STEPS TOWARDS THE REALISATION OF DURABILITY EXPECTATIONS FOR PRESERVATIVE-TREATED WOOD - A NEW ZEALAND PERSPECTIVE

Mick Hedley
Resource Centre Manager, Wood Protection and Preservation,Wood Processing Division, New Zealand Forest Research Institute, Rotorua

Introduction

The generally recognised purpose of wood preservation is to extend the useful service life of timber species which would otherwise have limited utilisation potential.

> "The desirability of employing some efficient process for the preservation of wood is now universally admitted, consequently the importance in the industrial world of such treatment is thoroughly recognised, and the use of preservative solutions is rapidly increasing. The advancing cost of timber has brought home to the consumer the fact that the only possible off-set to this enhanced cost is the use of such preservative methods to prevent, or rather to retard, decay, and thus not only to lengthen the life of wood in all its forms, but also to widen the field of supply by bringing into use a number of less valuable species".
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> *A.J. Wallis-Taylor, "The Preservation of Wood", 1917*

In some parts of the world (notably, perhaps exclusively, New Zealand) there is the notion that preservative treated wood should last indefinitely; treatment is to "prevent" decay, rather than "retard" it.

Why is this notion held?

Preservative treated radiata pine was introduced in the 1940s as an alternative to the use of rapidly diminishing supplies of naturally durable timbers. The latter were sourced from indigenous New Zealand forests - mainly moderately durable species used in above ground parts of domestic and commercial buildings, or durable species used typically for farm fencing - and from Australia - highly durable species for heavy construction (bridges, wharfs, cross-ties, electricity supply transmission poles).

Did these never decay, or require replacement, or maintenance?

Of course they did! The advent of wood preservation only occurred because scarcity of naturally durable timber made the cost of replacement with "the real thing" too high. But for some reason, we expect the alternative - preservative-treated timber - to perform to a higher standard.

Wood preservatives are many and varied and processes used to apply them range from a simple dip or brush application to sophisticated, automatic plant. But can a simple preservative treatment which increases the life of the untreated product for a limited period, be considered the same "wood preservation" as a process which extends the life indefinitely?

Yes; durability expectations are certainly not the same, but if any economic gain achieved by a simple treatment for short-term durability is as valuable to the consumer as economic gain achieved by more thorough treatment, then wood preservation has been a success.

Indeed, there may be more economic gain from lesser durability expectations of the former than longer durability expectations of the latter as this example will illustrate:

Some years ago the New Zealand Ministry of Agriculture and Fisheries issued a Bulletin on fencing economics. It compared the costs of a "standard" fence (i.e. one using commercially treated posts) with a design life of 40 years and a fence using home-treated posts with a design life of 15 years:

The comparisons were as follows:

Standard fence (design life 40 years) costing $1,000/km has an annual cost of:

		$
Depreciation over 40 years @ 2½ %	=	25.00
Interest at 8 %	=	80.00
Maintenance at 3 %	=	30.00
Total annual cost	=	135.00

Home-treated post fence (design life 15 years) costing $500/km has an annual cost of:

Depreciation over 15 years @ 6.66 %	=	33.33
Interest at 8 %	=	40.00
Maintenance at 4 %	=	20.00
Total annual cost	=	93.33

Thus there is an annual saving of over $40 per kilometre for the short-term cheap fence.

Because "do-it-yourself" wood treatments are actively discouraged in New Zealand these days for health and environmental reasons, this comparison may simply be of historical interest, although the economic argument is still applicable if farm-grown naturally durable fence posts are substituted for home-treated posts.

But simple economics may not be the only consideration in realising durability expectations:

> "Many electrical supply authorities service rural areas where electrical load density is low, but line lengths are significant. Line materials of low initial cost and long life are essential. The revenue per km of rural line is not great, but low cost and high reliability are now expected. The Wairarapa EPB can, with present resources erect new, or replace, 50-60 km of 11 kV line per annum. The Board has over 2200 km of lines in service, therefore lines erected today will need to last at least 40 years, even though the economic life of a power line as assessed by our accounting colleagues is only 20 or 25 years."
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> *K.D. McLeod, Deputy Chief Engineer, Wiararapa Electric Power Board, in a paper presented at the NZ Forest Service Roundwood Workshop, 1982.*

In other words, for the accountant, durability expectations are based on an asset depreciating at 4-5 % per year, but for the engineer durability expectations are based on the physical impossibility of replacing failed or failing poles within forty years of their being erected and his depreciation rate is, at most, 2.5 % per year. The Engineer can realise the durability expectations of the Accountant by hiring more linemen and buying more equipment, but common sense dictates that the Engineer's expectations are more rational if they can be met - and service test results have shown they can be- by adequate preservative treatment!

Other factors which can influence these expectations are the physical conditions of exposure of the treated wood.

There are many anecdotal instances world-wide of creosoted poles and railway sleepers (cross-ties) still in active service 100 years or more after they left the treatment plant.

In New Zealand in the 1950s, preservative-treated plantation-grown pines were introduced to replace imported naturally durable hardwood railway sleepers. Service tests soon showed that "resistance to biodeterioration" durability was relatively easy to impart by correct preservative treatment, but "resistance to physical damage" durability required a complete redesign of the hardware fastening the rail to the sleeper. This was because the strength and hardness of pines was lower than the hardwoods they replaced and bed-plates onto which the rail was fastened with screw-spikes were necessary, rather than just fastening the rail directly onto the hardwood sleeper with dog-spikes.

Even with this new fastening system, sleeper removals from the track because of physical damage have been far more than removals because of decay, but the average service life of 35 years achieved by treated pine sleepers has been considered most satisfactory.

There are instances when durability expectations may become largely irrelevant.

In New Zealand, the average length of ownership and occupancy of a residential dwelling is 7.5 years. Obvious reasons for this comparatively short stay are growth, then shrinkage of the family and changes in financial circumstance. The loving care which the original owner put into landscaping his garden using treated timber, or building decks and patios out of treated timber, may be completely lost on the new owner, otherwise satisfied with the internal layout of the dwelling. Maybe his first task is to rip down the deck and put in a swimming pool, or to turn the landscaped garden into a cabbage patch!

But in general, we in New Zealand still have this expectation of almost limitless durability of preservative-treated wood.

How this has come about, how and why it is likely to change, is undoubtedly the result of Government regulation and, over the years, changes to it. In this regard, the Timber Preservation Authority, followed by the Timber Preservation Council and the Building Industry Authority have had by far the most influence. Reasons for the establishment of this regulation and changes to it are considered in some detail, since it is a unique story of one country's development of, and likely changes in, durability expectations for preservative-treated wood.

The Timber Preservation Authority

> "I think your use of timber and the fact of having a Timber Preservation Authority almost speaks for itself. You have developed effective wood utilisation and you have the best standards and the best monitoring of wood preservation in the world, of that I have no doubt, and I also have no doubt that it's because of the TPA having an overseeing role that has contributed to that. You have a TPA and you have effective wood utilisation. In the UK, we don't have a TPA and we don't have effective wood utilisation".
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> *Frank Brooks, Chairman, Technical Committee of BWPA in his address to the NZ WPA Annual Meeting, 1985.*

Although, by far, now the country with the highest per capita use of preservative treated wood, the industry in New Zealand had a hesitant start.

During the second quarter of this century, it became obvious that because of dwindling supplies of quality durable timber from indigenous forests and scarcity (and thus increased costs) of imported naturally durable timber, plantation grown species - chiefly radiata pine - would increasingly have to supply most of the country's timber needs.

In the 1940s, a Government Agency - the State Advances Corporation - was the principal financier of domestic dwellings, both as owner of rented properties and as mortgagor for privately owned properties. Mortgages were usually spread over 25 or 30 years, and since the property was security, it followed that SAC required a minimum life of 25 or 30 years for the property.

In the late thirties, the Corporation, already expressing some concern at the quantities of borer-susceptible sapwood of indigenous timbers being used, was positively alarmed at the prospect of building with plantation exotic species.

As a result, an organisation known as the Timber Protection Research Committee was set up in 1938 by the Department of Industrial and Scientific Research (DSIR) for the purpose of testing and approving wood preservatives. Its secretary and most active member was the SAC Technical Officer. He developed a simple dip treatment based on dilute zinc naphthenate, which was adopted by the Corporation as the only approved treatment for building timber.

How effective this treatment was is not known, but after the end of World War II, a Mr Wright, who had been NZ Scientific Liaison Officer in England during the war, returned to New Zealand to establish a branch of Hickson Timber Impregnation Co.
Hickson's pressure treatment with Tanalith® U - a fluor-chrome-arsenate-phenol formulation - was readily accepted by the Corporation and, in turn, it became the only approved preservative treatment.

Meanwhile, in Australia, the increasing use of Lyctus-susceptible hardwoods had led to the development of borates to immunise such timber against attack. This work was taken up at the DSIR in New Zealand which was able to demonstrate that effective treatment of indigenous timbers and radiata pine, to protect against insect borer attack, could be achieved by a momentary dip/diffusion treatment.

Conflicting claims made by the proponents of pressure treatment with Tanalith® U and boron dip/diffusion treatments resulted in the Corporation's refusal to accept the latter for treatment of internal building timber. To resolve this conflict, in 1952 Government set up a Committee of Enquiry into the effectiveness of treatment with the DSIR borax-boric acid process.

Evidence provided by DSIR was accepted as proof of effectiveness of borates as wood preservatives and the Committee found in its favour. However, the Committee was deeply concerned with lack of co-ordination between government agencies and private sector groups involved with wood preservation. It recommended:

(1) The publication of a standard specification of timber-preservation treatment.

(2) The enactment of legislation to provide for a particular Government agency to control timber preservation generally, to approve treatment plants, and to police timber preservation, such legislation to include provisions regarding the branding, marking or colouring of treated timber according to the type of timber and the type of treatment.

(3) The establishment of a comprehensive and continuing series of field tests accompanied by accurate service records.

(4) The setting up of a timber preservation authority to control and co-ordinate activities in relation to timber preservation generally.

A result was the establishment in 1955 of the Timber Preservation Authority and enactment by parliament of the Timber Preservation Regulations. The Authority as constituted had representatives from government departments (Ministry of Works, State Advances Corporation, Forest Service), professional organisations (Institute of Architects, Institution of Engineers), trade organisations (Master Builders Federation, Sawmillers Federation) and other groups which had interest in use of preservative treated wood (Wood Preservers' Association, Federated Farmers, Municipal Association).

According to the Regulations:

> "The principal function of the Authority shall be to secure and maintain a high standard of timber preservation"

The unique features of the TPA Regulations were that the organisation had statutory powers and it alone could draw up specifications; approve preservatives; licence treatment plants; police plants and suspend operations of any plants which contravened the Regulations.

If the Specifications erred, they erred very much on the side of caution. There were only two timber species of any great commercial importance - radiata pine and, to a lesser extent (and mainly for posts and poles), Corsican pine. Both have very permeable sapwood, which, in the round is very wide, so complete sapwood penetration by preservatives was possible and a requirement at the outset.

Initially, only two exposure hazards (and thus retention levels) were recognised by the Authority;

- Interior, protected from the weather and leaching.
- Exterior, subjected to the weather, either in-ground or above-ground.

Although retentions for boron treatment were initially based almost solely on laboratory tests, and those for ground contact preservatives such as CCA and creosote based on overseas experience, the Authority was very cautious in approving preservatives without substantial local field performance data. The Authority ignored this caution at its peril, as will be shown later.

Although some sectors of the wood preservation industry initially saw the setting up of the Authority as an unwanted bureaucratic intrusion into the field of private enterprise, these criticisms gradually disappeared over the years. Under the influence of the TPA, the industry grew remarkably stable and public confidence in the use of treated timber and durability expectations increased.

Indeed, the typical "man-in-the-street" in New Zealand probably knows more about

treated timber than his counterpart in any other country. Likely reasons for this are:

- New Zealanders are, often by necessity, great exponents of "do-it-yourself".
- Wood has always been the principal construction material.
- The New Zealander knew which native timbers could be used for which purposes (in-ground, above ground, or interior).
- Hence, when these were no longer readily available, people had to recognise different forms of treated pine for different uses.

Without doubt, people were helped by advertising (chiefly by the TPA and NZ Wood Preservers' Association), typically wall charts displayed at timber merchant outlets explaining the meaning of different treated-timber brands.

The role of Hickson Timber Impregnation Ltd in this advertising cannot be over-estimated in creating this awareness. "Tanalised®" quickly came to be "tanalised ®" and synonymous with "treated for exterior use or ground contact".

Today, "tanalised" still remains the recognised and most used adjective for treated timber, even though a significant proportion of that treated with CCA is not treated with Tanalith ® . But "tanalised" is associated with almost limitless durability and "tanalised timber" is expected to last indefinitely in virtually all exposure situations.

In 1979 the TPA approved the use of alkylammonium compounds (AAC) for interior and exposed above ground use (in New Zealand, Hazard Class H3). At the time, this was hailed as a pro-active step in addressing slowly developing environmental concerns over the use of traditional wood preservatives containing metallic elements.

By 1982, 12 plants had approvals to treat with AAC, although 80% of production came from only four of them. In April 1982 came first reports of extensive decay in AAC-treated timber, much of it in block-stacked packets which had barely left the treatment plant! Reports of premature decay of timber in service were also received which prompted a small survey by FRI in June 1984. Decay was prevalent in many patio decks and kiwifruit support trellises, two main uses for AAC-treated timber and at the beginning of 1985, the TPA withdrew approvals for use.

Over the period 1978 to 1984, approximately 230,000 m³ were treated with AAC, most of it for Hazard Class 3 exposure. In 1986, user dissatisfaction over the level of compensation offered by timber merchants to consumers who reported premature decay of timber which they had purchased, led to an airing of their grievances on the consumer affairs television programme "Fair Go".

A surge of complaints ensued which prompted government and the timber preservation industry to set up a contingency fund of $NZ 5 million (50:50 government/industry) to compensate owners and a single channel through which complaints could be directed.

Although no precise cause of early failure was ever established, largely circumstantial evidence pointed to preservative depletion, particularly in sapwood, as the cause of failure in service. However, since severe decay was also encountered in packets of timber which had been kept under shelter since treatment, it could not have been the sole reason.

There is no question that AAC were very exhaustively tested in the laboratory; pure culture decay tests against a wide range of decay fungi, insect toxicity tests, leaching, stability and corrosivity tests. Extensive treatability trials showed that pines were readily treated with AAC by processes commercially used in New Zealand, although because of the rapid fixation of the preservative to the wood, vacuum and pressure pump efficiencies had to be high to avoid unacceptable concentration gradients being formed in the treated product.

For reasons which today still remain clouded, the TPA approved use of AAC with only very limited-duration field test data and no service test data despite this comment by the Chairman of the Authority just prior to approval being given:

> " Members will be aware of the experimental work that has been conducted in recent times on the AAC preservatives, the light organic solvents and the high pressure sap displacement.
>
> Such developments are a sign that the industry is in pretty good heart, and not resting on its laurels [and] reliance on traditional forms of treatment. However, when evaluating the long-term effectiveness of new methods, we must not jeopardise the very high standard that the timber preservation industry follows currently and the high standing that it enjoys in this country and in fact overseas.

With this in mind, I suggest to you that we must resist the very natural temptation that there would be to introduce new preservatives and processes before they had been fully and positively proven, lest we destroy that public confidence in which treated timber has been built up and hard won over the last 20 odd years".

Malcom Miller, Chairman TPA,
Address to NZ WPA Annual Meeting, 1979

Despite widespread failures of AAC-treated wood, the New Zealand public's expectations of durability of preservative-treated wood were not shattered overnight! However, there is little doubt that this incident accelerated Government's decision to disband the TPA in favour of an industry-run organisation.

The Timber Preservation Council

Before any decision was made, the Government in November 1986 set up a one-man Advisory Committee to report on the functions of the TPA and the future requirements for the control of timber preservation standards.

The terms of reference were:

- To identify the beneficiaries of treated timber and benefits provided by the Timber Preservation Authority and identify any disadvantages and implications of not having an independent Authority.

- Recommend whether it was desirable to alter the functions of the TPA, disband it, or substitute some other means of control of wood preservation standards, and if so, what organisation and forms of control are needed?

- Recommend how the new system be funded and constituted.

- Consider the effects any change will have on New Zealand's export of treated timbers, particularly to the Australian market.

The underlying concerns were;

Would the absence of an independent Authority result in a lowering of standards of treatment with more and more inadequately treated timber reaching the market?

Would it trigger a widespread lowering of durability expectations for preservative-treated wood?

The Advisory Committee said; "Yes":

- Standards of timber treatment would fall.
- Inadequately treated timber would find its way into the market place at an increasing rate.
- Lack of confidence in treated timber would result in moves into alternative or substitute products.
- Implications for export markets could be serious.

The wood preservation industry said; "No"

- The absence of a government body to dictate standards need not be detrimental to the industry.
- The industry has come of age and is mature enough to police its own proceedings.
- Quality assurance is an industry matter which industry can handle in a cost effective manner.
- An industry-sponsored Authority would be as effective as an independent body because members were very conscious of their collective good name.

In the end, the industry view prevailed and the NZ Timber Preservation Council was established in 1986.

Have standards declined?

Not significantly. Although TPA specifications were a combination of results-type specifications and process specifications, the TPC specifications, on which they are based, are almost solely results-type specifications. This has led to development of a number of novel processes (mainly for CCA preservatives), in which net uptakes are much less than in traditionally used full cell processes. A slight increase in incidences of samples failing to meet penetration and retention requirements has been ascribed to the introduction of these new processes, but the connection has not been proved.

However, there is no doubt that durability expectations remain the same.

As regards effects on exports of treated timber, these have grown rapidly, particularly to Australia, largely due to active and direct involvement by the TPC in promoting its own "Woodmark" timber identification and quality assurance programme.

The Building Industry Authority

The last major regulatory change which affects preservative-treated timber use in New Zealand, and one which is likely to have most impact on durability expectations, was the establishment of the NZ Building Industry Authority, a Crown agency set up by the Building Act 1991, as the sole regulatory authority for building controls. In 1995, it published the New Zealand Building Code.

Section 42 of the Building Act states:

> "The New Zealand Building Code (NZBC) is a schedule to the Regulations authorised by the Act. It contains the mandatory provisions for meeting the purposes of the Act, and is performance based. That means it says only what is to be done, not how to do it."

Durability expectations are clearly stated:

> "From the time a code compliance certificate is issued, building elements shall, with only normal maintenance, continue to satisfy the performances of this code for the lesser of; the specified intended life of the building, if any, or:

a) for the structure, including building elements such as floors and wallswhich provide structural stability; the life of the building being not less than 50 years.

b) for services to which access is difficult, and for hidden fixings of the external envelope and attached structures of the building; the life of the building being not less than 50 years.

c) for other fixings of the building envelope and attached structures, the building envelope, lining supports and other building elements having moderate ease of access but which are difficult to replace: 15 years.

d) for linings, renewable protective coatings, fittings and other building elements to which there is ready access: 5 years".

Examples of building elements requiring 15 year durabilities are exterior cladding, roofs, exterior joinery.

The objective of the durability requirement is to ensure that all other objectives in the code are satisfied throughout the life of the building. These objectives are related to health, safety, amenity, protection of other property, safeguarding the environment, and efficient use of energy.

To a large extent, the required durability depends on the consequence of failure, in so far as it affects those objectives. Clearly, if a component fails through decay which results in building collapse, the effects are far more severe than if it results in a minor water leak which can be identified and readily repaired before the building becomes unhealthy from dampness.

Although there are prescribed verification procedures for durability, the stated intention is not to stifle the development of new products which are unable to prove a specified durability in service.

Thus with a new wood preservative/product system for, say, exterior cladding, it is quite legitimate to state on the building consent a specified intended life of 10 years, rather than the required 15 years. This would be recorded by the territorial authority, which issued the consent, and an inspection of the building would be required at the end of 10 years. Based on that inspection, the product would need to be replaced, or if performance was still satisfactory, have the life extended for an appropriate number of years.

One construction niche market where this "name your own durability expectation" concept has been welcomed is log house building. These are normally self-designed and self-built by the prospective occupant. They are usually constructed from untreated logs, with superficial applications of wood preservatives/water repellents, and the construction methods are not included in any conventional building standards. In the past, therefore, territorial authorities have been very reluctant to give building consents, since the issue of these is approval of conformance with building standards. These contain requirements that if wood is preservative treated, it must be treated in accordance with recognised specifications.

The new Building Code now allows the builder to nominate his own durability expectations; 3, 5, 10, 20 years, or whatever. This expectation is recorded, but can be extended following a satisfactory inspection report at the expiry of the nominated time. These provisions safeguard the owner, the territorial authority and any prospective future buyer (who will now know for how long the builder expected his log home to last!).

Conclusions for the Future

There is little doubt that the wood preservation industry world wide, in adopting CCA and creosote, and to a lesser extent, PCP and ACA, as "standards", picked winners! When used to treat permeable softwoods, these preservatives have been shown to impart almost limitless durability. For forty years or more, preservative-treated timber has been in New Zealand, an indispensable commodity. There is no doubt that pastoral farming, home construction and the vast expansion of horticulture (kiwifruit and grapes) in the 1970s and 80s, could not have proceeded without it.

With permeable species, where deep penetration can be guaranteed, durability becomes a function of retention. Thus, when premature decay of horticultural posts became evident in New Zealand in the 1980s, the problem was apparently solved merely by increasing the preservative retention.

Due mainly to environmental concerns, use of these preservatives is set to decline in favour of "new generation" products perceived as being more "sensitive responses" to the environment and health issues. Both old and new are likely to co-exist in many countries for some considerable time, but should durability expectations be the same for both?

Although it can be argued that this is desirable, the very "sensitivity" or "environmental friendliness" of the new would seem to make this unlikely in practice.

But this should be an acceptable "trade-off" and in many respects it may have more benefits than drawbacks, so long as durability expectations are established at the outset. Thus, if one can predict that the service life of a product treated with the "new" will be half of that treated with the "old", but at the same time, being able to demonstrate that at the end of this shortened service life there are few, if any, of the disposal problems associated with the "old", from several viewpoints there may be net social and environmental gains.

Coupled with the provisions in the NZ Building Act, this allows much scope for "designer" preservatives; preservatives which will confer a predictable, limited life, but which allow environmentally acceptable disposal options at the end of that life.

Thus, it become increasingly important that protocols for evaluating new preservatives are designed and conducted in a manner which will allow for accurate prediction of service life, together with some realistic limit on the extent of reduction in expected durability.

Perhaps unfortunately (and in Australasia at least), there is still the temptation to "benchmark" performance of new formulations against CCA preservatives as the only criterion for acceptability. It would seem more logical; indeed, more rational, to "benchmark" wood treated with them against competing (non-wood) products. In which case, durability (resistance to biodeterioration) is but only one of several measurable parameters which contribute to "fitness for purpose".

It then becomes less a question of ; "Does a fence post treated with "Envirocuddlee" last as long as one treated with CCA?", but more a question of; "How does an Envirocuddlee-treated wooden post stack up against concrete, plastic or steel fence posts?"

This, of course, brings us into the world of Life Cycle Assessment; a world using criteria which, when applied to preservative-treated wood, make it capable of more than holding its own against competing materials.

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