UNDERSTANDING TIMBER PRESERVATION

A GUIDE TO TIMBER AND ITS PRESERVATIVE TREATMENT AGAINST BIOLOGICAL DEGRADATION

South African Wood Preservers Association

Preserving Confidence in timber
INTRODUCTION

The aim of this guide is to give a general introduction to the subject of wood technology and wood preservation. Knowledge of these fundamental factors can be of considerable assistance in gaining an appreciation of the value and importance of timber preservation and the selection of the most appropriate method of treatment.

The growth of the Wood Preservation Industry has been one of the most important technical developments within the forest industry. The wide acceptance of preservation as an integral part of wood processing and utilisation has been a significant contribution to the use of what is the only structural raw material having a renewable and sustainable source of supply.

There are timber structures still in existence after hundreds of years of service but there are fence posts which have rotted after only 18 months service. This is due not only to a great variability in wood properties and our environment but also to the way in which the products are used.

Wood suffers minor and gradual physical and chemical changes as a result of age. It is an organic material which can support the life of other organisms if the environment is suited to their growth and this, under certain conditions, leads to rapid breakdown of the wood. What are the circumstances in which wood is likely to be attacked by destructive agents and what measures should be taken to defeat them?

Most people can identify wood when they see it and can give names to the more familiar timbers in general use. However, much is taken for granted and relatively few may know timber in terms of a growing form of plant life or understand what structural variations produce the features characterising species which enable us to name them. The differences which exist between species are sufficient for us to realise that timber is a substance of greater diversity and character than materials such as steel and concrete.

To enable the best use to be made of wood and to ensure the correct selection of the type best suited to any application, it is necessary to understand something of its structural form and characteristics and how these vary from species to species.

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Wood preservation promotes the conservation of indigenous forests by making plantation timbers, which aren't naturally durable, into effective substitutes for durable timbers from indigenous forests. It also reduces the volume of wood used by prolonging the service life of wood for many years.

The outside of the trunk is covered by layers of an insulating and protective material known as the bark, guarding the wood from extremes of temperature, drought, biological and mechanical damage.

The leaves of the trees are predominantly green because the cells which make up a leaf contain a green coloured substance called chlorophyll. This material absorbs energy when exposed to daylight.

In the presence of daylight this substance catalyses, a process called photosynthesis whereby water derived from the soil and carbon dioxide derived from the atmosphere are combined into food materials called carbohydrates (i.e. plant sugars and starches).

Food materials are transferred through the branches and the trunk to a special layer of tissue just beneath the bark called the cambium where the growth of the tree takes place. The trunk of the tree is composed of two main parts known as the heartwood and sapwood.

The heartwood (also called the truewood) is the central portion of the trunk and is surrounded by a zone under the bark known as sapwood.

Usually these two zones can be clearly seen, as the heartwood in most species is somewhat darker in colour than the sapwood. The heartwood obtains its colouration from various tannins, resins and other matter which has been deposited there during its transition from sapwood as the tree grew.

The sapwood is the outer portion of the trunk through which water and dissolved mineral salts are conducted from the roots to the leaves and where food materials are stored, usually as starches. Wood changes from the sapwood to the heartwood condition gradually, through a region of variable width known as the "transition zone". The wood in this zone has intermediate characteristics between both the sapwood and heartwood and it is here that the resins and other deposits which are the distinguishing feature of heartwood first occur in the wood cells.

TIMBER CLASSIFICATION

All timbers can be broadly divided into two large groups, each with distinct botanical features. These are known as hardwoods and softwoods.

South African grown Eucalyptus hardwoods are broad (or flat) leaved plants with seeds enclosed in seed cases; their leaves are constantly being renewed during their lifetime and unlike hardwoods from the Northern Hemisphere, they do not shed all their leaves in the autumn.

South African grown Pine softwoods are characteristically cone bearing, evergreen plants with needle shaped leaves and seeds which are not enclosed in cases. Several exotic Eucalyptus and Pine species are used commercially in South Africa.

The division into "softwoods" and "hardwoods" differentiates between two broad botanical classes of timber not the physical hardness of the wood. In fact, yellowwood is a softwood which is actually harder than some timbers classified as hardwoods, such as balsa and willow. Frequently, timbers referred to as "softwoods" are actually soft "hardwoods".

TREES, THE SOURCE OF WOOD

Trees have several main parts each with special functions. These are the roots, the stem or trunk, the leaves, branches and bark. Wood is produced from the stems or trunks of trees.

The roots anchor the tree in the ground and absorb water containing dissolved mineral salts from the ground.
Wood, like other materials originating from living matter, is composed of an immense number of hollow individual units known as cells. It has been estimated that there are about 45,000 such cells in an ordinary matchstick.

In softwoods, the cells are shaped like tubes with wedge-shaped ends and a length many times their width. They are rather like drinking straws joined end to end and compressed on all sides to give the appearance of a honeycomb in cross section. These tubes convey liquids between the roots to the leaves and also provide strength to the structure.

The vertical tubes or cells are called tracheids. Passing between them are small bundles of horizontal radial elements composed of brick-shaped cells, known as rays which are essential food storage cells containing plant sugars and starches which are surplus to the growing tree’s immediate requirements.

Liquids pass up the length of the tree from cell to cell in the sapwood through numerous valves in their walls. These valves are called pits which are so placed that liquid can be passed from one cell to the next right up the tree. Each valve is divided into two parts by a flexible, permeable membrane.

In many softwoods, this membrane has at its centre a thickened pad large enough to cover either opening to the valve. Generally, the membrane and pad are centrally placed, leaving both openings uncovered, thus allowing liquids to pass freely from one cell to another.

Under certain circumstances however, the pad moves over and covers either one or the other opening, thus restricting the movement of liquids through the valve and therefore movement of liquid from one cell to the next throughout the timber.

It is this movement of the membrane that may cause the flow of liquid through the sapwood to be unpredictable. The moisture movement in the tree occurs in the sapwood, the heartwood playing little, if any part in water conduction.

The cells of the heartwood (truewood) are inert, often blocked by gums, resins or other chemical compounds and generally contain a high proportion of valves in which the pad on the membrane has moved to one side closing the opening.

Therefore, moisture movement is greatly restricted. In hardwoods, the arrangement of the cells is not as simple as that found in softwoods. Very small tubes known as fibres provide strength to the tree. In shape, the fibres are similar to the softwood tracheids, except that their ends are like pencil points rather than wedge shaped.

Much larger open tubes known as vessels or pores, pass water from the roots to the leaves. Again, there are masses of radially placed rays, similar in shape to the brick-shaped cells in softwoods which also act as storage containers for surplus food materials.

In hardwoods, many of the large, liquid-conducting tubes in the sapwood - the vessels - remain open and allow the free passage of liquids into the trunk. In the truewood of hardwoods however, these tubes are very often blocked in one way or another, making the passage of liquids along their length very difficult.
WOOD PROPERTIES AND CHARACTERISTICS

Timber species vary markedly in their structure and chemical constituents. These factors determine the extent to which wood is naturally protected from decay and the ability to penetrate it with protective chemicals.

Durability

Sapwood, irrespective of species, is of low natural durability. It generally has a lower density than the heartwood, has a high moisture content and high starch content, all of which are conducive to fungal or insect degradation.

Wood that is kept dry and is naturally durable is able to resist invasion by fungi or insects. Factors involved in providing this durability include carbohydrate and chemical makeup. Heartwood contains cells which have chemical deposits within the cells, little or no carbohydrates and relatively lower moisture content.

Heartwood in some species e.g. sneezewood, can be highly durable whilst in others e.g. Radiata Pine or Eucalyptus Saligna, durability is low.

Durability may be increased by the addition of chemicals that are toxic to fungi or insects, or which reduce the possibility that the moisture content of wood will increase from the seasoned state. It is the addition of these chemicals that provides the basis of the timber preservation industry.

Permeability

The ability to penetrate wood with chemicals toxic to insects or fungi is largely dependent on being able to remove moisture, so that the preservative liquid can be added in its place. (Some water soluble chemicals will move by diffusion to penetrate the wood sufficiently to protect it.)

Most preservatives will not pass through cell wall membranes by diffusion and require pressure to push them deep into the wood. The depth to which penetration is achieved is dependent on density, chemical inclusions within cells, moisture content, cell type, techniques used, etc.

Generally, softwoods such as radiata pine are more easily penetrated than hardwoods and sapwood is more easily penetrated than heartwood.

DETERIORATION OF WOOD

Depending upon the conditions of service, timber may be attacked by one or more outside agencies causing degrade. Proper design, and preservation practice can eliminate or minimise such attack.

The principal causes of attack are:

Fungi (Decay)

Fungi are classified as a separate kingdom, with characteristics of both plants and animals, differing from plants in that they have no chlorophyll in their structure. They develop from minute spores and when germinated in suitable conditions, send out filaments called hyphae.

These penetrate the wood structure and if suitable conditions exist, break down the wood tissues into simple chemical compounds on which they feed. Under favourable conditions, the development of attack can be rapid.

Timber which is attacked by fungi is sometimes covered by a mass of intertwined and overlapping hyphae resembling cotton wool, collectively called mycelium. When the fungus is mature and conditions are suitable, it produces fruiting bodies (mushrooms) which are very different from those of normal garden plants.

They can be microscopic or relatively large, either in the form of a fleshy plate standing out on edge from the decayed wood, or as a thick, flat skin covering part of the wood.

Fungal spores are produced by the fruiting body in vast numbers and may be carried by air currents, animals, birds etc. for considerable distances to other wood where they will germinate, provided conditions are suitable.

Requirements for Fungal Attack on Wood.

Conditions necessary for the development of fungi are:

> A moisture content suitable for their development.
> An adequate oxygen supply.
> A temperature range to suit their life cycle.
> Adequate nutrients.
> Sufficient Time.

Timber preservation is largely built around the nutrients, i.e. rendering the wood nutrient toxic, unpalatable or uninhabitable. There are two main groups of fungi which can cause decay in timber.

Whilst some particular fungi may be representative of both groups, they are usually classified as either wood destroying or wood disfiguring fungi.
Wood Destroying Fungi

These fungi feed on the compounds of the cell wall and consequently can weaken the structure of the wood to such an extent that the wood breaks and crumbles away. Wood destroying fungi can be subdivided into three groups:

(a) Brown rots. In this group, the fungi feed mainly on the lighter coloured cellulose content of the cell wall and leave the darker lignin more or less intact.

The timber, after attack, may become dark brown in appearance and as it dries, the surface can become badly broken by deep transverse and longitudinal cracks and generally, apart from the colour and smell, gives the appearance of wood which has been charred in a fire.

The decayed timber usually feels very dry and is low in strength, light in weight and burns easily. The most common brown rots are often found attacking softwood timbers and the lighter hardwoods.

(b) White rots. In the white rot type of fungi, the breakdown of the material forming the cell is more complex, since the cellulose and lignin are both attacked. The affected timber eventually becomes much lighter in colour and weight and loses its strength properties.

Badly decayed timber does not crumble in the same way as that which has been attacked by the brown rots. The timber breaks down more in a longitudinal direction with a fibrous appearance and there may be pockets of decayed wood between apparently sound areas. The transverse cracking found in the brown rot attack is generally absent.

(c) Soft rots. This group is typically found in wet situations such as cooling towers and wood in contact with the ground. The physical and chemical character of the form of wood cell attack caused by the group of fungi responsible for soft rot, differs markedly from that of the decay types described above.

Decomposition commonly results from the organism making longitudinal cavities in, and parallel to, the axis of the cell wall. In wet wood, its presence is evident if surface layers are soft and may be readily scraped away.

When dry, surfaces will exhibit a profusion of fine cracks and fissures both with and across the grain. Microscopic examination would reveal the characteristic cell wall cavities. hardwoods are thought to be naturally more susceptible to this form of degrade than softwoods though no wood is completely resistant.

Wood Disfiguring Fungi

Some wood colonising fungi, whilst having little or no effect on the strength of timber, can reduce the commercial value by adversely affecting its appearance. Fungi of this type fall into two categories:

(a) Staining Fungi. The sapwood of most species of timber is susceptible to fungal staining which can occur in both logs and sawn timber, especially in climatic conditions of warmth and humidity. Although staining fungi may be the only ones present initially, true decay fungal attack may follow unless control is initiated.

One of the most commonly occurring stains is referred to as sapstain or blue stain and usually manifests itself as a blue-black, blue-grey, brownish or purplish discolouration of the timber. Freshly felled softwoods are particularly susceptible and in cases of severe attack, the entire sapwood may be stained.

Staining is generally caused by fungi that depend on sugars and starches present in the wood rays and rarely utilise the lignin or cellulose, as in the case of wood decay fungi. It should be noted that chemical stains (as opposed to fungal stains) can occur in timber with a high tannin content, when in contact with such metals as iron, copper or copper alloys.

(b) Moulds. This form of disfigurement is caused by fungi which produce a powdery or woolly mycelial growth and masses of spores at the timber surface. The most common colours of these surface moulds are black, shades of green, brown and occasionally orange.

The moulds that cause disfigurement are most severe on sapwood, particularly that with a high carbohydrate content. Mould fungi are very similar in all other important aspects to staining fungi, i.e. colonisation, proliferation, nutrient requirements and limited or no capacity to utilise the cellulose and lignin content of the timber, thus having negligible effect on the strength of the timber.

As with fungal stains, the activities of moulds may increase the permeability of woods to fluids. Obviously, the consequence of this is that the affected timber absorbs moisture more rapidly and favours the development of fungal decay.
The symptoms of Lyctus (powder post beetle) attack are surface holes and in most instances, the presence of digested wood which appears as a fine flour-like powder.

Only the sapwood of certain hardwoods is susceptible to Lyctid attack. Because heartwood is never attacked, structural weakening can be caused only to those building timbers which have a large sapwood content e.g. Eucalyptus, Saligna Poles. Where timbers, often with a very wide band of Lyctid-susceptible sapwood, are used for building, Lyctid attack can be serious. Symptoms are surface holes with digested wood as a fine flour-like powder.

Wood Borers

Practically all timbers, under certain conditions, may be attacked by wood borers of one sort or another. Infestation by some wood borers may be of little or no significance, whereas attack by other borers may be serious and necessitate remedial action.

Wood borers are beetles which at some stage of their development bore into wood for food or shelter. Beetles pass through four distinct stages of development: egg, larva, pupa and adult. With the majority of wood borers, the major damage to wood material is done by larvae which actively tunnel in the timber from which they derive their nourishment.

With some exceptions, the only damage they cause as adult beetles is the cutting of a flight or emergence hole through the surface of the timber as they escape from it. After emergence, they usually live for only a few weeks. After mating, the females may re-infest the timber from which they emerged.

The Lyctid Borers

Lyctid borers infest the sapwood of susceptible hardwood timbers at between 8 and 25 per cent moisture content, but never the heartwood. The susceptibility of the various species of hardwood is determined by two factors - starch content and pore (vessel) size.

Female Lyctid beetles lay their eggs beneath the surface of the wood, by inserting their ovipositor into the pores. Any species in which the pores are too small to accommodate the ovipositor will be immune from attack.

Equally, if otherwise susceptible timber contains insufficient starch, there will be little or no larval development and that particular piece may be less damaged.

The Anobiid Borers

There are a number of Anobiid species which are important. The best known being the Common Furniture Beetle. Although a high moisture content is not essential, the Furniture Beetle prefers rather damp, humid conditions and flooring attack is most severe in those houses where sub-floor ventilation is insufficient.

Pine is technically susceptible, but instances of its infestation are rare, being usually limited to material of high moisture content. Old furniture is commonly infested, particularly pieces such as pianos and cupboards with plywood backing made from softwood veneers.

The female beetle lays its eggs in cracks and crevices in susceptible timber and also on the rough surface of unprotected end grain.

The larval period lasts 1-3 years and attack can be serious as once initiated, it is unlikely to cease or die out of its own accord. Symptoms are surface holes with digested wood as a granular powder.
Cerambycid Borers

Also known as Longhorn Beetles, most of the 13,000 species belonging to this family are forest insects and only a few attack timber whilst seasoning or when used in buildings. One species is, however, particularly worthy of mention.

An Attack by Hylotrupes, Commonly Known as the European House-Borer. There are normally no signs of damage until exit holes appear.

Hylotrupes bajulus, also known as the European House Borer and in South Africa is referred to as the Italian beetle because it is believed that it was introduced into South Africa in timber packing cases which contained marble imported from Italy. It was as a result of infestation by this borer that regulations, initially under the Forest Act and later in the Building Regulations, were promulgated to prevent the spread of these and other pests. Hylotrupes bajulus is located in the coastal and warmer low lying areas of South Africa with exceptional seriousness in the Eastern Cape and Western Cape. It attacks the sapwood of softwood with no visible symptoms until exit holes appear.

Termites

Termite (white ant) damage is accepted as a significant risk to building and other structural timbers in most parts of South Africa. Wherever there is a risk of termite attack, it is wise to take some precautions. For buildings, these precautions usually take the form of chemically treated-soil barriers or physical barriers and the use of properly preserved treated timber.

Subterranean Termites

Subterranean termites are soft-bodied insects, by nature ill-equipped to survive in the open because they lose moisture and die from dehydration. They conserve their moisture by working within a self-contained, enclosed gallery system. Typically, with the species which commonly attack timber in service, the nest from which the attack originates will be in a tree or a partially decayed piece of wood buried or half-buried in the ground. From the nest, foraging galleries will be tunnelled through the surrounding soil to useful food sources. The interior of susceptible timber will be eaten out, without perforating the surface layers and exposing the termites to the atmosphere. Sometimes the excavated wood is replaced by a honeycomb structure of digested matter, through which the insects can move quite freely. Alternatively and notably, in timbers with well-defined annual rings, the termites might eat out the early wood, leaving concentric rings of the denser late wood more or less untouched. When lightly tapped, infested wood often has a "papery" sound. If probed, the thin surface is easily broken to expose the gallery system beneath. Obviously, the presence of live termites in a freshly exposed gallery indicates active attack. A deserted gallery could mean old attack from a colony which might or might not still be active, or a foraging area which has been disturbed to such an extent that it has been (temporarily or permanently) abandoned by an active colony. Subterranean termites are not found throughout South Africa, but are limited to an area north of the Great Kei River in the east and the Olifants River in the west.
Dry Wood Termites

Dry wood termites occur throughout the tropics and the subtropics of the world and a few species extend into the warmer temperate regions. Some live in dry, sound wood; some live in the dead wood of living trees, apparently depending upon moisture from the living portions; and some live in damp wood.

Those species which live in dry wood, or at least, in wood not especially moist, are spoken of collectively as dry wood termites. Those of greatest known economic importance belong to the genus Cryptotermes, popularly known as powder-post termites.

Only two species of Cryptotermes have so far been found infesting buildings in South Africa. One of these, Cryptotermes brevis, is an exotic species introduced into, and established in Durban. It is now of considerable economic importance. The second species - Cryptotermes merwei - is an indigenous species and is distributed along the coastal belt from Durban to Port Elizabeth. Whereas C. brevis is essentially a domestic species and is found infesting timber within buildings only, C. merwei has only been found infesting outdoor timbers.

Marine Borers

Marine borers can be divided into two main classifications: the Molluscs and the Crustaceans. Marine borers are distributed along the South African seaboard and are found all over the world. They can be most active in the warm waters of the tropic zones, particularly in large river estuaries where the lower salinity is more conducive to their growth.

The Molluscs

Commonly known as shipworm because of their wormlike appearance, the molluscs produce eggs which hatch in the sea and attach themselves to a piece of wood. They bore into it leaving only a tiny hole on the surface, growing larger as they feed and, therefore, boring larger tunnels. If a mass of molluscs attack a wooden pile which is of a susceptible species and has not been preservative treated, it may be completely eaten away within three months. The Teredo is the most prevalent and destructive species and will attack most timbers. Mollusc attack is recognised by the very long round tunnels which riddle the inside of the timbers, (often leaving the surface intact) and by the smooth, shell-like coating in the tunnels.

Crustacea

Commonly known as “gribbles”, Crustacea includes the species Limnoria, Sphaeroma and Chilura. In form, some species, e.g. Chilura, resemble the prawn, while others, e.g. Sphaeroma, resemble the wood louse or slater.

The limnoria species or gribble make small shallow tunnels in timber and cause erosion of the wood surface.

The crustaceans are not as prevalent and do not attack as rapidly as the molluscs. Their attack is similar to that of dry-wood borers, with irregular holes or galleries in the wood and the damage is not concealed like that of the molluscs.

They work mostly between the high and low watermark, often eating the pile away until it develops an “hourglass” appearance. They breed irregularly, the female laying eggs in the wood and the larvae attacking the wood in which they occur, very rarely traveling very far from it.

Fire

Wood is naturally consumed by fire. Its use as a fuel and as a source of charcoal is well known. This does not mean that wood is an unsafe building material, rather the reverse is true. Wood is a good insulator; hence fire is a surface phenomenon.

The core of wooden beams maintains a low temperature, sustaining the natural strength of wood. Large beams and structures while burning, will continue to hold up a building during a fire. Compare this with steel which becomes hot, loses strength, sags and collapses suddenly. Wood has a well-known char rate typically 0.6mm/min, hence design for fire can be accommodated.

However, wood can continue to burn after a heating fire source is removed, hence the use of antiglow agents. These cause the fire and glow to extinguish.

Other chemicals can inhibit the ignition of wood by fire and can inhibit or slow up the spread of flames.

Improved fire resistance and fire retardancy are valid wood protection processes. Most casualties in burning buildings are caused by toxic fumes emitted by burning fittings and furnishings. Serious injuries from the collapse of fire damaged structural timber are virtually unknown.
**Weathering**

Timber is liable to breakdown by weathering. Ultraviolet radiation present in sunlight has a strong, degrading effect on the wood substance, particularly in the presence of moisture.

This effect is responsible for the familiar grey discolouration to which exposed timbers are subjected. However, since ultraviolet radiation cannot penetrate timbers to any depth, this is purely a surface effect mainly of aesthetic significance.

More serious breakdown is caused by the periodic movement of moisture into and out of the timber. As the cell wall takes up and releases moisture, it swells and shrinks, and continuous repetition may cause the bonds between the wood fibres to weaken so that minute checks or cracks are formed.

Unless the process of swelling and shrinking is inhibited by some form of protection, these cracks may enlarge until the timber becomes both visually unattractive and perhaps structurally unsound. The greatest danger of weathering is that the persistent presence of moisture may promote decay.

**WOOD PRESERVATION**

Essentially, the science of wood preservation is the treatment of wood to increase durability and give extended service life.

This involves the placement, within the wood microstructure, of preservative chemicals which are antagonistic to wood destroying agencies. The major factors which bear on the effectiveness of biological preservation systems are:

(a) The biological hazard to which the wood will be subjected in service.

(b) The toxicity of the preservative chemical to the particular wood destroying organisms which will be encountered. Also, the permanence of the preservative chemical under given conditions of hazard following treatment of the wood.

(c) The penetration and retention of preservative chemical, i.e., the extent of the penetration of the preservative chemical into the cross section of the timber and the amount retained in the penetrated zone per cubic metre of the wood.

A similar set of factors determines the effectiveness of preservative treatments against weathering and fire. Other relevant factors include:

(a) natural durability of the wood,
(b) the presence or absence of sapwood,
(c) variability within and between pieces and species,
(d) preservative distribution gradient.

**The Hazards Defined**

The hazard to which wood material will be subjected has an enormous bearing on the extent to which wood preservation will be effective. A piece of wood kept continually dry inside a building is subject to a much lower hazard than a piece embedded in the ground.

Its broad categories, ranging from low to high hazard, are as follows:
(a) Interior timbers (i.e. indoors - framing, linings, joinery, etc.)
(b) Exterior timbers (i.e. outdoors above ground - cladding, barge boards, window joinery, palings, rails, bridge decking, etc.).
(c) Ground Contact (i.e. posts, foundation piles, poles, house stumps, crib walls, landscape timbers, playground equipment, bridge and wharf timbers, etc.).
(d) Timber used in fresh water or heavy wet soil (i.e. poles for livestock pens, piling, jetties etc)

(e) Marine Timbers (marine piles, sea walls, etc.).

The hazard level determines the required intensity of the key wood preservation factors, namely the toxicity of the preservative chemical, its fixing characteristics, the penetration required and the retention required.

For example interior timbers may only require:
1. Protection only against wood borers, necessitating a simple borer-specific, unfixed chemical like boron.
2. Penetration only in the outer sapwood.
3. Retention level of a very low order.

However, for ground contact hazard, a heavy duty preservative such as a CCA or Creosote is required with continuous penetration to a significant depth and with relatively high retentions.

Wood Preservative Chemicals

All wood preservatives in South Africa that contain active ingredients (biocides) are classified as agricultural remedies and are therefore required to be registered by the Department of Agriculture.

Once registered a National Standard must be prepared by the South African National Standards Authority. Only then may the preservative be used for industrial and commercial purposes.

A ‘Protocol for the Approval of Wood Preservatives in South Africa’ is available from SAWPA.

Wood preservatives may be divided into three main groups

(a) Water-borne (CCA, Borate, Copper Azole and ACQ)
(b) Oil-borne (Creosote or mixtures of creosote and coal tar solutions)
(c) Light Organic Solvent borne Preservatives (TBTN-P and Azole-permethrin)

Water-borne Preservatives

The water-borne preservatives are traditionally inorganic chemicals which are dissolved in water, the water acting as a carrier in the treatment process.

There have been some recent additions of alternatives that contain organic or a mixture of organic and inorganic chemicals. The water-borne preservatives leave the treated wood odourless, clean to the touch, sometimes imparting a colouration.

They wet the timber during the treatment process, often causing dimensional variation, but once the carrier water has dried out, they have no effect on moisture content of the wood.

There are two main types of water-borne preservatives commonly used in South Africa.
(a) Non-fixed, such as the borate compound which is subject to water leaching.
(b) Fixed, such as the copper-chrome-arsenic (CCA) preservative, which is highly leach resistant.

Borate Compounds

Borate products are available as inorganic borates and can be applied as a dip diffusion treatment to green wood or as a vacuum pressure process to dry wood. The product has the ability to diffuse deeply into the wood.

The dip treatment can achieve full heartwood penetration. This process depends on sufficient time being allowed and on moisture content being maintained at 500g/kg minimum and above.

Treated wood is not coloured and, when it is dry, can be painted, glued or stained. The chemical remains water soluble in the wood and should be used only for interior applications.

It may be used for external applications where the wood is not in contact with the ground and is properly protected and maintained with weatherproof coatings to prevent leaching.
Copper Chrome Arsenic (CCA)

The copper-chrome-arsenic compounds are heavy duty wood preservatives covering a wide biological spectrum without being subject to significant leaching. The copper is a fungicide and the arsenic is an insecticide plus a back-up fungicide.

The chrome acts as a fixing agent, reacting in the presence of wood cellulose to render the copper and arsenic chemicals insoluble. CCA is applied by vacuum pressure impregnation and solution concentration can be varied according to the desired retention.

CCA treated timber is odourless and can be readily painted or stained once dry. It has a characteristic light green colouration. Where a "salts" type CCA formulation has been used, white powder occasionally forms on the surface of the wood for some weeks or months following treatment.

The powder is sodium sulphate which is quite harmless, being rather like table salt and can be hosed, scrubbed or wiped off. The white powder does not form where an "oxide" type CCA formulation has been used.

Hot dipped galvanised or stainless steel fasteners are recommended for CCA treated timber.

Alternatives to CCA

Although not yet widely available in South Africa, copper azoles (CuAz) and alkaline-copper-quaternary (ACQ) preservatives are more recent additions and alternatives to CCA.

It is applied by the same processes as for CCA, suitable for H2 to H5 end applications, has most of the characteristic normally associated with CCA except that they offer the end user environmental, and health and safety benefits.

Oilborne Preservatives

In South Africa the only oil-borne preservative which has been used, is creosote and mixtures of creosote and coal tar solutions, with or without a waxy oil additive.

Oil-borne preservatives are applied in hot and cold open bath or in vacuum pressure impregnation plants, always at elevated temperatures to lessen viscosity and increase uptake.
Light Organic Solvent Preservatives (LOSP)

The term Light Organic Solvent Preservative (LOSP) actually describes the carrier of the preservative and the LOSPs vary greatly according to the preservative chemicals with which they are formulated.

LOSPs are solutions of organic fungicides (such as tributyltin-oxide) and insecticides (synthetic pyrethrroids). They are suitable for interior, above-ground hazards such as in housing and other buildings. Effective preservative treatment of wood can only be achieved by impregnation in a vacuum pressure plant.

TBTN-P and Azole-permethrin are medium duty light organic solvent preservatives. The active ingredients used are internationally acceptable ingredients that have health, safety and environmental properties compared to lindane (now banned) that were previously used in TBTOL. It can combine effective insecticides and fungicides into a solvent carrier, such as white spirits, allowing these to penetrate the wood without causing dimensional distortion, i.e. a change in the size or shape of the wood.

It is suitable for use internally (under cover) or for use externally if it does not have contact with the ground and if protective coatings are used. The wood is not discoloured. However, some initial odour is possible until the solvent has fully evaporated. Wood may then also be glued or painted. Application is by low pressure vacuum plant. The solvent may contain plasticizers, pigment or waxy oils to improve the appearance and performance of this preservative.

Antisapstains

These are a range of preservatives applied by dip or spray to provide short term protection for the timber against mould, or staining fungi during the seasoning period, e.g. on freshly felled logs.

Penetration And Retention

The primary objective of wood preservation is to achieve, within every piece of timber, a defined retention of preservative chemical within a defined penetrated zone of the cross section, each being predetermined by a number of factors, most particularly the hazard level to which the timber is to be treated.

Retention is closely linked to "threshold", which is the minimum amount of a particular chemical per mass of wood material that will prevent degrade of the wood. Threshold values vary widely in respect of the particular chemical, the particular species of fungus, borer, termite, etc. and the particular species of wood.

Below threshold levels, degrade will occur. Above threshold levels it will not. Retention for a particular hazard is set at the highest threshold likely to be required plus an allowance for variation, plus a factor for safety.

(Variation occurs particularly because of different densities of timber and differences in the absorption of the wood preservative in a given parcel of timber in the treatment cylinder.) It is vital that the required retention for a given hazard is achieved in the treated wood, otherwise premature failure may well occur.

It is equally vital that the required degree of penetration is achieved in order that an effective zone of treated wood is created.

In summary, the key to wood preservation is the application of a known preservative chemical to a defined zone of penetration at a known required retention.

CONDITIONING
BEFORE TREATMENT

To achieve proper preservation, the timber must be in a suitable condition to absorb the preservative. This involves the following considerations:

Bark Removal

To ensure adequate penetration, it is essential that all bark, cambium and any foreign matter which might inhibit the entry of liquid into the timber, be completely removed.

Moisture Content and Drying

Seasoning and drying are two terms used to denote the same process of reducing the water content or moisture content (mc) of wood. Air passing across the surface of a piece of wet wood is able to pick up moisture and carry it away, thus leaving the surface of the wood slightly drier than it was before.

Moisture from the interior moves to the surface and in a continuing fashion, is removed by further dry air flowing over the wood.

When the moisture content has been reduced to the so called "fibre saturation point" of approximately 25-30 per cent (250 -300g/Kg), all free moisture has been removed from the voids in the wood (moisture held within the cell cavity) and the residual or bound moisture is contained within the cell walls only.

Seasoning (of the bound moisture) below the fibre saturation point dries the cell walls and shrinkage may occur.

Shrinkage in the tangential direction is considerably greater than in the radial direction. Shrinkage in the length of the timber is so small, relative to the longitudinal dimension, that it can be generally ignored. Commercial methods of drying (seasoning) timber are generally by kiln drying or air drying. The general method of air drying timber is to stack it in the open on a well-drained site exposed to a steady and adequate airflow.

All pieces of wood in the stack are separated from each other by small strips of timber to enable the air to move freely over all surfaces. Commercial kiln drying removes any dependence on the weather.

The stacks of timber are placed in an insulated building or kiln and drying conditions are artificially produced by strict control of temperature, humidity and air flow.

By practice and research over many years, kiln drying cycles have been developed for the many and varied species.

It is now possible to reduce the moisture content of timber to any predetermined level in the optimum time and with minimal drying defects and loss through checking, splitting, collapse or deformation. The moisture content of a piece of wood is always expressed as a percentage of the "dry weight" of that timber.
Vacuum pressure methods of preservative impregnation are widely used commercially and have proved to be a most effective means of controlling preservative loading and depth of penetration.

The most suitable method is generally determined by timber characteristics, preservative type required and the specified product end use.

**Full Cell Process or Bethell Process**

The timber is placed in a cylinder which is then sealed. A vacuum is drawn on the timber for a predetermined period of time and the cylinder flooded with preservative while maintaining the vacuum.

When flooding is complete, the preservative pressure in the cylinder is raised and held until the timber refuses to absorb further preservative or until the required retention has been obtained.

The pressure is then released, the preservative pumped back to the holding tank and a final vacuum drawn to remove excess preservative. The complete treatment cycle can vary from 1½ to 5 hours, depending on timber species permeability.

**Correct methods in the application of preservatives must be used to cater for the wide variation in timber absorption characteristics.**

See SANS 10005 'The Preservative Treatment of Timber.'

**Hot and Cold Bath**

Hot and cold bath treatment in open tanks is an immersion treatment and consists of immersing the timber in the bath, raising the temperature to about 85 deg. C for a predetermined period then allowing the preservative to cool or transferring the timber to an adjacent cold preservative bath until cool.

During this process a vacuum is formed in the cell cavities that ensures uptake of preservative. Oil type preservatives such as creosote is used, and proper seasoning of the wood is necessary before treatment.

**Vacuum Pressure**

Wood is dried mainly for the following reasons:

1. To make it more stable. Timber should be dried before it is fabricated, to a moisture content as near as possible to that at which it will be put into service, a.k.a. equilibrium moisture content.

2. To develop maximum strength. Wood that has had its moisture content reduced is much stiffer and stronger than it is in its "green" or unseasoned state.

3. To make it lighter. It is far easier to handle and more economical to transport when dry.

4. To reduce susceptibility to fungal attack. Dry wood (i.e. below about 15 per cent MC) will not rot. Starch may also be broken down in the seasoning process, reducing the wood’s attractiveness to certain borers.

5. To prepare it for preservation. Most of the water must be removed from the cell cavity and some from the cell wall before preservative liquids or solutions can be forced under pressure into the timber.

Most forms of treatment except diffusion, require the timber to have a moisture content not exceeding 25-30 per cent.

In the case of LOSP treatments it is preferable that the timber be at the appropriate equilibrium moisture content at the time of treatment.

**Machining**

It is desirable that all machining processes, including boring, planing, docking, etc. be carried out prior to treatment. Where this cannot be done it is advisable to re-treat any timber exposed by subsequent machining by means of liberal brush application of the appropriate preservative or a suitable supplemental or remedial preservative.

**Improved Penetrability**

For products, such as railway sleepers, produced from difficult-to-treat timber, it is most important that adequate penetration from the lateral faces is achieved. In some timbers it is often impossible to achieve adequate flow of preservative liquids from the end-grain for reasons previously described. By introducing many additional points of entry along the faces of the timbers the distribution and uptake of preservative liquid is improved. This is generally achieved by use of an incising machine, which consists of a series of geared rollers carrying blades which make slit-like incisions parallel to the grain of the timber.
The timber is enclosed in a sealed container and a partial vacuum drawn. The unit is then flooded with preservative and the fluid pressure may or may not be increased to a predetermined level depending on timber permeability. The pressure if applied, is then released. A final vacuum is applied to remove excess preservative. The timber is then removed and the organic carrier evaporates after a period of 48 hours, leaving the timber dry.

**CONDITIONING AFTER TREATMENT**

**Water-Borne Preservatives**

The treatment of timber with water-borne preservatives obviously reintroduces substantial amounts of water into the wood. Re-drying is less critical in commodities such as fence posts or transmission poles than it is in sawn timber where dimensional stability and painting of the treated timber could be required. However, where treated timber is to be used in building construction or for playground equipment or decorative landscaping purposes, it is recommended that the freshly treated timber be allowed to dry until the surface of the timber is dry to the touch before being transported from the treatment site.

**Oil-Borne Preservatives**

Timber treated with oil-borne preservatives such as creosote should be allowed to stabilize in a well ventilated situation for at least 48 hours to allow the volatile fractions to evaporate.

**Light Organic Solvent-Borne Preservatives**

Freshly treated timber contains some residual volatile inflammable solvent. This should be allowed to evaporate in an open well ventilated area for a period of at least 48 hours before the timber is used or installed.
Provided common-sense precautions are observed, preservative chemicals do not present a hazard to humans once fixed in the dried timber.

Sometimes a white powder will appear on the surface of CCA treated timber. This is mostly sodium sulphate, a harmless substance which, if necessary, can be simply brushed or hosed off.

Generally plants and animals in contact with CCA treated timber will be perfectly safe. Care should be taken with certain specific applications such as birdcages, beehives and fishponds. For further information contact SAWPA.

Safety Precautions

- Wear gloves to help avoid splinters.
- Cuts and abrasions should be protected from preservatives and from sawdust while sawing or machining treated timber. Use of sealed dressings is recommended.
- Wash hands and face free of preservatives and sawdust before meals or smoking. Food and drink should not be left exposed to the treatment solution or sawdust.
- When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.
- When power sawing and machining, wear goggles to protect eyes from flying particles.
- Sanding operations should be performed in well-ventilated areas. If this is not feasible, use dust protection equipment. A dust mask and goggles will generally suffice. Gloves and overalls in high dust situations are also recommended.
- If preservative or sawdust accumulates on clothes, launder separately before re-use.

Disposal of Unwanted Off cuts and Scraps

CCA treated timber must never be burned in barbeques, household fireplaces or wood burning stoves or in confined spaces. The best method of disposal is to take the unwanted treated timber to an approved dumpsite for landfill. It should never be left lying where other people may collect it for firewood.

Specifications and Standards

The Industry is required to achieve certain levels of treatment quality and these are laid down in the form of National Standards (SANS) available from the South African Bureau of Standards (SABS).

All preservative treated timber in South Africa should be treated in terms of a specific National Standard depending on the particular commodity, e.g. fence posts, transmission poles, sawn lumber.

In addition the chemicals used are required to comply with a specific National Standard, so as to ensure that the timber can be properly treated. Each piece or if in small sizes, the bundle of pieces, must be marked with the treatment plant.
identity, the Quality Inspection or Certification Authority’s logo, the year of treatment and the hazard classification in terms of which the timber has been treated. (See Hazard Classification)

The code of practice SANS 10005 prescribes the treatment of certain structural timber used in specified areas.

**MUNICIPAL AREAS WITHIN WHICH THE TREATMENT OF ALL SOFTWOODS USED IN A PERMANENT BUILDING IS REQUIRED**

Municipal areas, where timber treatment for softwoods are required are listed below:

- Amahlathi
- Berg Rivier
- Bitou
- Breede Valley
- Breede River / Winelands
- Buffalo City
- Cape Agulhas
- Cederberg
- City of Cape Town
- Drakenstein
- eNdondakusuka
- eThekwini Metropolitan (Durban)
- Ezingoleni
- George
- Great Kei
- Hibiscus
- Hlabisa
- Impendle
- Jozini Kamiesberg
- King Sabata Dalindyebo
- Knysna
- Kouga
- Kou-Kamma
- KwaDukuza
- Langeberg
- Makana Maphumulo
- Matzikama
- Mbonambi
- Mbhashe
- Mbizana
- Mkambathini
- Mquma
- Mooi Mpofana
- Mossel Bay
- Mthomjaneni
- Mtubatuba
- Mzunduzi
- Nama Khoi
- Nelson Mandela Metropolitan
- Ndlamle
- Ndwedwe
- Nkonkobe
- Nqquwsha
- Ntambanana
- Nyandeni
- Overstrand
- Port St Johns
- Qaukeni
- Richmond
- Richtersveldt
- Saldanha Bay
- Stellenbosch
- Sunday’s River Valley
- Swartland
- Swellendam
- The Big 5 False Bay
- Theewaterskloof
- Ubululalezwije
- Umdoni
- uMgeni
- uMhlathuze
- Umhlabuyalingana
- uMlalazi
- uMshwati
- uMziwabantu
- Umtani
- Umzwebe
- Vulumeleho
- Witzenberg

**HARDWOOD TIMBER AND POLES**

All hardwood timber including poles (e.g. Eucalyptus) used in structures throughout South Africa are required to be treated.

This is because the sapwood portion is a favoured source of food for the Lyctid borer which attacks and destroys the sapwood.

In the case of machined hardwood timber the exception can be made if the timber is an impermeable specie (e.g. meranti) or it contains very little or no sapwood, e.g. laminated timber, block and strip flooring, ceilings, paneling, mouldings and joinery, garden furniture and outdoor decking boards.
All wood preserving chemicals are classified as agricultural remedies and required by law to be registered by the National Department of Agriculture, which lays down conditions on their sale and use.

Health And Safety

No monitoring by any authority in South Africa over the past decade has produced any evidence to suggest that commercially used preservatives are damaging to individual health or to the environment.

Nevertheless, all the chemicals used for the protection of wood against biodegradation are toxic to some degree and, therefore, potentially hazardous to some forms of life.

The risk involved to humans is, however, quite minimal, both because the preservative chemicals are localised on and within the wood and because of the methods used to apply them. Also, they are highly resistant to removal from the wood, being either chemically bonded to it, or physically immobile.

As with hundreds of other chemicals in regular use, however, precautions are required and it is advisable to ensure that the risk to the environment, the occupationally exposed and the general public, remains within community acceptable limits.

The Environment

As a raw material of biological origin, wood is vulnerable to attack by insects and decay organisms and must be protected to extend its service life.

Treatment with chemicals can prevent, or at least slow down, such attack or deterioration. The hazards of such chemicals to the environment and people are determined by the active ingredients and the carrier solvent used.

By their very nature, the chemicals used to extend the life of wood are potentially toxic to living organisms. It is not possible to properly identify potential risks from wood preservation without knowing the physico-chemical and toxicological properties of the chemicals and solvents used.

This information is available from chemical suppliers or other national and international sources. It is also important to understand how chemicals move through the environment.

Impacts on human health depend on the type of chemical, whether we are exposed to the chemical by eating or drinking, breathing or absorbing it through the skin and the period of exposure.

The variety of chemicals and processes requires a corresponding range of environmental controls. These controls may be on the chemicals employed, the installation used to treat the wood, the operation, or all three.

Among these factors, proper design and safe operation of the timber preservation plant are critical. Environmental factors need to be taken into consideration when selecting a site, designing the treatment area, storage and handling facilities for chemicals and treated wood, and managing waste.

Operational concerns include the safe handling of chemicals, reducing staff exposures, maintaining equipment effectively and establishing emergency procedures for spills and leaks. Proper management of waste and effluent is of particular concern in controlling pollution on-site as well as off-site.

Environmental regulations are becoming stricter and companies have to pay a high cost to comply with them.

More and more companies are trying to save money by using design and operation approaches that prevent pollution from being generated, or prevent human exposure, a cheaper option in the long term than treating pollution that has already occurred.

Some hazards relate to the finished treated wood product. Safe handling, machining and transportation of the treated wood is important as workers can be exposed to the chemicals in the wood.

Under some circumstances chemicals can slowly escape into the environment. In order to reduce the impact of wood treatment on health and safety and the environment, the South African Wood Preservation Association (SAWPA) developed practical guidelines for safer practices in industrial wood preservation, which has now culminated into SANS 10255, "Health, safety and environmental guidelines for the construction and operation of timber treatment plants".

The aim of the standards is to help reduce the exposure of workers to chemicals and to reduce or prevent the release of pollutants to the environment.

The standard covers practices at wood preservation plants of all sizes and locations, and is intended for readers from different backgrounds and areas of responsibility, i.e.:

- wood treatment personnel will find descriptions of procedures and technologies that reduce environmental impacts, as well as policy and management guidelines for effective low-impact operation.

- government personnel and industry regulators will find indications of the environmental protection measures that can be achieved by the industry, together with a description of technical, planning and management tools that foster their implementation.

- the general reader will find an overview of environmental impacts related to wood treatment and recommended strategies for regulating these effects. The standard is available from the South African Bureau of Standards.
The General Public

By any comparison, treated timber is significantly less hazardous than scores of items the public handles daily. If any risk is involved, it can be virtually eliminated if treaters ensure that at the time of distribution, the surface of the product is dry and free from preservative deposits or exudates.

In addition, it is necessary to advise users including the "do it yourself" handyman that:

(a) light gloves should be worn.
(b) during any form of wood working which generates dust e.g. sanding, respiratory and eye protection should be worn.
(c) treated wood waste should never be burned in a barbecue or confined space.
(d) disposal to landfill is the preferred method of treated wood waste disposal.
(e) hands and face should be washed with soap and water before eating, smoking and use of the toilet.
(f) if all of the requirements described or referred to in this section are observed, there is no doubt that wood preservation will continue to be regarded as safe, as well as cost effective technology.

TIMBER TREATMENT AND THE LAW

There are two main regulations applicable to preservative treated timber in South Africa.

- VC 9092, The Compulsory Specification for the Preservative Treatment of Timber, which is administered and regulated by National Regulator for Compulsory Specifications (NRCS), covers the sale of preservative treated timber. In brief the VC 9092 specifies the following:
  - Preserved timber sold in South Africa shall comply with the requirements of SANS 10005; The producer of treated timber shall appoint a certification body recognized by the NRCS policy to verify the initial compliance and ongoing conformity of production of preserved timber with the requirements of the compulsory specification (the SABS and SATAS are currently recognised by the NRCS).
  - The manufacturing facility or importer of the preservative treatment of timber shall be pre-approved by the NRCS for conformity of production requirements as prescribed in Annex A of VC 9092.
  - The manufacturer or importer shall provide the NRCS with satisfactory evidence of conformity of production on request.
  - Preserved timber placed in the market shall be marked in accordance with the requirements of the relevant SANS standard, including the mark of conformity of the certification body.

- SANS 10005 covers the classification of timber preservatives, the hazard conditions (H classes) for timber, the various treatment processes, penetration and retention tables as well the requirements for the use of preservative–treated timber in specific areas in South Africa.

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THE HAZARD CLASSIFICATION

The performance of preservative treated wood depends completely on the type of preservative used, the amount of treatment contained in the wood and the hazard to which it will be exposed.

Much testing has been done that clearly show the solid relationship between the amount of chemical necessary to provide a long and useful service life for the wood being treated and the risk of insect and fungal attack in any particular application.

Different hazard classes for timber use have been defined in accordance with general service conditions and the associated biological hazards.

Each hazard class is defined by answering the following four basic questions:

- WHERE will timber be used? (i.e. service conditions under which timber will be exposed.)
- WHAT timber products are typically applicable? (i.e. relevant applications or end uses.)
- WHY is timber treatment necessary? (i.e. which wood-destroying organisms are of particular importance.)
- HOW can timber be preserved effectively? (i.e. type and level of preservative treatment required to ensure an acceptable service life under a particular application or end use. To achieve the specified retention of wood preservative chemicals in the timber, an adequate quantity of treatable sapwood needs to be present.)

A rating system, similar to those used internationally, is used in South Africa. In this system, the higher the hazard number, the greater the risk to the wood and the higher the chemical loading required.

Some products such as CCA and Creosote are effective heavy-duty preservatives and protect in all classifications.
IN SOUTH AFRICA WE HAVE 6 HAZARD CLASS LEVELS OF TREATMENT

H0-i INTERIOR

This is for interior uses only. Protection is only offered for prevention of certain commonly occurring insects and is a mild treatment process. All other hazard classes given below offer protection against insect and fungi attack. The products in this category are specifically for mouldings, ceilings, flooring boards and joinery.

H1

International trends set a H1 level. Because South Africa followed the international example when setting up its own Hazard classification, it was felt that H1 in the South African context would not be required, as this caters only for countries in which there are no termites.

H2 INTERNAL (LOW HAZARD)

This is also for interior use only and timber treated under this classification should be roof trusses, laminated beams, internally used structural timber, ceiling boards, flooring, panelling, doors, cupboards, skirting, window frames and plywood. Chemicals used here would be mainly CCA, TBTNP and Boron.

H3 EXTERIOR ABOVE GROUND (MODERATE HAZARD)

CCA and Creosote are mostly used for this and higher H class treatments. H3 covers balustrades, fencing bearers and slats, outdoor decking and beams, garden furniture, laminated beams, weather board, steps, cladding, stairs, log homes, gates, fascia boards and plywood. Spacers and cross arms used with electrical, distribution, telephone and light poles are treated to H3.

H4 GROUND CONTACT (HIGH HAZARD)

This level of treatment helps prevent agricultural posts and landscaping structures from rotting and termite attack. Also recommended for treatment in this hazard class are playground structures, fencing, pergolas, carports, flower boxes, decking, bridges and stakes, as well as electrical, distribution, telephone and lighting poles.

H5 FRESHWATER (HIGH HAZARD)

Timber which falls into this category, is timber exposed to continual wetting or where the timber is planted in wet soil. Timber which will fall into this category could be jetties, drains, walkways, retaining walls and slipways.

H6 MARINE (HIGH HAZARD)

Only the use of the CCA chemical with Creosote is recommended for this application. Only timber treated with both these chemicals will offer complete protection against marine borers. Jetties, slipways, retaining walls and walkways will fall under this section.
ACKNOWLEDGEMENTS

SAWPA gratefully acknowledges the contribution of the Timber Preservers Association of Australia (TPAA) towards portion of this publication.

SAWPA is an organisation comprising timber treaters, suppliers of preservatives, as well as organisations, institutions and individuals with a mutual interest in timber preservation and the use of preservative-treated timber.

SAWPA promotes the benefits of timber preservation, assists in the establishment of and adherence to standard specifications for preservative treatment of timber, and supports the maintenance of standards in all sectors of the preservation industry.

SAWPA is a facilitator to the industry and an information centre for both consumer and industry affairs.

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