CONVENTION PROCEEDINGS

THE PROCEEDINGS OF THE BWPDA CONVENTION, HELD AT THE CHESFORD GRANGE HOTEL WARWICK
18TH TO 19TH JUNE 1997

British Wood Preserving and Damp-proofing Association • BWPDA

97

The Proceedings of
The BWPDA Convention
Chesford Grange Hotel Warwick
June 1997

THE BRITISH WOOD PRESERVING & DAMP-PROOFING ASSOCIATION

Published by The British Wood Preserving & Damp-proofing Association
6 The Office Village, 4 Romford Road, Stratford, London E15 4EA.
Telephone: 0181 519 2588
February 1999

Contents

The President's Opening Remarks

Dr F. W. Brooks, BSc, PhD, President of the BWPDA

For the second time it is my pleasure to welcome you and open our BWPDA Annual Convention. This year is the 48th assembly and the organising committee has continued the recent policy of introducing new ideas while, at the same time, retaining the character of the presentations which do much to maintain the reputation of the Association as a learned society.

At the end of 1996 the BWPDA became a Trade Association and so is free to become involved in more commercial activities than was possible with the old charitable status. We will hear about some of these developments particularly in relation to the Remedial Contractors Section shortly. The charitable activities continue, largely devoted to educational aspects of the Association and it is in these areas that our Convention, this year, will again concentrate.

Last year I commented that numbers attending the Convention had declined steadily over the years from 200 delegates some 10 years ago to 120 last year and the new ideas were intended to halt this decline. This year we have about the same number attending but more appear to be attending for the formal sessions and not just coming for the final Dinner.

I believe we have a good programme of presentations which follows the style introduced last year and, this year, includes:

* reports on wood preservation in other countries - Ireland and South Africa.

* our annual paper from BRE, this time in their new livery of BRE Ltd., and seasoned commercial campaigners will be looking for any changes in style from Janice Carey to reflect this change of status.

* papers on environmental issues. It is a feature of our industry that there is no shortage of variety of subjects that can be covered under the "environmental" heading. This year we are concentrating on environmental law and the new Environment Agency.

* Last year we had two fascinating papers of general timber interest - the restoration of the Research Ship Discovery and the building of the New Globe Theatre. We thought how we could continue this general interest theme and I believe we have two equally interesting subjects this year - windmills and innovative timber structures.

Our new ideas this year are to have parallel sessions on highly specialised subjects. Dry rot control and wall ties were chosen as being suitable subjects which we hoped would attract more members from the remedial treatment side of the Association. Interest has been created by these and we hope they are useful to those members attending tomorrow.

One new initiative which we tried, but failed to achieve, this year was the attempt to have a "wood preservation exhibition" running alongside the Convention, and it was for that reason that this particular hotel was chosen. Sadly insufficient numbers of companies agreed to exhibit to make it financially viable and so, on this occasion, the plan was shelved. It is possible that we did not start planning sufficiently early so are cavassing opinions again for next year.

With that introduction we can now start on the details and so I have pleasure in welcoming you and declaring the 48th Convention of the BWPDA open.

Our first item as for the last 2 years is to give you a review of the activities of the Association as highlighted by the various conirnittee chairmen.

One consequence of the change from the old BWPDA Charity to the new structure of the Institute of Wood Preserving and Damp-proofiong (IWPD) and the BWPDA, now established as a Trade Association, is that the committee structure has changed to reflect the individual sectional interests of the membership. We now have 4 sections and the chairman for these are:

Remedial Installers - Alan Checkett; Manufacturers and Formulators - Justin Worringham; Associates - Chris George
Pretreaters - *pro tem* Dr Brooks

Much of the work of the Association crosses the individual sections and we have two Standing Committees which deal with Technical and Environmental issues and the current chairmen of these are Andy Saunders and Mike Connell.

After that Chris Coggins will give his Director's report to complete the session.

[*Editor's note: the details of these informal reports by Section Chairmen are not included in the proceedings*].

The EWPM

by Jean-Brice Simonin, President, EWPM Group

97

To be or not to be?

That was the question asked by Mr. WATSON and Dr. METZNER to the 13 attendants (Alliot, Bick, Böhmann, Chambers, Björn Jensen, Hilditch, Joergen Jensen, Dr.Lenz, Mathieu, Dr. Metzner, Miss Riman, Reydel, Watson) representing 6 companies from 4 countries and the BWPA at the meeting held the Friday 29 th July 1977 in London (Charing Cross Hotel).

Reason for this meeting was the wish / the need to establish a liaison between the manufacturers to promote communication on environmental and homologation matters. This point was agreed and after some further discussions and meetings the European Wood Preservatives Manufacturers Group (EWPM) was founded.

At the beginning the need of communication was identified by Mr. Watson and Dr Metzner formally at a FAO meeting in Rome. At that time European Directives began to be applied (67/548 on labelling of substances for example) and the pressure of national legislation or approval schemes was increasing. Reciprocal information and later on common action should help the companies to develop their business without stringent or unreasonable limitations.

The EWPM is grateful for its first president Mr Bick who chaired the new organisation until 1985 and so permit it to take its place in the world of the European Wood Preservation.

From the beginning also a link exists with the BWPDA, who assumes the secretariat of the group, at first provisionally for 2 years but was prolonged until today.

As you listen from the first attendancy EWPM is a small group. The participation was voluntary reduced to the manufacturers who have European wide activities and be able to represent their countries or national associations.

EWPM established in an earlier stage formal or informal links with organisations playing a role at European level.
So collaboration scheme was established with the European Homologation Committee and for a lot of years a representative of EHC attended our meetings and reciprocally, what permitted a fruitful collaboration. A major piece of the to day existing European Standards is EN 599. This standard is based on the pass fail criteria which were established by EHC with the collaboration of EWPM during the 80's.

EWPM received a status of observer by the CEN / TC 38 which deals with wood durability.

Other collaboration was established with older organisations as CEPE with whom an overlapping of activities already exists , what is particularly visible in Denmark where the national representation of the wood preservatives manufacturers is made by the paint makers association.

An other informal link exists with WEI, an association representing an important part of our industrial customers.
These existing links show clearly that in our complicated modern world it is impossible to live alone.

A second feature is that EWPM always tries to represent the interests of the wood preservatives manufacturers and many times discussions occur on how to make the best balance between the representation of our specific problems and the advantages to be included in a powerful but larger organisation. The members always decided to keep our independency to prevent any dilution of our own problems.

But what are our own problems? What is our specificity?

In few words, wood preservative manufacturers come from the chemical industry , handle biocides, sell their production to companies coming from the wood working sector and their products are mixed or introduced in a biological material, the wood. This material is often used for constructional purposes with a service life expressed at least in years, if not in decades.
A lot of activities may also shown specificity including one or more of these points. As we are alone to present the whole constellation, it is a cause for understanding difficulties and specific requirements.
We produce with a simple technology (mixing of materials) but the development of products is quite so complicated and long as a pesticide or a medicament. We have to protect the wood against deterioration for a long time, but our products should present a rapid biodegradation when removed from the wood.

As a wider lot of national or European bodies showed more and more interest in regulating or guiding wood preservation, the need for common action increased with the time and EWPM prepared some papers or initiated some tests. I have cited an example with the pass fail criteria shortly before, but other actions was conducted in the past on ageing procedures or fungal testing.

In front of the increased need for action, EWPM at the beginning of 90's modified its' statutes.

One important reason for this moving to an association with direct membership of companies at european level, instead of through a national representation, was:
the European level is the right one today for the establishment of a policy and the national becomes more and more an handling level.
The idea was to facilitate the finding of the true common interest despite the national or regional differences.

I have to confess that my own experience in european standardisation shows me how far the possible mode of application of wood preservation, as they are used in the different European countries, are able to hide the unity of the scientific knowledge.

That modification was also completed with a political decision for opening the membership to a larger extent, single companies instead of associations, extension to A.I. suppliers involved in wood preservation.

The need for further communication and increased representativity was taken into account by creating an associate membership for organisations interested or acting in the field of wood preservation.

The aim to insure the credibility of our industry was emphasized by the ethical assumption to promote the correct use of wood preservatives, as described in Art. 2 of the statutes.

After these statutes were adopted, I was elected as president of this association. So after more than 6 years as president, I am in the best position to appreciate how far the objectives addressed have been obtained.

EWPM works on long term interests and it is a pleasure to see how in our meetings the sense for common action and preparation for the future increased attendance despite the pressure of work for individuals.

Despite growth in membership since the beginning of EWPM, we are reaching now 23 companies members from 10 countries with 4 associated members from 4 countries, we remain a little association with few human and financial resources.

The reasons are that our members are normally SME´s or only a small part of the activity of bigger companies. We are active on an economical sector of main importance (Wood utilisation) but also mainly formed of SME´s with relatively little individual economical weight. Our association is younger than the national representations who become larger contributions of their members. Our human resources are those from our members so far as they are available.

Despite the apparent lack of means we are able to represent actively our activity at european level either in standardisation matters or in regulation matters.

From the organisations point of view, the association is directed by the president with an executive committee submitted to the general assembly who meets once a year. They are supported by the secretariat who is at BWPDA as previously mentioned.

Two permanent working groups deal more precisely with technical matters:

WG 1 deals with standardisation matters, contributing largely to a reciprocal understanding of the particular (national or individual) positions, aiming also to identify the long term needs for our members. It was certainly helpful to facilitate the establishment of compromises in the CEN / TC 38 activities, in the time where the manufacturers invested largely in the CEN / TC 38 working groups elaborating CEN standards for the purpose of the application of the Construction Products Directive.

The investment in these standards aiming to contribute to the improvement of the common market shows how important our industry views European development. But to day the return on the investment is not seen because the standing committee of CPD did not at present recognise wood preservatives as construction products and a unified scheme for technical approval throughout Europe remains a wish.

In any case activity remains needed in standardisation coming from some activities where a progress in standardisation will contribute to a consolidation of the European market. For example new techniques or products arise, needing adaptation of the existing test tools, and also to avoid some overstandardisation increasing the costs without benefit either for the producer nor for the consumer in return.

WG 2 deals with health, safety and environmental matters. At present the main activity is conducted in this WG, particularly because the development of the Biocidal Products Directive.

This general piece of legislation aims to establish a general and unified system of authorization to put a product into the market in Europe, with a high degree of security for man and the environment. The improvement and discussion of this piece of legislation with the European authorities takes place under the umbrella of CEFIC, the European Confederation of Chemical Associations, because 22 other types of biocidal products are also concerned with.

In principle our industry supports such legislation whose aim is in accordance with our ethics. We have to consider that at present each country in Europe has an authorization or approval scheme for wood preservatives, often coupled with a technical approval, so that the progress to be awaited from the Directive goes mainly in the mutual recognition foreseen between the countries. We try also to avoid excessive requirements not only to avoid suffering of animals as written in the draft directive, but also because dramatically increasing requirements will have a detrimental affect on our activity in a first stage and as a consequence on our customer activities by replacement of wood by plastic, metal or concrete depending on the commodity.

The ability of such legislation to stifle innovation is also not to be underestimated.

Further work is ongoing for the next implementation for which we are collecting data and preparing positions to be debated with the competent authorities.

A second piece of legislation, the so called VOC Directive asks also for participation of our industry which was also done under the umbrella of CEFIC. We had for example the task to present data to the Commission to avoid a high level of charges for our customer in the countries where the treatment with LOSP is usual. In one other country we had to demonstrate that the requirements in the draft proposal conducted to the paradoxal situation to penalize the installations with few solvent emanations.

This directive draft is recently published and is in the beginning of the discussion with the Parliament. The experience from the previous text shows that presentation and explanation to not specialised parliamentarians is a very difficult task, what we are unable to conduct alone.

I hope this short description shows sufficiently which challenge our profession is facing for survival in the next century for the benefit of the use of the alone renewable construction material we have, the wood.

So far I hope now the EWPM for you does not mean: much ado about nothing

Sustainability: can we still achieve it?

by Christopher L Wallis, C. Eng. M.I.C.E., M.I.O.C. Christopher Wallis Engineering

I speak as an outsider, one of your potential customers, an engineering woodworker, who makes things out of timber, supplied and treated with preservative by others. This is my short appraisal of things as they are now, and as I still hope they might be in the future, followed by a few slides to illustrate the sort of work I do.

Our country is no longer a powerful manufacturing and trading nation with colonies to provide cheap raw materials, so we need to consider using the sustainable assets we already have as raw materials. We have also lost the ability to work together as a unified population, possibly because of the end of the real or perceived 'cold war'.

Some of us are good at making money out of money, an activity which is supposed to benefit us all, but actually only makes a few rich. Our kind of democracy encourages us to aspire to live extravagantly with only a modicum of work, and we end up dreaming a fantasy life.

Even so, as a nation we still have a moral and physical influence, and we could be world leaders in sustainability and appropriate production. This can only be achieved if we change our attitude to work. The psychology of work is very complicated. It is sufficient here to say that efficient workers will generally be happy, or put the other way round: unhappy workers will be inefficient.

Our social and educational customs encourage us to learn, so that we can have a good job, where 'good' means 'well-paid', with status, but not necessarily interesting, emotionally rewarding or physically challenging.

School leavers without any academic qualifications are considered to have 'failed' and are condemned to a physical job, or none. The old adage 'that child has got no brains, but will make a good dustman', is far from true. Of course dustmen have brains. If in the past they had felt confident enough to use them, they would have forced the introduction of collection bins with separate compartments, for total recycling, fifty years ago. Apart from office jobs, most work requires some sort of physical activity, which, if not properly co-ordinated, will at best be inefficient, and at worst a disaster.

Babies start their education immediately at birth; they watch and imitate, which should be encouraged at every opportunity. Parents tend to restrict their childrens' early activity, because it is too 'dirty' or 'dangerous'. Instead, they occupy them in front of the television: ; a stultifying experience at any age. Children should be kept away from TV.

'Formal' education is (or should be) opening windows of choice and is supposed to end at sixteen or eighteen years. Real education continues throughout life, until the brain finally gives up. Watching people at work is a way for children and young people to find out about jobs. Nowadays there are fewer people visibly working, because they are hidden behind solid safety walls and locked gates. Formal apprenticeships are almost extinct and many jobs have been de-skilled to the level of pushing a button. Where can a child get inspiration? Schools have stopped teaching woodwork and metal work. Real tools, machines and work benches have been replaced by craft tools, sticks, cardboard and little tables, which children use for their Design Technology courses. All this is only appropriate when there is already a good understanding of how to make things, so that a practical problem can be fully understood, and solved with a practical working method.

Computer-aided Design is no substitute for drawing with pencil on paper. Conventional drawing gives the worker time to think about how the job will be built, assembled, and perform in its proposed situation. The computer cannot do this. It can only check details against pre-determined specifications. If, as often happens, the person who is using the computer, has set the specifications wrongly, the end result will be a design for a non-functioning end product.

Finally, it is incredible that those with most practical experience, say in their mid-fifties, are being replaced by less experienced, cheaper staff.

'Sustainability' could be defined as supplying our present needs without jeopardising the needs of those who will succeed us. Surely this is best undertaken by those with most experience. Our materials must be sustainable. Wood is our working material. It is beautiful and has different mechanical properties when loaded in different directions to the axis of the tree. It grows in all shapes and sizes and can be used in an infinite variety of ways for infinite uses. It is easy to work either with hand tools or with machine tools and is therefore very adaptable.

All parts of most trees could be used beneficially if we adopted an environmentally sound approach to our use of timber. It is ridiculous always to convert straight tree trunk poles into rectangular scantlings or fence posts. The tree is immensely strong in bending and axial loading when it retains its complete fibre structure, excluding only the bark. We should seriously consider producing structures made of stripped poles treated with preservative.

Many of Britain's trees grow naturally curved branches, ranging from extreme elbows to gentle bows. If these were properly harvested and dried, they could be used to yield the curved members which industry at present wastefully cuts from straight grained clear slabs. The industrial method produces very fragile members, which break across the shortest fibres. Broken members in turn give wood a bad reputation with the customers who do not understand that the method was at fault, rather than the material.

Timber is the only major structural material which is sustainable, i.e. it can be grown as and when we require it. We can grow excellent softwood and hardwood in this country, yet our imports of timber cause one of our largest trade deficits, about £15 billion every year. Although we have many large softwood forests, very little of the timber in them is used for structures. Most of it ends up as fence posts or as paper pulp.

Our hardwoods are slow to grow and take a very long time to dry. I do not understand why the public prefers tropical hardwoods with uniform texture and hardly any figure, when indigenous British hardwoods have wonderful colour and figure. There is at present no commercial incentive to grow more of them, so our hardwoods are gradually being depleted, as trees come to the end of their lives, are felled and are not replaced.

An enthusiastic member of the Environment Agency (Thames Region) has written a cogent report on our need to use more oak commercially, so that there would in turn be more oak grown to satisfy this need. So far the National Environment Agency shows no sign of accepting the writer's proposition.

Our timber products would be more interesting and better quality if we were content to wait until the wood was properly dry after felling and conversion into slabs and scantlings. But it seems that we don't want our timber products to be good and lasting because of fashion.

Fashion is iniquitous. It causes junk products and a throwaway attitude throughout society. It is totally alien to good and lasting design, and the concept of preservation, timber preservation. During the thirty seven years I have lived in High Wycombe, I have seen the local furniture industry, whose raw material used to come from the beech woods of the Chiltern Hills, vanish in a cloud of chipboard and MDF.

We have reached the stage where we have enough of everything, and we only need mass production to satisfy our craving for fashion and for throwing things away. The majority of massproduced objects are ephemeral. They have no intrinsic value, such that they are really well designed and made, look good, function well and last indefinitely through generations of owners.

The argument against making quality products is that we must have volume production to keep the factories running economically. But in modern workshops, staff have more and more been replaced by automated machines. All the eggs are in a 'global capital basket', which someone else drops, leaving no work and no factory.

At present the outlook in the timber industry is fairly dismal. The good designs that TRADA was promoting in the 60's have been replaced by poor CAD details. Every week our phone rings with offers of a 'new kitchen' made of chipboard, or new windows and doors, made of plastic. Yet anyone who visits a council tip can see people bringing their discarded, out of fashion kitchen cupboards or window frames and doors to throw away. On the edge of any large town we can see superstores built in fields. Their buildings are trimmed with wood to make them look falsely traditional. Another familiar use of timber is in housing estates where each house has some non-functional mock tudor beams applied to the front elevation. Whither the shell roofs and timber trusses which we tested at Tylers Green? There is definitely a lack of ability to conceive proper and exciting timber structures.

As providers, preservers and users of timber we should aim for the following:

1 More forests growing poles and big trees for structures.

2 Educate the public to stop wasting the small parts of trees.

3 Encourage the re-establishment of more local timber mills, instead of concentrating all the supply in large, inflexible ones.

4 Use old farm and industrial buildings as cheaper, more widespread local workshops. This is a better use of such buildings, which still exist in large numbers, than converting them to homes, whence architecture is lost.

5 Re-establish proper woodworking and engineering shops in schools, with real design and drawing.

6 Simplify regulations, so that apprenticeships can be provided by small workshops, where apprentices can gain far more experience.

7 Wake up TRADA to nurture simple but good design with some architectural embellishment.

8 Encourage larger timber structures by improving transport regulations for moving long, light loads.

9 Lengthen pressure preserving cylinders to 100 feet, possibly increase the diameter too. Why not have a moveable diaphragm at mid-point, so that pressure cylinders could be used either in two 50 foot lengths or in one 100 foot length?

Timber Preservation in South Africa

By Angus Currie Executive Director South African Wood Preservers Association, SAWPA

This Association was formed in 1980 but it was only some 6 years ago that full time staff was appointed to take on the main object of the Association which is the promotion of timber treatment and treated timber products.

Typically, treated timber in South Africa is used for:

Accommodation in Game Reserves

Pole Structures

Decks

Transmission Poles

Playground Equipment

Outdoor Living

Housing

Shopping Malls

Members of SAWPA:

Timber treaters fall into three distinct categories. The first is Sawmillers, the second is Builders' Merchants and the third is Pole Treaters.

There are a half a dozen organisations involved in manufacturing and distributing chemicals to treaters in South Africa. They are expected by the treater to be not only a chemical supplier but also a wealth of knowledge about all matters relating to timber treatment.

We have a number of organisations which are interested in our activities that are members of our Association - organisations such as large customers for poles i.e. our Electricity Supply Commission and our Telecommunications Department. Also our National Department of Agriculture which is required to approve the use of all chemicals used in wood preservation, the Council for Scientific and Industrial Research, The South African Bureau of Standards, etc.

Our offices are situated near the Johannesburg International Airport.

Activities:

In addition to being responsible for promotion we have become a centre for enquiries in all matters relating to wood preservation from both within and outside of the wood preserving industry. We handle technical enquiries and we also have become a clearing-house for matters referred to us by the consumer.

Through the practice of becoming involved with the industry in all matters relating to the industry, we have found that we have become the facilitator for the industry on an ever increasing number of issues but we do steer clear of commercial matters directly related to the industry such as the selling price of timber or the selling price of chemicals.

Income:

We raise our income by means of a levy on the sale of chemicals from the chemical producer to the treater. This is preferable to raising a levy on the sale of treated timber as it significantly reduces the number of people we are dealing with who need to pay us. Some chemical organisations have decided that all their customers should be given the opportunity to belong to our Association and therefore pay the levy on behalf of all their customers. Other chemical organisations have taken the attitude that they wish to recover the levy from the customer and in these instances not all of their customers have elected to pay the levy and be members of the Association.

Harmonising with the environment is a feature which we promote on an ongoing basis.

Safety of wood preservatives is a key issue in our promotion.

Projects

In our role as the facilitator for the industry we have been involved in producing certain protocol documents. Approximately a year ago, we published a protocol document on how to go about registering a new wood preservative in South Africa.

We are in the throes of producing a second protocol document on how to go about installing a new wood preservation plant which will highlight the formalities that are required to be adhered to in South Africa.

We have also published Guidelines for the Timber Preservation Industry and how to construct and operate a timber preservation plant in such a way that it is least harmful to health, safety and the environment.

When we first started operating we used to manage our technical affairs through a technical committee but this did not work particularly well and we have now changed to a system of using working groups. A Working Group is appointed if and when there is a particular project to be attended to, such as the preparation of a protocol document or a change in one of the specifications. The members of the working group are drawn from members of the Association from a list of persons who have indicated that they are willing to participate in this type of activity. The Working Group meets as often as is necessary and when the project has been finalised, that working group is disbanded. At any moment in time we probably have a half a dozen active working groups.

In the advertising that we do to support our promotions campaign, we specifically only promote the use of treated timber products which bear the 'standards' mark on the timber. This 'standards' mark indicates that the timber has been treated in accordance with what is laid down in the South African Bureau of Standards Specification. We also have a Hazard Classification in South Africa which is similar to the one used in Australia which we also advertise on an on-going basis.

We operate a toll free telephone and this number is prominently displayed on all advertisements.

We have a good relationship with the editing staff of the magazine which is aimed at the members of the forest product industry and when appropriate we provide editorial for this magazine. We also provide editorials for magazines directed at the home owner, the builder and the architect.

We have laws in place which protect the environment. Until such time as these laws are enforced, we will continue to have some treatment plants operating in an irresponsible fashion. Typical of this irresponsibility is the pollution which surrounds some treatment plant cylinders.

Every treated pole in South Africa is required to show the year that the pole was treated, the appropriate hazard classification in terms of which the pole was treated, by whom the pole was treated and the South African Bureau of Standards Mark.

Sawn timber is required to have similar information in addition to grading details.

One of our promotional campaigns has been the provision of pamphlets supporting the sale of treated timber for particular applications. The most popular one that we have produced is a pamphlet on decks and we have also done others on car-ports, sheds, playground equipment and outdoor entertainment structures.

Another aspect of using treated timber which we promote is the speed with which one can erect structures.

Also the suitability of the material for do-it-yourself consumers, is a theme which we use in advertisements in 'Handyman' type publications.

Contact with our Members:

We maintain contact with our members by using the following means of communication:-

Newsletters -
approximately six per annum

Seminars -
not annually as in the case of the BWPDA but every three years

Regional Meetings -
at least every year in each of the six different regions
Annual General Meeting - one a year
Working Groups - at any time there would be approximately 40-50 people involved in working groups.

There is a definite need for the Association to be visible by its members and there must be a perception by the members that membership is worthwhile.

Poles vs Sawn Timber Involment

The primary business activity of our members falls into two distinct categories. One is the preparation and sale of treated poles and the other is the treated sawn structural timber market. The interests of these two activities are different and requirements for each need to be taken into account when we formulate promotion plans.

The future demand for treated timber will be affected by:-

- The new Forest Act which we expect to be promulgated within the next year or two and which will not contain the strict regulations for timber treatment which are applicable in South Africa today.
- The Provision of Housing for the poor which has not yet reached targeted levels but which is expected to escalate.
- The need for poles in agriculture particularly in the wine and fruit growing industries where more and more vineyards and orchards continue to be planted.
- The overall economic situation where currently for the first time for some twenty years, a positive growth cycle is being experienced.

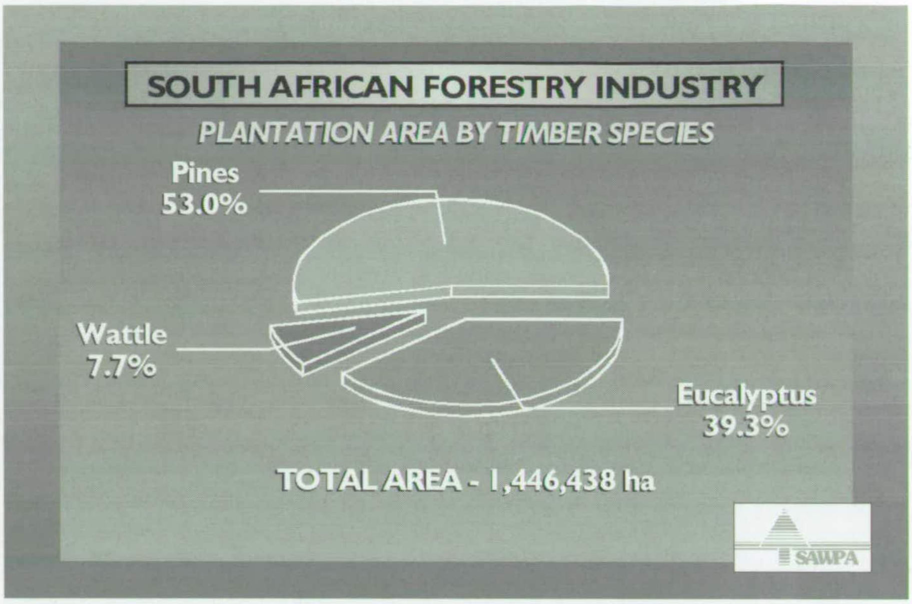
The use of poles in roof structures is popular in South Africa particularly in the case of a house which is being built with a thatched roof.

There is a wide spread of the population in South Africa, not only from the rich to the poor but also for those living in rural areas and those in urban situations. Over the years there has been a tremendous influx of illegal immigrants and people from the rural areas into the cities resulting in the creation of what is termed as "squatter camps". The conditions prevailing in a typical squatter camp are not pleasant to say the least but these will continue to be part of the South African scene until such time as the provision of housing can start to meet the demand. To try and improve the quality of life, squatter camps are being provided with macadamised roads, water, water borne sewerage, electricity and telephones. Whilst making life a little more bearable this cannot compare to life of the more affluent or middle class South African, living in more acceptable conditions.

Timber Treatment Chemicals

In South Africa we use the usual treatment chemicals i.e.

- CCA
- Creosote



- TBTO
- Boron - which is fairly new to the market.

In the case of TBTO there is a practice of adding wax to the treatment solution for the treatment of timber for housing. In the treatment process the wax is impregnated into the timber where it provides surface protection from the environment and thereby reduces the leaching of the preservative from the timber.

Technical Development

When it comes to technical development we rely on what happens in other countries.

We are members of IRG and thereby keep up to date with certain research.

We are members of other wood preserving associations and through their activities get to know what is going on elsewhere.

The Council for Scientific and Industrial Research has been active in developing wood preservatives but because of a change in the funding of this institute, its activities in wood preservation have been severely curtailed. The chemical manufacturers operating in South Africa who have overseas connections have been and continue to be a valuable source of technical knowledge.

Specifications

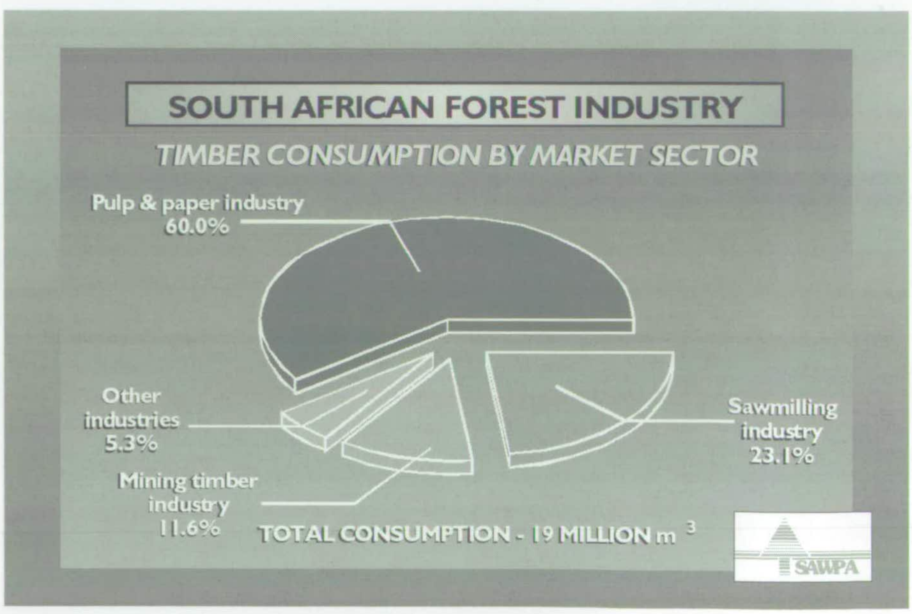
In South Africa we have specifications for the treatment of timber , the chemicals that are used and for the end product. These specifications have been drawn up in terms of the Forest Act which make the specifications compulsory. We do however expect a change in this situation and we anticipate that all specifications will in the future become voluntary.

South African Forest Industry

The wood preserving industry is a small portion of the total South African Forest Industry which is 100% plantation based. It is spread over 1,4 million hectares which represents 1,2% of land area.

The two main species of timber grown for poles and for sawn structural timber are pine and eucalyptus and these two together make up the vast majority of timber plantations in South Africa.

The South African Timber Industry is established adjacent to the south and east coasts of South Africa from Cape Town right



up to the Northern Province.

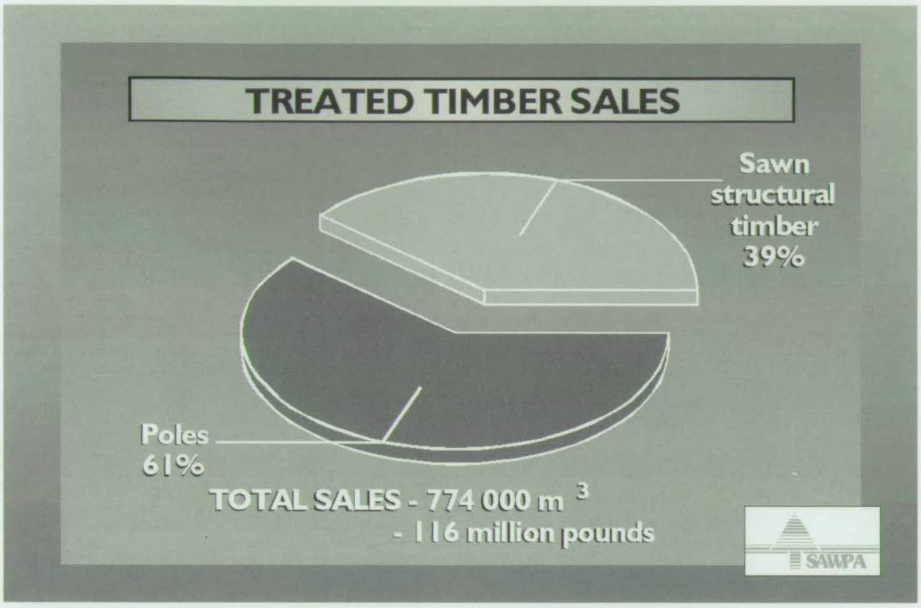
The main species of eucalyptus which is grown in South Africa, is Saligna grandis.

Various species of pine are grown according to the rainfall, soil and altitude.

Typical consumption in South Africa by the various industries totals 19 million cubic metres per annum. By far the majority of this i.e. 60% is used by the pulp and paper industry, with the sawmilling industry being the next biggest consumer at 23%.

Another significant consumer is the mining timber industry which utilizes eucalyptus timber. Other industries amounting to 5% would include the pole industry.

Total sales of treated timber in South Africa amount to some 774 thousand cubic metres with a value of £116 million. The volume sales of poles represent 61% and sawn structural timber 39%.



Sales of treated timber in the various categories of treatment chemicals show that 48% of treated timber is Creosoted, 48% is treated with CCA and 4% treated with TBTO or Boron. The number of treatment plants in South Africa are :-

Creosote	38
CCA	102
TBTO	24
Boron	3

Wood Preserving Chemical Manufacturers / Distributors

The producers of CCA, Boron, TBTO and anti-sapstain chemicals are as follows:-

COASTCHEM
RENTOKIL
TIMBERLIFE

The producers of Creosote are:-

Suprachem
Sasol Carbo Tar

Deltamethrin is distributed by AgrEvo.

Trends for Forest Products

The huge expansion in the pulp and paper industry over the last twenty years is slowing down considerably. Most of the world's new pulp and paper production capacity will be in South America and South East Asia.

The dramatic decline in mining timber requirements is expected to level off at approximately 1 million cubic metres per annum but unfortunately this decline will not be reversed.

In plantation forestry economics there will be a swing towards producing pruned pine sawlogs. The price is about £80 per cubic metre for pruned logs versus £20 per cubic metre for unpruned logs. Log exports currently at 200 000 cubic metres per annum will increase dramatically over the next thirty years.

Sawmillers have concentrated almost entirely on the domestic market for 50 years. There will be a decisive change in the next few years with some 30% of industry capacity dedicated to export customers or export orientated remanufacturers.

Imports from Zimbabwe, i.e. lumber, furniture and treated poles will grow steadily. Zambia, Malawi, Kenya and Tanzania will also export wood products to South Africa.

The expected home building boom of 5 million houses in 20 years versus 3,5 million in 3,5 centuries, will be beneficial for jobs, home ownership and social stability, but the volume of structural timber used will be modest at around 100 000 cubic metres per annum.

The development of the Maputo Corridor will lead to the Mpumalanga Province becoming one of the worlds leading forest products export regions in the 21st century. This will include sawlogs, poles, lumber, furniture, plywood, mouldings, joinery, prefabricated wooden houses and a host of other products. Some wood processing industries will be foreign owned.

There will be a number of integrated wood processing facilities. The same factory will sort logs from a single log yard and manufacture pulp, lumber, plywood, poles and chipboard in varying proportions as required by customers.

Nearly all waste from wood processing industries will be made into by-products. Even bark and saw dust will have profitable uses.

Wood burning for cooking, heating and lighting will largely be replaced by electricity even in remote rural areas.

Brazil will become the world leader in plantation hardwood lumber - a missed opportunity for South Africa.

General Trends in the South African Economy Over the Next 30 Years

Genuine free trade in agricultural produce locally and internationally will produce clear winners and losers. Winners will be fruit and wine.

Losers will be sugar, maize, beef and poultry. These can all be produced more cost effectively by several other countries in the Southern African region. Irrigation farmers will find themselves paying for the water they use and the survivors will learn to use water cost effectively.

The ANC will remain in power, but will abandon socialist doctrines in favour of a relatively free enterprise orientated economy with generous social welfare programmes.

South Africa will become a "post gold economy" as gold mining steadily declines to perhaps a 3rd of its peak tonnage while the South African economy quadruples in 30 years.

There will be a tremendous increase in industrial activity with levies being paid by industry to pay for the cost of training.

There will be a huge expansion in small businesses. From the present 700 000 of which 50% are white owned to perhaps some 7 million of which 90% will be black owned. Employment in the civil service and large corporations will decline. These organisations will have much of their work done by sub-contractors rather than employees. Trade Union membership and influence will decline.

A huge boom in tourism will occur. The current 1 million overseas tourists per annum will become 5 -6 million within the next 30 years. South Africa aims to be bigger than Spain as a tourist destination as it is counter seasonal to the northern winter, and is also a "four seasons" tourist destination. Tourism will shift the economy away from the Johannesburg / Pretoria area to the coast, the mountains and game reserves. Western Deep Levels will become the "Worlds Deepest Tourist Attraction."

All commerce, industry and agriculture will become more "eco-friendly" than at present. Whereas only a few "funny" people such as foresters are currently worried about "sustainability," this will become everybody's business in the future. All industries will pay the full cost of managing their pollution. All mines will have comprehensive rehabilitation programmes.

South Africa / UK Relations

12 million people in Britain which represents 1 in 5 have relatives in South Africa. South Africa and Britain have had historic and economic ties for over 200 years. Britain has been South Africa's major trading partner for most of this time.

Britain is the largest purchaser of South African exports and the 3rd largest suppliers of South African imports after Germany and the USA. Britain is South Africa's most balanced trading partner. Imports and exports are approximately £800 million each way. We have huge deficits in our trade with Germany, USA and Japan and huge surpluses with the rest of Africa.

There is an opportunity to dramatically increase sales to Britain of South African fruit, fruit juices, vegetables and wine.

More overseas tourists in South Africa are from Britain than any other country - 250 000 per annum. Germany is next with 170 000 per annum. The 250 000 will probably increase to more than a million over the next 30 years with a little help from British Airways and Richard Branson.

The opportunity to present this paper to the BWPDA Convention is as a result of generous unsolicited sponsorship from the following organisations in South Africa:

Coastchem
Sasol Carbo-Tar
Suprachem
Timberlife

Wood Preservation in Ireland

by Declan Cahill, Forest Products Department, Forbairt

97

Role of Forbairt

Forbairt is the industrial development agency responsible for developing the Irish timber sector and for deploying Forbairt's full range of industrial development supports to the timber sector - the sawmills, board manufacturers and the joinery and furniture industries. The work of the timber division has been ongoing for over 30 years, although it previously went under other names and Forbairt itself has only existed for the past three years. In addition to its business development role, the Forest Products Department of Forbairt is the principal organisation responsible for the development of the technical application of Irish timber. Major funding for Forbairt's technical work in the timber field comes from the Forest Service, with extra funding from COFORD, (Council for Forest Research), and the EU for research projects.

The Forest Products Department, headed by John O'Dea, has a staff of twenty. Most of them are technical specialists in various aspects of timber. Two others are in charge of business development, and responsible for the State's millions of investment in the board mills, Medite, Masonite, Finsa and LPC. They also have responsibility for supporting the sawmills and joinery and furniture firms in the areas of new product development, innovation and research.

Role of Forest Products Department

Current research projects involve investigation of the physical properties of Irish timber, finding the best ways for drying and preserving Irish timber and discovering how to improve and create new added value products.

Advice, testing and inspection services is provided to contractors, timber users and local authorities. The Forest Products Department also runs the Timber Quality Bureau of Ireland, (TQBI), which was recently constituted as an independent company. This is a quality assurance body which marks structural timber and roof trusses, qualifies and trains timber strength graders and operates a quality assurance scheme for machine graded timber. Some 150 Irish firms are members of TQBI, which operates with the aim of raising the quality and image of Irish timber. In addition, the Forest Products Department runs twenty training courses a year in the timber area on topics such as visual stress grading of timber, timber drying, kiln operations, timber specification, sawmill simulation, finger jointing, timber floor installations, timber Standards.

Forbairt is a member of the Irish Forest Industry Chain, which aims to bring the different sectors of the forest industry around one table. It is useful to have a forum to agree on what is important for an integrated industry and speak with one voice on the issues that affect the development of the timber sector in Ireland.

Achievments

The main achievements on the business side during the last ten years have been helping to fund the investment in the sawmilling sector in the 80s, and attracting into Ireland and funding the big investment in the board mills over the last five years.

On the technical side, the chief thing Forbairt can claim to have done in the last decade is to have helped to raise the market perception of Irish timber through standards and quality assurance schemes. Forbairt has developed the standards which underpin Irish timber and, through the TQBI, we have raised the quality of Irish timber in the marketplace. Fifteen years ago, Irish timber had a very poor reputation. Now the situation is transformed and Irish timber is fetching at least the same price as imported material.

Other specific achievements listed are the development and the writing of all the standards which underpin Irish timber. Additionally the Forest Products Department has, with industry, undertaken research into new added value products and processes. An example of this is the finger jointing of Irish structural material. As a result of Forbairt's work during the past three years, long high value lengths of Irish structural material will soon be on the market. A number of Irish sawmills have been helped in terms of new added value products, while on the technical side, they drafted the new Irish Standard IS 444. This will affect structural and timber design and is to be published by NSAI, the National Standards Authority of Ireland, this year.

There is real potential to add value to Irish timber. The challenge is to achieve this by ensuring Irish industry is more innovative and more productive, and uses the most up to date technology to get Irish timber into the market place. The output from the forest is increasing. Irish timber needs to get out of commodity markets into high added value products that create wealth and employment. The industry has come from producing basic sawn products and sawmill residues and pulpwood, which were very largely exported because they could not be processed here. Ireland is now at the stage where all the pulp and residues are used for board materials creating value and employment, while the price of our sawn product is level pegging with imported timber. The challenge is to go one better by getting out of the high volume basic markets for structural timber and pallet wood and taking the next step into branded products that trade at a premium.

1997 will be a pivotal year because of the change in the way the Irish forest sales regime is going to operate. This change will put a clear focus on the economics of sawmilling and is likely to provoke strategic moves within that sector. This year holds great promise for putting the processing sector on a much sounder footing with more emphasis on adding value and increasing market share.

Availability of Irish Timber

The total forest area in the Republic of Ireland has increased from 100,000 hectares at the beginning of the century to approximately 560,000 hectares today or 8% of the total land area. Half of our forests are under 25 years old. It is projected that in fifteen years over 740,000 hectares will be under forest. It is government policy to increase the area of forest cover to 17% by the year 2030.

Almost 300,000 hectares of Irish forests are at the productive stage. These are largely owned by Coillte, (The Irish Forestry Board), and supply over 2.4 million cubic metres, (m3), to the sawmilling and panel-board industries. Irish forests comprise 90% conifers and 10% broad-leaves: the EU average is 50%. Sitka spruce is the predominant species, (62%), followed by lodgepole pine, (21%), while species such as Norway spruce, Scots pine, Douglas fir and larch make up the balance.

Over 55% of all planting is now carried out by the private sector compared with 3% up to 1980. 70% of private sector planting is carried out by full-time or part-time farmers. The private sector now plants over 20% broadleaves which are suited to better quality mineral soils at low elevations.

The national planting target is 30,000 hectares including 6,000 hectares of broadleaves. About IR£50 million annually is being invested in new forests. Ireland is probably planting more trees per capita than any other country in the developed world. By the year 2015, annual timber production is expected to reach 4.5 million m3. By then Coillte will be joined by private sector suppliers when plantations established from the 1980s onwards come on stream.

The current value of forest output is IR£170 million. This is projected to rise to IR£1,000,000 by 2015. Mill output is expected to grow from IR£160 million to IR£350 million over the same period. Timber exports are planned to expand to almost IR£300 million over the next fifteen years from a current IR£70 million level.

Profile of the Wood Preserving Sector.

A directory of preservation plants in Ireland is published annually by Forbairt. This is distributed widely throughout the industry from specifier to user. The publication lists, on a county basis, the address, telephone number and type of each plant. Whilst it is a simple document, it has been a very useful tool in the promotion of the use of timber in Ireland.

During the early development of the preservation sector in Ireland, a convention was followed regarding the description of treatment plants. This was done to avoid undue confusion. A pressure treatment meant timber was treated with a CCA or creosote preservative in a high pressure treatment cylinder and by no other preservative or method. Although many double vacuum plants in Ireland have a facility to include a pressure phase in their treatment schedules, the actual pressure involved is much lower than that experienced in a CCA or creosote cylinder. This convention is still followed although it is likely to change over the next few years as the new European Standards, which put the emphasis on penetration and retention regardless of application method, are implemented.

There are 89 plants in Ireland at present with the following breakdown:

Double Vacuum Plants		Pressure Plants	
Protim Prevac:	44	CCA:	37
Hickson Vac-Vac:	3	Creosote:	5

Records have been maintained since 1975 when the first directory was published. A gradual increase in the number of plants has taken place over the past twenty years as shown in Table 1. Overall, there has been a 140% increase in the total number of plants in the country. Both the CCA and the double vacuum categories exhibit a similar percentage increase while the number of creosote plants has remained static.

Table 1: Timber Preservation Plants Installed in Ireland : 1975 - 1997

	Number of Treatment Plants			
Year	CCA	Creosote	double Vacuum	Total
1997	37	5	47	89
1989	24	6	41	71
1986	20	5	40	65
1980	20	5	28	53
1975	14	5	18	37

The double vacuum treatment process is generally used to treat external softwood joinery, carcassing timber and roof trusses.

Timber in high decay risk situations is treated by the pressure process. Most farm and roadside fencing is treated with the CCA process. Creosote is used for the protection of transmission poles, railway sleepers and stud farm fencing. Some owners of existing double vacuum plants are actively considering changing from LOSP to boron. However, they will be required to strictly follow the recent BWPDA Treatment Manual Update on the matter.

A survey of preservation plants was carried out in March/April 1997 by Forbairt. The results of the survey provide broad information on the preservation sector. The age profile of the plant stock in Ireland was assessed, in this survey and the results are shown in Table 2. Two-thirds of the total number of plants are less than 10 years old. However, more than 10% of the plants are more than 20 years old.

Table 2 : Age of Treatment Plants in Ireland

Age of Plant (Years)	Number of Plants (%)
1 - S	27
6 - 10	39
11 - 15	15
16-20	10
21-25	7
>25	2

The average volume of a double vacuum plant is 9.9 m3, a CCA plant is 13.3 m3 while a creosote plant averages at 64.5 m3. The majority of the plants (70%) only treat spruce/ whitewood while 25% of the plants treat pine/ redwood. The survey also indicated that just over half the plants (55%) only treat sawn timber while 40% of the facilities treat both sawn and round timber.

It is always difficult to get reliable data regarding the volume of timber treated per annum. It is even more difficult to obtain information from companies about the proportion of treated timber relative to total timber sales. However, the survey provides information about the first topic and this is shown in Table 3.

Table 3 : Average volume of timber treated per annum

Plant	Average Volume of Timber Treated Per Annum (m3) per plant	Max (m3)	Min (m3)
Double Vacuum	2,900	12,000	150
CCA	7,400	29,000	450
Creosote	29,000	-	-

An analysis of the questionnaire returns regarding the second topic indicates the following:

Proportion of Treated Timber relative to total sales	Number of Plants (%)
Upto 10%	36
lO to 2O%	12
21 to 40%	21
41 to 70%	9
71 to 100%	21

The cost of treated timber in Ireland can vary depending on the product and preservative employed. Our survey provides some information on this topic and the findings are shown in Table 4:

Table 4 : Average charge for treated timber

Preservative Type	Plant Type	Average Charge Per m3 (IR£)	Max (IR£)	Min (IR£)
LOSP	Double Vacuum	35	59	20
CCA	Pressure	32	80	15
Creosote	Pressure	80	-	-

The last series of topics in our survey addressed environmental issues. The majority (86%) of plant owners expressed confidence in dealing with the new Irish environmental regulations. While only 56% of plant owners indicated that they needed advice on the regulations, 85% of respondents requested training from Forbairt on this topic. A large majority (68%) of plants have not received a visit from their Local Authority Environmental officer, while only 13% of treatment plants have been visited by officials of the Irish Environmental Protection Agency

WOOD PRESERVATION RESEARCH WORK ON IRISH SPRUCE

Considerable work has been carried out over the past eight years examining the preservative treatability of Irish grown sawn spruce.

Roof Trussed Rafiers

Timber sections, (100 mm x 35 mm x 2.4 m), from Irish Sitka spruce were selected along with typical imported whitewood employed at that time, (Russian 2 star Archangel). The roof truss material received a double vacuum preservative treatment, in accordance with British Standard 5707, in a 'Prevac' plant located in Forbairt.

Details of the schedules are shown in Table 5.

Ten samples of Irish and ten samples of imported timber, all randomly selected, were included in each treatment charge and each treatment schedule was triplicated. Each sample was weighed before and after each charge and the uptake of preservative solution in each sample was recorded. The gravimetric uptake was converted to volumetric uptake and subsequently converted to litres of

Table 5 : Double Vacuum Treatment Schedules:

	Initial Vacuum		Impregnation		Final Vacuum	
Schedule Code	Pressure (Bar)	Time (Min) 1	Pressure (Bar)	Time (Min)	Pressure (Bar)	Time (Min)
DVI	-0.33	3	0	3	-0.67	20
DV2	-0.33	5	1	5	-0.67	20
DV4	-0.83	10	1	60	-0.83	20

1 : minutes

preservative solution per cubic metre of timber. The outer 3 mm layer of each sample of the nine charges was quantitatively analysed for tri butyltin oxide, (T.B.T.O.), using an atomic absorption spectrophotometric method, according to British Standard 5666.

Ten samples each of Irish and imported timber were randomly selected from the nontreated stock and were cross cut at their mid points. Each of the end grain areas of the samples sealed with two coats of a proprietary polyvinyl acetate-based wood adhesive. The forty samples received a double vacuum schedule, (DV1), with both the Irish and imported material treated together.

The results of the work on the roof trussed rafter samples are summarised in Tables No.6 and No.7. If the average uptake of preservative solution, (see Table No.6), is examined, it can be seen that the Irish timber had an 80% higher uptake than the imported for the mild schedule DV1. This increased to 126% for the next schedule and the difference rose to 182% for the most severe schedule, (DV4). The Irish timber achieved higher preservative uptakes than the imported timber in the three schedules by the following factors:-

Schedule DV1 : 1.8, Schedule DV2 : 2.3

Schedule DV4 : 2.8

At the time of this work, Protim 'Prevac' double vacuum preservative solution contained both tri butyltin oxide (TBTO) and pentachlorophenol (PCP) as the main fungicidal ingredients. The analysis of PCP in 'Prevac' treated wood is complicated and time consuming and therefore was not normally carried out but the analysis of TBTO was considered to give an accurate picture of the level of 'Prevac' treatment. It has been found that a loading of 0.03% w/w TBTO (+0.13% w/w PCP) in the outer lateral 3 mm sapwood layer of redwood, (*Pinus sylvestris*), is needed to give protection against decay in an external but out of ground contact situation. No preservative levels were available for whitewood for similar situations but it was considered that lower levels would be expected because of its refractory nature.

Furthermore, it was considered by some that a loading of 0.03% TBTO (+0.13% PCP) in the outer 2 mm layer of whitewood is an acceptable level of treatment. However it was decided to adopt the redwood loading for the outer 3 mm layer as the datum for this aspect of the study. Table No.6 shows that the average loading in the Irish timber using Schedule DVl achieved this level. No increase was noted with Schedule DV2 but a 2.7 increase was observed with Schedule DV4. However the required loading in the imported timber was not achieved until the DV4 Schedule. It was found that the loadings in the Irish timber was greater than the imported timber by the following factors:

Schedule DV1 : 1.9, Schedule DV2 : 2.1, Schedule DV4 : 2.5

The effect of end grain sealing, (Table No.7), on the preservative uptake in the two types of timber is also very clear with the Irish timber achieving almost twice the uptake of preservative solution than the imported material. It would appear from the small number of samples examined that a greater lateral penetration was achieved in the Irish samples than the imported samples. This supports the results of the quantitative analysis of preservative in the lateral zones.

Fencing Rails

The treatability of Sitka spruce fencing rails, both green (high moisture content) and dry, was investigated and compared with the dry imported whitewood. All the timber was pressure treated with a Copper/Chrome Arsenic (CCA) preservative in accordance with the schedule shown below:

All samples were individually numbered and weighed before and after preservative treatment. The concentration of the CCA preservative solutions were analysed in accordance with BS 5666. The uptake of preservative salt was then obtained for each sample.

The green timber was commercially treated in a CCA pressure plant under the supervision of Forbairt personnel. Prior to treatment, 66 samples were randomly selected for moisture content measurements which were carried out using the oven-dry method. The moisture content range of the samples was 33 to 174% with an average of 61%. The latter samples were transported to Forbairt for preservative penetration assessment.

Both the air-dried Irish and imported timber were treated in a CCA pressure plant located in Forbairt. The moisture content range of the air-dried timber was 17 to 19%.

The lateral and end grain penetration of preservative solution was examined in all the samples in Forbairt by staining exposed surfaces with a reagent, which highlighted the copper portion of the preservative, in accordance with BS 5666.

A summary of the results of the work carried out on the fencing material can be seen in Table No.8. The required uptake of preservative (9.6 Kg/m3) was easily achieved by the dry Sitka spruce rails. The average uptake in the Irish material was more than twice the level

Initial Vacuum		Impregnation		Vacuum	
Pressure (Bar)	Time (Mins)	Pressure (Bar)	Time (Mins)	Pressure (Bar)	Time (Mins)
-0.8	60	12.4	180	-0.8	-

This schedule was designed to obtain a CCA loading of 9.6 kg/m3 in fence posts and rails to ensure a long service life.

Table No.6 : Summary of data relating to the treatment of Irish and imported roof trussed rafter samples using three double vacuum schedules.

Origin of	No. of	Double Vacuum	Uptake of Preservative Solution (1/m3)1			Loading of T.B .T. O. (% w/w)2		
Timber	Sam3	Schedule	Mean	Std.4 Dev.	Coef5 of Var.	Mean Dev.	Std of Var.	Coef
Irish	30	DV1	16.71	4.47	0.27	0.030	0.019	0.65
Sitka	30	DV2	24.19	5.60	0.23	0.030	0.01	0.33
Spruce	30	DV4	94.79	31.19	0.33	0.081	0.029	0.36
Imported	30	DVl	9.26	4.17	0.45	0.016	0.006	0.39
Russian	30	DV2	10.68	3.80	0.36	0.014	0.008	0.53
Whitewood	30	DV4	33.51	14.97	0.45	0.033	0.018	0.56

1. litres per cubic metre. 2. weight to weight. 3. samples.
4. standard deviation. 5. coefficient of variation.

Table No.7 : Summary of data relating to the treatment of end sealed Irish and imported roof trussed rafter samples.

Schedule	Origin of Timber	Uptake of Preservative Solution (1/m3		
		Mean	Standard Deviation	Coefficient of Variation
DV1	Irish Sitka Spruce	14.85	3.79	0.26
	Imported Russian Whitewood	7.62	2.10	0.28

These results indicate that Irish Sitka spruce was more permeable than the imported timber of equivalent quality for the same end-use.
Fencing Rails

achieved by imported whitewood. The lateral and end-grain penetration of the preservative was deeper in the Sitka spruce than the imported timber.

With regard to service life, the findings of an earlier report showed that Sitka and Norway spruce fencing rails (with high moisture content) treated with CCA to an average loading of 4.8 kg/m3 were in excellent condition after 18 years in service. In the present work, average loadings of over double that level were achieved and it is considered that CCA treated dry Sitka spruce rails will perform well in service. Adequate quality control of these components can ensure compliance with the criteria necessary for adequate preservative treatment.

The adverse effect of high moisture content on the uptake of CCA preservative can be clearly seen. The average uptake in the green (high moisture content) Irish timber was far lower than the equivalent air-dried Irish material and was similar to the uptake in the imported timber. This illustrates the importance of using properly dried timber if adequately treated material is required.

As a result of this work, the Irish specification for roadside fencing has been modified to include spruce rails.

Farm & Forestry Posts

A recent project has looked at the viability of air drying farm and forestry fence posts. The report has not been released yet. The project looked at the drying of Sitka Spruce and Lodgepole Pine with the following variables: covered and uncovered; two diameters; two drying seasons (winter/spring and summer). The dried material was then treated with CCA in a commercial plant. Retention and penetration data were collected on all samples. A summary of the summer results is shown in Table 9.

Implementation of new European Standards

A current project is underway to examine how common Irish softwood species, in a high decay risk category will comply with the preservation requirements of the new European Standards. Creosote and CCA were the preservatives used to treat the timber. Penetration data of the preservatives as well as retention levels within the analytical zone will be collected.

Table No.8 : Summary table of data relating to the treatment of Irish and imported fencing rails using a CCA Schedule.

Sample Description	No. of Samples	Preservative Uptake (kg/m3) Mean (kg/m3)	Standard Deviation (kg/m3)	Coefficient of Variation
Treated in Forbairt Sitka spruce dry 3.01 m:	100	10.37	2.75	0.26
Imported material dry 3.01 m :	60	5.38	1.86	0.35
Sitka spruce green 3.1m:	66	5.21	1.32	0.25

Table 9 : Summary of Results/Farm Fencing

Post Diameter		Sitka Spruce		Lodgepole Pine	
		Covered	Uncovered	Covered	Uncovered
75mm	CCA Loading kg/m3	5.3	4.9	6.2	5.5
	Lateral CCA Penetration mm	5.4	4.6	10.2	9.8
150mm	CCA Loading kg/m3	4.4	5.0	7.8	7.1
	Lateral CCA Penetration mm	6.7	5.9	25.7	22.6

Environmental Laws

Since the passing of the Environmental Protection Agency Act in 1992, Irish industry has had to comply with strict environmental managemental regulations. The timber industry in Ireland was advised of the impending application of these laws to its sector at a Forbairt workshop on the topic in January 1996. The need for a code of practice and advisory note on environmental requirements was identified at this workshop.

The Code is entitled Advisory Note and Code of Practice for the Operation of Timber Treatment Plants in a Safe and Environmental Conscious Manner and is published by the Timber Quality Bureau of Ireland (TQBI).

This code of practice been developed by a working party comprising of the Irish Timber Council, Irish Timber Trades Association, Hickson Timber Products Ltd, Protim Abrasives Ltd, the Forest Service of the Department of Agriculture, Food and Forestry, Coillte, Coford (the Council for Forest Research) and Forbairt.

The industry has not had a significant requirement for environmental licensing prior to the advent of Integrated Pollution Control Licensing (IPC) under the Environmental Protection Agency (EPA).

The relevant dates, regulations and fees are shown in Table 1.

It should be noted that the definitions in Schedule 1 of the EPA Act for sectors 8. .3, 12.1., 12.2., do not exclusively apply to timber preservation plants but apply to the 'treatment and preservation' of wood or 'surface coating' with organo tin. Therefore all operations of treatment preservation or surface coating are included.

OBJECTIVES

The Code seeks to guide operators of timber preservation plants, in a common sense way, how to operate in a safe and environmentally conscious manner and to prevent, or significantly reduce, the hazards and risks associated with handling biocidal materials. The Code also provides guidance to those involved in handling or dealing with the active substances and provides guidance on the safety and environmental issues involved.

The Code or Practice is based on the code used in the UK developed by BWPDA (British Wood Preserving and Damp-Proofing Association).

Active Substances Control

The active ingredients and proprietary formulations used in timber preservation are strictly controlled under the European Community (Classification and Labelling of Pesticides) Regulations 1994, S.I. 138 of 1994.

These regulations specify the list of approved products for a specified use.

The regulations allow for an ongoing review of products. Those used in the timber preservation sector have been recently reviewed and approved. The current list of approved products has been published by the Pesticide Control Unit of the Dept. of Agriculture, Abbotstown, Co. Dublin.

The Health and Safety Authority (HSA) is the regulatory body responsible for safeguarding the health and welfare of workers and the general public from hazards arising from workforce. A large and growing body of legislation (see appendix) now exists, based on four principal acts, Factories Act, 1955; Safety in Industry Act, 1980; Industrial Activities Safety, Health and Welfare at Work Act, 1989 and the European Communities Act, 1972.

Regulatory Framework

Planning Regulations

Sites must operate under the relevant controls of the Local Government Planning and Development Acts, 1963 as amended 1995. Under those regulations any site developed since 1963 ordinarily requires planning permission to have been granted. Alternatively an exemption may have been claimed under the provisions for items in the nature of plant and machinery (i.e. for development of timber preservation activities on an existing industrial site where the relevant criteria were met).

The operator/owner should ensure that the site(s) are operated in compliance with the Planning Code.

Environmental Protection Agency Act 1992

The EPA Act in 1992 brought timber preservation and treatment and surface treatment into the ambit of integrated pollution control licensing - (IP C). The relevant dates for application of these regulations are specified in Table 10.

Under the following schedules,

- Section 8.3 of the Licensing Schedule "all plants for the treatment or protection of wood, involving the use of preservatives, with a capacity exceeding 10 tonnes/day.
- Section 12.1 "Operations involving coating with organo tin compounds" and
- Section 12.2 "The manufacture or use of coating materials with a capacity to make or use 10 tonnes/year of solvents".

1. From 16th May, 1994 all new plants with a capacity for treating or preserving 10 tonnes of timber/day, or for surface treatment of timber with more than 10 tonnes of solvent per annum are required to apply for an IPC licence to the EPA.

2. Also from 16th May 1994 any existing plant which is scheduled for integrated pollution control as defined about must notify the EPA if any proposed change in its activities which would change its emissions e.g. expansion proposals, installation of new plant or change of preservation system. On notification, the EPA may require an application for a licence to be made at a specified time.

3. Existing surface treatment plants were required to apply for a licence on or before 1st March 1996. All other treatment plants will be required to apply for licensing by October the 14 1997. Note that the categories 8.3, 12.1 and 12.2 do not exclusively apply to formal mechanical plant but to any facility carrying out the activity. Therefore dipping and coating or deluging systems are also covered by IPC.

Applications:

All applications for IPC license must be made in accordance with licensing regulations under the EPA Act, S.I.85 of 1995. These specify the form of the application. The full details for an application are available from EPA Headquarters, Ardcavan, Co. Wexford or the regional offices.

Licence Details:

The Licence will specify operational and maintenance controls and environmental controls to be implemented by the company. Ongoing monitoring and auditing will be required. Licensed plants will have to achieve the objectives of the EPA BATNEEC Guidance Note for Timber
Preservation over a determined period. New plants will be required to meet the requirements from the beginning.

Water Pollution Act 1977

Ordinarily timber preservation should not entail the generation and treatment of process effluent. Exceptions are where site run-off is subjected to treatment prior to discharge. Such discharges are subject to licensing under Section 4 (discharges to waters) or Section 16 (discharges to sewers) of the Water Pollution Act 1977 (as amended 1992).

Table 10: IPC Licensing Requierment

Schedule 1 Category	Description	New Plants		Established Plant		Fee S.I. 60 of 1995 IR£	
		Statutory Instrument S.I.	Date	Statutory Instrument S.I.	Date	Small	Large
8.3	The treatment or protection of wood involving the use of preservatives with a capacity exceeding 10 tonnes per day	S.I. 82 of 1994	16.5.'94	S.I. 140 of 1997	14.10.'97	4000	7000
12.1	Operations involving coating with organo tin components	S.I. 82 of 1994	16.5.'94	S.I. 140 of 1997	10.3.'98	4000	7000
12.2	The manufacture or use of coating materials in processes with a capacity to make or use at least 10 tonnes/year of organic solvents and powder coating manufacture with a capacity to produce at least 50 tonnes/year	S.I. 57 of 1995	3.4.'95	S.I. 58 of 1995	1.3.'96	4000	7000

However, it should be noted that the obligation to prevent accidental spillage or any source of contamination having a detrimental effect on all waters including groundwaters, applies to all operations.

S.I..271 of 1992 requires Local Authorities to review all activities on or in the ground which might give rise to groundwater contamination by dangerous substances (including those used in timber preservation) to ensure that adequate protection is provided. They are empowered to take or to insist that remedial action is effected.

Air Pollution Act 1987 (APA 1987)

Timber preservation does not require licensing under the Air Pollution Act. However those companies scheduled under the EPA Act may have air emission standards specified. The general provisions of the APA do apply and require the companies to ensure that nuisance or dangers to health are not caused by their activities.

Seveso Regulations

The European Community regulations on the Control of Industrial Major Accident Hazards Regulations (8.1.292 of 1986) apply to all activities insofar as the obligation exists to operate all sites in a safe manner. The more onerous regulations, requiring emergency plans and offsite notification procedures, may apply to large sites, where large stocks of preservation chemicals may be held. This would include holding stocks of active ingredient of high toxicity greater than certain specified quantities (e.g. arsenic pentoxide> 500 KGs) as specified in the Annexes to the Regulations where the HSA is the relevant authority.

Waste Regulations

The Waste Act 1996 implements the EU Directives on waste. These Directives classify all materials as hazardous, non-hazardous or inert wastes and require minimisation at source, segregation of contaminated material and optimised recycling or reuse in preference to disposal. In timber preservation, the main issues relate to the optimised use of reusable or recyclable containers for active ingredients or the preferred use of bulk delivery where possible.

Consequently, the disposal of contaminated packaging, offcuts, or sludges must be carried out in accordance with the regulations. S.I.133 and S.I.137 of 1997 implement the Waste Act in Ireland.

Under the Waste Act, the European Waste Catalogue (EWC) coding is used to identify all possible wastes. This is a six digit code system.

All wastes are classified as non-hazardous or hazardous. Wastes are defined as hazardous if they exhibit any of the 14 characteristics listed in the Directive on Hazardous Waste. For convenience, a Hazardous Waste List based on the EWC coding has been developed.

The codes relevant to timber preservation are:

03 00 00	Wastes from Wood Processing and the Production of Paper Cardboard, Pulp Panels and Furniture
03 01 00	Waste from wood processing and the production of panels and furniture
03 01 01	Waste bark and cork
03 01 02	Sawdust
03 01 03	Shavings, cuttings, spoiled timber/particle board/veneer
03 01 99	Wastes not otherwise specified
03 02 00	Wood preservation waste
(h) 03 02 01	Non-halogenated organic wood preservatives*
(h) 03 02 02	Organochlorinated wood preservatives*
(h) 03 02 03	Organometallic wood preservatives*
(h) 03 02 04	Inorganic wood preservatives*

Wastes indicated by * are defined as hazardous and are subject to specific controls.

Hazardous waste

The generator of hazardous waste must meet the following general obligations; (conditions relating to these obligations are likely to be incorporated in a waste licence):

- No mixing of different categories of hazardous wastes, or of hazardous waste with non-hazardous, is permitted except in special cases, such as where safety issues are of concern.
- All wastes must be properly packaged and labelled and temporary on-site storage must be to a high quality.
- Waste to be transferred must be accompanied by a consignment note containing specified details of the waste and the transfer operation.
- If the waste is given to another party for transport or treatment/disposal, that party must itself have a licence.
- Detailed records of wastes and disposal options must be maintained by the generator for at least three years.

These conditions may be imposed as part of an IPC licence, or in the case of a non-IPC licensable activity, as part of a separate licence from the EPA. As with other licences, any application to the EPA must be made on the appropriate form and publicly advertised.

The following aspects are also addressed in the Code:

- Site Selection for New Plants
- Environmental Protection
- Plant and Equipment
- Occupational Health
- Fire Prevention
- Emergency Procedures

The draft code was presented to the EPA in early June 1997. The document was well received and the pro active attitude of the industry to this matter was favourably noted by the EPA. Although the regulations are very strict and will cause major problems for the industry, a collaborative approach between the regulators and the preservation sector is required. It is expected that this will be forthcoming.

Conclusion

Considerable investment has been made in the forestry, sawmilling and processing sectors of the timber industry in Ireland. The annual output from our forests will more than double over the next 20 years. A quality control system is in place and it is predicted that the TQBI will increase in significance as the industry develops. As the timber culture continues to grow in Ireland, the use of timber will increase throughout society. The need for a responsible, proactive and effective wood preservation sector is vital. Problems lie ahead particularly in the environmental protection area. However the industry has the ability to tackle these difficulties provided it works together in a concerted and focused way.

Assessment of the Protective Effectiveness of Wood Preservative Treatments against Fungal Attack

by Janice K Carey[1] PhD DIC FIWSc Building Research Establishment Limited

97

1 Introduction

In his paper to the 1974 Convention on 'Harmonisation of European standards for wood preservative testing', Baker (1974) stated that 'The unification of laboratory tests to indicate the efficacy of a preservative against wood-destroying fungi did not start until 1968 but immediately proved a more difficult problem than harmonisation of the insect test methods.'. At that time, agreement had been reached on the broad principle that tests against basidiomycetes should follow the method already used in both the British Standard BS 838 and the German Standard DIN 52176 in which test specimens, fully impregnated with the preservative under test, were exposed to attack by a range of test fungi growing in pure culture on an agar medium. In due course, EN 113 (BS 6009: 1982) was agreed as the standard method and a revised version has just been published (BS EN 113: 1997).

In the new European performance standard for wood preservatives BS EN 599-1, a procedure is prescribed for deriving minimum amounts of wood preservatives (the so-called critical values) for each of the categories of use defined as hazard classes in BS EN 335-1. The critical value is the highest of the biological reference values determined from each of the specific prescribed methods of test necessary for each hazard class. It is the amount of wood preservative product found to be effective in test in preventing attack by the particular biological agencies being tested. For each hazard class, tests are carried out using those biological agencies appropriate to the hazard class. For example, in hazard class 1 (above ground, covered, dry) timber is not subject to wetting. Therefore, there is no decay hazard but there is an insect hazard. In hazard class 2 (above ground, covered, risk of wetting), there is a risk of decay due to brown rot fungi, but not to the white rot fungi which require higher moisture conditions for decay. Results from tests using BS EN 113 are specified as most appropriate for the evaluation of the protective effectiveness of preservative treatments applied by penetrating processes.

The only fungal decay tests necessary for hazard classes 2 and 3 are against basidiomycete decay fungi using BS EN 113. For hazard class 2, preconditioning by evaporative ageing is required and for hazard class 3, evaporative ageing and leaching are required. For hazard classes 4 and 5, additional tests of effectiveness against fungi capable of causing the type of decay known as soft rot are required.

In the 1974 paper, Mr Baker also noted that '... there is an urgent need for tests of practical treatments using surface applied preservatives.'. With superficial application processes, penetration by the wood preservative is limited and thus only creates a protective envelope. Even with penetrating treatment processes which are intended to overcome the natural resistance of wood to penetration by a wood preservative product, penetration may not be complete. Additionally, within the treated zone, there is a retention gradient with highest retentions close to the wood surface. If an envelope treatment is to be effective, it must prevent for an appropriate period of time growth of wood decay fungi through the treated zone if it is to protect the untreated inner portion of the wood from colonisation and decay. This paper reviews the development of a method to test the protective effectiveness of wood preservative treatments, to evaluate the information so far obtained, and to consider likely future developments.

2. Early work at Princes Risborough Laboratory

2.1 Background

With the introduction of the widespread use of preservative treatments for window joinery, there was a need to evaluate the effectiveness of these treatments. Field trials had been set up (Morgan, 1971; Baker *et al*, 1975) but these could not be expected to yield comprehensive information sufficiently quickly. Therefore, a programme was undertaken to evaluate treatments using laboratory tests.

The programme involved three different approaches to the problem. First, data were accumulated for the chosen test preservatives using the earlier BS 838 methodology with fully impregnated test specimens. Secondly, the tolerance of spores to the test preservatives was investigated because it was considered that colonisation of exterior joinery would be predominantly by air-borne spores. The results of this part of the study indicated that the same retention of preservative was required to prevent germination of the spores, and subsequent colonisation of the test specimens, as was required to prevent colonisation and decay by the mycelium of the test fungus. This supported the use of the third and key approach, in which test specimens treated by immersion or double vacuum were exposed to colonisation by the mycelium of the test fungi. This work was reported to the Convention in 1976 (Savory and Carey, 1976) and updated in the subsequent year (Baker *et al*, 1977).

2.2 Methodology

Sticks of Scots pine sapwood, 300 mm in length and 20 mm x 20 mm in cross section were treated with the wood preservative solutions prepared by dissolving the active ingredients in a 50/50 mixture of Shellsol A and distillate. The solutions were applied to the wood either by 3 minute immersion or by the double vacuum treatment schedule specified for Baltic redwood in Technical Note 24 (Anon, 1967). These schedules are still recommended in BS 5589 (BSI, 1989). Following drying, one 50 mm long specimen was cut from each end and two from the central portion of each stick. In total, six end blocks and six central blocks of each treatment were exposed to each test fungus. All the newly cut surfaces of the blocks were treated with a fungus resistant sealant before being exposed to the test fungi. The tests were assessed by determination of the percentage loss in mass over a 12 week incubation period.

2.3 Discussion

The results indicated that, despite the greater penetration of preservative via end grain than via side grain, the degree of protection afforded to the test specimens cut from the ends of the sticks was not consistently greater than that given to the test specimens cut from the central portion. Accordingly, results from the two groups of specimens were combined. During the evaluation process, it was recognised that the mean loss in mass of all the test specimens exposed to each test fungus did not provide an accurate picture of the performance of the treatments. Therefore, each test specimen was rated individually as having been protected (loss in mass less than 3 % (*m/m*)) or having failed (loss in mass 3 % (*m/m*) or more). A treatment was regarded as 'effective' provided that not more than one test specimen had failed among the 12 blocks per treatment exposed to each fungus.

The test seemed to provide a severe challenge to the test preservatives. When applied by three minute immersion, none of the test preservatives provided protection against all of the test fungi (Table 1). When applied by double vacuum, only two products provided protection against all test fungi; these were 5 % pentachlorophenol (PCP) plus 1.0 % zinc as naphthenate and 1.75 % PCP plus 0.4 % tri n-butyltin oxide (TnBTO). Because there was no previous experience upon which to calibrate the severity of the test, testing was also undertaken using joinery quality pine heartwood to investigate how this performed under the same test conditions. Two planks of joinery quality Scots pine from Scandinavia were used and the results showed that the majority of treatments tested, including those applied by three minute immersion, increased the initial decay resistance of sapwood to a

Table 1 Summary of results extracted from Savory and Carey, 1976

Method of treatment	Preservative (as % (*m/m*))	Test fungi *Coniophora puteana*	*Serpula lacrymans*	*Gloeophyllum trabeum*	*Coriolus versicolor*
Three minute immersion	2.75 % copper as naphthenate	-	-	+	+
	5.0 % lauryl PCP	-	-	-	nt
	1.8 % zinc as naphthenate; 2.0 % PCP	-	-	-	nt
	5.0 % PCP	-	-	+	+
	1.0 % TnBTO	-	+	+	-
Double vacuum	2.0 % copper as naphthenate	+	-	+	+
	1.8 % zinc as naphthenate; 2.0 % PCP	+	+	+	+
	1.75 % PCP; 0.4 % TnBTO	+	+	+	+
	1.0 % TnBTO	-	+	+	-

- Treatment not effective + Treatment effective nt Not tested

level equal to or better than that of untreated heartwood (Baker, *et al*, 1977).

Following from these studies, further work to evaluate and predict the performance of treatments for exterior joinery concentrated on refining the use of the so-called L-joint field trial samples by destructive examination, results from which were reported to the Convention in 1985 (Carey and Bravery, 1985). As a consequence of this BRE work, the L-joint method (with visual assessment only), was adopted as a European Standard (BS EN 330).

3 A new approach

Despite all the earlier work, a rapid, realistic and reliable laboratory technique for accelerated prediction of the performance of those treatments which did not fully penetrate wood still remained elusive. Destructive assessments of L-joint samples gave indications of the performance of preservative treatments more quickly than a conventional field trial, but a period of exposure of two to three years was still required to give possible indications of long-term performance. Therefore, there remained a need for a more rapid method of assessment.

It was also recognised that the sample size used in the earlier laboratory work (cross-section 20 mm x 20 mm) could allow complete penetration by some treatments and, therefore, the ability of a superficial treatment to protect the untreated core of the wood was not being fully challenged. If the size of the test specimens was increased, then the applicability of an assessment system using loss in mass becomes questionable, since the actual loss in mass as a result of decay necessary to exceed the normal 3 % (*m/m*) threshold rises in proportion to the weight of the test samples.

The use of larger specimens (cross-section 50 mm x 50 mm) was investigated by members of the European Wood Preservative Manufacturers Group (EWPM). The specimens were exposed to the test fungi in tanks, with each test fungus having been established on untreated feeder blocks which were subsequently embedded in a moisture retaining medium (vermiculite or a flower arranging material). The methodology proved problematic in two ways. First, the tanks were prone to contamination by moulds which affected the vigour of the test fungi. Secondly, the assessment of efficacy could not be made using loss in mass for the reasons given above.

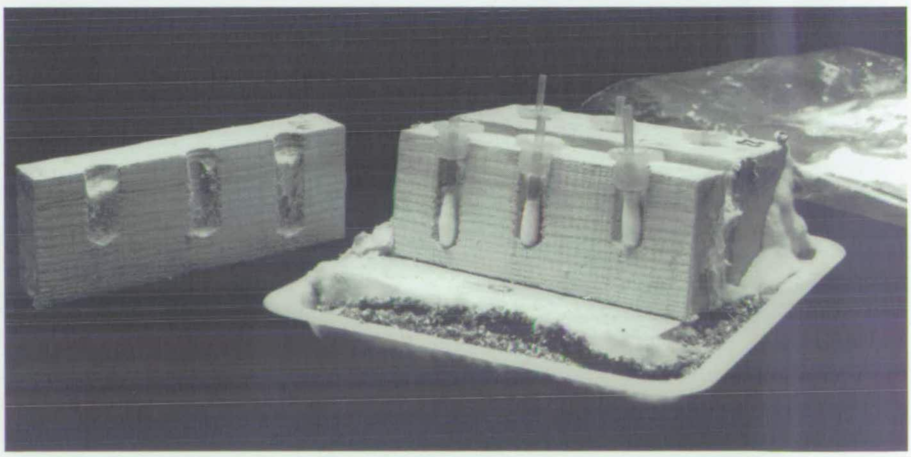


Figure 1.

An alternative approach to assessment was tested, in which the large test blocks were cross cut in several slices. These slices were then incubated to allow the test fungus to grow from the cut faces. Although the slices were dipped in a selective fungicidal solution to suppress mould growth, it was still not possible to be certain, without microscopic identification, that fungal growths on the cut faces were caused by the test fungus.

BRE also evaluated a range of possible methods (BRE, unpublished data). Lengths of timber 38 mm x 38 mm in cross-section were end sealed and then treated with preservative. From the treated sections, 2 mm slices were cut and exposed to the test fungi following the method of Sutter (1978). This proved to be a simple way of visualising the gross effective distribution of the preservative, since the test fungus grew through the slice only in the untreated or inadequately treated parts. It indicated that timber with a cross-section of this size had a central untreated core even when treated by a double vacuum process. From other lengths of treated timber of the same cross-section, 38 mm lengths were cut and the newly cut faces coated with a fungus resistant sealant. These were then exposed to attack by the test fungi in jars following the methodology of EN 113 (1982). However, it was considered that the losses in mass recorded for the test specimens did not correlate with their visible condition and that the ability of the test fungus to grow through the treated zone was not being assessed objectively.

A thin surface layer was removed from treated lengths of timber and various testing systems employed in an attempt to assess the ability of the test fungus to grow through this treated zone. None proved successful.

The inadequacies of all these earlier attempts led BRE to take a wholly new approach involving the development of the method using baits (Carey and Bravery, 1988). The principle remained the same throughout the development process. Following treatment and drying, holes were drilled into a lateral surface of the test specimens to within a particular distance from the opposite face, which would become the test face. Baits were inserted into the holes and the specimens exposed to fungal attack (Figure 1). After various periods of time, the baits were removed and placed on a nutrient growth medium. If the test fungus grew from this bait, then the fungus must have grown through the treated zone and the treatment could be considered to have failed. Thus, this method of assessment provided for the first time an objective way of assessing the performance of the test preservative in resisting colonisation by an invading fungus. On each removal of the baits, fresh baits were inserted and incubation continued. In this way, the same test specimen could be monitored repeatedly and non-destructively to determine the time for the treatment to fail.

Subsequently, this BRE technique was proposed for adoption as a European Standard to assess the effectiveness of superficially applied treatments. The need to assess such treatments directly had been established by CEN/TC 38, and its Working Group 9 had been charged with the task of drafting a suitable method. In all, four methods were submitted to WG 9. The German proposal, the so-called planer test, had been developed at the Bundesanstalt für Materialforschung und - Prüfung (BAM) in the late 1960s and first published by Becker and Starfinger (1971). It used specimens only 25 mm x 15 mm in cross-section. Initially, the test preservative was required to provide protection to the test blocks following planing off of the surface 1 mm, 2 mm or 3 mm after treatment. The requirement for planing was later withdrawn. The small cross-section could result in complete penetration by some treatments and, therefore, it was believed that it would not test the ability of the treatment to protect an untreated core. In a Swiss proposal, the outer 2 mm was sliced from the treated surface and this portion exposed to decay. This revealed how well the outer portion was protected but again did not test the ability of the treatment to protect an untreated core. The EWPM method described above was also proposed. Eventually, the method published as a European Prestandard (DD ENV 839: 1994) contained elements of both the EWPM method and the BRE method. The ENV 839 methodology, with some variation, has been used extensively at BRE.

4 Assessing the effectiveness of preservative treatments

4.1 Introduction

Convinced of the distinctive merits and powerful potential of the bait-type methodology, BRE has carried out an extensive programme using it to investigate some of the more fundamental aspects of the colonisation of wood and the performance of wood preservative envelope treatments in preventing this colonisation. Preliminary results were reported in 1992 to the International Research Group on Wood Preservation (Carey, 1992).

4.2 Orientation of the timber and detection depth

It is well established that in most permeable softwood species, wood preservatives penetrate further into wood in the radial direction (that is from a tangential face) than in a tangential direction (from a radial face) because the rays provide pathways for penetration. It was expected, therefore, that subsequent fungal colonisation of treated wood would be more effectively inhibited in the radial direction than in the tangential direction. In fact, this was not so (Table 2) and in some cases, for example product 2 challenged by *Coniophora puteana*, the difference was marked. Presumably, the faster rate of colonisation in the radial direction is due to the rays still providing an available and the preferred route for colonisation, despite the presence of any preservative.

In developing the ENV 839 methodology, the thickness of wood remaining between the bottom of the sampling hole and the challenged surface of the test specimen (detection depth) was initially selected to be 5 mm, 10 mm or 15 mm. It was thought that sampling at different depths would highlight the greater protection afforded by treatments which penetrated more deeply. However, with brush, immersion and double vacuum treatments it was found that it was really only the time to penetrate the first 5 mm which varied (Tables 2 & 3). This can be explained by the precise distribution of the preservative within the treated zone. For example, the profile for radial penetration of pine sapwood demonstrated by Morgan and Purslow (1973), using a solution containing 0.5 % (-BHC applied by double vacuum, indicated that about 60 % of the active ingredient was deposited in the outer 5 mm and, at a depth of 5 mm, the loading was less than half the maximum loading recorded near the surface. Thus only a relatively superficial layer of the wood is actually fully treated. Deeper within the treated zone, preservative penetration is not uniform and leads to a combination of treated and untreated wood cells. Orsler and Stone (1982) established that at a depth of 6 mm from the surface, only 14 % of rays cells would contain any treatment. Therefore, once through the completely treated zone, untreated ray cells would provide an easy pathway for colonisation by the test fungus.

Table 2 Rate of colonisation in radial and tangential directions.

Treatment*	Detection depth - mm	Mean recovery time - weeks			
		Coniophora puteana		*Coriolus versicolor*	
		Radial	Tangential	Radial	Tangential
Untreated	5	4.0	6.0	2.7	4.0
	10	4.0	6.0	4.0	4.0
	15	6.0	6.7	4.0	4.0
1.0 % (*m/m*) TnBTO	5	13.3	13.3	4.0	4.7
	10	15.3	15.3	4.0	6.0
	15	15.3	17.3	4.0	6.7
Product 1	5	10.0	14.0	4.7	6.0
	10	10.7	15.3	5.3	7.3
	15	10.7	16.7	6.0	7.3
Product 2	5	7.3	12.7	4.0	4.7
	10	8.0	14.7	4.0	6.7
	15	9.3	17.3	4.7	6.7

* All preservatives applied by brushing at c.15m^2/Litre.

Table 3 Influence of detection depth on the recovery of the test fungi; immersion and double vacuum treatments.

Test fungus	Test preservative - application method**	Time to first recovery - weeks			Mean recovery time - weeks		
		Detection depth - mm			Detection depth - mm		
		5	10	15	5	10	15
Coniophora puteana	Untreated	2	4	6	4.0	5.0	6.0
	1 % PCP - dip	6	8	8	9.3	10.0	12.0
	1 % TnBTO - dip	6	6	6	6.0	6.0	6.0
	1 % TnBTO - dv	12	12	14	14.0	>13.0	>15.0
Gloeophyllum trabeum	Untreated	2	4	4	3.3	4.0	4.7
	1 % PCP - dip	6	6	6	6.0	6.0	6.0
	3.25 % PCP - dip	8	8	8	15.3	15.3	15.3
	1 % TnBTO - dip	6	8	8	6.7	8.0	8.7
	1 % TnBTO -dv	8	8	10	>8.0	>8.0	>10.0
	1 % TnBTO -dv*	6	8	10	8.0	9.3	10.7
Coriolus versicolor	Untreated	2	2	4	2.7	2.7	4.7
	1 % PCP - dip	4	4	4	4.0	4.7	4.7
	3.25 % PCP - dip	6	6	6	6.7	6.7	6.0
	1 % TnBTO - dip	4	4	4	6.7	8.0	8.0
	1 % TnBTO -dv	4	4	6	6.0	7.3	8.0
	1 % TnBTO -dv*	8	8	10	8.7	10.0	12.0

* Formulated product   ** dip = double vacuum (V/1 schedule)

4.3 Determining adequate performance

With most fungal tests, the process of colonisation and decay is continuous and, therefore, the extent of fungal attack will depend on the elapsed time before the test is evaluated. For example, the toxic values obtained from an EN 113 test after the normal 16 week exposure period would be lower than those obtained after 32 weeks exposure. With the preventive fungal test in the form used at BRE, the method of evaluation is non-destructive permitting the test to be evaluated progressively at intervals throughout the incubation period. Therefore, a decision is required as to what constitutes adequate performance. In the early tests at Princes Risborough (section 2), adequate performance was defined as not more than one block having a loss in mass of greater than 3 % (*m/m*) after the 12 week incubation period. The concept of 'not more than one failure' has also been invoked more recently in BS EN 599-1 as the

Table 4. Effective treatments of TnBTO and PCP in relation to application method.

Test preservative	Test fungus (FPRL strain number)	Superficial Effective treatment	Penetrating Effective treatment		Mid toxic value**
		g/m²*	kg/m³*	g/m²*	kg/m³
TnBTO	*C. puteana* (11E)	137	26.0	247	48.0
	C. puteana (11R)	250	60.7	577	
	G. trabeum (108N)	250	>46.9	>446	6.0
	C. versicolor (28A)	>57	>70.5	>670	64.0
	C. versicolor (28G)	>400	>44.3	>421	
PCP	*C. puteana* (11E)	110	<9.6	<91	25.0
	C. puteana (11R)	147	<37.8	<359	
	G. trabeum (108N)	203	<30.2	<287	21.0
	C. versicolor (28A)	nt	37.8	359	20.2
	C. versicolor (28G)	>164	>26.6	>253	

* Expressed as 1% (m/m) TnBTO or 5% (m/m) PCP

** Mean value based on unaged data from EN 113 and BS 838 tests using data for all strains of the test fungi.

ai Active ingredient nt Not tested.

basis for evaluating termite tests. This same approach was adopted for evaluating the data from the BRE preventive fungal test method. Adequate performance was defined as preventing colonisation of more than one block over a 12 week incubation period.

4.4 Effect of application method on performance

The effect of application method on preservative performance was studied using 1 % (*m/m*) TnBTO and 5 % (*m/m*) PCP as the model test preservatives (Table 4). These were applied by brush or dipping (superficial treatments), and by double vacuum (penetrating treatment). To provide a direct comparison between the retentions achieved by double vacuum treatment and those achieved by superficial treatments, the retentions as a result of double vacuum treatment have also been expressed in terms of g/m^2. Because the data are incomplete, the effect of application method on performance can be assessed only on certain fungus/preservative combinations. With TnBTO, comparisons can be made with two strains of *Coniophora puteana* and with *Gloeophyllum trabeum*. In all three cases, superficial application with a TnBTO solution was twice as effective as a double vacuum treatment in achieving the adequate level of protection. With PCP, comparisons can be made only for one strain of *C. puteana* (FPRL 11E) and for *G. trabeum*. In both cases, there was no major difference in effectiveness of PCP between the two methods of application. This indicates that the effectiveness of particular wood preservative treatments are indeed influenced by the precise distribution of the active ingredient.

The distinct difference in the effectiveness of these two active ingredients depending upon distribution in the wood is surprising, for both have similar known modes of action on fungal metabolism, that is they affect the energy system called oxidative phosphorylation. However, the result reinforces the need to challenge superficial treatments directly, as their performance may depend not only on their active ingredient(s) but also on the distribution of them; other parts of the formulation may also have an effect on performance.

4.4 Comparison of preventive test and toxic values tests

The mid toxic values (as defined in BS EN 599-1) have been established for each of the test fungi (Table 4), using data from tests in which the blocks were fully impregnated with the preservative (EN 113 and BS 838). Only data from tests carried out without ageing have been used since the preventive tests were also carried out without ageing. Both TnBTO and PCP appeared to be relatively more effective against *G. trabeum* when fully impregnated with no untreated core than when applied as envelope treatments. For example, as envelope treatments, 250 g/m^2 of 1 % TnBTO provided adequate protection against both *C. puteana* and *G. trabeum*. However, when fully impregnated, 48 kg/m^3 was required to provide protection against *C. puteana*, six times that required to provide protection against *G. trabeum* (6 kg/m^3). These results, together with those showing the effect of distribution on performance again reinforce the need for a method of test which challenges directly the effectiveness of envelope treatments. The data also indicate that it would be more realistic to challenge directly the preservative distribution profile obtained with more deeply penetrating treatments, rather than to rely on extrapolation from toxic values tests (such as EN 113) using fully impregnated blocks.

4.5 Interpretation of data in relation to European performance standards

In European Standard BS EN 599-1, the effectiveness of preservatives against wood-rotting fungi is required to be assessed using the EN 113 test method. The test establishes toxic values for each test fungus specified for particular product types. The toxic values are the highest retention permitting attack and the lowest retention preventing attack. The standard then defines how the biological reference value (brv) is to be established from the toxic values and whether this should be derived from data after evaporative ageing to EN 73 (BS 5761: Part 1: 1989) and leaching to BS EN 84. The brv is the mid-toxic value (usually the mean of the range of retentions which constitute the toxic values). If this is the highest amongst all the brvs derived from all the tests carried out, it becomes the critical value and, as such, is used as the basis for defining the retention required in the analytical zone of the treated product in accordance with BS EN 351-1. The retention requirement is derived by multiplying the critical value for each hazard class by an adjustment factor, which is expected normally to be stated in the relevant commodity standards. The adjustment factor may be less than, equal to or greater than one.

The retentions which proved effective as double vacuum treatments in the preventive tests (Table 4) have been converted and presented in Table 5 as the mean retentions of active ingredient likely to have been achieved either throughout the treated zone, in the outer 6 mm of the treated zone or in the outer 3 mm of the treated zone. The conversion was based on the profile produced by a double vacuum

Table 5. Comparison of the loadings for penertrating treatments which gave adequate performance, together with the criticle values.

Test preservative	Test fungus	Effective treatment kg/m³	Mean* retention in treated zone kg/m³	Mean retention** in parts of the treated zone: Outer 6 mm kg/m³	Outer 3 mm kg/m³	Mid toxic† value kg/m³
1% (*m/m*) TnBTO	*C. puteana*	60.7	78	102	133	85CV
	G. trabeum	>46.9	>60	>78	>102	21
	C. versicolor	>44.3	>57	>74	>97	44
5% (*m/m*) PCP	*C. puteana*	<37.8	<49	<64	<83	37CV
	G. trabeum	<30.2	<39	<51	<67	32
	C. versicolor	>26.6	>34	>45	>58	37

* Calculated assuming a penetration of 10mm (which has been observed visually during treatment of blocks of these dimensions.

** Based on the profile for a double vacuum treatment given in Morgan and Purslow (1973): outer 6mm and outer 3mm are the analytical zones for penetration classes P5 and P2 respectivly in EN 351-1.

† Mean value based on data from EN 113 tests and BS 838 tests, including data after leaching or evaporative ageing, using data for all strains of test fungi.

CV Criticle value (based only on the data for preventing decay by basidioniycetes.

treatment as presented by Morgan and Purslow (1973). The 6 mm and 3 mm zones were chosen because they are both the minimum penetration requirement and the analytical zone for penetration classes P5 and P2 respectively in BS EN 351-1, which generally represent current practice in Scandinavia and the UK respectively. The values presented in Table 5 are only estimates and may not be accurate. Therefore, caution must be exercised when considering them in conjunction with the mid toxic values. The data indicate that a retention in the outer 6 mm or 3 mm equivalent to the critical value derived from EN 113 tests following evaporative ageing and leaching (85 kg/m^3 for 1 % TnBTO or 37 kg/m^3 for 5 % PCP), and using an adjustment factor of one, would not appear to provide protection regarded as being adequate when challenged directly in the preventive test. For example, with 1.0 % (*m/m*) TnBTO, the retentions in the outer 6 mm and 3mm required to provide adequate protection against the test fungus *Coniophora puteana* were 102 kg/m^3 and 133 kg/m^3 respectively, whereas the critical value was 85 kg/m^3.

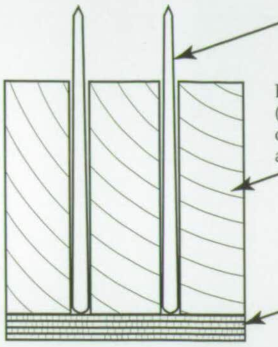


Figure 2. The completed test spcimen used with treated veneers.

These indications are important because they imply the possibility of uncertainty when applying the new European Standards for the evaluation of the efficacy of preservative treatments. Because of this, a Partners in Technology Project, sponsored by the DETR Construction Directorate and with five BWPDA members as Industrial Partners, has recently started to investigate thoroughly the relationships for a range of products appropriate to each hazard class.

5 Assessing the efficacy of protection afforded by the critical values

5.1 Background

The biological assessment of the performance of preservative treatments applied directly to the test specimens showed that:

i) the distribution of the active ingredients could affect performance, and

ii) a retention equivalent to the critical value from an EN 113 test may not correlate directly with the amount needed in the outer zones to give protection in the preventive test.

Therefore, it was concluded that a more fundamental study on the effect of the depth of the treated zone on the ability of an active ingredient to prevent colonisation should be carried out. Most of this study has been reported in detail by Carey and Hull (1997); additional data for acypetacs zinc are included in this present paper.

5.2 Methods

A new, composite veneer test system was developed in which 1 mm thick veneers of either Scots pine sapwood or beech were treated with the active ingredients and assembled into composite blocks to create particular depths of treated wood. The treating solution concentrations were chosen to give specific target retentions of the chosen active ingredient. The target retentions were equivalent to the biological reference values applicable to different hazard classes as determined from EN 113 tests, using the strains of the test fungi defined in the standard and including pre-conditioning by evaporative ageing and leaching as appropriate (Table 6). The veneers were fixed to one face of a block of solid Scots pine sapwood having its other faces treated with an effective fungicidal treatment. The holes to house the baits were drilled through the solid block so that the baits were just in contact with a treated veneer (Figure 2). The test block assemblies were exposed to the test fungi and monitored for penetration of the test fungi through the treated veneers.

5.3 Results

The data recorded have been evaluated with adequate performance being defined as preventing colonisation of more than one block over a 12 week incubation period. However, rather than expressing the results as the retention of preservative required to provide 12 weeks protection, the depth of treated veneers required to provide 12 weeks protection has been recorded. The data are summarised in Table 7.

Table 6 Summary of target retentions (in kg/m3) based on the highest biological reference values* determined in EN 113 tests with pre-conditioning appropriate to the hazard class

Timber type	Hazard class	Active ingredient			
		TnBTO	PCP	Tebuconazole	Acypetacs zinc (as zinc)
Softwood	1	na	na	na	na
	2	0.85	1.86	0.23	2.71
	3	0.85	2.07**	0.23	3.78
	4	0.85	2.74	0.23	3.78
	5	0.85	2.74	0.23	3.78
Hardwood	1	na	na	na	na
	2	0.85	1.86	0.23	2.71
	3	(c 2.0)	(5.74)	(c1.10)	3.78
	4	c2.0	5.74	c1.10	3.78
	5	c2.0	5.74	c1.10	3.78

c Close to
na Not applicable
( ) Additional local requirement
* The highest biological reference value is equal to the critical value if no further tests are required or provided that it is not exceeded by the biological reference values determined in other tests appropriate to the hazard class
** If white rot is included as an additional local requirement, a retention of 2.74 kg/m3 would be appropriate

Table 7 Depth of zone (in mm), treated to the appropriate brv, required to provide at least 12 weeks protection from colonisation by all the test fungi

Timber type	Hazard class	Depth of zone required to provide 12 weeks protection - mm			
		TnBTO	PCP	Tebuconazole	Acypetacs zinc
Softwood	1	na	na	na	na
	2	1	5	5	3
	3	1 (3)	5 (2)	5 (5)	4
	4	3	2	5	4
	5	3	2	5	4
Hardwood	1	na	na	na	na
	2	nt	nt	nt	nt
	3	(2)	(4)	(>3)	2
	4	2	4	>3	2
	5	2	4	>3	2

( ) Including the additional local requirement for activity against white rot fungi
na Not applicable
nt Not tested

5.4 Discussion

The data presented show that, at the retentions required to provide protection of fully impregnated test specimens (in EN 113 tests), the depths of treatment necessary to provide adequate protection against the test fungi were different for each active ingredient tested. For example, with TnBTO, 3 mm of Scots pine sapwood veneer treated to its brv for hazard classes 4 and 5 was sufficient to prevent colonisation by all the test fungi for 12 weeks. With other active ingredients treated to their respective brvs, different depths of treated Scots pine sapwood veneer were required to provide the same level of protection, that is 2 mm for PCP, 5 mm for tebuconazole and 4 mm for acypetacs zinc. This effect was observed when using veneers of either Scots pine sapwood or beech.

The interpretation which can be put on these results has to take account of the effects of pre-conditioning on performance. The brvs which were used as the target retentions were, as required by BS EN 599-1, derived after pre-conditioning appropriate to the hazard class, namely evaporative ageing (to EN 73) for hazard class 2 and evaporative ageing and leaching (to BS EN 84) for hazard classes 3, 4 and 5 (Table 6). Therefore, for products which lose some activity during pre-conditioning, the brvs will not represent accurately differences in freshly treated specimens, as used in the veneer study.

All the active ingredients used in the veneer study showed some loss of activity following pre-conditioning when tested using EN 113 methodology (Table 8). The significance of these losses in activity when interpreting the data from the veneer study was considered by Carey and Hull (1997). They showed that there was no simple relationship between the performance of the retention applied to the treated veneers and the retention required to provide protection to fully impregnated test specimens.

Overall it can be concluded that the retention of preservative needed to give protection in practice may be different from that predicted directly from laboratory tests, and that the difference will be dependent on the active ingredient. This finding emphasises the need for further work to calibrate the direct biological method to give better prediction of the performance of a range of products applied by normal commercial processes. Changes in efficacy following pre-conditioning confirm the need for laboratory tests to be carried out after appropriate pre-conditioning. An EU funded project has just started with the aim of developing such pre-conditioning methods.

6 Effectiveness of treatments for spruce

In order to improve prediction of performance in service of treated spruce, studies have been carried out using sticks, 38 mm x 38 mm in cross-section. These were end-sealed and treated using the V/3 schedule of BS 5268: Part 5 to apply a product containing 14.5 % (*m/m*) acypetacs zinc. When dry, the sticks were cross-cut into 100 mm lengths and both ends of each block sprayed with dithizone solution (0.1 g dithizone in 100 ml toluene). The colour change in the reagent due to the presence of zinc allowed the penetration of the preservative into the blocks to be observed. As expected, the penetration was variable and showed greater penetration in the latewood bands. The blocks were sorted visually into groups showing different levels of penetration. These groups have been referred to as '3 mm', '5 mm' etc which indicates broadly the minimum depth of penetration from the face subsequently to be challenged by the test fungus. For reference purposes, Scots pine sapwood blocks of the same dimensions were brush treated with 18.7 g/m^2 of the same product to represent the typical retention achieved by three minute immersion. All the blocks, plus untreated controls of both spruce and Scots pine sapwood, were exposed to the brown rot fungus *Gloeophyllum trabeum* using the modified ENV 839 method with baits as described previously. Chemical analyses were also carried out on samples from the treated spruce sticks which had not been exposed to the test fungus. From these data, the retention in the outer 3 mm zone of each of the groups of spruce blocks exposed to the test fungus was estimated.

The time to 'failure' of each replicate by the test fungus was recorded (Table 9). Overall, the spruce blocks in treatment classes 5 mm and >5 mm (estimated retentions of 42.7 kg/m3 and 70.7 kg/m^3 respectively) performed better than the brush treated pine blocks (estimated retention 64.3 kg/m^3). Therefore, despite the irregular penetration into the spruce, the test product was apparently more effective in spruce than in pine, as shown by the lower retention in the outer 3 mm. Similar indications of the better performance of treated spruce have also been obtained in field trials (Orsler and Smith, 1993). This correlation with field trial data gives added confidence that the new BRE laboratory method can provide a useful means of predicting the relative protective effectiveness of preservative treatments.

Table 8 Mid-toxic values (in kg/m3) derived from EN 113 tests*

Active ingredient	Unaged	Pre-conditioned	
		Evaporative aged	Evaporative aged and leached
TnBTO	0.26 (0.50)	0.85 (0.85)	0.85 (0.85)
PCP	1.68 (2.48)	1.86 (2.75)	2.07 (2.75)
Tebuconazole	0.13 (0.23)	0.23 (0.23)	0.23 (0.23)
Acypetacs zinc (as zinc)	2.58 (2.58)	2.71 (2.71)	3.78 (3.78)

* Highest value for brown rot fungi; highest value for brown rot fungi and Coriolus versicolor on pine in parenthesis

Table 9 Effectiveness of the treatment of spruce

Treatment	Time to first retrieval of the test fungus from each replicate - weeks										Retention* kg/m^3
Untreated pine	2	2	2	4	4	4					
Acypetacs zine/pine	8	10	10	18	18	18					64.3
Untreated spruce	2	4	4	4	4	4					
Treated spruce											
- less than 1 mm	6	8	8	8	10	10	10	18	18	24	21.5
- 1 mm	6	6	6	6	6	8	10	10	10	10	21.5
- 2 mm	6	8	8	8	8	10	10	10	12	M	21.5
- 3 mm	6	8	10	10	14	14	18	22	22	M	45.3
- 5 mm	10	12	16	22	22	24	24	28	32	>52	42.7
- above 5 mm	>52	>52	>52	>52	>52	>52	>52	>52	>52	>52	70.7

* Estimated retention of solution in the outer 3 mm based on chemical analyses for spruce and application rate for pine

M Tests blocks found to be mouldy at the end of the test

7 Testing chemically modified wood

One method of enhancing the durability of timber without the use of conventional biocides is by chemical modification. The principle is to react the chemicals within the timber with externally introduced chemicals such that the timber cannot be utilised as a food source by wood decay organisms or such that the timber cannot absorb enough moisture to allow fungal attack (Rowell, 1996). In co-operation with the University of Wales, Bangor, BRE has been attempting to quantify the decay resistance conferred to timber by chemical modification using predominantly straight chain alkyl anhydrides with pyridine as the solvent and catalyst for the modifier. This work continues that reported to the BWPDA

Convention last year (Hill and Jones, 1996) concerned with dimensional stabilisation, and water and moisture resistance conferred by the treatments.

In the programme at BRE, test methods based on both EN 113 and ENV 839 were used (Suttie et al, 1997). In EN 113 type tests, the three brown rot fungi *Coniophora puteana*, *Gloeophyllum trabeum* and *Poria placenta* caused decay of untreated Scots pine sapwood controls resulting in between 35 % and 42 % losses in mass whilst the white rot *Coriolus versicolor* achieved 22 %. Decay of solvent controls treated with pyridine was somewhat reduced but not prevented with the test fungi *C. puteana*, *G. trabeum* and *C. versicolor* but decay *P. placenta* was prevented completely. Modification with acetic, butyric and propionic anhydrides inhibited decay by *C. puteana* and *G. trabeum*, resulting in losses in mass of less than 10 %, and prevented any significant decay by *C. versicolor*.

Using ENV 839 type methodology, the effectiveness of 2 mm, 4 mm and 6 mm of modified wood against the fungi was compared with the effectiveness of a brush treatment with 1.0% TnBTO applied at 150 g/m^2. The results demonstrated that the test fungi were able to grow through the modified wood relatively easily, thus the pathways within the wood were not sufficiently obstructed by the chemical modification or the moisture conditions sufficiently reduced. The treatments slowed down the rate of penetration but this could be because the fungi derived no nourishment from the modified wood and had to transport nutrients from the untreated feeder blocks from which they were growing. None of the types of chemical modification tested prevented colonisation as effectively as the TnBTO treatment. The precise profile achieved during chemical modification of the larger blocks used in this methodology is not yet known, but it is thought that deeper than 10 mm from the surface there was probably a substantial reduction in the percentage of hydroxyl groups modified.

As with previous work with conventional preservative treatments, there was a marked contrast in the performance of the wood modification treatments depending on the method of assessment which was used. Whilst the modification treatments significantly reduced decay, as assessed by losses in mass, they had little effect on the ability of the fungi to grow through modified wood. Once again, this emphasises the need for an evaluation technique suitable for challenging directly treatments applied to wood. It shows also the value of the particular test developed at BRE for indicating likely performance in service.

8 The future

The methodology developed by BRE for testing directly the effectiveness of wood preservative treatments applied as so-called 'envelopes' has proved to be a very useful tool in investigating the processes of colonisation and decay of untreated, preservative treated and modified wood. At present, the future of the method in relation to European Standards is in doubt following an inconclusive vote at the end of the two year life of the pre-standard. However, the method has been shown to be extremely versatile and its use has been extended well beyond its original intention of assessing the effectiveness of simple, surface applied preservative treatments.

The methodology has been used on a limited scale to investigate treatments on spruce. It seems clear that it could also be used to assess the protection afforded to any other species difficult to treat, in particular hardwoods. At present, according to BS EN 599-1, the retention required to protect hardwoods is derived from the retention required to protect fully penetrated beech test specimens in a test using BS EN 113. For some commercial hardwoods, it is very unlikely that these retentions could be achieved in practice in the analytical zone appropriate to most penetration classes in BS EN 351-1. Additionally, many of the hardwoods likely to be used have a higher natural durability than that of beech. Therefore, it is legitimate to question whether the retention determined in beechcan be relevant in all cases. In any case, a reliable basis for determining an adjustment factor is required in order to determine the retention requirement to be used in BS EN 351-1, from the critical value established in BS EN 113 tests. The BRE laboratory method has the potential to provide the basis for this adjustment factor rather than waiting for the results of field trials.

The work carried out to date has investigated the relative protective effectiveness afforded by penetration and retention from lateral surfaces, as required predominantly in EN 351-1. With minor modifications to the method, it would be possible also to quantify the effectiveness of end grain penetration. It is usually assumed that the greater penetration achieved through end grain surfaces results in a higher degree of overall protection of a commodity. However, this principle needs to be quantified because in some of the work referred to earlier, test blocks with end grain penetration were no better protected than blocks prepared having only lateral penetration.

The methodology is also ideally suited to quantify the residual protective effectiveness of treated wood after periods of natural exposure in service. Samples of treated wood, in a size relevant to practice can be used in the new method and could be exposed directly to challenge by test fungi after sealing of any newly cut faces. It is likely that this would provide a better method for assessing residual effectiveness than that provided by chemical analysis alone which has to assume that the residue of active ingredient in the wood has the same effectiveness as the same amount introduced into new wood. Chemical analysis of wood after exposure has been used to assess the permanence of TnBTO (Henshaw et al, 1978). This work showed that TnBTO breaks down in treated wood in service producing di-butyl and mono-butyl derivatives, particularly when the wood is unpainted. If tri-, di- and mono-butyl forms are impregnated into wood, their effectiveness against decay fungi reduces by around 90 % with the removal of each butyl group. The direct measurement of the protective effectiveness of aged TnBTO-treated timber could examine whether this is true also for TnBTO degradation *in situ*. The methodology has been used to assess residual effectiveness of TnBTO treatments following six months natural weathering of unpainted wood (Bravery et al, 1995) and the work did show that loss of effectiveness was more marked with a three minute immersion treatment than with a double vacuum treatment. These results again lend weight to the case for having a suitably realistic combination of bioassay method and pre-conditioning method to give reliable indications of the likely efficacy under service conditions.

9 Summary

The need for procedures to enable the assessment of the protective effectiveness not only of wood preservatives but of wood preservative treatments (particularly those that do not fully penetrate the timber), has been recognised for over 20 years. The results of early work at BRE were reported to the BWPDA Convention in 1976.

Since that time, a new method of test has been developed by BRE which can be used to challenge directly a preservative treatment, thus including the interactions between timber species, process type and formulation parameters. Most of the main principles of this method have been incorporated into the experimental European Standard DD ENV 839.

The BRE method has been used extensively to study some of the fundamentals of the protection process using preservative treatments. For example, it has shown that the greater penetration of preservatives in the radial direction does not necessarily result in greater protective efficacy, at least with some active ingredients. It has also shown that some active ingredients, though not necessarily all, may be more effective when applied at a high retention in a relatively superficial zone rather than the same quantity of active ingredient being more evenly distributed throughout a deeper zone.

Results of research conducted by BRE to investigate the philosophy embodied in the new European performance standard for wood preservatives (BS EN 599-1) have shown that the retentions of different active ingredients which provide protection in laboratory tests using fully impregnated test samples, do not necessarily give the same level of protection when the same retention is present only in a superficial zone. Therefore, for the purposes of BS EN 351, which defines penetration and retention classes, the target retentions derived from laboratory tests according to BS EN 599-1 (i.e. the critical values) may require different adjustment factors to convert then into the retentions required in the analytical zone. However, the new BRE methodology provides a useful tool for being able to establish appropriate adjustment factors for different formulations.

The unevenness of preservative distribution when treating spruce is well known. However, BRE investigations using the new method have shown a better performance by treated spruce than by pine sapwood treated to the same retention in the analytical zone. This result, which correlates with experience from field trials, gives added confidence to the use of this new test method for determining and predicting the performance of preservative treatments.

Other specific aspects of preservative performance that need to be investigated further include the end-grain penetration necessary to provide adequate protection for specific commodities, and the levels of treatment necessary to afford protection to other difficult to treat species, in particular hardwoods. Although we do not have all the answers yet, we now have a methodology and the confidence in it necessary to proceed.

Acknowledgement

I should like to acknowledge gratefully the technical and financial support of the DETR Construction Directorate and the consortium of companies sponsoring the project at BRE on Integrated Joinery Protection.

References

Anon (1967). Preservative treatments for external softwood joinery. BRE, Princes Risborough Laboratory, Technical Note 24 (revised 1975).

Baker, J M (1974). Harmonisation of European standards for wood preservative testing. *Record of the 1974 Annual Convention of the British Wood Preserving Association*, 71-85.

Baker, J M, Laidlaw, R A, Miller, E R and Savory J G (1975). Research in wood protection at the Princes Risborough Laboratory 1973 & 1974. *Record of the 1975 Annual Convention of the British Wood Preserving Association*, 127- 150.

Baker, J M, Laidlaw, R A, Miller, E R and Savory J G (1977). Research in wood protection at the Princes Risborough Laboratory 1975 & 1976. *Record of the 1977 Annual Convention of the British Wood Preserving Association*, 3-27.

Becker, G and Starfinger, K (1971). Über die Reichweite der fungiziden und insektiziden Worksamkeit pigmenthaltiger öliger Holzschutzmittel im Holz. *Holz als Roh und Werkstoff*, **20**, 344-348.

Bravery, A F, Berry, R W, Carey, J K, Miller, E R and Orsler, R J (1995). Progress in wood protection research at BRE. *Record of the 1995 Annual Convention of the British Wood Preserving and Damp-proofing Association*, 37-49.

British Standards Institution (1961). Method of test for toxicity of wood preservatives to fungi. BS 838.

British Standards Institution (1982). Wood Preservatives. Determination of the toxic values against wood destroying *Basidiomycetes* cultured on an agar medium. BS 6009: 1982 (EN 113).

British Standards Institution (1989). Structural use of timber. Part 5. Code of practice for the preservative treatment of structural timber. BS 5268: Part 5: 1989.

British Standards Institution (1989). British Standard Code of practice for Preservation of timber. BS 5589: 1989.

British Standards Institution (1989). Wood preservatives. Accelerated ageing of treated wood prior to biological testing. Part 1. Evaporative ageing procedure. BS 5761: Part 1 (EN 73: 1988).

British Standards Institution (1992). Hazard classes of wood and wood-based products against biological attack. Part 1. Classification of hazard classes. BS EN 335-1: 1992.

British Standards Institution (1993). Wood preservatives - Field test method for determining the relative protective effectiveness of a wood preservative for use under a coating and exposed out-of-ground contact: L-joint method. BS EN 330: 1993.

British Standards Institution (1994). Wood preservatives - Determination of the preventive efficacy against wood-destroying basidiomycete fungi. BS EN 839: 1994.

British Standards Institution (1996). Durability of wood and wood-based products - Preservative-treated solid wood. Part 1. Classification of preservative penetration and retention. BS EN 351-1: 1996.

British Standards Institution (1997). Wood preservatives - Accelerated ageing of treated wood prior to biological testing - Leaching procedure. BS EN 84: 1997.

British Standards Institution (1997). Wood preservatives - Test method for determining the protective effectiveness against wood destroying basidiomycetes - Determination of the toxic values. BS EN 113: 1997.

British Standards Institution (1997). Durability of wood and wood-based products - Performance of preventive wood preservatives as determined by biological tests. Part 1. Specification according to hazard class. BS EN 599 -1: 1997.

Carey, J K (1992). The preventive effectiveness of preservative treatments against wood-rotting fungi - preliminary results. *International Research Group on Wood Preservation*, Document No: 2407-92.

Carey, J K and Bravery, A F (1985). Developments in the assessment of joinery preservatives. *Record of the 1985 Annual Convention of the British Wood Preserving Association*, 3-11.

Carey, J K and Bravery, A F (1988). A technique for assessing the preventive efficacy against decay fungi of preservative treatments applied to wood. *International Research Group on Wood Preservation*, Document No: 2309.

Carey, J K and Hull, A V (1997). The relationship between the depth of the treated zone and the performance of wood preservative products. Wood Protection (in press).

Deutsches Institut für Normung (1969). Prüfung von Holzschutzmitteln. Bestimmung der vorbeugenden Wirkung von Holzschutzmitteln. Prüfung mit holzzerstörenden Basidiomyceten nach dem Klötzen-Verfahren in Kolleschallen. DIN 52176: 1969.

Henshaw, B G, Laidlaw, R A, Orsler, R J, Carey, J K and Savory, J G (1978). The permanence of tributyltin oxide in timber. *Record of the 1978 Annual Convention of the British Wood Preserving Association*, 19-29.

Environmental Liability

by Pamela Castle, Partner, Head of Environmental Law, Cameron McKenna

Introduction

Environmental liability in the United Kingdom involves the potential for both civil and criminal liability and essentially arises when three factors are present. These are:

- a "Source" (i.e. polluting/dangerous substances);

- a "Pathway" (i.e. surrounding circumstances enabling the substances to move/escape: e.g., leakages and underlying strata types);

- a "Target" (i.e. potential sensitive receptors which could be damaged by any pollutants: e.g., a local water course or underlying aquifer).

Common Law and Statutory Liability

Common Law Liability

At common law, liability for environmental damage may arise in respect of the following actionable wrongs:-

- a person may be liable in nuisance if he permits an unlawful interference with another person's use or enjoyment of his land or of some right enjoyed by him over land or connected with it, where such interference is unreasonable in all the circumstances. However, if a person merely "adopts" a nuisance (e.g. by failing to remove contamination he suspects may be present when he has power so to do), he may also be liable in these circumstances;

- a person may also be strictly liable under the rule in Rylands v Fletcher if he brings something onto his land, collects it and keeps there "anything likely to do mischief if it escapes" and the damage it causes is the natural and foreseeable consequence of its escape, provided such accumulation etc. of substances constitutes a "non-natural" user of the land. The test of what is a non-natural use is linked not only to the nature of the use but also its utility. A Canadian case has held a landfill site to be a non-natural use of land and collection in a sewer of a large volume of effluent has been held in England to be a non-natural use.

- a person may also be liable in negligence if he owes a third party a duty of care of which he has been in breach and the damage caused to the plaintiff is a reasonably foreseeable consequence of that breach;

- where any object has been placed on another person's land or where there has been an unlawful entry to another's land, an action in respect of trespass to land may be brought without the need for the plaintiff to establish loss.

Interference might be by way of the passage of pollutants on to another's land. Action may be brought against the person(s) who caused the unlawful interference by the owner of the land affected. In addition, it is not necessary to prove that the defendant entered or caused the entry intentionally or negligently.

Statutory Liability

The most important statutory provisions in relation to the operation of an incinerator and the ownership of land which may be contaminated by either past or present uses are:

- Part 1 of the Environmental Protection Act - Integrated Pollution Control;

- Sections 85, 161 and 161A of the Water Resources Act 1991 (the "WRA") and Section 118 of the Water Industry Act 1991 - Water Pollution;

- Sections 79 to 82 of the Environmental Protection Act 1990 - Statutory Nuisances;

- Sections 33, 34 and 59 of the EPA - Waste Management;

- Section 219 of the Town and Planning Act 1990 (the "TCPA") - Land Detrimental to the Amenity of an Area;

- Occupier's Liability Acts 1957 and 1984;

- Sections 78A to 78YC of the EPA (as inserted by the Environment Act 1995) - Contaminated Land;

- directors' and Officers' Liability and Liability for Aiding and Abetting.

1. Intergrated Pollution Control

Control of pollution arising from certain industrial and other process became regulated under two regimes introduced by the EPA. Processes which are subject to central control by the Environment Agency are known as Part A processes and fall within the integrated pollution control regime and Part B processes are designated for local authority control and fall within Local Authority Air Pollution control.

Offences

It is an offence to carry on a prescribed process except under an authorisation and in accordance with the conditions to which it is subject. In addition, certain prescribed substances are set out in regulations, the release of which into environmental media is subject to control.

The Environment Agency is entitled to serve an enforcement notice or a prohibition notice upon a person carrying out a prescribed process or using a substance falling within Part A processes or substances. Failure to comply with such a notice is an offence which is punishable on summary conviction by a fine not exceeding £20,000 or by imprisonment for up to three months, or by both; or on conviction on indictment, by a fine or imprisonment for a term not exceeding two years or by both.

Numerous other offences relating to this regime are provided under section 23 EPA including failing to supply information, making false statements, intentionally obstructing an authorised person in the exercise of his powers/duties, failing to comply with the requirements of an authorised person, impersonating an authorised person, failing to comply with a court order.

Administrative Action

If an operator carries out an unauthorised prescribed process or fails to comply with an enforcement or prohibition notice and thereby causes harm which it is possible to remedy, under Section 27 EPA the Environment Agency may arrange for reasonable steps to be taken towards remedying the harm and recover the cost of taking those steps from any person convicted of the offence. Such action by the Environment Agency may only be taken with the written approval of the Secretary of State.

Clean Up Powers

Where a person is convicted of carrying out an unauthorised process or of failing to comply with an enforcement or prohibition notice, in respect of any matters which appear to the court to be matters which he can remedy, the court can, in addition to or instead of imposing any punishment, order him to take specified steps for remedying these matters. Failure to comply with such an order is itself an offence.

2. Water Pollution

Offence and Penalties

It is an offence under Section 85 of the WRA for a person to "cause or knowingly permit poisonous, noxious, polluting or solid matter to enter controlled waters". "Controlled Waters" are relevant territorial waters, coastal waters, inland freshwaters and ground waters, and would, in our view, include the underlying aquifer.

Commission of this offence may result, on summary conviction, in imprisonment for a term not exceeding three months, or a fine not exceeding £20,000 or both and on indictment, imprisonment for a term not exceeding two years or an unlimited fine or both.

Clean-Up Powers and Cost Recovery

Furthermore, under the provisions of Section 161 of the WRA the Environment Agency can take clean-up action where such matter is likely to enter controlled waters or has been present in controlled waters.

Where the Agency carries out such works itself, it is entitled to recover the expenses reasonably incurred. These costs are recoverable from any person who caused or knowingly permitted the matter to enter or to be likely to enter controlled waters.

A new section 161A has been inserted by the Environment Act 1995 whereby the Agency can now serve a "Works Notice" on the person who "caused or knowingly permitted" such substances "to be present" on the land or in the water, requiring such person to carry out any necessary clean-up works at their cost. This power is likely to brought into force early 1998.

Who will be liable

Case law shows that "causes" can essentially be considered as follows:

- it is a normal word to be construed in accordance with common sense;
- it involves active participation in a chain of activities carried out by the defendant;
- it is probable that an omission can constitute "causing";
- a failure to maintain a system can be sufficient to constitute causing;
- there can be more than one cause of the same event. Where there are two causes, it is not necessary for both causes to be prosecuted;
- where a company is charged with the offence, the status of the individual employee said to have caused the discharge is not relevant. It is not a requirement that the act be that of the controlling minds of the company for the company to be liable in respect of that act;
- mere standing by and looking on is insufficient to amount to causing.

The expression "knowingly permitting" is viewed as a failure to prevent pollution, though the failure must be accompanied by knowledge. The word "knowingly" has also been construed as referring to the knowledge of the act in question and not knowledge that the act was in fact outside the terms of any relevant licence or permission.

To permit is taken as giving leave without which an act could not legally be done, or to abstain from taking reasonable steps to prevent the act where it is within a person's power to prevent it.

As regards trade effluent consents, Section 118 of the Water Industry Act 1991 provides for an offence where the discharge of trade effluent into a public sewer is in contravention of a trade effluent consent or where no such consent is held. This offence is punishable by fines and/or imprisonment. Plants subject to IPC will be subject to IPC conditions in relation to that discharge and will also require consent from the sewerage undertaker.

Control over water - Overlap with IPC

Where an IPC authorisation covers the discharge of substances to water s88 of the Water Resources Act 1991 provides that any discharges made in compliance with that authorisation will not amount to an offence under s 85. Where a discharge is made in breach of an authorisation or without authorisation then an offence will be committed under s 23 EPA and S 85 of the 1991 Act.

3. Statutory Nuisances

Abatement Notices and Penalties

Sections 79, 80 and 81 of the EPA provide powers to local authorities in relation to statutory nuisances. They are empowered to serve abatement notices where they consider a statutory nuisance exists. Failure to comply with an abatement notice can result in the imposition of a fine of up to £20,000 where the offence relates to trade, industrial or business premises. Clean-up liabilities can also be imposed.

Matters which may amount to statutory nuisance under Section 79 of the EPA include:

- any premises (including land) in such a state so as to be prejudicial to health or a nuisance;
- any accumulation or deposit which is prejudicial to health or a nuisance. Where a statutory nuisance relates to land in a contaminated state, the new provisions on contaminated land will apply rather than the statutory nuisance provisions (see later).

Thus, if land which is in a contaminated state is presenting a statutory nuisance in some way unrelated to the contamination (e.g., noise), then the statutory nuisance provisions remain applicable

Who will be Liable

An abatement notice will be served by the local authority on either the person who is "responsible for the nuisance" (i.e., the person whose act or default or sufferance the nuisance can be attributed to) or if that person cannot be found the "owner or occupier of the premises/land". If the nuisance is due to a structural defect it is the owner of the premises against whom the local authority will bring proceedings.

"Owner" is defined in Section 81A of the EPA as "a person (other than a mortgagee not in possession) who, whether in his own right or as a trustee of any other person, is entitled to receive the rack rent of the premises or, where the premises are not let at a rack rent, would be so entitled if they were so let."

"Occupier" is not defined in the EPA but the courts have taken two broad approaches in considering who is an "occupier":

- the control test which provides that "wherever a person has a sufficient degree of control over the premises that he ought to realise that any failure on his part to use care may result in injury ... he is an "occupier";
- the "comprehensive and stable relationship" test, which provides that "the occupier is someone who, although lacking the title of an owner, nevertheless stands in such a comprehensive and stable relationship with the land as to be, in company with the actual owner, someone to whom the mechanisms [of the statute] can sensibly be made to apply.

Clean-Up Powers and Cost Recovery

As stated previously, failure to carry out the terms of an abatement notice may result in the imposition of a fine. In addition, as well as suffering criminal sanctions, the person so responsible may suffer further financial hardship if the local authority exercise their powers to carry out the clean-up work itself and recover the costs of such work from the person responsible for the nuisance or from the owner for the time being of the premises where the nuisance is caused by their default.

Controls over statutory nuisance - Overlap with IPC

Where a local authority wishes to initiate its statutory nuisance powers in relation to a prescribed process, it must first get the Secretary of State's consent (EPA, s 79(10)). This only applies in cases of smoke, dust, steam, effluvia, accumulations or deposits. In essence then, statutory nuisance provisions would only apply in respect of noise as other enforcement action can be taken by the Agency under its IPC powers.

4. Waste

a) Deposit of Waste

It is an offence under Section 33 of the EPA to:

- deposit "controlled waste" (as defined to include household, industrial and commercial waste) or knowingly cause or knowingly permit its deposit unless a waste management licence is in force and its conditions are being complied with;
- treat, keep or dispose or knowingly cause or knowingly permit controlled waste to be treated, kept or disposed of in or on any land without a waste management licence;
- treat, keep or dispose of controlled waste in a manner likely to cause pollution of the environment or harm to human health.

Such an offence is punishable in the Magistrates' Court by the imposition of a fine of up to £20,000 or imprisonment for up to 6 months. Where proceedings are brought in the Crown Court, an unlimited fine maybe imposed and/or imprisonment for up to two years.

b) Duty of Care As Regards Waste

Section 34 provides that it is the duty of any person who imports, produces, carries, keeps, treats or disposes of controlled waste or, as a broker, has control of such waste to take all reasonable measures:-

- to prevent anyone else committing an offence under section 33;
- to prevent the escape of waste from his control or that of any other person; and
- to ensure compliance with transfer note requirements and to secure that waste is only transferred to an authorised person.

Failure to comply with the duty of care is a criminal offence punishable on summary conviction by a fine not exceeding £5,000 or on indictment, to an unlimited fine.

c) Removal of Waste - Clean-Up Powers and Cost Recovery

Section 59 of the EPA provides a power for the Environment Agency to require the removal of waste unlawfully deposited by the "occupier" of the land (see previous definition of "occupier"). An unlawful deposit would include any waste deposited in contravention of a waste management licence or where there is no such licence in place. Failure to comply with a removal notice is a criminal offence. In addition, non-compliance allows the Environment Agency to do whatever the notice required the person served with the notice to do and recover their costs of so doing from the person served with the notice.

Where the Environment Agency considers it to be necessary to remove or prevent pollution and finds that there is no occupier of the land or that the occupier neither made nor knowingly permitted the making of the deposit, the Environment Agency may remove the unauthorised deposit and recover the costs from the occupier, unless the occupier proves that he did not deposit or knowingly cause or knowingly permit the deposit. The Agency may also seek to recover its costs from any person who did deposit or knowingly cause or knowingly permit the deposit.

Control over waste management - Overlap with IPC

Certain activities governed by other pollution control regimes are excluded from the WML regime :

- the deposit in or on land, recovery or disposal of waste under an IPC authorisation unless this involves the final disposal of waste by deposit in or on land;
- the disposal of waste under a Local authority air pollution control authorisation for an incineration process insofar as the activity results in the release of substances into the air (again, unless this involves the final disposal of waste by deposit in or on land);
- the disposal of liquid waste under a discharge and other consents under the WRA.

5. Land Detrimental to the Local Amenity

Under Section 215 of the TCPA if it appears to the local planning authority that the amenity of a part of their area, or of an adjoining area, is adversely affected by the condition of land in that area, they may serve on the owner and occupier of the land a notice under this section. This notice may require such steps for remedying the condition of the land as may be specified in the notice.

Offence and Cost Recovery

It is an offence to fail to take the steps required by the notice within the period specified. Cost recovery provisions apply to the person who is then the owner of the land.

6. Occupier's Liability

An owner/occupier may also be liable for any injury caused to visitors under the Occupier's Liability Act 1957 if he fails to take such care as, in all the circumstances of the case, is reasonable to see that the visitor will be reasonably safe in using the premises for the purposes for which he is invited or permitted by any occupier to be there. The Occupier's Liability Act 1984 imposes a liability on occupiers in respect of trespassers in certain circumstances.

These provisions are probably only really of relevance where the land in question is heavily contaminated such that the trespasser or visitor will be obviously harmed by entering on the land.

7. Liability for Contaminated Land

A new statutory liability regime (sections 78A to 78YC, EPA) is soon to be introduced (possibly later in 1997) which imposes retrospective strict liability in respect of land which local authorities consider to be contaminated.

Meaning of Contaminated Land

Such land is defined as being in such a condition, by reason of substances in it, that either significant harm is being caused or there is a significant possibility of such harm being caused, or pollution of controlled waters is being or is likely to be caused.

Draft statutory guidance was recently issued for consultation which sets out the circumstances in which it is likely that land will be construed to be causing "significant harm" or to be creating a significant possibility of such harm being caused. Essentially, it is a matter to be determined on the basis of a risk assessment in relation to the potential sources, pathways and targets of contaminants.

This regime will not however apply to land in relation to which a waste management licence is in force, save it would seem in respect of off-site contamination.

Who will be liable

Once such land has been identified (and the local authorities are under a duty to inspect their area to determine whether or not such land exists), the enforcing authority (i.e. the local authority or the Environment Agency in relation to certain "Special Sites") will serve a "remediation notice" on the "appropriate person" requiring the site to be cleaned-up.

In the first instance, such a person will be the person who "caused or knowingly permitted" the substances which are causing the problem to be present on land. (See the clarification of these terms set out earlier in this note).

Where there are two or more such appropriate persons falling within this category, what are known as "Exclusion Tests" are likely to apply. These Tests are still in draft consultation form and may not therefore reflect the regime as it may be enforced in practice.

If the person who causes or knowingly permits cannot be found (after reasonable attempts have been made to trace such a person) then the owner or occupier for the time being is the appropriate person. In addition, other Exclusion Tests may apply in respect of this category of "appropriate persons".

Furthermore, an "innocent" owner/occupier who does not cause or knowingly permit substances to be present on the land shall not be responsible for the clean-up of controlled waters which have been contaminated by substances which were brought on to the land by another person prior to the present owner/occupier's occupation. The enforcing authority may carry out remediation in such a case but it shall not be entitled to recover the cost from such person.

Enforcement

Failure to comply with a remediation notice will result in the imposition of a fine of up to £5,000 (plus a daily fine) and up to £20,000 where the offence relates to industrial, trade or business premises.

In addition, the enforcing authority may instead bring proceedings in the High Court if it considers that proceedings to impose a fine will afford an ineffectual remedy to secure compliance with the remediation notice.

The enforcing authority itself has a power to do what is appropriate by way of remediation to the relevant land or waters to the extent that such remediation could have been required of an appropriate person.

Cost Recovery and Charging Orders

Where it does carry out such remediation, in certain cases, the enforcing authority may recover the reasonable cost incurred in doing it from the appropriate person, or if there are two or more appropriate persons, from those persons in due proportion. In deciding whether to recover the cost and if so, how much of the cost the enforcing authority is to have regard to:

- any hardship which the recovery may cause to the person from whom the cost is recoverable; and
- any guidance issued by the Secretary of State for this purpose.

The enforcing authority may also serve a charging notice on an owner of any premises, which consists of or includes the contaminated land in question, who caused or knowingly permitted the substances to be in the land and serve a copy of it on every person who, to the knowledge of the authority, has an interest in the premises capable of being affected by the charge, until the cost and interests are recovered. It is likely that such a charge will rank in priority to any other charges already secured over the land.

Conclusion

As these new provisions are yet to be brought into force, it cannot be determined with any degree of certainty how they will apply and be enforced in practice.

8. Personal Liability of Directors and Officers

It should not be forgotten that directors and officers of companies may suffer personal liability for criminal offences committed by their company. The Environmental Protection

Act 1990 and the Water Resources Act 1991 provide that where an offence under these Acts is committed by a corporate body which can be proved to have been committed with the consent or connivance of or to have been attributable to any neglect on the part of any director or other similar officer (or a person purporting to act in that capacity), he shall also be guilty of such an offence as well as the corporate body.

Furthermore, where such an offence is due to the acts or defaults of another person, that other person may be charged with and convicted of the offence whether or not proceedings for the offence are taken against the first-mentioned person.

On general criminal law principles, a person may be liable to conviction as an accomplice for aiding, abetting, counselling or procuring an offence under section 8 of the Accessories and Abettors Act 1861 or section 44 of the Magistrates' Courts Act 1980 in respect of summary offences.

In broad terms, to encourage or assist in the commission of the offence is sufficient. Regret at the situation or lack of any desire to see the offence committed is irrelevant.

A person may be liable for conviction of the offence as if they themselves had committed the act amounting to the crime, providing that the had knowledge of the facts which gave rise to the offence, although it is not necessary that an aider etc., should know that what he brought about was an offence.

In addition, if a number of people agree that an act or omission which amounts to a crime shall be arranged, then, even though someone else may actually commit the offence, those parties may be liable for prosecution for conspiracy.

On conviction, accomplices face the same maximum penalties as if they had committed the offence themselves. Conspirators are liable to imprisonment for the same maximum period but there is a power to impose an unlimited fine regardless of the maximum set for the offence in question.

Conclusion

Environmental liability can arise in a number of situations and can be imposed on a variety of parties. In addition, in environmentally sensitive operations an operator and anyone with whom the operator is involved will be required to give consideration to the applicability of legislative requirements to those operations.

Implications range from the imposition of fines or clean-up costs to the revocation of necessary operating licences with consequential commercial viability considerations.

The Environment Agency and the Wood Preservation industry

by Gerry Claydon, The Environment Agency

Mr Claydon's presentation dealt with the proposed joint BWPDA / EA / HSE Code of Practice for Safe Design and Operation of Timber Treatment Installations. This is now available from BWPDA

Design for Durability in Timber - A History

by Peter Ross, Associate Director, Ove Arup and Partners

The designer in timber has in general four aims in mind: strength, stability, durability and appearance, although these aims are sometimes in conflict. The art of structural design (for it is more an art, or at least a craft, than a science) is to balance these technical aims with a client's desire for economy. In this paper I shall attempt to follow the designer's quest for durability over the last thousand years, with a brief look at the current picture.

We cannot see the beginning of the timber tradition of building. The archeologist can show us Roman work which is confident and assured, but I will start with the oldest timber building in England still standing in its original location - the small church of Greenstedjuxta-Ongar, in Essex. Here we see an almost singular example of the Scandinavian tradition - vertical logs, split and turned, and joined with loose tongues. The church was 'severely restored', as The Builder put it, in 1345, at which time the brick plinth was introduced, but most of the staves are still original, and the building illustrates the traditional approach to durability - oversailing eaves, no water traps, and, above all, a naturally durable species - oak - with the sapwood removed.

These principles were used for the next five hundred years - timber's 'golden age'. Churches, from the twelfth century on, used timber for the roofs, initially with steep pitches, which were perhaps originally thatched, or later slated or tiled. Domestic buildings were completely framed in timber, using waffle and daub infill panels. Regional styles emerged, from the strongly vertical panels of the South, to the square panels of the North, which often contained decorative infills. Barns, were almost entirely of timber, although the grandest resemble churches rather than grain stores.

Early in the sixteenth century, however, the West Front of Hampton Court Palace had been completed in brick. This was not the first brick building in the country (the Romans, for instance, had used brick) but it was the first major use of the material after the techniques of manufacture had been lost in the Dark Ages. As the technology spread, bricks were capable of mass production to an extent which could not be achieved with the timber frames. Moreover, bricks were fire-proof. After the Great Fire of London, the 1667 Rebuilding Act forbade the use of timber in front and party walls. Thus in the (now Classical) buildings of the seventeenth century on; timber was used only for floor and roof elements, within masonry walls.

Around this time there was also a rapid rise in imports of softwoods from ports around the Baltic Sea. These were of course less durable than oak, but cheaper. The timber was now 'inside' the building, and the lower durability could be accepted. There were, however, still vulnerable points in the construction - principally the parapet gutters, intermediate floor joist ends, and ground floors generally, where water could potentially get to the timber and allow rot to develop. Whether it did or not depended to some extent on the quality and scale of the construction, and the Darwinian principle has to some extent determined the buildings which are still with us today. The softwoods were also useful for external joinery, being straightgrained and with a lower moisture movement than oak. To compensate for the lower durability, paint was now used generally as a decorative finish.

The Industrial Revolution of the nineteenth century created demands for new and larger forms of structure, such as mills and warehouses, and most spectacularly the covered slips of the dockyards - needed of course to prevent premature decay occurring in oak ships under construction. Almost the sole survivor is the No.3 slip of 1833 at Chatham Dockyard. However, only eight years later, the adjacent slip, No.4, is constructed in the new wonder material, wrought iron, and from this time on, iron (and then steel), rose to prominence for commercial applications. And although these metals were ultimately vulnerable to the effects of water, they generally out-performed the softwoods, given routine maintenance. In parallel, ship design took a quantum leap forward with the introduction of iron. Brunel's Great Britain, the first ocean-going vessel to be screw-driven and built entirely of iron, was launched in 1843.

Timber was still used in domestic work, and for church roofs, for instance, now being built again after a lapse of some four hundred years. Sometimes the new tropical hardwoods were used, but these were employed primarily for their outstanding durability in marine structures, such as groynes, jetties, and the tea clippers such as the Cutty Sark, although strictly this was a composite ship of wooden planks on an iron frame.

Techniques of mass production meant that such common-or-garden items as nails were now relatively cheap, and it became possible to fix small pieces of timber together to make relatively large structures, such as Belfast trusses, originating in the city of that name and intended to be covered with the newly-invented bituminous felt.

Felt also made possible the economic introduction of the damp-proof course into buildings generally which, together with the cavity wall, helped to protect the internal timber. Detailing around cavity bridges, however, particularly the window, was still difficult, and was not fully solved until the commercial development of a PVC sheet in the 1960s.

The search for larger spans in Victorian times had produced the bolted laminated arch, used originally for the structure of the train sheds of King's Cross Station in 1852 (although they were later replaced by iron). The shear capacity of the bolts was relatively low, however, and the principle could not be used for beams - these needed adhesives. Unfortunately, the two forms available - animal glues, and casein (based on milk) - were not durable. It needed the War-time development of the formaldehyde adhesives, used for the assembly of the Mosquito aeroplane, to allow the manufacture of the 'glulam' - the glued laminated beam. By finger jointing the individual laminations components could be produced of a size which was limited only by the question of transport and which were as durable and fire resistant as solid timber..

The post-Medieval dominance of the softwoods, which generally included sapwood in the sawn section, meant that timber was potentially non-durable unless it was in an internal or protected external environment. This led, of course, to the search for preservatives; materials which were toxic to fungi and wood-boring insects, could be introduced into the timber to an effective depth and then fixed there.

The development of preservatives is familiar ground to most members here today and so I will briefly summarise. After much experimentation, the first commercial preservative was creosote, which has been in use now for some 150 years. Its effectiveness was increased by the invention by John Bethell of a method of impregnating the timber under pressure, borrowing expertise in the construction of strong cylinders from the railway engineers. Used for the impregnation of countless railway sleepers and telegraph poles, creosote was nevertheless too pungent to be applied to building construction. The principal two building preservatives - the water-borne CCA compounds, and the organic solvents - are essentially twentieth century products, dating from the inter-war period.

In the 1950s the timber frame re-emerged for domestic construction, although now a modest inner leaf only. The Building Societies' approach to durability was simple - you could clad the frame in any material you liked as long as it was brick. Nevertheless, the timber frames' share of the market was approaching 30% until a Granada 'World in Action' programme suggested that the hidden frame was prone to rot. Sales plummeted, and BRE were commissioned to investigate. After ten years, they found there wasn't a problem.

Historical surveys are difficult to bring up to date, but for timber the current issues are probably environmental concerns and alternative materials. Timber, of course, is virtually the only renewable building material (Putting aside thatch), and softwood reserves are apparently still increasing. The use of tropical hardwoods, however, is seen as a contribution to the destruction of the rainforests, although their use in construction work is insignificant compared to the joinery trade. The obvious alternative, which also makes economic sense, is to preserve softwoods for the relevant applications, particularly with the likelihood of more juvenile wood coming on stream. However, the preservatives themselves are also coming under scrutiny - the pendulum rarely hangs in a vertical position.

Alternative materials to preserved timber are dominated by the environmentally unfriendly UPVC components - in particular, when used for windows - advantaged by the recent Regulatory increases in required insulation values. Long-term durability and availability of the often sophisticated metal furniture may be their undoing, but the timber window industry looks set for a winter of discontent.

The Dry Rot Fungus

Anne Pia Koch, Danish Technological Institute, Department of Biotechnology

Problem

The Dry Rot fungus (*Serpula lacrymans*) is the most destructive wood decaying fungus found in building timber. It can develop and destroy wood very quickly and it easily penetrates inorganic materials, e.g. masonry. As other fungi it reproduces by developing air-borne spores. If insufficiently repaired, further development of an infestation may occur. By unauthorized reutilisation of materials from demolished buildings there is a risk of spreading fungal decay caused by the Dry Rot fungus.

It is essential to:

1. identify the fungus correctly,
2. determine the extent of the attack,
3. eliminate all sources of moisture and promote drying,
4. eradicate and repair correctly.

Items 1 and 2 often involve laboratory analysis.

Solutions

Occurrence

As all other fungi Dry Rot is dependent on moisture. However, once established, fungal activity can continue under conditions with limited access to moisture (see "Explanation").

Dry rot is not found in nature. It is most commonly found in internal timber constructions bearing into masonry or other calcareous material. The fungus most likely utilizes basic materials, e.g. lime, to neutralize the acid produced during its development. Certain metals, e.g. iron, may also contribute to this process.

Dry rot attacks are most often concealed within constructions. An outbreak may be of considerable size before showing any visible signs of its presence. Obvious evidence of a Dry Rot attack is the occurrence of brown fruit bodies with a white rim, brown spore dust or bulging surfaces of floor boards, panelling and skirtings. Attacks are often discovered when surface mycelium becomes evident when furniture is moved or wall panelings are taken down. Active infestations often smell like mushrooms. Old moist attacks may have an unpleasant smell. Desiccated, dormant or dead attacks have no smell.

The Projecting Phase

In practice, a new attack of Dry Rot is not Initiated in wood not already slightly degraded by other types of wood decay.

Thus, new timber from a timber yard is rarely infected with Dry Rot. However, if brought into contact with infected timber or masonry, even new timber can become infected.

Reutilization of building material involves a risk of spreading an infection. Infected timber from demolished buildings should be disposed of during the demolition phase. Only timber which has been investigated and declared free from Dry Rot should be reused.

When projecting a new building or reconstructive work, all risks of water ingress must be identified and eliminated. Untreated timber must not be placed in direct contact with masonry. Wherever existing constructions are at risk of being exposed to moisture, e.g. built-in wall plates, headers, half-timbering, etc., impregnated timber should be used.

Direct absorption of moisture from masonry, into e.g. wall plates and joist ends, can be prevented by the use of base felt. Timber constructions must be ventilated to the greatest possible extent.

The Construction Phase

During construction of new buildings as well as repair work, compliance with the projected specifications must be ensured. Moisture originating from the construction work must not be confined within the building. If exposure to moisture cannot be prevented completely, timber constructions must be ventilated and/or impregnated. Cut edges, plane sections, sheared edges, holes, etc. in impregnated wood must be protected by subsequent application of a wood preservative by surface treatment and perhaps remedial treatment. Reused timber to be placed in constructions that may be exposed to moisture must be impregnated industrially or in situ by remedial treatment.

The Service Phase

Sooner or later, the daily use of a building combined with the effects of the weather will lead to the development of holes, cracks, clogged or leaking pipes, etc. Via these defects moisture can reach timber constructions. If the water ingress is not stopped quickly, the result may be the initiation of fungal decay.

This risk is minimized considerably if regular systematic inspections of relevant constructions are carried out. They must be followed up by repairs as soon as holes and leakages are detected.

Maintaining a building in good condition is facilitated if a maintenance plan is described and followed. Development of a suitable maintenance plan demands specialized knowledge and experience. Involving the services of an engineer or an architect may be an advantage in this context.
The plan should contain a list of items to be checked when surveying a building. Further more it should contain information about the recommended interval between surveys as well as a list of specific maintenance works to be carried out within the next few years.

The correct interval between surveys depends on the type of construction in question and its maintenance standard. For example, a gutter on a house surrounded by tall trees becomes clogged more easily than one on a 5-storey building.

Repair Work or Eradication Strategy

An attack of Dry Rot demands a much more thorough eradication procedure than other types of decay. Remnants of the fungus left in wood or brickwork can spread into newly repaired constructions, leading to further damage.

There are several methods of controlling outbreaks of Dry Rot. The traditional method, described below, is based on many years of experience. Heat treatment is a new method based on the fact that the Dry Rot fungus is killed when exposed to 50C for 16 hours. At higher temperatures shorter exposure trine is necessary. Other methods, for example microwave treatment, are under development.

The choice of method should be based on an economic evaluation. Heat treatment may not be the optimal solution if major repair work is necessary in a relatively simple construction due to extensive decay.

Furthermore, environmental and safety aspects must be considered when determining the optimal solution.

Preliminary Building Surveys

To ensure an adequate basis for the choice of method, the full extent of the attack and extent of weakened constructions must be determined.

These investigations are usually carried out during a preliminary building survey which includes determination of the moisture distribution.

The next step is to investigate hidden constructions, for example by lifting floor boards along façades and exposing embedded timbers.

In the near future the extent of internal decay in timber can be determined by means of RDS, Radiological Density Scanning, a new method under development at the DTI.

The equipment can determine the density distribution of a beam section without removal of floorboards. This means that the extent of weakening due to fungal decay can be established.

Other instruments, such as specially developed drilling machines, e.g. the Decay

Detecting Drill, may be used to determine the density of timber.

Endoscopies can be used to detect changes in surfaces and the possible occurrence of surface mycelium or fruit bodies within hollow constructions.

In general, if extensive damage due to fungal decay is found in a building, a plan for its repair should be described before repair works are Initiated. Any changes made in the work plan alter the contract has been signed may lead to an increase of expenses.

The Traditional Control Method

The recommendations listed below are in accordance with guidelines used all over the world, for example in the German Norm DIN 68.800, Teil 4.

1. All sources of moisture must be eliminated. Moisture can originate from leaks in the roof, gutters or downpipes, rising damp in foundation walls, cellar floors, etc.

2. All visibly decayed wood is removed. As the extent of decay can be difficult to detect in the boarder zones of the attack, an additional 50-100 cm is removed. If this safety zone is to be reduced, a specialist must be consulted.

3. The affected timber must be burned as it is highly contagious.

4. As fungal mycelium easily penetrates plaster, mortar, etc. in masonry, the plaster is removed and 3 cm of the mortar joints are scraped out wherever mycelium is visible plus a safety zone of 50-100 cm in all directions.

5. The surface of the brickwork is singed with a gas burner as new mortar adheres with difficulty to remnants of mycelium.

6. The wall is brushed or sprayed with a suitable registered fungicide. Half of the recommended dose is applied initially. The joints are filled and the other half of the recommended dose is applied. The wall is rendered or trowelled with plaster so that the fungicide is enclosed within the wall. The same type of treatment is applied to any embrasures for doors or windows within the treatment area.

7. For the replacement of structural timber, wood having been pressure-impregnated according to existing standards is used. Timber to be built into brickwork should not be cut or sawn after impregnation.

Shortening of joist ends will expose untreated heartwood. In this case the end surface should be otherwise protected, for example by boring 3-5 holes which are then fined with a wood preservative to protect the heartwood.

Windows and doors should be double vacuum-impregnated according to existing standards.

8. Wood in contact with external walls, e.g. strings, floorboards and skirtings, should be brushed with a registered, colourless wood preservative containing a fungicide.

9. Suspended wooden floors in basements or above crawl spaces and solid floors are preferably replaced by concrete on a damp proof course. Furthermore, use of wooden skirtings, panelling, etc. should be avoided in basements and other places with occasional moist conditions.

The traditional method described above has proved to be the safe method. In addition, alternative methods are available. Application of these methods must be planned in collaboration with a specialist in fungal decay.

Heat Treatment

Heat treatment of Dry Rot consists of exposing the totality of all infested constructions, e.g. masonry as well as timber, to 50°C for 16 hours.

Even though the process is simple, it must be carried out by experienced personnel under adequate control procedures. The treatment must comply with existing demands regarding temperature and duration of treatment.

To ensure the quality of heat treatment, the companies specialized in this service in Denmark have made a voluntary organization called VKS.

All heat treatments are carried out under the auspices of this supervision system; a standard control scheme according to the rules set up by the Danish Society of University Engineers, DIF. The regulations for performing heat treatment are laid down by an independent supervision board who's members represent independent institutions with relevant expertise.

The regulations contain specific demands concerning

- the initial advisory services,
- building surveys,
- description of the heat treatment procedure aimed at optimizing the process and ensuring sufficient heating of all infested constructions,
- temperature recordings,
- preventive measures,
- documentation.

Explanation

Occurrence and Optimal Growing Conditions

Dry rot is the economically most important wood destroying fungus. This is due to two factors: Dry Rot is able to develop quickly and it can transport water and nutrients in its strand mycelium. Thus it can moisten wood at a distance of several meters from any moisture source. However, it is most common in moist unventilated constructions.

As opposed to most types of decay in buildings, the Dry Rot fungus is not found in nature in Europe. It is most often associated with mortar, cement, pugging and similar calcareous building materials. The distance to the nearest lime source rarely exceeds 100 cm.

As is often the case in wood decaying fungi, Dry Rot produces oxalic acid, which probably makes the lignin component of the wood more permeable to cellulose degrading enzymes. Accumulation of oxalic acid results in inhibition of the fungus. Consequently, the Dry Rot fungus is found close to materials that can neutralize the excess acid.

Infested wood turns brown when the cellulose component is degraded by the fungus. Characteristic transverse cracks are formed with intervals of 3-7 cm.

Degradation of the cellulose leaves a brittle brown material with lignin as the main component. The strength of the wood is reduced. This becomes obvious when boards no longer can carry their load of plaster, which consequently falls down, or when floors or staircases collapse. Infestations of wood destroying fungi, which are the most economically important, result in the formation of brown rot.

The optimal wood moisture content is 20-30%. When thoroughly established in wood, the fungus is able to regulate the moisture content to some extent by transporting water for some distance via the strand mycelium. The water can then be exuded if conditions are too wet.

The mycelial strands can become up to 8 mm thick. They grow across wood and penetrate mortar joints via cracks and crevices. Thick dry strands are brittle and snap if bent.

Under extremely moist conditions with a high relative humidity and stagnant air, a cottony layer of fungal mycelium can develop on surfaces of wood and brickwork. At later stages it turns grey and leathery and is easily pulled off.

The fact that Dry Rot is confined to wood in buildings can be explained by its ability to regulate moisture and acidity. Furthermore, only minor temperature fluctuations occur in constructions where Dry Rot is most common. Its preferred temperature is 20°C.

The fruit body of Dry Rot varies in shape depending on the position in which the fruit body develops. It can be a thick, fleshy plate or a thick, broad bracket. It is fastened loosely to the surface and can easily be removed. The spore producing layer can be folded or irregularly toothed. The spores are rusty brown. The size of the fruit body can vary from a few centimeters to 1 meter or more in diameter.

Moist wood can become infested via spores that germinate on the surface, leading to the development of branching mycelium within the wood. Contact with infested wood can also lead to new attacks. Old timber or firewood should not be kept in moist rooms. Timber from demolished buildings should only be reused after careful inspection.

History of Control Methods

Dry Rot is mentioned in the bible along with recommendation of severe control methods which include more belief than efficient treatment.

Today fungicides that can kill or inhibit the fungus are available. However, no professional laboratory would recommend control of Dry Rot in wood by chemical means only. The process also involves removal of infested wood. However, for environmental reasons it is strongly advisable to develop new integrated control strategies which involve less use of chemicals.

Heat Treatment

Laboratory experiments have shown that the Dry Rot fungus is very sensitive to heat. Growth cannot be induced in mycelium that has been exposed to temperatures of 50°C for 16 hours.

The exact effects of heat on Dry Rot under different conditions is being investigated. It seems that vital parts within the cell itself are damaged at the heat dose mentioned above.

The fungal spores are not killed at this temperature. However, this is considered less important, as spores are present everywhere. Furthermore, a wood moisture content of more than 30% is necessary for spore germination.

When performing a heat treatment, moist constructions must either be dried or chemically protected. It is important to optimize the heating process to ensure the best economy and to minimize the risk of unwanted side effects due to desiccation. The heating process and thus the temperature development is planned before the heat treatment takes place.

Without careful planning the heat amount may be insufficient, resulting in an increase of heating time and drying of constructions. Introduction of too much heat will lead to a large energy consumption without reducing the heating time correspondingly.

Development

New methods for investigating and controlling fungal decay are being developed, among others vital staining and microwave treatment.

A general intention to reduce the expenses of repairing fungal attacks in buildings can lead to the adoption of new, unknown methods before sufficient knowledge of their possibilities has been accumulated.

Serious consequences to all parties involved can be the result if many buildings are treated inadequately.

It is paramount to consider whether the efficiency of a specific method has been documented and evaluated by a competent, impartial authority.

Vital Staining

The possibility of determining the vitality of fungal mycelium by means of staining techniques is being investigated in the laboratory. The results have not been unambiguous, so general application of these techniques is not recommended.

In addition, the location and number of samples to be investigated is difficult to determine. 95 % of an attack can be dead, while the remaining 5 % can be alive, deeply imbedded within the construction.

Microwaves

An adequate dose of microwaves kills living organisms. The use of microwaves to control small attacks is a promising technique. However, several aspects need elucidation, for example definition of the dosage, control of its application and, of major importance, protection of humans against the radiation.

Copenhagen, 17 June 1997

Remedial Wall Tie and Masonry Restraint System

Francis Brownsill, CSRT Cementone Beaver Limited

1.0 The History of Wall Ties and Causes/Symptoms of Corrosion

1.1 Function

Cavity wall construction has become the norm in domestic and commercial construction. Although in limited use throughout history in various guises, the cavity wall as we presently perceive it has been in general use for approximately 60 years.

With its development has come the requirement to physically tie inner and outer leaves of the masonry together to resist the stresses imposed by lateral loading on the walls from internal floors etc. and also the forces of wind, both as pressure and suction effects.

The ties must allow for some degree of flexibility and movement in a building due to thermal movement of dissimilar building materials used in the inner and outer skins.

1.2 History

A wide range of materials have been used as ties. In some early constructions brick or other ceramic materials have been employed to fulfill the function. However, most commonly metal ties have been utilised; initially consisting of wrought or cast iron with a bituminous or galvanised protective layer. More recently, ties have been constructed from mild steel strip or wire with similar coatings.

In 1964 a change in the requirements of the British Standard BS 1243 resulted in a reduction in the required weight of galvanising zinc applied to wall ties. In the light of subsequent reported corrosion problems and failures the required figure was consequently increased in 1981 to a uniform 940 g/m_ zinc coating.

There is therefore a substantial stock of housing where:-

a) The ties are 30-60 years old and may be approaching the end of their useful service life.
b) Stock constructed between 1964 and 1981 may contain ties of reduced performance and durability as a result of the thinner zinc coating.

1.3 Other Factors of Degradation

In addition to the above (1.2), wall tie corrosion is heavily influenced by other factors. Most important are the levels of moisture in masonry from various sources (this being the main reason for the difference in the degree of corrosion noted between the inner and outer leaves of a cavity wall). There may be significant circumstantial evidence in a given area of housing stock indicating a higher level of risk to wall ties:-

1) Constructed using black ash mortar.
2) Subject to higher than normal exposure, e.g. near the coast, on exposed hills or areas subject to heavy industrial pollution.
3) Built between 1900-1940.
4) Buildings with vertical twist ties built post-war or early 1970's.
5) Buildings over 20 years old with galvanised wire ties.
6) Timber framed buildings over 15 years old with galvanised ties.

As a general guide, properties meeting the first three criteria should be considered significantly at risk.

1.4 Physical Indications - Cracking

Rusting mild steel can expand in volume fourfold, therefore the thicker vertical twist ties can cause splitting of the joint in which they are embedded. Recognisable as horizontal cracks at 300-450 mm intervals. These effects are usually more noticeable at eaves' level or below openings, i.e. windows, where the reduced weight of masonry may permit greater heave. In fair faced brickwork problems may be indicated by wider mortar joints which may be cracked and spalled with associated vertical or diagonal cracking, with possible evidence of past repointing works.

Horizontal cracking shows up very clearly in rendered surfaces. Conversely recently applied render can be very effective in masking the effects of wall tie corrosion in the short term.

Care should be taken to avoid confusion between cracking caused by sulphate attack which can cause cracks in every bed joint or randomly on rendered walls. Sulphate attack cannot affect lime or black ash mortars.

1.5 Movement/Bulging of Masonry

In some cases the cumulative effects of tie corrosion can result in overall expansion of gable walls which can visibly lift the verge of the roof. In designs where the roof is strapped to the inner leaf the additional stress of the roof load and associated cracking can result in bulging of the outer leaf.

If no remedial action is taken the outer leaf could collapse when subject to wind suction. It should be noted that the more dramatic manifestations of wall tie corrosion tend to be restricted to the large gauge fishtail ties which contain sufficient metal to create problems of expansive corrosion. Wire butterfly ties, on the other hand, will corrode to the point where they no longer contribute any structural benefit as masonry restraints but the problem may not be readily apparent from external observation.

2.0 Wall Tie Inspection

After initial assessment of the building to determine the potential for a problem with the wall ties it is necessary to confirm the findings of this preliminary assessment by examination of a number of ties to determine their condition and type as well as other factors which may influence the remedial techniques required.

2.1 Location

Wall ties can be located by the position of any cracking in the wall, where this is not readily apparent or clear it is common practice to use a metal detector to locate ties to within approximately one brick error. The ties can be directly examined by removal of an appropriate brick or in some cases by removal of a section of mortar joint to expose the end of the tie.

In cases where inspection damage must be kept to a minimum it may be possible to examine the ties in-situ using a borescope or endoscope, it should be noted that these devices only permit examination of the section of tie visible in the wall cavity and that the majority of the damaging corrosion occurs inside the masonry of the outer leaf where it may not be readily visible using this equipment.

2.2 Inner Leaf

It is important to remember that whilst the most significant corrosion of wall ties occurs in the outer leaf the condition of the inner leaf fixing should also be considered not only with respect to the condition of the wall tie but also the type of material, condition and general structural integrity.

The construction and material of the inner masonry leaf will have a significant influence upon the type of remedial wall tie selected - hard materials being able to accept a mechanical fixing whereas the softer products, cinderblock, thermalite, etc. will require a resin/chemical fix.

2.3 Inspection

A range of equipment is required to assist in carrying out a comprehensive inspection.

This equipment should consist of:-

1) Metal detector
2) Marking chalk
3) Drill and suitable bits
4) Endoscope
5) Hammer and selection of chisels
6) Dry sand/cement mix and slate packing
7) Ladder and fastenings
8) Plumb line and spirit level
9) Tape measure
10) Mirror and torch.

3.0 Wall Tie Selection

The correct type of tie must be selected for remedial work. This selection depends upon the structure and construction of the building, i.e. hardness/density of the substrate, suitability for mechanical or resin fixing, appropriate length for wall thickness, any special requirements according to individual specification.

3.1 Double Steel Mechanical Ties

May only be used in hard substrates capable of accepting a high point loading which will be imparted by the physical nature of the tie. This type of tie is generally only used when an unusually high specification is demanded and the substrate of a suitable type.

3.2 Double Neoprene Mechanical Ties

Relies upon the expansion of neoprene sleeves incorporated in the wall tie body. The expansion occurs over the full length of the neoprene sleeve avoiding point loading and ensuring a large area of surface contact. Each individual element of the neoprene tie can withstand a test loading of 2.5 kN, equating to a static load of about 220 Kg.

3.3 Resin Ties

May be used in situations where the substrate is unsuitable to accept a mechanical fixing. This situation may apply an inner or outer leaves or both.

3.4 Trial Installations

The remedial tie selected must be compatible with the substrate and construction of the property. BRE Digest 401 - details a procedure for selection of suitable ties as denoted in BRE Digest 329.

Three trial installations should be carried out on the inner leaf and outer leaf of the specified system in random positions to check that the system will work in the particular wall and under the prevailing conditions.

Trial installations may be waived if a system has proven performance in a given building type, but site quality control testing should still be carried out.

3.5 Density and Layout of Remedial Ties

Unless otherwise required by specification, ties should be installed at a density of 2.5 ties/m_ overall with additional ties at the sides of openings or adjacent to movement joints and gable verges; in those situations a recommended spacing of 300 mm should be followed.

A standard 2.5 kN test load is a useful "catch all" specification which may be excessive for low rise construction in sheltered areas. However, this figure is relatively easily achievable.

N.B. Wall ties frequently require a setting or stabilising time prior to pull testing this varies from one hour for expanded ties to up to four hours for resin based systems and four days for cement grouted systems.

4.0 Control of Site Workmanship

1) Locate and mark positions of existing ties.

2) Ensure remedial tie placement holes are correctly positioned and blown clear of drill dust or debris.

3) Carry out proof test to fixings on inner and outer leaves.

4) All remedial ties should be inspected:-

(i) Before grouting or expanding into place, to ensure none are omitted

(ii) After grouting or expanding, to ensure grouting is correctly carried out and expanders adequately torqued.

5) Proof test at the following rates:-

NO. OF TIES	MINIMUM PROOF TEST RATE %	MAXIMUM FAILURE RATE OF THOSE TESTED %
First 20	100	10*
21-250	10	5
250-1000	5	5
1000+	2.5	5

* If initial failure rate exceeds 10% take further sample. If combined failure rate exceeds 10% carry out design check or specify alternative system.

4.1 Removal/Cropping of Existing Ties

This work should be carried out after installation of the new ties and is generally only necessary in the case of metal strip fishtail ties, there being insufficient volume of metal in wire butterfly ties to cause damage by expansion of corrosion.

The presence of wire ties that can be left in-situ must be positively established at the time of survey.

Depending upon prevailing site conditions it may be necessary to totally remove the tie from both inner and outer leaves, which would be highly labour intensive and costly and only necessary where corrosion was ongoing or imminent on the inner leaf. More usually it is sufficient to crop or isolate the existing ties.

Cropping involves removal of a brick below the tie location to permit access to the tie which can be bent into the cavity or cut off. Slate packing will be required for correct brick placement. A third option involves isolation of the tie by removal of a pocket of mortar around the embedded end followed by insertion of an isolating sleeve or highly compressible waterproof foam prior to repointing.

For the purposes of quality control it is important to ensure that there is a cross check between the number of ties identified for removal and the number actually removed or otherwise processed.

4.2 Final Visual Checks

All repointing or other making good should be to a satisfactory standard and not intrusive to the appearance of the building. There should be no runs of mortar or grout disfiguring fair faced brickwork.

5.0 Documentation

The installation should be accompanied by documents for the building owner's retention.

The documents should include:-

1) Details of survey including construction and materials of walls.
2) Condition of masonry.
3) Number, type, position, condition of ties.
4) Consequent damage, i.e. cracking, bowing, lifting, etc.
5) Level of exposure.
6) Work specification.
7) Method of removal of existing ties.
8) Numbers, reference and source of remedial ties.
9) Installation method.
10) Q.C. checks - Results.
11) Guarantee(s).

6.0 Lateral Restraint Systems

The walls and floors of buildings (cavity wall construction and otherwise) may require stabilisation for a variety of reasons (cracking, bowing, storm damage, etc). More recently, building regulations have been introduced which specify certain minimum performances with regard to strength of lateral restraint between walls and floors and many refurbishment projects are now required to upgrade existing structures to meet these standards.

'Crack-stitching', 'drill ties', strap-ties and corner restraints are all used to meet the above requirements together with joist beam extensions/splices.

7.0 REFERENCES

BRE Digests:

329 Installing wall ties in existing construction

401 Replacing wall ties

BRE Information Papers:

4/81 Performance of cavity wall ties
4/84 Performance specifications for wall ties
6/86 Spacing of wall ties in cavity walls
17/88 Ties for masonry cladding
12/90 Corrosion of wall ties, history, background treatment
13/90 Corrosion of wall ties - Recognition & inspection

BRE Good Repair Guide

4 : Replacing masonry wall ties

Closing Remarks

Dr F. W. Brooks, BSc, PhD, President of the BWPDA

We have come to the end of the formal sessions of the 1997 Convention. With the smooth running it is difficult to imagine how much work is involved in the planning of the Convention. I would like to record our thanks to several groups of people:

- to Lewis Woodhouse and his team in arranging the programme of lectures and seminars which has given us a rich variety of relevant subjects of topical interest for our industry.

- to the Staff of BWPDA, particularly Nethelia Thomas and Mike Bromley, for dealing with the detailed arrangements and the many individual queries which arise during the proceedings.

- to all people who presented papers. We have heard fascinating accounts of subjects of specialist and general interest. All speakers have maintained the highest traditions in the excellence of their presentations and have demonstrated that they are masters of their subject.

- to the BWPDA committee chairmen and their committee members who work very hard throughout the year on behalf of the general good of the Industry and whose reports we heard yesterday.

In closing the proceedings I want to emphasise a point made in my opening remarks. The BWPDA is now a new Trade Association. The Association needs to expand to be efficient. We need to expand the services offered to make best use of office facilities. We need to be bigger to meet the criteria of Government so that we can effectively represent our Industry with Government Departments. We are receptive to new ideas. The Director awaits your comments and proposals.

With that I declare the formalities of the 1997 BWPDA Convention closed and I look forward to meeting you for a convivial evening at the reception and dinner.