. Beggs, Porest Officer

South Australia: (Woods and Forests Dept.)

B. H. Bednall, Conservator (Policy Session only)

Forestry and Timber Bureau:

G. J. Rodger, Director-General (Policy Session only)

A. G. Hanson, Research Officer

C.S.I.R.O., Division of Entomology:

F. Gay, Senior Research Officer

Building Research Liaison R. E. Banks, Head (part only) Service:

C.S.I.R.O., Division of Forest Products:

S. A. Clarke and Officers

University of Melbourne:

J. H. Chinner, Senior Lecturer in Forestry

Chairman S. A. Clarke

Secretary -A. P. Wymond

OPENING OF CONFERENCE BY DR. I. CLUNIES ROSS, CHAIRMAN OF THE EXECUTIVE, C.S.I.R.O.

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

Dr. Clunies Ross: Mr. Clarke and gentlemen, it is always a pleasure to welcome representatives of the Commonwealth and State Departments to meet and discuss matters of common interest. I am very pleased also to welcome the representative of the Territory of Papua and New Guinea and Dr. Rahman from the Pakistan Forest Research Institute.

When the importance of problems in forestry and forest products is considered, the desirability of holding discussions such as these cannot be questioned. I am afraid that the general public has little appreciation of how forestry and forest products matters interpenetrate so many aspects of life in this country. When one thinks of what the interests you represent have accomplished in the last decade or two you have every reason to be proud of what has been done. We have seen a complete revolution in this time, not only of the use of hardwoods for pulp and paper but also in the effective treatment and seasoning of timber for a multiplicity of purposes. Studies in wood anatomy and physics which have led to great development of timbers for alternative and particular uses have completely changed the outlook in Australia as to timber resources and uses to which timber can be put. I like to think we are beginning to make some progress in overcoming the great wastage in the forestry and timber industries and that gradually we are getting closer to using a significant proportion of the tree rather than a relatively minor part of it. No estimation, I imagine, has been made of the consequences of research and developmental activities in which your Departments have been involved. I am satisfied that effectively Australia is saved or has additional resources worth many millions of pounds yearly. If this Conference can bring together more effectively these diverse aspects of work and lead to more effective integration of your activities I am sure it will be very well worthwhile.

I hope you will come to some specific and definite conclusions which will lead to more effective development of your activities.

In conclusion, I would welcome you again very warmly to this Conference and wish you every success in your deliberations. ITEM 2 GENERAL REPORT ON CURRENT PRESERVATION ACTIVITIES

Mr. Tamblyn: Time does not permit more than a brief review of our Preservation activities but I will try to cover the main lines of work under three topics - (a) advisory work,

(b) field tests and other practical work, and (c) laboratory programme.

(a) Advisory Work

Answering of technical enquiries continues to occupy a very considerable amount of time. Although these enquiries come from all States, they are mainly from Victoria and now vary between about 1200 - 1500 yearly, compared with about 400 per annum in the 2 years immediately before the war. While we are always glad to answer enquiries, they do cause interference to our set programme of work.

(b) Field Work

South Australia

Tests in South Australia have tried to anticipate the day when <u>F. radiata</u> will be available for use as sleepers and poles. At the inspection last year it was clearly evident that pine sleepers pressure treated with preservative oils compare favourably with untreated jarrah sleepers and that properly treated pine poles are also highly satisfactory. The South Australian Railways are at present designing a pressure treating plant and we have had three visits from their designing engineers who are enthusiastic to begin treatment.

We are now planning a new test in South Australia to determine the most satisfactory size of treated pine sleepers from the dual aspects of best mechanical performance in the track and maximum recovery from the log. With this new test the total number of sleepers and poles in test in South Australia will be almost 2000. While this work is of immediate value to South Australia it should not be forgotten that the conclusions reached will apply in the future to other States producing a surplus of exotic softwoods.

Western Australia

Over the years a number of field tests have been installed in Western Australia, including sleeper and fence post tests, protective coatings for karri wood stave pipe, and tests to determine whether heart rots in jarrah are able to continue in sawn timber in outdoor service. We have recently crecsoted 150 karri, marri and jarrah sleepers at high pressures for a new test and have also done some work on the treatability of jarrah and karri crossarms.

The fence post test is yielding valuable data on the comparative merits of different preservatives and the effect of retention and depth of penetration on service life. It has clearly demonstrated that small round eucalypt and radiata pine posts can be readily treated to give very long life comparable with split posts of the best durable species. These tests are most helpful to us in our new project to simplify and cheapen fence post treatments.

It may be of interest to other States to know that we have recently applied our momentary dip treatment method, using a variety of preservatives, to green karri veneer with the object of increasing termite and decay resistance. Resulting from this we are hoping to see treated karri plywood flooring used commercially in Western Australia.

Tasmania

Preservation problems in Tasmania are largely paralleled in Victoria and are catered for by work more conveniently done in our home State. However, in February of this year we co-operated with the Tasmanian Forests Commission and Railways in making a survey of the causes of sleeper failure over the whole of the Tasmanian rail system by sampling rather more than one sleeper per mile. The survey clearly

indicated the need for preservative treatment as decay is a major cause of failure and sleepers are giving an average life of only 10 years or less. We believe that a high pressure treatment plant will be favourably considered. We have already high pressure treated about 50 sleepers for a small scale test and found no difficulty in obtaining good penetration in Tasmanian eucalypts.

Victoria

For convenience we have more tests here than in other States but most of them are of much more than local significance. Our pole tests have formed the basis for recommendations to the State Electricity Commission and the P.M.G.'s Department for full scale preservation of less durable Victorian pole timbers. The arguments for treatment are overwhelming and we have had the pleasure of assisting the S.E.C. and a private company on the design of two pole treating plants, which are now at an advanced stage on the drawing board. The P.M.G. pole investigating committee took very full evidence on our pole tests and we understand unofficially will recommend at least two additional plants.

Last year we completed the high pressure treatment of over 2000 eucalypt sleepers for the Victorian Railways and will shortly be treating about 500 radiata sleepers for comparative test. Victorian Railways have designed a 2 cylinder high pressure plant with an annual throughput of 400,000 sleepers and we are hopeful of action here fairly soon.

New South Wales

Our tests in New South Wales are of treated poles at three sites and fence posts at one site. There are also some tests of small specimens treated with various preservatives at Camberra which are locked after for us by the Division of Entomology. All these tests have their counterpart in Victoria and serve to extend the geographic significance of the results. In particular the pole tests are valuable as their periodic inspection provides an opportunity for

preservation officers of this Division to meet their opposite numbers in the Division of Wood Technology and also some twenty or more N.S.W. pole engineers who regularly attend the inspections.

Queensland

Our only test in Queensland is a small one of bandage; treated poles in the north. We are conscious of the need for more tests, particularly in areas where <u>Mastotermes</u>, the giant northern termite, is present. We are now planning a large test involving some 7000 stakes treated with a great variety of preservatives and hope to have one site in Queensland and also one in New Guinea.

New Guinea

At present we have no tests in New Guinea but hope to remedy this soon with the treated stake tests already mentioned. In tropical areas we lack information mainly on the relative performance of various preservatives and believe that preservative screening tests should precede service tests of treated timber.

It may be of interest to mention that we have a small test of treated and untreated New Guinea mangrove sleepers installed in the track between Flinders Street and Richmond Stations. To date they are performing quite well.

Surveys

Before reviewing laboratory work, I would like to mention two surveys we have completed on an Australia-wide basis. - A survey of the causes of failure of crossarms and a survey of fencing practices and problems. The crossarm survey showed that decay, mechanical breakdown and termites were the main causes of failure but it also showed that in most cases an untreated crossarm lasts as long as an untreated pole. Until pole life can be increased there would be little economic advantage in treating crossarms. The fence post survey, which will be discussed later by Mr. Wymond, was a Gallup pole by post and exceeded our expectations both in the enthusiastic co-operation of farmers in all States and in the amount of information obtained.

(c) Laboratory Work

Since the last Conference we have spent much time in the study of water borne preservatives - particularly their fixation mechanisms, leaching characteristics and the toxicity of the residual compounds in the wood. This work is giving us basic information in a field in which there is little published data and seems certain to prove a most valuable project.

On the mycological side we are now making good progress in assessing the relative resistance to decay of Australian timbers. When fully developed this work aims at correlating such factors as growth rate, site quality, position in the log, density of the wood, etc. with durability. It will also include a study of fungicidal compounds in the wood which presumably confer natural durability.

During the last 12 months we have done intensive work on the taxonomy of Australian basidiomycete fungi and in this have been fortunate in having the services of Mr. Neville Walters who returned early last year from taxonomic studies at the Kew Herbarium. We have organized some 200 collectors throughout Australia and have received literally thousands of specimens from them. This work must unfortunately cease very soon when Mr. Walters returns to the Division of Plant Industry.

Other current mycological work includes comparative testing of preservatives, fungal physiology, and an attempt to develop a technique for producing fruitifications of basidiomycete fungi in culture. We are also preparing a card sorting key for identification of basiciomycete cultures.

Current entomological work includes a project to determine the threshold toxicity to <u>Lyctus</u> of various preservatives including the Boliden salt for which approval has been sought in Queensland. We are also testing a number of Queensland timbers for susceptibility to <u>Lyctus</u> and are continuing work in co-operation with the New Zealand D.S.I.R. on the susceptibility of <u>P. radiata</u> to Anobium. There is no

doubt that radiata is susceptible but the degree of susceptibility has yet to be shown.

Despite the comparative success of high pressure treatment we are still very interested in the problem of penetrating the refractory heartwood of sucallypt timbers. We believe that debris from the vessel walls carried by the advancing meniscus is partly responsible for unsatisfactory penetration and propose testing sharply fluctuating - or impact pressures - as a means of improving our present treatment.

Time does not permit review of all projects but on conclusion mention should be made of work to develop the cheapest and simplest methods for treating round fence posts. We have tested four methods - long scaking, scaking under a small pressure head, open tank treatment and vacuum treatment. All methods have given reasonably good results and we are now preparing a bulletin for distribution to farmers. The draft of this bulletin has been completed and it should be issued sometime later in the year.

Mr. Booth: Mr. Tamblyn mentioned green dip preservation of karri veneer in Western Australia. I would like to ask what preservatives were used and what penetration was achieved in the heartwood?

Mr. Tamblyn: Six preservatives were used :- sodium pentaborate, zinc chloride plus arsenic, "Celcure", greensalt, copper borate and chromated zinc chloride. We chose a range of preservatives, including the non-arsenicals such as sodium pentaborate, "Celcure" etc. and hoped that a non-arsenical preservative would be satisfactory because the use of arsenic in flooring might become controversial. The treatment technique was to momentarily dip and then block pile the wet veneer for 2 hr. before drying. This gave time for diffusion to occur. Penetration into the heartwood was quite satisfactory.

Mr. Booth: There is a move amongst New South Wales
manufacturers to endeavour to market a preservative treated plywood.
They thought of preserving veneers in that way before gluing. If they

used a preservative which does not affect bonding of veneer, the process would be satisfactory.

Mr. Huddleston: There are several matters concerning this item which I would like to raise. First of all, I propose to suggest that the Division of Forest Froducts might add to its fundamental work the question of fixing water borne preservatives in timber by the use of ammonia. The present method is to use dichromates, which are not particularly effective as fixatives, as there is quite a high degree of leaching. If ammonia is used it may be more effective than dichromates. The question of sleepers was raised; New Zealand, by good salesmanship, sold the New South Wales Government Railways P. radiata sleepers ranging in size from 4 in. to 6 in. x 9 in. wide. These sleepers have been pressure treated at the Futney plant and are being installed in various sections of the line in N.S.W. If your Division is carrying out investigations in South Australia, you may be able to use these 15 or 16 thousand sleepers to obtain further data. We could probably arrange to supervise the collection of data for them if a Working Plan is prepared.

Another point mentioned was a life of 10 years or less for sleepers in Tasmania and Victoria. I take it that they were mainly eucalypts of lesser durability. It is of interest to note that in about 1945-46 the New South Wales Railways relaxed specifications and took brush box, stringybarks, and blue gum as acceptable species for sleepers. The first failures of those sleepers are now occurring, and they are pulling out brush box and stringybark sleepers which have failed from decay. These sleepers are failing in the track after 8 or 9 years, which ties in quite well with Tasmanian and Victorian experience.

Mr. Tamblyn also mentioned a Bulletin. One Agenda item we will be discussing deals with work on fence posts treated with water soluble preservatives. Some mention of this should be made in the Bulletin.

Mr. Tamblyn: At the moment we are not attempting to criginate a new preservative, though this may be an indirect result of the work. We are testing preservatives which are already accepted and we have noted that chromating is not always a good fixation method. Chromated zinc chloride is no better fixed in wood than straight zinc chloride. However, Boliden salts and zinc and copper chrome arsenates are highly fixed and very effective. What function chromium has there other than anti-corresive properties is not yet known. Chromium, if it remains in wood, is fungicidal and it may be that combined in metallic arsenates it increases toxicity and improves fixation. We will note your remarks on creosoted P. radiata and see what information can be obtained from the N.S.W. sleepers. With reference to the sleeper survey in Tasmania, the main cause of failure in Tasmania was decay, also a condition at the rail seat which we called "metalliferous decay" because it gave the impression that iron dissolving from the rail plate or rail had accelerated deterioration at this point. Tasmania uses practically all soil ballast. Untreated sleepers there are failing from decay in perhaps 7 - 10 years due partly to a much more hazardous decay condition occasioned by soil ballast and partly to the nondurable timbers used.

Mr. Gay: Do you intend carrying cut tests of the fungicidal agents present in the more durable timbers? If so, we would be interested in testing them against termites. We are in a position to carry out tests as we have a suitable carrying material in which to impregnate these materials. This is balsa, which has a low density and is susceptible to both Coptotermes and Nasutitermes.

ITEM 3 (a) (i) RESULTS OF D.F.P. FENCING SURVEY

Mr. Wymond: In connection with the development of practical methods of fence post preservation it was found necessary to obtain information on fencing practice throughout Australia, and the particular problems which exist in different States. Information on such items as the type of post preferred and the reasons, species used,

cost, life of posts, causes of failure and whether farmers generally were interested in preservative treatment were all required to obtain a clear indication as to the treatment methods desirable and the economics of fence post treatment.

To obtain this information the Preservation Section suggested that a survey of fencing practice be carried out and with the co-operation of the State Departments of Agriculture a questionnaire was sent to 695 farmers in all States. Of these, 428, representing 61.6 per cent., were returned. This was a particularly gratifying result and far above our expectations.

The details of the survey and analysis of returns from each State are given in the project report and it will only be necessary here to indicate the main features.

The reasons for preference and non-preference of the three main types of posts, wood, steel and concrete are extremely interesting.

Wooden posts were favoured by approximately two-thirds of the total number of farmers contacted, the main reasons being that the posts were cheap, available locally, or available on their property.

Steel and concrete were favoured by a far smaller percentage, the main reasons for perference being that they were rot, fire and termite resistant. However the reasons for non-preference for these two types of posts are worth recording. In the case of steel posts it was claimed that besides being susceptible to rust, they bend easily, especially with cattle. Galvanized wire corrodes, due no doubt to electrolysis and they push over easily in soft ground. In addition, they are expensive compared with wooden posts.

Reasons for non-preference of concrete posts were as follows:They break at ground level with cattle. The reinforcing rusts,
causing disruption of the post. Wires wear badly. Very heavy to handle,
very expensive and many of poor quality are on the market.

The average life computed from the returns for wooden fence posts in each State varied from 17.5 years in Tasmania to 33.9 years

in Queensland. These figures are presented as an indication only, as many of the figures given in the returns were obviously guesses.

According to the returns in this survey the principle cause of failure of fence posts in Australia is rot. The low percentages claiming termites as the prime cause of failure is an indication that the average farmer is well aware of which species are resistant to termite attack and he uses those species as far as possible.

The average cost per 100 of wooden posts varied from £8 in Western Australia to £32 in South Australia, the lowest price being £4 in Western Australia for posts sawn from sawmill edgings and the highest price was £50 in South Australia for red gum posts which were carried some considerable distance.

The most interesting factor in the survey insofar as preservation activities were concerned was the indication by approximately two-thirds of the farmers contacted that they were interested in using preservative treated fence posts. The majority of these indicated that they were prepared either to treat fence posts themselves or to purchase treated fence posts.

We feel that the survey as a whole will provide valuable information in connection with the preservation of fence posts, although it must be remembered that many of the answers give an indication of feelings orly and do not necessarily indicate exactly the state of affairs.

Mr. Booth: Was any attempt made during the survey to ascertain what proportion of posts used in farming is purchased by the farmer? Most farmers I think - even with quite large holdings - fence their properties from timber obtained on their property or from their neighbours. In New South Wales we would have the possibility of supplying durable fence posts from iron-bark areas such as the Fillaga to others where there is a deficiency of durable timbers. If one could encourage farmers to buy fence posts it would be quite significant for us, but I think that, while we cannot persuade farmers to buy fence posts, treatment is very desirable.

Mr. Wymond: I had the impression from the returns that the average farmer considered the price for durable species was about twice the amount he was prepared to pay. Many commented that fence posts were too expensive and that was noticeable in cases where we were surprised that durable species were not being used, and it was obvious that they were using local timbers at a little over half the price. Nevertheless I am quite sure that the majority of farmers are purchasing their posts from some cutside source.

Mr. Dale: Freight costs are so high as to make cartage of posts long distances uneconomic. It costs about £6 per 100 to take posts 50 or 60 miles in the southern States.

ITEM 3 (a) (ii) A SIMPLE METHOD FOR THE PRESERVATION OF FENCE POSTS

During past conferences, repeated mention has been made of the fact that whilst many users of fence posts, e.g. farmers, public utilities, etc., are fully seized with the advantages to be derived from the preservation of fence posts, and whilst very satisfactory methods of preservation have been developed, there has been general reluctance to adopt these methods. Thus, whilst we issue various recommendations on fence post preservation to a large number of bons fide enquirers it is only rarely that these recommendations are implemented. The basic reason for this is that the methods now recommended are too cumbersome to appeal to farmers particularly due to the high cost of labour involved.

The standard current recommendation is for a hot and cold bath treatment with creosote which means that the posts must be debarked, seasoned and then treated in a preservative which is unpleasant to handle and expensive to transport to country areas. It seems evident, therefore, if large scale treatment of fence posts is to be carried out, that some simplification of treatment technique is essential.

With this object in view, we have commenced an investigation

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

into a "sap-displacement" method of treatment for round posts, and whilst our work is still in its early stages, the results obtained to date seem to justify discussion at this Conference.

The following is a brief outline of our work. We have treated small samples of A. lanceolata and E. maculata in a 10 per cent. solution of copperized chromated zinc chloride, the only samples of fence post size being those of E. maculata. In our tests the material was used as soon as possible after felling and the treatment consisted of removing the bark and placing the post upright in a container holding sufficient 10 per cent. copperized chromated zinc chloride solution to give the desired salt retention in the timber. In all tests we aimed at a retention of 1 lb. salt/cu.ft. of sapwood and in samples of fence post size this was achieved in periods varying from 1 - 3 days.

We found that the best results were obtained on material which had all the bark removed. In other words, if the posts were placed in the solution with the bark intact or only partly removed, less satisfactory absorption resulted. Another variable which affects the treatment is the weather. Fence posts were treated within one day, during periods of fine weather, when good drying conditions obtained, whilst three days were required for material of similar size during a period of very high humidity and intermittent rain.

In this treatment, the solution uptake is confined to the sapwood. Originally, we feared that patchy treatment would result from this method, and for this reason commenced this investigation with rather dilute treatment solution and longer treatment periods. However, we have found a very satisfactory even and complete penetration of the sapwood in the few samples we have analysed so far, and expect a slight concentration gradient from bottom to top of the posts, when all our results are assembled. Some slight chromatographic separation of the three salts does occur during treatment but subsequent diffusion during seasoning seems to eliminate this possible difficulty.

A method of treatment such as the one described would be of great value in that a great deal of the labour and inconvenience attached to the standard method would be avoided. Obviously a great deal of work is necessary before we can say anything other than that certain timbers can take up substantial quantities of a salt preservative in a very brief period. We do know, however, that copperized chromated zinc chloride is one of a number of efficient preservatives which are very resistant to leaching. We have been able to locate only one reference in the literature on this method of treating fence posts. It appears that this method has been used for some years in Canada to treat fence posts with copper sulphate.

* "The Preservative Treatment of Fence Posts by Non-pressure Processes", Canada, Dept. of Resources and Development, Forestry Branch, Bull. No. 107, p.12.

Discussion:

Mr. Huddleston: We find a lively interest in N.S.W. directed towards preserving fence posts, but we have found a general reluctance on the part of farmers to handle creosote. There are three reasons for this - creosote is greasy, there is a fire risk in heating it and the cost of transport is quite high for long distances. If we use a salt, freight rates would be considerably lower for preservative to treat the same volume of timber. We are rather keen to develop water soluble preservatives for use by farmers, and feel that this method, which has been used in Canada, is the method which we should be advocating in N.S.W.

Mr. Clarke: You mention that Canada have had success with water soluble salts. It is advisable to remember that climatic conditions are very different in Canada and Australia. For a fair percentage of the time in Canada leaching conditions would not be nearly as serious as under Australian conditions.

Mr. Huddleston: That is one reason why I suggest you might look into the question of using ammonia as a fixative.

Mr. Tamblyn: I do not dislike water borne preservatives for fence posts and base my conclusion on the fact that the Western Australian tests, after 21 years, show favourable results with a zinc chloride-arsenic mixture. The mixture presumably precipitates zinc arsenate because it is proving to be as good as creosote in some areas. However, I would be much less certain of copperized chromated zinc chloride because our leaching tests here do not show it to have a high degree of fixation. The method of sap displacement is, I think, the same one that Madison Forest Products Laboratory were investigating in 1950. They produced quite a lot of data showing that the period of treatment varied from about 2 days to 6 weeks with a number of American species - including hardwoods and softwoods - which were not barked. Such factors as time of cutting the post, weather conditions at time of treatment and whether the post had been out 24 hr. or 3 weeks etc. affected the treatment period. In all cases the ends were docked to expose a new surface before dipping in preservative. Each post was treated separately to be sure that enough preservative was absorbed. When about half the preservative was gone the post was turned upside down. They felt that re-use of solution would not be advisable because it was a diffusion process as well as a soaking up process. We tried this method here in a small way on unbarked posts and obtained poor results. Over a period of about 3 weeks there was very little absorption. If the posts were barked, and if weather conditions were favourable, the results might be different.

Mr. Dale: With regard to the barking problem in this method, we did a test with the bark on because we hoped it would offer additional advantages. Apparently removing the bark does give a better result. We got no appreciable absorption of 5 per cent. zinc chloride at all. The other objection is the problem of keeping green any quantity of posts that were cut ready for treatment. Presumably they would have to be stacked with the bark on, and end sealed, unless only a few posts for the one treatment were cut at the one time. Most

farmers would not like that. Removal of bark is one of the biggest costs, and hence is probably one of the biggest objections to treatment of round fence posts. Depending on the time of the year, some species are harder to bark. We are looking into the question of mechanical barking.

Mr. Chinner: The bark is extremely difficult to remove after a long dry period. A.P.M. have no difficulty in winter or in carly summer, or throughout summer if it is wet.

Mr. Booth: There is one point that I did not bring out. The disadvantage as far as farmers are concerned with creosote is that they have to partially season posts and that is raised as an objection because many farmers handle their posts green. In some cases it is normal to bark posts and there is no particular problem in W.S.W. in barking fresh eucalypt posts, spotted gum especially. We see our treatment as suited to small farmers where replacement of fences is desired. It is an excellent means of utilizing fast grown sucalypt trees which are absolutely useless for fences in the ordinary way. With regard to subsequent shrinkage causing checks, and exposing untreated wood, final seasoning causes most checks, that is the drop in moisture content from fibre saturation to air dry. Partially dry material probably also suffers to the same extent as green material. Complete penetration of sapwood occurs in this process, and thus, assuming checking right through sapwood you only expose slightly more durable heartwood and this is no serious decay problem.

Mr. Huddleston: We had to provide a treatment for mine props, and took the attitude that with timbers which really required treatment you could get at least 3 in. of treated material around a prop about 8 in. diameter and if you lost the heart from it it would not be of great detriment to the strength of the prop. The average prop of 4 - 6 in. diameter would still have sufficient timber left to give the greater part of the strength. With fence posts, most species to which you apply treatment would have sufficient sapwood even if you lost the whole of the untreated heartwood. We have to date only tried spotted gum.

ITEM 3 (a) (iii)

FENCE POST PRESERVATION

Review of Work at Division of Forest Products

Since the last Forest Products Conference the demand for information on fence post treatment has been steadily increasing and with it the feeling that the information given is inadequate and is very often disregarded. This situation can and must be remedied and the Division has been working on the problem in three ways, namely:-

- (1) The development of new methods of treatment
- (2) The simplification and improvement of old methods
- (3) The presentation of selected methods in a new Trade Circular or Bulletin of Fence Post Preservation.

It was considered essential to develop new methods, as well as improving the old, so that a number of alternative treatments could be presented in the Bulletin, at least one of which would be applicable to any post treatment problem that might arise. The treatments chosen and their characteristics are discussed later.

To ensure that this work be successful our knowledge of fencing practice had to be brought up to date. This was done by distributing over 60C questionnaires throughout Australia to farmers, graziers and others. The detailed results of this survey are discussed in another paper to this Conference. The most important single result, as far as this work is concerned, is that the majority of those questioned are interested in treating posts or buying treated posts.

Our work has been confined to the treatment of round timber, not only because it can be simply treated, but because it appears to be the logical fence post material, whether it comes from one's own property or from forest or plantation thinnings. Tan bark stripping produces a large amount of round material already barked, ideal for treatment as posts. The drop in demand for pulpwood also means that there are plenty of pine thinnings available, which are easier to treat than the eucalypts and make very attractive posts.

The work in hand will be reviewed under these headings:-

- (1) Choice of methods
- (2) Test material
- (3) Testing
- (4) Comparison of methods
- (5) Development of equipment
- (6) Presentation of Bulletin

(1) Choice of methods

After considerable exploratory work, the following methods have been tentatively chosen for inclusion in the Bulletin -

Hot and Cold Bath
Prolonged Cold Soaking
Soaking under Low Pressure
Vacuum Treatment

The hot and cold bath is well known as a thoroughly reliable treatment, which must be included in any work on post treatment.

Prolonged cold scaking is the method most likely to be used because of its simplicity and low cost.

Soaking under low pressure is a means of accelerating the scaking process, without much complication.

Vacuum treatment uses vacuum instead of heat to remove air from the sapwood and can give adequate clean treatments in a short time, but it requires a moderate expenditure on plant and careful supervision.

(2) Test material

The preliminary work for this project was done on small round sections of <u>E. obliqua</u>, <u>E. regnans</u>, <u>E. sideroxylon</u> and <u>Pinus radiata</u>. Some repetition of the tests was needed because some of the early material was atypical, for instance, mountain ash and messmate thinnings were found to have sapwood only in. - in thickness, while some <u>P. radiata</u>, cut in July, would not absorb much preservative even when treated by the hot and cold bath process.

So that the treatment of full sized posts could be checked against the laboratory tests, 200 posts of each of the above species, except the ironbark, 6 ft. long x 3 in. to 6 in. diameter, have been

obtained from the Victorian Forests Commission, and stacked for air drying.

In order that the treatments recommended should be applicable in all States, the State Forest Departments have been asked to supply us with 6 pieces, each from a different tree, of 5 or more species most likely to be used as treated round posts in their State. The species supplied are as follows:-

Western Australia - Jarrah, marri, brown mallet, gimlet, merrit

South Australia - Brown stringybark, sugar gum, mallee

Victoria - Sugar gum, red gum, mallee

New South Wales - Spotted gum, blackbutt, Sydney blue gum

Queensland - Spotted gum, rose gum, carbeen

The timbers from Viotoria are extra to the timbers already supplied and represent those more likely to be available in the drier north-western part of the State. Tasmania was not asked for material as their timbers are similar to the Victorian ones under test.

Preservative

Crecsote to S.A.A. Standard K.55 has been used in all this work, as it is the cheapest oily preservative available and can be thinned with small amounts of light tar oil without loss of efficiency.

Provided the creosote does not have to be heated, clean treatments can be obtained without difficulty.

5% pentachlorphenol in light til behaves similarly to creosote and there should not be any reason why the results obtained cannot be applied to this preservative.

(3) Testing

Laboratory tests were made on 2 ft. sections of the main Victorian species, 3 in. to 6 in. in diameter, having one end lacquered to reduce penetration, with the results shown in Table 1 below.

TABLE 1

Mean Absorptions of Crecsote in lb./cu.ft.

Treat	ment	Hot & Cold Bath	Cold Soak	Low Pressure Soak	Vacuum
		2½hr. heating to 120°C. Cool overnight	7 days at room temp.	24 hr. at 7½ p.s.i.	25" vacuum for 1 hr. Soak 1 hr.
Species	No. of trees				
E.obliqua sapwood	6	8.5	10.9	8.6	10.2
E. regnans sapwood	4	13.5	14.4	9.9	12.1
P•radiata ** Fotal Volume	6	21	8.2	9.9	16.2
lon sapwood	5	9.6	7.1	8.5	7.8

& Calculated on total, not sapwood volume

If the hot and cold bath is accepted as a criterion, then the other 3 treatments are satisfactory. It is realized that these results are not necessarily applicable to 6 ft. posts, and the full length treatments of these species are being done now to confirm them and to test our field equipment.

The treatment schedules shown in Table 1 are not necessarily the ones to be recommended in the Bulletin. In particular some variations of the hot and cold bath may be included, such as the one in which the posts are boiled in 5% zinc chloride and then cooled in creosote, giving good combined absorptions of the preservatives. Also the vacuum treatment is capable of considerable variation by varying the vacuum and soak times.

(4) Comparison of methods

The relative merits of the methods chosen can best be compared in tabular form as in Table 2.

TABLE 2

Comparison of Treatment Methods

Treatment	Advantages	Disadvantages
Hot and cold bath	(1) Long service records (2) Simple equipment (3) Cheap (4) Very reliable (5) Sterilizing (6) Capable of variation	(1) Fire danger (2) Difficult to control temperature (3) Dirty (4) Easy to overtreat
Prolonged cold soak	(1) Very simple (2) Cheap (3) Safe (4) Easy to control (5) Clean	(1) Posts must be really dry (2) Small output in posts/day
Pressure soak	(1) Simple (2) Good output - about same as H.aC. bath (3) Clean	(1) Special tank needed (2) Posts must be really dry
Vacuum	(1) Fast, high output (2) Clean (3) Minimum labour requirement	(1) Special equipment needed (2) Posts must be really dry (3) Good supervision needed

The inclusion of vacuum treatment in the Bulletin may be criticized, but the speed and ease of treatment obtainable more than compensates for the cost of equipment and there should be a definite place for it in small commercial operations, such as the treatment of thinnings for sale, or as portable plant to be hired for short periods.

Pinus radiata must be considered separately from the eucalypts in assessing these treatments. It usually absorbs far too much by the hot and cold bath treatment and our best results have been achieved by long cold scaking, which gives very uniform penetration and ease of control.

(5) Development of Equipment

Perhaps the most difficult part of small scale post

treatment is the collection and setting up of the necessary equipment. We have tried to devise simple equipment for each treatment. preferably adaptable for several treatments. The practicability of each method has been tested in the field using portable plant, largely made up from 44 gallon drums. The hot and cold bath is an open drum, heated by a gravity fed kerosene burner to avoid some of the danger of heating cily preservatives over an open fire. A universal tank, made of 2 new 14 gauge drums welded end to end, with a sealing lid, was made for the other treatments. It is mounted on trunnions so that it can be loaded horizontally and swung upright for differential treatments. Vacuum is obtained from a water cooled pump driven by a petrol engine, which can be used as a blower for emptying the tank. Static pressure is obtained from an elevated tank connected by a hose to the treating tank. A l in. semi-rotary hand pump, on its own light stand, has proved much better for transferring preservative than the usual drum pump.

A 40 gallon drum will only hold 10 posts 5 in. in diameter. As an alternative for those who can afford something better, we have designed a simple universal tank, 6 ft. long x 3 ft. in diameter, with a sealing lid, to stand low pressure and vacuum. This will hold 50 posts and will be portable by truck or trailer. A prototype of this tank will be made for the Division for demonstration and loan purposes, and it is hoped to interest an agricultural machinery manufacturer in making them for sale.

(6) Presentation of the Bulletin

It is hoped to publish the fence post preservation Bulletin shortly, on the lines of our latest Trade Circular. Every effort will be made to present the maximum of information in as compact a form and in as few words as possible. Bold outline drawings will illustrate each treatment, preferably on the page opposite the description. Alternative methods, e.g. for heating the hot and cold bath, will be stressed, so that no intending post treater will feel that he has not at least one method particularly suited to his needs.

Figures from our Western Australian post test in particular will be used to present a strong case for the treatment of round posts in the opening pages.

Discussion:

Mr. Booth: I notice that the proposed new treatments require that the post must be really dry. I think from the farmer's point of view there are objections to this, as he has to plan ahead and he has to know that the post is really dry, which means air dry. How do you propose to cover the latter point?

Mr. Dale: We cannot specify moisture contents. All we can do is to say the posts must have been cut at least 3 months in summer and 6 months in winter. It is quite a difficult problem as no farmer has a moisture meter nor is he going to weigh them. We can only give him a time limit.

Mr. Benallack: In Victoria I think there are just as many posts used dry as green and I feel that farmers will have a stock of posts and they will by a second sense know they are dry enough for treatment. Another point is the question of barking. In Victoria the barking cost would probably be the biggest cost other than crecate.

Mr. Tamblyn: Should the sap displacement treatment investigated by the Division of Wood Technology be included in the proposed bulletin or would D.W.T. prefer to issue it as a separate paper? I take the view that if we can be assured that it is a satisfactory method, then with D.W.T.'s approval, it should go in the bulletin with acknowledgements. If too much work is involved we will have to omit it. However it seems a pity to have one publication issued and then shortly afterward have a second paper giving another method. It would tend to be confusing to farmers who might wonder whether we approve of the D.W.T. method or whether D.W.T. disapprove of our methods. They may not understand that all methods are equally acceptable.

Mr. Clarke: Would D.W.T. be able to carry out the work in a reasonable time? The first thing they would need to do would be to try out this process at various times throughout the year. That means 12 months to start with before you felt you could advocate it. I think we can cover the position in the bulletin by stating the fact that other methods are under investigation.

Mr. Dale: I think we might even go further than that and just give the outline of the method because we have mentioned in the draft bulletin one other method which we are not recommending yet, that is a variation of the hot and cold bath method. Cold soaking in creosote may prove to be a better method than the hot and cold bath treatment. Fuller information should be published when it is available.

Mr. Crane: In this proposed bulletin, the essential thing to indicate is what the farmer can get out of the methods you are advocating, that is you should tell him what is to be the result of the treatment. It is no good publishing a method which is tentative or that is being investigated and distributing it to the farmer, who wants to know which one he can apply himself. You should give him positive results.

Mr. Clarke: We might make this bulletin cover the preservation of fence posts with oil preservatives, and leave the field open for water-soluble preservatives at a later date.

Mr. Turnbull: Publication should not be delayed until the recommendations are regarded as perfect. I think that if a method is improved or a new method perfected at a later stage it might be covered by a supplement as has been done previously, for example the supplement to the Handbook of Structural Timber Design.

Mr. Dale: In order to ascertain that the processes which we recommend will be applicable to all States, we have asked the State departments for samples of timbers which are most likely to be available for posts. All this material is now to hand, and will be tested shortly. The co-operation of the States in this matter was excellent.

Note: It was later agreed that the treatments to be covered by the bulletin would be discussed at the specialist level.

FIELD TESTS OF PRESERVATIVE TREATED STAKES

I. INTRODUCTION

Within the last ten years or so, manufacturing chemists have produced quite a number of substances which have possible application as wood preservatives. Few of these have been scientifically investigated under Australian conditions, although some, such as pentachlorphenol and copper naphthenate, have been accepted commercially. In recommending these substances for wood preserving purposes research laboratories have had to rely on overseas experience for their data. With the cooperation of the State Forest Services, the Division of Forest Products is now in a position to undertake a comprehensive test of these preservatives in an effort to provide factual information on their performance under a wide range of Australasian conditions.

An initial working plan for this test was outlined in a letter to the Forest Departments of New South Wales, Queensland and New Guinea in January 1952. The project was mentioned (Item 7a) at the 1952 Forest Products Research Conference, when all the State Services concerned signified their willingness to cooperate.

The following summary of the proposed working plan for this project will serve to remind delegates of the scope of the test and will provide a basis for discussion and criticism. It is hoped that a final working plan will be prepared soon after this Conference ends.

II. SUMMARY OF WORKING PLAN

The principal components of the test may be considered under the three headings of preservatives, timbers and test sites. These have been presented, in summary form, in the attached Table.

(a) <u>PRESERVATIVES</u>: The following groups of preservatives shall be tested:-

[#] Prepared by Division of Forest Products

- Creosote oils and their mixtures with diluents and additives
- ii) Organic (cil soluble) preservatives
- iii) Water soluble preservatives

Each preservative shall be tested at three loadings, which shall be designated as "high", "normal" and "low". In most cases "normal" would be the retention recommended by the manufacturer, or else the standard generally accepted. "High" and "low" would be respectively double and half the "normal" loading for the preservative. Specimens showing abnormal pick-up would be rejected.

Where, for economy of material, only two retentions of preservative are to be used they shall be "high" and "low".

One or two preservatives from each group shall also be applied as a brush coating to one set of specimens at each of two sites.

- (b) TIMBERS: The test will include both treated timbers of low natural durability, and a few well-known durable timbers.
- (1) Treated timbers: Laboratory tests have shown that there is a difference in the manner and extent to which some preservatives are leached from hardwoods and softwoods. Similar differences might be expected between the behaviour of some preservatives in eucalypt sapwood and their behaviour in eucalypt heartwood. Therefore, three timbers will be used:-
 - Pirus radiata an easily impregnated softwood of commercial importance, which could be used as the main part of the test;
 - Eucalypt sapwood natural round specimens about $2\frac{1}{2}-3\frac{1}{2}$ in. in diameter, consisting mainly of sapwood, e.g. E. maculata or E. obliqua;
 - Eucalypt heartwood E. regnans or some other easily impregnated commercial timber of moderate to low natural durability.
- (ii) Untreated timbers: Untreated timbers shall be of two types, controls and durable timbers.

Controls - Four sets of specimens, matched with the treated timber specimens, shall be retained as controls

at each site. One set to be installed at the commencement of the test and replaced by a fresh set at five yearly intervals.

<u>Durable timbers</u> - For purposes of comparison between sites, and as a measure of the protection to be expected from preservative treatment, durable timbers, with an established reputation shall be included in the test, together with two or three local timbers.

At all sites - Jarrah Teak Cypress pine · New Guinea - Local timbers, as required Queensland - Grey ironbark Other timbers, as required New South - Tallowwood Wales Turpentine Other timbers as required Victoria - Southern mahogany Southern blue gum Other timbers, as required

(c) NUMBER AND PLACING: Round eucalypt specimens shall be about $2\frac{1}{2}-3\frac{1}{2}$ in. in diameter; sawn specimens shall be square sections, tentatively 2 x 2 in. and all specimens shall be 18 in. long. Specimens will be placed vertically in the ground to a depth of 12 in. and spaced 3 ft. apart, in rows. The arrangement and spacing between rows shall be dependent upon the area available and the hazards of the site. The approximate number of treated specimens at each site would be:-

P. radiata	Euca			
9/1	Sapwood	Heartwood	Total	
Site 1. 620	350	350	1320	
Site 2. 750	200	200	1150	
Site 3. 1250	1250	630	2510	
Site 4. 1150	500	500	2150	

⁽d) <u>TEST SITES</u>: Test sites representing the following four types of hazards will be used:

- Site I. New Guinea. Tropical decay, without termites, under conditions of high rainfall.
- Site 2. Queensland. Mastotermes area, with only low to moderate decay hazard. It is essential that this site should be in an area where the hazard can be expected to persist for the duration of the test.
- Site 3. New South Wales. An area of fairly high termite hazard, with a moderate decay hazard, in the 15-25 in. M.A.R. belt.
- Site 4. Victoria. An area of high decay hazard, in Victoria or Tasmania, without appreciable termite hazard.

In selecting the sites, consideration will be given to the type of hazard to be expected. In areas of high termite hazard specimens will have to be spaced so as to ensure maximum contact with the termite oclonies, and so as to avoid reduction in hazard in the event of a colony becoming devitalized.

The termite exposure test sites will present special problems of fencing, fire protection, clearing etc.

TABLE OF PRESERVATIVES

SITES AND CONCENTRATIONS

Site 1 - Tropical decay Site 2 - Mastotermes Site 3 - N.S.W. Decay and termites Site 4 - Viotorian decay

Preservatives	P. radiata sapwood		Eucalypt sapwood and heartwood	
	Conc.	Sites	Conc.	Sites
K.55 Crecsote oil British Standard orecsote U.S. Standard orecsote Australian brown coal tar orecsote	3 3 3	all all all	3	all
K.55 Creoscte plus: fuel oil (1:1) - " " (1:2)	5 3	all all	3	all

TABLE OF PRESERVATIVES (Contd.)

Preservatives	P. radiata sapwood		Eucalypt sapwood and heartwood	
	Conc.	Sites	Conc.	Sites
K.55 Creosote plus: 5% penta. in fuel oil - 2% dieldrin - 2% benzene hexachleride - 2% chlordane - 2% D.D.T.	3 3 3 3	all 2,5 2,5 2,3 2,3		
5% pentachle phenol in - heavy oil - light oil 20% cupper pentachlorphenate	3 - 3 3	all 3,4 all	5	all
Naphthenio acid (Acid No > 250)	. 3	all		*
Copper naphthenate (3% Cu.) - Acid No.> 250 in heavy cil - Acid No.> 250 in light cil - Acid No.< 250 in light cil	5 5 3	3,4 all 3,4	5	all
Chemonite Tanalith U Celcure Asou Beliden Salt (normal) " (S.25) Zinc chloride (5% conc.) Copperized chromated ZnCl2 Copper sulphate Copper borate Chromated copper borate Boron compound (Borax?) Mercuric naphthenate Chromated mercuric chloride Zinc meta-arsenite	555555555555555555555555555555555555555	all all all all all all all 3,4 3,4 3,4 3,4 3,4 3,4 3,4	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	1,3 1,3 1,3 1,3 1,3 1,3 3,4 3,4 3,4 3,4 3,4
Zino chloride(3%) plus Arsenic (2%) Nickel arsenite Seekay wax Xylamon	3 3 3	3,4 3,4 3,4 3,4	2 2 2 2	3,4 5,4 3,4 3,4

Also to be applied as a brush coating to P. radiata specimens at all sites.

III. CO-OPERATION AND COMMENT

To a large extent the success of this project will depend upon the goodwill and co-operation of the State Forest Services, who will be expected to assume responsibility for the selection, proteution and maintenance of the test sites, as well as for most of the periodical inspections.

Comment is therefore, invited on all aspects of the test, and especially the following:-

- i) Choice of timber species, particularly the eucalypts, and collection of the test material. Can the State Services undertake to supply a sufficient quantity of the chosen timbers?
- ii) Choice of preservatives. Are there any important omissions?

 Can the list be pruned without prejudice to the value of
 the test as a basis for recommendations for preservatives
 for use in contact with the coil, against decay or termite
 attack, in any part of Australia or the adjoining islands?

 Is testing at three retentions enough?
- iii) Choice of test sites. How could the distribution of sites, with respect to hazard, be improved? What arrangements should be made to protect the sites from fire, vandalism, or from becoming overgrown or unreasonably exposed? Clearing of adjacent lands might affect the termite hazard, for example, on a test site. What areas of known hazard are available as test sites?
- iv) It is desirable to have all specimens installed at about the same time, at all sites. Subsequently, all inspections should be made more or less simultaneously. Which periods suit best?
- v) The test makes provision for the inclusion of local timbers of high durability. Which timbers should be included at each site, and which at all sites? Will the State Services assume responsibility for the collection of these, so that they can be included in the test?

Discussion:

Mr. Booth: Why not use high and normal concentrations of preservative instead of high and low, because, if after the 25 years, you find the high is satisfactory and the low is not, you then have no indication of whether the manufacturer's normal recommendation is satisfactory. If you have high and normal concentrations and the normal is satisfactory, you can then try the lower concentration. You might not get any useful criticism or comment out of the tests as to whether the recommended concentration is satisfactory.

Mr. Beesley: We picked the high and low by using double and half the manufacturer's recommendation. We have included only the less well-known preservatives at two concentrations. Actually, treatment at two concentrations has been limited to the eucalypts listed. With radiata pine three concentrations have been used for all treatments. The reason for this difference in treatment is that some of our leaching work has shown that with certain types of preservatives fixation in softwoods is different from fixation in eucalypts, and therefore we have decided upon two retentions mainly as a check on fixation of those preservatives in eucalypts. We have treated radiata pine at three retentions to answer the question as to whether or not the maker's (or standard) retention is adequate.

......

In the considerable discussion which followed it was pointed out that the question of fixation in the eucalypts would still not be decided if the high and low levels of concentration only were used for this species. It was suggested that a better result would be obtained if the high and normal concentrations were used. Mr. Tamblyn said that one loading had been eliminated to reduce the amount of work but agreed that the matter should be given a lot more thought. However, inclusion of the low loading for all preservatives was attractive as it should give the earliest comparison between preservatives.

Mr. Gay: It may be worthwhile using aldrin, dieldrin and chlordane on their own. Recent tests carried out indicate that all these on their own have quite good preservative effect and aldrin has the best.

Mr. Da Costa: Is it possible to get separation of decay and termite hazards, and if so, should we attempt it?

Mr. Gay: Under certain circumstances if you don't eliminate decay hazards you won't get any termite attack. We have found in New South Wales in testing P. radiata that if the stakes become affected by certain types of decay the termites won't touch them.

Mr. Beesley: We are trying to find out how these preservatives will perform under conditions of service throughout Australia. We have tried to select four sites which will enable us to make recommendations on field performance of the preservatives in Australia. Four sites are too few to cover the whole Australian area.

Mr. Jennings: The question of observation on this comparatively long-term test is one that concerns me. It depends on where you locate the site in Queensland as to how much observation we can do on it, especially if it is located in a place where we have no convenient staff.

Mr. Tamblyn: We could put the Mastotermes site at the Katherine River Experiment Station, or it may be possible to locate the test at Darwin where Mr. Bateman might be able to give it the necessary attention.

Mr. Jennings: Regarding the site, we would have no control outside our State forests and timber reserves. Anywhere else it is a difficult problem for us to do the observation. Control of the area is quite important.

After discussion as to the durable species to be included for comparative purposes, it was agreed that the following species be included: - Victoria - red gum and yellow stringybark; Queensland - cypress pine; New Guinea - kwila.

Mr. Huddleston: In connection with the use of 1.55 creosote plus fuel oil, I think some difficulty may be experienced with this mixture in getting penetration into the timber. We get sludging which prevents penetration. (Further discussion on this point under Item 3 (a)).

Mr. Clarke: It is desirable to have all specimens installed at the same time in all sites, and all inspections should be made more or less simultaneously. Which is the best time for installation probably not before the end of this year.

Mr. Gay: From the point of view of termite activity it is much better if they are exemined in the cooler part of the year. It is very inadvisable to disturb the stakes in the summer months. This should be the guiding point, and I would suggest about May-June-July. Very careful consideration should be given to the selection of sites. We have had experience now in the selection of sites laid down in private property, which the ewner says will not be used, but two or three years later he wants to plough it over.

Mr. Huddleston: You are suggesting that this test be on State forest as far as possible ?

Mr. Clarke: I think we will have to make it definite that the test be on State forest as far as possible, except for the Katherine one on Mastotermes which may be looked after by C.S.I.R.O. The New Guinea one could be in the Botanical Gardens.

ITEM 5 (c) PRESERVATION OF TIBER WITH CREOSOTE AND CREOSOTE-FETROLEUM OIL MIXTURES *

The important advantages of adding petroleum oils to creosote for timber preservation have been recognized for a long time. Because of these advantages, this Division has carried out a survey of available oils with a view of evaluating their compatibility with the locally produced creosote. The method of test used in this survey was that recommended by the A.W.P.A. in which is rejected any creosote-oil

^{*} Prepared by Division of Wood Technology.

mixture showing more than 2 per cent. sludge after exhaustive centrifuging. None of the olls which were in the cheaper price range resulted in less than 5 per cent. sludge when mixed with creosote. In fact, the only oil which complied with the specification was one costing more than 4/6 per gallon.

As a result of this unexpected difficulty, we set up a laboratory apparatus for treating small samples of timber and to test the effect of this gross sludge formation. In our initial tests we used a 50:50 mixture of creosote and one of the cheaper fuel oils, which in previous tests we had found to produce less sludge than the others available here. The tests showed that the sludge inhibited the penetration of the preservative, clogged the apparatus very rapidly and deposited sticky flecks of tar on the surface of the timber.

Although the sludge can be separated fairly well by heating and decanting, the added cost due to this process and the cost of the plant required to do it, would not be offset by the use of a cheap fuel oil. In addition, we do not know what valuable toxics are removed with the sludge.

The reason for the incompatibility of the cils can be traced to the low aromatic content of both the petroleum and the crecsote available locally. Sydney crecsote comes from vertical gas retorts and can, therefore, be expected to be low in aromatics. The petroleum cils also are low in aromatics as is indicated by their low specific gravity. The A.W.P.A. in their standard P4-51 "Petroleum for Blending with Crecsote" requires the specific gravity of the cil to be above 0.96. None of the cils tested by us had a specific gravity greater than 0.91 except one which was in the higher price range. Although such cils are suitable for "bridging", they would have to be used in such large quantities under our conditions that their use becomes uneconomical.

Our work was initiated with the idea of using creosotepetroleum oil mixtures in the treatment of P. radiata railway sleepers in our Putney pressure plant. As the position stands now, we are unwilling to risk using any of the sludge forming oils in our pressure plant, and do not feel justified in mechanically removing the sludge mainly on economic grounds, but also because we do not know the effect of gross sludging on the toxicity of the preservative.

No immediate solution to this problem appears to be in sight unless other petroleum oils and/or creosote oils become available. Although this work has been carried out only on materials available in Sydney, it may well be that the same problem may arise when treatment plants are established in other States.

Discussion

Mr. Tamblyn: We have not much information to offer. We have used mixtures of creosote and petroleum oils and have had small sludging troubles. At no time have we felt the problem is too serious for commercial use of the mixture.

In 1936, when P. radiata sleepers were treated for test in South Australia, an oil produced by Commonwealth Oil Refineries, having a specific gravity of 0.86 or 0.88 was used, and according to our records we had very little sludging trouble. When treating sleepers for the Victorian Railways test last year, we tried adding bridging solvents including an oil ("Sovacide") available locally with high aromatic content. It was effective if enough was used, and cost about 4/6 per gallon. Finally we used mixtures without bridging solvent. We got some sludge but did not judge that it put the mixture out of court commercially.

In discussion with officers of Oil Companies here, we came to the conclusion that if commercial plants are using thousands of gallons of oil each year, it would be practical for oil companies to import a special grade of high aromatic content oil, such as is satisfactory in America. Whether this oil would cost much more we do not know, but there seems no reason why it should.

We regard it as a problem which will iron itself out in commercial practice. The South Africans have had the same problem and they have been using a bridging solvent which they claim is effective and costs about 2/3 per gallon. We tried to get an equivalent and the best we could get at short notice was "Sovacide". Cheaper high aromatic oils could probably be made available. If importation of large quantities is uneconomic we could look to bridging solvents or, alternatively, could put up with sludge.

Mr. Humphreys: Putting up with sludge does not appear to be practical, considering the amount of sludge formation experienced in Sydney. There is a large amount of tar deposited on the timber. It is hard to see why Sydney creosote should be different from creosote produced anywhere else from vertical retorts. It seems to me as though the Melbourne material should be the same.

Mr. Huddleston: The position is that until such time as this problem is solved we cannot mix crossote and oil. We get sludge which stops penetration into the timber.

Mr. Tamblyn: You have used these mixtures on a commercial scale. We have not, and experimental scale work is probably not the best way of judging the sludging problem. Our creosote oil mixtures, if anything, gave slightly higher absorptions than straight creosote. They were definitely dirtier on the surface but this did not affect penetration of preservative.

Mr. Huddleston: It may be a question of pressure. We are working at comparatively low pressure. The extreme is in the hot and cold bath treatment where we get full sapwood penetration with creosote only but with a 70:30 mixture of creosote and fuel oil it is not possible to obtain more than 1/16 in. penetration in radiata.

.......

At a later stage in the Conference, the Chairman asked Mr. Bland to comment on sludging of creosote-fuel oil mixtures.

Mr. Bland: I would warn delegates that it is 10 years since
I worked on crossote and some of the information given may be out of
date. There has, however, been no major change in the gas industry
(from which crossote is derived) in that time.

Our first problem was to evolve a method whereby we could measure the amount of sludge formed. Sludge is not a definite compound which can be filtered off, washed etc., it is a thick semisolid mass. We made a mixture of the creosete and mineral oil, took 100 ml. of the mixture in a 250 ml. beaker and allowed it to stand overnight. In the morning a layer of sludge had formed on the bottom. We then poured the oil off and drained the beaker for one hour. The beaker and remaining sludge were then weighed.

We tested a number of creosotes as follows: -

Freshly distilled (made in laboratory)

Commercial (produced in tar distillery) (Low boiling range (within or almost within Spec. K.55) (Medium boiling range (High boiling range

Oxidized (1 litre of crecsote heated to 130-140°C. and slow stream of air bubbled through for 6 hr.)

American and European (derived from horizontal retort tar as distinct from Australian derived from vertical retort tar)

The following results were obtained: -

Freshly distilled creosote prepared in the laboratory gave no sludge whatever. If we denote sludge formation by + the crecsotes may be rated roughly as follows:-

Commercial Low + Medium ++ High +++

Oxidized crecsotes Low ++ Medium +++ High ++++

American and European +

Oxidized American and European +

I cannot give much information about mineral oils because it was not possible to rate one mineral oil against another. The following solvents for sludge were found: commercial benzol, commercial

tricresol, 10 per cent. NaOH. It was also soluble in hot neat creosote of low or medium boiling range.

Benzol would be rather expensive and a dangerous fire hazard as well as an insidious health hazard. Tricresol would be expensive; 10 per cent. NaOH might be practicable, also hot neat creosote of low or medium boiling range.

If the operators are prepared to do some treatments with neat creosote, sludge could be cleared from the plant.

Removing the oil mixture, cleaning the plant, and redistilling would be prohibitively expensive.

This work is covered in a progress report which can be sent to the States interested.

Producers of cresol are probably extracting the phenols from the tar oil, fractionating the crude phenols to get high priced phenol and meta-para cresol. The residual phenols would go back into the creosote which reaches the customer well oxidized. In our experiments removal of phenols and then blowing did produce some sludge but very little. Most sludge is therefore produced by high boiling phenolic bodies.

Mr. Humphreys: We gave some thought to installing a simple plant to precipitate the sludge first but it could not be installed simply enough to make it an economic proposition.

Mr. Huddleston: Should we approach the Standards Association with a view to having K.55 amended ?

Mr. Bland: The present specification says the distillation residue shall be soft but not sticky. It is purely a personal judgement whether the residue is "soft" or "sticky".

Mr. Humphreys: Could the specification be amended to provide that it should not give more than a certain amount of sludge on mixing with oil ?

Mr. Bland: The percentage removed is not great, even in the worst sludging mixture only 3 or 4 per cent.

Mr. Huddleston: We have had as much as 15-20 per cent. as sludge in the laboratory with the creosote available to us.

In a treatment plant creosote will be oxidized - this cannot be avoided with recirculation. Anything we do must apply to creosote with a fair amount of oxidation.

Mr. Tamblyn: We have not felt sludging was a real problem with Victorian crecsotes but we did try the use of bridging solvents but in the case of "Sovacide" the oil was too dear. We later tried the addition of middle tar oil to crecsote and this reduced sludge quite considerably.

I suggest to Mr. Huddleston that since this middle tar oil is the same price as creosote, he might try adding 10 or 15 per cent. to attempt to reconstitute the creosote. Where sludge occurred we have cleared our cylinder with a proprietary compound sold locally as "Magnusol".

Regarding work we might carry out. We have a very full programme and I suggest that initially we arrange for the supply of two or three typical mineral oils to American Wood Preservers' Standard Specification. We will send half of them to New South Wales for mixture with Timbrol creosotes and the other half will be mixed with our Victorian creosote. If these oils reduce sludge reasonably I have no doubt that they can be made available by the oil companies. We have understood from the oil companies that they would be prepared to make oils of this type available if there were sufficient demand.

Mr. Huddleston: I think the solution lies in the creosotes rather than in the oils. It would be better for us to approach the Steel Companies and Gas Company for supplies of creosote. I suggest that the matter be left in our hands to prepare a draft specification for submission to the Standards Association of Australia.

ITEM 3(d) PENTACHLORPHENCL AS AN INSECTICIDE *

Examination of service records and tests on pentachlorphenol, which are now becoming available from many areas, suggest a need for review of the recommendation of pentachlorphenol as a general insecticide.

Specific examples on tests of pentachlorphenol as an insecticide are summarized as follows:-

Division of Wood Technology, N.S.W.

Blocks dip treated with 3 and 5 per cent. pentachlorphenol in chloroform were subject to attack by 6 pairs of <u>Lyctus</u> beetles on each block. Eggs were laid by the females and large numbers of beetles were obtained 3-4 months later from the treated blocks.

Spiller, New Zealand

Showed that a single brush coat of 5 per cent. pentachlorphenol in power kerosene was unsatisfactory for Anobium control. Claimed that power kerosene gave the same control as 5 per cent. pentachlorphenol in power kerosene. Calculated that pentachlorphenol solution giving 82 per cent. initial control would afford no control 2 years later.

Becker, Germany

Testing lethal concentrations to Hylotrupes bajulus larvae by reduced pressure impregnation of wood in chloroform solution concluded that for short term storage of wood 0.3 lb. of pentachlorphenol/cu.ft. of wood was required. Toxicity decreased rapidly and was also influenced by the vehicle. Surface treatments prevented attack for less than 6 months.

Gay, Australia

Relatively high retentions of pentachlorphenol were necessary to obtain high protection with <u>G. lacteus</u>. Soil treatment tests with pentachlorphenol ($\frac{1}{2}$ gal. of 5 per cent. pentachlorphenol/cu.ft. of soil) have shown a higher incidence of termite attack

^{*} Prepared by Division of Forest Products.

than is the case for soil treated with creosote, sodium arsenite or D.D.T.

International Termite Exposure Test

After $10\frac{1}{2}$ years' service 5 per cent. pentachlorphenol treated stakes showed more attack than stakes treated with equivalent loadings of creosote although no stakes were destroyed in this time. Untreated controls had an average life of $1\frac{1}{2}$ years.

Smith, United States Department of Agriculture, Bureau of Entomology and Plant Quarantine

Tool handles dipped for 3 min. and subjected to Lyctus attack -

- 1. Kerosene failed after about 6 months
- 2. Deobase (a de-odcrized kerosene) failed after about 6 months
- 3. Xylene " " 3 "
- 4. Velsicol AR 50 G " " 12 "
- 5. 5 per cent. D.D.T. in aq. suspension some breakdown after 2 years
- 6. 2 per cent. copper naphthenate in deobase very slight failure after 2 years
- 2 per cent. Chlordonein (chlordane) in deobase no attack in 2½ years
- 8. 5 per cent. naphthenic acid in kerosene no attack in 2 years
- 9. 3.5 per cent. pentachlorphenol (prop. soln.) failed in 1 year
- 10. 1 per cent. D.D.T. in Velsicol no attack in 22 years
- 11. 5 per cent. Toxaphene " " 21 "
- 12. 1 per cent. B.H.C. in Velsicol " " 21 "
- 13. 0.5 per cent. B.H.C. in Velsicol " " 21 "

Kowal, United States Department of Agriculture

Tests on green timber indicate pentachlorphenol has more value as a fungicide than as an insecticide.

Summarizing, accumulated evidence suggests that although pentachlorphenol may have high initial toxicity as a contact and respiratory insecticide, its permanence may be relatively low. The toxicity is influenced by the vehicle and this in turn may be related

to the tendency of pentachlorphenol to "bloom", whereby the chemical is eventually lost from the wood. A recent paper by Walters (University of Illionois, U.S.A.) indicates that blooming is related to arcmatic content and distillation range of the solvent. Least blooming results from solvents distilling above 300°F. at the 50 per cent. point and with arcmatic contents of greater than 40 per cent. Solvents for pentachlorphenol when used as an insecticide generally do not fall within this range.

As a result of the above evidence and correspondence from the N.S.W. Division of Wood Technology, a small test was carried out to examine relative permanence of toxicity of several contact insecticides.

Two ml. of three concentrations each of several contact insecticides dissolved in acetone, were pipetted on to 1/8 in. thick end grain wafers of P. radiata. Adult Lyctus beetles were then enclosed on the wafers after the acetone had evaporated. The condition of the beetles was noted after fixed intervals. The samples were then placed in a kiln at 110°F. for 4 days, after which fresh beetles were placed on the samples and observed. Scores were given each preservative according to the mortality and paralysis which affect the beetles, the results being shown in Table 1.

TABLE 1

RELATIVE TOXICITY OF VARIOUS INSECTICIDES TO ADULT LYCTUS BEETLES

Preservative	Concentration %	Effective "Initial" Control	Effective Control after "Weathering"
PCP + linseed oil PCP Dieldrin	1 - 5 1 - 5	89 76	9
Gammexane Chlordane	0.5 - 1 0.5 - 1 0.5 - 2	76 70 63	56 4 20
Aldrin Dichlorethyl ether	0.5 - 1 5 - 20	61. 42	32 -7
Acetone	-	0	0

These results show that although the "initial toxicity of pentachlorphenol is higher than any other insecticide at the concentrations used, the residual toxicity is less than that for

dieldrin, aldrin and chlordane. A further test is at present under way in which higher loadings of preservatives were used.

In view of the indications that pentachlorphenol has considerably less permanence in toxicity relative to other available contact insecticides, it is desirable that further work be carried out on this subject with a view to ascertaining the practical effectiveness of pentachlorphenol in comparison with other available insecticides. The Division of Forest Products would find difficulty in undertaking this work in the near future, and it is suggested that there be some discussion at the Conference as to the possibility of the problem being taken up by the New South Wales Division of Wood Technology and the Queensland Department of Forestry.

Discussion:

Mr. Jennings: We have not regarded pentachlorphenol as a satisfactory insecticide, mainly because all the examples you have from everseas, in particular, Spiller in 1952, raise a lot of doubt. It is not an approved treatment in Queensland as far as <u>Lyctus</u> control is concerned. We are not particularly interested in it from the point of view of an insecticide.

Mr. Huddleston: We have ceased to recommend P.C.F. as an insecticide. Our recommendation now is for dichloroethyl ether-dieldrin mixtures. We have found several failures where P.C.P. has been used.

Mr. Gay: We are not particularly impressed with P.C.P. either. It failed in our soil test after 4 years. Some other materials are still showing some protection - creosote, sodium arsenite, etc. so it does not appear to be quite as good as was hoped. In other tests we found it extremely valuable. In tests for proofing hardboard, we can get very effective protection against termite attack by adding 0.5 per cent. P.C.P. On that basis we suggested to manufacturers of rubber cable that they add P.C.P. to it. Samples were prepared with up to 6 per cent. P.C.P. In our tests we found that

with up to 2 per cent. loading there was no significant difference between those samples and the untreated ones. The only real protection was at 6 per cent. loading. We are more inclined to investigate more promising materials such as dieldrin, aldrin, etc. If Conference would like us to carry out more tests on the effectiveness of P.C.P. we could do so.

Dr. Ellwood: There is one other thing to consider. P.C.F. is available to householders everywhere in Victoria, at least, for use as an insecticide. We would be loath to recommend people not to use it, because its availability is good, and other insecticides are not as readily available. We do not feel happy about throwing P.C.P. away.

Mr. Huddleston: There have been several cases in Sydney where after injection treatment with pentachlorphenol, Lyctus has been quite vigorous a few months after treatment. One reputable pest exterminating firm was questioned and we found that the job was done thoroughly but the insecticide was just not effective. It did not disturb borers from timber and therefore we feel that we should not recommend it.

Mr. Tamblyn: I feel that more work is necessary. We have constituted ourselves as advisors on the Lyctus problem to the public and trade, and have been recommending P.C.P. on overseas evidence. What are we going to do now - continue to recommend it or do new tests so that we can be sure of the higher effectiveness of other materials? I do not think that we should just throw P.C.P. away. To tackle the job properly some work should be done to produce the evidence necessary to satisfy ourselves and the trade.

<u>Mr. Clarke</u>: I feel that it is of doubtful value to do more work on P.C.P. as an insecticide. If the chemical firms want to sell P.C.P. it is up to them to do the work.

HIGH PRESSURE TREATMENT OF EUCALYPT AND OTHER TIMBERS

RAILWAY SLEEPERS

Since the last Conference, 2,400 eucalypt sleepers have been treated for the Victorian Railways and are ready for installation. The treatments given the sleepers were enumerated at the last Conference. The water borns preservatives used were Cu CZC and Greensalt K. Calculations of treatment data have not yet been finalised. However, Table 1 shows the crossote oil retentions for the 4 species treated at 1000 p.s.i. pressure at 150°F. for 1½ hours.

Retention of Crousote Oil in Four Sleeper Species treated at 1000 p.s.i. at 150°F.

Species	Creosote Oil Retention (1b./cu.ft				
	Mean	Minimum	Maximum		
E. obliqua	8.0	2.6	21.7		
E. australiana	7.0	2.7	26.2		
E. eugenioides	5.2	1.7	12.7		
E. regnans	10.2	3.6	23.5		

Approximately 150 sleepers comprising 50 each of E. obliqua, E. gigantea and E. sieberiana were treated for the Tasmanian Railways. A pressure of 1000 lb. per sq.in. was used with crecosete oil and 60:40 Vacuum furnace oil/crecosete oil. Retentions are shown in Table 2.

TABLE 2

Species	Preservation Retention 1b./cu.ft.			
	Inched	Not Incined		
E. obliqua	7.5	6.4		
E. gigantea	6.8	5.7		
E. sieberiana	7.4	5.7		

Retentions varied from 3.2 to 11.3 lb. per cu.ft. and the greater retentions shown by the incised sleepers were highly significant and consistent for the three species.

These sleepers have been shipped to Tasmania for installation.

POLES

A consignment of small diameter round poles of spruce was received from Sweden for impregnation tests under high pressure. Swedish spruce has a reputation of being difficult to impregnate at ordinary commercial operating pressures; however, fairly good absorptions (mean 13.0, range 8.2 - 17.8 lb./cu.ft.) were obtained at 150 p.s.i. at 190°F. for 3 hours. The improvement in retention was quite marked at higher pressures but collapse of the specimens was difficult to avoid. At 400 p.s.i. treating pressure and 150°F. the specimens were not collapsed after 2 hr. treatment but did partly collapse in the third hour. Treatment at 400 p.s.i. at 130°F. for 1½ hours resulted in good retention and no collapse. (Mean 19.4, range 14.6 - 25.4 lb. per cu.ft.).

COOLING TOWERS

Following discussions with engineers of the State Electricity Commission (Victoria) tests of high pressure treated cooling tower slats and timbers were initiated. Approximately 2400 s.ft. of 5 x l in. and 4 x 3 in. E. obliqua was treated with crecote at 1000 p.s.i. Absorptions were generally in the range 7 - 12 lb./cu.ft. though scmewhat lower retentions were obtained with the 4 x 3 in. material which was not sufficiently dry. This material is now installed at Yallourn and operation of the cooling towers is expected to commence later in the year.

MINING TIMBERS

Preliminary discussions were held with an officer of Consolidated Zinc Corporation (Broken Hill) on the high pressure treatment of underground mining timbers. Pending a survey of the nature of the failure of the underground timbers, recommendations for treatment will be made.

FUTURE WORK

An examination will be made of the treating variables, pressure, temperature, duration of treatment, moisture content, species, and effect of pretreatment in relation to retention and penetration of preservative.

Discussion:

Mr. Huddleston: New South Wales Railways are becoming intensely interested in preservative treatment, so there should be no difficulty in arranging for high pressure treated timber to be placed in New South Wales tracks, but I do not think low durability timbers will be among sleeper supplies.

Mr. Clarke: The position might arise where it would be better to take low durability timbers than transport high durability sleepers long distances. If there is no demand for low durability timbers to be treated in N.S.W., there is the question whether it is worthwhile carrying out tests.

Mr. Huddleston: Tests would tend to maintain the interest of the Railways, and might have some effect in changing their outlook as regards the use of low durability timbers. On the Northern Tablelands we have mainly non-durable species, and if we get their interest in treatment we may be able to establish a treatment plant there.

Mr. Jennings: We would be quite happy to co-operate in the matter. We will have to depend on low durability species before many years have passed but with extensive use of hogback sleepers in Queensland, even at present the hot and cold bath treatment would be desirable for the durable species. Service tests indicate that it would be good practice to use the hot and cold bath treatment and leave

the sap on. From the point of view of main supply in 10 or 15 years, there are definitely a lot of species where pressure treatment would be an advantage.

<u>Mr. Grenning</u>: To what extent would pressure treatment give durable species longer life?

Dr. Ellwood: As far as resistance to decay, insects etc. that is one side of the matter, but then we have mechanical deterioration which is another aspect, and by suitable juggling of preservative and the weather resistant agent - usually an oil - you have some control over mechanical or splitting failure. Then, of course, rail fixing methods, spiking methods etc. also influence sleeper life. Would the Queensland Forest Service give some thought to tests? If you could give some idea of the tests desirable we could plan ahead on use of the cylinder.

Mr. Grenning: We would be glad to do that. Our desire is to get a longer life for any type of sleeper used.

Mr. Clarke: Your specifications can be more lenient if you are going to treat sleepers than if you are not going to treat. If you carry out experiments on prolenging life of sleepers which already have a long life, it would be desirable to start very soon because results will not be available for 25 years or so. Would you give some thought to species?

Mr. Jennings: We will let you have a note about it.

ITEM 3 (1) LABORATORY TESTS ON THE RESISTANCE TO LEACHING OF VARIOUS PRESERVATIVES *

With water-borne preservatives of high initial toxicity and low volatility, resistance to leaching is undoubtedly one of the most important factors determining satisfactory performance in outdoor service. In the present series of tests fourteen different water-borne preservatives were chosen and this summary deals with the resistance to leaching of these preservatives when treated blocks of E. regnans sapwood were leached in distilled water. Further tests are in progress using treated blocks of P. radiata sapwood leached in distilled water and both E. regnans and P. radiata blocks leached in acid and alkaline waters.

E. regnans was selected as a typical eucalypt in the low durability class. After testing for uniformity of pick-up three logs were chosen and the 480 blocks (each 2 in. x 1 in. x \frac{1}{2} in.) required for the test were cut from the sapwood of these logs. The preservatives included in the test were zinc chloride (at retentions of 0.25, 0.75 and 2.25 lb./cu.ft.), zinc chloride + Triolith Z (in the ratios of 10:1, 10:2.5 and 10:10), Triolith Z, Triolith U, Tanalith, chromated zinc chloride, copperized chromated zinc chloride, Boliden salt 'S', Boliden salt 'S.25', acid copper chromate, ammoniacal copper arsenite, chromated copper arsenate, chromated nickel arsenate, and chromated mercuric chloride, with creosote and distilled water as controls.

Twenty-four blocks were then allocated to each preservative and pressure impregnated with that preservative. After allowing sufficient time for 'fixation' of the preservative each set of twenty-four blocks was divided into two sets of twelve. From each of these sets three blocks were removed for analysis prior to leaching. The remaining sets of nine blocks were then impregnated with distilled water and shaken for periods of \$\frac{3}{2}\$ hr., \$1\frac{1}{2}\$ hr., \$3\$ hr.,

^{*} Prepared by the Division of Forest Products

6 hr., 12 hr., 1 day, 2 days, 4 days, 8 days, 16 days, 32 days, and 64 days. After each period the leach liquor was removed and replaced with fresh distilled water. At the end of the leaching the blocks were dried to 12 per cent. moisture content and from each set, 3 blocks were taken for analysis after leaching and the remaining 6 blocks in each set used in the decay resistance tests. All leach liquors were analysed for toxic radicals as well as the 3 unleached and the 3 leached blocks. The results of the leaching are shown in Table 1.

It will be noticed from the table that the values for percent. leached in total time plus residue lie within the limits 100 per cent. ± 5 per cent. of the initial retention and all but 10 of them within the limits 100 per cent. ± 2 per cent. The major portion of this error is undoubtedly due to the sampling of blocks for analysis, since a sample of the 3 blocks is taken from a set of 12 for analysis prior to leaching and a sample of 3 blocks from a set of 9 for analysis after leaching. Errors in the sampling and analysis of solutions would also contribute small amounts of the total error.

TABLE 1
RESULTS FOR THE LEACHING OF BLOCKS TREATED WITH WATER-BORNE PRESERVATIVES

Preservative Radical		Initial	Percent	Residue		
	Retention by Block Analysis mg.	in g hr. *1 (end of 1st period)	in 3.95 days *1 (end of 7th period)	in 127.95 days (end of leach)	by Block Analysis	
Zinc chloride	Zn	287.5	29.8	86.6	89.4	10.7
Zinc chloride	Zn	882	28.5	60.5	63.4	34.7
Zinc chloride	Zn	2637	26.1	70.1	72.9	25.2
Zinc chloride and Triolith Z (10:1)	Zn F D.N.P.*2	855.2 22.5 33.3	26.1 49.8 41.8	70.7 103.6 92.6	73.2 103.6 102.2	28.7 0 0
Zinc chloride and Triolith Z (10:2.5)	Zn F D.N.P.#2	719.7 98.8 68.3	24.7 24.6 22.3	75.5 89.7 89.1	77.5 98.3 101.8	20.1
Zinc chloride and Triolith Z (10:10)	Zn F D.N.P.#2	279.8	21.2 29.3 13.0	67.6 93.5 89.4	72.3 100.6 104.6	30.6 0 0
Triolith Z	F *2	070 %	32.1 10.5	102.3 93.0	105.2 101.0	0

TABLE 1 (Contd.)

Preservative Toxic Radical	masses	Initial Retention by Block Analysis mg.	Percen	Residue		
	Radical		in 3 hr. *1 (end of 1st period)	in 3.95 days*l (end of 7th period)	in 127.95 days (end of leach)	by Block Analysis
Triolith U	F D.N.P. #2	178.3 69.0	17.9 17.9	91.9 94.1	102.2 101.8	0
Tanalith	F	77.9	14.3	95.8	103.7	0
	D.N.P.*2	86.9	12.8	94.4	103.8	0
	As	106.2	4.4	34.9	59.5	41.4
Chromated zinc chloride	Zn	669.0	22.3	68.6	72.0	28.1
Copperized chromated zinc chloride	Zn	592.5	20.3	50.9	63.0	41.9
	Gu	59.1	6.8	22.7	28.0	73.6
Boliden salt	Zn	280.5	5.6	36.6	39.6	61.2
	As	339.7	5.2	31.7	56.1	45.4
Boliden salt	Zn	195.8	4.0	14.8	15.1	84.3
	As	3100	2.4	33.2	57.7	43.1
	Cu	124.5	0.2	2.7	3.1	96.6

Preservative	Toxic Radical	Initial Retention by Block Analysis mg.	Percen	Residue		
			in 3 hr. H (end of 1st period)	in 3.95 days *1 (end of 7th period)	in 127.95 days *I (end of leach)	by Block Analysis
Acid copper chromate	Cu	225.9	1.3	6.3	9.5	90.8
Ammoniacal copper arsenite	Cu As	749.7 859.5	0.4	1.9 40.6	3.0 61.9	96.9 37.1
Chromated copper arsenate	Cu As	160.7 198.7	1.6 0.5	19.7 3.8	28.4 8.3	72.6 91.7
Chromated nickel arsenate	Ni As	146.4 328.2	5.1 4.2	35.1 42.6	52.2 67.9	46.7 31.3
Chromated mercuric chloride	Hg	157.9 ^{#3}	2.0	3.3	3.6	-

Mot including period of approximately $2\frac{1}{2}$ hr. during which blocks were saturated under pressure immediately before leaching.

m2 D.N.P. = 2,4 - dimitrophenol.

^{*3} Values calculated from weight of solution absorption.

Discussion:

Mr. Crane: Is the zinc retained fairly satisfactorily ?
Has it any particular value against decay ?

Miss Wilson: In most tests we did not get very great retention of zinc, except in Boliden salts. From the results of the toxicity test, both sets of blocks treated with Boliden salts showed resistance to fungal attack. That is probably due to the presence of arsenic rather than to zinc. Blocks treated with zinc chloride preservatives do not show any great resistance to attack by the three fungi which we tested.

<u>Mr. Da Costa</u>: In the blocks treated with zinc chloride at the high loading, the amount of zinc left after leaching would be equivalent to $\frac{1}{2}$ lb. of zinc chloride/cu.ft. This did not give protection against all fungi but American tests have shown that attack can occur at $\frac{1}{2}$ lb./cu.ft. immediately after treating, i.e. without any leaching.

<u>Wiss Wilson</u>: It should be noted that in the case of acid copper chromate most of the copper remained after leaching but blocks were attacked by one of the three fungi tested.

Mr. Da Costa: Although copper is retained it is not sufficient protection. In the testing of preservatives by this method it is not sufficient to know that some toxic chemical is present and that by chemical analysis you can show that the toxic part of it is present in substantial amounts. It may be retained in a form which is not toxic. This was particularly noticeable in test with mercuric chloride, a preservative recently developed in England. There was no doubt that most of the mercury was retained in the blocks and was equivalent to, I think, something like 3 parts/1000 of mercuric chloride. The blocks were attacked, indicating that the mercury present in the blocks must be in a very much less toxic form. It seems necessary to take into consideration how much zinc, radical copper, or arsenic is retained after leaching, and in what form it is retained.

Copperized chromated zinc chloride was resistant to one fungus but not to the other two.

PRESERVATIVE TREATMENT OF TIMBERS FOR COOLING TOWERS

The Division is at times asked to advise on the suitability of different timbers for use in cooling towers, the causes of their deterioration and the need for preservative treatment. We have not made any thorough investigation of this problem but feel that it deserves attention because cooling towers represent large capital outlay and because Californian redwood which was preferred in the past is now neither readily available nor cheap.

From overseas work and limited observations here some tentative conclusions have been reached which may be summarized as follows:-

Decay: Slats and supporting timbers which are directly in the water stream are subject to a type of decay which may not be caused by common basidiomycete fungi. Work at Princes Risborough has established the presence of various mould fungi which are believed to cause the slow breakdown of the slats. These fungi belong to the type which are relatively tolerant to some wood preservatives.

Other structural timbers which are often damp but rarely saturated are subject to decay by common wood-destroying fungi.

Timber Species: Redwood has been preferred for slats because of its easy machining and high natural durability. On this latter point it seems unlikely that the fungicidal extractives in redwood slats which are known to be water soluble could resist leaching for very long. We are inclined to believe that a timber such as radiata pine, treated with a suitable preservative, would be more decay resistant than redwood, and would be mechanically satisfactory, particularly if heavier slats were used. Probably any timber with good working properties which could be treated with a preservative would be

^{*} Prepared by the Division of Forest Products

satisfactory provided it has good dimensional stability.

This latter point may be of great importance only in towers which are used intermittently. Where treatment is not practicable the possibility of using cypress pine should not be overlooked.

For the framing timbers it seems reasonable to expect that any durable timber with good weathering characteristics would prove satisfactory without treatment. We would be interested to receive information on practices in other States both with regard to slats and framing timbers.

To obtain this information and other data on the extent and nature of deterioration, etc. we are considering preparing a simple questionnaire and would like to know whether the State Forest Services would be willing to assist in its distribution. Because only a limited number of questionnaires would be circulated, it would be desirable that some personal canvas of firms using larger cooling towers be made. If it were practicable it would be even more helpful if the officer distributing the questionnaires could inspect some of the towers and report hiw own estimation of the problem. Any suggestions from the States on this matter would be most welcome, together with an indication as to whether they would be favourable to arranging some tests of local timbers.

Discussion

Mr. Booth: Gonians of Newcastle are building a large cooling tower, and in discussion with our Preservation Section it was suggested that they try creosoted radiata slats. We would like to raise the point that in some tests on cooling towers in England, sponsored by the Timber Development Association, they used a number of timbers but none of the preservatives used was creosote, they were all water borne. What does the Division of Forest Products think of creosote in cooling towers in view of English tests, and is there any suggestion that it may be unsuitable?

Mr. Tamblyn: Cooling tower engineers do not like oily preservatives in case they upset water flow in the tower. The English work has indicated that non-wood-destroying fungi are causing some breakdown of slats. Continual leaching of the wood apparently causes hydrolysis and renders the cellulose susceptible to attack by mould fungi. If that is true, a number of preservatives which are quite good for normal decay prevention would not be effective, as mould fungi are not susceptible to many of these preservatives. I do not think we can take any preservative which is normally regarded as good and recommend it for use in cooling towers, tests would have to be done first. The Princes Risborough people feel that no preservative can be recommended and we feel similarly doubtful. We have treated slats with creosote for tests by the State Electricity Commission. We would like to survey the picture and then put in tests in more than one State, using several preservatives designed to cover a wide range of toxic materials - pentachlorphenol, creosote, chromated arsenicals, with perhaps a mercury salt. Until this is done I do not think we could make any positive recommendation for creosote.

Dr. Ellwood: The Yallourn test may not be a good one, because it is operating under unusual conditions. The position there is that they will probably only be using the cooling towers during summer when the water supply is too low to cool the generators. We understand that they will not be in use as cooling towers for the greater part of the year, whereas most cooling towers work the whole year round. Water borne salts are included in the test also. Regarding the use of creosote, the State Electricity Commission do not like it because it is very dirty. If creosote is recommended clean treatments should be made.

Mr. Da Costa: We would like some indication from the States as to what extent decay, whether caused by basidiomycete or by non-basidiomycete fungi is a problem in cooling tower slats. Is it a serious problem? Is breakdown mechanical or caused by decay?

Mr. Booth: There are two sides to the problem. In Australia up till recently the idea has been to install low performance towers. Such towers have usually been small and have been constructed with tallowwood slats, which I think are quite satisfactory. Nowadays, with building of larger stations away from large rivers, they have to have more carefully constructed slat systems. Durable eucalypts are not easily amenable to construction of high performance towers. We have no answer at the moment, except to use Californian redwood which fulfils conditions of high durability.

Mr. Tamblyn: I do not see how redwood can be leached even at neutral pH for long periods and still retain durability. Its physical properties may be its main virtue. We do not know sufficient to say that P. radiata used under identical conditions as redwood would not give the same life. Some basic data is necessary first, and after obtaining that data we can go shead and plan a project to answer problems.

Mr. Turnbull: We have no quick way of getting field information on this problem. The suggestion to distribute a questionnaire is a good one, but not enough data may be revealed - whether and where decay is occurring, any correlation between forms of construction used and breakdown occurring, etc. Officers in the various States should get around and see what has actually been used and build up personal experience to interpret the questionnaire data more effectively.

Mr. Jennings: We would be happy to co-operate.

Mr. Clarke: This is a problem which is growing all the time, and I think all States who get enquiries should circulate the enquiry and the advice they give to other States and to Division of Forest Products.

Mr. Huddleston: I agree that that would be very helpful. Exact conditions of operation should be stated.

ITEM 4 DURABILITY RATINGS: LABORATORY AND FIELD DURABILITY TESTS*

Discussion is invited under this item on three aspects of the investigation of natural durability in timber (apart from the laboratory and field tests of termite resistance being conducted by the Division of Entomology which will be discussed under Item 6 (a)). (a) Durability Ratings

Although lists of timbers showing their expected durability in service have been issued by this Division and by some of the State Forest Services, it is felt that there is need for a more complete, detailed and systematic grading of timbers in this respect. It has been found that many enquiries are received regarding timbers whose durability has not been officially listed, and also that many listed gradings are regarded as being dubious or even incorrect by some people with experience of the timbers concerned.

The Division therefore proposes to prepare a list of important Australian timbers showing their anticipated resistance to termite attack and to decay and to circulate it for comments, corrections, and additions, to forestry officers, timber users and other persons throughout Australia who may be expected to have some knowledge of the performance in service of some of the timbers therein. When all such comments have been collated it should be possible to compile a list of durability ratings which will reflect the concensus of opinion amongst those people with a knowledge of the subject, including any discrepancies of opinion.

Such a list would be invaluable not only in recommending which of the available timbers should be used in a given type of service, but also in plenning future research into natural durability of timber. Any timbers regarding which there is a wide diversity of opinion should be investigated experimentally to ascertain the true durability and the reasons for the divergences of opinion, whilst any

^{*} Prepared by the Division of Forest Products

timbers unanimously accepted as highly durable would be a good starting point for work on the causes of decay and termite resistance. Both for advisory work and planning of research, it would be highly desirable to give two separate ratings for durability: where termite attack is the main hazard, and where only decay resistance need be considered.

The initial list to be prepared by this Division should be completed before the Conference and will comprise 150-200 timbers, in alphabetical order, with separate ratings for termite and decay resistance on the following basis:-

- Class 1 Extremely resistant to attack (e.g. wandoo, white mahogany, red ironbark against decay and termites; white cypress pine against termites)
 - 2 Resistant to attack (e.g. jarrah, yellow stringybark, brush box against termites; salmon gum against decey)
 - 3 Moderately resistant to attack (e.g. brush box against decay, salmon gum against termites, southern blue gum against decay and termites)
 - 4 Not resistant to attack (e.g. <u>Pinus radiata</u>, mountain ash against decay and termites, karri against termites).

In addition to grading timbers into these four main classes, a + sign will indicate that the timber is more resistant than most in its class, and a - sign that it is less resistant than most in its class (e.g. red mahogany might be graded as 2 +, yellow stringybark as 2 and white stringybark as 2 -).

It is suggested that a number of copies of the list be forwarded to each State Forest Service for circulation amongst their officers and other copies supplied to State Electricity Supply authorities and so on. It is regarded as essential that all copies be returned to the Division signed by one person, and that all notations thereon represent his personal opinions, based on his own experience with the timber or on discussion with other timber users.

Any gradings already on the list are purely suggestions and not authoritative and any different opinions held should be noted, whether they can be backed up by objective evidence or not. If the officer is not personally familiar with a timber (and few persons can be expected to know more than a fraction of the timbers listed) no opinion should be expressed. In grading a timber fer durability it is suggested that the general basis should be how long a split fence post from the sound heartwood of a normal tree would last in the ground (a) where termites are very active, and (b) where no termites are present.

Discussion:

Mr. Huddleston: Have you given any thought as to how to correlate information obtained? We have carried out several surveys of this kind and have asked people to express an opinion. We usually obtained very conflicting opinions.

Mr. Da Costa: That is why we circulated to get a full range of opinions. In an area where termites are prevalent a certain timber may be poorly regarded. In an area without termites, that timber may be highly regarded because of decay resistance.

Mr. Turnbull: Should the survey cover 200 species? I doubt whether 200 are marketed in important quantities. Many species are used where durability is not important.

Mr. Crane: Fence post timbers extend the range a long way. I favour 200 species.

Mr. Da Costa: Regarding Mr. Turnbull's comment, the minor species are the ones which give us the most trouble when we are asked for an opinion.

Mr. Huddleston: There are not only the species which are used in the ground. Brushwood species give a lot of trouble through use in external joinery, where decay causes deterioration of sashes and joints. We need to know something of the brushwood species as well as the eucalypts. Will this method give it to us?

<u>Mr. Jennings</u>: You are not likely to get more reliable information than you already have. Most opinions will be based on whether the timber lasts in the ground.

Mr. Da Costa: One of the purposes of the survey is to show the conflicting opinions. Sometimes opinion will agree but other times there will be a great variation regarding the one timber.

Mr. Grenning: Should we include some of the better known overseas species? English oak is regarded as a strong, durable timber, which we know it is not.

Mr. Clarke: Would the States be in favour of lists being sent to each Forest Service to get best opinion available on the species?

Mr. Da Costa: We want to get an estimate based on field experience to compare with our laboratory results. We will circulate a list to the States.

(b) Laboratory Decay Resistance Tests

in laboratory tests are continuing in the Division and results are now available for over thirty species. In general, the results follow closely the durability ratings ascribed to these timbers beforehand, and it is now considered that a timber species of unknown decay resistance could be assigned to one of the four main resistance grades 1-4, by this method. The results show that there is a large variation among trees of the same species, and also that relative decay resistance depends to some extent on the test fungi used, so that more precise comparison of timbers may require further tests, using more trees than the 4-8 trees of each species so far tested.

Investigations of this inter-tree variation, and the causes of it, have been commenced for jarrah and will also be carried out for a number of other important species. In this connection, it is hoped to investigate the extent, if any, to which fast-grown trees are less

durable than slow-grown trees of the same species, and the co-operation of the State Forest Services in the selection of suitable species and collection of suitable trees for this work is sought.

Discussion:

<u>Wr. Jennings</u>: We could get material for varying growth rates.

Mr. Huddleston: We can supply that in some species, but I should think it would be difficult to get definite data to show whether the individual tree is fast grown or slow grown in other species. We could supply in ironbark and certainly in blackbutt, blue gum and other similar species.

Mr. Jennings: We can give it to you, particularly in ironbark and blackbutt.

Mr. Crane: We could give it to you two ways. We can give species by sites or by difference in growth rate through competition between individual trees on the same site.

Mr. Da Costa: Trees of fairly advanced age are required.
Mr. Clarke: The importance of comparing fast and slow grown is indicated by the fact that we have in the past been dealing with natural forests and people looking for the most durable timber go for slow-grown material.

(c) Field Durability Tests

It is proposed to carry out a series of graveyard tests on Australian timbers at various sites throughout Australia, using 2 in.x 2 in. stakes. This work will give a direct indication of relative service life of the various timbers in such usages as fence posts or poles, and may enable some estimate of the actual service life of each timber under some conditions of service. It will also provide valuable data on the extent to which the results of measurements of the resistance of timber to decay and termite attack in the laboratory can be used to predict performance under field conditions.

A working plan for this series of graveyard tests is being prepared, but before completing this it was thought desirable to seek the co-operation of the State Forest Services and other organizations concerned, and the present summary of the proposed work is issued as a basis for discussion at the 1954 Forest Products Research Conference.

Timbers in Test

The species to be included in the initial series of tests are listed in Table I. Sufficient material has already been collected of most of these species to enable an immediate installation of stakes, although in some species there are gaps in the collection which will need to be filled before testing can commence. Several imported timbers have been included in the tests to enable comparison of the results with overseas test results and service data. In addition to the timbers listed, it is hoped to make further installations of other species, or of additional trees of important species, at intervals of 2 - 3 years as material comes to hand, or as questions are raised as to the durability of various timbers.

Sampling of Each Timber

It will be essential for comparison of timbers that an adequate number of stakes of each timber be installed on each site, ten stakes being suggested as the minimum number permissible. Because wide variation in durability among trees of the same species is expected, a number of trees must be represented. Also, in order to estimate the size of this inter-tree variation and to permit closer correlation between field results and the results of decay resistance and termite resistance tests on matched material in the laboratory, duplicate samples from each tree will be required. It has therefore been decided to test five trees of each species and to install two stakes from each tree on each of the five test sites; this arrangement fits in with the limited amount of material available from each tree in our collection material.

The five trees of each timber tested will be selected to represent as wide a range of geographical origin as possible.

Test Sites

It is not possible with a small number of sites to cover all the variations in climate and in decay and termite hazard which occur in Australia, but it is hoped to establish tests in all the major types of climate and in conditions of severe, rather than average, termite or decay hazard. The exact location of sites has not been decided, but the following areas are tentatively proposed:-

- A. Coastal belt, winter rainfall area.
 - High decay hazard, negligible termite hazard (? Belgrave, Victoria)
- B. Inland area, winter rainfall.

High termite hazard, moderate to low decay hazard (? Canberra A.C.T., ? Deniliquin, N.S.W.)

- C. Coastal area, high summer rainfall, uniformly high temperature. High decay hazard, negligible termite hazard (? Cairns, N.Q., ? Lae, N.G.)
- D. Coastal or inland area, summer rainfall with long dry season.

 Moderate decay hazard, high termite hazard

 (? Townsville, N.Q., ? Katherine, N.T., ? Darwin)
- E. Coastal area, summer rainfall or uniformly distributed rainfall, moderate temperatures in winter.

High decay hazard, nil to moderate termite hazard (? Brisbane, Q., Coff's Harbour, N.S.W.).

The sites selected must be available for a minimum period of 25-30 years, must be completely or almost completely cleared and must be protected from damage by fire, water erosion, straying stock or vandals. The growth of grass and weeds etc. thereon will need to be kept within bounds (e.g. by slashing or mowing when the growth exceeds 3 ft. or just before inspections).

It would be an advantage, although not essential, to use sites adjacent to those to be used for the small specimen graveyard test of preservatives, as this would facilitate maintenance and inspection.

Each site will be divided into a number of sub-sites for laying out the experiment, and these sub-sites may be contiguous or up to half a mile apart. The number and shape of sub-sites, and the arrangement of individual stakes of the various trees and the various

species on the site, will be decided by the Section of Mathematical Statistics when the ground available at the site has been surveyed and the amount of test material available of each species determined. Preparation of Stakes

Stakes will be cut from the outer heartwood of the tree, preferably near the base of the butt log. They will be sawn to give a finished size of 18 in. x 2 in. x 2 in. when air dry and will be pointed to facilitate replacement after inspection. All stakes will be free of sapwood, heart, incipient decay, severe checks or other blemishes. The stakes in each site will be numbered in order to indicate their position in the site and this number will be stamped into the end grain on the upper end of the stake and protected by a coat of red lacquer. Installation of Stakes

Stakes will be set out at 2 ft. intervals in parallel rows 3 ft. apart, the order of the stakes in the row being determined by the serial numbers stamped on the upper ends. A hole will be opened with a crowbar and the stake forced gently down until it is buried to a depth of 12 in. with the top projecting 6 in. Installation should be carried out, on the one site, in a period of 3 days; and it would be preferable to install stakes at all sites within a 3 month period.

Inspection of Stakes

Stakes will be inspected at yearly intervals by removing the stake carefully from the ground, and inspecting it to make a visual estimate of the amount of decay and of termite attack, separately, as "nil", "slight", "moderate" or "severe". Any stakes which are so weakened that they break readily in the hands will be regarded as "failed" and removed from the test. Such "failed" stakes will be forwarded immediately to this Division for examination in the laboratory to determine the nature of failure, and, where possible, the species of termite or fungus responsible. Other stakes will be replaced in the same position, depth of insertion and orientation as they had had previously. Assessment of Results

The comparative durability of the timbers tested will be assessed on two bases - the time taken for stakes to reach the "failed" condition; and the average condition of the stakes at the most recent inspection. On either basis, the results will be analysed to establish the statistical significance of differences between species for each site as well as over-all.

TABLE 1
TIMBERS TO BE INCLUDED IN FIELD TEST

Standard Trade Common Name	Labell- ing Code	Botanical Name	Density (a)	Expected Durabil- ity(b)	
Blackbutt	В	Eucalyptus pilularis Sm.	55	2	
Black peppermint	BP	E. salicifolia Cav.	100	3	
Brown stringybark	BS	E. capitellata Sm. E. blaxlandi Maiden & Cambage E. baxteri (Benth.) Maiden & Blakely	56	3	
Brush box	BB	Tristania conferta R.Br.	56	IT 3D(0)	
Forest red gum	FRG	E. umbeliata (Gaertn.) Domin. E. blakelyi Sm. E. seeana Maid. E. bancrofti Maid.	61	1	
Grey box	GB	E. hemiphloia F.v.M. E. largeana Blakely & de Beuz.	70	1	
Grey ironbark	GI	E. drepanophylla F.v.M. E. paniculata Sm. E. fergusoni Baker	69	1	
Gympie messmate	GM	E. cloeziana F.v.M.		1	
Jarrah	J	E. marginata Sm.	51	2+T 2D(0	
Karri	K	E. diversicolor F.v.M.	56	3	
Manna gum	MG	E. wiminalis Labill. E. manifera (Cunn. Herb) Mudie	51	3	
Marri	M	E. calophylla R. Br.	53	3	
Messmate stringybark	MS	E. obliqua L'Herit	47	3	
Mountain ash	MA	E. regnans F.v.M.	44	4	
Mountain grey gum	MGG	E. goniocalyx F.v.M.	54	3+	
Myrtle beech	MB	Nothofagus cunninghamii Oerst.	44	3-	
Oregon (Douglas fir)	0	Pseudotsuga taxifolia (Lamb.) Brit.		3-	
Raspberry jam	RJ	Acacia acuminata Benth.	66	IT 2D(c)	

TABLE 1 (contd.)

Standard Trade Common Name	Labell- ing Code	Botanical Name	Density (a)	Expected Durabil- ity(b)	
Red ironbark	RI	E. sideroxylon A. Curm.	66	1	
Red mahogany	RM	E. resinfera Sm.	59	2+	
Red stringybark	RS	E. macrorrhyncha F.v.M.		3	
River red gum	RRG	E. camaldulensis Dehn.	56	1-	
Rose gum	RG	E. grandis (Hill) Maiden	49	3+	
Salmon gum	SAG	E. salmonophloia F.v.M.		3T 2+D(
Satinay	S	Syncarpia hillii Bailey	52	2	
Scribbly gum	SOG	E. micrantha DC.	55	3-	
Silvertop ash	SA	E. sieberiana F.v.M.	53	3+	
Southern blue gum	SBG	E. bicostata Maid. Blakely & Simmonds E. globulus Labill.	56	3	
Spotted gum	SG	E. maculata Hook.	65	2-3	
Swamp box	SB	Tristania suaveolens Sm.	51	2+	
Tallowwood	TW	E. microcorys F.v.M.	62	1	
Teak (d)	TK	Tectona grandis L.f.		1	
Turpentine	T	Syncarpia laurifolia Ter	. 59	1-	
Wandoo	W	E. redunca Schau.	68	1	
Western red cedar(d)	WRC	Thuja plicata D.Don			
White cypress pine	WCP	Callitris glauca R. Br.	42	1T 2D(c	
White stringybark	WS	E. eugenioides Sieb.	52	2-	
Yellow box	YB	E. melliodora Cunn.	65	1	
Yellow gum	YG	E. leucoxylon F.v.M.	64	1	
Yellow stringybark	YS	E. muelleriana Howitt.	55	2	

(a) Density = average density for species as lb./cu.ft. at 12 per cent. moisture content, before reconditioning.

(b) Expected durability - expected performance under conditions of test; 1 = highly durable; 2 = durable; 5 = moderately durable; 4 = not durable; + = more durable than most of this class; - = less durable than most of this class.

(c) Where decay resistance and termite resistance are expected to vary markedly, durability in termite areas (T) is given separately to that in areas where only decay hazard is present (D).

(d) Imported timbers.

Discussion:

Mr. Jennings: We could possibly provide you with two of the sites, at Mt. Glorious and Gadgarra. On these two sites we will have some stakes of our own for testing of oil borne preservatives. From our point of view if we are going to do the actual evaluation for you it would be desirable that your stakes and ours be in the same area. We would be quite happy to do the evaluation for you. It has to be decided how you are going to ensure uniformity between observers.

Mr. McAdam: In New Guinea we could make a site available adjacent to the preservative testing site. It would probably be secure for the next 25 years.

Mr. Da Costa: One of the difficulties is getting away from the termites. It will be desirable to "trap-stake" suggested sites with P. radiata to see what the extent of the termite hazard there is. At Mt. Glorious I think it is fairly severe; we had some stakes there two or three years ago. We had three sites around Brisbane, and Jolly's Lookout was the best with regard to freedom from termites.

Mr. Huddleston: We can find sites at Coff's Harbour and also at Mathoura and Deniliquin, although at Deniliquin we cannot do much. They would all have to be on State Forests.

Mr. Gay: There is a field station at Deniliquin and we have some tests there already. If you wanted a site in Canberra free from termite hazard I would suggest that in the radiata plantations the termite hazard is extremely low and they would be quite suitable. Before clear felling took place there were quite a number of mound colonies. If there are any marginal invasions after the field tests have been running for a while they could be sealed off.

Mr. Ds Costa: The best thing is for us to get in touch with the various States and discuss with them the location of sites. Coff's Harbour would be very suitable from the climatic point of view.

Mr. Grenning: It was mentioned before that you find a big variation in durability within a species. How are you going to get sufficient material of each species that would be representative?

Mr. Da Costa: For this field test we are proposing initially to use five trees of each species. This is not a fully representative sample of the species but it gives an indication and fulfils well enough the second purpose of the test - to correlate the laboratory and field results. We will be doing laboratory tests on the same five trees and that will be ample to give us the correlation.

Mr. Booth: Is the list of timbers final - has any thought been given to bloodwood?

Mr. Da Costa: The list of timbers should read "Timbers to be used in First Installation" because they are timbers we have in stock or which we can obtain quickly. If we can get bloodwood within the next three or four months we could include that too. We will also include kwila from New Guinea if we can get it in time.

Mr. Crane: We can do a test in Tasmania, either in the north or south.

Mr. Da Costa: We would like to have one test close by so that we can maintain our own observations, so would prefer to have the southern "decay" site in Victoria if we can get away from termites there.

ITEM 5 (a) REPORT ON LYCTUS INVESTIGATIONS AT DIVISION OF ENTOMOLOGY, C.S.I.R.O.

Mr. Gay: Since the last Conference, the nutritional studies, which I reported to you then, have been carried on to some extent. In these studies we have been interested in the problem of the basic requirements of Lyctus larvae and, as I told you previously, we had succeeded in rearing the larvae through to adult stage on a completely synthetic diet. We have been altering that diet and checking over the ingredients to show what the basic requirements were. We had thought at one stage that there was evidence of the need of some accessory food substance other than starch and we thought it might have been sugar in some form or other. We found that various sugars could be substituted in the diet for sucrose, etc., which were originally present, without having any deleterious effect, as the larvae developed quite

satisfactorily whether any sugars were used or not. Then we found subsequently that if we eliminated sugar completely we still got quite satisfactory growth. Eventually we managed to put the larvae on a diet consisting only of starch, yeast and cholesterol. The starch was the basic part and the yeast provided the Vitamin B complex; it also apparently supplied them with sufficient salt. The yeast provided ash and possibly enough protein in the form of nitrogen for their requirements, and the cholesterol was absolutely essential in order to support insect growth. The significant feature in the diet is the cholesterol or some other sterol, and in many cases it may be the limiting factor in the amount of attack which takes place on various timbers.

On the question of the starch I reported to you last time that we had tested starch substitutes. We had samples of amylose and amylopectin prepared by fractionation of the starch and we got satisfactory development on both these materials, which was interesting because neither gives the characteristic starch reaction with iodine. I have also been able to grow these insects on a diet in which starch was replaced by glycogen. I have not been able to find any evidence that glycogen occurs in wood. Glycogen of course does not have a characteristic iodine reaction.

Another feature of the dietary work was the investigation of possible reasons for immunity of such timbers as Cryptocarya and Melicope. Both of these timbers give characteristic starch reaction, indicating there is adequate starch present. I have thought it was possibly due to the presence in the timber of some toxic substance in the form of alkaloids which kill the young larvae shortly after hatching. With the assistance of Dr. Price of the Alkaloids
Investigations Section we obtained a number of samples of extraoted materials from these two timbers and incorporated them in the synthetic diet at the same concentration as they occurred in the wood. The total methanol extract of both those timbers was toxic and no larval

development took place. We fractionated the complete extractives and Dr. Price obtained four different extractions (ethanol soluble and ethanol insoluble fractions etc.). None of those individual fractions showed any toxicity at all so that it would appear that the toxicity is possibly due to some sort of synergistic effect between two of the fractions, or to some additive effect. None of the individual fractions isolated so far have shown any toxicity at all.

That is briefly our progress in the nutritional work to date.

Dr. Ellwood: What have you programmed for the future as far as Lyctus investigations are concerned? Would you be amenable to suggestions of carrying out evaluation of preservatives on Lyctus?

A comparison of some of the newer preservatives becoming available, also pentachlorphenol, would be very valuable. I think we could combine on that.

Mr. Gay: Yes, we would be very interested in any suggestions for future work. I have someone I can put on to such work.

June or July.

LYCTUS TESTS - TOXICITY OF PRESERVATIVES AND THE SUSCEPTIBILITY OF VARIOUS QUEENSLAND TIMBERS**

Since the last Forest Products Conference work on two main aspects of the Lyctus problem has continued.

A. Preservation Tests

- (i) Boliden Salt Test: This test is being conducted in cooperation with Rosenfeld & Sons and the Queensland Forest Service. At prosent Rosenfeld's anticipate using Boliden salt as a general word preservative. While it is felt that this preservative at normal field retentions will give complete protection against Lyctus, there is no experimental evidence to support this view and no information on minimum safe concentrations. As arranged with the Queensland Forest Service a toxicity test to determine the lethal concentration of Boliden normal salt to Lyotus has been commenced. Also, two salt components of the Boliden salt mixture, namely line sulphate and arsenic pentoxide, are under separate test together with Tanalith U and boric acid. Three timber species (pepperwood, silver ash and brown tulip cak). representing low, medium, and high density have been impregnated with each preservative in 5 to 7 concentrations. The three timbers are expected to show whether or not density affects the lethal concentration. The whole test entails the impregnation and preparation of some 3000 specimens. Initial inoculation with Lyctus beetles has now begun and results should be available during
- (ii) Glue Line Test: This test was commenced in 1946 and entailed the addition of seven chemicals to urea and casein glue used in the manufacture of three-ply from susceptible sapwood. Since the test commenced a total of 14,600 beetles has been added to the forty cages housing the test panels. At the last inspection (1953) the results were promising only for benzene hexachloride. D.D.T., which at the 1949 inspection appeared

m Prepared by the Division of Forest Products

satisfactory at the higher concentrations, has since lost its effectiveness. Borax and boric acid have also become progressively less
satisfactory. The remaining chemicals, sodium pentachlorphenate,
pentachlorphenol, microfine sulphur, and sodium fluosilicate, were
shown to be ineffective before 1949.

Benzene hexachloride at the lowest concentration (4 lb. per 1000 sq.ft. single glue line) has now proved satisfactory for 62 years and can be recommended for at least this period. There is no information at present to show that this method of protecting susceptible plywood has been used commercially, but we are prepared to recommend it where a temporary treatment is required.

Toward the end of 1950 it was decided to test benzene hexachloride on a semi-commercial basis. The Veneer and Gluing Section, with the co-operation of the Queensland Forest Service and the Australian Plywood Board, have carried out this test, and Mr. Gordon will report progressive results. Material was also placed in test at Brisbane and it would be of interest to have this section of the test reported at the Conference.

B. Sapwood Susceptibility Test

This test was first proposed in 1949 in a letter from the Queensland Forest Service requesting the Division to determine the susceptibility of some 82 Queensland species on which information was lacking. The matter was discussed further at the Forest Products Conference in 1949 when it was arranged that samples of 80-90 species of unknown susceptibility be forwarded to the Division for test. The first consignment of 44 species comprising 120 samples arrived at the Division during October, 1952. These specimens were starch tested, prepared and divided into two matched sets. One set was inoculated with Lyctus at the Division and the other was forwarded to Mr. Gay at Canberra for independent testing. Inoculation commenced at the Division on 4/5/53 and was completed on 22/4/53.

The starch loading in approximately 75 per cent. of the species, based on the loding test appeared insufficient to support attack. An examination of specimens during January, 1954, confirmed

this when emergence from specimens of only 10 species was recorded. A similar pattern of attack was also observed by Mr. Gay.

It therefore appears that a recasting of the test may be expedient.

The specimens from which samples were cut arrived either in sections approximately 2 ft. x 5 in. x 5 in. or 5 - 8 in. diameter billets of the same length with the bark intact. The collection of such specimens, together with their preparation for test, naturally took some considerable time. As a result, it is possible that some starch rescription had taken place before the specimens arrived at the Division. On the other hand, we cannot be certain that the apparent immunity of some species was due to starch rescription before testing.

While the Division is very willing to co-operate in this test, the inoculation of specimens in jars and the duplication of the test at Canberra is very time-consuming. To reduce work to a minimum and also to increase the accuracy of the test, the following suggestions are offered for discussion.

- Smaller specimens be cut from a greater number of trees of each species and allowed to dry as rapidly as possible before packaging.
- 2. These specimens be all tested under one set of conditions either by the Queensland Forest Service, this Division, or the Division of Entomology. To reduce the labour of testing, these specimens be stored on shelves and if necessary given periodic inoculation by Liberating Lyctus beetles.

Discussion:

Mr. Jennings: As to whether starch resorption took place I don't think we can tell you for sure, but I will look into the question. The iodine test can be difficult and is not always reliable. If you want us to do the testing, we would find difficulty in providing the Lyotus population, and have no facilities. We regard this work as basic and consider it better done by you.

Mr. Tamblyn: I would like to hear Mr. Gay's comments on whether the tests should be continued in the present form. Doing the test the way we have done is time consuming and we feel that simply storing the specimens on shelves and giving them a mass inoculation with beetles would produce the same result. However when we embarked on the test we promised to do it a certain way so that we could get two sets of results from different operators. I don't want to go back on that promise unless weight of opinion is that we do so.

Mr. Gay: Firstly to give you an idea of my results: I have not inoculated all the blocks I received, only 215, representing 45 tree species, and from those there have been emergences from only 14 blocks, and signs of activity in 5 other blocks. There is something odd here as we should have got a much higher proportion of attacked blocks. We would be prepared to carry on the test; we have overcome the temporary difficulty of stocks and the only other hitch is likely to be adequate supplies of material - we are having difficulty in getting good starch susceptible timber. We were using Sloanea which appeared to have adequate starch but after a while the starch disappeared.

I would prefer to see the tests carried on in the way they were first started. There is the possibility of preference on the part of the beetle for certain timbers, but that preference may not hold under actual service conditions and it may give you a false impression of some timbers.

ITEM 5 (c) FUNIGATION OF TIMBER *

Rather limited progress has been made in our investigations into the funigation of timber since our report to the last Conference. The commercial use of methyl bromide for the sterilization of timbers infested with insects is now well established. Due to a considerable reduction in the price of the gas, the process is now very economical and replaces heat sterilization especially where such work must be carried out in situ.

This work has been extended to the field sterilization of turpentine poles. In one case, 160 piles, measuring up to 80 ft. in length were fumigated in groups of about 50 by covering them with large polyvinyl chloride covers and fumigating at the rate of 2 lb./1000 cu.ft. for 24 hr. A complete kill of the bark beetles infesting these piles was obtained.

Further experiments were carried out to test the efficacy of methyl bromide against staining and wood destroying fungi. Eight organisms were included in these tests and it was found that high concentrations, such as 12 lb. methyl bromide/1000 cu.ft. for 96 hr., were necessary before complete sterilization was achieved. Lower concentrations of methyl bromide were found to be ineffective against the test organisms.

The extension of this work to cover the fumigant ethylene dibromide, suggested at the last conference, has yielded rather disappointing results, mainly on account of its low vapour pressure which does not allow sufficient diffusion of the fumigant for fumigation under atmospheric conditions.

Work on other fumigants is being extended - particularly with a view to obtaining immunization as well as sterilization by fumigation. In this regard we have carried out an extensive literature survey and it appears that some fumigants have given surprisingly long immunity against insect attack to various materials. The most promising of these fumigants will be tested shortly.

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

J. B. Cartwright, D. W. Edwards and M. J. McMullen, Nature, Vol. 172, P552 Sept. 19, 1953.

Discussion:

Mr. Gay: Ethylene dibromide is much less effective if applied the same way as methyl bromide. The normal practice is to apply the former by means of an atomizer. You can also vaporize ethylene dibromide from a hot plate. There has been considerable success with ethylene dibromide in Hawaii with fresh fruit.

Mr. Tamblyn: What practical application does Mr. Booth foresee in using fumigants for controlling decay? Could an internal heartrot in a pole be controlled by fumigating through a bored hole?

Mr. Huddleston: I don't think there is any application in connection with poles or for use in the ground, but there is an application for fumigants for such things as timber for battery separators, when it is necessary to prevent mould growth on timbers partly green, and also for some timbers which are prone to grow mould and which are difficult to kiln dry. One timber which gives trouble is erima from New Guinea, where mould growth can occur during a week-end shut down of the kiln if the moisture content of the timber is above 18 per cent. Methyl bromide can satisfactorily prevent mould growth in these circumstances.

5 (d) INVESTIGATIONS INTO THE USE OF DICHLOROFTHYL FITHER AGAINST LYCTUS AND ANOBIUM

Mr. Huddleston: Some 12 months ago Mr. Hadlington saw reference to the fact that dichloroethyl ether was in use against Anobium and Lyctus. The article which came under his notice seemed to show so much promise that he carried out some laboratory investigations, first by treating blocks of timber with a brush treatment of dichloroethyl ether, putting those blocks of timber in jars, placing Lyctus in each jar and measuring the effect on the Lyctus. He found that he got 100 per cent. kill. At the same time he was testing dieldrin and, I think, aldrin, at the request of the Shell Oil Co., and for that purpose he had a number of blocks which had been inoculated and which were actively infested with Lyctus larvae. He applied a

brush treatment of dichloroethyl ether to some of those blocks and found that he got a complete kill of the larvae in the blocks within 24 hr.

At about that time an attack of Anobium in spotted gum came to our notice. He decided to try dichloroethyl ether to control this attack and obtained the co-operation of Houghton and Byrne who fogged the undermeath portion of the building with a solution of dichloroethyl ether and subsequently cut a section of the 4 in. x 2 in. spotted gum joist out of the flooring. About 6 weeks after the treatment he tested the 4 in. x 2 in. section for the presence of dichloroethyl ether in the centre and found it was still present. Examination of the block showed that all Anobium larvae present had been killed.

Subsequent to that he carried out further investigations against Lyctus and found that with a straight brush treatment on infected material he could get a complete kill of the Lyctus larvae.

The application is very simple, just a straight out brush treatment which seems to provide sufficient material on the surface to penetrate very deeply into the timber. We now recommend dichloroethyl ether in preference to pentachlorphenol. We realize there is probably no residual effect and for that reason we are suggesting that dieldrin be added to give a surface protection.

Dr. Ellwood: In the test we did here on small blocks the residual effect of dichloroethyl ether was nil. The initial toxicity obtained from it was lower than some of the others because we had allowed a period of 24 hr. to elapse for the solvents to evaporate. That was sufficient to allow the dichloroethyl ether to evaporate giving it a lower initial toxicity.

Mr. Gay: In a communication I had with Mr. Hadlington he said he was using chlordane. Has that been superseded?

Mr. Huddleston: At one stage he did use chlordane but he is now preferring dieldrin.

Mr. Gay: Under field conditions against Argentine ants dieldrin gives kills after 12 months.

Mr. Clarke: Is it worth while for Lyotus? Is there any advantage in killing Lyctus if you are only going to immunize the timber for a year or two?

Mr. Huddleston: Nevertheless the people want a recommendation for a material which will kill Lyctus. In the case of trim, if you can eliminate the Lyctus and maintain your surface coating you will not get a Lyctus attack.

<u>Dr. Ellwood</u>: It points out the need for someone to take on these tests. There is reason to believe that the permanence of some of these chlorinated organics may be considerably longer under some conditions than the ones we have been using in the past.

Mr. Clarke: There is obviously a problem here; we are not happy about pentachlorphenol, and we want something which can be recommended to the householder. If you kill Anobium without immunizing you have overcome the problem for 8 or 10 years or more, but that is not necessarily the case with Lyctus.

Mr. Gay: We really need to know something about the permanency of aldrin, dieldrin and ohlordane.

Mr. Tamblyn: If it can be shown that dichloroethyl ether vapour does penetrate deep into the timber then it would seem worth considering as an alditive to other preservatives.

ITEM 5 (e) THE SUSCEPTIBILITY OF P. RADIATA TO ATTACK BY ANOBIUM

Mr. Beesley: This Division commenced research into the susceptibility of Pimis radiata to attack by the common furniture borer, Anobium punctatum, during the summer of 1949/50. This test, which was fairly ambitious, was made in co-operation with the New Zealand D.S.I.R., and was designed to give some factual information on the susceptibility of P. radiata grown in different localities in both Australia and New Zealand, to attack by Anobium. Unfortunately,

the oviposition obtained on the test specimens during the 1949/50 flight season was so poor that, at the 1952 Conference (item 8(d)) the test was reported to have been a failure. This opinion was more or less confirmed during the summer of 1952/53 when some 170 adult beetles emerged from 180 test panels (representing the 9 Australian grown trees). Apart from one panel yielding 106 adults, and another yielding 25, fewer than 10 adults emerged from any of the test pieces. These emergence figures seemed to suggest that the test procedure was satisfactory even if most of the timber used was not acceptable to the insects. Emergence during the 1953/54 flight season was also disappointing.

Because of the unsatisfactory results obtained in the original test, the Division gladly agreed to a New Zealand suggestion that the test should be repeated during the 1953/54 flight season. For this test specimens were taken from 28 different trees, between 6 in. and about 14 in. in diameter, from plantations in South Australia, Victoria and the Australian Capital Territory. The specimens were out in the form of blocks, about $3\frac{1}{2}$ in. wide and $3\frac{1}{2}$ in. deep, extending from bark to bark through the pith.

Satisfactory oviposition was obtained on these blocks and first emergences are to be expected during the summer of 1955/56, with the peak occurring about 2 years later.

During the 1952/53 flight season the Division started a second test to determine the susceptibility of P. radiata in comparison with other timbers. Test insects were obtained from the Division's insectary. By using 7 pairs of insects in each test jar, containing 3 test blocks, egg counts gave the following result:

Species	Supplied from	No. of trees	No. of eggs counted		
			Av.	Max.	Min.
P. radiata	New Zealand	2	67	112	22
	N.S.W. (Wagga)	2 2 5 2 4 3 2 5 5	70	104	37
	Tagmania	5	58	116	15
	South Australia	2	45	84	7
	Victoria, Central	4	67	165	12
	" , North	3	24	34	8
manage of the same	, West	2	107	202	13
Spruce	Europe	5	2	8	0
Scots pine N.Z. white pine	New Zealand	10	40 10	95 92	1 5

In all cases about 90 to 95 per cent. of all eggs were laid on the end grain of the test blocks, which were left rough sawn.

From all these observations it is safe to say that Anobium is capable of infesting freshly milled timber, and that P. radiata is no less susceptible to attack by this pest than many other softwoods which have been used in Australia.

Although not an Agenda item, it is worth mentioning at this point that the Division has received requests for advice on the Anobiid, Ernobius mollis over the last few months.

This pest, which is very like Anchium, lives in the cambial zone of softwoods, such as \underline{P} . radiata; it attacks dry timber, but only when the bark is present. It is sometimes found in the pith as well. Its attack seldom extends more than about $\frac{1}{2}$ in. into the wood beneath the bark so far as we have observed.

This Division would be interested to receive notification of any attacks by this pest, as it is comparatively rare, but may be increasing in Australia.

Mr. Grenning: Have you any evidence of attack of Anobium in radiata which has been in position for a period of years?

Mr. Beesley: There have been one or two reports from South Australia, but little else.

Mr. Cay: In Camberra there is quite a large amount of radiata milled and consequently there is a considerable supply of offcuts, which people have been using for sheds, etc. Nearly everyone using this material has been reporting outbreaks of beetles which are attacking these offcuts. In all cases attack is due to Ernobius. It is not causing any serious damage but the owners are very concerned.

Mr. Clarke: One of the most serious problems is that with radiata you often have included bark round a knot; Ernobius infects the bark and it can be very serious if the material is used as a corestock.

Mr. Gay in Pinus pinaster at Gnangara in Western Australia.

ITEM 5 (f) GLUE LINE PRESERVATIVES

Mr. Gordon: The commercial test of glue line preservatives was initiated in December 1950, by the preparation of plywood in a commercial plant in Brisbane using veneers which had been selected as susceptible to Lyctus attack. Three species were involved and these were made up into 100 sheets of plywood glued with casein glues incorporating benzene hexachloride containing approximately 12-13 per cent. gamma isomer, so that the glueline contained B.H.C. at the rate of approximately 1 lb./1000 sq.ft. of single glueline. As controls, a further 25 sheets were made up using casein glue of the same formulation with the exception that no B.H.C. was included in the mix.

In August 1951, 100 sheets of plywood, using tested veneers of two Lyctus susceptible species, were made up at a second commercial plant in Brisbane. In this case the B.H.C. was incorporated in the casein glue at the rate of \(\frac{1}{4} \) 1b./1000 sq.ft. of single glueline and a further 25 sheets were made up without preservative for use as controls. All this plywood was cold-pressed. When the first two batches were received at this laboratory for installation in March 1951, the control sheets were already showing considerable Lyctus attack, which had doubtless been initiated over the summer period while the sheets were in Brisbane. Several months elapsed before the control plywood accompanying the second batch was attacked. Attack had continued in both control batches but at a somewhat reduced rate.

As in the laboratory test, beetles for reinoculation have been introduced into the wall cavities behind the plywood at intervals and the exposed surface of the plywood made in the second test batches was not painted. After 3 years there is no sign of attack in any of the plywood containing "Gammexane D.919" (B.H.C. 12-15 per cent. gamma isomer).

The experiments, both on laboratory and commercial scale, have been confined to glues which have been cold-pressed and to attack by Lyotus borers.

Mr. Jennings: Our fundamental question of this method is that we do not see any particular advantage with regard to cost, which is in the vicinity of 2.11 pence for B.H.C. for 100 sq.ft. of 3/16 in. ply and 2.51 pence for boric treatment. The main disadvantage from our point of view is that you don't get any protection for stored veneer. In Queensland they quite frequently store veneer in order to continue plywood mamufacture during the wet season when they lack log supplies.

Mr. Gordon: Before leaving this subject, does the Conference wish to make a recommendation for use? We regularly receive from Australia and from overseas enquiries asking for information on the method and what our recommendations are. Previously we have been very cautious.

Mr. Jennings: From our point of view we would not be prepared to make B.H.C. an approved treatment under the Act for the reason that they don't get protection for the veneer. Storage conditions are a very real problem with the northern mills.

Mr. Clarke: So far as we know B.H.C. is not a permanent treatment. We know now that boric acid treatment costs very little more and there does not seem any justification for using B.H.C. instead of boric acid.

Mr. Huddleston: I have no objection to that.

ITEM 6 (a) REPORT ON TERMITE INVESTIGATIONS AT DIVISION OF ENTOMOLOGY C.S.I.R.O.

Mr. Gay: The termite investigations carried out since the last conference are not essentially different from the broad lines covered then. The field testing has consisted of the 25rd annual examination of the international termite exposure test and I don't propose to say anything about that nor about our tests in co-operation with the Division of Forest Products. There are just a few points about the soil tests in which we are interested.

We have two areas now in which we are carrying out tests on soil poisons, one in the Canberra-Braidwood area and the other in the Riverina. In the Camberra area the tests are being carried out around mound colonies of wood destroying species and in the Riverina the same types of tests are being carried out against subterranean species. The Camberra-Braidwood tests have been running now for 6 years or so, the Riverina tests for about 12 months.

The outstanding feature about the Camberra-Braidwood tests is that pentachlorphenol failed after 4 years. Creosote is still giving some protection. In all cases the dosage was the same, 0.5 gal./cu.ft. of soil. Sodium arsenite is still giving protection, and DDT (5 per cent. solution) is still proving effective. Quite recently we have put in another test of chlordane and dieldrin; the former has given protection for 2 years and the dieldrin 1 year.

The laboratory testing has been very largely concentrated on <u>Coptotermes acinaciformis</u>, for us the most important because it is the most widely distributed species. Mastotermes is the most important in the areas in which it occurs. <u>C. acinaciformis</u> is present in all States and it will certainly be the number 1 test species.

We carried out quite a number of tests in Queensland during the past year. The results of these tests are quite interesting. During this last season we put in about 380 test colonies, twice as many as last time. The types of materials tested were cable coverings, various hardboards of the Masonite type, and also that of Paper Makers Pty. Ltd. Preservative treatments included dieldrin, chlordans, and A.42. We have tested certain overseas and Australian commercial timbers.

We also tested the addition of pentachlorphenol to rubber cable. These tests, in which the materials were subjected to a severe hazard showed that the pentachlorphenol up to 2 per cent. concentration gave no additional protection to the rubber cable compounds. Six per cent. was effective but with 6 per cent. pentachlorphenol the rubber looked like a block of chalk and was much too expensive to consider. We have tested various types of metal-sheathed cables, including aluminium. They stood up quite well.

Concerning the hardboards, an interesting feature is the effect of adding quite small quantities of pentachlorphenol to the hardboard during the process of manufacture. The percentage loss of the untreated board is about 71 per cent. weight, during a 12-week test. With ½ per cent. of pentachlorphenol in the hardboard the amount of damage drops to about 15 or 18 per cent., with 1 per cent. pentachlorphenol the attack ranges from about 5 to 9 per cent.

With Burnie hardboard and Masonite we have noticed a very curious thing, the process of tempering of these boards, that is the process of adding an oil to the board during manufacture, increases the susceptibility to termite attack.

The next test was one in co-operation with the Division of Forest Products in the treatment of karri plywood. The treatments were - sodium pentaborate, copperized chromated zinc chloride, greensalt, copper borate, "Gelcure", zinc chloride and arsenic pentoxide, and untreated water controls. Treatments were made on karri, duplicate treatments on mountain ash veneer, and a third treatment at half strength on mountain ash veneer. The results showed that at the full strength treatment the sodium pentaborate was successful, as also was copper borate and the zinc chloride and arsenic pentoxide. There was one anomalous feature about zinc chloride and arsenic pentoxide treatment - the specimens showed little sign of termite damage but showed over 14 per cent. weight loss which I found difficult to explain.

The next series was on new types of preservative materials aldrin, dieldrin, chlordane, organical arsenical A.42. Treatments were
made on Sloanea australia as the susceptible timber and the materials
were tested at three concentrations, 0.01, 0.05, and 0.2 per cent.
A.42 was tested at 0.05 and 0.1 per cent. The results showed that
aldrin was the most outstanding of the materials.

At 0.2 per cent. none of these treatments, with the exception of the arsenical, showed as much as 5 per cent. damage,

whereas the untreated material showed 30 per cent. damage. Aldrin down as low as 0.05 per cent. concentration showed less than 1 per cent. damage, indicating a very high protective value for this particular treatment.

Two groups of <u>Sloanea</u> were treated with solvent only; one with water; and one with alcohol. The <u>Sloanea</u> treated with water or alcohol was more susceptible than the untreated control material.

Apparently the solvent removes some extractive from the <u>Sloanea</u>.

The last series of tests was on various types of commercial timbers, including a test on New Guinea mangrove. At the last Conference I gave you some information on the performance of these mangrove species against <u>Coptotermes lacteus</u> and, briefly, these tests showed that <u>Bruguiera parviflora</u> showed 70 per cent. destruction in 12 weeks; <u>Rhizophora apiculata</u> was probably resistant, showing about 14 per cent. destruction in the same period, and <u>Bruguiera</u> gymnorrhiza showed from 8 - 13 per cent. destruction.

Against Coptotermes acinaciformis, Bruguiera parviflora is heavily attacked, showing 60 - 68 per cent. destruction. Bruguiera gymnorrhiza is the most resistant, being just about double (26 per cent. destruction), the attack in C. lacteus tests and the Rhizophora apiculata is increased to 23 - 35 per cent.

The Malayan Forest Service are interested in termite resistance, and tests on some of their timbers may be of interest.

Three species which stand up under Malayan conditions are -

Betis (<u>Madhuca utilis</u>)
Membatu (<u>Shorea guiso</u>)
Nyatoh (<u>Palquium maingayi</u>)

These timbers have been tested both against <u>Coptotermes</u>

<u>lacteus</u> and <u>Coptotermes acinaciformis</u>. The acinaciformis figures show
that Betis suffers only about 2 - 4 per cent. damage in 12 weeks;

Membatu about 12 - 33 per cent.; and Nyatoh 4 - 11 per cent.

Tests on the following Australian commercial timbers have been carried out: E. micrantha, E. crebra, Syncarpia laurifolia,

E. paniculata, E. tereticornis, E. grandis, E. rostrata, E. propinqua, E. eugenicides, E. punctata, E. saligna, Acacia acuminata, Callitris glauca, E. calophylla, E. marginata, E. redunca, E. diversicolor, Castanosptermum australe, E. megacarpa, E. astringens, E. gomphocephala, E. patens and E. regnans.

There are two species in this collection which stood out. Black bean, which is the most resistant Australian timber as far as termite resistance is concerned, showed 1 - 2 per cent. destroyed in 12 weeks. Wandoo gave a very good performance also, showing only 5 - 16 per cent. destruction. Samples were from 10 trees. Figures for jarrah show 30 - 53 per cent. destruction.

Mr. Tamblyn: Regarding the termite susceptibility of jarrah, it seems that Mr. Gay's tests may not be discriminating between timbers which are not liked by termites and timbers which are definitely toxic. Practical evidence is pretty strong that jarrah is not highly susceptible in service to termites, including Coptotermes acinaciformis in Adelaide. We would be interested in a test in which Mr. Gay might include susceptible material with the jarrah to determine whether susceptible material is eaten and the jarrah left. If that is so, it would line up with practical conclusions. If jarrah is eaten, then we must abide by these results.

Mr. Gay: The jarrah would not be eaten. If you put two timbers of different susceptibility in the same test colony, the timber of greater susceptibility is always eaten preferentially.

Mr. Turnbull: In view of the doubts cast upon P.C.P. earlier, does Mr. Gay expect the good performance of P.C.P. in hardboard to continue if hardboards are exposed for a longer period?

Mr. Gay: We could check that by testing periodically to see if there is any indication of a drop-off in performance.

Mr. Da Costa It may be desirable to determine the permanence of P.C.F. in these hardboards, perhaps by a sun and wind exposure test for say 6 months. We included P.C.P. treated blocks

in our test on the permanence of copper naphthenates and it went fairly rapidly.

Mr. Booth: I suggest that in the case of hardboards v. solid timber, the difference is that P.C.P. is present at the pressing operation of hardboard production. This may lead to the formation of other chemicals, and might be a case for investigation. Conditions in the press amount to a high pressure temperature hydrolysis reaction.

Mr. Beesley: P.C.F. is supposed to be thermo-stable to 300°C., which is a little high to be affected greatly by temperatures normally used in the press. Is the P.C.F. included as the phenol or as the sodium salt?

Mr. Gay: I believe the Masonite people put it in in the form of the sodium salt.

Mr. Clarke: It could be precipitated with alum. In most hardboards they size the board with either wax or rosin size, which is precipitated by reducing to a pH of 4.5 with aluminium sulphate. If sodium pentachlorphenate is put in under these conditions it is converted to pentachlorphenol and it precipitates with the sizing material. However, I do not think a sizing material is normally used in the Masonite process.

Mr. Tamblyn: Was any analysis made of this hardboard?
Was the loading which you mention an analytical figure or one given you by the manufacturers?

Mr. Gay: It was an analytical figure given by the manufacturers.

Mr. Tamblyn: As I understand it, the sodium salt is put in with the slurry and the P.C.P. is precipitated on the wood fibres. You might get a result once, but it may not be a figure which is repeated every time. I suggest we do an analysis on Mr. Gay's material and see if we agree with the reputed figures.

Mr. Gay: I will have samples of the material sent to you for analysis.

ITEM 6 (b) THE NEED FOR STANDARD RECOMMENDATIONS FOR TERMITE SOIL POISONS **

Before discussing use of termite soil poisons it should be made clear that good building practice and correctly fitted metal shields are still considered the most reliable and permanent methods of safeguarding a building against termites in most parts of Australia.

The need for alternative measures arises mainly in buildings erected without attention to shielding and which have subsequently become infested, and in new constructions where the use of a mechanical barrier (concrete mat or metal shields) is considered by the builder to be either impracticable or too costly. This latter case is of common occurrence, particularly in brick or brick veneer houses where it is necessary to carry the shields around many engaged piers in the foundation wall.

Use of soil poisons clearly provides one of the best answers in the case of unshielded buildings and is usually an acceptable compromise in new constructions where the builder cannot be persuaded to fit shields. While there are many arguments against a compromise on the grounds that shielding of houses during erection is seldom impracticable and that the cost is relatively small, the fact remains that many builders are prepared to undertake soil poisoning but are averse to fitting strip shields into brickwork.

Although this Division is recommending use of soil poisons, particularly for remedial treatment in already infested houses, we have so far applied the recommendations cautiously to new buildings where metal shielding is not impracticable. The reasons for this caution are -

(a) The Division has made no tests of termite soil poisons and it has been necessary to base recommendations on results

^{*} Prepared by the Division of Forest Products

obtained by the U.S. Department of Agriculture and more recently by the Division of Entomology (Camberra). These latter tests have been proceeding only since 1947.

- (b) Although these tests are promising they have been made outdoors and have not clearly shown the degree of permanence which might be expected from soil treatments not exposed to weathering. In 1950 the U.S.D.A. were claiming only 5 years certain protection with the probability of 10-15 years being obtained.
- (c) The most satisfactory method of applying the treatment has still to be decided. The U.S.D.A. have been recommending application in a 12 in. deep trench around the external foundations of a building. We have preferred to recommend application in a shallow (3-4 in. deep) trench around all internal foundations.

Because there is need for soil poisoning in Australia, there is need for us to standardize recommendations, and to decide to what extent this method should be offered as an alternative to strip shielding of brick buildings during erection.

Briefly our recommendations are to excavate a shallow trench about 4 in. deep and 3 in. wide directly in contact with all internal foundations. As the soil from this trench is replaced it is puddled with creosote oil at the rate of 1 pint/lineal ft. of trench. This rate of application is thus approximately 1½ gal. of creosote/cu.ft. of soil and is three times as much as Mr. Gay has used successfully in the Camberra tests. The main reason for such a large safety factor is that the size of trench and hence the amount of soil to be puddled is likely to vary considerably with different operators.

Where wooden stumps which have not been shielded are to be treated, deeper excavation and more liberal application of creosote is usually recommended to reduce the danger of decay. Also it is considered desirable to jet the point of contact of the ntump and the bearer with creosote in case termites work up inside the stump from below the treated soil zone. In recommending soil poisoning we consider it necessary to draw the attention of the operator to the danger that termites may enter the wall cavity below ground and thus evade the barrier. With cavity walls extending down to the concrete foundations it is an essential termite precaution to fill the cavity with concrete to ground line. Where a concrete floor is to be poured on a consolidated fill, special precautions are necessary.

The main object in raising this matter is to determine whether these recommendations are acceptable to all States and to discuss whether soil poisoning should be offered as an alternative to shielding. If it is offered as an alternative it seems likely that in brick buildings it will more or less entirely displace shielding which we consider at present to be a preferable method.

Discussion:

Mr. Tamblyn: The American method for soil poisoning seems largely to put the poison on the outside of the foundations. We have scrapped that entirely and suggested putting it on the inside. The point on which I want an opinion is whether we should go ahead recommending these soil poisons. We should decide here whether we are going to accept soil poisoning.

Mr. Huddleston: We still recommend the provision of ant caps. Where we recommend soil poisoning it is as an addition to ant caps. I think that will continue to be our approach to the problem for some time to come.

Mr. Jennings: That would be our opinion too. It is almost universal practice in Queensland.

Mr. Booth: The lending authorities' attitude is quite simple. There is no way in which you can see if soil poisoning treatment is being carried out effectively. Ant capping is readily seen by an inspector.

Mr. Beggs: W. A. practice in brick buildings has been to disregard ant caps because of the use of a durable timber. I don't know what the attitude would be as regards lending authorities.

Mr. Gay: Creosote oil applied at the rate of ½ gal./cu.ft. of soil is the best material available for soil poisoning at the moment. Our other tests have not been going long enough to make a recommendation. We are including aldrin and trichlorbenzene in the present tests.

Mr. Huddleston: A lot of solid concrete floors are constructed as a raft laid on the ground, with the building erected on top of it. Termite attack is common with this type of construction and we have recommended rather extensive soil poisoning around the outside of the slab with chlordane and creosote oil.

ITEM 6 (c) TERMITE RESISTANT PLYWOOD

Mr. Tamblyn: Last year a Western Australian plywood company requested assistance in the production of karri plywood with sufficient termite resistance for satisfactory use as flooring.

Green karri and mountain ash veneer in in. thick was obtained and treated by momentary dipping in six different preservatives - sodium pentaborate, copperized chromated zinc chloride, greensalt K, copper borate, Celcure and a zinc chloride - arsenic pentoxide mixture. After block stacking the green treated veneer for 2 hr. it was kiln dried at a relatively severe schedule.

The preservatives were used at about 7.8 per cent. concentration for karri and 7.8 and 3.9 per cent. concentrations for mountain ash veneer. Analyses of the treated wood have not yet been completed but based on solution absorption, a preservative retention of about 0.5 per cent. dry salt on the oven dry wood basis is expected for the high concentration and approximately half this retention for the low concentration.

All boards were glued with a urea glue and except for the copper borate treatment, appeared to bond satisfactorily. Mr. Gordon has since done some tests with P.F. resin glues using the two best preservative treatments as disclosed by the termite test (i.e. sodium pentaborate and the zinc ohloride-arsenic mixture). As expected, the

boron preservative affected the water resistance of the bond but the zino chloride-arsenic preservative seems to have improved it. We are enthusiastic about this latter treatment, as the preservative is similar to the water borne salt used very successfully in our Western Australian fence post tests which have now been in service for some 24 years.

The termite resistance of the various treatments was tested by Mr. Gay at Atherton using Coptotermes acinaciformis as the test species. Further tests are now in progress at Canberra to test resistance against N. exitiosus and C. lacteus. At present we are awaiting action by the W.A. plywood factory and are hopeful that the results will lead to commercial production of termite and decay resistant karri plywood for flooring. With the better fixed preservatives a satisfactory treatment for plywood subject to leaching should be possible.

Mr. Gay: I have one point to add to what Mr. Tamblyn has said. There is a marked difference in the reaction of termites to plywoods bonded with urea-formaldehyde and phenol-formaldehyde glues. If you use U.F. glues the termites readily attack it. If you put in P.F. glues it makes the plywood highly toxic to termites, possibly due to traces of free phenol. P.F. glues would be the ideal choice if termite resistance is being considered.

Mr. Booth: We are interested in this work because of the need for waterproof plywood which is also decay resistant. It is impossible to buy such material in N.S.W. and there is a big demand for it. Regarding termite resistance, why were fluorides not tried, as they give no trouble with phenolic adhesives and they are free of the objection of arsenic preservatives. It seems to us that there is a real possibility in the zinc chloride-arsenic treatment using phenolic resins which would have adequate resistance to decay.

Mr. Tamblyn: We selected these preservatives on the basis that four preservatives should not contain arsenic and the remainder

should be arsenical preservatives which were cheap and available. Pluorine compounds have less termite resistance than the arsenicals and they do not have, in our experience, any degree of fixation in the wood. We included sodium pentaborate which has no fixation, but that was on the understanding that the material would be used for flooring. For the remainder we tried to use preservatives which were fixed so that if the test was successful we could make recommendations under any service conditions.

Mr. Gordon: We were initially requested to carry out tests with urea glues. We chose pentaborate because we knew from past experience that it was most unlikely that we would have any trouble with gluing. Copper haphthenate and some of the oil borne preservatives were rejected on the score of cost. Momentary dipping appeared to be the only economical method. Several years ago we did make up some plywood from veneers impregnated with copper naphthenate which were subsequently tego glued and they have stood up remarkably well to exposure in the weatherometer and to the weather, but the cost is quite high compared with momentary dip.

ITEM 7 (a) SOME FUNDAMENTAL ASPECTS OF THE DEVELOPMENT AND STRUCTURE OF FIBRES

Dr. Wardrop spoke on this subject, and indicated results and status of investigations in this particular field.

There was no discussion.

ITEM 7 (b) GROWTH STUDIES - STATUS OF INVESTIGATIONS AT D.F.P.

<u>Dr. Dadswell</u>: Under this heading I think it is appropriate to review briefly the various aspects of the work being carried out in the Section of Wood and Fibre Structure. After all our investigations deal with the products of growth and with the effect of changes in growing conditions on the structure of material, both xylem and phloem, laid down by the tree during its life.

These investigations can best be referred to under five major headings, namely:

- 1. Cell development and cell wall organization.
- 2. General wood anatomy and methods of wood identification.
- 3. Bark, its anatomy and the nature of the extraneous materials it contains.
- Spiral grain, its occurrence and reasons for its development.
- 5. Structure in relation to properties.
- 1. Cell Development. Dr. Wardrop has just given you a picture of our knowledge of the fundamental structure of the cell and of the way such cells develop in the living tree. Much evidence has been accumulated to show that, in response to varying conditions of growth there are changes in cell wall organization and resulting changes in properties of wood formed. Some reference to these aspects will be made later. I only wish to stress here that we feel that the fundamental investigations being carried out and just presented are essential, and, further, that a greater knowledge of the various growth factors concerned in cell development is necessary before we can arrive at complete answers to problems relating to the behaviour of woody tissue in use.
- 2. General Wood Anatomy. In this field, I think it can be said that we are progressing rapidly to our goal, which is a knowledge of the structure of the many and varied timbers occurring both in Australia and the whole of the South-west Pacific area. Our investigations of the timber species according to families have continued, and so far we have published information on four families the Anacardiaceae, Apocynaceae, Anmonaceae and Myrtaceae. Work is progressing on other families, and during the year we hope to complete studies on the Cunoniaceae and Burseraceae. In this work it is, of course, necessary to have available for examination as many representative timber samples from the region as it is possible to procure. We are materially helped towards this end by the wide range of specimens coming from the territories of New Guinea and also

from the Forest authorities in Malaya, Indonesia, Borneo and Netherlands New Guinea. This co-operation was considerably developed during the past year because of the visit paid to the Solomon Islands, New Guinea, Indonesia, Malaya, Borneo and the Philippines by Mr. H. D. Ingle, who was able to arrange for an exchange of wood specimens, particularly those belonging to families on which we are working. I think it may be said that we are gradually approaching the stage where we are recognized as the authorities for the region on timber identification. Our work has been accelerated greatly by the development of our card sorting key for families and family groups. This key has been based largely on the examination of material that we have received, but also on the information available in the text book on the Anatomy of the Dicotyledons, by Metcalfe and Chalk. With its help we are in a position to place an unknown timber in its correct family, and often in its correct gemus, very quickly. This enables us to go through and identify specimens collected or submitted for identification without undue loss of time. We have, during the past 4-5 months identified 160 samples for the Netherlands New Guinea Forest Service, some 300 samples collected by the C.S.I.R.O. Land Survey Research Unit in New Guinea, in addition to the normal quantity of material received from the New Guinea Forest Service. It is very pleasing to note that, in over 95 per cent. of the material handled we can place the specimens in their correct botanical family. Such determinations are of considerable assistance to the field botanists, especially when, for various reasons, corresponding botanical material has been incomplete. In addition, we have prepared a report on the identification of the various timbers from the mangrove association.

3. <u>Bark</u>. Over the past 2 years considerable attention has been given to the anatomy of bark, under the direction of Dr. M. M. Chattaway. We were originally concerned by the fact that little appeared to be known about the bark structure of our Australian timbers, although for the same timbers quite a lot of information was available about

the wood. The utilization of bark is becoming more and more an important factor, and, after all, the bark, as well as the wood, is a product of the growth of the tree. Our preliminary investigations soon developed into a much more general project, and it became apparent that not only had very little work been done on the bark of eucalypts, but there were many features in the anatomy of the bark of these species that had not been recorded. The first part of the work now published covered a general examination of these features, and, in some instances, of their development. During this work, a classification of the species according to bark characteristics was also considered, and it was found that in the main the groups as at present defined tended to show homogeneity of bark structure; further, that the finer details do assist in the rearrangement of several established species, and the elucidation of a few heterogenous groups. At the present time, over 1300 samples of about 260 species have been investigated, and sufficient data amassed for the classification to be reviewed. During this work, it became apparent that certain groups, and particularly certain species within them, are extremely variable, that there is no correlation between this variability, geographic distinction, soil type, etc. These variable species also show morphological and anatomical variability. The possibility must therefore be considered that they may be hybrids of which the parent species have disappeared or no longer grow in the same habitat as formerly. Hybridization between eucalypt species has led to the establishment of colonies, or hybrid swarms, which can be recognized by morphologists in the field. In some instances, the parent species are anatomically similar in all respects, and the hybrid nature cannot be traced in wood or bark, but there are other cases where, although the wood structure does not give a clue to hybridization, the bark structure does. In one particular example in which the hybrid swarm from two known parents was examined, it was found that an assessment based on bark structure was in close agreement with

that based on morphological characters. It is considered that "hybrid swarms" may be the answer to the extreme variability of some well-known species such as red gum and manna gum. The evidence on which to complete a factual hypothesis is difficult to find. Material from as wide a range of habitat as possible is being examined.

As is well known, the best source of tannin is from the bark of wood of a number of forest species. At the present time, when there is a world shortage of tannin, it is necessary to examine the bark from other species to determine their possibilities as a source of tannin. Not only is the quantity of tannin present in the bark of importance; the quality of the tannin is of equal importance. With few exceptions, barks of certain sucalypt species may provide tannin, but this type of tannin gives a red colour to the leather and lowers its commercial value. The work we have carried out indicates that the red colour is due to the presence of leucoanthocyanidins. We are therefore carrying our fundamental investigations on this class of compound. The more knowledge we can gain concerning them, the better are the chances of improving the colour problem. As is well known, the bark of brown mallet from Western Australia is an excellent source of tannin. This species grows rapidly in cultivation, and a certain amount of publicity has been given to the possibilities of using it as a shelter belt tree in various areas. The advantage to the farmer is two-fold: the rich tan bark, and the valuable timber obtained.

4. Spiral Grain. We have commenced fundamental investigations into the occurrence of spiral grain and possible causes of its development. The work is at present confined to Pinus radiata, on which species a certain amount of information is available. The occurrence of spiral grain has been examined in some detail in four trees. Two were selected because of the slight spiral appearance of the outer bark, and two at random. The general picture from the examination of these is as follows: Looking at the surface of the wood, whatever the radius, the magnitude or direction of the

inclination of grain is not uniform in vertical sequence up the trunk. It would appear from the work done to date that this applies to all growth rings. The pattern of changed inclination in any ring in vertical sequence on the north radius was similar to that on the south radius in only a minority of cases. Looking along the north or south radius at any level the inclination varied from ring to ring in such a way as to give an appearance of a slight interlooking with 3 to 7 crossings in any radius in the lower half of the tree. In the material examined the maximum inclination to the pith line ranged from 9° left to 9° right. This is still substantially true neglecting the 7 innermost rings. Site and climate do not appear directly relevant to grain inclination, which must be primarily a property of the individual tree. This is the opinion crystallizing from work at various centres throughout the world, and implies some genetically transferrable factor, at least a liability to grain inclination. As it is important to know how grain itself develops, we are carrying out some investigations on young stems to determine where, how and why the first inclination of grain occurs.

The establishment of the cambium takes place as the primary tissues are matured out of the cells of the growing point, as that growing point is continually giving rise to the primary tissues of the stem. While this process is occurring at a level in the apex of the plant, it is exhibited as three successive phases of growth - formation, enlargement and differentiation of cells. When enlargement in different direction differs, the last phase encroaches on the second. The establishment of the cambium in the form and lie of the cells occurs during the close of the differentiation phase of growth at the apex. It is therefore fundamental to the problem of the direction of grain to study apical growth as leading to an understanding of the establishment of the cambium. This study is proceeding with the recording of outward appearance and extension of the young shoots of seedlings, together with an anatomical study of the apex of the shoot and the young stem just below it.

5. Structure in Relation to Properties. The influence of growing conditions on structure and subsequently on properties is perhaps most clearly apparent in "reaction wood". It is well known that both compression wood and tension wood have certain undesirable properties that make timber containing them unsuitable for many purposes; it is also well known that both are structurally distinct from normal wood. Recently, considerable attention has been paid to tension wood, with particular reference to its cell wall structure, the degree of lignification and the method of its formation in the living stem. For the latter purpose, a series of field experiments has been set up. It has been found that small branches and young stems are extremely suitable for such field investigations, because they can be easily handled and because in recent months, at any rate, the development of tension wood as a response to changes in conditions of growth has been extremely rapid. Observations can be made within 1-2 weeks of the time of setting up the experiment. These experiments are designed to test the view expressed by Hartman in Germany that the development of reaction wood is functional in character and forms part of the mechanism governing tree form. Two important results have been forthcoming. One, which we do not believe to have been reported previously, is the development of specialized fibrous elements in the phloem on the tension wood side of the stem. These are apparently "tension phloem fibres" corresponding to "tension wood fibres". In essence their structure varies from that of normal phloen fibres in the same way as the structure of tension wood fibres varies from that of normal wood fibres. The second important result is the observation of the comparative lack of lignification on the tension wood side of the stems in comparison with normal wood. This has only been demonstrated by staining techniques, but is most marked. All our previous work had indicated lack of lignification in the cell wall of tension wood fibres, but the latest work on small stems gave most striking confirmation. This question of degree of lignification has some practical significance in

that it had been previously observed to be associated with the grindability of wood for manufacture of newsprint. Lignin distribution in cell wall and middle lamella zones is also being studied by means of ultra-violet microscopy.

In all cases of tension wood recently investigated it has been observed that such wood is definitely associated with collapse. In addition, where tension wood occurs there is the development of minute compression failures in the tension wood itself and on the pith side of it.

Following the discussions at the last Conference on the changes in structure in the wood of successive growth rings from the pith outwards, and resultant changes in properties - I refer to the increase in fibre length and corresponding decrease in angle of micellar spiral orientation in the middle layer of the secondary wall it might well be expected at this stage that additional confirmatory evidence would be forthcoming. This, however, is not the case, as some conflicting results, or perhaps I should say results for which no satisfactory explanation is so far available, have been obtained with specimens of Pinus taeda from Queensland, and P. ponderosa from Canberra. In these specimens, although the average fibre length has increased through successive growth rings from the pith outwards, there has not been a very great change in angle over the same growth rings, although the trend is in the right direction. This has meant that for some 15 growth rings from the pith the angle has been as high as 40°. Longitudinal shrinkage has also been high from the pith outwards, corresponding to these large angles, dropping slowly from over 1 per cent. to less than 0.5 per cent. Where some compression wood was present, longitudinal shrinkages of over 4.5 per cent. were observed. Much more additional work needs to be done on specimens of these species before questions regarding their apparent divergence in pattern can be answered. Perhaps discussion on this aspect of our work can be joined with that on the next item of the agenda submitted by Queensland.

In conclusion, I would like to draw attention to the fact that at the forthcoming International Botanical Conference in Paris the agenda includes a sub-section on Wood Anatomy which will include discussions on tension wood and questions of the relation between shrinkage of timbers and their structure.

Mr. Booth: What is the present view regarding the mechanism for the formation of tension wood; is it regarded now as a response by the tree to a stress condition; the resultant formation of tension wood in the tree eliminating the cause of the stress, or is the formation of tension wood merely a response to stress without causing an alteration in the stress?

Dr. Wardrop: It was formerly considered that tension wood was formed in a stem as a response to tensile stress. Later, its formation was regarded as a gravitational response. Although these individual factors may have some influence, the development of tension wood is now regarded as an anatomical manifestation of functional processes governing the tree form. Thus, the tree form is regarded as an inherited characteristic and during the development of the tree the disposition of the branches may alter - the so-called "movements of orientation" - as part of the process of the development of the mature form of the tree, or the axis itself may change its position. In effecting these movements, tension wood is formed - either on the upper or the lower sides of branches or heavy stems. Its formation cannot be attributed to the operation of any single stimulus or environmental factor.

SOME OBSERVATIONS ON THE WOOD QUALITY OF PLANTATION CONFERS AND NATURALLY REGENERATED HARDWOODS IN SOUTH EAST QUEENS-LAND*

INTRODUCTION

The declared aim of the Queensland Forest Service policy in the establishment of coniferous plantations and the regeneration of the State's mixed hardwood forests, is to obtain as rapid growth as is possible consistent with the maintenance of desirable quality in the wood produced.

The comparative paucity of the native forest resource and an expanding economy makes it essential that the forest capital be built the possible maximum in the shortest possible time and to this end investments in the order of over £1,000,000 annually have been made in the post war years.

The protection of this investment and the securing of the best return is of obvious importance. The results will be largely influenced by the quality of the product grown.

The basic demand is for sawn timber and the efforts of the Service must be directed to the production of wood suitable for the multiple end uses to which sawn timber is put.

There are many specially desirable properties for particular uses but in all uses there are certain constant qualities demanded, namely:-

- (a) Strength. Freedom from defect impairing strength and working qualities is of primary importance.
- (b) Stability. The word is used in the sense of maintenance of the plane surfaces of the original sawn section in subsequent use. This naturally is limited by the hygroscopic nature of any wood but the term implies comparative freedom from excessive and uneven shrinkage, distortion of cross section, twist, spring and cup.

The fundamental question facing the Service then is:"To what extent are these qualities affected by the silvicultural
practices used; can they be controlled by <u>any</u> technique which it
is practicable to employ in a large scale reforestation program."

In an attempt to answer this question the Service has endeavoured to check on the quality of the wood being

^{*} Prepared by Queensland Forest Service

produced and has used silvicultural practices designed to control some aspects of quality e.g. pruning and genetical control of seed provenance have aimed at the control of knots and the production of trees of desirable form and growth habits.

In all this work, it has been limited by the primary necessity to judge a particular stem on external characters of form and vigor. While through suitable breeding procedures it can be reasonably sure of the transmission of desirable external characters, to what extent are the basic wood qualities of strength and stability modified by any subsequent application of silvicultural technique?

The transmission of desirable wood quality from parent to progeny in certain exotic species, is currently under investigation by the Division of Forest Products and material has been provided for this and related anatomical investigations. The results of this work undoubtedly are of major importance.

Because of limitations of scaff and equipment, the Service has confined its own work on wood quality to a consideration of basic density. Some results of this work are presented in the graphs and tables appended.

It will be convenient to discuss the results separately for softwoods and hardwoods. While the observations have been taken at various levels in the stem, the results presented deal only with the section 1' - 2' from ground level. Similar trends are apparent in the other sections studied.

The results for the sucalypts, brush box and turpentine do not include sapwood. Excepting blackbutt, all trees studied were from the dominant or codominant crown classes and approximate age and diameter at breast height over bark are shown.

Due to deficiencies in sampling, the results are only to be regarded as indications.

SOFTWOODS

Reference is made to Graph I and Table I. There are marked differences between the three native confers (hoop and kauri pines) and the two exctics (Pinus taeda and Pinus caribaea). The wood laid down in the early years of the former has a tendency

to be slightly denser than that in later years but there is little variation across the section except in A. robusta. The opposite occurs in the two exotics and there is a pronounced increase in density from the pith outwards.

At 30.6.53 the area of coniferous plantations established in Queensland was -

Hoop and bunya pine - 32,927 acs.

Kauri pine - 1,808 "

P. caribaea - 11,089 "

P. taeda - 3,672 "

Other species - 3,762 "

TOTAL - 53,258 "

The silvicultural techniques employed require a first thinning at age 15 to 15 years. The logs are small and range from 6" to 10" diameter at breast height. Utilisation is generally to a 4" top diameter under bark. The total log out for the decade 1941/42 to 1951/52 was over 52,000,000 super feet hoppus and the estimated quantities available from the plantations in the decades indicated are:-

1950/59 - 172,000,000 s.ft. hoppus 1960/69 - 447,000,000 " " "

The end use is primarily for case manufacture but when the market has been starved of higher quality softwoods, the material has been put to higher grade use. Apart from knots, the sawn material frequently exhibits twist of varying degree after seasoning.

In hoop pine this twist can often be correlated with the occurrence of spiral grain. Since the stoms thinned are of the worst form some compression wood is also a feature particularly from trees with "pistol butt". Twist also occurs where spiral grain in not present and there appears to be little difference in the degree of twist from that occurring where spiral grain is present. This observation is based only on limited quantitative examination but there is sufficient reason to suspect the presence of some other determining factor.

In kauri pine twist is present to a minor degree,

and although only very small samples have been inspected, spiral grain is probably the chief factor. The basic density trends for these two species are so unlike those normall expected in the excite conifers that there is an obvious necessity for further and more detailed investigation of the basic cell structure.

In <u>P. taeds</u> and <u>P. caribaes</u> the basic density trend is of expected form but there appears to be little correlation between twist and spiral grain.

Recent work by the Division of Forest Products on the structure of the secondary wall and the angle of inclination of the micelles would seem to explain the basic causes of this behaviour.

There are however, indications that P. tueda and P. caribaea do not conform to the general pattern of micellar organisation observed in P. radiata and other conifers. The differences observed might be summarised as follows.

- P. radiata (a) Decreasing micellar angle with distance from pith up to a certain point where the angle tends to be more or less constant.
- (b) Approximately 25% variation in fibre length from earlywood to latewood within the one annual ring.
- P. taeda and P. caribaea (a) No significant variation of micellar angle with distance from pith, the angle remaining fairly constant and is in comparison with P. radiata, quite large.
- (b) 40% variation (P. taeda) and 50% variation (P. caribaca) in fibre length from earlywood to latewood within the one annual ring.

These observations are sufficient justification for more intensive investigation of those two species which already form a large part of reafforestation programs in the sub-tropical areas of eastern Australia.

The problem is twofold - on the one hand there are expected yields of thinnings where the wood has already been grown with all the faults already observed, on the other hand the need to ensure that the trees selected as "elite" for the production of future plantations should exhibit the right internal qualities as well as the external form and vigor.

In the final crop - stems remaining after thinning, is any change desirable in the current silvicultural technique to ensure a reasonable standard of wood quality? In the thinnings

available for marketing, is there any technique of seasoning or conversion that can ameliorate the lack of stability that is only too apparent in the sawn product? As far as can be seen, the usual strength values of this material are adequate for general softwood purposes, the factor limiting the major end use to case material being lack of stability.

Any contraction in the demand for the conventional wooden case made from Australian plantation grown material must raise grave questions of policy. There is an economic limit, diotated by internal costs in the Australian industry, to counter action by price reduction for the manufactured case. That limit has now been reached for quite a few plantations in Queensland now.

In the face of rapidly diminishing supplies of native softwoods, it will be impossible to grow these plantations on very long rotations. The dilemma of unmerchantable thinning or stagnation for lengthy periods has to be avoided.

HARDWOODS

Reference is made to graphs and tables numbered 2, 3, 4 & 5. Observations in all the species examined were confined to stems where age was known with reasonable certainty. In the case of grey ironbark and tallowwood the exact age of plantation material was known. In blackbutt, comparison is made between stems of known age and stems which were known to be of very much greater age but the same size as the former.

Comparison is also made with the mean and range of basic density shown in C.S.I.R.O. Pamphlet No. 92, "The Density of Australian Timbers (2)". All the eucalypts exhibit similar trends of rapid increase in basic density in the earlier years followed by a gradual levelling as diameter increases. Brush box (<u>T. conferta</u>) and turpentine (<u>S. laurifolia</u>) do not conform to this pattern.

The results from blackbutt, gren ironbark and tallowwood are of major interest and are discussed below in more detail: <u>Grey ironbark</u> - The stems aged 24 years and 8 years are from the same site in the same plantation and were selected at a 16 year interval. Up to 8 years of age at a mean annual diameter increment of 1 in. none of the wood was within the range of density for normal wood of this species.

At age 24 years with a mean annual diameter increment of 0.39 in. all wood outside a 2 in. diameter was within this range. Natural regeneration aged 28 years (from a different site) with a mean annual diameter increment of 0.55 in. provides an interesting comparison. Here all wood outside a 3 in. diameter limit is within the range of basic density of normal wood.

Tallowwood - Again up to 8 years of age at a mean annual diameter increment of over 1 in., none of the wood was within the normal range. At 24 years with a mean annual diameter increment of 0.4 in. all wood outside a 4½ in. diameter core was within the normal range.

Blackbutt - The stems aged 30 years and 14 years (curves 2 and 4) are from the same site and were selected at a 16 year interval. Curves 3 and 5 represent stems very much older but of the same size as 2 and 4 and consequently a much slower rate of growth.

Comparing 2 and 3, the very old stems had barely reached the lower level of the normal range of density at $2\frac{1}{2}$ in. diameter while none of the wood at age 14 years and an annual diameter increment of 0.53 in. was within this range. In curves 4 and 5, the 30 year old (mean annual diameter increment 0.36 in.) material reached the lower limit of the range at $5\frac{1}{2}$ in. diameter and the very old material at 4 in. diameter.

Thereafter there was no great difference in their densities. Curve I represents 50 year old material with a mean annual dismeter increment of 0.4 in. The range of normal density was reached at approximately 5 in. diameter. The results of all species are summarized in the following table.

Species	Age	Mean Annual Diameter Increment in,	Diameter where Normal Density Range is Reached in.	Remarks
Grey ironbark	28	0.55	3	
	24	0.39	2	
	8	1.00	-	All wood below normal range
Tallowwood	24	0.40	4.5	
	8	1.00		All wood below normal range
Blackbutt	50	0.40	5	
	30	0.36	5.5	
	?(old)	-	4	Same size as 30 yr. material
	14	0.53	-	All wood below normal range
	?(old)	*	2.5	Same size as 14 yr. material
Spotted gum	35	0.38		All wood within normal range
Grey gum	28	0.55	3.5	
Red mahogany	35	0.44	4.5	
Turpentine	35	0.45	-	All wood within normal range
Brush box	28	0.54	2.0	

Eliminating the 8 yr. old material in grey ironbark and tallowwood and the 14 yr. old in blackbutt, there does not appear to be any significant effect of rate of growth on the size of the low density core nor is there any great variation between the species studied except for turpentine and spotted gum where no wood of lower density than the normal range was present.

Within the practical limits of growth rates under forest conditions, there might then be some reason to believe that the wood produced after a certain size, independent of rate of growth, is reached, will be within the normal density range.

CONCLUSION

It is apparent that the present state of knowledge of the factors governing the production of wood of desirable quality in coniferous plantations and the hardwood forests is inadequate.

There is an urgent need for the co-ordination of forest research and forest products research activities and consideration might well be given to an early determination of the necessary co-operative research program.

TABLE 1
FLANTATION CONIFERS

	Age	D.B.H.		Ba	sic De	nsity	(1b./c	u.ft.)	at di	stance	from	pith :	in in		
Species	yr.	0.B. in.	1/2	1	11/2	2	21/2	3	31/2	4	41/2	5	5±/2	6	61/2
A. cunninghamii (hoop pine)	13	7.5		29.0		29.9		29.5	29.1						
A. robusta (kauri pine)	16,	7.0	26.0	23.8	22.5	22.3	22.1	21.3							
A. palmerstoni (kauri pine)	36 ,	14.0	26.4	26.6	26.3	25.9	26.3	25.8	25.9	24.7	25.4	25.9	26.0	25.1	24.6
P• taeda (loblolly pine)	10	7.6		25.9		26.6		32.9							
P. caribaea (slash pine)	10	7.4		23.8		26.3		29.3							

A. cunninghamii	-	8	trees	-	64	specimens
A. robusta	-	3	11	-	36	11
A. palmerstoni	-	4	u		104	11
P. taeda	-	3	n		18	0.
P. caribaea	-	3	11	-	18	H

TABLE 2

GREY IRONBARK (EUCALYPTUS DREPANOFHYLLA), TALLOWWOOD (E. MICROCORYS)

	Age	D.B.H.	Comment of the last t											
	yr.	o.B.	1/2	1	1 1/2	2	21/2	3	31/2	4	41/2	5	51/2	6
E. drepanophylla (grey ironbark)	8	8.1	43.0	45.2	49.8	46.0	45.7			2	Dominan			
11	24	9.4	4.252	50.9	1000	53.2	No.		53.3		same si	ion a	at 16:	yr.
Grey ironbark	28	15.4	44.6	47.7	50.6	51.5	52.6	52.7	53.5	54.	interva 5 54.3	56.3	5 52.9	55.7
									reg	ener	t trees ation ag s, may b	e not	older	than
E. microcorys (tallowwood)	8	8.2	33.5	35.2	35.2	37.1	38.7			?	Dominan			om
V 20- 0-10/10/00/2	24	9.7	35.9	38.8	43.2	43.5	48.3	49.2	48.9	3	same si plantat: interval	ion a		r.

Tronbark - 10 trees - 172 specimens

Tallowwood - 6 " - 76 "

TABLE 3 BLACKBUTT (E. PILULARIS)

Orderin	Ago	D.B.H.		Ba	sic De	ensity	lb./cu	oft. a	t dist	ance f	rom pi	th in	in.		
Origin	yr.	O.B.	0.4	1.2	2.0	2.75	3.55	4.53	5.1	5.9	6.7	7.5	8.3		
Gooloolabin	50	19.5	33.9	34.1	40.1	41.5	42.2	43.1	43.5	44.3	44.2	45.6	46.1	age n	ant tree
Mapleton (2)	14	7.5	29.5	31.2	31.8	34.5		Do	minant	trees					
Mapleton (3)	?	7.5	29.2	36.7	39.3	39.4	Su	ppress		es muc same si		r than	(2) t	out of	the
			1/2	1	11/2	2	22	3	31/2	4	41/2	5	51/2	6	61/2
Mapleton (4)	30	10.8	26.1	29.3	32.4	34.0	35.1	38.9 Domi	39.6	733.41	41.3	40.2	41.5	42.5	41.5
Mapleton (5)	7	11.0	31.8	31.8	31.1	37.6	39.7	Supp	ressed	41.8 trees	very	43.5 much o			.)

(1) 4 trees - 88 specimens

(4) 2 trees - 16 specimens

(5) 2 " - 48 "

(2) 2 " - 16 " (5) 4 " - 104 "

TABLE 4

NATURAL REGENERATION - EUCALYPTS

Species	Approx.	D.B.H.		Ва	sic De	ensity	(lb./c	u.ft.)	at di	stance	from	pith :	in in			
	Age	in.	10	1	11/2	2	$2\frac{1}{2}$	3	31/2	4	41/2	5	5 <u>1</u>	6	61/2	7
Grey gum	28	15.4	38.5	42.0	45.0	50.7	53.0	53.1	53.4	54.3	55.5	54.9	54.9	56.2		
Gympie messmate	28	15.1	28.4	31.5	35.6	38.1	39.7	41.8	43.7	44.5	44.3	47.0	45.3	45.0	46.5	
Turpentine	28	15.0	42.2	43.2	43.4	43.5	43.2	43.5	44.3	42.0	42.1	44.3	43.7	45.8	43.8	
Spotted gum	35	13.3	45.6	50.4	51.5	53.9	55.2	55.4	57.0	56.1	54.8	55.7	56.7	58.5	57.0	
Brush box	35	15.7	37.1	40.2	41.6	40.0	41.0	42.2	42.5	42.6	39.4	42.1	42.5	41.4	41,9	42.7
Red mahogany	35	15.4	34.3	35.7	38.2	40.1	43.3	45.5	48.2	48.8	49.2					

All trees dominant or co-dominant, crown class.

Age approximate only, but no older than indicated.

Four types from each species.

TABLE 5

BASIC DENSITY

C.S.I.R.O. Pamphlet No.92.

Species		lb./cu.ft.
Species	Mean B.D.	Range for 95 per cent. Probability
Blackbutt	44.2	36.8 - 51.7
Brush box	43.7	39.7 - 47.7
Grey gum	52.6	46.9 - 58.3
Spotted gum	49.9	41.1 - 58.7
Grey ironbark	55.7	50.6 - 60.9
Red mahogany	48.0	41.7 - 54.3
Tallowwood	50.1	45.1 - 55.2
Turpentine	44.0	38.6 - 49.4
Hoop pine	28.7	23.2 - 34.3
Hoop pine from young trees to 8 in. diameter	26.5	21.8 - 31.2

Discussion:

<u>Dr. Dadswell</u>: In this paper, the figures given as the difference in tracheid length between early and late wood of <u>Pinus</u> radiata, <u>P. taeda</u> and <u>P. caribaea</u> are incorrect. We have never found this difference more than 12 per cent, varying from about 4 to 12 per cent.

Mr. Turnbull: Is work going to continue with the possibility of correlating quality and some other property? Density is interesting, but unless its relationship holds with other properties, we may be overlooking the chance of finding another index of quality.

Mr. Kloot: Current investigations suggest that the relationship between density and other mechanical properties is very good indeed.

Mr. Booth: Supported by our results on plantation grown blackbutt, our basic density figures agree with the Queensland figures. Further, Izod values increase from the pith, and also compression parallel to the grain increases, but 3 in. from the pith they are still only about two-thirds of the figure for mature blackbutt. The modulus of rupture figures show the same trend but they are not yet completed. This means that logs 6 - 8 in. diameter have not yet reached the strength value of mature wood.

<u>Dr. Dadswell</u>: In the case of softwoods, I take it from the Queensland report that it is not a question of strength but a question of stability in material from thinnings or very young trees.

Mr. Jennings: We are faced with a two-fold problem.

Firstly, are the silvicultural practices applied to the plantations going to yield a satisfactory product? So far, in first thinning, the product is lacking in stability. Secondly, from the genetical point of view, in the trees which have been selected for establishment of seed gardens, it is essential that they should have satisfactory wood qualities, otherwise our chances are obviously limited.

Dr. Wardrop: Is there any information available on stock from which these trees were grown ?

is the southern States of America, but we have had it from various sources. We have had a fairly wide range of types in our original collection.

<u>Dr. Dadswell:</u> We are having sent to us specimens from U.S.A. These include <u>P. taeda</u> and the specimens are from trees 20 to 25 years of age. They may yield some information.

Mr. Gordon: Forestry Departments are faced with a considerable problem in connection with efforts to utilize small diameter plantation grown trees for sawnilling and other wood using industries. It is a problem which has not been acknowledged to any great extent in the past, chiefly because for the last 10 - 15 years softwoods were in such short supply that anything from which a 2 in. x 2 in. piece could be cut was accepted without query. We are now faced with a much more critical timber using market and we are in a position where we can import timber from overseas. I am bringing up this point because in the course of my work in the Veneer and Gluing Section on corestock on the one hand and, more recently, in wooden case investigations, I constantly run up against problems resulting from attempts at utilization of small diameter logs of plantation grown pine trees. It seems to me that many of the problems of both would be largely overcome if the minimum log diameter could be increased. Most of the trouble, as Dr. Dadswell pointed out, arises in the wood grown in the first 10 - 12 years, but for practical purposes it is mostly within the central 4 or 6 in. of the logs, the worst case being in logs less than 6 in. diameter. Might not the easiest approach in the long run be to chip this material with low density, spiral grain, irregular longitudinal shrinkage, and low mechanical strength both intrinsically and because of defects, and use it for some form of hardboard or chemical product in which its properties are not so critical?

Mr. Grenning: No matter how you grow your pine species in plantations you are going to have trouble with the central core. There is also spiral grain and the differential longitudinal shrinkage from pith to bark. It is felt that the centre square should be cut out to get the better quality timber by cutting round this square.

Mr. Booth: In view of what Queensland has said concerning sources of seed supply, we have some information on P. Ponderosa, which though rather sketchy, seems to add point to some of the trouble described by Dr. Dadswell. P. ponderosa is grown in A.C.T. and over the border at Bago, S.F. in N.S.W. While the growth rate is not as rapid as that of radiata under the same conditions, and therefore we do not regard it as an unqualified success, nevertheless we are able to dispose of the thinnings along with radiata, and there have been no complaints; the average person cannot pick it out. We have tested this material and found that it has no abnormal longitudinal shrinkage. It is quite normal, and its density and mechanical properties are about the same as our plantation grown radiata pine, although it is slightly inferior to the American grown ponderosa pine. The Canberra material we examined has no obvious compression wood, the density of the material is not high, about the same as our Bago ponderosa pine, and yet it has a very marked longitudinal shrinkage which gives rise to both simple shortening in length and considerable bowing. There does not seem to be any obvious reason for the difference between them except the matter of seed source.

At the request of the Chairman, the following letter received from Mr. Bednall was read.

"I do not know that I can usefully comment on the cause of distortion in young plantation grown softwoods, but some general comment on the occurrence itself may be of interest.

As far as young trees are concerned, our experience here is limited for practical purposes to short lengths for case manufacture. Some rejections occur ahead of Linderman jointers, and there is also some failure of glue joints due to twist. The percentage, however, has not been sufficient to be classed as serious. (Incidentally, the material is kiln dried before jointing). With such a process as electronic gluing on a continuous operation basis, however, the problem of twist may be much worse.

The fault, as you probably know, is not confined to young trees by any means. A fair percentage of boards but on our board lines show twist even from trees 30 years and over. This may not be so marked in the milder and more humid climate of the South East and Melbourne, but it is certainly noticeable in the drier climate of Adelaide.

Within limits this is not a serious defect for many board uses, except in a small percentage of boards where excessive twist occurs. The boards can be mostly straightened out in fixing, i.e. flooring, weatherboards or lining.

It is felt that one of our biggest problems will be in the framing timber for houses and other buildings. For buildings in the South East, the timber is used green and fixing takes place before it dries out, and in most instances the nails hold in position fairly well. Study need to be well checked into the top and bottom plates and extra trimming is often used as a wise precaution, particularly for ceiling joists. Some careful selection is always advisable for top and bottom plates, fascias etc. When the intervals between sawing and fixing in the building are sufficient to allow drying to a fairly low moisture content, particularly in Adelaide and other dry summer climates, twist can be a real problem.

It has been claimed that the bundling of green timber (after dipping), if well held with fairly heavy gauge wire, and kept in this condition until required for use, helps prevention of twist to some extent, even if it does not provide a complete answer to the problem.

Also, for what it is worth, we have been informed that recent developments in high temperature drying kilns have tended to minimize spiral twist.

Normal kiln seasoning and re-conditioning (even double reconditioning) does not overcome the trouble.

Generally, the experience here over many years has been that timber from sizable trees sawn well free of heart behaves well, and little trouble is experienced. Even with corestock, a process which requires selected timber, edgings from wide boards is a favourite source of supply.

The cause of the phenomenon of twisting, however, is a subject that certainly needs investigation."

Mr. Crane: I know very little about this, because we have not milled any great quantity of radiata from State plantations. We took some samples following pruning and I have in my office at the moment a board, which is approximately 14 x 1 or 12 x 1, out right through the centre of the tree which was 14 or 15 years old, grown at about 1 in. in diameter per annum. But down at a plantation at Cambridge something of the order of 20,000,000 ft. of thinnings have been cut out. They were cut into squares up to 10 in. or 12 in. There has been no evidence of any great distortion, even of the small stuff. It has been sold commercially, exported, paid freight all the way from Hobart to Melbourne, and even to Sydney. They are now being remanufactured in a case plant at Cambridge. Apparently the logs have held themselves together very well in complete heart-in squares for the first drying process. It is obvious that where there is spiral grain they kick and twist quite a bit. There is not a large quantity of timber affected in this way judging from superficial observation. Whatever we do in the future we are always going to grow that square in the centre of our trees. This also is the weakest part of the tree, because I understand from talks we have had that your fibre length consistently rises to a certain figure, and is constant thereafter, irrespective of variations in micellar angle. I have not heard anything to the contrary that the relationship is irrespective of the growth

rate of the particular tree and I understand that the particular relationship holds for the genetic region of the tree concerned. It varies from tree to tree but is apparently related genetically to it. We have got to use that heart for whatever purpose we can find for it. Obviously one approach is to extract it in the general sawing of the log; in other words, to square your heart out and treat it separately, and you do then take away some of the longitudinal shrinkage. I have, however, seen many boards used for coffin bottoms and shelving, out right through the heart, which have proved to be quite satisfactory.

Mr. Boyd: The reason for stability of squares and deep out boards referred to by Mr. Crane is the balanced stress condition of pieces out symmetrically with respect to the pith. If you are not drying in that balanced condition, at the drying stage curvature will develop as a result of the differential shrinkage.

<u>Mr. Wright</u>: Generally speaking, where trouble with twist or spiral grain is experienced, the best practice seems to be to dry as quickly as possible to develop quickly a dry stiffened case which will inhibit further movement as the core or remainder of the piece dries. Slow drying generally accelerates warp. If you can restrain the warp in the early stages of drying, there is a chance of getting something out of it.

ITEM 8 (a) REPORT ON THE CORRESPONDING COMMITTEE ON TIMBER SEASONING OF THE BRITISH COMMONWEALTH FORESTRY CONFERENCE

Mr. Wright: Delegates to the Forest Products Pre-Conference of the Sixth British Forestry Conference held in Ottawa in August, 1952, resolved that "a Corresponding Sub-Committee known as the Seasoning Sub-Committee is to be set up with Australia supplying the Secretary". It was recommended that "the functioning sub-committee should be continuous, should be reviewed every five years, and should continue until Forest Products Conference requests them to round off their work. It was agreed that the sub-committee be made up of individuals from the respective Laboratories. Every five years, names of members

or associate members of sub-committees should be re-submited to the secretary of corresponding sub-committees. It was further suggested that instead of having chairmen for sub-committees, secretaries should be raised to the level of convenors.

Member Laboratories were to comprise -

1.	Australia	Division of Forest Products, C.S.I.R.O.,
		South Melbourne.

2.	Canada	Forest Products Laboratories Division,
	-	Department of Resources and Development,
		Ottawa.

3.	India	Forest Research Insti	tute and College,	
		Dehra Dun.		

4.	Federation of	Department of Forestry,
	Malaya	Forestry Research Institute,
		Kepong, Selangor.

5.	New Zealand	New Zealand Forest Service,
	Colombia.	Wellington.

6,	Pakistan	Ministry of Food and Agriculture, Government of Pakistan,
		Karachi.

7.	South Africa	Forest Products	Institute,	
	Pretoria.			

8.	Uganda	Forestry	Department,
		Entebbe	

9.	United Kingdom	Forest Products Research Laboratory,			
	Princes Risborough,				
	Bucks., England.				

10.	United States	Forest Products	Laboratory,
	of America	Madison 5,	
		Wisconsin.	

I was subsequently advised that, as representative for Australia, I was to be responsible for establishing this Committee and initiating a programme of mutual value to all members, the purpose of which could be accomplished in correspondence.

Accordingly, early in the second half of last year, I prepared material covering suggestions for the future operation of the Committee, and distributed this to the heads of the various member

laboratories with the request that they pass the material on to their nominees. The response obtained was gratifying, and in subsequent months I received comment from almost all the individuals named as members. This has now been collated and put up into a form which is enabling members to be kept advised of all comment made by all other members. The second of these Communications, as I have called them, is now ready for distribution. In addition, of course, the Committee is encouraging correspondence directly between members on matters of limited interest where it is felt that one member can assist the other. This aspect has already been availed of quite appreciably over the last 6 months. It has, in fact, already strongly stimulated the exchange of material between our Seasoning staff and their opposite numbers in Canada, Malaya, Uganda and the U.S.A.

Out of the comment already received by me in correspondence a fairly clear picture is emerging of subjects of mutual and more immediate interest to all member laboratories. This includes -

- (a) the laboratory rating or assessment of seasoning degrade
- (b) high temperature drying
- (c) the measure of "warping" or "stability"
- (d) aspects of kiln design, such as the conservation of heat in hot air vents of kilns, door design for kilns
- (e) the use of moisture meters
- (f) the economics of seasoning
- (g) moisture quality standards
- (h) timber handling in seasoning yards
- (i) end and surface coatings for degrade control
- (j) the drying of rail sleepers, poles etc.

In order to channel our energies, give some direction to the activity of this Committee, and ensure as complete a cover as possible of each item for discussion, I am recommending to the Committee that we take one of the above subjects as the theme or common subject for discussion for each future Communication.

I see this Committee as having two prime functions which I have defined as follows:-

- (a) to enable individual members to exchange views and opinions of information on subjects of mutual interest, at a level difficult to achieve through normal official channels: this can be done in two ways either direct with other individual members, or through the Convenor. Both means will, no doubt, be used, the method selected in a particular case being determined by the type of enquiry, and
- (b) to act as a co-ordinating body to enable the assembly or collation of information on subjects of importance in timber seasoning research, and to provide a forum at which hypotheses, analyses, considerations or procedures developed by members can be submitted for critical (and sympathetic) review.

I feel that this Corresponding Committee can achieve a very useful purpose in forest products timber seasoning applied and fundamental research. It is acting as a debating ground and provides a means whereby each contributing laboratory can throw its opinion or contribution into a common pool. Copies of the first Communication were distributed to Forest Products Laboratories of Queensland and New South Wales about last August and I was glad to receive comment from them. As mentioned, the second Communication is now also ready for distribution. I deferred sending copies of the first Communication to Forest Services other than New South Wales and Queensland because I did not know of seasoning officers in these other organizations. If, however, any of the other States feel they would like to receive copies, I would be only too glad to send them forward.

No discussion.

ITEM 8 (b) A NEW AFPROACH TO DRYING STRESSES

The following is a summary of Dr. E. L. Ellwood's remarks on the above subject.

The present status of the approach to the establishment of drying schedules for wood was reviewed. Emphasis was placed on a study of certain mechanical properties of wood perpendicular to the grain in relation to temperature and moisture content as a basis for a more fundamental approach to the problem of drying stresses in lumber.

Matched samples of American beech were tested in compression and tension perpendicular to the grain at twenty different combinations of temperature and moisture content. Regression equations were calculated for the effect of temperature at all moisture contents of strength, modulus of elasticity, stress at proportional limit.

Maximum strain in tension was also evaluated.

Compression and tension data were integrated and the expected stress and strain behaviour of a simplified hypothetic model of a drying beech board was discussed. Under the limitations of the model it was shown that compression set was a major factor in causing variation of shrinkage with drying conditions. Liability to surface checking was greater at lower drying temperatures.

Exploratory tests were carried out to determine creep behaviour in compression and tension, these results were discussed in relation to drying stresses and strains.

Recommendations for further study were made particularly on the effect of duration of load on strength and relative creep and relaxation behaviour in tension and compression.

Discussion:

Mr. Huddleston: The work that Dr. Ellwood has introduced is of interest more particularly with some of our rain forest species where we get two zones, one a clear zone which is easily dried and the other zone inside, which we tend to refer to as dark heart, a zone rather difficult to dry. Undoubtedly, there are two stresses in these

two zones. I would like to know whether it is the intention of the Division of Forest Products to carry on this work.

Mr. Wright: The question seems to me, like all work in all forest products laboratories, to be "what is the most important work to be done in relation to the number of staff you have?" I agree that this work is quite important and has a fundamental approach. If we had the staff, we would like to proceed with this aspect of the work, but at present there is work of greater urgency.

Mr. Huldleston: I agree with Mr. Wright that the work should be done by Whis Division.

Mr. Booth: I would like to ask Dr. Ellwood about the model illustrating the development of drying stresses. It seems to me that the strain energy needed to deform the central core only comes from the outer layer. How does he link up his midel with the need to take into account the amount of cross section available in the outer layer, the only layer available to deform the inner zone. It is obviously something which is going to depend on moisture gradient. An important factor is to pick a temperature at which the elasticity modulus or inverse rate of stress relaxation in tension is high in relation to the corresponding properties in compression.

Dr. Ellwood: I did not cover all aspects because of limitation of time. The usual case is initially, of course, the thin drying section around a relatively large non-shrinking inner core. You have a relatively high strength material acting on a rather weaker material. By consideration of static conditions, you cannot arrive at a satisfactory answer to that problem. Consideration of time effects indicates there was a definite difference between compression and tabails effects. For example, under a constant load over a period there was a greater tendency for creep in compression than in tension. By evaluating these time effects in relation to the ratio of strength in tension and compression, it may eventually be mathematically determined at what would be the best conditions to dry the material. You cannot do this sort of project in a day. It will probably take many years, but the results would be well worthwhile.

ITEM 8 (c) REVIEW OF ACTIVITIES OF THE SEASONING SECTION, D.F.P.

Mr. Wright: Greatest emphasis - in terms of personnel and time - is still being given to industry assistance and the more applied studies of timber seasoning. This, no doubt, is rightly so. It is refreshing, however, to be able to report a resumption of fundamental studies after a lean period while two research officers were either overseas or on study leave.

I have subdivided our seasoning interests into three groupsindustry assistance; applied studies; and basic or fundamental studies.

1. Industry Assistance

This is still maintained in the following forms.

- (a) Plant Visits. These are made to test or report on kiln or dryer performance, seasoning plant practice, wood waste incineration in McCashney burners, plant lay-out and timber stacking and handling and the multitude of troubles that joinery plants and timber users still experience because of shrinkage and E.M.C. troubles. We average from 80 to 100 local and interstate plant visits each year.
- (b) <u>Kiln Design</u>. Considerable use is made of this service by industry. Kiln designs were prepared for over twenty firms and approximately 300 drawings were issued. It is probably worth mentioning that the capital value of the seasoning plant designed by the section for industry over the last 12 months approximated something like £350,000.

Special attention was given to pre-drier design, particularly on the heating and instrumentation aspects. Currently one pre-drier of 200,000 s.ft. capacity is operating successfully in Tasmania, four others are being built by three different firms (two of these are each of 160,000 s.ft. capacity), and we are preparing design data for a further three firms. A paper discussing some aspects of the construction and economics of pre-driers has been issued as a pre-print for this conference.

Future work may involve the development of kiln designs for high temperature drying of soft woods, and the developing and testing of kiln equipment for using the heat in the hot air vented from kilns; work has already been done in this field in Sweden. We are also anxious to get more information on the relation between air speed and wood drying rates; and we want to assess the value of part time drying for the small man. It is interesting to report a rapidly growing interest in automatic control for driers: this is possibly because of the increasing cost of heat, and possibly because operators are more frequently being required to dry hardwoods from the green condition.

To facilitate discussion with members of industry who call in on us with all sorts of proposals for drier installations, we have also been preparing a number of charts showing such factors as the steam demand for various drying targets, and cost comparisons for electric and steam heating for various species.

- (c) Industry Advisory Work. Not including enquiries leading to plant visits, some 1500 inquiries on timber seasoning matters were received over the last 12 months. This service takes up an appreciable amount of the time of almost all officers of the section but is, no doubt, an essential service to industry.
- (d) Sawmill Waste Disposal. There must be a very considerable number of McCashney units now operating in industry. We feel some gratification that our adoption of this unit and our subsequent design work on it has proved so useful to industry in solving what was once an embarrassing problem in the disposal of sawdust and mill waste. However, we were recently taken aback when a McCashney unit failed to provide satisfactory burning of wet radiata pine sawdust of large particle size in South Australia. With this material combustion was just not sustained and the impact of the heavy particles appeared to beat the fire out. We can now report, however, that design modifications to suit this condition have proved successful. This was achieved, among other means, by flattening the slope of the coned portion of the burner to give better reverberation surface for this class of material.

- (e) Correspondence Course. This has remained very active, with some twenty students currently engaged on the course.
- (f) Miscellaneous. We continued a series of lectures to the building science students of the Melbourne Technical College; to the Supply and Management Class of the same College and gave other talks to other groups. Again, as in past years, nominees from industry were taken into the laboratory for special training purposes. Worthy of special mention is the study period spent with us by Mr. Domingo Lantican, lecturer in wood technology at the Philippine College of Forestry, who spent 12 months with us for training in the theory and practice of timber seasoning.

2. Applied Studies

(a) <u>Kiln Schedules</u>. Work on the development of kiln schedules was continued. The principal species studied recently include <u>E. fastigata</u>, of both N.S.W. and Victorian origin. <u>Bruguiera</u> and <u>Rhizophora</u> species, <u>E. macrorrhyncha</u>, <u>E. muelleriana</u> and <u>E. gigantea</u> of Victorian and Tasmanian origin.

Further work will include a fairly comprehensive study of some of the New Guinea species including <u>Pometia pinnata</u>, <u>E. deglupta</u> and <u>Anisoptera polyandra</u>, <u>Terminalia complanata</u>.

We also carried out quite a number of kiln runs for industry to determine drying characteristics and drying time for the timber from specific areas. This has proved particularly valuable in enabling accurate planning for specific drier capacities. For example, 1 in. thick E. gigantea from the Mansfield district will dry in about 8 days from the green condition in perfect condition. The same species from, say, Burnie, Tasmania, might well take twice as long. Without this information (to take an extreme) there could well be twice as much drier capacity provided than needed, or, alternatively, only half as much.

It is also possible that the drying characteristics of re-growth sucalypts may be appreciably different from that of the original or virgin stock. There is no doubt that industry will be increasingly using re-growth timbers, possibly in much younger age classes than they have been using over the last 20 or more years. It is possible that the drying characteristics of this material, with respect to collapse and checking may be different from that of the virgin stands, so that some work may be needed from time to time to check these points.

(b) Veneer Drying. Special attention has been given to the kiln drying of rotary peeled veneers, particularly in relation to the method used for racking for drying. The handling of veneers on and off trays has for a long time been recognized as a costly process, and it has weighed heavily against their use in the comparatively low cost drying compartments as used in Australia.

On the other hand the use of the vertical racking arrangement with projecting fingers (as commonly used in air drying veneers in Australia) has not been very successful in standard cross shaft compartment kilns. The prime difficulties were end splitting, end frilling and general buckling, due to differential drying across the sheets. An examination of the problem has resulted in design modifications to veneer kiln designs, including the use of air diffusers or screens in the kiln plenum chambers, which now enable the rapid drying of the cheaper vertically racked green veneers in these units.

In a unit completed in Western Australia recently, green 1/16th in. ramin veneers are being dried in 36 - 40 min., and the quality of drying is considered better than good air drying. Karri veneer of 1/16 in. thickness is also being dried in about 1 hr. A second unit of similar design is to be installed.

We have been keeping in fairly close touch with officers of the Queensland Forest Service on aspects of this work, and I believe information made available has enabled similar designs to be issued for Queensland - one or two plants have recently completed such units. (c) Wood Waste-Binder Products. Experimental work in this field was suspended, but appreciable time was given by one officer to writing up results.

Reports on studies on the "Suitability of Decayed Heart Material as a Binder for Sawdust Products", "The Nature of Burning in Hot Pressed Ligno-cellulose Products", "Studies on Bagasse-Resin Combinations for Hardboard", "The Suitability of Coconut Fibre in Hardboard Manufacture", "The Suitability of Coir Fibre Dust for Lardboard Manufacture" were prepared.

- (d) The Drying of Wood Blocks for Charcoal Manufacture. Work was undertaken on this project at the request of Wood Distillation Charcoal Iron and Steel Industry of Wundowie, Western Australia, to determine quality of drying and drying rates for jarrah blocks of differing sizes (i.e. 40 sq.in. end areas and 3 in. to 10 in. or more long). This Company requires to dry some 100 to 150 tons of blocks per day from the green condition to a moisture content a little below fibre saturation point. The blocks are required for destructive distillation for charcoal manufacture. Work is progressing on the effect of various drying conditions, including temperature up to 300°F. from retort and blast furnace gases and air circulation rate, on rate and quality of drying, and in determining the static head resistance to air flow with bulk piled material. The information obtained is also required for special future drier design.
- (e) Collapse. Several studies were commenced with the object of developing a quick field method for identifying collapse susceptible timber while it is still in the log form. Aspects being examined include permeability to air and chemical salt and a comparison of dimensional change in very short sections and 1 in. long sections under various drying conditions.
- (f) Quantitative Rating of Drying Degrade. Work in this field has aimed at developing a numerical method for assessing drying degrade in veneer and sawn timber. The object is to obtain a basis subject

to statistical analysis, for comparing the effects of different experimental methods on quality of drying. We have developed a scheme of this type for "ash" eucalypt veneers.

There is an outstanding need for a sound scheme to cover drying degrade in sawn timber: preliminary consideration is being given to this.

(g) Vapour Drying. Although experimental work on vapour drying was suspended over the last year considerable work was involved in the preparation of reports on vapour drying for (i) "ash" eucalypt and myrtle beech flooring sizes from both the green and partial air dried condition, (ii) a number of sub-tropical rain forest species in flooring sizes, (iii) softwoods in flooring sizes, and (iv) the vapour drying and pressure impregnation of pervious timbers in sleeper sizes. All reports were completed and most have been distributed. A paper summarizing the research studies was published in the "Australian Porester" and is being reprinted by the Australian Timber Journal.

It is anticipated that work on possibly the most potentially useful aspects of vapour drying - the vapour drying and pressure impregnation of hardwood railway sleeper sizes - will be resumed when deliveries of jerrah and karri sleepers are received from Western Australia. This is expected to be in the very near future. Species in this project include mountain ash (representing collapsing eucalypt of moderate density), red gum (representing a collapsing eucalypt of fairly high density), jerrah (non-collapsing) and a peppermint.

(h) Other Projects. Additional applied projects on which work has recently been done include the effects of seasonal conditions on the moisture content of railway sleepers in service track at a number of sites near Melbourne and on the value of platen drying for "ash" eucalypt veneers. Some limited work has also been done on the value of protective surface coatings on logs and heavy sizes in storage in exposed dumps in reducing drying degrade. This can be an important factor in recoveries obtained in the sawmill, particularly where what is now high priced timber in log form is left exposed through a severe summer. We expect to commence field tests on this study later to determine covering capacity and cost of treatment and usefulness.

3. Fundamental Studies

- (a) Moisture Diffusion in Hardwoods. From time to time the work of the section has been hampered by a notable lack of information on the influence of physical conditions on moisture movement in hardwoods. This includes the influence of such factors as temperature, vapour pressure and total pressure on diffusion constants and drying rates. Work on this project has been commenced, and I am hopeful Mr. Kauman of our section will have some useful and interesting information to report next year.
- (b) <u>Collapse</u>. Much still remains to be known on the phenomena of collapse and recovery. We are interested in finding out which of the Tiemann theory or the Barkas Postulation is the more correct, as the answer could well affect the method of attack for finding a means of preventing collapse.

We would like to know also the influence of reaction wood on collapse: for example, while we do not believe that all timber that collapses is tension wood, we should find out whether all tension wood collapses, and if so, whether the relationship is due to the delignification of tension wood, or to some other factor. We also want to know why collapsed timber recovers on reconditioning, and whether there are any economic pre-treatments which will inhibit or prevent collapse.

Fundamental studies are being carried out in this field in co-operation with the Section of Wood and Fibre Structure.

(c) Mechanical Breakdown in Railway Sleepers. The question of whether work should be resumed on the causes and prevention of mechanical breakdown in railway sleepers - from end splitting, rail cutting, spike kill or general weathering and brooming may also have to be given consideration.

Mr. Huddleston: Mr. Chairman, a lot of the matters which have been raised will be raised again by me in the policy session tomorrow afternoon. I feel that the basic work which is put on one side because of lack of staff, could take priority over a lot of the applied work which is being done, because it is being done for the benefit of certain States who do not provide a service to their industry. If these States did their part, the staff you are using on applied work could be better applied to the determination of fundamental information. At this stage, I would just like to throw up a problem to you which is of very great economic importance and that is the question of drying rain forest species containing dark heart, particularly yellow carabeen which dries very satisfactorily in the case of clear yellow timber, dries reasonably well in some of the dark timber but some with black timber in the heart cannot be dried at all. If we could find a schedule to dry this black timber, we would be able to make use of very much more yellow carabeen than we are able to use today. I feel this is a problem which is important not only for yellow carabeen but for other rain forest species.

ITEM 8 (a) SOLVENT SEASONING*

Various systems of solvent seasoning have been used in the past, usually with indifferent results. Recently, however, our attention was drawn to a report ** on the excellent drying properties of a solution containing 20 per cent. diacetone alcohol in petroleum ether. The impressive description of this process in the above report seemed to warrant an investigation of this process to determine its suitability for the timber industry.

Some experimental work was carried out in this Division and we found that when green timber is immersed in 20 per cent. diacetone alcohol in petroleum ether, the moisture is precipitated out of the timber in a separate liquid phase. Further tests were carried out to study this solvent drying and it was found that the initial water removal is due to a phase phenomenon. When water (in the green timber)

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

m. J. G. Nash, Chem. and Ind. (2) 40-1, 1952.

is brought into contact with diacetone sloohol in petroleum ether, a partition of diacetone between the water and the petroleum ether occurs in which the water is favoured. This results in the formation of a heavy, water containing phase which detaches itself from the timber and forms a separate phase on the bottom of the container. This process continues until the timber is dry and at this stage the timber has a moisture content of about 14 per cent. but is saturated with diacetone alcohol.

Up to this point almost no shrinkage occurs in the timber, but when the timber is allowed to air dry subsequent to the treatment, it commences to shrink. The process of air drying is extremely slow. In our tests, samples of E. gigantea, measuring 1 in. $\times 1\frac{1}{2}$ in. $\times 4$ in., did not reach constant weight until after 5 months and even then we were not certain whether the samples had reached constant weight, because slight changes in E.M.C. could have masked the very small changes in weight. After 5 months air drying, the samples were found to have a moisture content of 12 per cent. and a total volatile content of 19 per cent. This indicates that the diacetone alcohol is held very strongly by the timber.

The retention of the solvent by the timber is a serious disadvantage in this process. In addition, our tests showed that when the solvent finally dries out, the properties of the timber are similar to material dried in the conventional manner. Thus, for instance, collapse is not avoided and shrinkage is not reduced. For these reasons no great advantages can be claimed for this method of solvent seasoning and no further investigations into its applications seem warranted.

Discussion:

Dr. Christensen: I have just become aware of this method of solvent seasoning in the last few days but I think Mr. Booth's suggested mechanism is probably correct, with one or two modifications. I think what happens is not so much that the water diffuses out of the wood into the external alcohol solution but rather that the discetone

alcohol diffuses into the water in the wood. This is due to the relative solubilities of the diacetons alcohol in water and in petroleum ether and its resulting partition between the two. The diacetone alcohol in water persists as a separate phase which increases in volume as more diacetone alcohol dissolves in the water. As the wood is incapable of holding this increasing volume, some of the solution is cushed out and falls away from the surface of the wood in droplets. Gradually the diacetone alcohol is taken up from the external ether solution until its concentration in the water in the wood reaches the equilibrium value, which is about 10 per cent. water in diacetone alcohol. The result is that the original water in the wood is replaced by an approximately equal volume of diacetone elochol solution. There is one other point I would like to mention. That is the extent to which this applies to molecularly adsorbed water is probably limited but some displacement of this water also by diacetone alcohol must occur to account for the difference between the 14 per cent. moisture content that is finally reached and something like 25 per cent. at which shrinkage commences during drying. This must be partial replacement of the water in the fibre structure by diagetone alcohol.

Mr. Wright: It is of particular interest to me to find that even after getting down to 14 per cent. moisture content you subsequently get collapse. If that is so and if Tiemann's theory is correct, it seems that you must have water or other liquids within the cell cavities.

Dr. Christensen: The mechanism of this process is not comparable with normal drying. We have just carried out a test using a glass capillary tube closed at one end instead of wood. This was filled with water and placed in the diacetone alcohol-petroleum ether solution. The aqueous phase was observed to expand and fall away from the capillary as droplets, but at the conclusion there were still two phases quite definitely present, the diacetone alcohol water solution still filling the capillary. The collapse on final drying of the wood, probably resulted from the presence of the liquid phase still present in the wood, even though the moisture content was only 14 per cent.

THE DESIGN, PERFORMANCE AND ECONOMICS OF PREDRIERS* THE USE AND FUNCTION OF PREDRIERS

The name predrier was originally coined to identify large, well insulated, multi-line timber driers specifically intended to partially dry green hardwoods to moisture contents approximating 25 per cent. prior to kiln drying.

Because the equipment used in predriers and kilns is similar (in that suitable steam or flue gas heat-exchangers heat air, which is then circulated by means of fans through the stacks of timber to be dried), the principal differences between the two are ones of function and method of operation.

Predriers are designed to operate continuously at constant low temperature conditions, the dry and wet bulb temperatures being the optimum for the green stock being dried. Any charge line can be unloaded of its dry timber and reloaded with green, without affecting the drying on adjacent charge lines. Kilns, on the other hand, are designed so that drying conditions can be changed easily and rapidly, so that advantage can be taken of the changing characteristics of the species. Kilns, furthermore, are designed to operate with higher temperatures than predriers. The predrier has not, and is not intended to have, the flexibility of kilns, and cannot effectively handle a range of species nor attain the drying rates expected from kilns. On the other hand, on the basis of charge capacity, predriers are cheaper to install than kilns.

As corceived by this Division, the specific function of predrices is, then, to partly season large quantities of timber under conditions which might be described as the equivalent of "accelerated air drying weather". Their special field of use is in areas where partial air drying is unduly prelenged, or, possibly, in places where sufficient area for air drying is not available and multiple stacking is unsatisfactory.

m Propaged by the Division of Perest Products

Predriers are capable of fully drying a timber charge and, in some cases they have been used in this manner. However, the design, method of operation and economics of the process are such that this method of use involves a much longer drying time than the predrier plus kiln technique. This is because the constant relatively low temperature held in predriers is far too mild to enable maximum drying rates to be obtained once the timber is below 25 or 30 per cent. At this stage drying rates have generally slowed up. In fact, they become progressively slower unless advantage is taken of the ability of timber to "take" the much higher temperatures and lower humidities provided in kilns, a practice usually necessary if drying rates are to be kept to an economic level.

If the timber concerned is collapse susceptible the stage at which it should be reconditioned is dictated by its moisture content at the transfer stage from predrier to kilms. If the core moisture contents are less than, say, 25 per cent., reconditioning can often be done as the timber comes from the predrier. Otherwise this will need to be deferred until sufficient further drying (preferably to a moisture content approximating 17 per cent.) has been completed in kilms.

CONSTRUCTION

The largest predrier so far installed in Australia has a charge capacity approximating 200,000 super feet. Two units, each to hold 160,000 super feet, are currently (1954) being built at one plant in Tasmania, and it is planned to duplicate these at a later date. One other unit is also operating, and several others are planned or in process of construction.

In principle the design of all these units is similar, except that in one case recirculation is not provided, and in another air circulation is supplied from fans on a longitudinal shaft rather than the more common and efficient cross shaft.

Figure I shows a diagrammatic sketch of a typical unit with a charge capacity approximating 160,000 super feet.

Almost any conventional construction material, including reinforced concrete, brick or timber, is suitable for predrier buildings. Because timber is convenient, is generally readily available, and is the cheapest of these three materials, all predriers so far installed are of timber frame construction with either a wood or asbestos-cement wall sheathing, the wall cavity being packed with insulation ranging from sawdust and buzzer chips to rock wool. The greatest hazard likely to cause deterioration in a predrier is the very slightly acid atmosphere caused by the evaporation of volatiles from the drying of green timber. This may tend to accelerate corrosion in ferrous fittings or fastenings (including nails) so that these should be painted with a protective seal such as a bitumastic paint.

An air velocity of approximately 300 ft. per minute through the drying stacks is usually aimed at, so that fan size, speed and spacing to suit this delivery is required; 48 inch diameter propellor type fans operating at about 450 R.P.M. are suitable.

Heating is usually most conveniently provided by steam heated coils, as steam is generally readily available at seasoning plants or timber mills, and it can be easily controlled. Any suitable form of heating oan, however, be used, with electricity, coal gas and boiler flue gases as the most likely alternatives in Australia. Generally, however, electricity is somewhat too costly for timber drying and coal gas is not always convenient: flue gases (including boiler exhaust gas) may be passed to a heat exchanger or used directly as the circulating atmosphere within the predrier. In the early stages of development (1946) consideration was given by officers of the Division of Forest Products to the use of flue gases, and suitable flue gas heat exchangers were designed, but it was later decided not to recommend their use (except in special cases) because of the fire risks involved and the special measures need to control temperature effectively. For most purposes the heat exchanger should have a capacity capable of

some 15,000 B.T.U./hr./1000 s.ft. of charge capacity. Either manual or automatic temperature and/or vent control can be provided without difficulty.

The only limitations on the length (i.e. depth) of the charge lines in the predrier are those inherent in handling stock in and out of the unit, and in obtaining uniform heat distribution along the length. The longest so far constructed is approximately 130 ft. deep.

Predrier width, or more strictly, the number of charge lines which can be designed for, is dependent on stack width, and is determined by two principal factors. These are (1) static resistance to air flow: this is influenced by the total length of air travel through timber stacks, air velocity and the thickness of the stacking strips, and (2) the extent of the increase in temperature between the "air inlet" and "air discharge" sides of the predrier. This automatically results when operating at a constant wet bulb depression with reheat coils.

In general, the length of the air path through timber stacks (i.e. stack width multiplied by number of charge lines) should not exceed about 40 ft., otherwise there is risk of the temperature becoming too high at the "air discharge" side of the predrier. This is because a slight but cumulative increase in wet bulb temperature occurs at each reheat stage. This is inevitable, and approximates one quarter the temperature rise needed to regain dry bulb temperature lost by the circulating air, since the previous re-heat stage. In fact, to ensure operation at constant wet bulb depression, the dry bulb temperature at each re-heat stage has to be taken a little higher (usually about 2 f.) than it was at the previous re-heat stage to compensate for the automatic wet bulb temperature rise during re-heating. It is important to maintain a constant wet bulb depression as it is this depression which provides the "drying potential" of the drying air.

As the cumulative effect of this re-adjustment of drying

conditions is to cause a gradual overall increase in both the dry and wet bulb temperatures between the "air inlet" and "air discharge" sides of the predrier, it is clear that too long an air path can cause drying conditions at the "air discharge" side to become more severe than desired.

For wide stacks, of the order of 8 ft. or so, re-heat coils are required between each charge line. For stacks which are fairly narrow, it may be sufficient to provide re-heat coils between every second charge line.

Predriers are loaded and unloaded in the same manner as kilns. In Australia this is by means of transfer and Christensen type lifting trucks. Loading and unloading, and the movement of stock to or from predriers can, of course, be done by straddle or other type trucks if desired.

INSTALLATION COSTS

Installation cost of predriers ranges from about £80 to £160/
1000 s.ft. charge capacity depending on the quality of the buildings
and equipment installed. For near minimum requirements a predrier
building could be constructed for about £40/1000 s.ft. charge capacity;
while the supply and installation of heating, fan equipment, and
minimum instrumentation would cost about the same amount. In this case
maintenance charges could become heavy, however, and the unit would
probably not operate at maximum efficiency at all times. At the higher
rate, a building to include a reinforced concrete floor slab and stack
supports, high quality wall and ceiling insulation, etc., could be
provided at a cost of up to £85/1000 s.ft.; with the supply and
installation cost of heating, fan equipment and automatic
instrumentation approximating some £75/1000 s.ft.

The installation cost of a predrier of, say, 200,000 s.ft. capacity can, therefore, range from some £16,000 to £32,000 depending on the quality of installation demanded.

For purposes of comparison kiln installation costs currently range from approximately £200 to £250/1000 s.ft. of charge capacity.

The above costs refer only to the units named and do not include any portion of the cost of associated seasoning plant or equipment, such as (a) a steam raising boiler (the installed cost for which probably range? from about £3,000 or £3,500 for a new 40 H.P. boiler, to about £5,000 for a new 100 H.P. boiler, (b) a boiler house, (c) Christensen and transfer trucks (ranging in price up to about £1,800 each for powered units), (d) air seasoning yard (if any), (e) storage buildings, (f) stack bearers and stacking strips, (g) offices, (h) land and fencing etc.

As mentioned earlier, a predrier may be used either as equipment for partially drying hardwoods before kiln drying, or for complete seasoning. However, the question of whether a predrier is better or not than alternative methods of seasoning must also be examined. To assist in assessing the economic sphere for predriers, the order of the amount of capital required for plant and timber stucks, for each of four variants, is given in Table I. Custs are, again, quoted only for the specific items named. It is assumed that the following conditions apply. (i) a weekly output of 50,000 super feet of 1 in. thick Tasmanian "ash" type hardwood; (ii) the timber is to be seasoned from the green condition to approximately 12 to 14 per cent. moisture content and requires reconditioning: (iii) kiln drying from the green condition requires three weeks (approximately 500 hours) - this is fairly typical for 1 in. thick Tasmanian "ash"; (iv) after partial air drying or predrying to 25 per cent. moisture content, kiln drying requires 5 days (approximately 120 hours); (v) for the quality of construction required kiln installation costs lie in a range £232 to £245 per 1000 super feet charge capacity; (vi) for the quality of construction required, predrier installation costs lie in a range of £130 to £150 T ir 1000 super feet charge capacity; (vii) installation costs for an air drying yard approximate £10 per 1000 super feet apecity; (viii) the value of timber while seasoning approximates £4 per 100 super feet; (:) except where an air drying yard is provided, a timber stock equivalent to two weeks' output is held ahead of driers.

m Secondhand boilers, de-rated in allowable gauge pressure (and, therefore, appreciably cheaper than new ones) are frequently suitable for him installations because steam pressures required are usually not high.

TABLE 1

APPROXIMATE INSTALLATION COSTS FOR THE PLANT LISTED

Drying Process	Cost of Plant Installation for Units Named in Column 1 (not including other associated seasoning plant)	Value of Timber Stocks Required	Boiler Horse Power Required for Plant
Combined Air Drying and Kiln Drying (a) Air drying yard (b) Kilns, and (c) Reconditioners (i) Partial air drying for 4 months	£15,000 to £16,000	£34,000	40
(ii) Partial air drying for 8 months	£22,000 to £24,000	£65,000	40
Combined Predrying and Kilns (a) Predrier (b) Kilns, and (c) Reconditioner	£27,000 to	£12,000	100- 120
Kiln Drying Fully (a) Kilns, and (b) Reconditioner	£36,000 to	£10,000	120- 130
Predrying Fully (a) Predrier ** and (b) Reconditioner	£40,000 to	£16,000 to	130- 150

^{*} A possible variant would be to operate two predriers, one at a relatively low temperature for partial drying to, say, about 25 per cent. moisture content; and the other operating at a much higher temperature (say, 140°F. or so) for final drying.

DRYING COSTS

Timber seasoning costs can generally be subdivided into three largely independent but related items; (i) the cost of sorting, stacking and handling: this is largely a labour charge; (ii) the cost of air drying (if any): this largely consists of overhead charges on yard costs (interest on plant, depreciation, insurance and maintenance), but may also include charges for rents and rates, etc., insurance on value of timber, and (a debatable point) an interest charge on the value of the timber while seasoning; and (iii) kiln drying and reconditioning costs: the principal operating costs under this item are for steam (primarily dependent on boiler attendants' wages and fuel costs) and labour (portion of wages of the kiln operator), with the usual overhead costs of interest on plant, depreciation, insurance and maintenance. The order of the drying costs in kiln drying has previously been discussed elsewhere.

For a combined predrier and kiln drying process the costs of items (i) and (iii) above should not be markedly different from those for the combined air and kiln operation, assuming there is space for either system on a particular site, so that the comparison becomes basically a question of whether the predrying or partial air drying is the more economic proposition in terms of both drying cost and returns on capital invested. This, again, assumes equal quality of drying.

With respect to <u>predrier</u> drying costs, no information from the commercial sources is, unfortunately, at present available to the author. However, the chargeable items would be similar to those for kiln drying and comprise (a) steam and power charges, (b) wages, and (c) overhead charges on the pre-trier, and interest and insurance charges on the value of the timber in the predrier. Taking interest charges at 5 per cent., depreciation at 10 per cent., and insurance and maintenance at about 2 per cent., item (c) above has

m"Plant Installation and Drying Costs for Timber Seasoning Kilns" by G.W. Wright: Australian Timber Journal Sept. 1952.

been assessed at about 3/-/100 s.ft. Item (b) is rather an unknown quantity and would comprise that proportion of the kiln operator's time it is necessary to charge against the predrier. If we assume half the kiln operator's time, then this cost would be about 5d. or 6d./100 s.ft. for a plant handling about 50,000 s.ft./week; kiln drying costs would, of course, require to be reduced accordingly. Wages for handling in and out of the predrier are charged elsewhere as previously indicated.

Costs other than for steam and power would, therefore, probably approximate 3/6 or so per 100 s.ft.

Fower charges for the predrier fans would probably approximate 5d. or 6d./100 s.ft. for each ld./K.W.H. of power charge. The cost of steam thus becomes the remaining unknown item. It can be assumed that from 400 to 700 lb. of steam will be used per 100 s.ft. over the drying period, depending on the moisture content at which the timber enters the predrier. If steam costs, say 10/-/1000 lb., the steam cost will, therefore, range from about 4/- to 7/-/100 s.ft. Accepting the accuracy of the above assumptions it would appear that predrier costs could range from about 8/- to 11/-/100 s.ft. for 1 in. stock partially dried to about 25 per cent. moisture content.

For purposes of comparison it can be taken that a reasonable air drying cost (again including no handling costs) would probably approximate 8d. to 9d./100 s.ft./month, about half of this being an interest charge on the value of the timber.

For a 4 months' partial air drying period (assuming good climatic conditions) partial air drying charges would be about 2/9 to 3/-/100 s.ft., and would, therefore, be considerably below predrier charges. For an 8 or 9 months' partial air drying period, costs would range from about 5/6 to about 7/-/100 s.ft.: this would still be below predrier costs, but for this longer period of air drying, the cost of timber stock would increase the capital investment to such an extent that it is probable the return or profit obtained, when

expressed as a percentage of capital investment, would be at a much lower rate than obtained from the predrier.

QUALITY OF DRYING IN PREDRIER

Information available on the quality of drying obtained from predriers is limited, and confined to reports on the drying of "ash" eucalypts. The results obtained so far indicate satisfactory quality of drying by the combined predrier and kiln operation. It is suspected, however, that where fairly impervious, collapse susceptible species are dried, collapse may be slightly greater, and moisture gradients a little steeper in stock which has been predried than in similar stock which has been partially air dried. It is possible that checks may be slightly less in predried stock than in air dried material.

Tests were made recently by officers of the Division of
Forest Products to check the uniformity of drying in a large
commercial predrier. This was done by testing the moisture content of
individual boards on each layer of several "predried" timber stacks of
Tasmanian hardwood; and also, later, as they came from kilns. The
variation in moisture content found within stacks was sometimes
appreciable. Because of the irregularity of pattern, however, the
strong impression gained was that this was not due to any fault of
air circulation or heat distribution, but entirely to the differing
densities and drying characteristics of different boards. As great,
and greater, differences are found in kiln drying this somewhat
difficult species from the green condition.

Discussion:

Mr. Clarke: Before we pass from Seasoning, I want to mention that when I was in New Zealand, I had a look at a Bachrich kiln. It is a prefabricated unit, taking 18,000 s.ft. of 1 in. timber. It consists of wall pieces in about 4 ft. sections which are all bolted together. The whole of the heating coils, fan assembly, steaming pipes, vent pipes, and fan drives are in two ceiling sections placed on top of the walls to complete the kiln. The kiln is, I understand, designed to operate at about 250°F. Its cost, landed in New Zealand, was about £6,000. They seem to think that by the time it was taken up to Putaruru, etc. the total cost would be somewhere of the order of £9,000 (N.Z.).

I saw the first charge after it had come out. They had had trouble with the kiln in the early stages, chiefly in getting a suitable grease to stand up in the bearings. It was obviously still in the teething stage. I did ask Mr. S. Reid of the State Forest Service to make a test with the kiln when it was properly in operation and to give us the results of the investigations. I also saw the Putaruru people and mentioned this to them, so that when the kiln gets over its teething troubles, we should be able to get a good idea of its performance. It is supposed to dry l in. P. radiata in 36 hr.

Mr. Wright: It may be of interest to the meeting to know that a Bachrich high temperature unit has been ordered for South Australia by the same organization as that at Putaruru: this latter firm has a controlling interest in a firm in the Mt. Gembier area.

Mr. Gottstein: A prefabricated Bachrich steam heated kiln of imported manufacture has also been installed in Melbourne. This kiln is intended to be operated at ordinary temperatures and was supplied for the drying of ash eucalypts. It is unfortunate that the designers do not appear to have a full understanding of the drying of collapse-susceptible ash type eucalypts from the green condition. As a result of this, the vents are badly under-designed for the operating

temperatures necessary. In addition, heater capacity is rather low for the intermittent operation economically necessary of the small unit installed. On the advice of manufacturers, this unit was installed without a separate reconditioning chamber and this, together with the very small capacity boiler supplied, has led to considerable dissatisfaction.

ITEM 9 (a) SURVEY OF AUSTRALIAN FLYWOOD LOG SUPPLIES

Mr. Gordon: About three-quarters of the plywood used in Australia goes into furniture or flush doors. Discussions with a wide range of plywood users and distributors in Australia suggest that the major plywood demands call for the characteristic of hoop pine namely, low density, light colour, smooth texture, easy working. Sheets should be flat and well glued. Supplies of hoop pine plywood are now greatly reduced although the use of hoop pine faces in composite plywood goes some distance towards meeting the desire for hoop pine plywood. Bunya pine, klinki pine, and kauri together with some pale low to medium density scrubwoods and imported woods are also readily accepted if satisfactory quality plywood is presented regularly. Plywood is being produced in different States from the species listed below.

Western Australia. You might recall that plywood was first made in Western Australia during the war following work by this Division which demonstrated that plywood could be made from karri, but immediately after the war as a result of reaction to karri plywood, which by no means compares with hoop pine, ramin logs were imported from Borneo for furniture plywood. A current proposal to use karri plywood for flooring is a good one, the use of 5 or 7 plies making selection of faces less difficult than in 5 ply for furniture.

In South Australia radiata pine is the chief species used.

In Tasmania, up to the end of January, 1954, when the plywood factory was destroyed by fire, myrtle beech was the main species. Ash eucalypts were also used to some extent but difficulties

resultant from poor drying behaviour and unsatisfactory facilities restricted their use. From 1955 radiata pine veneers were peeled for faces and backs of a composite plywood with hardwood centre veneers. Initial production was of poor quality when they appealed to us for assistance in improving their peeling technique. Investigation showed that they were peeling unsuitable logs. With reasonable log selection and suitable peeling technique this composite construction overcomes a lot of problems in making 3/16 in. plywood when either knotty pine or ash eucalypts are the only logs available and must be used for all three plies.

In <u>Victoria</u> plywood production is almost exclusively from imported logs, chiefly from the Pacific - Vanikoro kauri is the main species. We have assisted in developing satisfactory techniques for producing veneers from ash eucalypts but supplies in reasonable quantities have not been obtained for the project to develop.

In <u>New South Wales</u> there are virtually two industries - in Sydney and in country districts. The main production in Sydney is from imported woods, ramin, "Borneo cedar", knuri and other Pacific species, while the country mills use a wide range of brushwoods.

In Queensland you have the pine group, maple, silky oak and walnut, and a multiplicity of brushwoods and imported logs.

Apart from problems of warping and twisting which are due in part to composite constructions and ineffective drying, furniture manufacturers try to avoid lining cupboards with dark coloured woods, which make it difficult to see inside. They point out that it is a definite disadvantage and to spray inside with white paint is a costly additional operation. In consequence I anticipate in the future the greater use of plantation grown pines but prejudice against knots will have to be overcome. Steps are being taken in Victoria and New South Wales for radiata pine plywood plants to be established but no scheduled dates are in sight.

We have standing arrangements with the Queensland and New Guinea Forest Services to carry out investigations on species which they care to nominate as being worth investigation. We have not actually done much in that field in recent months. However, Mr. McAdam assures me that we have a log or two coming. Mr. Jennings has told me that floods have hampered logs coming through from North Queensland.

I would like to hear opinions on what I have just said from various States.

Mr. Jennings: I am not prepared to accept what Melbourne distributors say about requirements for white-face plywood. The Queensland plywood production was 80 million sq.ft. for the 6 months ending 51/12/55 and the Australian production was 160 per cent. of the 1941 level. There is no difficulty in selling species other than hoop pine for face plywood and business has picked up particularly well, most firms finding it difficult to fulfil orders.

Mr. Huddleston: I agree with Mr. Jennings' statement; even in the depth of the slump furniture manufacturers in Sydney found difficulty in obtaining good quality plywood. At no time was N.S.W. able to obtain sufficient good plywood to meet their demands. One of our manufacturers managed to get a number of radiata pine logs but was unable to sell the plywood to furniture manufacturers in spite of its light colour.

Mr. Grenning: I discussed the question with North
Queensland manufacturers in 1952. Many of them had started during the
war, and hadn't any experience with keen competition that others had
during the depression. Manufacturers and users were each partly to
blame because agents purchased reject plywood at their own request.

ITEM 9 (b) DEVELOPMENTS IN HOT PRESSING OF FLYWOOD AND THE USE OF SYNTHETIC RESIN GLUES

Mr. Gordon: Firstly, I would like to give some information regarding hot-presses in Australia. At the present time we have two in Western Australia, one in South Australia, six in Victoria, approximately twelve in New South Wales and somewhere between six and nine in Queensland.

It is now theoretically possible to get all the waterproof plywood desired. I would like to point out however, that a large percentage of the hot-pressed plywood is the highly moisture resistant type which I personally believe has no special field of application as far as economy is concerned. It is intermediate in price - between waterproof and non-moisture resistant - and while admitting it is superior to the last I consider that if conditions of use are too hazardous as regards water, high humidity and high temperature, there is only one safe type of glue - waterproof. On this point, I would mention briefly that plywood which is currently made in New Guinea is of the highly moisture resistant type and will be sold as "waterproof" plywood as it will thus command a higher price than ordinary plywood, but I believe it will be used chiefly in furniture.

There should be no difficulty in selling klinki pine as it is a hoop pine substitute.

Liquid phenolic glues are now being used to some extent by plywood manufacturers but unless a 10 or 12 daylight press is available the economics of its substitution for Tego film are doubtful.

One or two failures have been noted in plywood glued with liquid phenolic being shipped into Melbourne as a result of rough veneer being used. The glue is absorbed by the centre ply.

Resorcinol formaldehyde glues are being produced on request by three companies although there have been no major sales of them. For many years there were no waterproof cold-setting glues available in Australia but we should now be able to construct any type of laminated member for use where a waterproof glue is required for satisfactory service.

Mr. Booth: One of the reasons noted for poor quality waterproof plywood being available is that some hot-presses are not really satisfactory for producing Tego plywood because of their low maximum operating pressure. Even if a hot-press will go up to 200 lb./sq.in. it may not turn out good waterproof plywood with Tego. A number of firms in Sydney have attempted to make Tego glued plywood with rather poor results. There are some other presses, hot water heated, which are specially designed for urea. Some manufacturers, in an endeavour to take advantage of the higher price for waterproof plywood are not above passing on urea-glued plywood as "waterproof".

ITEM 9 (c) DURABILITY OF PHENOLIC FILM GLUED FLYWOOD USING SODIUM FLUORIDE TREATED VENEERS *

The fact that reliable waterproof bonds cannot be made using phenolic film glue on boron treated veneer seriously restricts the raw material base of the waterproof plywood industry, many excellent susceptible species are excluded from this field because of this difficulty.

Trials have been made by the Division of Wood Technology using sodium fluoride immunized veneers to ascertain if durable bonds can be made using phenolic film glue.

The tests have been made using white birch (Schizomeria obata) veneer immunized by a momentary dip with sodium fluoride.

The treated veneers analysed 0.38 per cent. sodium fluoride.

Six 12 in. square 3/16 in. 3 ply panels were made using treated veneer and six untreated control panels from the same batch of veneer.

Pressing details were 200 lb./sq.in., 140°C. for 8 min.
The following mean results were obtained for glueline shear strength.

Control Panels

Shear strength:- Dry 310 lb./sq.in. 90 per cent.W/F.

After 6 hr. boiling 300 " 80 " " W/F.

Treated Panels

Shear strength:- Dry 290 lb./sq.in. 90 per cent.W/F.

After 6 hr. boiling 300 " 70 " " W/F.

There is on the above results no appreciable difference between treated and untreated veneer. This contrasts with boron

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

treated veneers which under the same conditions show a serious loss of strength, often delaminating, after boiling 6 hr.

Weathering tests were carried out as follows: -

- Exposed at D.W.T. Sydney.
 Exposed 22/5/53.
 - Both treated and untreated panels in excellent condition in March 1954.
- (2) Exposed in intertidal zone at Fort Macquarie, Sydney Harbour. Exposed 7/5/53.

Both treated and untreated panels in excellent condition in March 1954.

(3) Exposed at Baradine, N.S.W. Exposed 26/8/53.

Both treated and untreated panels in excellent condition in March 1954.

It will be seen from the above that the treated veneer is performing satisfactorily. Incidentally, treated and control panels prepared in the same way using a faulty batch of film glue are still in excellent condition at Baradine having been exposed since 9/9/52.

It seems reasonable to assume that sodium fluoride veneers treated to 0.4 per cent. are quite satisfactory for the production of waterproof plywood using phenolic film glue.

Arrangements have been made to carry out commercial tests at a Sydney factory next month.

Health Hazards Associated with the Use of Sodium Fluoride in Timber Preservation

At the last Forest Products Conference there was some discussion on the possible uses of sodium fluoride in timber preservation. At that time, Mr. Jennings stated that Queensland Health Authorities were opposed to the use of this salt in view of possible health hazards attendant on its use.

In view of the fact that sodium fluoride is already widely used in various salt mixtures and that the use of this preservative

may prove of great value, particularly in the treatment of veneers for the manufacture of waterproof plywood, we considered that the health hazards involved should be re-examined.

It was agreed that the maximum danger would arise in the manufacture of plywood, particularly during sanding and for this reason the health hazard likely to occur during this operation was examined in co-operation with the N.S.W. Department of Public Health.

The tests were carried out in two Sydney factories, one (A) a modern plant where drum sanding is used with a satisfactory dust extraction system, and the other (B), a plant where belt sanding is carried out and the dust extraction system is poor, and where the health hazard could be assumed to be most severe. Both factories were working at full capacity at the time of the test.

The following results were obtained in the test conducted by the Health Department: -

"The tests showed that the following average quantities of wood dust were present in the atmosphere.

- 1. Factory B 43.6 mg./cu.m.
- 2. Factory A 24.8 mg./cu.m.

With wood dust containing 0.1 per cent. sodium fluoride, 500 mg. would be required to equal the suggested maximum of 0.5 mg./cu.m. It can be concluded, therefore, that there should be no danger of fluoride poisoning from the above processes, using wood that is so treated, providing that the impregnation of the wood is reasonably uniform."

Discussion:

Mr. Jennings: Queensland is not at all happy about the use of sodium fluoride treated veneers.

Mr. Huddleston: The N.S.W. Health Authorities were very reluctant at first but after discussion with them, they finally agreed to carry out tests which showed that there was no health hazard in the use of sodium fluoride.

Mr. Jennings: The Queensland Health Department would agree as long as adequate exhaust system is installed but this is not workable and is impossible to police.

Mr. Gordon: Can veneers treated with sodium fluoride be glued with other glues? It is essential for practical use that veneers immunized against Lyctus should glue satisfactorily with all glues.

Mr. Booth: Results of work were reported at the last Conference. Glues used were animal, casein and urea - both extended and unextended and no trouble was experienced.

Mr. Gordon: Adoption of sodium fluoride dipping might mean the banning of borax and boric acid treated veneers, as it is impracticable to have veneers immunized by different methods in a plywood plant dependent on bought veneer.

<u>Mr. Booth</u>: One factory in Sydney making phenolic film glued plywood spot tests every sheet of veneer to see whether it has been treated with boric acid.

ITEM 9 (d) DURABILITY OF BLOOD ALBUMEN GLUES *

Laboratory trials of blood albumen glues based on mixtures of lactic or hydrochloric casein and liquid whole blood were reported at the last Conference. Excellent adhesion was obtained with cold setting mixes. The effect of ageing on these glue joints was unknown at the time.

Since the last Conference tests have been made on panels of multiple plywood cold glued with casein-blood adhesive. The panels of 12 in. square 7 ply had been kept at room temperature for 14 months.

The following average results were obtained when tested according to AS.059.

Knife test dry excellent adhesion
" after 6 hr. boiling in water - fair to good adhesion.

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

The results show that no deterioration has occurred in this time and presumably the adhesive would be quite satisfactory for general purpose plywood. Though the bond is boil proof it is not suitable for exposure to weather.

Following the return of more competitive conditions in the plywood industry no progress has been made in trying out the adhesive under factory conditions. Other things being equal urea glued plywood is more salable than casein. For this reason some casein users have recently switched to urea and there is a reluctance to use an adhesive such as blood-casein which might affect the salability of their product, even though glueline costs would be much lower.

No discussion.

ITEM 9 (e) ACING OF FLOUR EXTENDED UREA FORMALDEHYDE ADHESIVES

From time to time assertions are made regarding the ageing or loss of strength with time of highly extended urea glues. The normal extender used in this country, namely wheaten flour, has been used as an extender in New South Wales plants up to 300 per cent., i.e. three times the weight of resin used in the glue mix. The proposed Australian standard for plywood for general purposes does not take into account the effect of ageing, if any, and the question is often raised, particularly by Government Departments and other large users of plywood, as to what loss of strength with ageing may occur with highly extended urea glue for plywood. Also, if ageing does occur. how can the buyer protect himself when buying to the proposed Australian standard. This question requires an answer because urea glued plywood is frequently used; apart from furniture; in structures of a rather permanent character calling for a high capital investment. This is particularly true of built-in furniture. for example, in hospitals, large flat buildings and so on where replacement cost may far exceed the initial cost. There appears to be little definite evidence on this point available in published

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

literature. Recently, we had an opportunity to test some highly extended urea glued plywood, both cold and hot pressed. This plywood had been tested by us a few weeks after manufacture and we re-tested specimens from the same sheets after ageing at room temperature and normal indoor humidities for 18 months. The average results are given in the attached table. The results, with the exception of the chisel tests, are averages of 5 or more tests. It will be seen that in the case of the cold pressed panels there is no significant difference between either wet or dry tests when a flour extension of 100 per cent. is used. In the case of 150 per cent. extension, a slight falling off in both dry and wet strengths can be noted. In the case of hot pressed panels extended to 250 per cent. there is no loss of strength through ageing dry, but a marked reduction has occurred in wet strength. Chisel tests were made on the cold pressed panels and both wet and dry tests were good. In other words, as far as the chisel test is concerned, and this is called for in the specification, there is no deterioration apparent. If we assume that the above tests are fully representative, then probably large extensions with flour could be used with safety. However, the above results are contradicted to some extent by (1) a statement by one leading urea adhesives manufacturer that flour extension beyond 100 per cent. leads to serious weakening with age, and (2) a number of observations made by this Division where apparently quite satisfactory flour extended urea plywood has delaminated 6 to 12 months after manufacture.

Unfortunately, in all the instances observed, no specific data has been available on the conditions of storage, but it is believed that the panels had not been subjected to any unusual conditions of storage. At the present time urea glue manufacturers are rather non-committal about the likely effect of ageing on their resins when extended with flour. It is reasonably well-known that strong flours are not as suitable at the point of production as weaker flours (lower gluten content) and it may be that some flours

give more trouble from ageing than others. It will be seen from the above that the resistance to ageing of flour extended urea adhesives is important from the users point of view and until some satisfactory experiments are carried out a strong element of doubt will continue to exist. We suggest that trials to clear up this problem should be carried out by the Division of Forest Products.

TABLE 1
MEAN RESULTS OF GLUE SHEAR TESTS

Timber species: - Mixed coachwood and sassafras.

Adhesive: - U.F. syrup wheat flour extended.

Description	Age of Panel	Type of Test	Mean Failing Load lb./sq.in.	Mean Wood Failure
Cold pressed 3/16 in.				
100% flour extension	2-5 weeks	dry	240	50
	n.	24 hr.cold soak	240	60
n	80 weeks	dry	240	90
n	11	24 hr. cold soak	240	90
ii	11	dry chisel test	good	
n,	п	24 hr. cold soak chisel test	good	
Cold pressed 3/16 in.				
150% flour extension	2-3 weeks	dry	320	90
	#	24 hr. cold soak	300	60
n .	80 weeks	dry	280	50
11	it	24 hr. cold soak	250	60
9	ti	dry chisel test	good	
и	n	24 hr. cold soak chisel test	good	
Hot pressed 3/16 in.				
250% flour extension	2-3 weeks	dry	230	50
18	it	24 hr. cold soak	190	20
n	80 weeks	dry	230	0
· it	11	24 hr. cold soak	60	0

Discussion:

Mr. Jennings: The main trouble in Queensland is to get flour of suitable quality for glue extension. Manufacturers of plywood using high flour extension have produced very poor quality plywood. They run into all sorts of difficulties. The highest extension is 150 per cent. but they have generally gone back to 75 per cent.

Mr. Gordon: I have not encountered any urea glued plywood which has failed with time, and I think it may have been an odd instance that Mr. Booth has quoted. Some urea glued plywood for use in the University at Canberra was referred to D.F.P. but it had been badly glued in the first instance. We have advised glue manufacturers of the advantages of using biscuit flour rather than bakers' flour. Most trouble is likely to be encountered in N.S.W. and Queensland where the baking quality of flour is better than in Victoria.

Mr. Plomley: In Queensland and N.S.W. even biscuit flour produces dispersions of comparatively high viscosity. When used in recommended concentrations they tend to produce glue mixes of almost doughy consistency. It is not surprising if the plywood manufacturers get uneven distribution of the resin when using them. We have tested flour of Queensland, N.S.W. and Victorian origin and of these the Victorian flour is undoubtedly better for extension of resin.

Mr. Booth: In well controlled plants quite good adhesion is obtained in plywood using glue extended up to 250 per cent. but in at least two authentic cases delamination has occurred a few months after manufacture using lower extensions of 100-120 per cent. In another case, delamination occurred after 6 months.

Mr. Huddleston: It is not only glue manufacturers but also plywood manufacturers who want to use heavily extended urea glues to obtain gluelines at the same price as casein. These failures are coming under the notice of general users and are putting urea glues into disrepute. What can we do to control extension of glues so that we shall not get failures?

Mr. Clarke: Extensions beyond 75 per cent. should not be recommended. If glue manufacturers want to encourage extension beyond that it is up to them to do some work on it. We should warn people that there is some evidence that high extension might be followed by failure and until that is worked out, the practice should be discontinued.

Mr. Gordon: Extension of about 100 per cent. reduces the cost of urea to that of casein glue, but it depends on how thinly the glue can be spread and still obtain satisfactory adhesion. You can extend much more for hot pressing than for cold pressing. With regard to the cases of glue failures, there were probably other factors involved beside the flour and resin. It is common practice in fixing labels or laminating of paper to use dextrins with perhaps 5 per cent. of urea formaldehyde added to speed up the setting and provide mould resistance. I have hot-pressed some plywood using flour alone, and adhesion both immediately and after 6 months was effective, but wood failure was low.

ITEM 10 (a) REPORT ON INVESTIGATIONS INTO USES OF WOOD WASTE Sawdust for Packing Grapes

This work is reported under Sub-Project U.16-1, Progress Report No.2, January 1953, and Progress Report No.4, January 1954.

With gramulated cork from Portugal costing up to £240/ton, packers were easer to find a cheaper substitute, but this work was only concerned with the utilization of sawdust in this use. The experiments of the two seasons showed that of the species tried, radiata pine and mountain ash were technically suitable and acceptable to packers and cool storage representatives. Jarrah and karri were also suitable, but would be subject to prejudice because of their reddish colour.

Of the types of sawdust tested, both that from band or frame saws and that from circular saws showed no significant differences in deterioration as compared with cork. However, the former type was preferred in Singapore, and the extremely long chips from large circular saws were less acceptable at the packing stage.

^{*} Prepared by Division of Forest Products.

The coarser fractions (passing an 8-mesh and retained on a 14-mesh sieve) were preferred for handling. Sieving must follow drying to about 12 per cent. moisture content, to ensure removal of dust.

It is considered that sawdust could be used satisfactorily with simple treatment, and that further promotion for this use should be undertaken by State forest authorities, Agriculture Departments and packers. Packers and shippers in Victoria are to send several small shipments to Singapore for sale next season. Western Australia is the State most concerned, and with the greatest problems. Possibly the best approach there is to try radiata pine sawdust, and the preference for sawdust from band or frame saws might be considered an incentive to install these types of saw.

Wood Waste as a Soil Improver

The first report on this Project is U.16-1, Progress Report No.3.

Like straw and similar organic wastes, sawdust can be used as a mulch to limit weeds and prevent crusting, or mixed with the soil to improve physical properties and retention of mutritive elements.

Sawdust and chips have often been used successfully as a mulch, as the tendency to fix nitrogen is not so manifest in this use, and this use alone would dispose of most of the sawdust produced. Most cases of regular use have occurred where the waste was close to hand, but when the systematic disposal of waste in this use is being considered, the cost of handling and transporting this bulky material becomes a big problem. Unfortunately there is little information on how much a farmer should pay for a purely mulching material - what transport and handling costs he should be able to absorb. Handling and transporting wood waste by readily available methods is costly, so that the economical radius of distribution seems to be small. Therefore, consideration is being given to special methods and equipment, which it is thought would increase the economic radius several times. The

possibilities on a national scale can only be assessed by a study of the distribution of wood waste sources relative to the main horticultural districts. Such a project would require the help of State agricultural and forest authorities, the latter being in the best position to supply information on the distribution of woodworking plants.

It appears that organic materials are more valuable if incorporated in the soil. Wood waste reduces the availability to plants of some elements, by far the most important one being nitrogen. Use of an artificial fertilizer can meet this nitrogen demand, which is about 1 per cent. by dry weight of wood. This is not an additional expenditure because all this nitrogen is finally released to plants. However, this outlay might be spread over a period by treatment to remove the less resistant cellulose. One approach made was to hydrolyse this portion of the cellulose, rendering it soluble. In experiments using a large autoclave, treatment at 100 lb./sq.in. for 10 min., with a wood-water ratio of 1 to 4, without acid, was found to sufficiently reduce nitrogen demand when added to soil at the rate of 2 per cent. by weight. Further work has been done towards finding the most economic conditions of hydrolysis. It is thought that the process would probably not be economic at the present demand for such organic materials, unless the liquor could be made to yield usable material, such as sugars which could grow yeast, and some attention is being given to this.

Consideration has also been given to the possibility of using sawdust from old mill heaps. It is possible that decay may have reduced the nitrogen demand of this old sawdust, and an attempt is being made to arrive at the age at which heaps of sawdust have decayed sufficiently. The organisms involved in decay of old heaps are also being studied. This also leads to consideration of the possibility of commercial treatment of waste using micro-organisms instead of chemicals to reduce nitrogen demand.

Disoussion;

Mr. Jennings: There were two cases in Queensland where orchards were lost through using as a mulch, sawdust which contained an excessive amount of boron.

Mr. Grenning: It has been recommended as standard practice by the Agricultural Department for ginger, also it has been standard practice for over 20 years to cover hoop pine seed with 1 in. of hoop pine sawdust. Tests of soil indicated no deterioration. It is the most effective soil cover of all those we have tried.

Mr. Turnbull: Arrangements are in hand to install a small chipper in the Heyfield area to test economics of producing chips and transporting them to the pulp mill at Maryvale. This form of utilization is already established in north-west Tasmania. Most requirements for the hardboard mill at Burnie are obtained from waste of sawmills along the coast. At present they get 40 tons daily.

I think the difficulties of developing fuel in Victoria, particularly in Gippsland, are more acute than possibly elsewhere in Australia because of the very fierce competition that wood fuel meets from brown coal. Local brown coal is cheap in that area, and chipped wood would have a very difficult marketing problem to overcome. The possibilities of use in loose form should be explored fully before efforts are directed to manufacturing other products such as briquettes. With regard to domestic use, the sawdust burner stave is commonly used on the Pacific coast for internal heating and hot water services. As yet we have no similar use in Australia.

Mr. Humphreys: Sawdust is used in the Gosford area for orchards. It costs farmers 6/- a ton for delivery only. Wood waste is being used in one form or other in order to maintain a high level of organic matter in the soil. The sawdust is highly regarded by some farmers because it conserves moisture and is fairly cheap. Orchardists using sawdust do not have any trouble with nitrogen deficiency. They treat twice yearly with ammonium sulphate which is the normal treatment

method. It is washed straight through the sawdust when it rains. The sawdust does not seem to interfere at all with the availability of nitrogen underneath.

We have stripped 200 young grey ironbarks at Wallaroo State
Forest in order to obtain re-growth cork. The original cork taken off
the trees would, I think, be of sufficiently good quality for grape
packing purposes. The extractives which may be of importance in this
connection are quite low and it is reasonably dry when it comes off the
tree. As far as the cost of collection of this material is concerned,
it appears to us that with good organization in a plantation it would
be possible to collect 1000 lb./man/day. Ironbark occurs normally
however, in scattered stands and as a result, the figure would probably
come down to about 500 lb./man/day. Of this material, 70 per cent.
would probably be usable after processing. At present there is nothing
like a reasonable quantity available. It is not as light in colour
as the Quercus suber material but approaches it. Grey ironbark varies
enormously in this respect. Bark from the second stripping, which
takes place 10-15 years after the first stripping, is of better quality.

Mr. Clarke: This brings up the question of cork bark from sheeak which is common in the karri country in Western Australia. It should be possible to produce good quality cork for packing from this source.

ITEM 10 (b) MICROBIAL BREAKDOWN OF SAWDUST AND ITS POSSIBLE APPLICATION

Mr. Plomley: In recent years there has been considerable research overseas devoted to investigations into microbial decomposition of wood waste and other cellulosic materials. Particular attention has been given to the process of composting and to the possibility of establishing an industrial fermentation using thermophilic and mesophilic types of bacteria. Both processes present similar difficulties.

Under natural conditions bacteria do not play an important part in the decay of wood, and in the laboratory some preliminary treatment is necessary in order to obtain appreciable breakdown. In composting agricultural wastes bacteria play a major role and cause rapid breakdown of cellulose. In the composting of sawdust however, it is not likely that they are very effective in the primary stages, though they may cause rapid secondary decomposition. Delignification or hydrolysis render wood susceptible to bacterial attack, but it is not economic at present to carry out these processes chemically and it is necessary to try some other method.

The common wood rotting fungi have not been considered promising for composting or for fermentation, mainly because their action is slow. However, some of the organisms inhabiting the litter and surface soil of forest areas may be more effective. Also, although complete decay of timber is usually a slow process, the time required for fungal action to make sawdust susceptible to attack by bacteria may not be excessively long. These points are being investigated by us in relation to the composting of sawdust.

To further our investigations we are obtaining samples of forest soil and litter, compost etc. for examination for the presence of active wood decomposing organisms. We are collecting samples locally and from northern N.S.W., Queensland and the Northern Territory and in this we have had the collaboration of the Queensland Forestry Service and other Divisions of C.S.I.R.O. Micro-organisms are being tested both in mixed and in pure culture for ability to decompose E. regnans sawdust and for rate of decomposition.

We are also investigating optimum conditions for decay by some of the more active sawdust decomposing fungi, first of all with regard to optimum moisture and nitrogen content. We have found it necessary to add an organic form of nitrogen to the sawdust to get satisfactory growth of some fungi usually considered good timber rotting organisms, but this work is not yet completed.

Other organizations and Divisions of C.S.I.R.O. have provided assistance in this work, and are also interested in various aspects of the investigation.

No discussion.

THE NATURE OF "BURNING" DURING THE PRESSING OF LIGNO-CELLULOSIC PRODUCTS AT HIGH TEMPERATURES.

INTRODUCTION

Previous experimental work with wood particles had given some indication of the factors involved in "burning". In an investigation of board ferming properties of bagasse-cresylic resin combinations, along lines similar to sawdust-cresylic resin boards, it was decided to include some additional specimens for specific tests on incidence of "burning".

All boards described here were made in a Carver type laboratory press using electrically heated, circular, forming platens of 20 sq.in. area. The laboratory and test procedure was similar to that described in an earlier report. (1)

The "burn" as developed under these conditions varied from a somewhat darkened or brownish patch in the incipient stages, to black, sometimes lustrous areas. If the "burn" developed during pressing its presence could usually be anticipated, because a cloud of volatile products almost invariably appeared as platen pressure was released. The bagasse and sawdust boards behaved similarly in this respect.

When "burning" is severe the fibre structure of
the original material tends to disappear. The "burnt" material
is hard, dense and gives brittle fractures. Very dark patches
show a fairly clearly defined boundary on the board surface,
suggesting, perhaps, that some flow occurs. Cross sections of
burnt zones show that the "burn" usually extends from the lower,
or smooth, face to within a few fibres of the upper, or breathing,
surface in contact with holes in the ram. The upper surface is
relatively unaffected in the majority of burnt boards and the
upper surface "burning" is quite unusual when a breathing screen
is used.

^{*} Prepared by the Division of Forest Products

^{(1) &}quot;Some Studies of Sawdust-Synthetic Resin Combinations for Hardboard Mamufacture" by J.W. Gottstein

EXPERIMENTAL RESULTS

Some of the more significant test results are tabulated below. In Table 1 is shown the burning obtained with bagasse-cresylic resin mixes at a range of moisture contents between 0 per cent. and 17 per cent., over a range of board temperatures between 360°F. and 420°F. Particles were retained on a 14 mesh BSS sieve. No screen was used in pressing.

The extent of "burning" obtained with ungraded bagasse at temperatures between 395°F. and 410°F. is shown in Table 2. Moisture contents ranged between 5 and 20 per cent. A screen was used during pressing.

TABLE 1

EFFECT OF MOISTURE CONTENT AND TEMPERATURE ON EXTENT OF
BURNING IN BAGASSE-CRESOL RESIN BOARDS

Temp.	Moisture Content %	Extent of "Burning"
360 380 385 390 395 400 410	Ó	None " " " " " "
370 395 405 410	3	" "
385 390 395 400	5	n n n
405 390 400 410	6	11 11 0
420 370 400 370 410	11	Slight on lower face only Lower face only " " " Burnt and blown Severe both faces

TABLE 2.

EXTENT OF "BURNING" OBTAINED WITH UNGRADED BAGASSE

Temp. °F.	Moiature Content %	Extent of "Burning"
395	5	Slight superficial on lower face
410	5	Superficial on lower face
400	8	None
400	15-20	Severely both faces

In Table 3 results for three grades of bagasse pressed at several temperatures are shown.

TABLE 3.

EXTENT OF "BURNING" OBTAINED WITH SEVERAL GRADES OF BAGASSE

Temp.	Moisture Content %	Whether Screened	Extent of "Burning"
(a) Retai	ned on 23 mes	h BSS sieve	
390	5	Yes	Vory slight lower face only
400	8	Nc	Lower face only
(b) Pass	14, retained	on 23 mesh BSS	sieve
375	6	Yes	None
375 400	5	Yes	None Severe
400	120	No	2000
400	5	No	2000
400 (c) <u>Retai</u>	5 ined on 14 mes	No h BSS sieve	Severe

Results in Table 1, in which temperatures and moisture contents are the only significant variables, make it apparent that these factors are interacting at least within the range examined.

It will be seen that no "burn" was obtained at 0 per cent., 3 per cent. and 5 per cent. moisture content, and that a temperature of 420°F. was necessary at 6 per cent. moisture content to produce a very minor discoloration: yet at 17 per cent. moisture content "burning" was severe at 570°F.

The results of Table 2 with ungraded bagasse are slightly confusing. No "burn" at 400°F. at 8 per cent. moisture content compares with slight discoloration at 595°F. and 5 per cent. moisture content. This suggests that the perticle size might be involved to some extent and this is confirmed by Table 3 where it becomes apparent that larger particles tend to inhibit the "burn" phenomena. Table 3(c) shows minimum "burning" while 3(a) containing some larger particles seems a little better than 3(b) in which the smallest particles were used. The combined results of Tables 1, 2 and 3 suggest that the screen, while it may be helpful, is secondary to moisture content, particle size and temperature in the development of "burning" phenomena, at least in the small laboratory specimens. The tendency of a "burn" to be initiated on the lower face is notable. All specimens shown in the Tables were formed at 500 lb./sq.in. but scout tests showed that 250 lb./sq.in. pressures reduced initiation of "burning".

Breathing of the platens was not used on specimens listed in the Table above, but scout tests on breathing of the platens during pressing, carried out with several ligno-cellulose resin combinations, showed that breathing can be a definite factor in inhibiting initiation of "burning".

That "burning" should increase with temperature, is, perhaps, not surprising, but the "burn" at 370°F. and 17 per cent. moisture content and the absence of "burning at 410°F. at moisture contents up to 6 per cent. suggests that something other than normal exidation or thermal degradation is involved.

It seems possible, therefore, that we are concerned with a high temperature reaction in which water is involved either as a reactant or catalyst. This suggests that thermal hydrolysis leading to the formation of resinous material may be involved. Dry resin powler was used in all these tests and resin concentration was usually 10 per cent. but experiments in other parts of this laboratory have shown that similar "burns" can be initiated in bagasse fibres in the absence of binding resins. Contributions to the "burning" phenomena on the part of the resins would, therefore, appear to be limited to (a) possible catalysis, (b) heat of condensation of the resins which would rise with resin concentration, and (c) effect of fluid movement of the resin on board permeability. This would also re bably increase with increase in resin concentration.

DISCUSSION

A survey of the available literature on the utilization of waste sugar-came bagasse showed that at least two attempts have been made, with some degree of success, to produce a resin from bagasse using high temperatures and pressures in the presence of moisture alone. These were:

- (a) A process patented in 1938 by Masonite Corporation virtually a development from an earlier (1928) Masonite process for the disintegration of wood. The conditions specified varied from temperatures and pressures exceeding 470°F. and 500 lb./ sq.in. respectively to temperatures less than 470°F., but for a considerably longer period of time". A moulding material is obtained in which the unconverted material acts as a filler. The raw material specified was "lignocellulose, e.g. wood chips, sawdust, cornstalks, cane bagasse and straw".
- (b) A process patented by Irvine and Frederick (1946). This is of greater interest since the range of conditions specified includes those existing in the mould for the production of bagasse-cresylic resin boards (viz. 500 lb./sq.in. and in the region of 400°F.). The process is essentially as follows:

 "A cellulose filled synthetic resin moulded article is prepared in one step. A cellulose fibre such as bagasse, containing 7 11 per cent. moisture is heated under pressure at 500 1500 lb./sq.in. to 545 395°F. for 10 12 min. in a gas-

tight mould......The gases formed in the heating must be retained in the compressed mass and are said to act as catalysts." The latter provision supports the observation made in the pressing of the bagassecresylic resin boards, viz., the retention of gases (including water vapour) in the mould during pressing was chiefly responsible for the occurrence of "burning" at the level of temperature used.

No description is given of the appearance and colour of the product obtained by the process indicated under (b); but all moulding materials and plastics produced from lignocellulosic materials, including bagasse, by other methods are described, in general, as being "black (or dark) with a lustrous finish". In this respect, therefore, these substances resembled the "burnt" patches in the bagasso-cresylic resin boards. While the nature of the reactions involved in these processes is not closely analysed, lignin is attributed to be the reactive material from which the resins are formed.

The reaction of water alons with wood at ordinary temperatures and pressures is too slow to be detected by usual analytical procedures. However, at elevated temperatures and pressures water becomes an active hydrolytic agent producing primarily, a hydrolytic degradation in which "all components are drastically changed" (Wice and Jahn, 1952, p.887), and "its effect has often been neglected, yet it plays an important part in many industrial applications, including the usual chemical pulping processes, mechanical pulping processes, coarse fibre production by the Masonite, Applund or other processes....." (Wise and Jahn, 1952 p.883)

The properties of the fibres resulting from the Masonite process of producing coarse fibre for fibre board and wood plastics (i.e. "Benalite" and "Benaloid") are attributed to be the result of a thermal hydrolysis of this type in which up to 30 per cent. of the carbohydrates of the wood become water soluble in the form of partially hydrolysed polysaccharides and in which the lignin is "in a more active form that has enhanced thermosetting properties". (Wise and Jahn, 1952, p.891; Waheman 1947, p.728).

Similarly, both Wise and Jahn, 1952 p.905, and Simonds and Ellis, 1943, p.516, find the production of moulding materials by various methods of acid hydrolysis of wood (or agricultural wastes) is essentially a hydrolytic treatment resulting in the formation of a ligneous residue which is suitable for moulding purposes.

It is suggested, therefore, that the use of elevated temperatures and pressures during the hot-pressing of the bagasse-cresylic resin hardboards and of wood-based hardboards made by both "wet" and "dry" processes, in the presence of sufficient moisture, may easily result in the hydrolytic degradation leading to the formation of resinous substances which are manifested as "burns".

Although a minute amount of sucrose was present in the bagasse, the smell of burnt sugar which was noticed only with "burned" boards may be considered as an indication of the formation of sugars by such a reaction.

It is evident from observations made on the bagasse-cresylic resin boards, that the changes occurring under the conditions of pressing of these boards, due to thermal decomposition, are negligible relative to the changes due to hydrolytic action which take place when "burning" occurs. Pressing times did not exceed 15 min.

However, the effect of temperature on the physical properties of a hardboard is considerable. It is well known in the manufacture of hardboard by both "wet" and "dry" processes, that the use of elevated temperature is necessary to impart an adequate or "improved" stability or moisture resistance to the board.

An interesting comparison may be made with heat-stabilized wood or "Staybwood": the effect of heat treatment of wood was examined by Stamm and Hansen in 1937 (Wise and Jahn 1952, p. 971) who found that decreased hygroscopicity and improved stability were permanent changes, which, however, did not occur in the presence of excess moisture. They advanced the hypothesis that the "loss in hygroscopicity, and reduced shrinkage and swelling, are due to the splitting out of water between hydroxyl groups in adjacent molecular structures with the formation of ether linkages. There is no chemical evidence to support this."

It is, therefore, of interest to note that Klaudits and Stegmann (1951) from studies on the heat treatment of fibre boards concluded that "the special physical effect of heat treatment is not connected with the lignin, but mainly with the hemicellulose in the cell walls of the remaining fibres and probably especially in their polyuronide parts." They showed that the same hardening and decrease in hygroscopic properties occurred in boards made with delignified poplar pulp as in the normal wood fibre boards. They also showed that while the strength of the individual fibres is decreased by the heat treatment (which is in agreement with results of strength tests on heat stabilized wood) the strength of the board as a whole is increased by improved adhesion of the fibres, i.e. there is greater utilisation of the remaining fibre strength.

It is clear, then, that the extent of the reactivity of water with lignocellulose fibres, at the temperatures and pressures necessary for the production of a stable hardboard, should be recognized if "burning" is to be avoided, and the maximum tempering effect obtained in the initial pressing (extra stability may be obtained by subsequent "tempering" treatments.)

The reduction of "burning" effected by breathing of the platens is clearly associated with loss of moisture and prevention of high gas pressures within the boards during the hot pressing operation.

For the bagasse- and sawdust-cresylic resin boards the presence of some moisture appeared necessary to develop maximum strength properties. Its function is probably that of plasticizing the fibres or particles, and hence improving their contact and adhesion. In those boards where resin is used as a binder, the presence of moisture also probably assists the initial spread of the resin when it is in the water soluble state.

Also, for most types of "wet" process fibreboards, including "Masonite" (Wise and Jahn, 1952, p.891) the presence of moisture is necessary during the hot-pressing of the boards to ensure proper adhesion of the treated fibres.

CONCLUSIONS

As shown by the work done on bagasse-cresylic resin

boards, the amount of moisture which can be tolerated within the mould during pressing is dependent on a number of factors. These are:

- (a) the moisture content of the raw material,
- (b) permeability of the material to the progressive egress of steam and volatile products: this is a function of the particle size and shape, and also of the applied pressure, and
- (c) the design of the mould, i.e. whether allowance is made for the ready escape of volatile products. This is usually, but not always, assisted by the use of a screen which is placed on the upper surface of the board, so that the breather holes provided may function more efficiently.

In conclusion, it appears probable that the "burns" which inadvertently occur in the manufacture of hardboards made from bagasse, sawdust, or wood fibre (and presumably, other lignocellulosic materials) using elevated temperatures and pressures in the presence of moisture, are of a similar chemical nature and are primarily due to the hydrolytic action (or thermal hydrolysis) which can occur very readily under such conditions.

It has been found that such "burns" may be controlled by suitable adjustment of those variables which control the moisture of the mass during hot pressing.

Discussion:

Mr. Humphreys: When we were doing some work on green spotted gum sawdust from the south coast of New South Wales, we found this phenomena exactly as Mr. Gottstein described it; even at quite low temperatures and pressures (180°C., 170°C., 300 lb./sq.in.). The material was quite wet but not as wet as green. It did not occur when the sawdust had been lying around for some time, even though it was not much drier. It seems to be associated with materials in the fresh sawdust.

Mr. Gottstein: It seems quite likely that the acetic acid vapours would be involved in the hydrolytic breakdown under these

conditions. In the so-called "burning" condition it is very hard to find any actual temperature rise in the "burnt" zone. The moisture factor is very critical. If moisture is present at high temperatures and pressures it leads to very serious "burning".

Mr. Turnbull: I do not believe that "burning" is prevented by the control of the moisture content. The Burnie plant has overcome the trouble by filling the edges of the wire mesh carrier, leaving a few openings at intervals. As in hardboard manufacturing practice elsewhere, the press is closed at a very high pressure which is then released almost immediately, then built up again to about half the initial pressure. The high initial pressure squeezes out a lot of water but not to a definite moisture content, the residue being much higher than 20 per cent. and this has to be removed by the drying during the rest of the cycle. They have overcome their troubles that way.

Mr. Gottstein: The dry and wet processes are quite different and represent the minimum and maximum of water content, but the factors are the same. In the wet process special provision is made to dispose of the gases and vapours in the process; in the dry process there is little or no water present.

ITEM 11 (a) REVIEW OF CURRENT ACTIVITIES OF THE TIMBER MECHANICS SECTION - D.F.P.

Mr. Boyd: The following is an outline of the current Investigations and activities of the Timber Mechanics Section.

1. Nail Tests

Case Nails. An experiment has been started to examine in detail the holding power of case nails in radiata pine, mountain ash and karri. Plain and processed cement-coated nails of 12, 13 and 14 gauge are being driven into green 20 per cent. and 12 per cent. moisture content timber and are being pulled immediately and 3 months later. The delayed tests are being carried out at 20 and 12 per cent. moisture content,

Building Nails. An experiment similar to the above but using building nails is being carried out to determine the effect on withdrawal resistance of rusting in situ. Species being used are karri and messmate stringybark. Plain and processed cement-coated 11 and 9 gauge nails are being driven into green timber and pulled immediately, 3 months later and 12 months later. The delayed tests are being made at 12 per cent. moisture content.

An extensive study is being made of the strength of nailed joints using single nails in single and double shear. The species being used at present is messmate stringybark. It is hoped from the tests to derive suitable expressions for the design of nailed joints. In this investigation X-ray photographs are being taken at various stages of loading so that an understanding of the critical stage in the nail loading can be reached. The reaction of the nail varies with proportions of pieces and size of nails. On this basis it is hoped to define a basic stress for nails for use in design.

2. Investigation of Column Strength

Timber columns, like timber beams, exhibit plastic flow under loads maintained for long periods. For relatively low loads, such as occur in structures, the increase in deflection due to plastic flow usually ceases after some time. For higher loads, the plastic deflection may, after an initial period of fairly rapid increase, proceed for some time at a diminishing rate, perhaps even becoming stationary, until a stage is reached at which the rate increases and failure results.

Overseas practice in designing columns for dead loads has been to limit the extreme fibre stress. However the formula due to Langlands and published in our "Handbook of Structural Timber Design" not only limits the extreme fibre stress but in calculating it assumes the column is subject to a total lateral deflection (plastic plus elastic) equal to three times the initial elastic deflection. As the maximum bending moment depends on the lateral deflection of the column,

this assumption of a large extra deflection results in the Handbook formula giving smaller safe dead loads than overseas formulae, particularly for slender columns,

At the time of publication of the formula, experimental information on the effect of loads of long duration was meagre but nevertheless sufficient to cast doubt on the adequacy of overseas practice. An extensive series of tests has now been in progress for 21 years to provide detailed information on the behaviour of columns under sustained loads. The first tests of columns were made under short duration loading in a testing machine. The results of these tests were carefully studied and a method developed whereby the strength of matched columns under short duration loading could be accurately predicted. On this basis, long duration tests were planned. Constant loads of 50 per cent., 60 per cent. or 70 per cent. of the estimated short-time strength of the columns are applied by springs acting through knife edges. Three sizes of columns are under test, the slenderness ratios being 10, 20 and 50. Most columns to date have been set up green and kept green but others have been allowed to dry out. Three species are represented, mountain ash, yellow stringybark and Douglas fir.

Some conclusions can be drawn from the results but the test has not been going long enough for apparent trends to be established. Of 117 columns loaded to 70 per cent. of their estimated short-time strength, 88 have failed, mostly within a couple of weeks of setting up. Of 56 columns erected under 60 per cent. loads, 29 have failed, 14 within a month of setting up. Twenty-three mountain ash columns have been set up under 50 per cent. loads and 12 have failed after carrying loads for 6 months to 2 years. There is some indication that, under the same percentage of the short-time failing loads, the more slender columns are able to survive for longer periods without failure than the short columns, but this is by no means confirmed as yet.

Three eccentricities of loading have been applied, zero, length/360 and length/120 and no effect of eccentricity is apparent to date.

3. Silvicultural Project

The investigations which have been going on for the last 2 or 5 years on the relationship between silvicultural treatment and the mechanical properties of pines have now reached a critical stage. Briefly reviewing what has been done to date, we have tested specimens from 92 trees of P. radiata, 24 trees of P. taeda and 46 trees of P. caribaea in both the green and dry condition and in compression, bending and toughness. Density and percentage summerwood determinations have also been made. Altogether some 13,000 tests have been made.

Analysis of the data is in progress and as it will not be completed for some months it is only possible at this stage to give an outline of the position at the moment.

Summarized, our findings to date are :

- (a) Density alone accounts for more than 80 per cent. of the variation in the strength of wood.
- (b) Density and age together account for nearly 90 per cent. of the variation in strength, in individual trees these two factors account for as much as 97 per cent. of the variation. Age contributes a significant amount to the variation in strength over and above that contributed by density.
- (c) Rate of growth appears to have no significant effect on strength other than that arising indirectly from its high correlation with both density and age.

These findings are rather similar to those of Turnbull of South Africa. However we have also found that after adjusting our results for age and density there still remains a highly significant between-tree difference in strength. In other words, the mean strength of the trees at a given age and density, although differing little, still differ significantly. It is on this aspect that we are concentrating at the moment.

Although the sampling has been extensive, it has been limited to trees of more or less normal growth; trees in which density

and age are very highly correlated. We hope to obtain from Western Australia trees in which these two factors are not so well correlated and with these we may be able to separate more effectively the effects of age and density.

4. Hybrids

Dr. Dadswell has mentioned the work being done in his section on hybrid eucalypts. Parallel material has been subjected to mechanical tests, the species being E. rossii, E. robertsoni and their hybrids. On the results obtained it would appear that the hybrids are intermediate between the parent species in density and strength and their properties vary according to the degree of hybridization although there is some evidence to suggest that the latter, as determined by density, is not linearly related to the degree of hybridization as measured by morphological characteristics. Similar work will be starting shortly on E. maculose and E. elaeophora and their hybrids, the material having already been supplied by Mr. Pryor of Camberra.

5. Western Australian Project

Since the last Conference a radical departure has been made in the policy of this Division and a sub-section working on timber mechanics problems has been set up in the Engineering School of the University of Western Australia.

By this means we hope to achieve a number of objectives.

- (a) Better appreciation by the timber industry in Western Australia of the work of D.F.P. with consequent greater co-operation and therefore greater efficiency of our work.
- (b) A greater interest of the Universities in engineering research, and particularly research in timber.
- A better understanding by University students, at least in Western Australia, of the nature of timber research and of timber as an engineering material.
- A better understanding by University engineering students of our research workers and of the Division so that some of them may

become interested in research, and at least they will be encouraged to enquire about the work of the Division and the facilities and assistance available to them.

This project could not have been started without the enthusiastic encouragement of the former officer-in-charge of Timber Mechanics, who is now Professor of Civil Engineering in Western Australia, or without the testing facilities and the accommodation which the University has been able to make available to us.

The project has only just got under way, and many problems of establishment remain to be solved, however we are encouraged by the attitude of the University and by the co-operation of the W.A. timber industry and the W.A. Forests Department to put forward a considerable effort. The present staffing of the sub-section consists of a Research Officer and a Technical Officer, but when the project gets effectively under way we may well add at least one Technical Assistant.

6. Pole Testing

Perhaps some mention should be made of the proposal to do some strength testing of poles.

The origin of this proposal lies in the seriously reduced availability of poles of the more durable species. As some of the largest pole-using authorities are forced to use less durable species and to consider preservative treatment, the time seemed opportune to direct the attention of these authorities to greater efficiency and economy which might result from an overhaul of the principles of engineering design of poles.

While it is considered that a very big margin for economy exists even within the present basis of estimation of pole strengths from clear specimen tests, it is believed that many authorities will be convinced of the potential gain in economy of properly designed poles only if a more precise knowledge of actual pole strength can be demonstrated. However a satisfactory programme of testing would be costly and exacting in respect to the Division's facilities so that we

feel that we should undertake it only if we are assured of effective co-operation from both the pole suppliers and the pole users.

The comments of the delegates on this proposal would be appreciated.

7. Species Testing

Up till a few years ago comparatively slow progress was being made in the testing of mechanical properties of the commercially important species in Australia. The method then used was to test a very large number of specimens from a considerable number of trees. Subsequently a statistical investigation of the principles of sampling was made and it became evident that the older method was inefficient. Consequently a new method has been instituted in which, we aim at sampling slightly more trees (for the more important species), but the number of specimens of each type taken from each tree has been very drastically reduced to only one. Then, too, all our sampling is carefully planned with a view to achieving a definite precision of estimate of the strength properties.

In the field the present method of sampling is to collect from each forestry district in turn and to select samples of all commercial species in the one effort. It is anticipated that in general it will not be necessary to sample again over the same ground. Occasionally, however, after testing is complete and the variability and precision of the estimate of the mean of the species is known, it may be necessary to obtain some further samples to improve the precision. As a consequence of the introduction of these new methods our species testing is now advancing at perhaps five times the rate that was possible under the old system. From the point of view of achieving as soon as possible, a reasonable overall picture of the strength of Australian timbers, the advantage of the present system is much greater still.

Sampling in Victoria has been continuing steadily since the last Conference but is now reaching a position which can be classified as reasonably complete in respect to this stage of our Australia-wide sampling plan. Accordingly it is necessary to turn to other States for co-operation if we are to continue this important work. Afterwards I would like to hear the reactions of the States to this suggestion.

The outline of the present species testing position is as follows. In this outline the general remarks on species tested refer to those in which a full range of mechanical properties have been investigated on standard size specimens. Over a period quite a large number of tests of less extensive character have been made on less important species.

First in respect to Australian native timbers:

Of approximately 40 eucalypts which we have listed for sampling we have a reasonably good sample of 20, i.e. we know the value of their mechanical property means with a precision of about ± 7 per cent. or better. However, many of this 20 we consider should be sampled a little more so that the precision of the estimate can be improved.

Of a little over 20 hardwoods other than sucalypts which we have planned to sample, the mechanical properties of 6 are known to a precision similar to that above. Perhaps half of the total could be classed as not very important structural species, and we consider therefore that it would be satisfactory if the means of their mechanical properties were determined with a precision ranging as low as ± 10 or 12 per cent.

Of the 6 softwoods - cypress pine, hoop, bunya, King William, kauri and Huon pine - the first 4 are moderately well sampled.

Of the New Guinea timbers, eleven have been sampled to various degrees, but of these only one, klinki pine, has been sampled so extensively that the precision of its mean strength values is approaching that which we would consider desirable for a major species.

In addition to all of these there is, of course, the testing of exotics which must reach a position of ever-growing importance.

Species on which considerable testing has already been done include radiata pine, slash and loblolly pines.

Mr. Booth: Mr. Boyd, on column tests, said, I think, that the short-term loading strength of columns can be estimated with considerable precision, and yet in the test on long-term loading a fairly high proportion have failed but 50 per cent. have not failed. Does that mean that the method of estimating from the short-term life is not accurate, or is there some other random factor which causes half to fail and the other half to stand up?

Mr. Boyd: One class of column which is difficult to estimate is the short-length column. There, part of our variability could be accounted for by lack of precision of that estimate, but there are other factors operating and we are not in a position yet to tie down these factors. It is worthwhile mentioning that in connection with columns drying out they frequently show a tendency to fail even quicker than green columns although the drier columns might be expected to be stronger. In other words the variability in the rate of drying causes other eccentricities which become critical. However this is too big a problem to discuss these details at this stage.

Mr. Kingston: The results referred to by Mr. Booth appear to be systematic. Failures in beams did fall off with percentage of short-time strength. We found that at high stresses there were failures under continued loading, the percentage falling off as you reduce the percentage of the short-time strength. In confirmation of Mr. Boyd's figure where 50 per cent. of short-time load about half failed, in beams we found that at 45 per cent. of the short-time load between a third and a half of the beams failed.

Mr. Chinner: The work on tensile strength of small sections established clearly the correlation between rate of growth and fibre length and between fibre length and tensile strength.

Earlier I gathered that it was suspected that there was a particular correlation between tensile strength and the other mechanical

properties. If so, then there would appear to be a contradiction between the results of Mr. Kloot's work and the earlier work on fibre length.

Mr. Kloot: There is apparently a contradiction but, as Mr. Boyd pointed out, we are in the middle of the analysis of these data and I don't feel inclined to try and explain the contradiction until we are certain of the results of the analysis.

Mr. Jermings: What has happened to the progeny of those trees? Have you been able to get any indication at all of whether the progeny have the same desirable or undesirable characteristics as the parents?

Mr. Kloot: I explained at the last Conference our approach on this subject. We scarted with P. taeda and P. caribaea. It became obvious from the start that before we could look for any hereditary factor we would have to eliminate the major factors causing variation of strength in these species. At the moment we can account for the tremendous amount of the variation simply with density and age. It would seem that if heredity is a separate factor it is of very slight importance. On the other hand there may be some relationship between heredity and density. We won't be able to give a definite answer until we can account for the between-tree differences mentioned by Mr. Boyd.

Mr. Booth: Re pole-testing. I feel that not a great deal of value can come from the testing of new sucalypt species. In the general design of power poles, the designers' hands are tied by the shape of pole available. The over-riding consideration is the provision of sufficient wood at the butt to cope with decay problems. The main problem in the new species of sucalypts is not one of mechanical surength as a critical all-deciding factor requiring tests other than laboratory tests, but rather is it a problem of solving the decay hazard. However in the case of plantation-grown pines there may be a good field for full size tests. There we have a factor not common in the experience of Australian pole engineers, that is knot clusters.

Mr. Boyd: With regard to the point raised by Mr. Booth, I doubt that pole-designing engineers know their problems in relation to eucalypts. My contacts have shown positively that the biggest users do not know how to design their poles, and they are reducing their working stresses very considerably because of their own consciousness of the "unknowns". We can guide them on the basis of overseas pole designs and experience with our clear specimen tests, but we still do not know for sure the effect of the various blemishes. Until we do we cannot point to the most desirable stresses, and I think further we will not convince users who are not conscious of the wasteful methods of their present practice until we have effectively demonstrated the strength of poles.

Mr. Dale: Obviously there is a need for these tests in view of the approaching liklihood of treatment of local eucalypts for poles. Existing pole strength criteria do not apply. We have to start off with the promise to pole users that the treated poles will have full strength at the butt. Therefore this work is very necessary as the corollary to pole preservation on a large scale.

Mr. Higgins: In regard to the nail-holding capacity of wood, it seems there are two aspects to be considered. One is the design of new types of nails and so on, and the other is to investigate the mechanism whereby wood holds nails. In respect to the latter, I have been wondering whether it can be related to stress relaxation in the wood. A high rate of stress relaxation would be expected to give rise to rapid weakening of the joint, and vice versa. It might be worth while attempting some correlation between nail-holding ability and rate of stress relaxation perpendicular to the grain.

Mr. Boyd: Mr. Higgins' point has been considered. In relation to this series of tests, we feel that at this stage we should not pursue this particular line though we are not by any means ruling it out. The reason for the emphasis at this stage on the work we are proposing to carry out is that except for boxes where withdrawal

resistance is the criteria the mechanics of nail-holding is not important structurally. The biggest problem is the bending of the nail and the resistance of the timber to crushing under the nail. The nail does not tend to withdraw and therefore the mechanism of its holding does not become important until you have had a failure in a structural sense.

ITEM 11 (b) THE NEED FOR DATA ON THE DESIGN AND PERFORMANCE OF GLUED LAMINATED CONSTRUCTIONS **

Whilst the O.S.I.R.O. Handbook of Structural Timber Design can be criticized in some respects, nevertheless it has provided and continues to provide a most useful reference work on the design and likely performance of conventional types of timber structures under Australian conditions. For some years it has been obvious that the lack of a similar work covering glued laminated structures under Australian conditions is seriously holding back the development of this technique in Australia.

During the past few years there has been a marked increase in the use of, and interest in, glued laminated construction in Australia. This has corresponded with the growth of the plywood industry, the improvement in synthetic glues available, and the general industrial expansion which has called for large numbers of medium sized factory buildings. The acute shortage of structural steel, coupled with the fact that glued laminated structures can usually be erected for about 60 per cent. of the cost of the steel equivalent, has been a further important stimulus to this technique. Overseas the industry is on a more satisfactory technical basis and it has proved possible to economically import into Australia glued laminated components for factory buildings which have been designed and manufactured overseas to order. Generally speaking, overseas information is difficult for the average engineer to obtain and requires considerable modification in most instances to fit local building requirements; the pecularities

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

of Australian timbers and the traditions of the local laminating and plywood industry. There are many successful instances of glued laminated construction in Sydney, particularly in factory buildings, but from time to time instances arise which reveal the great lack of satisfactory information available to engineers generally on this technique. We give below four examples, briefly described, which indicate the need for published information similar to that given in the Handbook of Structural Timber Design.

1. Glued Laminated Form Work for Dam Construction

For the construction of a large concrete dam, a Sydney firm specializing in laminated construction suggested the use of glued laminated box beams for form work and various accessories such as glued laminated profiles, keys etc. The scheme, as proposed, was ingenious and its light weight and other advantages appeared to offer a saving in cost over conventional methods. Since solid timber for form work was difficult to procure and steel shuttering etc. was prohibitive in cost and also difficult to obtain, the proposal was accepted on the assurance of the manufacturer that the form work would perform satisfactorily. Subsequently, after some difficulties had arisen in the supply of material, the Division was approached by the constructing authority for information to be used in drawing up a specification to cover the supply of the forms and accessories. At this stage the Division pointed out a number of flaws in the design of the forms which would probably lead to rapid breakdown in service. These were briefly:

- (a) The type of construction used would encourage rapid decay of the timber in the forms.
- (b) The method of construction, whilst yielding an adequately strong form at time of manufacture, forms would lose strength rapidly in service because of glue line deterioration.

Since it was anticipated that forms would be needed for use up to 6 years, it was unlikely that they would survive for this length of

time. As the project was already under way, there was little which could be done to correct the troubles, and at the present time the forms already stored on the job and those in use are continuing to break down in the way the Division predicted. If some rudimentary handbook on this type of construction had been generally available, we feel that this trouble would never have occurred, it being a simple matter to construct laminated forms having all the advantages of this particular type and yet free of its disadvantages.

2. Glued Laminated Tunnel Form Work

A Sydney firm specializing in glued laminated construction offered glued laminated form work for tunnels to be constructed in connection with a large dam. The proposal was accepted on the assurance of the manufacturer that the product would do the job. The form work, whilst initially appearing to offer advantages, proved unsound for two reasons:

- (a) Inadequate strength.
- (b) Failure of glue joints through weathering. It is again felt that in this instance, had information been readily available, the flaws in the proposal would have been more obvious to the constructing authority.

3. Plywood Toll Barriers

Flywood toll barriers were constructed by a local authority. Waterproof plywood was specified for their construction. The assurances of the manufacturers of the plywood that the product was satisfactory were accepted, and no control tests were made on the quality of the sheets supplied. After a period of about 18 months, the first signs of deterioration appeared and after a little over 2 years complete replacement of a major portion of the structure is proposed. This structure would have been perfectly satisfactory if:

- (a) The quality of the plywood supplied had been checked to ensure elimination of most of the faulty sheets.
- (b) If the design had properly taken into account the susceptibility of many species used for marine plywood constructions, to rapid decay.

(c) If the designers had realized the correct way in which exterior plywood structures should be constructed.
Sound information on the design and performance of waterproof plywood structures would probably have added many years to the life of this structure.

4. Decorative Wooden Arches

Laminated wood construction is a surprisingly flexible medium and it is not surprising that many proposals were put forward for construction of decorative arches etc. for the recent Royal visit. The Civic authority, conscious of its responsibility to safeguard the lives and property of citizens, declined to accept the simple assurance of the builders of such arches that they were, in fact, safe. They based their decision on the lack of published data on the performance of such structures, and the absence of any design calculations to support the contention that the arches were safe. This necessitated engaging a consultant to present the case to the Civic authorities on the safety or otherwise of the arches. Many of the projected arches were found to be unsafe in their proposed form, but the majority were accepted after modifications such as addition of wind bracing guys etc. The consultant's task was made very difficult by the lack of any easily accessible published information on this form of construction. (Incidentally, it might be mentioned at this point, that the existence of the C.S.I.R.O. Handbook of Structural Timber Design did not prevent the collapse of an orthodox connectored timber arch whilst in process of erection for the Royal visit. The failure being caused apparently by an unsatisfactory design).

Generally speaking, the absence of accessible information results in the over-designing of many structures to be on the safe side, and results on the other hand in many blunders being made in this field. Naturally, unfortunate experiences which need not occur, seriously retard the acceptance of glued laminated structures by

Civic authorities etc. Admittedly, the preparation of the handbook proposed is time-consuming, and as a suggestion for partly overcoming this obstacle, we suggest that the Division of Forest Products, in co-operation with other interested bodies, should organize a symposium on this form of construction, the resultant papers to be published subsequently in a booklet form. Such a symposium should cover at least:

- (a) Design methods and behaviour of wooden laminated structures.
- (b) The behaviour of adhesives and glued constructions generally on exposure to the elements and under cover.
- (c) Methods of construction used in the industry and some examples of successful Australian glued laminated structures.
- (d) A bibliography and tabulation of the sources of information on such structures in Australia.

Discussion:

Mr. Turnbull: I think it is a worthy objective and compliment Mr. Booth for bringing it forward.

Mr. Huddleston: It is something that is badly needed.
Glued laminated construction is being fairly widely used in New South
Wales. It is based purely on empirical observation and a lot of it
will fail through lack of knowledge in its construction and design.

Mr. Turnbull: The time is ripe for something in this field. The laminated construction development implemented in U.S.A. in recent years has demonstrated its possibilities and aroused interest of designers and users.

Mr. Clarke: I am not certain what the proposal is here. Should we tell them what other people have done or should we give them information on design of Australian laminated timber. Have we the information available?

Mr. Huddleston: There are structures being designed and built satisfactorily today, and in cases where people know what they are about there is no trouble with construction at all. The trouble

is where people try to copy without any information and erect buildings which are not properly designed. Surely we have sufficient information to prepare a bulletin or book on the subject.

Mr. Boyd: This is a subject which we have considered previously. There are a number of difficulties in relation to doing something speedily and effectively. We know very little really about the application of this technique to Australian timbers, and the variables that might be introduced as compared with similar structures in Europe and the United States. I think that until we have experimental work done in this field we would be in difficulty in making up a technical brochure on techniques of construction.

The principle put forward by Mr. Booth of having a symposium is, of course, a good one. There would be difficulties in implementing the proposal through the Institution of Engineers, firstly, because the construction has been used almost only in New South Wales, and secondly, because it has not been used appreciably by the better known engineers who regularly contribute to the activities of the Institution of Engineers. Such work as has been done, even through acknowledged consultants, is not, I would think, very soundly based. In any case we would have to depend on such information as we could get from New South Wales. The burden of collection of material therefore would tend to fall on Mr. Huddleston's staff, unless we could make available an officer who could devote a large amount of time to investigation of the problem as a whole and collection of such material as is available. No such officer is available at the present time.

There are two approaches. One is to collect information which illustrates the uses that have been made of laminating so far, and from the survey it may be possible to state if present techniques are producing a satisfactory structure. I do not think we know enough about the controls to be satisfied that this is so. The other approach is to institute a programme of research and hope that in the future we will have more information.

Mr. Clarke: We do propose to carry out research on one small part of this programme. The question of combined timber and plywood structures is listed as a Western Australian project.

Mr. Gordon: I have gained the impression that in many instances failure was due to ill-advised selection of glue rather than to the actual mechanical performance of the structure. Mr. Booth might correct me if I am wrong in this assumption. Another factor which should be considered is the necessity for preserving the timbers which, although suitable for lamination from standards of gluing, are in many instances non-durable. Casein glues are quite satisfactory provided they are protected from the weather as they have been in laminated arches and most structures erected until recently.

Mr. Booth: As we see the problem the construction industry is an enormous consumer of wood and there is an important fringe, laminated timber structures, which properly used are definitely competitive with other materials such as steel and concrete. It does take a lot of the chance out of timber design. Wood becomes a much more predictable material in its behaviour. There is a possibility for doing a lot for the timber industry by getting out some sound data on the problem. A good deal of ignorance exists about glued laminated construction and it does seem a lot can be done for the expenditure of comparatively little effort. When the Handbook of Structural Timber Design was first put out I am sure no one felt sure it was the final word. The point is once something is produced it gives a basis to build on. At the moment the lack of any information at all is seriously retarding the technique as a whole.

Mr. Turnbull: Could the ground be broken with a series of technical notes which in due course could become a skeleton of your major publication. Faults have already appeared in structures of very short life. Could something be written about this, pointing the causes of failure and laying down remedies?

ITEM 11 (c) A NEW TYPE OF TIMBER DECK ROAD BRIDGE *

Timber deck road bridges have been used for many years on the highways of this State, but with the increase in road speeds and the loading of vehicles they have become less popular because it is difficult to produce a bridge deck with a perfectly satisfactory pavement. Composite timber and concrete highway bridges have been used in North America for many years in which the timber forms the tension side of the bridge slab and the upper or concrete section is in compression and forms the road surface. Shear between these two layers is transmitted by means of steel shear plates driven into the surface of the timber section. Such bridges have been little used in Australia to date, because of the unavailability of large timber sections treated with preservative.

In an endeavour to overcome the disadvantages of the wooden bridge and retain the economic advantage of this form of construction over others, the N.S.W. Main Roads Department commenced experiments with a new type of timber decked bridge. As a result of discussions with the Division, we supplied timber for model testing the proposed timber decks so that full sized structures could be designed. Initially, it was proposed that the bridges should be constructed, for example, from 10 x 3 sawn timbers placed on edge side by side across the span and spiked together. Model tests were carried out on timber 14 in. x 1 in. Arising from the experiments, it was decided to construct two types of bridge - one with a sawn timber deck and the other using round girders which had been spotted on three sides to enable them to be assembled into a flat top deck of similar characteristics. The pavement proposed for these bridges would be of bitumen mix and would not contribute to the strength of the bridge. Since the decay hazard due to bitumen mix laid on timber would be rather great, it was decided to use a membrane of PVC sheeting laid over the top of the timber. Bitumen asphalt mix would be spread on

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

this to provide the pavement, the general construction resembling in many respects a flat wooden roof as used in dwelling constructions. In the case of the girder type bridge, information was desired on the rate at which such girders would season and the latter part of this contribution is concerned with this aspect. The details of construction of the girder type bridge are as follows:-

The bridge in question is over Vineyards Creek, on the Kissing Point Road, near Parramatta. The span between abutments is approximately 27 ft. and the width of the carriageway is 23 ft. 6 in. The deck is composed of 28 sawn girders, mostly blackbutt, with some tallowwood. The girders are sawn from round slow taper power poles and are spotted on two opposite sides to give a horizontal width of 10 in. The top of the girder has been spotted with a 1 in. deep slabbing cut and the bottom surface is natural round. Unfortunately, the girders were cut on a single Canadian saw instead of a twin frame sew, and they were therefore somewhat bowed horizontally as well as vertically. This gave rise to some difficulties in assembly but they were overcome and this problem should not arise in subsequent bridges. One half of the deck was assembled on dummy sills at the roadside and lifted into position with a mobile crane. The other half was assembled in situ to simulate conditions where no crane was available. The girders are pinned to one another with 1 in, steel dowels driven in pre-bored holes along the neutral axis of each girder. The pattern is staggered as the sketch and gives one dowel in shear every 4 ft. The deck itself is carried on timber sills resting on reinforced concrete abutments and the ends of the girders and lower side of this sill are carefully shielded against ants and to shed water by zinc sheet. On the top surface at the junction between adjacent girders, there is a triangular trough formed by the wane on each girder. These troughs are sealed by first fixing along them a bent zinc strip and filling the trough flush with the top sawn surface of the deck with asphalt mix. A coat of bituminous emulsion is applied to the deck surface and

0.15 in. PVC sheeting is laid down. Side laps in the sheeting are 7 in. cemented. A coat of bitumen in benzol is painted over the PVC to promote the adhesion of the pavement which consists of 3 in. total thickness.

The sawn timber bridges are constructed in essentially the same way. The Department of Main Roads is very pleased with the performance of these bridges and they provide a road surface which is indistinguishable from the normal pavement laid on solid ground. The only point so far which is causing any concern is the shrinkage between adjacent girders on the girder type bridge. The girders are 10 in. wide as opposed to about 5 in. in the sawn timber bridge and consequently the shrinkage gap is wider. It is possible, but not likely, that some asphalt mix may be forced through the opening and that this may result in the rupture of the PVC membrane. We have suggested that in the next girder type bridge to be constructed foil electrodes be placed on either side of the PVC membrane so that the electrical properties of the moisture barrier can be checked while the bridge is in service. Aluminium-coated sisalkraft strips will be made to form these electrodes and by periodic measurements, especially after rain, any break-down in the membrane will be apparent and repairs can be carried out by digging up the pavement at the appropriate point. It is felt that this type of timber bridge is an important development in that it not only provides a timber highway bridge cheaper than other competitive materials, but also the quality of the pavement is quite satisfactory and the method of construction adopted enables use to be made of less durable and more readily available timbers. Clearly, the question of preventing decay is the most important aspect as on it hinges the whole success of the bridge.

The only preventive measure taken to avoid the possible incidence of decay was a liberal brush application of creosote to the sawn surfaces of the bridge girders. In addition, to obtain some data on the changes in moisture content of the girders in service, the moisture content of the upper surface of the girders is being tested at monthly intervals.

The bridge over Vineyards Creek is composed of 28 girders each approximately 29 ft. 6 in. long with a 10 in. minimum width. The moisture content of the girders is being measured by means of megger readings on electrodes placed in seven of the girders. Two copper nails each $\frac{7}{8}$ in. long were driven $\frac{1}{2}$ in. apart to a cepth of $\frac{1}{2}$ in. into alternate girders. The electrodes were placed diagonally across the bridge so that the electrodes in the first girder are located 2 ft. 6 in. from one end of the bridge, and in the third girder they are 4 ft. 6 in. from the end. This spacing was continued until the electrodes in the fourteenth girder were placed at the centre of the bridge.

To protect the electrodes they were in each case driven in from the bottom of a groove cut \(\frac{1}{2} \) in. deep in the centre of the surface of the girder. These grooves are approximately 5 in. long and 1 in. wide and each pair of nails was located in its correct position at one end of the groove. Eighteen gauge copper wire, sheathed in polyvinyl chloride tubing was soldered to each nail. To avoid damage to the wires, they were laid along the grooves and then carried through \(\frac{1}{2} \) in. diameter holes to the underside of the bridge where they were collected in a common junction box. These grooves tere immediately filled with bitumen and covered with a metal plate.

Periodic readings are being obtained by means of a megger. This test was installed in November 1953, and to date the results obtained indicate a slight but reasonably consistent drop in moisture content.

Discussion:

Mr. Huddleston: The quantity of timber in the bridge is identical with timber in a conventional bridge. It is particularly free from vibration. With regard to further protection against decay hazards they are looking at the possibility of a portable treatment plant. They have carried out some experients with a tar kettle in which the creosote was heated and sprayed on the logs for half an hour. With very elementary treatment they were able to get complete sapwood penetration with creosote.

Mr. Grenning: We have had bridges built with girders only for a number of years and they have behaved very well. They have not been sealed.

ITEM 12 (a) SAWING PATTERNS AND TECHNIQUES FOR SOUTH-EAST QUEENSLAND HARDWOODS ★

In early 1953 some thirteen sawmills in South East Queensland, operating mixed hardwood species, were studied from an engineering standpoint to determine the main reasons for their low overall production efficiency and to devise methods of increasing efficiency in keeping with the general small nature of the plant.

It should here be emphasized that because of the limited extent of the forest resource and its comparatively low overall growth capacity it is desirable that present individual mill capacity (averaging some 1.5 to 2 million s.ft. Hoppus annual log input) should not be increased.

Consequently the aim of the studies has been to increase the operating efficiency of the existing mill with a reduction in unit labour costs rather than an overall increase in total annual production from that mill.

The conclusions to date indicate three major features in this low production efficiency:

- Log heart defect coupled with present techniques of handling defect is the most important factor.
- (2) Lack of sound engineering design and maintenance of breakdown units with their consequent inability to handle logs adequately.
- (3) Operation of No.1 Benches well below their optimum, giving additional installed equipment (No.2 and Docker) well in excess of production requirements.

Further to these observations it is proposed to discuss the various items of equipment, and what appears to be their optimum operating conditions and arrangements insofar as the Queensland industry is concerned.

^{*} Prepared by Queensland Forest Service

BREAKDOWN RIG

Because of its ability to handle most log classes with equal ease the Twin Saw Canadian is deservedly the most popular unit but general poor mechanical condition and inadequate log treatment gives most units a poor performance.

The highest production rate of 55 S.F.S.S. per man hour noted during the studies was due principally to above average mechanical condition and handling of the Canadian unit.

A quite reasonable production rate was achieved in one frame mill where the frame was used to produce sized flitches. The sawn quality of the product was, however, quite poor due to misalignment of cuts during belster changes and run on the saws. The conclusion is therefore reached that the general type of frame is not suitable for a centrolled flitching, and the capital expenditure involved in a Gangsaw installation is not warranted.

From an efficiency standpoint then, the main use of a Frame should be as an auxiliary to a Canadian in areas where very large logs are encountered. Treatment of large pipey logs on a Frame by the sawing out of a large central flitch housing the heart has certain advantages on the treatment of defect, but in most cases a new Frame installation would not be warranted for the advantage gained.

In the earlier days of sawmilling the Rack Bench was a popular auxiliary to the Frame, but benches of this type encountered during the studies, merely served to indicate their obsolescence, the Canadian proving superior in all respects.

On the basis then of a Twin Saw Canadian Breakdown, the following features have been set down as necessary to the efficient use of that unit.

(a) Feed Speeds: In lew capacity mills high forward feed speeds and consequent high saw horsepowers are not warranted.

As a compromise, a general forward feed of 60-80 f.p.m. with BO H.F. (min.) on the bottom saw has been adopted.

Reverse feeds should however be high (200-250 f.p.m.)

to compensate for the low forward feeds and promote an overall low breakdown time giving the crew adequate time to handle its normal duties and to devote more time and thought to the efficient breakdown of the log.

(b) General Construction: The carriage and bench should be of heavy construction, a fabricated assembly having the advantage of ease of repair.

Powercd setworks with independent control of each knee make operating conditions much more acceptable with probably an increase in crew interest in the task.

Shook skids on oither side of each knee are an advantage since they protect the knee slide from log turning shocks. These log turning shocks do most damage to a carriage, and no matter how heavy the carriage may be it should be protected as much as possible by the turning of the log away from the knees against removable inclined skids on the log deck.

Twin toggle operated dogs to each knee are an advantage.

(c) Heart Disposal: Heart can be and is sawn out on the Canadian in a number of mills but it is then passed to the No. 1 bench which simply forms a convenient disposal point as in most cases the No. 1 does no productive sawing on the boxed heart.

With adequate breakdown capacity, heart should therefore be completely disposed of on the Canadian itself. This would in most cases, involve a single discharge point for subsequent bulk removal for burning.

This practice must save mills considerable time not only on the direct disposal but also on the general plearing away of debris which accumulates from the sawing of defective logs.

(d) <u>fog Breakdown Patterns</u>: This section has been in roduced since log breakdown is generally regarded purely as a "carving-up" process with little thought as to subsequent flitch conversion.

Short log lengths (not more than 22 feet) lend themselves to specialised breakdown techniques and the Queensland industry could well give more thought to shorter log lengths as in southern sawmills. Unduly short logs of course reduce the advantage and a concentration of logs in the 15-22 feet length range seems ideal.

Spring is a problem aggravated by small logs and long lengths, but it is submitted that more advanced techniques giving sufficiently accurate sawing are possible by frequent log turning in which the log breakdown is really a compromise peeling process.

Mechanical control of spring by heavy dogging gear is not regarded as a practical proposition, a far better technique being the control of spring by balanced cutting as outlined below.

Some species and log sizes undoubtedly lend themselves to flitching to size by their lack of spring and this is further enhanced if green sawn tolerance is relaxed when the main mill output is subsequently machined.

These techniques are beyond the everage Canadian at present installed since they demand a sawn quality from the Canadian sufficient for the final product without refacing or resizing on the No. 1 Bench.

The breakdown patterns shown on the following 3 pages have been designed to modify the effects of spring and produce easily manageable flitches sensibly clear of defect.

NO. 1 BENCH

Under present mill conditions the breakdown rig merely serves to produce reasonably manageable flitches and in consequence man-handling of these flitches at low feed speeds becomes the basic method of conversion and the labour cost the major compenent of the conversion cost.

These heavy cuts should be handled on the bench designed for them, viz. the breakdown rig and the No. 1 Bench should be strictly a high production unit designed around the sawyer and should not be concerned with heart disposal and other general non-productive cutting.

At present, a high performance for a 3 man No. 1 Bench is regarded as 400% s.ft. nett log per day. An improved breakdown technique and the use of a double sided fence has given production up to 6,500 s.ft. nett log per day on at least one 3 man No. 1.

Considering then, the No. 1 as essentially a production bench and for which every effort should be made to raise

its performance to its peak before auxiliary equipment is installed, the following standards for the bench have been set up.

In many Queensland mills efficient use of the No. 1 Bench would obviate the need for a No. 2 and its attendant docker.

(a) Feed Speeds: Provision of forward feeds up to 250 f.p.m. for running out and to 100 f.p.m. for general breaking down is necessary.

Higher feeds (280 f.p.m. in 6" cuts) have been noted but it is reckoned that a peak of 250 f.p.m. presents the best compromise between production and working conditions for the crew.

A reverse of 200 f.p.m. is quite adequate, as high reverse feeds to compensate for low forward feeds, are not suited to breast bench operation.

A quick reversing feed gear is a definite asset and for this reason steam feeds are still popular.

(b) Bench Crew: A minimum of three men is required on a No. 1
Bench. With only 2 men on the bench the sawyer is too concerned
with feed operation and assistance to the tailer-out. In at least
one mill studied a 2 man bench was largely responsible for the
low production rate.

A better proposition for the Queensland industry would be the use of a 4 man team including two tailer-outs. An argument against two tailer-outs has been the poorer quality material produced by poor "pull out" but it is submitted that correct training and encouragement of the crew would obviate whis argument.

The particular advantages of two tailer-outs are as follows:

(i) <u>During Flitch Breakdown</u>: One tailer-out concentrates on the discharge of sized flitches to storage and the other on the return of the main flitch to the sawyer for further sawing.

The present practice of passing back the two pieces to the sawyer who, with the feed man is responsible for the discharge of the sized flitch to storage is rather inofficient use * the sawyer's time and the time cut-to-cut is consequently surprisingly high.

(ii) <u>During Running Out</u>: One tailer-out discharges sawn material to the docker and the other concentrates on the return of the flitch to the sawyer.

The whole technique is designed to confine the sawyer's time more to productive sawing than is possible with only the one tailer-out and must have a major effect on bench production.

(c) <u>Fence Gear</u>: The peg-type fence is surprisingly popular, but when compared with the notched-bar type, they are rather slow and cumbersome of movement apart from the width of bench required for their installation.

A double sided fence or twin fence gear is a decided advantage, especially under two tailer-out conditions, since it allows of breakdown of a flitch on the opposite side of the saw to running out and consequently facilitates the passage of flitches to storage preferably on an extended bench roll system.

NO. 2 BENCH

The general run of the No.2 Bench gives a poor performance being mainly used as a salvage bench.

It is doubtful if the average mill requires a No.2 to maintain production if more thought were given to improvement of the No.1 and Canadian performance.

Where mill capacity is such that a No.2 has to be installed, it should be a high production unit being fed with sized flitches from the No.1 and be concerned only with repetition cutting.

No more than two men should be employed and constant forward and reverse feed rolls (200-250 ft./min.) should be provided. Such a bench can easily produce some 500 s.ft. sawn in 1 in. material/hr.

The conventional swing type docker is quite adequate mechanically for the task but the general handling techniques and quality of material fed to the bench leave much to be desired.

In addition, the training of the operator appears to be very lax and in many cases lack of knowledge of general defect and susceptible sapwood has a marked effect on grade, recovery and the production of short length material.

The major difficulty with all dockers is the quantity of firewood fed to them and every effort should be made to improve the handling methods of this material. Two alternatives suggest themselves:

- Provision of a conveyor belt (150 ft./min. 6 in. wide) under the docker so that firewood falls automatically on to it from the docker.
- (2) The handling of obvious firewood on the off-gauge side of the saw with an automatic firewood docker. The output of this unit can combine with the firewood still produced from normal improvement cutting on the docker, and fed to a common storage point.

Under conditions of sound handling aids around the docker and sound general mill layout it is submitted that one docking bench is adequate for the average two bench mill.

LAYOUT

With regard to layout there are three main points for consideration:

- (a) Elimination of non-productive labour as much as possible; any man who takes hold of a piece of timber should do useful work on that piece and not be employed merely to overcome deficiencies of layout.
- (b) Adequate but not excessive skid room between operations with simple handling aids such as roller top skids.
 - (c) Easy flow of material from any one operation.

One of the biggest causes of poor layout is lack of initial ambition or foresight. Too often the extension of a mill to include a No.2 Bench has caused considerable confusion of layout and production.

With these points in mind the two attached layouts have been drawn up to cover the mills which form the bulk of the State's hardwood industry.

The final handling system from the docker has been left open as it depends very largely on the sawing schedule and final product treatment.

Discussion:

Mr. Turnbull: It seems to me that working within the limitation of log allotments the objectives of Mr. Jennings' study will be very hard to attain. If the only improvement that can be brought about is one of greater man-day output from a fixed volume of logs, you cannot get that greater man-day output until you are in a position to dispose with one or two men. The point at which you can dispose with one man constitutes a very considerable increase in the man-day output of a small mill, and I do not think that efficiency goes up in steps like that.

Mr. Jennings: To a certain extent that is agreed, there is a limit beyond which we cannot go. However I do know this that in most 2-bench mills we could eliminate the docker-man by providing an automatic firewood docker. There is no reason why 2 docker-men are needed.

Mr. Huddleston: The last remark of Mr. Jennings brings up the wider question as to what grading you are going to do in your sawmill. If you are going to run your timber and just sell the output of the mill as mill-run material, admittedly you don't want two dockers. If you are going to get a higher price you will require two dockers for outting out defects.

A field in which we can do a lot of good is flooring. I think you will find that most of the lengths used in the modern house could be put down to possibly 12 or 14 set lengths and those 12 or 14 set lengths are within the range of the practical log lengths in most mills. If you could properly select your boards, season them and make them available to the builder in such lengths in sufficient quantities to do his job, you immediately have the prospects of increased price for the flooring. Builders allow 15 per cent. for waste and to that waste they have to add the charge for cutting on the building. In the present practice of flooring, if you can eliminate 15 per cent. of the waste by supplying the number of boards required cut to

length, you can immediately put up the price. You can't eliminate a docker-man; you are likely to want more docker-men than less.

Mr. Jennings: We would regard those problems as applying to re-manufacturing. Seasoning and dressing are outside the considerations expressed here. The point which Mr. Huddleston raised is an important one but in our consideration of the effects of the industry's efficiency on our whole log price set-up, we refuse for many reasons to go beyond the green off-saw basis. One docker-man can readily handle and do a reasonable job of grading provided he does not have to handle firewood. We have tried this out in one particular mill and it has been the logical thing to do. In other words the firewood has been channelled away from the docker-man into an automatic firewood saw. It will never be possible for us to reach the optimum efficiency because of the limitation of log supply.

Mr. Huddleston: We should be striving to have our mills do more re-manufacturing rather than leave it to someone else. Mills are sending out a range of products from good to bad; some is just usable and some is high grade. It is left to the timber merchants to take that material and convert it to a marketable product. I feel we should be pushing the mills into producing marketable products out of the logs they are using.

Mr. Jennings: In probably 90 per cent. of the cases in Queensland there is no wholesale trade, and therefore the miller is also his own marketing organization. It is not the same set-up as in Sydney.

Mr. Grenning: One of the jobs of this particular set of studies was to ascertain the percentage recovery on today's marketing basis rather than on the immediate post-war basis where anything that would hold together was salable.

Mr. Wright: There is often one operation in sawmilling where a man can be saved, and that is in a sawdust disposal system. In those cases where an exhaust fan and ducting system is not used,

a man is often employed to get the sawdust away from the mill. By installing a blower exhaust system not only is the cost of working this man saved, but the sawdust can often then be used as a fuel for the boilers and the waste wood previously used as boiler fuel made available as firewood for householders.

Mr. Clarke: A study should be made of all causes of nonoperative time with the object of reducing them. It is unfortunate
that it is necessary to restrict the output of the mills, but we
seem to have developed a restrictive complex which affects the
attitude of our timber people.

Mr. Booth: The basic trouble in the sawmills - the lack of any desire to mechanize - is bound up with the stump appraisal system. If they improve their practice an extra levy is taken out.

Mr. Jennings: There is the fact that the crown is entitled to a reasonable return. From memory, of the thirteen studies there were at least five which were well above average and they were the ones which were most receptive to recommendations of improved efficiency. I do not think that it automatically follows that the general system of stumpage appraisal restricts the incentive to improve. It does have the effect of eliminating from the industry the least efficient.

ITEM 12 (b) STUDIES IN SAWMILL ECONOMICS - METHODS AND TECHNIQUES*

The effect of the standard of economic and engineering efficiency of the sawmill industry on the management of Australian forests is not appreciated by professional foresters to the extent that it should be.

The forest resource has multiple use values - some protective, some recreational but primarily it is a reservoir of constructional raw material and here constructional is used in its widest sense.

In the latter case the ultimate test of the quality of management of the resource is whether what is grown can be directed to useful purposes at prices and qualities competitive with other materials.

If this is true, then the interest and knowledge of the profession cannot stop at the mechanics of growth and management of the forest itself (important though these are) leaving wholly to the industry the decisions on economic and technical considerations affecting the converted product.

To do so, places forest management on an unsound basis which hazards the continued existence of the resource. The saw log is, and probably will continue to be, the forest product of greatest economic importance, and it is the saw log from the native eucalypt forest which by the very nature of those forests and their constituent species, will continue to present the challenge of efficient management not only of the forest itself but the industry using the raw material.

The picture of unbalance of size classes with a preponderance of volume of saw logs in large decadent trees often carrying serious heart defect is the primary challenge. Before these forests can be brought to full and efficient production these trees must be removed.

In fact, they still form an important part of the log

supply to industry. Queensland hardwood forests consist of a mixture of species some of high quality and durability. Some twenty or more different species are commonly used as saw logs. The overall resource is perhaps barely sufficient to maintain the present industry and then only if the utmost efficiency in conversion is sought and maintained.

The deficiencies in numbers of stems in the classes approaching cutting size are such that unless every effort is made to use the defective stems at present of merchantable size then there will be no prospect of continued maintenance of the industry in its present form. Such a policy of course necessarily requires the determination of the limit of defect which can be accepted in a log of any given size or species.

In the ultimate the value of any log to the sawmill is dependent on the price of the sawn product, the costs of its conversion, and an equitable return for enterprise. In general terms this may be stated as -

M = R(P - C)

where

M = log value at mill skids/100 s.ft. Hoppus

P = average mill run sawn price/100 s.ft. sawn

C = milling costs and profit/100 s.ft. sawn

R = recovery percent. expressed as a decimal

The determination of the variables in this equation is the responsibility both of the industry and the Forest Service, the former because if it is to meet competition from other materials and imports, it has to base its cost structure on some reasonable standard of efficiency; the latter because if it is to have any sound management of the resource entrusted to it, it has to know within fair limits of accuracy, the correct log price as influenced by economic conditions from time to time.

This must be such that all units of the industry can compete on an equitable basis for their raw material, having regard also for an equitable forest revenue. The necessity for co-operation in determining the facts is obvious and the Service has received in very generous measure, co-operation from industry in Queensland.

It is also obvious that the determination of these variables cannot be static. Cognisance must be taken of changing economic conditions and a continuous program of co-operative study maintained. Studies in sawmill economics then have the following aims:

- (1) To determine the basic production statistics and to set up therefrom, an industry wide standard of performance and efficiency which will determine the log price structure.
- (2) To improve the performance of the individual mill by providing information on production and engineering defects in both that mill and the industry generally.

Variation in species, log size and defect can considerably affect the recovery quality and value of the sawn product, unit labour and overhead costs, and the dividend on capital employed. If a reasonable estimate of the effect of this multiple variation is to be obtained, the studies must be designed with due regard for efficient sampling and the application of biometrical methods of analysis. Only by this procedure can the reliability of the results be properly estimated.

The scarcity of reported information on studies of Sawmill Economics in Australian Forestry literature is marked and it is the purpose of this discussion to present the basic methods of study and analysis, which have been used in some years of work in this field. General Procedure

In pursuance of the general considerations of policy outlined above, a series of studies in thirteen hardwood mills in south-east Queensland was conducted throughout 1953. This followed a similar series completed in the post war years and both sets of results led to the same general conclusions. All results quoted herein refer to the most recent studies.

The purposes of the studies were to clarify the effects of major factors which influence milling costs and to reduce to a minimum the errors to which such figures are subject.

The first matter to be considered was the general study design. Where results are to be applied to determine the basis of log pricing for the industry as a whole, the mills chosen must be representative of the industry. To achieve this, the best principle to adopt is to sample as many mills as possible for a short period of time. Hence, it was decided to study operations for 3 days in each of thirteen mills. During this time, 522 logs representing 274,000 s.ft. Hoppus gross log volume was milled.

After original computations were complete, investigations were undertaken to determine the influences of log size and class on the variables in the equation -

$$M = R (P - C)$$

These factors are now considered separately and their combined influence on mill door log value is illustrated. Recovery

Observations on the sawn recovery from each log were recorded at all mills. A relationship between recovery and gross log volume was determined by regression analysis. The best estimates of recovery for a log of any size, class or species are given by the following equation -

$$R_1 = 0.589 H - 0.237 D - 18.70$$
 $R_1 = Recovery including reject material and$

In both cases -

H is the gross log volume (s.ft. Hoppus)
D is the defect volume (s.ft.)

and R is recovery as s.ft. solid sawn.

The influence on percentage recovery of log centre girth for the average defect in each girth range can now be determined from the equations above. These variations are shown in Table 1 below and are represented graphically on Figure I. The figures for solid logs

are included for comparison. It is most important that the position of such variations should be determined as accurately as possible. By the use of regression analysis, such accuracy is automatically achieved and a valid estimate of error provided.

TABLE 1

Log Centre Girth (in.)	Average	Recovery Including Rej.(% of G.H.V.)	Recovery	Solid Logs		
	Pipe Diameter (in.)		Excluding Rej. (% of G.H.V.)	Recovery Including Rej.(% of G.H.V.)	Recovery Excluding Rej. (% of G.H.V.)	
40 50 60 70 80 90 100	3.3 5.0 6.8 8.5 10.3 12.0 13.8	46.3 48.7 49.6 50.0 50.1 50.2 50.2	42.7 45.6 46.7 47.3 47.5 47.6 47.6	48.9 52.5 54.4 55.6 56.4 56.9 57.3	45.4 49.5 51.7 53.1 53.9 54.5 55.0	

In each case, 92 per cent. of the variation in N.S.S. recovery is accounted for by the regression formulae.

Average Mill Run Sawn Price

From the study results, a distribution of recovery through the grades and sawn sizes was produced for the several girth classes used in log pricing. This was used to determine whether a variation in sawn price with girth exists. Using the wholesale selling prices listed in the Price List of the Queensland Timber Stabilization Board effective from 17/8/53, the variation was found to be as shown in Table 2.

TABLE 2

Girth Group	Value of Product				
36-47.9 in.	81/8				
48-59.9 "	83/6				
60-71.9 "	83/2				
72-83.9 "	83/1				
84-95.9 "	83/2				
96-107.9 "	83/1				

It is most important to check this variation frequently to allow for -

- Any changes in the price lists particularly in the structure thereof; and
- (2) any variation in general milling practices.

There was very little variation in the average grade of material produced from logs of different girth. There was, however, an approximately constant proportion of material produced in the two size classes 4 to 8 x 1 (and L_1 in.) and other sizes up to 5 x 5 in., irrespective of log size.

With increasing girth (and therefore increasing defect) less material was produced in the 4 to 8 x l group and the balance went into the other group - a less profitable size class. This preference is felt most in the 48-59.9 in. girth class where a slightly higher average value is recorded.

The actual selling prices do not reflect true differences in value between sizes insofar as cost of production is concerned. Trade and consumer preference upsets the direct approach to the problem.

Overall, the sawn product was distributed within the grades as follows:-

Standard and better	76.14	per	cent
Common	18.30	n	11
Reject	5,56	0	11
	100.00	11	12

Milling Costs

Milling costs vary with girth and defect in the same way as production rate does. Hence, the problem is to determine the influence of log dimension on rate of production.

During the studies, time of production was determined on a daily total basis. The principles used are similar to those outlined in a previous paper delivered at the 1946 Forest Products Conference ("The Application of Statistical Principles to Sawmill Studies" by E. J. Williams). Overall, 39 total times were recorded at the thirteen mills and the corresponding sawn and log tallies were noted.

It was found, in the first place, that by conducting this part of the study in such a way, the overall study crew was reduced by

at least two men. (The usual crew for these studies was three men). The method proved to be highly efficient and economical.

A relationship for time spent in milling a log in terms of its gross Hoppus volume was determined by regression analysis. The total milling time for a log of any size, species or defect is given by the equation -

$$T = 0.669H + 10.61$$

where H = gross log volume (s.ft. Hoppus)

T = milling time (man min.)

Again, 92 per cent. of the variation in milling time is accounted for by the regression formula. It is considered, therefore, that milling time for any log can be assessed at least as accurately by daily total methods as by log by log observations.

The influence of log centre girth on rate of production for the average defect in each girth class can easily be determined. This is illustrated in Table 3 below and the variations are represented graphically on Figure II.

TABLE 3

Log Centre	Production Rate S.F.S.S./man hr.							
Girth			Solid Logs					
(in.)	Including Reject	Excluding Reject	Including Reject	Excluding Reject				
40	38.3	35.3	40.4	37.5				
50	41.4	38.8	44.6	42.1				
60	42.9	40.4	47.1	44.7				
70	43.6	41.3	48.5	46.3				
80	44.0	41.7	49.5	47.4				
90	44.3	42.0	50.2	48.1				
100	44.4	42.1	50.7	48.7				

After discussion and agreement on a standard cost schedule with the industry the milling cost per unit labour and time is grafted on to these statistics. In other words, a milling cost is determined as pence/man min. of mill time and applied to the production rates determined as above.

Mill Door Log Value

Having determined the variation of the three factors R, P and C with log dimension, the calculation of mill door log values is a simple matter. Using these results, the appropriate mill door log value for a log of any size, class or species can be determined. Figure III illustrates a typical variation of log price with girth and defect and provides the fundamental information required for stumpage assessment.

Some General Conclusions from the Studies

The results of the hardwood studies indicate that, within the limits of the sample studied, there is no difference between species insofar as green off saw recovery is concerned. In this regard it must be stated that the sample is incomplete with regard to all hardwood species normally sawn; in particular, there were no scribbly gum or bloodwood logs milled.

The above statement may need further elucidation. It is known for example that grey gum generally has a lower recovery than ironbark. When it is remembered that grey gum is also inherently more defective than ironbark and that the recovery formula makes allowance for such defect, the statement seems reasonable. The comparative defect figures for these two species from study observations are ironbark 9.4 per cent. of G.H.V., grey gum 26.4 per cent. of G.H.V.

In the log sample studied, defect occurred primarily as faulty heart more commonly known as pipe. A further observation made from the study results is that pipe has no significant influence on milling time and that the difference insofar as production rate is concerned between defective and solid logs is a difference in performance with regard to recovery.

An explanation of this point probably lies in the method of heart disposal presently used. Under existing mill techniques, heart, whether boxed out on the Canadian or not, is usually passed to the No.1 bench for disposal. The time spent on this operation appears to be equal to the time spent in sawing the equivalent solid volume. A

more advanced technique of completely handling heart defect on the Canadian must result in less timber being passed to the No.1 bench as the defect percentage increases. A different pattern of variation of milling time with defect would then be determined by future studies.

Mill Efficiency

The performance of a mill cannot be evaluated from its production rate alone. It is felt that three factors should be taken into consideration. These are :-

- (a) The production rate expressed as S.F.S.S./man hr.
- (b) The average value of the sawn product.
- (c) The size and quality of the logs being handled.

These three factors could be combined to form an index of mill efficiency. A suggested form for the index is -

$$\mathbf{E} = \frac{\frac{\mathbf{S} \times \mathbf{F}}{\mathbf{L}}}{\frac{\mathbf{S}_{1} \times \mathbf{F}_{1}}{\mathbf{L}_{1}}}$$

where S = the mill's average wholesale selling price

P = " " production rate

L = the recovery which the mill should obtain from the log sample used.

For a single average log L = 0.568H - 0.243D - 21.36

where H = average gross Hoppus log volume

D = average defect

 \mathbf{S}_1 , \mathbf{P}_1 and \mathbf{L}_1 are the industry's average performance figures. Since all figures are referred to standard results, an index of 100 would mean that the operation was identical with the average of the industry.

In the index itself, the average wholesale selling price of product reflects the value of the product and the operational efficiency of mill machinery and crew.

Production rate also reflects both crew and machinery efficiency. The log quality index L should make allowance for the log size and defect being handled. The formula reduces to

$$E = \frac{0.0145 \text{ S x P}}{L}$$

All three factors should be determined for the same period

of time. For the thirteen hardwood mills studied, the index would be as follows:-

Mill	Shillings/	P SFSS/man hr.	L Per cent. of G.H.V.	E	Classification
1	83/6	55.7	45.5	148.2	A
1 3 4 5	83/6	45.0	46.3	112.5	В
3	83/6	44.1	47.6	112.3	В
4	80/1	46.6	48.9	110.8	B B
	78/7	43.2	46.7	105.5	В
6	78/3	45.1	48.5	100.8	В
7	78/4	39.7	45.6	98.9	C
6 7 8 9	79/10	39.3	47.6	95.6	C
9	78/1	40.4	48.3	94.8	C
10	80/8	37.1	47.1	92.1	o o
11	76/6	34.0	45.1	83.6	D
12	77/11	34.5	48.6	80.2	D
13	79/1	32.1	46.4	79.3	D
rerage	79/10	40.8	47.1	100.0	

General impressions on the subject of mill efficiency, gained by the study crew agree with the classifications listed above.

If the basic principle used in log pricing is that all mills should be able to make the same amount of profit/man min. of working time irrespective of the size or class of logs handled then the best index of efficiency is obtained by a comparison of actual dividend rate with the average rate allowed. This has been done for the above mills. Both indexes place the mills in the same order of efficiency and very close agreement between actual values for E was obtained.

Most mills, to the present time, have not kept records of production in any detail. It is hoped that the indexes quoted above will be sufficient stimulus to encourage the industry to make a regular practice of keeping records in future and to use the index as a guide to improvement in technique and general mill operation. Routine operational control should be an essential feature in efficient sawmilling.

References

Williams, E. J. The Calculation and Interpretation of Multiple Regression Equations. Project S.M.1-2. Review of Miscellaneous Statistical Methods. Progress Report No.1. Schumacher, F.X. and Jones, W. C. Empirical Log Rules and the Allocation of Sawing Time to Log Size. Jour. of For. 38 (1940).

Discussion:

Mr. Turnbull: I would like to know whether Queensland have interested themselves in the effect of log length on recovery and on milling rate. We who visit there notice that their practice of milling is basically a long log method whereas in the south they have the short log method of milling. I can see a good deal of advantage in the short length method, particularly when you are getting down to lower girth groups and when you have an appreciable taper in the logs. I am aware that the practice in Queensland is bound up with marketing practice where, for many years, the builders and other large consumers are used to receiving long pieces which span the whole width of their dwelling. I question the necessity for that state of affairs continuing. I think quite satisfactory construction would be achieved, as Mr. Huddleston pointed out, with 12 or 14 ft. lengths. I notice in this study the recovery is correlated with log girth only and would like to know whether they have any data on the influence of log length.

Mr. Jennings: In the series of studies we have paid some attention to length. It was not originally designed to illustrate any detailed information on length. It is a fact in the Queensland industry over the past 5 years that the average log length going to the mill has dropped by about 4 ft. which is a move in the right direction. The data from those 15 studies show actually that there was no improvement in the average length of sawn products as compared with the original log lengths after you had passed 21 ft. There is a tendency for them to saw logs shorter now.

Mr. Turnbull: There is the additional benefit of reducing the effect of spring as the length of a log is reduced. This is a serious matter and more important as the years pass.

Mr. Grenning: I might mention that our mills are probably receiving a much more defective log than in other States. One of the objects of this study was to get a more realistic assessment of the values from the logs; more correct pricing.

Mr. Jennings: Our average log milled in the south-eastern area of the State generally is about 20 ft.x 38 in. with a 25 per cent. defect and that has dropped in the last 5 years from a log 25 ft.x 72 in. with about a 15 per cent. defect.

ITEM 12 (c) SAVING INVESTIGATIONS ** Circular Saws

The Division's circular sawing research was initiated with the construction of an experimental saw bench which, it was hoped, would prove an accurate and reliable fact-finding machine. The fundamental principle on which the bench operated was unique in that the energy stored in a flywheel on the saw shaft was used to do the cutting. The specimen was automatically fed into the saw while the saw speed fell between two predetermined limits. These limits defined the quantity of energy supplied by the flywheel to be consumed in the cut. This quantity of energy was made constant, and cutting efficiencies were compared by comparing the weight of wood removed by the saw from the specimen. The advantage of this machine was considered to be that reliance on human measurement and control was entirely eliminated.

A large amount of experimental work was done with this saw bench, and this work has been written up in a report completed last year, "Preliminary Investigations on an Experimental Saw Bench". However, continually recurring mechanical and electrical trouble marred the work, and no conclusive results were obtained. The difficulties encountered were:

- The automatic feed regulator did not consistently start and finish the cut at the required saw speeds.
- (ii) Friction variations in the bearings of the saw shaft seriously affected the results.

In addition to these faults, there are disadvantages inherent in the basic principle of the bench. They are:

- (i) The saw speed does not remain constant during a cut, but rapidly drops from the speed at the beginning of the cut to a lower speed at the end of the cut.
- (ii) It is impossible to obtain data on feed speed and feed power without the installation of special instruments. The cost of these would be out of all proportion to the use made of the bench.

^{*} Prepared by Division of Forest Products

Consideration is being given therefore to the advisability of constructing a new experimental saw bench on more conventional lines. To assist in a decision the flywheel bench has undergone a thorough trial to determine if it is capable of supplying sufficient accurate and reliable experimental data. An experiment was designed especially to provide this trial. It compared the efficiency of two standard profile, 18 in. circular saws, one with twice as many teeth as the other. The saws were compared at three different rim speeds and three different feed speeds. Special techniques were adopted to eliminate from the results the effects of inaccurate feed regulation and changing bearing friction. Very much more data was collected than was usual in past experiments.

At the time of writing, the results of this experiment were being analysed. If the flywheel bench is satisfactory it is expected that fairly outstanding differences such as those between the saws will be clearly shown up. The ability of the bench to separate the more minute variations such as density effects will also be revealed. It is proposed to calculate, for each cut, the net energy consumed and the average net power required. Then these energy and power figures will be correlated with number of teeth, saw speed, feed speed, density and moisture content. Other studies will be made for the sake of interest and completeness. For example, a correlation will be sought between the weight of oven dry wood removed and the net energy and power figures.

If any results are available at the time of the Conference they will be submitted, but they will also appear, as soon as possible, in a Progress Report.

There is no lack of important work to be done in the solving of Australian circular sawing problems. When finality is reached on the most suitable fact-finding machine to be used, the Division will immediately be able to continue its investigations in this field.

Power Saw Chains

Of the many aspects of power chain saw design and operation the Division has concentrated particularly on the sawing chain which is a common source of trouble and provides problems in the cutting of wood, a subject well within the Division's scope.

It was established early that a first requirement was accurate sharpening to produce a uniform chain. A practical procedure for doing this was established, and this has been publicized in the wall chart "The Maintenance and Sharpening of Power Saw Chains", and in a 16 mm. sound film of the same title. The film should be of interest to many authorities who operate chain saws and who are interested in promoting efficiency in logging operations. To give widest viewing of the film, copies are being made available at a small cost.

Experimental work has been aimed at developing more efficient chains. To this end a machine was built to permit the study of cutting under controlled conditions, the time and power demand of cutting being measured.

Study of scratch type chains has proved difficult, there being fifteen factors directly concerning the chain to be controlled. Big variations occurred between re-sharpenings for replication.

However, a preliminary analysis has been made of the effects on energy consumed, of hook angle of cutters and of height difference between cutters and rakers. This indicates that increasing hook angle decreases energy consumed, and increasing height difference increases energy consumed. Time of cut and power demand are more variable and the results not so clear, it being apparent that other factors have a greater influence, for instance top angle of the rakers.

Preliminary studies have also been made of the properties of gouge type chains. Increase of front bevel angle was found to rapidly reduce power demand. The interaction of pressure on the cutter bar and depth of gauge clearance on power

demand were also studied in a preliminary way and this appears to be a fruitful approach. Several types of gouge chain have been obtained for comparative study of different styles of tooth.

A simple pendulum type of dynamometer is being constructed to help in this work, permitting the study of a single tooth, and so reducing considerably the variables involved. Discussion:

Mr. Huddleston: If you want problems we can give you plenty. What is the right speed of the saw? What is the right tooth shape? What set will you give your saw? All these problems are purely empirical at the moment and we have no information at all which is soundly based.

Mr. Irvine: Why has it not been possible to obtain information on the performance of the saw by maintaining the power into the saw constantly and adjusting the rate of feed to keep that power constant? It seems to me it would be a lot easier to do that to maintain various variables.

Mr. Jones: There are disadvantages in that method. The speed of the saw could not be kept constant. If you fed in the same amount of power to the saw and only altered the feed speed the saw speed could not be accurately forecast. We need to operate saws at predetermined saw speeds. It is necessary to do that in any sawing research work.

Mr. Irvine: The answer that you want is, what saw will give you the greatest output in a particular type of timber of a particular size.

Mr. Turnbull: Regarding the problem of what type of saw, you can have few or many teeth with different shapes and clearance angles. There are a lot of variables. Investigations have to be designed so that factors can be compared one at a time, otherwise, you would never deduce what was the main influence on your result.

ITEM 13 (a) EXTRACTION OF PINUS RADIATA BARK

The survey of P. radiata from Jenolan S.F. has shown that the bark of this species is a good potential source of vegetable tannin. Loe, working on the extraction of tannin from P. radiata, starting with material from a wet debarker which consisted of wood and bark chips, was able to recover only 36 per cent. of the original tannin in a counter current extraction system.

In 1952, the Tanning School, N.S.W. University of Technology, received a consignment of about 2 tons of bark from a wet debarker. The bark had been bagged in a moist condition, and no tannin could be extracted in the tannery's counter current system. Further Loe observed that the liquors he obtained were unstable and on standing large losses occurred due to excessive phlobophene formation, also large amounts of insolubles were formed during evaporation of liquors and the finished extract was only partially soluble in water.

It was felt, therefore, that since the bark available from N.S.W. plantations would be stripped from mill logs in a comparatively dry condition, it may behave differently to wet debarker material. Hence a study of the extraction of this bark and the liquors obtained was thought to be worthwhile.

The bark used consisted of a composite sample taken from ordinary mill logs in a millers yard. Wet snow was falling at the time of sampling. The bark obtained was air dried and kibbled. The tannin analyses were as follows: - Tannin 14.4, non-tan 5.0, total solids 20.3, moisture 11.5.

The extraction was carried out in the laboratory extraction apparatus and evaporation in a modified climbing film evaporator which was operated under high vacuum. Highly concentrated liquors were dried to solid extracts in a vacuum oven. The counter current system consisted of 6 cells, the first three were at 60°C, 70°C, and 70°C, respectively, whilst the last three were maintained at 95°C.

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

Hymphreys, F.R. and Martin P.J. D.W.T. Sub-Proj. C6-4. Progress Report No.2.

MARY Loe, J.A. N.Z. Forest Products Ltd. Bark Investigation Report No.2.

Liquors and barks were analysed by the official method. The sulphite mixture used consisted of equal quantities of sodium sulphite heptahydrate and sodium bisulphite.

Four liquors prepared from the radiata bark in the presence of varying quantities of sulphite mixture were examined for total solubles at intervals during 28 days. The liquor containing no sulphite lost 10 per cent. of its solubles, whilst the liquor containing 10 per cent. sulphite on dissolved solids showed no signs of decomposition.

The counter current extraction of the bark using filtered tap water gave a yield of 82.7 per cent.

The same method of extraction with 2 per cent. sulphite mixture added to the 4th extractor gave a yield of 110 per cent. based on total solids in the fresh bark as shown by official analysis.

Construction of an extraction diagram showed that due to the drop in temperature from the 4th to the 3rd extractor, very little extraction took place in the 3rd cell of the plain water extraction and in 3rd, 2nd and 1st cells of the sulphite extraction.

The solid extracts prepared from (a) the head liquor of the plain water extraction; (b) the sulphited head liquor of the plain water extraction; and (c) the head liquor of the sulphite extraction were all readily soluble in water and did not contain appreciable quantities of insoluble matter. The colour of the (c) extract was much darker than the others.

The foregoing has shown that P. radiata bark can be extracted in fairly good yield by water extraction with considerable improvement by sulphiting.

The information gained now allows the selection of more appropriate conditions for the extraction, with possibly better yields and improvement in the quality of the sulphite extract.

Note: Full details of this work are contained in D.W.T. Sub-Project C6-4, No.5, at present in the process of preparation.

^{*} Wiegand, W. Collegium 1942, p.249.

Discussion:

Mr. Hillis: This is very important work, not only from forest utilization standpoint but also for supplying another badly needed extract for tanners. We have carried out some qualitative investigations and the tannin became insoluble when as extract was made. Also when pine bark was stored for a period, only small amounts of tannin could be extracted. This was particularly so if the bark was given a solvent extraction to remove the resin first. The Germans have similar trouble with spruce bark. In view of our experience, and also that of New Zealand, I would query whether Mr. Humphreys has an ideal set of conditions in the collection and testing of this bark.

Mr. Humphreys: The bark was collected from about 15 trees at a case mill. Snow was falling during collection of the bark, the journey to Sydney was in rain but the bark was dried fairly rapidly on arrival in Sydney.

Mr. Hillis: The difficulty seems to be the storage of green bark for any length of time. When you kept the liquors for 28 days were they kept in an open vessel without agitation?

Mr. Humphreys: They were heated in autoclaves to stop enzyme action and scaled against the entry of fungi.

Mr. Hillis: In the tan yard liquors are used for periods up to 3 months and are agitated with the regular removal and entry of hides. Such conditions would encourage insolubilization of tannins if that tendency exists. I wonder whether during the storing of your bark liquors, agitation would promote precipitation of tannins.

Mr. Humphreys: This point should be investigated. The final concentration of the liquors was quite low (about 4 per cent.) but this was purely fortuitous.

Mr. Hillis: In tan yards 6 per cent is common. Has any thought been given to extracting resin by solvent extraction?

Americans are isolating resin from Douglas fir in this way.

Mr. Humphreys: Some attention has been given to this point but we have concentrated mainly on the Callitris bark. After

completion of this work we may do some work as suggested by Mr. Hillis.

Mr. Hillis: Leather manufacturers have stated that if there were any resin in the liquor it would seriously interfere with the tannin process and some means would have to be found to remove it completely.

Mr. Humphreys: I do not think there is much resin in the liquor. In the tests which we carried out there was no difficulty associated with the tanning process.

Mr. Turnbull: In repeating this work, could radiate bark from Canberra be included? There is a mechanical barker operating in the Territory and a large amount of raw material available. If it was proved that sufficient percentage of tannin extract of commercial quality could be obtained the problems of development should be simplified by the large quantity of bark that is removed from logs at one place.

Mr. Humphreys: We are in close contact with Camberra and supplies of bark for the next stage in the work will come from the Territory.

ITEM 13 (b) EXTRACTION OF FATTY ACIDS AND HYDROXY FATTY ACIDS FROM CORKY BARKS *

The corky tissue of the bark of <u>Melaleuce leucadendron</u>, when treated with hot alcoholic caustic, yields up to about 52 per cent. of its weight as a mixture of long chain acids. From comparisons with the constituents of suberin from <u>Quercus suber</u> (the cork oak), it is expected that these acids will be fatty and hydroxy fatty acids in the range $C_{18} - C_{22}$. The possibility of obtaining these acids in large supply by comparatively simple degradation of a waste material could be of industrial importance.

The constituents of this acid mixture are at present being studied. Three acids have been obtained as white crystalline products, but have not yet been identified.

[#] Prepared by Division of Wood Technology, N.S.W.

Discussion:

Mr. Humphreys: The fatty acids obtained may have commercial value if they can be produced cheaply enough. This has yet to be investigated. They would be of no use to soap manufacturers as they have cheaper sources of raw material. The fatty acids may produce particularly good detergents or they may be of use when incorporated with other materials to impart special cork-like properties.

ITEM 13 (c) DEVELOPMENTS IN THE PAPER BARK INDUSTRY *

A small industry using paper bark as a raw material is now well established. There are two manufacturers in Sydney, both making mattress and pillow filling by similar processes. Four to five hundred tons of wet bark per annum are being used. The yield of fibre and dust-free mattress filling is about 50 per cent. of the dry bark. The bark as collected contains about 100 per cent. moisture (oven dry basis). There are as yet no manufacturers in New South Wales making products for insulation purposes. The reasons for this appear to be:-

- (a) The insulating industry is extremely competitive. It requires considerable resources to successfully enter the industry with a new product.
- (b) Large concentrations of paper bark do not exist in or around Sydney, making it a poor location for the conversion of the bark into a product in the high quantity, low price field.

The bark preferred by the present manufacturers is obtained from Melaleuca styphelioides. M. leucadendron is reported by the more experienced of these to be too dusty. An examination of the raw material on which the opinion was formed showed that:

- (a) It was extremely dry.
- (b) The material was taken from old trees from country through which fires had been frequent.

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

A high yield under manufacturing conditions depends, to a large extent, upon processing the bark in a damp condition, relying upon the final sieving stage for complete drying.

Improvements in the present methods of processing can be made by substituting an efficient air separator for the present sieving plant used. As would be expected, the buoyancy of the flat corky particles is much greater than that of the fibres. A laboratory air separator has been constructed so that more data can be obtained in order to design an industrial scale plant.

The making of insulating blocks has been continued, and attempts have been made to produce satisfactory blocks using the roughly chopped bark -

- (a) without a binder
- (b) with a sodium silicate binder
- (c) with a urea formaldehyde binder.

Blocks made without a binder were made by thoroughly scaking the bark in water and allowing to dry at 100°C. in an oven under about 1 lb./sq.in. pressure. A block made in this way had a thermal conductivity of 0.76 x 10⁻⁴ OGS units. Sodium silicate was an unsuccessful binder, as it altered the characteristics of the corky layers of the bark, making the board unattractive and considerably increasing its density. Quite attractive blocks have been made using urea formaldehyde binder. The binder was sprayed on to the chopped bark and the block cured at 100°C. under slight pressure. Various percentages of urea formaldehyde were used, from 3 to 8 per cent., the strength of the block increased as the extra binder was added, but no difference was detected in the K value, all being in the region of 0.75 x 10⁻⁴ CGS units. The appearance of these blocks is quite pleasing and they should be quite marketable if production can be rationalized sufficiently to make them cheap.

Although the industry is as yet small, and will probably remain so while the bark is restricted to its present use, it is in a healthy state and is developing satisfactorily. New types of consumer for the filling material have been developed during the year, while modifications to the present product are constantly being investigated by at least one of the manufacturers in co-operation with the Division.

Discussion:

Mr. Crane: What quantity of this bark is being harvested?

Mr. Humphreys: About 500 tons a year. It is a small industry at present but if the use of the bark is extended to the insulation field the quantities harvested will be much greater. There is an enormous field for use of this material for insulating purposes, especially in areas such as Brisbane where there is no local production of slagwool.

<u>Dr. Dadswell</u>: Is the development of shredded rubber likely to spoil the market for this material ?

Mr. Humphreys: I think that the two materials can exist side by side. Many people do not like rubber for mattress and pillow filling.

Mr. Grenning: There is one manufacturer commencing operations in Brisbane and he is optimistic regarding markets. He has a lease of the Black Swamp area. There is still a lot of information to be obtained on annual production per tree, rotation of stripping etc. but the factory is under construction and will be operating shortly. The manufacturer is interested in extending further north where there are reported to be good stands of tea tree.

ITEM 13 (d) TAN BARK FROM EXPERIMENTAL PLOTS OF ACACIA MOLLISSIMA

In December, 1943, three Black Wattle plots were established with the following objectives:-

(a) To compare under different soil conditions the rates of growth and tannin production of various stands of Black Wattle reproduced from trees whose bark contained a high tannin content.

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

- (b) To determine whether the tannin yielding capacity of the parent tree is inherited by stock raised from the seed of such trees, and if such inheritance is not apparent, to study the results obtained.
- (c) To establish plots of stud trees raised from high tannin producing stands in order to obtain good quality seed for re-afforestation and for farmers who are interested in cultivating the species for tan bark production.

Of the three plots established in 1945, only one has proved to be successful, this being a plot at Bodalla State Forest. It is located on a small river flat, and is 2 agrees in extent. Three thinnings have now been carried out and analyses done on a large number of the thinned trees. Some of the relevant data is set out below in tables:-

Data Showing Variations Between Thinnings (Moisture Content 11.5 per cent. and Parent Trees)

		Tannins (%)			Non-tannins (%)			Insolubles				
Strain No.	Thi	inning	gs	Francisco		innin	gs		Thinnings			
	1st.	2nd.	5rd.	Parent	1st.	2nd.	3rd.	Parent	lst.	2nd.	3rd.	Parent
77	27.6	30,8	32.3	49.6	15.0	11.1	8.8	7.2	46.0	46.7	45.2	31.8
78	27.3	30.4	36.5	50.8	16.3	11.6	9.5	7.3	44.8	46.3	41.3	30.5
86	20.1	32.7	35.7	49.1	16.5	11.9	9.2	7.1	42.9	43.9	44.0	32.3
90	27.8	31.9	34.2	48.8	16.1	12.1	10.1	7.1	44.0	44.4	42.8	30.6

	Tannina %	Non-tannins	Insolubles %
Mean for 1st thinning	27.9	16.1	44.5
# " 2nd "	31.4	11.7	45 - 4
" " 3rd "	34.8	9.5	43.2

It will be noted that over the three thinnings the soluble matter has remained constant and that there has been an upward trend in the tannin content with a corresponding decrease in the soluble non-tannins, as the trees have become older. The tannin content of the bark is still very much short of that of the parent tree, although the trees were 7 years old when the last thinning was carried out. The final thinning was carried out early this year, and analyses have been commenced on the samples obtained.

Since this work was commenced, the Wattle Research
Institute of South Africa, has commenced its extensive investigations
into all phases of the industry. As a result of their work, many of
the questions which this experiment set out to solve, have been or
are being answered. Because of this, after the analysis of the final
thinnings, no further work is contemplated on the tannin content of
this bark. The stand will be left as a plot for the study of the
mechanical properties of the timber. Data will also be collected on
the yield of bark per acre as the timber is removed.
Discussion:

Mr. Booth: In our search for a tree which would give combined bark and timber crop, we last year established two more experimental plots, one of Acacia penninervis and the other of an unknown Acacia which we call "A. bodalla". Both yield good timbers suitable for axe handles and give useful tanning barks. A. penninervis is almost as good as hickory for axe handles. There is some interest by private people in the planting of A. penninervis as a source of timber and bark. It is also considered as good, or superior, to American hickory for baseball bats. It is a good bending timber and has properties similar to blackwood in this regard.

Mr. Hillis: With the use of barks from other Acacias for tanning purposes, care will have to be taken that they do not have the red colour which tanners do not like. The growth of silver wattle in South Africa has now been prohibited by law because of this undesirable feature.

Mr. Humphreys: Tanners prefer to use freshly stripped bark rather than the extract. In addition, they can sell the spent bark.

Mr. Hillis: From the tanner's point of view, extract does not give as good properties as the liquor freshly extracted from the bark.

ITEM 14 REVIEW OF CURRENT ACTIVITIES OF THE TIMBER PHYSICS SECTION

(Presented by Mr. Kingston)

1. Cellulose-Liquid Relations

(a) Shrinkage and Density Measurements

Work on this project was commenced in the early 1930's and the results of a large number of measurements, together with a discussion of the methods used was published by Greenhill a little before the last war. During the war, further measurements were carried out on species of interest in the aircraft and other war industries. After the war, an attempt was made to fill certain gaps in the work, to give a reasonable estimate of the shrinkage and density of all the commoner Australian species to an accuracy which was considered justifiable in each case on the basis of the importance of the species.

Recently this work has been extended to cover not only Australian timbers but those from the South-West Pacific area as a whole. In accordance with this, measurements have been made during the last 2 years and are being continued on a considerable number of the more important species from New Guinea, together with ones imported into this country, from Borneo and other parts of the South-West Pacific. Further measurements are being carried out on a considerable number of secondary North Queensland species.

A survey is also in progress of the shrinkage, density and moisture absorption of building boards, both hard and insulating boards including those of local production and those imported into this country from Europe. Rather more extensive tests are being carried out on <u>Pinus</u> radiata to show the effect of age of tree, ring age and site factors on these properties.

A study has been made of the technique of shrinkage measurement to eliminate certain errors and as a result certain modifications have been introduced. A report of the critical studies made has recently been published in America in the Forest Products Research Society's Journal.

Certain modifications of the method of determining intersection point have been introduced to enable a closer assessment to be made, as it was found that the method originally in use introduced errors with some species. The results tended to be too high and occasionally very much too high (e.g. jarrah). This was due to departure of the shrinkage moisture content curve from a straight line as zero moisture content was approached. The intersection point is therefore now estimated from measurements made at 5 per cent. and 12 per cent. moisture content.

(b) Influence of Temperature on Sorption

The influence of temperature on the scrption isotherm, that is, on the relationship between moisture content and relative humidity at constant temperature, is being determined for wood, in addition to measurements to determine the effect of temperature on the heat of wetting. It is hoped from this work to obtain information which will throw further light on the method of bonding of water to wood in various ranges of moisture content.

(c) Capillary Sorption Studies

This work has arisen out of the visit of Dr. Christensen to the University of Manchester, where he worked for 2 years with Dr. Barkas. His work there was concerned with capillary sorption in paper pulp but it is thought that the method can, with modification, probably be used with advantage in the study of wood. By capillary sorption is meant the retention of liquid water above the intersection

point at humidities between 99 per cent. and saturation. This covers the most important part of capillary scrption, although there is some at relative humidities well below this.

An entirely different technique from that normally used previously is adopted. It does not depend on the conditioning of specimens at various relative humidities. It is hoped that it may lead to a better understanding of the phenomenon of collapse and may provide a method of studying the retention of water by wood at relative humidities in the vicinity of saturation which could not be investigated with any accuracy by methods previously available.

2. Creep Phenomena

(a) Creep in Tension, Compression and Bending

Tests to assess the amount of creep occurring (increase in deformation with time) and its effect on the strength of the wood are being continued on beams at 14 per cent. moisture content and in tension and compression both green and at 14 per cent. moisture content. The deformation does not increase as rapidly or as much in tension and compression as in bending, being only doubled, or thereabouts, in a year in tension whereas the increase may be 4 to 5 fold in bending. Creep for dry material in compression appears to be very slight especially at low stresses. New tests are at present being initiated to study additional species to see whether all species behave similarly with regard to creep. The species are being selected in such a way as to include an important timber of each of the strength groups and some of these tests will be left under load as long as possible in order to assess creep behaviour over times comparable with the life of an engineering structure.

Tests are in progress on creep in shear. There are considerable difficulties in carrying out creep tests on shear specimens, especially if the shear strain is to be measured but a reasonably satisfactory technique has been established and a number of shear tests have been carried out and more are in progress.

One advantage of direct shear tests is that an assessment of the effect of shear by the use of beams is very much more complicated. Barkas shows that with a substance so extremely anisotropic and heterogeneous as wood, most types of stress result in a predominantly shearing stress in the cell walls and hence such a stress is considered a very important one, apart from the intrinsic importance of shear in plastic deformation in general.

(b) General

Consideration is being given to methods of throwing light on the mechanism of creep in wood. This may present very considerable difficulties on account of the complicated structure of wood both from a molecular point of view and from a microscopic one.

One factor occurring in all creep tests is the sudden and unexpected increases in creep from time to time. These do not appear to be closely connected with climatic changes and have also occurred under controlled conditions. No explanation is yet available.

A study is also being made of the relaxation of stress of wooden beams under constant deformation. Relaxation is of practical importance in gluing in clamps and in structures using metal connectors, although in the latter case, shrinkage would also have a very big influence. A study of relaxation may also throw light on the stresses involved in swelling and shrinking. The relation between relaxation and creep is also under investigation to find if one set of properties can be derived from the other. That relaxation could be important is shown by the fact that gradual development of failure is observed in beams, even under constant deformation. This may be of importance in the study of stresses in the living tree.

Changes due to creep in the stress distribution in beams are also being studied. That there is such a change has been shown by tests carried out by Dietz at the Massachusetts Institute of Technology. A marked difference in the change in length of the tensile and compressive faces of beams during creep tests was observed here, and

appears to support Dietz's observations. The greater change occurred in the compression face. Dietz' results would lead to a greater change in the tensile face and this contradiction is now being investigated.

The damping of wood and its elastic properties are at present being determined from vibration tests. This gives a picture of the other end of the time scale from creep and relaxation tests. Vibration tests can be used to show whether creep tests can be speeded up by using higher temperatures. If this could be done, it would be extremely valuable in enabling us to obtain results in a reasonable time, as one of the greatest difficulties with creep tests is their extreme slowness. The results of vibration tests may also be of practical importance in the use of wood for musical instruments, for instance, as sounding boards in pianos, although this is not the immediate aim of the tests.

Discussion:

1. Cellulose Liquid Relations

Mr. Clarke: Why not estimate intersection point from measurements made at 12 and 20 per cent.

Miss Kelsey: That may not always be satisfactory because if the intersection point is about 20 per cent., the curvature in the graph of shrinkage against moisture content near the intersection point would introduce errors in the estimate. For certain species from New Guinea which we have tested recently, the intersection point was about 17 per cent. The species concerned was Artocarpus.

Mr. Booth: Has the species with a 17 per cent. intersection point a normal total shrinkage and if so, what is its equilibrium moisture content? If its equilibrium moisture content is normal, it seems to be rather an abnormal kind of wood.

Miss Kelsey: The equilibrium moisture content and shrinkage were more or less normal. This apparent anomoly is probably explained by the fact that the intersection point is not necessarily related to the fibre saturation.

Mr. Wright: It would mean that if the intersection point and fibre saturation point were in relation, in many parts of New Guinea you would not get any shrinkage.

Mr. Kingston: It seems unlikely that they are related. I think most of the tests done overseas show that the total amount of moisture in the fibre is about 30 per cent. and by the time you get the fibre saturated, there is quite a lot of capillary water present as well.

2. Creep

Mr. Booth: Is it possible to explain the greater creep in beams than in compression specimens by the much lower shear modulus along than at an angle to the grain.

Mr. Kingston: Shear stresses in beams are fairly low. The shear modulus would come in in the initial strain but would not necessarily affect the creep.

Mr. Grossman: In our beam tests 4 point loading was used and the creep deformation was generally measured between the points of loading. Shear was thus excluded.

Mr. Kingston: We did take a few measurements over the whole span but the results were contradictory.

3. Moisture Weters

Mr. Booth: What progress has been made with moisture meter correction figures for impregnated timbers?

Mr. L. N. Clarke: Tests are in progress on timbers impregnated with boric acid and borax. We cannot yet say whether it will be possible to develop a moisture meter for this purpose. Resistance meters cannot be used as you can get very large errors at high moisture contents.

Mr. Huddleston: You cannot get a species correction for brush box, and samples have to be sent to Sydney for moisture tests. This is inconvenient and expensive and a moisture meter for brush box would be very helpful.

Mr. Wright: This question is even wider than our limit of 25 per cent. We have reason to believe that towards 40 per cent. resistance meters are reasonably reliable. We have done 30 to 40 tests on the ash group. The accuracy seems to be about \pm 2 per cent. moisture content.

Mr. S. A. Clarke: I don't believe that you can get a moisture meter to operate successfully to 40 per cent. under ordinary conditions.

Mr. Huddleston: I agree. We have tried it out on varying species and our recommendation today is that they cannot be used satisfactorily above about 25 per cent. moisture content.

Mr. Kingston: We find that errors up to ± 5 per cent. moisture content occur in the range between 25 and 40 per cent.

Mr. S. A. Clarke: I have been disturbed at the tendency to use moisture meters in the range up to 40 per cent. because I feel that there is a strong possibility that it will result in ruining their reputation.

Mr. Gottstein: I agree that the meter should be used with caution but it is still particularly useful. We also did some work with railway sleepers of river red gum and messmate. There is no doubt that the accuracy is worth while, if the meter is properly used. We are using it from 24 to 40 per cent. and it seems to be accurate within 5 per cent. Similarly, in drying ash, the higher range is particularly valuable and only an indication is needed.

Mr. Kingston: I agree with Mr. Gottstein. We have carried out tests at 25-40 per cent. moisture content and found a gradual rise in errors, with ± 5 per cent., even around the 50 per cent. range but it would be difficult to make people realize the limitations. Allowing for variation in species correction from piece to piece, we can probably only get ± 2 per cent. moisture content even below 25 per cent.

Mr. Huddleston: I am concerned about the development of recent moisture meters, because you cannot buy anything but an 8-40 per cent. meter. The previous model was fairly robust and could be

used in the field without undue care. The present model has to be handled with kid gloves, and we refuse to buy it. We are repairing our old meters. To extend the range, the manufacturers have sacrificed ruggedness.

Mr. L. N. Clarke: I couldn't comment on the relative fragility of the old and new meters without notice. I know the manufacturer makes the 8-40 meter in response to a definite demand.

ITEM 15 (a) BATTERY SEPARATOR VENEER - PRODUCTION FIGURES

(Presented by Mr. Hansen)

During 1952/53, 145,000 and during 1951/52, 198,000 motor vehicles, excluding motor cycles, were newly registered in Australia and during the July to December 1953 period a further 90,000 motor vehicles excluding motor cycles were newly registered. It would appear then that during 1955/54 the number of new registrations will exceed 180,000 and there appears to be no reason why this number shall not be maintained. If every registration has a 6 V 13 plate battery 1,800,000 sq.ft. of battery separators will be required. At 30th June, 1953, there were 1,691,000 motor vehicles excluding motor cycles registered. If every one of these vehicles replaces its battery once every 21 months there should be required approximately 966,000 new batteries, which will require 9,660,000 sq.ft. of separator veneer, 1.e., a total requirement of about 11½ million sq.ft. of veneer (less the requirements for a small number of motor vehicles which go out of use each year).

An increasing number of cars are using 12 V 9 plate batteries and the separator requirements for these are slightly higher than the 6 V 13 plate. Defence vehicles were not included in the above figures. In addition there are the requirements for motor cycles, aircraft, boats, home lighting plants, tractors, radios and caravans, so that an estimation of requirement of 12 million sq.ft. of veneer per annum would not be excessive.

^{*} The mamufacturer claims that the new instrument has been designed to avoid the faults of the old one and his maintenance sheets show that it is more trouble-free.

The highest rate of production yet achieved was in 51/52 when 9.2 million sq.ft. of veneer was produced. However, in recent months there has been an increase in the rate of production and if this rate is maintained 10.7 million sq.ft. per annum will be produced. Less than quarter of this production is from Australian grown timber, the rest being A. klinkii imported from New Guinea.

The recent increase is entirely due to the improved supply of A. klinkii flitches from New Guinea and should this supply again decrease a shortage of separators would develop. Although suppliers of flitches have given assurances that the volume of flitches will not decrease, circumstances beyond their control such as war, industrial trouble, shipping and change in the export policy of the New Guinea authorities, could bring this about.

In C.S.I.R.O. Bulletin No.271 the statement is made that P. radiata proved satisfactory as a battery separator timber in a life test and its suitability only needs confirmation on a commercial scale. The wooden separator industry has lost ground to the synthetic separator industry largely because of uncertainty of supply by the former, and this uncertainty has been due to erratic delivery of flitches. Most of the synthetic separators to date have been imported but there is one small factory which has been in operation for some time and another is nearing completion. I understand that these use and will use a high percentage of imported materials.

From the point of view of improving continuity of supplies of wooden separators to the manufacturers and from the point of view of conserving overseas' currency, and of being independent of overseas' supplies in the event of war, the tests to confirm the use of radiata should be carried out.

Discussion:

Mr. Kingston: Our laboratory tests on radiata did show it was a satisfactory timber for battery separators but this requires confirmation with service tests. I think the South Australian radiata is not mature in sufficient quantity for this use yet. I consider Mr. Hanson has underestimated the life of batteries. We discussed this point at a meeting of the S.A.A., with users and manufacturers, and the average life was thought to be $2\frac{1}{2}$ years.

Mr. Booth: The Forestry and Timber Bureau contacted us re doing commercial tests with radiata. We are having difficulty in obtaining flitches of sufficiently high quality but when they are obtained Amplex has offered to slice them for us.

Mr. Huddleston: Associated Batteries are agreeable to testing South Australian radiata but cannot get material.

Mr. S. A. Clarke: I suggest that we obtain some New Zealand radiata and carry out the necessary tests on that; there would be no difficulty in getting suitable flitches and results obtained would be applicable largely to South Australian radiata also.

Mr. Gordon: Although it is generally recognized that quarter cut separators give better service, at least two manufacturers have used peeled veneer and I suggest that peeled veneer be included in the tests.

Mr. S. A. Clarke: It would be desirable to carry out the tests on sliced veneer in the first instance and if they are successful, carry out further tests on rotary veneer. Service tests should be installed as soon as possible.

Mr. McAdam: Fibre glass and resins are likely to be used in Australia in the near future for separators; this would change the whole economic structure of the market.

We are concerned at the high specification required for battery separator flitches - this means low recovery and first class veneer logs have to be used. I feel there is room for laboratory work on the respective use of peeled and sliced klinki veneer.

Mr. L. N. Clarke: We did work on sliced and peeled klinki some years ago. The only reason we did not recommend peeled veneer was the high breakage rate - negligible breakage in sliced as against 50 per cent. breakage in peeled veneer. Mr. Crane: Battery separator manufacturers some few years back would not use peeled veneer - if they are going to have 50 per cent. breakage they would want to buy peeled veneer at half the price of the sliced veneer.

Mr. Jennings: There is probably more rotary kauri veneer being used in Queensland than is suspected. I was surprised at the quantity being shipped from North Queensland.

ITEM 15 (b) TIMBERS SUITABLE FOR PULPWOOD

(Presented by Mr. Hansen)

By adding Australian pulpwood production to the pulpwood equivalent of pulp and paper imports (converted by use of F.A.O. conversion figures) it has been possible to estimate the Australian consumption of pulpwood in terms of super feet. In 1950/51 Australian pulpwood production was 173 million s.ft. and pulpwood equivalent of pulp and paper imports was 500 million s.ft. giving an Australian pulpwood consumption equivalent to 673 million s.ft., or nearly 81 s.ft./capita. In 1951/52 Australian pulpwood production was 178 million s.ft., imports the equivalent of 673 million s.ft. giving a total pulpwood consumption equivalent to 851 million s.ft. or 99.6 s.ft./capita. In 1952/53 Australian pulpwood production was 244 million s.ft., imports were the equivalent of 316 million s.ft. giving a total pulpwood consumption equivalent to 560 million s.ft. or nearly 64 s.ft./capita.

1951/52 and 1952/53 were both abnormal years in that currency restrictions limited imports in 1951/52 and the build up of stocks during that period and their subsequent depletion in 1952/53 has had the effect of overstating consumption in 1951/52 and understating it in 1952/53. It appears therefore that the per capita consumption of wood in this form is slightly in excess of 80 s.ft. or about quarter of the consumption of sawn timber expressed as log volume.

The economics of growing forests are affected by whether small diameter logs can be disposed of at a price to give a nett return to the forest owner. The forester looks to the pulp industry to buy these small diameter logs. I have not seen many pulp mills but all of those I have seen with the exception of Cellulose in South Australia use a very high proportion of logs which are very suitable for sawmilling and would be regarded as an economic size by sawmillers. The various forest authorities in Australia have from time to time stated that our forests are being overcut and I have no reason to doubt those statements. At the same time, it is desirable that Australia becomes self-supporting in pulp and pulp products as soon as possible. There is probably at present spread over the forests of Australia, sufficient small sized trees to support a pulp industry large enough for Australian needs and good forestry practice requires their removal. Any extension of the pulp industry however, on present day standards would further accentuate the shortage of sawmill logs which will be felt to an increasing extent in Australia.

The sale of small material of plantation conifers is becoming increasingly difficult yet good forestry demands that this material be removed. The use of much of this material by the pulp industry is not possible at present because a pulp mill requires an input of about 50 million s.ft./year, and for various reasons our plantation areas are too scattered to yield this quantity in small sizes within an economic working radius of a pulp mill of present day economic size. Forest owners, if they want this small material utilized, must divert some of their sawmill log production to pulping in order to make up the quantity required.

There is an urgent need for research to be devoted towards the obtaining of a method of economically pulping small quantities of this material.

Discussion:

Mr. Huddleston: All Forest Services have the problem of utilization of small material but plantations generally have not reached the stage where they can maintain economic sawmilling units. We have trouble now in maintaining quota of timber to sawmillers and I think it would be a retrograde step to establish pulpmills to take high grade material from sawmills. It would be better to let the pulpwood go to waste and increase sawmill efficiency.

In the discussion which followed delegates agreed that Australia generally did not have sufficient of this type of material available within reasonable distance of any one location to make it economic to establish further pulpmills.

Mr. Crane: I would be interested to hear a statement as to the minimum amount of raw material necessary for the establishment of a pulpmill.

Mr. S. A. Clarke: For standard grades of pulp it does not pay to put in a pulpmill with a capacity of less than 100 tons of pulp a day. Cost of production in small plants is appreciably higher than in larger units.

Mr. Humphreys: Pulping for small plantations in New South Wales is not feasible and other methods should be tried of utilizing small material. It seems that we may be able to find effective uses for most of this from Tumut mill.

Mr. McAdam: Locality for pulpmills is limited to sites with good water supply and cheap power. I think there may be a future for using portable chippers in the forest, chipping material on the spot, baling and sending it to central pulp mills and we would appreciate the Utilization Section of the Division keeping us advised of developments along this line.

Mr. S. A. Clarke: Present indications are that the raw material available in Australia is mostly suitable for alkaline cooking requiring recovery plant and large units. If we had material for sulphite cooking smaller plants could be operated economically. Foresters should aim at concentrating plantings as much as possible. This would enormously simplify the waste problem and increase the value of the forest.

Mr. Grenning: We have endeavoured to locate our forests as near to the centres of use of sawn timber as possible. It would not be possible to concentrate all our forest, even if we desired to do so, because the land is not available.

Mr. Turnbull: We are now trying to live on the legacy from unplanned land use. It is impossible to remedy the present situation quickly. If dispersal of forest resources and allocation of supply among numerous small operators could have been prevented we might now have integrated industries. Very small pulpmills have not been economic anywhere in the world.

Mr. Huddleston: In Eden we have large areas of coast ash suitable for pulping. It could maintain a pulpmill of the Maryvale mill size for 80 years when regrowth would be available. We would be glad to see a mill located here.

Mr. S. A. Clarke: Australia is rapidly approaching the stage when it can supply its own pulp requirements, with the exception of material suitable for newsprint and some long fibred pulp for kraft products. The economics of small mills are more hopeful as long as the material is used in Australia and not exported.

ITEM 15 (c) PULPING OF NEW GUINEA TIMBERS

Investigations are being carried out to determine the pulping and papermaking properties of a number of New Guinea timber species considered as a possible source for the development of a paper industry. The results of the work to date indicate that good grade

^{*} Prepared by Division of Forest Products. This item was not presented at the Conference due to shortage of time.

pulps, some with very high strength properties, can be made from most of the species investigated using the sulphate process. However for this process a large and complicated plant is required, and in some areas the timber available for economic operation of such a plant may not be sufficient. Attention is therefore being paid to alternative pulping processes suitable for smaller scale operations.

1. Mangrove Species

The following species have been examined: - Bruguiera
gymnorrhiza, Camptostemon schultzii (trade name, tamagama),
Sonneratia acida, Exceecaria sp. Of these the first two are common species of the mangrove association.

Material from all four species pulped readily by the sulphate process using 17-18 per cent. total alkali. With the exception of <u>Bruguiera</u>, all gave pulps similar to those obtained from the eucalypt species used in south-eastern Australia for pulping. The pulp from <u>Bruguiera</u> showed a higher tearing strength than eucalypt pulps but its other strength properties were inferior.

The mangrove forest areas should be seriously considered as a possibility for sustaining a sulphate mill. Preliminary experiments on the species of the genus Rhizophora have given results similar to those of the other mangrove timbers and it should be possible to prepare a sulphate pulp from mixtures of the most common species.

The light-coloured low density timbers tamagama
(Camptostemon schultmii) and Excoecaria may be possibilities for the production of groundwood. However, before considering it as a source of groundwood, information is needed on the quantities available.

Semi-chemical pulping processes offer possibilities for the utilization of the mangroves. These processes give higher yields than the straight-our sulphate process. The plant cost is lower but the pulp is more restricted in its range of uses. Preliminary investigations using some of the most economical semi-chemical methods are planned.

2. Araucaria Areas

Two species, Araucaria klinkii and Araucaria cunninghamii, occur in the central highlands of New Guinea. Sawmilling and plywood operations involving these species are now planned for the Bulolo Valley. It is anticipated that in connection with these operations there will be quantities of material available from sawmill and veneer mill waste, also from tops and thinnings.

Virgin growth and plantation grown trees of both species were submitted for pulping investigations.

By the sulphate process both species gave good yields of high quality pulps which had exceptionally high tearing strength. Both species were similar in chemical composition and could be pulped under the same conditions.

Experiments were also carried out using the sulphite process as this process can be operated economically on a smaller scale than the sulphate process. Good yields of pulp were obtained but the tearing strength was reduced to a value below that of many short-fibred pulps.

As the quantity of waste material and thinnings from these two species has been estimated to be sufficient to provide only 9-10,000 tons of pulp per annum, serious consideration has to be given to the method of pulping. The important factor is the very high tearing strength obtained by the sulphate process. Attempts should be made to utilize this to advantage, and one possibility is in the manufacture of special grades of paper, e.g., stencil paper, where a high tearing strength is required; another possibility is to use the Araucaria pulp in a blend to improve the tearing resistance of a short-fibred pulp. Experiments carried out in the Division have shown that, when blended with cucalypt pulps, a greater improvement in tearing strength was obtained with the Araucaria pulps than with commercial long-fibred pulps usually employed for blending.

The pulp obtained by the sulphite process from these species had a very greatly reduced tearing strength. However this pulp had a low pentosan content which, together with the high yield obtained, indicates some possibilities as a dissolving pulp for rayon manufacture.

3. Eucalyptus deglupta areas

These areas are of interest from the pulping point of view because this species occurs in relatively pure stands, and, in addition, its rate of growth is such that in a relatively short time it may be possible to establish an industry using plantation grown material.

Pulps have been prepared from a number of trees of Eucalyptus deglupta by the sulphate process. The yields and pulp quality are very similar to those obtained commercially from eucalypts in south-eastern Australia, but the alkali requirements are slightly greater.

It is considered that this species might be suitable for the production of groundwood as its colour and density are similar to that of <u>Eucalyptus regnans</u>, the main groundwood species in Australia.

ITEM 15 (d) CARD SORTING IDENTIFICATION KEY

Dr. Dadswell: We get requests from time to time from a wide range of people for our card sorting key for the identification of the commercial timbers of Australia. In many cases those asking for the key are quite willing to purchase sets. Because of the limited number of sets available, we have to police these requests, and we do this in the case of those coming from New South Wales with the help of the Division of Wood Technology. The reason for the number of requests from New South Wales is that in that State courses in Wood Technology are given at technical schools. Our present policy is to let sets go out to various educational institutions and to firms where we can be assured that someone on the staff has had training in wood identification. The present position of our card sorting key is that we have distributed some 400 sets. We only planned to prepare 500.

This particular key needs a certain amount of revision. This seems to be the right time for such revision in that we are reaching the end of the distribution of the original set. I had in mind that we should now revise the key to cover not only the principal commercial timbers of Australia, but also the timbers used in Australia. This will mean including the imported timbers, particularly those coming from the Northern Hemisphere, Malaya and New Guinea. At this Conference I should like to have discussion on this aspect. Secondly, I thought that we would not be justified in using our staff to make up hundreds of sets for distribution to all and sundry. A possible way of getting over the problem is to follow the Princes Risborough idea and publish a booklet in which is given a facsimile of the card, front and back, a list of the timbers included, and the notchings for each of these timbers. Arrangements could then be made for a number of the cards to be printed and available for sale to anyone interested. If such a procedure were adopted people concerned in wood identification problems could arrange to get from us the booklet giving the information, to buy the cards they need, and to make up their own keys. Following such a procedure, however, the photographs of gross sections of each of the timbers would not be available. These photographs have been extremely useful in the last stages of identification when the structure of an unknown timber can be compared directly with the structure of several possible timbers, as shown in the photographs of these timbers. The problem can, I think, be overcome by having our photographs reproduced on special art paper and supplied with the booklet referred to above, in the nature of a supplement. Then everyone getting a booklet and a supplement could, after buying the cards, stick a photograph of each timber on the back of the card for that particular timber. These are our ideas for the revision of the card sorting key; delegates at this Conference may have something to say on the proposals put forward.

Mr. Huddleston: I thoroughly agree with all the suggestions. I think the key should be extended to cover all the timbers used in Australia rather than just Australian timbers. I don't think it is reasonable that you should be asked to prepare such an extensive card sorting key for distribution to all people who want them but who have no great claim for them. At the same time those people who want them and who could use them should be able to get them. The suggestions put forward by Dr. Dadswell are excellent. Possibly we could use an organization like the T.D.A. as a means of distributing them, and for those who are not satisfied with the type of paper for the photographs it may be possible to make available to them through a commercial photographer actual photographs which they could purchase.

Mr. Jennings: It seems to me the logical way to do it.
You cannot be expected to continue on the previous basis.

Mr. Chinner: I agree that it is an excellent suggestion, the cost is too much to expect the Division to keep distributing the key. I think we should record our appreciation of what has been done in the past.

Dr. Dadswell: It will take a long time of course to revise and we may have to write to the various States and ask for suggestions for timbers to be included. The same type of key could be extended to cover New Guinea species, and later perhaps timbers of other parts of the region. When Mr. Ingle was in the region he discussed card sorting keys and they were all in favour of this type of key; however they all had greatly different ideas of the features to be used and the magnification. Some of them use 20x, whereas we use 10x. We may have to include features for identification based on 20 magnifications. With supplementary features we could make it of wider application in the region; Indonesia, the Philippines, and Malaya are all interested.

Mr. Huddleston: As a practical application could we not forget the additional timbers which are to go in the key, publish the pamphlet or bulletin for the existing key, and then from time to

time issue supplements to that bulletin to cover the additional timbers available in Australia. The people having card sorting keys can arrange to buy the necessary cards and add them to the key. That is all that is necessary.

<u>Dr. Dadswell</u>: That is alright, but our greatest trouble is in the card itself. We don't want to lose the features which are on the present card but we may want to add to them.

Mr. Jennings: Lamson Paragon in Queensland would be quite happy to print the cards for you. They printed ours for us when we issued a modified key for the use of our officers.

Mr. Turnbull: I feel that we should exercise a little thought as to the number and size of cards printed. The cards are difficult to handle when a set contains a large number. Remembering how many timbers were included in the "Nomenclature of Imported Timbers", the set could become large. Perhaps subdivision by regions or on some other basis might be considered.

Mr. Chinner: On the question of printing the cards, would it be possible to get some advance indication of requirements of various departments?

Mr. S. A. Clarke: That is where Mr. Huddleston's suggestion is a good one. The T.D.A. could take a big block and beyond that the cost would be quite small.

TTEM 15 (e) DEVELOPMENTS IN THE EXTRACTION OF RUTIN *

There are two manufacturers extracting rutin from the leaves of E. macrorrhyncha in New South Wales. Both are producing basically for the American market, although some is now being exported to the United Kingdom. It is probable, however, that the greater part of this will find its way to the U.S.A. in the form of pharmaceutical products. One producer manufactured 20,315 lb. in 1953, while the other made 9,764 lb. of crude rutin. The method used for extraction is the same in both cases. The leaves are dried, finely ground and extracted with boiling water. The hot solution is filtered and allowed to crystallize

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

in large vats and tanks. The crude rutin is then filtered, and the mother liquors run to waste. The filter cake is then dried on trays. Recently, the larger manufacturer has installed a drying plant in the field, so as to increase the efficiency of field operations, which were formerly at the mercy of the weather, and which were difficult to organize efficiently, even during dry weather.

The yields from these plants do not appear to be in excess of 5 per cent., and are usually in the region of 5 per cent. from air dry leaf. Nothing is known of seasonal variation, the effect of drying, and little is known concerning leaf age or the effect of regenerating. The best sieve size for the subsequent industrial operations of the prepared material has not been established. The best method of extraction, particularly having in view the subsequent purification, is not known, neither are the optimum conditions for crystallization, where it is clear that a considerable amount of rutin is wasted. The development of a cheap method of purification would also appear to be of considerable advantage to the industry. A working plan has been written outlining the way in which we hope to tackle these problems. Preliminary work on this project has been mainly confined to investigating whether species other than E. macrorrhyncha contain commercial quantities of rutin in their leaves. Only single samples of most of the species listed below have been investigated; none of these has shown any rutin content at all.

E. wilkinsoniana, E. tindalae, E. robertsoni, E. botryoides, E. micrantha, E. yangoura, Melaleuca lineriifolia, M. styphelioides, M. alternifolia, Acacia glaucescens, Syncarpia laurifolia and Jacksonia scoparia.

However, the leaves of E. delegatensis (3 samples) showed a rutin content of 3.5, 3.8 and 4.0 per cent. (air dry basis). The samples were all obtained from the Batlow district. A sample of E. youmani which species was reported by Rodwell to contain a high percentage of rutin, was found to contain less than 1 per cent. The

tree from which these leaves were taken was grown at Pennant Hills, whereas the normal habitat for <u>E. youmani</u> is on the northern tablelands. This matter was not further investigated because northern tablelands foresters cannot locate any stands of <u>E. youmani</u> which can be worked economically.

Discussion:

Mr. Hillis: In this work the recovery of rutin is rather low, probably because the mother liquors are wasted. I think it would be worthwhile investigating the recovery of quercetin from the liquors after acid hydrolysis, as it is more insoluble in water and is easier to handle than rutin. It is used in the United States as an anti-oxidant for ediple fats.

Mr. Humphreys: This has been considered but the basic market has been for rutin. Anti-oxidants have not been tested because t the State Health Departments have insufficient biological facilities for the work. It seems however, as though anti-oxidants will come into use, especially quercetin, because of its probable lack of harmful biological effects. I hope to see both rutin and quercetin produced.

ITEM 15 (1) EXPERIMENTAL TURPENTINING OF PLANTATION GROWN PINUS CARIBAEA **

At the last Forest Products Research Conference, it was reported that a new turpentining experiment had been commenced at Banyabba. The results of the first season's work are to hand. They show that the experiment was successful in fulfilling its main aims, namely in practically doubling the yield and halving the labour cost in comparison with the previous experiment.

The bi-weekly bark chipping method with chemical stimulation was used. The stimulants were either a 2 per cent. aqueous solution of the sodium salt of 2,4-D or a 50 per cent. solution of sulphuric acid. Chipping two faces per tree, with acid stimulation, was also tried.

The results indicate that:

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

- 1. 2 per cent. 2,4-D, though it may stimulate gum flow as well as 50 per cent. sulphuric acid, can harmfully affect the tree.
- 2. The trees at Banyabba are too small to carry two faces. The extra gum obtained per tree by this treatment is out of proportion to the additional work involved.
- 3. A bi-weekly, bark chipping procedure with acid (50 per cent. sulphuric acid) stimulation yields a satisfactory emount of gum (200 g./face/fortnight). An estimate of the initial capital investment, cost of production, and rate of profit of commercial scale turpentining, on the basis of this yield, is given below.

During the present turpentining season, the experiment had to be stopped temporarily at the beginning of January because the severe drought on the North Coast had so weakened the trees that many of them showed signs of fungal attack. However, up to the time that the experiment was stopped, yields were about 20 per cent. better than those obtained during the corresponding period last season.

The figures quoted below should be taken as merely an indication of the costs of turpentining on a commercial scale.

Information regarding man-hour requirements was supplied by the United States Department of Agriculture. Freight costs are as quoted by the N.S.W. Department of Railways and the North Goast Steam Navigation Co. Ltd. The cost of cups and gutters is only an estimate. The value of the crude gum was calculated on the basis of the price paid for crude gum in the United States. The Royalty of 10 per cent. is an arbitrary one, as the Commission has not yet decided on the royalty. Cost of Gum Production, including Freight, to Sydney, Based on Chipping

50,000 Faces (Assuming an annual yield of 810 barrels, i.e. a yield of 200 g./face/fortnight)

- (1) Hanging of cups and gutters at 6 man days/1000 faces
- (2) Chipping at 800 faces/man/day (Assuming a 32 week season)
- (3) Dipping at 5 barrels/man/day

300 man days

1000 man days

162 man days

1462 man days

	1462 man days at wage of £13/10/0 per week (Allowing for holidays, annual leave, sick pay and wet-weather)		£5100.	0-	0
(4)			400.		
(5)		£305	200.		
	By boat between Grafton and Sydney	£1370			
	25 Personal distribution and by and	£1675	£1675.	0.	0
	(This figure can be considerably redu transport is so organized that large quantities only are shipped)	ced if			
(6)	Overheads		£1000.	0.	0
(7)	Depreciation Cups Truck Tools Shed	£500 200 5			
		£731	£731.	0.	0
(8)	Running expenses of truck (8000 miles)		£200.	0.	0
(9)	Royalty at 10 per cent. of value of crude gum	produced	£1150.	0.	0
			£10256.	0,	0
Init	tial Capital Outlay		_	-	_
(1)	Assuming a cost of 2/-/tree for cups, etc.	gutters	£500c.	0.	0
(2)	Truck		£1000.	0.	0
(3)	Shed (for storage)		£ 400.	0.	0
(4)	Tools		£ 100.		
			£6500.	0-	0
Retu	rn on Initial Capital Outlay		20000	0.	
Value of crude gum		£11,500.	0.	0	
Cost	The contract of the contract o		£10,256.		
			£ 1,244.	-	-
	Percentage return = $\frac{1244}{6500} \times \frac{100}{1}$	per c		90	

= 19 per cent.

Experimental Turpentining of Plantation Grown Pinus radiata

During the past year, the Division has been carrying out turpentining experiments on <u>Pinus radiata</u> at Murraguldrie, Carabost and Jenolan State Forests. As far as is known, <u>P. radiata</u> has not been turpentined on either a commercial or a full sized experimental scale before. From theoretical considerations, this species is not very suitable for turpentining. Its resin canals are both small in diameter and few in number and it appears to thrive in what, for N.S.W. conditions, must be considered colder regions. Nevertheless the Division decided to do these experiments, mainly because the plantations of <u>P. caribaea</u> which are, or will be suitable for turpentining are so small.

The two-entining was carried out according to the bi-weekly bark chipping method with chemical stimulation (either 50 per cent. sulphuric acid or 2 per cent. 2,4-D). The experiments have not yet been completed, but the results to date show that gum yields are well below those obtained from P. caribaea. It seems that it will be necessary to increase the chipping frequency, and possibly the depth of the streaks in order to obtain yields, approaching those obtained from P. caribaea. It remains to be seen whether turpentining, under such conditions, would be profitable.

No discussion.

ITEM 15 (g) STANDARDS

Mr. Turnbull: The Division of Forest Products has continued to collaborate with the Standards Association of Australia in the preparation of Australian standards. An active part has been taken in activities of committees and in preparing data for their consideration. Mr. Clarke is Chairman of Timber Industry Committee and its Executive - the steering committee for work on timber.

The position regarding various standards is briefly as follows:

Recently issued -

Revised A.S. 0.6 - Plywood for General Purposes

Int. 366 - Heavy Engineering Structural Materials

Int. 367 - Sleepers

Int. 370 - Adhesives for Fruit Case Labels

K.88 - Synthetic Resin Adhesives for Plywood

Ready for issue -

Int.328 - Roof Tilers' Ladders

Int.363 - Nomenclature of Imported Timbers

Proof issued receiving public critical review -

Doc. - FreshFruit Cases

Doc. - Cross-arms of Eastern Australian Hardwoods.

Committees have been dealing with specifications on

Flooring - revisions to conform with latest grades for sawn timber.

Radiata pine - series of grades to cover major sawn and
milled products. An interstate
conference of forestry and timber
interests has been held to resolve the
differences that had arisen in the
course of correspondence and discussions
in individual States.

Pre-committee work is at present proceeding on -

Terms and Definitions (A.S.O.1) - First draft revision has been prepared and circulated to forestry and a few other authorities. Comments are being returned. When all these are in hand a second draft will be prepared and be passed to a Sectional Committee.

Nomenclature - Little progress has been made with the revision due to staff losses at a time when preparation was made for considerable advance.

A.S. 0.56 - Revision is under consideration. CEBS is advocating the implementation of a loading code.

Sleepers - Queensland has conducted a field investigation and sent data to D.F.P. for analysis. Latter is almost complete. We hoped that results would be ready for reporting here, but a few weeks work has yet to be done. We desire to know whether New South Wales intends to carry out a field study. If so, a modified field sheet is recommended to be used.

Activities of Overseas Organizations

The F.A.O. is sponsoring the preparation of standard nomenclature and grades for timbers of the Asia-Pacific region. A Permanent Committee on Standardization and Utilization has been set up under the Asia-Pacific Forestry Commission, and various sub-committees have been working on the different branches of the subject. Progress was reported at a meeting of the Asia-Pacific Forestry Commission in Singapore in December, 1952. Continuation of activities was recommended towards standardizing (a) nomenclature to include species currently or potentially exportable; (b) grades for logs and (c) grades for sawn timber. The grades for logs have now reached the stage of a third draft based principally on North Borneo rules. Grades for sawn timber have advanced to second draft which has been circulated to the trade in Australia. Comment is slow coming in. Adequate comment is sarnestly desired.

Commonwealth Forestry Association - Resulting from an exchange of draft terms and definitions between British Commonwealth countries, Canada prepared a document for consideration at the Sixth British Commonwealth Forestry Conference. Compilation was then passed to the Empire Forestry Association. The latter has combined terms and definitions used in forest products research with forestry and utilization terms in their draft. This is now to hand in Australia and comment is invited.

Mr. Huddleston: We have carried out quite an extensive survey on sleepers. Field sheets have not been forwarded to the Division but about half the programme is complete and the other half will be completed in the near future. The delay has been occasioned by staff difficulties. It is too late to make alteration to field sheets now because half of these have already been filled in.

ITEM 15 (h) WOODEN CASE RESEARCH COMMITTEE

(Presented by Mr. A. Gordon)

Relatively few of the members of the Conference will be aware of the history and development of this Wooden Case Research Committee. A request that the Division re-enter the field of wooden case research to assist wooden case manufacturers of Australia in improving their products and retaining markets which had slumped fairly badly was made to Mr. Clarke by Mr. E. L. Aitken about two years ago. The Division had been quite active in wooden case research and in the testing and design of cases, virtually from its inception until about 1948 when, on account of lack of interest, in the immediate post-war period the project was closed down and the testing drum was lent to the Division of Wood Technology in New South Wales.

Mr. Clarke pointed out that we were reluctant to re-enter a field in which little interest had been shown, and would certainly not re-enter it unless some indication was given of some real and continued interest in the work. Subsequently an offer to subscribe £1000 for each of 2 years to sponsor the work was made, and towards the middle of last year I was asked to re-open the work in this field.

Two Forestry Departments, Sawmillers' Associations in Queensland, New South Wales and Victoria, Wooden Box and Case Mamufacturers' Organizations in New South Wales, Victoria, South Australia and Western Australia and hardwood agents in Victoria all subscribe to the wooden case research fund. To co-ordinate investigations with the wishes of subscribing organizations the Wooden Case Research Committee was set up and comprises Mr. S. A. Clarke

as Chairman, myself as Executive Officer, Messrs. G. F. Padbury,
E. L. Aitken and Mr. J. White representatives of the Wooden Packing
Case Manufacturers' Association of Victoria, some of whom act as
proxies for Interstate subscribers, Mr. R. T. Page of Softwood
Products Ltd. represents the S. A. Chamber of Manufacturers, the late
Mr. Jack Thomas represented the Victorian Sawmillers's Association and
Mr. F. C. White of Riverina Sawmills at Wagga represents the
Associated Country Sawmillers of New South Wales. A representative
for the Forestry Departments has not been finalized.

Meetings of the Committee are held at intervals of about 2 months and are relatively informal. Matters dealt with by the Committee are selection of work and allocation of priorities. The main activities undertaken to date are usage of wooden cases, investigations on cases for dried and fresh fruits and other export foodstuffs, assistance to the Department of Commerce and Agriculture in making reasonable interpretations of specifications for export cases, but at the same time ensuring that they are of a reasonably high standard, both as regards serviceability and appearance, proposals for the standardization of certain types of case, the development of a specification for a nailed wooden case for the transport of clothing for the Army, and adhesives and techniques for the labelling of export fruit cases.

Arising from the survey of the general usage of cases the following points immediately came to notice: - use of green or only partly seasoned rather than dry timber, inadequate nailing, ineffective use of wire or flat strapping, unsatisfactory thiskness and poor selection of shooks.

A request from the Department of Army for assistance in the development of a lightweight nailed case for transport of clothing revealed a gap in our knowledge of the comparative powers of Australian timbers of different densities and at different moisture contents to resist withdrawal of polished and cement coated nails

and led to the initiation of a comprehensive investigation by the Timber Mechanics Section to remedy this lack. A specification for a lightweight clothing case has been adopted by the Army and representatives of the three Services - Army, Navy and Air - have now agreed in principle to adopt this type of case for clothing when some minor differences have been settled.

Complaints concerning the unsatisfactory behaviour of badly stained and brittle shocks of radiata pine used in export fruit cases led to their rejection this year, whereas in past years they have been accepted when packers have made representations that shocks of better quality were not available. This has led to collaboration with Preservation and Timber Mechanics Sections with a view to carrying out some work to determine the effect of sapstain on the strength and brittleness of radiata pine.

The wooden case industry was concerned when nail manufacturers were turning to the use of drums rather than wooden cases for the transport of nails and investigations of the practices in this trade have been carried out with a view to improving performance of wooden cases. A number of recommendations made have been adopted with satisfactory results.

Observations have been continued on a project which was initiated before the wooden case research activity was taken up. This was an investigation commenced following representations by the Department of Commerce and Agriculture to the Standards Association of Australia seeking a standard for adhesives for attaching labels to cases for the export of fresh fruit. When we were asked to undertake this task the labelling was very poor. Investigations revealed that many of the adhesive failures were associated with the use of unseasoned timber and were commonly accompanied by severe mould growth obliterating much of any label still adhering. It was subsequently shown that with timber below 25 per cent. moisture content adhesives in common use were satisfactory, but in many instances labelling methods

were pitiful and in any case rough surfaces on case ends are not conducive to good adhesion. Advice on these points was given to the Department of Commerce and Agriculture and the Standards Association of Australia, the former circularizing inspectors and packing sheds with copies of the S.A.A. Int. 370 - Adhesives for Fruit Case Labels - and our recommendations for labelling techniques. I have pleasure in reporting that labelling of export fruit cases is considerably improved this year.

One of the main problems which has been encountered is complaints associated with shocks produced from small diameter logs, chiefly Pinus radiata. This material, if I may be permitted to make a sweeping statement, would be alright if it were heavier, (low density, as pointed out this morning by Mr. Boyd, being accompanied by low mechanical strength) and free from defects. However, the strength of many low density shocks is further reduced by the presence of spiral grain, wide pith streaks, and knots especially butterfly knots. Another point not fully recognized is the very poor nail holding power of low density material especially if nailed when green. This was one of the factors leading to my representations for nail holding tests to be carried out. I have endeavoured to make case manufacturers insist on material dried to moisture contents below 18 per cent. and have tried to get them to adopt anti-sapstain dipps or sprays and better drying practices.

Interstate it was interesting to note that in Sydney the wooden case manufacturers are again looking to overseas timber partly because it is available in larger sizes and longer lengths but also because the price is competitive, perhaps not in the raw material, but certainly in the finished work. Hemlock and New Zealand radiata pine are being used fairly extensively, the former being slightly cheaper.

No discussion.

ITEM 15 (i) BUILDING RESEARCH LIAISON SERVICE

Mr. Banks: I am indebted to Mr. Clarke for this opportunity of once again speaking at one of your periodical Forest Products Research Conferences.

Although the work of the Liaison Service has not brought us into frequent contact with many of you we have at least one very important interest in common, namely to encourage the wise and economical use of our timber resources in building. For this reason I believe you should know what we are doing. There may be scope for more co-operation between us.

As you know, it is the job of the Liaison Service to try and awaken the building industry generally to an active interest in the results of research - to help the practical man to make intelligent use of the information he can obtain from a number of sources including the organizations represented here.

As with all extension work, our activity calls for persistence and ingenuity. Whether we are persistent enough or ingenious enough I am unable to judge. However, since I last addressed you in November, 1952, we have covered a lot of ground and I believe that a fair proportion of the seeds we have sown have taken root.

At your last Conference I mentioned our lecture programme which started in August 1952. To date we have addressed 87 audiences totalling more than 4,000 persons in the six States and the Capital Territory. Included among these talks is one prepared by the Division of Forest Products and illustrated by a series of excellent coloured slides describing the work of the Division. These slides have been seen by nearly 2,250 people including builders, students of architecture, building construction and civil engineering, as well as by professional officers of the Department of Works. In every instance, the talk has aroused keen interest and in several cases locally, visits to the Division have resulted. In giving these talks we always mention

the existence of State timber research organizations to which builders can refer their local problems.

We are continuing to use the written word as a reliable medium for disseminating research information. In collaboration with the Division articles have been published recently in the building press in all States on such subjects as the care of seasoned timber on building sites, damp in building, the <u>Lyctus</u> borer, termite prevention, preservation of paling fences. In addition, wide circulation has been given to issues in the Notes on the Science of Building series dealing with Termite Prevention in Buildings and Borers.

We also try to keep in touch with the practical use of research results on the job and during the past year have observed the progress of a number of interesting projects using the light-weight hardwood timber roof trusses designed and tested by the Commonwealth Experimental Building Station. A series of coloured slides is being made of one project for illustrating talks to builders on the production and use of these trusses. As you are aware, this type of roof construction makes possible a saving of over 40 per cent. of the hardwood timber used in the normal rafter type of roof. In every case we have been in touch with there has also been a worthwhile saving in labour.

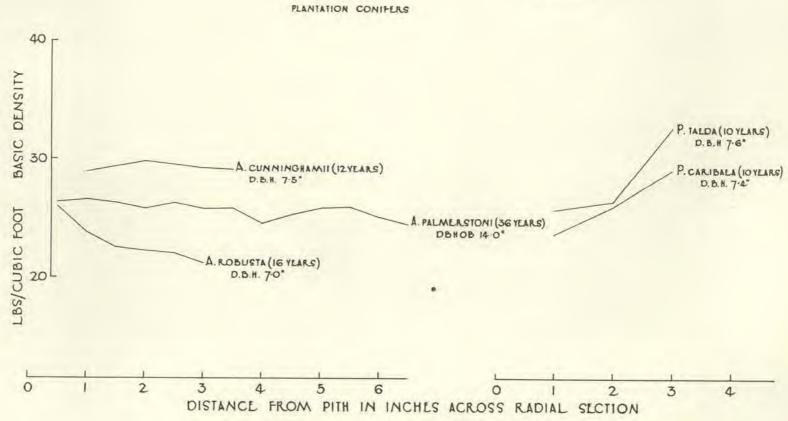
An illustrated talk has been prepared on Damp in Buildings in which we have used material provided by the Division illustrating the rapid decay of timber in buildings where inadequate precautions have been taken against the ingress of moisture.

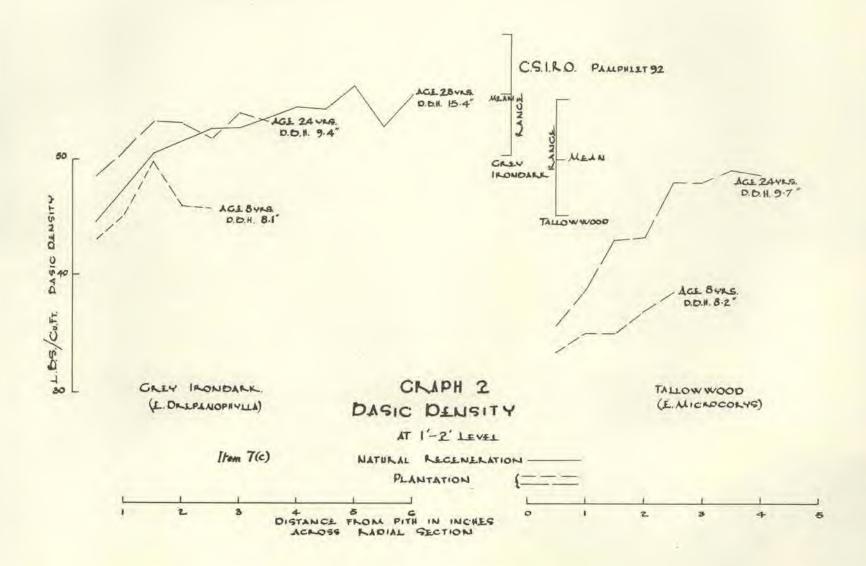
With the recent filling of a vacancy on our staff by an experienced and qualified architect we hope to develop the practical side of our work more widely and we shall welcome opportunities to work in co-operation with your organizations on building projects wherever this can be of mutual benefit.

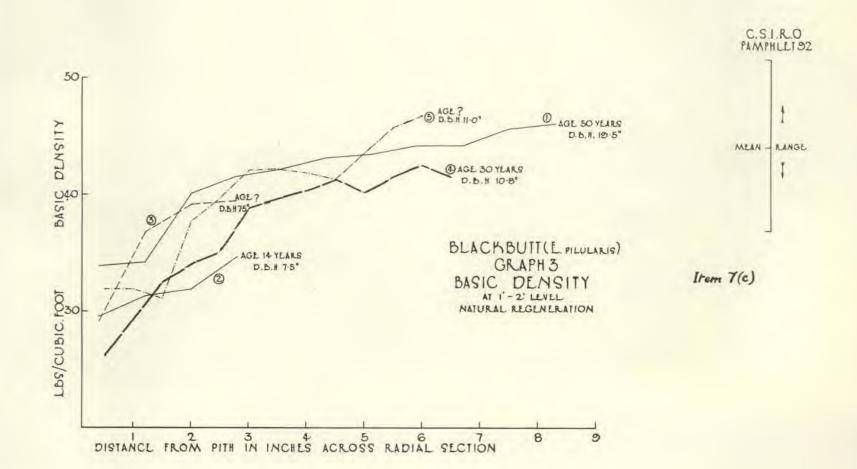
No discussion.

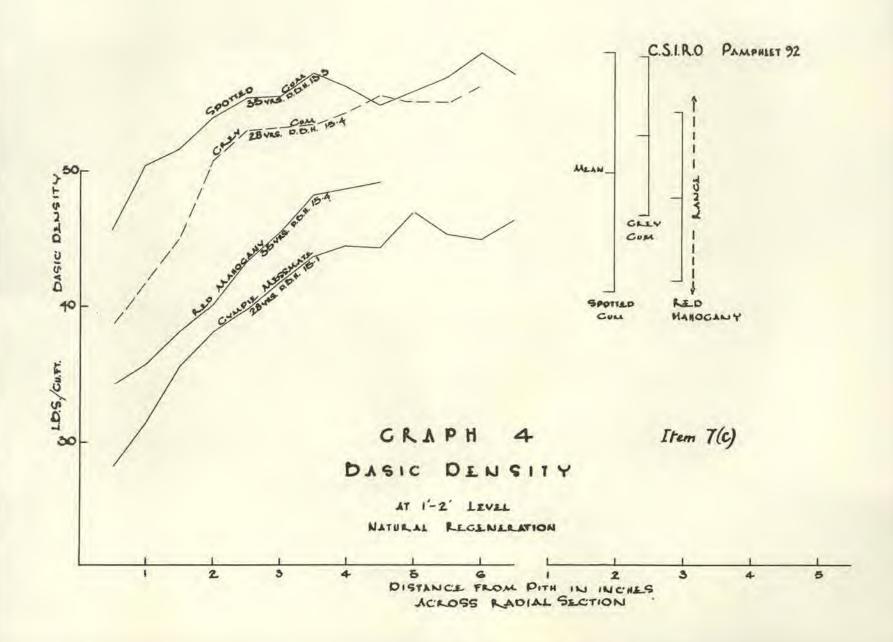


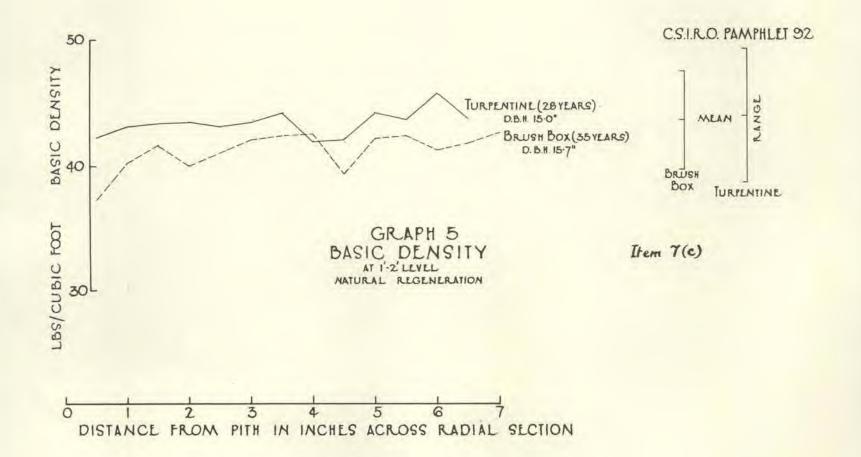
Irem 7(c)

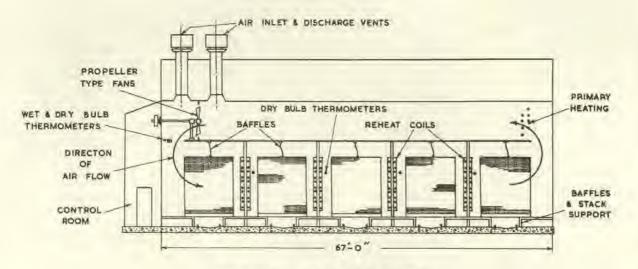




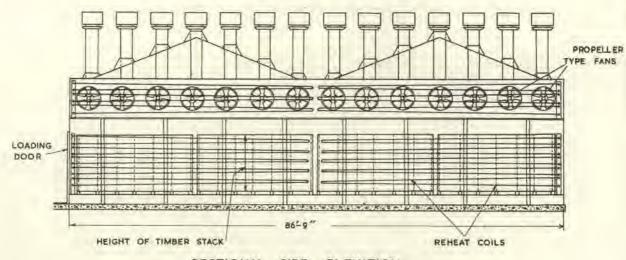








SECTIONAL FRONT ELEVATION



SECTIONAL SIDE ELEVATION

FIG. 1. SKETCH OF 5 LINE PRE - DRIER SHOWING PRINCIPAL EQUIPMENT

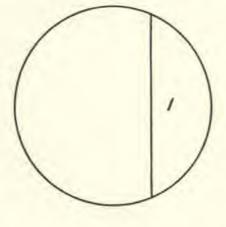
Girth Class

Breakdown Pattern

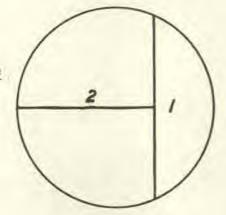
Remarks

-50" CGUB

Lower range



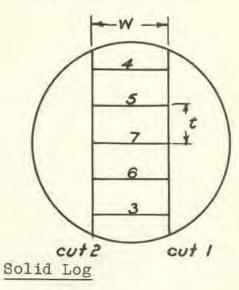
Upper range



Spring in these small logs coupled with the general small flitch size makes further sawing impractical. Heart is generally small and is sawn up in normal sawing schedules, but excessive defect could be treated by the centre flitch method as outlined for the group below. Where long lengths are required and spring is troublesome, a technique of holding the log by the rear end only and allowing the head end to spring seems to be most effective and prevents the centre of the log from bowing into the saw.

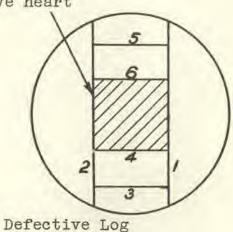
ITEM 12(a)

50" - 80" CGUB Solid logs or reasonable defect

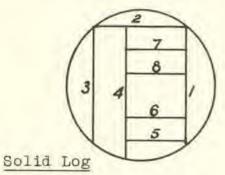


Cuts 1 and 2 are sawn
parallel by log rotation
through 180°. The width
W depends on pipe defect,
sawn product and sawing
schedule. For backsawn
material W is a multiple
of product width and t
a multiple of product
thickness and for quartersawn material a vice
versa arrangement

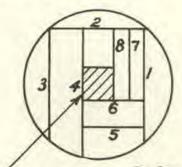
Defective heart



80 + CGUB Solid logs or reasonable defect



Logs of this girth are not particularly susceptible to spring and breakdown patterns are therefore not as critical as for the smaller logs

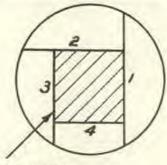


Flitch thicknesses and widths again depend on the sawing schedule i.e. back or quarter

Defective heart

Defective Log

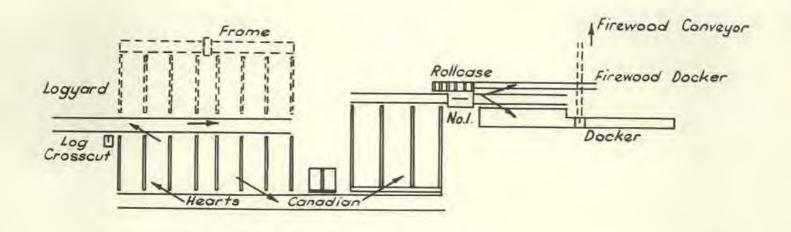
Very defective logs

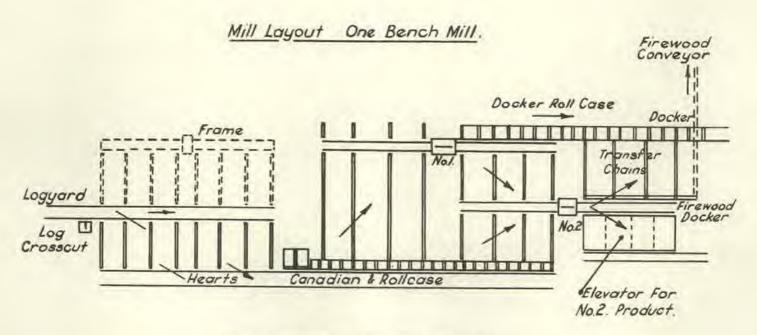


It is unlikely that sufficient flitch depth exists for further sawing, the pattern merely serving to box out the heart

Defective heart

ITEM 12(a)

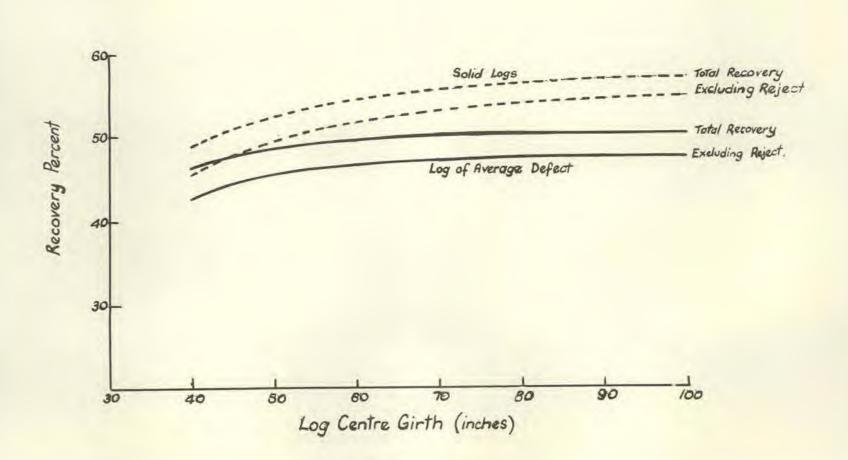




Mill Layout Two Bench Mill

Fig. 1 The Influence of Log Centre Girth on Percentage Recovery related To G.H.V.

Item 12(b)



FigII The Influence of Log Centre Girth on Rate of Production S.F.S.S. per Man Hour.

Item 12(b)

