060608

Timber Advisory Note

Timber Advisory Centre

TREATING TIMBER WITH *LYCTUS*-SUSCEPTIBLE SAPWOOD

G. K. Brennan

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT, HARVEY

Lyctid beetles are commonly referred to as 'powder post borers' because of the fine powder found in attacked wood. They belong to the family Lyctidae and are commonly found attacking the sapwood of certain hardwoods. The most common species of this family in Western Australia is *Lyctus brunneus*. Eggs are laid in the pores (or vessels) of the wood, so attack does not occur in softwoods because they do not have pores. The Lyctid larvae (grubs), which do the main damage, feed on starch and other food materials which are confined to the sapwood, so that infestation of the heartwood does not occur.

Usually timber which carries susceptible sapwood will be infected within the first year after milling. Wood with a moisture content of between 8 and 30 per cent is susceptible to attack by the powder post borer, and the infestation will continue until the food supply (starch) has been exhausted. In some cases the sapwood may be reduced to dust, but the extent of attack depends largely on the amount of starch present.

Lyctid attack may be prevented by removal of the susceptible sapwood or by treatment of such sapwood with an approved preservative. With an increasing number of regrowth trees (containing large proportions of sapwood) being utilised for timber, discarding the sapwood would result in an enormous wastage. Treatment of susceptible sapwoods can be done by diffusion, open tank methods, or vacuum/pressure methods.

Lyctus-susceptibility of the commercial timbers grown in Western Australia.

The *Lyctus* - susceptibility rating of the common commercial timbers produced in Western Australia is given below. In general, the ratings in this list refer to the susceptibility of sapwood to attack by the powder post beetle *Lyctus brunneus* under Australian conditions. The rating given does not necessarily correspond to the susceptibility of the same timber to attack by other powder post beetles of the family Lyctidae.

The *Lyctus* - susceptibility ratings are :

S - Susceptible
This rating has been given to those timbers whose sapwood has frequently been attacked or which have been found to be susceptible experimentally.

RS - Rarely susceptible
This grading has been given to those pored timbers whose sapwood has seldom been attacked in service.

NS - Non-susceptible
This grading has been given principally to non-pored timbers which in general cannot be attacked because of the absence of pores for egg laying by the adult beetle. Pored timbers in which attack has never been recorded have also been included in this grading.

Species	**Susceptibility Rating**
Allocasuarina fraseriana (W.A. sheoak)	S
Eucalyptus astringens (brown mallet)	NS
E. calophylla (marri)	S
E. diversicolor (karri)	S*
E. gomphocephala (tuart)	S
E. marginata (jarrah)	RS**
E. patens (W.A. blackbutt)	S
E. salmonophloia (salmon gum)	NS
E. wandoo (wandoo)	NS
Pinus pinaster (maritime pine)	NS
P. radiata (radiata pine)	NS

* Recent research by CSIRO Division of Forest Products/CALM has shown mature and regrowth karri to be susceptible to *Lyctus* attack and information published in Australian Standards requires modification.

** Recent research by CSIRO/CALM indicates that jarrah is rarely susceptible, as compared with the susceptible rating given in AS1720.2 'SAA Timber Structures Code'.

The sources of the information on *Lyctus*-susceptibility of the other species listed are AS1720.2 and Bootle (1983).

Relevant references include :

Bootle, K.R. (1983). Wood in Australia - Types, Properties and Uses.
McGraw - Hill Book Company Sydney.

Standards Association of Australia (1990). SAA Timber Structures Code.
AS1720.2 - 1990. Timber properties.

Standards Australia (1993). Timber - Preservative-treated - Sawn and round.
AS1604 - 1993.

METHODS OF TREATING TIMBER

Boron treatment has traditionally involved momentary immersion in a tank or tunnel spraying of freshly sawn green timber, followed by block stacking, then storage under cover for several weeks to allow diffusion. The period of block stacking before stripping the timber out to dry depends on the species, initial moisture content and sapwood thickness. The rate of diffusion is increased by high humidity, high temperature and high concentration of boron salts.

The recommended diffusion storage period is four weeks for every 25 mm of sapwood thickness, in good drying conditions, but this can vary with season. Low density species can be treated effectively in more diluted solutions than denser species can. A typical treatment solution contains 4.5 per cent 'Borax' (45 kg of 'Borax' dissolved in 1000 L of water). Warming helps to dissolve the borax, while covering the tank when not in use prevents rain diluting the solution and loss through evaporation.

Dip diffusion process

This involves dipping green timber immediately after sawing in a 4.5 per cent solution of borax or boric acid. After draining the excess liquid the timber is block stacked and covered completely with plastic to prevent drying and to facilitate the diffusion of the preservative throughout the sapwood. After diffusing into the sapwood the timber is strip stacked for air or kiln drying. If mould or fungal activity occurs during drying, anti-sapstaining chemicals may be applied.

After each treatment cycle, measure the number of litres of preservative solution used and replace this volume with fresh stock solution. While treating and topping up, the treatment solution should be stirred to ensure overall mixing. Stirring is best carried out with a circulating pump, but in smaller plants, manual stirring with a paddle should be sufficient.

Momentary dip

This involves the momentary immersion of green-off-saw timber in a similar concentration of preservative solution in a dip tank or chain dip, or the application in a spray tunnel.

Dip tank - consists of an open tank of suitable dimension, a separate mixing tank suitably interconnected, and facilities for draining surplus solution from the timber back into the dip tank after immersion.

Spray tunnel - consists of a number of spray nozzles arranged as a tunnel, and when the timber to be treated is passed through it, all surfaces are sprayed with preservative. The spray nozzles are connected to a pump which is connected to a storage tank. A drip tray is located under the outfeed rollers to catch the surplus preservative.

Chain dip - consists of a number of mechanically powered conveyor chains passing through a shallow V - shaped trough, and timber is carried on the chains and submerged in the treating solution. The trough is of sufficient width to allow surplus treating solution to drain from the timber as it passes out of the trough.

The following points must be considered when using the dip-diffusion process.

(i) Only green-off-saw material can be treated, with a moisture content above 50 per cent. The time between sawing and diffusion must be less than 18 hours. Appearance grade timber generally needs treatment, but staining would not be a problem in most structural grade timber because it is not exposed.

(ii) Timber surfaces wet with rainwater should not be treated because the uptake of treating solution may be considerably reduced.

(iii) For appearance grade timber, timber must be free of sapstain prior to treatment, and precautions taken to prevent its later development. This may require the addition of an anti-sapstain ingredient to the diffusion formulation.

(iv) Borates are generally effective in the control of sapstaining fungi in more temperate climates, and are usually at high pH, so that borax is more reliable than straight boric acid solution. However, they are relatively inefficient against superficial moulds such as *Penicillium spp* and *Trichoderma spp,* so they must be employed in combination with other toxicants. These surface moulds are readily removed when the timber is dressed, resulting in very little effect on the appearance of the timber.

Cold soaking

Timber is strip stacked so that the treatment solution can readily contact every surface and is lifted into a tank containing the 4.5 per cent concentration treatment solution, commonly borax. Soaking times can be up to two weeks for 25 mm thick sapwood, depending on the time of year and the species. For temperatures between 18°C and 40°C soaking times for 25 mm thick sapwood can be reduced to 7 days and for 38 mm thick sapwood to 14 days. This method is recommended for sawmills with a small output.

Hot and cold process - green timber

This method is quicker than dip diffusion or cold soaking with treatment taking approximately 24 hours. Lower density eucalypts can be treated by heating the treatment solution to between 85° C and 90° C, and immersing timber with 25 mm thick sapwood for 2 hours and 38 mm thick sapwood for 4 hours. Higher moisture content of the timber increases the time required, and longer times are also required for medium to high density hardwoods. The timber is cooled in the solution overnight (allowing a temperature drop of 40°C) for about sixteen hours, then removed the following morning for air or kiln drying. Treatment solutions can be heated with electric elements, or using wood or oil. Lagging of exposed pipes and

insulation of the treatment vessel is recommended, to cut down on heat loss and to reduce heating costs.

Steam and cold quench process

This method is similar to the hot and cold process. It involves placing partially seasoned timber into a treatment vessel, where steam is applied for several hours with live or exhaust steam to raise its full cross section temperature to about 85°C. The steam is cut off and the cold treatment solution is flooded in as quickly as possible, making sure that sufficient preservative is added to keep the stack fully immersed at all times. Weight restraint is used to prevent the stack from partially floating. After soaking for about 15 hours the solution is pumped out and the timber removed to a storage area for a period of block stacking to allow diffusion.

A schedule for timber with 25 mm of thick sapwood is :

- Steam heat timber for 3 hours at 85°C.
- Quench in 2 to 3 per cent boric acid equivalent solution.
- Hold for about 15 hours in solution.
- After treatment block stack to allow diffusion. This may not be necessary with an efficient steam / cold quench.

Vacuum and pressure

To ensure sufficient penetration into the sapwood, vacuum/pressure treatments are very effective. The sapwood is generally dried to fibre saturation point (30 per cent moisture content) before treatment with CCA or borax. CCA is preferred because it fixes in the wood cells, if the timber is to be used in hazard levels above H1. This process is the most commonly used for commercial operations because it permits a rapid throughput of timber.

Vapour boron treatment

This is a new process for boron treatment of sawn timber and composite panel products. It is not used in Australia but is commercially used in New Zealand, where it is incorporated with high temperature drying, in the one process. Timber is dried to between 4 and 6 per cent moisture content, then a gaseous form of boron is added to the treatment cylinder, and reacts with the moisture in the timber to produce boric acid. If the moisture content is too high the consumption of chemical is increased and uneven preservative loading can occur. The advantages of this system are that the entire treatment process from start to finish is completed in less than one hour after high temperature drying, and the boron is evenly distributed throughout the wood.

CHEMICALS USED TO TREAT *LYCTUS*-SUSCEPTIBLE SAPWOOD

Level of preservative to prevent attack

Revised Australian standard A.S. 1604 - 'Preservative treatment for sawn and round timber' requires *Lyctus*-susceptible sapwood to be treated to hazard level H1 and the preservative must penetrate all the susceptible sapwood. Preservatives used to treat *Lyctus*-susceptible sapwood are listed in Table H1-1 of AS1604 - 1993 and include copper-chrome-arsenic (CCA), boron compounds (boric acid), synthetic pyrethoids, fluorine compounds and organochlorines (aldrin, dieldrin, heptachlor and chlordane). Boron compounds have been commonly used eg. 'Borax' (sodium tetraborate), 'Timbor' and 'Polybor' (disodium octaborate tetrahydrate), and a retention of 0.27 per cent mass/mass boric acid (0.047 per cent mass/mass boron) or 0.035 per cent mass/mass elemental arsenic is required in the inner sapwood. Per cent mass/mass is the mass of preservative compared with the mass of the treated wood.

Full sapwood penetration is required, therefore a brushing application of preservatives is not recommended. CCA preservatives can fix in the sapwood cells, however, other chemicals may be non-fixing and subject to leaching when exposed to continuous wetting.

Table H1 in A.S.-1604 - 1993 lists the chemicals that can be used to treat sapwood against *Lyctus* attack. Boron compounds have been commonly used e.g. 'Borax', 'Polybor' or 'Timbor', where a sapwood retention of 0.27 per cent mass/mass boric acid is required, or CCA where a sapwood retention of 0.035 per cent mass/mass elemental As is required. 'Perigen 500' is a synthetic pyrethroid insecticide containing 500 g/L permethrin 25:75 and can be effective against *Lyctus* and other wood borers, for example *Anobium punctatum*. It is mixed at a rate of 1 L of 'Perigen' with 99 L of diesel, light oil or water and applied to sawn timber at 1 L per 20 m^2 of surface area. A retention of 0.006 per cent m/m permethrin is required in the inner third of sapwood (Standards Australia 1993).

'Diffusol ™' is a thickened boron treatment used in New Zealand. Compared with treating with an unthickened solution, it allows higher uptakes, use of lower solution concentrations, and the use of cold application rather than heated bath saves 25 per cent in time to achieve the required core loadings. Vapour boron is also used in New Zealand, and was discussed above.

TRADE NAME	ACTIVE INGREDIENT	SUITABLE APPLICATION METHOD	DILUTION RATE	APPLICATION RATE	COST (NOV 1994)	AVAILABLE FROM
Perigen 500	500g/L permethrin 25:75.	Spray, dip	Prevention : 20 ml in 10 L of diesel or water.	1 L/20 m^2 of surface area or point of run off.	$13/L (20 L drum) $15/L (1 L container).	Robert Linton Pty Ltd
		Spray, dip	Remedial : 40 ml in 10 L of diesel, light oil or water.	1 L/20 m^2 of surface area or to point of run off.	As above	Robert Linton Pty Ltd
		Vacuum/pressure impregnation with *LOSP's.	11.2 ml per 100 kg of sapwood.	Until full uptake of solvent.	As above	Robert Linton Pty Ltd
Dehybor	Borax (sodium tetraborate).	Dip diffusion.	45 kg/1000 L (4.5 per cent).	Sufficient to treat full sapwood.	$2.60/kg (based on a 25 kg bag).	Spectrum Distributors
Timbor Polybor Solubor	Disodium octaborate tetrahydrate	Vacuum/pressure impregnation, open tank methods or dip diffusion	170 kg/1000 L at 40^{o}C or 340 kg./1000L at 60^{o}C	Sufficient to treat full sapwood	$3.50/kg (based on a 25 kg bag)	Spectrum Distributors
Boracol 200 RH Boracol 400 RH	Disodium octaborate tetrahydrate and Benzalkonium chloride.	Spray, dip	No dilution required.	200 RH - Preventative 10 ml/1000 cm^3 (10 L/m^3) Remedial : 20ml/10006m^3 (20 L/m^3) 400 RH - Preventative 5 ml/1000 cm^3 (5 L/m^3) Remedial : 10 ml/1000 cm^3 (10 L/m^3).	$16.70/L (based on a 5 L drum) $14.12/L (based on a 20 L container) $20.05/L (20L containers) $25.00/L (5L container).	W.A. Hardware, Midland or Hale Road Hardware, Forrestfield Chemicca Ltd (Nufarm), Kwinana. (09) 411 4000.
Tanalith CP Tanalith C Tanalith O Celcure A	CCA : Copper, chrome arsenic	Vacuum/pressure impregnation	Treatment Plant directions.	To a hazard level 1 (H1) retention.	Available from treatment plants.	Koppers, Chemicca Ltd, and Bunnings Forest Products.

*** LOSP - Light organic solvent preservative.**

METHODS

Equipment

Dip diffusion

Small output - 200 L steel drums cut in half lengthwise.

Large output - Steel, concrete or brick tanks built to suit production (steel tanks need to be sealed with a bituminous paint to prevent corrosion).

- Lifting equipment (e.g. crane or overhead hoist) is required.
- Storage tank and recirculating pump will allow thorough mixing, otherwise manual stirring with a paddle is required.
- Warming helps to dissolve borax, therefore appropriate heating facilities will be required.
- Covering the tank prevents rain diluting the treatment solution and loss through evaporation.

Momentary immersion

'V' shape steel dip with mechanically powered conveyer chains to move the fresh sawn timber through the solution.

Tunnel spraying facilities.

Any dip diffusion method, using a dip tank or spray application requires the timber to be block stacked and wrapped in plastic or tarpaulins to allow diffusion.

Vacuum/pressure impregnation

A pressure cylinder is required for CCA and (LOSP) or permethrin treatments.

Treatment plant must be licensed.

(a) Tanks

- Dip a block stacked or stripped stacked bundle in 4.5 per cent borax solution (see below) for 5 to 6 minutes.
- Wrap in plastic or tarpaulins for diffusion into the sapwood.
- Allow 3 to 4 weeks diffusion for 25 mm and 6 to 8 weeks for 50 mm thick sapwood. This period will vary with species, humidity, temperature and concentration of boron salts.
- Store in a place protected from the weather.
- After dipping, top-up the treatment vessel with fresh stock solution.

stirred to ensure overall mixing.

(b) Chain dips and spray tunnels

- Allow sufficient immersion time to allow the timber to cover all surfaces.
- Block stack the timber, wrap in plastic or tarpaulins and store for the diffusion period, in a sheltered position.
- A drip tray is required to catch any surplus chemicals.

Chemicals

A comparison of commercially available products for *Lyctus* control and available in Western Australia is outlined in the table below.

Retention and Penetration

The revised Australian Standard AS1604-1993 requires sawn and round timber with *Lyctus*-susceptible sapwood to be treated to hazard level H1 and the preservative must penetrate all the sapwood. The preservative retention in the penetration zone of the treated sapwood shall be not less than that specified in Table H1 in AS1604 i.e. 0.27 per cent mass/mass boric acid equivalent, 0.035 per cent mass/mass elemental arsenic, or 0.006 per cent mass/mass permethrin.

Retention and penetration requirements for the other chemicals listed in the table should follow the manufacturer's recommendations.

Solution strength

Borax - 4.5 per cent 'Borax' (45 kg of 'Borax' dissolved in 1000 L of water).
CCA - Determined by the timber treatment plants.
- For other chemicals refer to Table H1 of AS 1604 - 1993.

Storage

- Stacked timber should be wrapped in plastic to allow the chemical to diffuse into the sapwood.
- It is best to store the timber under shelter, because borates are subject to leaching.
- If moulds or other fungi grow on appearance grade timber during storage, anti-sapstain chemicals which are compatible with borax may be required e.g. Koppers-Hickson's NP1 sapstain control.

PENETRATION TESTS

Penetration (spot) tests are used to check that the full sapwood depth has been penetrated with a waterborne preservative, such as copper, zinc, arsenic, boron or fluorine. Test methods are described in A.S. 1605 - 1974 - 'Sampling and analysis of wood preservatives and preservative treated wood'. A starch test as described previously is also required to identify the sapwood containing starch.

Boron penetration (spot) tests

Penetration (spot) tests are used to check for depth of penetration of boron into the treated timber. Samples should be taken from each batch of treated timber and are usually taken from within the treated stack, as shown in Figure 1. At least 500 mm is removed from the end of each sample and discarded. A radial section as shown in Figure 2 is split cleanly with a knife or axe. One face is tested for starch (starch spot test), and the matching face is tested for boron penetration.

Boron spot test

Reagents:

(a) Turmeric reagent : 200 g turmeric powder and 500 ml methylated spirits are stirred together for two hours. The reagent and any remaining solids are stored in an air tight bottle. The reagent is thoroughly shaken and filtered before use, to give a clear solution.

(b) Concentrated hydrochloric acid : Laboratory grade reagent (all reagents, samples and apparatus, must be kept free of water).

Procedure

Dry a radially split section of the test sample overnight in an oven at 70°C and allow the sample to cool before testing.

Measure 20 ml of filtered turmeric reagent and add 1.0 ml of concentrated hydrochloric acid. Once prepared, this mixture must be used within twenty minutes. Larger quantities may be prepared in the same ratio of 20:1.

Apply the boron spot test mixture to one face of the split test sample.

The production of a red-orange coloration after twenty minutes indicates the presence of boron.

The following scheme relates the colour of the spot test result to the approximate level of boron present, and is applicable mainly to light-coloured wood. The scheme describes colours developed on the wood surface under test, at twenty to twenty-five minutes after reagent application.

Colour	% Boric acid	
yellow	0.00-0.05	... not adequately treated
orange	0.10-0.15	... barely treated
orange-red	0.15-0.20	... adequately treated

Colour differences can be more readily seen if the spot-tested material is viewed under an ultraviolet lamp.

Starch spot test

As well as the boron test, the matching split face of each sample must be tested for the presence and extent of starch-bearing sapwood, as the preservative chemical must penetrate all starch containing sapwood, and that the zones must contain the required minimum level of boron.

Reagents

Iodine-iodide solution. Mix 12 g of potassium iodide and 6 g of iodine in a minimal quantity of water, and then make up to one litre with water. Store in a dark bottle.

Procedure

The matching split face is brushed with the starch spot test reagent and examined for the presence of starch after two minutes. Starch reacts with the spot test reagent to give a blue-black deposit and is best observed with a times 10 magnifying glass. In many species, the blue-black deposits are so abundant in the sapwood that they are readily seen with the naked eye.

CCA tests

Because CCA treatments are carried out by registered treatment plants, they are responsible for quality control standards. The retention of CCA in the treated timber is estimated by standard laboratory tests, and sampling and analyses are carried out as specified in Australian Standard AS 1605 - 1974 'Methods for the sampling and analysis of wood preservatives and preservative - treated wood'.

Permethrin tests

Currently there is no spot test for permethrin and chemical analysis by an approved laboratory is required.

HEALTH AND SAFETY

Boron compounds and CCA are commonly used to treat *Lyctus*-susceptible sapwood. CCA is only available to licensed treatment plants, where strict health and safety proceeds are specified. All persons handling or using Lycticides need to be aware of the safety precautions when mixing and handling these chemicals in concentrated or diluted form.

Boron - borax

Although 'Borax' has a low mammalian toxicity, care must be taken when handling the chemicals and dealing with the treatment solution. When mixing wear a full length apron, elbow length gloves, goggles and a twin cartridge respirator with chemical filter. Applying the chemical requires the use of the above equipment except the respirator.

Personal precautions	-	Avoid contact with skin and eyes.
	-	Wash skin immediately after use with soap and water and also before eating, drinking, smoking or use of the toilet.
	-	Wash contaminated clothes.
	-	If these liquids penetrate clothing, remove immediately and wash the skin thoroughly, using soap and water.
	-	If irritation or other effects consistent with skin absorption are present after washing, seek medical attention.
Ingestion	-	Contact a doctor or a Poisons Information Centre.
Eye contact	-	If dust or liquids containing these preservatives get into the eyes, hold the lids apart and gently flush eyes with large amounts of water.
	-	Contact lenses should be removed before flushing.
	-	If irritation or pain persist after fifteen minutes of flushing, seek medical attention as soon as possible.
Inhalation	-	Move the exposed worker to fresh air.
	-	Establish that the airway is not blocked, to maintain respiration.
	-	If necessary use respiratory resuscitation measures after washing the skin around mouth and nose.

Do not dispose or spray mixture near domestic water supplies or irrigation areas.

Any spillage should be immediately soaked up with sawdust. When sawn, treated timber will blunt saw blades more quickly than untreated timber. When burned, borax-treated timber may create a 'glass' or clinker and block the fire grates. Borax-treated timber should not be used in cooking fires.

Boric acid solution is corrosive to steel, particularly when hot, and now borax or

easier to dissolve.

Boric acid is a non-selective herbicide and is toxic to plants at low levels, therefore the chemical should not be disposed of near established vegetation. Borates are subject to leaching, but if treated wood is reasonably well protected from rain during storage and delivery, this is not considered a problem. Although boron - treated timber is not allowed in exposed conditions, leaching would not occur from treated wood in structures if the builder follows proper construction practices such as adequate roof overhang, proper drainage, and well maintained finishes.

CCA

Australian Standards specify the requirements for treatment plants in using timber preservatives. These include wearing gloves and washing hands before eating, drinking, smoking and use of the toilet. Treatment plants need to be licensed and need to comply with specific plant design and operational requirements.

The preservatives contained in CCA-treated timber are toxic chemicals, but as they are locked into the timber in an insoluble form they can only present a hazard by burning. Care therefore must be taken not to inhale the fumes from burning off-cuts and the resulting ash should be buried. It is preferable to dispose of unwanted CCA-treated timber by burying at an approved disposal site. CCA-treated timber must never be burnt in an enclosed space and it must never be used for fuel in barbeques, cooking stoves or grates. Anybody using CCA-treated timber must wear light gardening type gloves and during any form of wood working which generates dust (e.g. sanding), respiratory and eye protection should be worn and it is advisable to keep the work area well ventilated. As stated previously, personal hygiene is important.

DISCLAIMER

Information on methods to treat *Lyctus*-susceptible sapwood and some of the chemicals available for treatment are given in this technical sheet. Suppliers of the chemicals listed in this sheet are responsible for issuing health and safety procedures which must be followed, as well as the manufacturer's instructions on handling and usage. Consequently, neither the Executive Director nor the Department of Conservation and Land Management shall be liable for any loss, injury, damage or death whether consequential or otherwise whatsoever or however arising from the incorrect use of chemicals or applications methods specified in this sheet.