

PROTOCOLS FOR ASSESSMENT OF WOOD PRESERVATIVES

*A PRODUCTION OF
THE AUSTRALASIAN
WOOD PRESERVATION
COMMITTEE*

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FOREWORD

The Protocols for Assessment of Wood Preservatives were first issued by the Australasian Wood Preservation Committee (AWPC) in September 1997. They were based on a clear need to develop commonly accepted testing procedures as a basis for approval of new preservative formulations. In the Australasian region, the major research providers with the capabilities of carrying out rigorous preservative testing worked through the auspices of the AWPC to compile their current laboratory and field test procedures for all hazard class exposures (H1-H6) in a single document.

This amendment includes test procedures to evaluate preservative systems for NZ Hazard Class H1.2 and Australian Hazard Class H2F. It also includes details of Accelerated Field Simulator (AFS) and an alternative test procedure for Hazard Class H2. There have also been editorial changes to improve wording in some sections and to extend test procedures to reconstituted wood products.

The AWPC is grateful to Dr Laurie Cookson, Ensis Wood Processing, Clayton, for steering through these amendments in their various draft formats. In addition, the AWPC would like to acknowledge all of the constructive comments received from around the world during the various public review drafts.

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SCOPE

These protocols have been prepared for the benefit of suppliers of wood preservative formulations. The purpose of the protocols is to provide procedures for determining the biocidal efficacy of wood preservatives intended for use in Australia and New Zealand. They have been prepared by the Australasian Wood Preservation Committee (AWPC) with input from experts in the wood preservation industry and testing laboratories.

The AWPC protocols are not meant to stifle innovation by being too prescriptive. However, deviation from the procedures described in these protocols should be endorsed by the various approval bodies and/or assessors before the start of experimentation.

The protocols are the minimum procedures needed to provide biocidal efficacy data for obtaining preservative approval by the appropriate regulatory authorities. The AWPC does not guarantee that a candidate preservative which is assessed using these protocols will be approved for commercial use by the regulatory authorities.

The AWPC recommends that prospective suppliers of wood preservative formulations should discuss their proposed needs with any of the organisations listed in the attachment, so that the most relevant tests may be established.

The protocols are provided on the basis of the disclaimer set out in the footnote.

Disclaimer: The protocols are provided on the basis that the AWPC and its members, as listed on page 1 disclaim, to the extent permitted by law, all warranties whether expressed or implied. The protocols are of an advisory nature only, are provided in good faith, and are not claimed to be an exhaustive treatment of the subject. Further professional advice may be required before taking any action based on the protocols and the AWPC recommends that such advice be obtained. Neither the AWPC or its members shall be liable, whether under contract, tort, equity, breach of statutory duty or otherwise for any direct, indirect, incidental, consequential loss of business profits or special damage arising out of any use of or reliance on the protocols.

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PREFACE

- A flowchart outlining procedures for preservative approval and inclusion in Australian Standards is given in Figure C1 of Australian Standard 1604.1 “Specification for preservative treatment, Part 1: Sawn and round timber”.
- The Hazard Classes referred to in these protocols are those set down in AS 1604.1 “Specification for preservative treatment, Part 1: Sawn and round timber” and NZS 3640 “Chemical preservation of sawn and round wood” (see Table 1, which is based on the Hazard Class Selection Guide of AS 1604).
- The protocols cover a combination of laboratory, AFS (accelerated field simulator) and/or field testing as summarised in Table 2. In most cases laboratory and AFS data shall not form a minimum requirement on their own, but are included in assessment procedures as they can support field data particularly where field site variability is extensive. The laboratory data for Hazard Class H1 and H1.2 end-use may be used as sole performance criteria.
- Field tests shall be conducted on the preservative formulation that is intended for registration and commercial use. If the preservative formulation, upon which the original approval is obtained, is

TABLE 1 HAZARD CLASS SELECTION GUIDE

| HAZARD CLASS | EXPOSURE | SPECIFIC SERVICE CONDITIONS | BIOLOGICAL HAZARD | TYPICAL USES |
|--|--|--|---|---|
| H1 | Inside, above ground | Completely protected from the weather and well ventilated and protected from termites | Insects other than termites (lyctids in Australia, and lyctids and anobiids in New Zealand) | Framing, flooring, furniture, interior joinery |
| H1.2 <small>NEW ZEALAND ONLY</small> | Inside, above ground | Inadequately protected from the weather, allowing rainwater penetration | Decay | House framing |
| H2 & H2F | Inside, above ground | Protected from wetting. Nil leaching | Borers and termites | Framing, flooring, etc. used in dry situations |
| H3 | Outside, above ground | Subject to periodic wetting and leaching | Moderate decay, borers and termites | Weatherboard, fascia, window joinery, framing and decking |
| H4 | Outside, in-ground | Subject to severe wetting and leaching | Severe decay, borers and termites | Fence posts, greenhouses, pergolas and landscaping timbers |
| H5 | Outside, in-ground contact, with or in fresh water | Subject to extreme wetting and leaching and/or where the critical use requires a higher degree of protection | Very severe decay, borers and termites | Retaining walls, piling, house stumps, building poles, cooling tower fill |
| H6 | Marine waters exposure | Subject to prolonged immersion in sea water | Marine wood borers and decay | Marine piles, jetty cross-bracing, landing steps, etc. |



to undergo substantial change, then some level of new efficacy testing is required. Substantial changes would include changing the solvent system (e.g. from oil to water-borne), significant alteration to the proportion of water repellents or other additives, or new

combinations of actives. Long term field testing of the previously approved actives is not required if laboratory testing (H1 to H3, and H6) shows that there has been no reduction in efficacy relative to the original formulation. Modification to existing H4 and H5 actives would also require a fungal AFS trial.

- Field data may be generated at overseas sites if the biodeteriogens and timber species are appropriate to the countries of end use. If in doubt, advice from a member of the AWPC should be sought.

- The function of untreated control specimens particularly in field tests, is to monitor the level of the hazard to ensure that the test is relevant to a preservative's performance. Should untreated controls fail to be attacked another test site should be selected. Biometric expertise in experimental design and layout is considered advantageous.

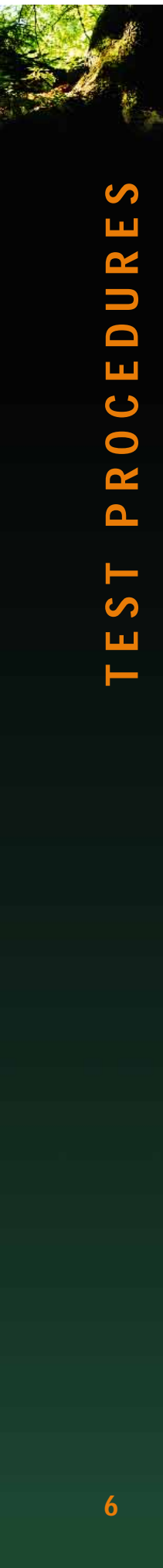


- Reference preservatives must be selected from those currently approved in the relevant Australia and New Zealand standards and included in any test procedure at threshold and sub-threshold levels. Usually, CCA is the recommended reference preservative for H3 to H6.
- The determination of chemical distribution, spot test development, preservative behaviour in the wood, safety, environmental, and engineering aspects are not covered by these protocols.
- The majority of the test procedures described should be conducted by independent laboratories. If test timbers are treated by the preservative company, then the treatment work shall be witnessed by an independent party, and/or a representative sample of test specimens shall be chemically analysed by an independent laboratory.
- Wood composites may be tested using similar protocols to those described here for solid wood. Accepted differences and points to note in test methods are:

TABLE 2
ASSESSMENT PROCEDURES FOR EACH HAZARD CLASS INCLUDED IN THESE PROTOCOLS

| HAZARD CLASS | INSECT | DECAY | MARINE BORERS |
|--------------|--------|---------------|---------------|
| H1 | | | |
| LABORATORY | ★ | ★ (H1.2 only) | |
| FIELD | | | |
| H2 | | | |
| LABORATORY | ★ | | |
| FIELD | ★ | | |
| H3 | | | |
| LABORATORY | ★ | ★ | |
| FIELD | ★ | ★ | |
| H4 | | | |
| LABORATORY | ★ | ★ | |
| AFS | | ★ (Optional) | |
| FIELD | ★ | ★ | |
| H5 | | | |
| LABORATORY | ★ | ★ | |
| AFS | | ★ (Optional) | |
| FIELD | ★ | ★ | |
| H6 | | | |
| LABORATORY | | | ★ |
| FIELD | | | ★ |

1. Test specimen size shall accommodate composite profiles or board thicknesses.
2. Glueline additives shall be tested in the same glue type as will be used commercially. Results in UF resin do not apply in PF resin.
3. Field test specimens from engineered wood products should comprise all components of the product. For example, I-beams should be tested intact rather than with web and flanges separated.



LABORATORY LYCTID BORERS

HAZARD CLASS H1

TIMBER SPECIES

Timber species shall be known lyctid-susceptible species which have sufficient starch concentration to ensure attack of untreated controls. The timber species shall be appropriate to the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be sapwood with a minimum dimension of 18 (radial) x 25 (tangential) x 75 (longitudinal) mm, and have moisture content between 10-15%. Specimens shall be cut to size prior to treatment using a sharp blade that does not cause burrs that can occlude vessels. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a basis on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on

treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retention levels shall be segregated during these procedures.

PRE-TEST CONDITIONING OF SPECIMENS

After air-drying, test specimens shall be vacuum oven-dried at 40°C and -95 kPa for two days or fan-force convection oven-dried at 50°C for two days.

Test specimens shall then be brought to equilibrium moisture content in a conditioned insectary (26°C, 70% RH) prior to inoculation with test insects.

BIOASSAY

Each test specimen shall be exposed to not less than 20 unsexed *Lyctus brunneus* adults for a period of not less than three months.

PERFORMANCE CRITERIA

The test specimen shall be split longitudinally and visually examined for evidence of larval channelling. Toxic values for the preservative under test are between the highest retention which allows larval channelling and the lowest retention which prevents larval channelling. Results shall be valid if a minimum of 80% of untreated and, where applicable, solvent controls show evidence of larval channelling.

APPROVAL CRITERIA

The recommended minimum retention for H1 shall be 1.5x the higher toxic value.

LABORATORY

ANOBIID BORERS

HAZARD CLASS H1

ANOBIUM PUNCTATUM EGG-LAYING TEST

TIMBER SPECIES

The timber species shall be a known anobiid-susceptible species appropriate to the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be sapwood cut from the outer growth rings of freshly-felled trees. Test specimens shall have a minimum dimension of 20 (radial) x 30 (tangential) x 50 (longitudinal) mm. Annual rings shall be parallel to the tangential faces. Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of ten specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a broad guide on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retention levels shall be segregated during these procedures.

EXPOSURE TO OVIPOSITION

The two 50 x 30 mm tangential surfaces of each specimen shall be lightly punched with a sharp point to provide suitable oviposition sites. The depth and number of indentations is not critical, but fifty, 1-2 mm deep on each surface is recommended. Specimens shall then be randomly enclosed in glass containers, one formulation per container. A minimum of 50 adult *Anobium punctatum* (50:50 male to female mix) shall be placed in each container. Each specimen shall be examined each day for presence of oviposited eggs. Individual specimens shall be removed when they have accumulated a minimum of 25 eggs. Fresh adults shall be supplied to containers if needed.

STORAGE OF TEST ASSEMBLIES FOR EGG-HATCHING

Specimens shall be stored in open-topped containers at ambient temperature. Containers shall be stood in trays of paraffin oil as a means of avoiding mite infestation. After six months storage, specimens shall be examined by X-ray, or, less desirably, by dissection, to determine whether eggs have hatched and whether larval development has occurred. Any specimen in which there is no evidence of egg hatching shall be rejected from the test at this stage.

Specimens shall then be returned to storage for a further six months, after which further examination by X-ray or dissection shall occur.

PERFORMANCE CRITERIA

Toxic values for the preservative under test are between the highest retention which allows egg-hatching and larval development and the lowest retention which allows egg-hatching, but prevents larval development in all test specimens. Results shall be valid if a minimum of 80% of untreated controls and, where applicable, solvent controls show evidence of egg-hatching and larval development.

APPROVAL CRITERIA

The recommended minimum retention for H1 shall be 1.5x the higher toxic value.

LABORATORY ANOBIID BORERS

HAZARD CLASS H1 - CONTINUED

ANOBIUM PUNCTATUM LARVAL TRANSFER TEST

TIMBER SPECIES

The timber species shall be a known anobiid-susceptible species appropriate to the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be outer sapwood cut from the outer growth rings of freshly-felled trees. Test specimens shall have a minimum dimension of 20 (radial) x 30 (tangential) x 50 (longitudinal) mm. Annual rings shall be parallel to the tangential faces. Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of ten specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a broad guide on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

LARVAL TRANSFER

Following treatment and when dry, ten tapered holes 3-4 mm deep and with 3 mm maximum diameter shall be drilled into one face of each test specimen. A weighed *Anobium* larva of between 3 and 6 mg shall be placed head down into each hole. Larvae shall be examined microscopically before transfer to ensure they are undamaged and free of *Pyemotes* mites.

STORAGE OF TEST ASSEMBLIES FOR LARVAL DEVELOPMENT

Assemblies shall be placed in a container with a sheet of glass placed over the specimens and larvae contained therein. The container shall be placed in a tray of paraffin oil to prevent infestation with mites.

Each specimen shall be examined daily for the first week and larval activity recorded (i.e. larval activity penetrating the specimen, chewings and/or frass being produced). These observations shall provide insight into the type of preservative toxicity involved (i.e. acutely or chronically poisonous). Further inspections shall be made weekly. At the end of three months specimens shall be examined by X-ray, or less desirably, by dissection, to assess larval activity. Specimens shall then be returned to containers for a further three months after which further examination by dissection shall occur. Larvae shall be further checked visually and weighed.

PERFORMANCE CRITERIA

Toxic values for the preservative under test are between the highest retention which allows larval development as evidenced by larval weight gain and the lowest retention which prevents larval development, as evidenced by mortality or lack of active feeding or weight gain, in all test specimens. Results shall be valid if a minimum of 80% of untreated and, where applicable, solvent controls show evidence of larval development.

APPROVAL CRITERIA

The recommended minimum retention for H1 shall be 1.5x the higher toxic value.

LABORATORY – Wall Frame Cavity Test

DECAY

HAZARD CLASS H1.2

H1.2 is an indoor decay hazard applicable to New Zealand. The development of protocols to assess preservative systems for temporary (up to 5 years) protection of framing timbers is an on-going activity. One such procedure is described below. However, Ensis, Wood Processing, Rotorua staff should be consulted when deciding appropriate procedures for particular products.

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use: it may be necessary to utilise both softwood and hardwood substrates.

TEST SPECIMENS

Test specimens shall be standard framing timber (90 to 95 x 45 mm). For each test unit (with all timbers in the one unit of the same treatment), two studs shall be 500 mm long, top and bottom plates 500 mm long, and the central dwang or noggin about 450 mm long to fit the test unit (Fig. 1).

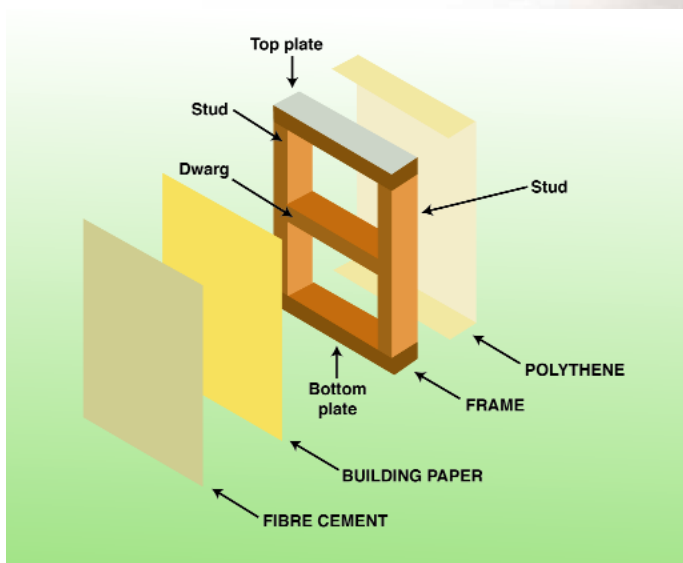


Figure 1. Components of the wall frame cavity test.

Components are cut after the treatment of end sealed specimens at least 1000 mm long and with moisture content of between 10-15%. Sufficient specimens of each retention of reference and candidate preservative shall be treated to permit selection of a minimum of six exposure test units per treatment. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a basis on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF SPECIMENS

After assembly of the timber components, frames from each treatment group shall be stacked in a large tank, weighted and the tank filled with water. They are soaked for two hours, drained and placed in a large covered stack. This period of soaking results in an average sample moisture content of around 40%, but most of the moisture is in the outer 5 - 10 mm of the sample. Framing units shall be weighed before and after wetting to allow calculation of moisture content. The water repellent properties of LOSP treatments may require 1-2 repeats of the wetting procedure before wood reaches 40% moisture content.

LABORATORY – Wall Frame Cavity Test DECAY

HAZARD CLASS H1.2 - CONTINUED

EXPOSURE

A sheet of 250 micron thick black polythene 900 x 500 mm shall be placed on the back of the frame. The ends shall be wrapped over the top and bottom plates and held in place with stainless steel staples in the front edge of the plates. The edges of the polythene sheet are fixed to the back of the studs with 35 x 10 mm CCA treated battens and 30 mm galvanised flathead nails.

Test specimens shall be exposed to at least two different species of brown-rot fungi for softwood framing, or one brown-rot and one white-rot fungus for hardwood framing. The brown-rots shall be typical of those found in decaying framing. In NZ these include *Antrodia xantha*, *Paxillus panuoides* and *Serpula lacrymans*. The white-rots shall be *Perenniporia tephropora* or *Trametes versicolor*. Feeder strips about 7 x 35 x 35 mm of a susceptible timber shall be first inoculated by placing them on plastic mesh placed over actively growing cultures of each fungus maintained on 2% malt agar for four weeks until feeder strips are overgrown with fungus.

The upper horizontal surfaces of timber pieces near the corners shall be surface sterilised by swabbing with 100% ethanol, and then allowed to dry for ten minutes. Decaying feeder strips shall be tacked with galvanised nails into the swabbed corners. The two test fungi may be placed in the same test unit, with one fungus placed in the right hand corners, and the other in the left hand corners.

Fibreglass insulating batts (R1.8, 75 mm thick) cut to wall cavity size shall be thoroughly wet by immersing them three times in water, allowed to drain for 30 seconds, and placed in the wall unit cavity. Sheets 600 x 500 mm of standard black bituminous building paper and 6 mm thick fibre-cement sheets shall be placed on the front of the unit and fixed to the studs with two 20 mm long stainless steel screws on each side.

Units shall be stored in a controlled environment room maintained at 27°C and 85-90% relative humidity. All units shall be periodically sprayed with water to maintain the wood moisture content at a level suitable for decay to progress. Incubation shall be for a minimum of 12 weeks.

PERFORMANCE CRITERIA

Each timber specimen shall be inspected for extent of decay, and rated using any internationally recognised system. The spread of fungal growth shall also be determined.

APPROVAL CRITERIA

The candidate preservative may be approved when it has a mean rating equal to or above the H1.2 reference preservative after a minimum of 12 months testing.

LABORATORY TERMITES

HAZARD CLASSES H2, H3, H4 AND H5

TIMBER SPECIES

The timber species shall be softwood or hardwood and representative of the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be sapwood with a minimum dimension of 15 (radial) x 25 (tangential) x 50 (longitudinal) mm. Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention for each termite species or vacuum oven control. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean..

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a broad guide on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF SPECIMENS

All test specimens (including H2) shall undergo the vacuum oven drying procedure. The leaching procedure is only required for termiticides to be used in Hazard Classes H3, H4 and H5.

Test specimens shall be vacuum-impregnated with water for 30 min. and allowed to remain for a further 30 min. in a jar containing at least three times the volume of water as of specimens. Water shall be drained from the jars and replaced with an equal amount of clean water. The jars shall be placed in a shaking water bath maintained at 35°C for 5-7 days with the water in the jars changed daily during five of the days. Specimens shall then be placed on drying racks for two days to surface dry.

Specimens shall be dried in vacuum ovens at 40°C and -95 kPa for five days and then weighed to obtain initial masses.



LABORATORY TERMITES

HAZARD CLASSES H2, H3, H4 AND H5 - CONTINUED

BIOASSAY

Test specimens shall be exposed to at least one species of subterranean termite. If only one species is to be used then the preferred species is *Coptotermes acinaciformis*. However, if the preservative is intended for use North of the Tropic of Capricorn then *Mastotermes darwiniensis* also shall be used. Termites shall be fresh, field collected stocks and shall be used within two weeks of collection.

PREFERRED METHODOLOGY

1. *Coptotermes acinaciformis*

The bioassay shall occur within a glass jar filled with a moist matrix of mound material. One test specimen shall be embedded in the matrix, unless the candidate preservative is of a freely diffusible formulation; in this case the specimen shall not be in direct contact with the matrix, but separated from it by an impervious material. A minimum of 10 grams of termites shall be added to each jar and a ventilated lid shall close the jar. The jars shall be maintained in an insectary at 27°C and 75% RH for eight weeks. In order to minimise potential environmental effects in the insectary, all jars shall be rotated 90° on a weekly basis.

2. *Mastotermes darwiniensis*

The bioassay shall occur within a glass jar filled with a mixture of vermiculite and sawdust of a susceptible timber species, e.g. *Eucalyptus regnans*. One test specimen shall be embedded in the matrix, unless the candidate preservative is of a freely diffusible formulation; in this case the specimen shall not be in direct contact with the matrix, but separated from it by an impervious material. Water shall then be added to the matrix to achieve a 300% moisture content. A minimum of 15 grams of termites shall be added to each jar and a ventilated lid shall close the jar. The jars shall be maintained in an insectary at 32°C and 75% RH for six weeks. In order to minimise environmental effects in the insectary, all jars shall be rotated 90° on a weekly basis.

POST-BIOASSAY CONDITIONING

At the conclusion of the bioassay exposure, specimens shall be removed from the jars and cleaned. Specimens as well as vacuum oven controls shall be vacuum oven dried at 40°C and -95 kPa for five days. Specimens shall be weighed and compared with their initial mass to obtain mass loss.

Mass losses of test specimens exposed to termites shall be adjusted to accommodate any changes recorded by the vacuum oven controls. The test will be valid for those termite species that produce a mean mass loss of more than 40% in the untreated control specimens. Attack is controlled when mean mass loss is 5% or less.

PERFORMANCE CRITERIA

The toxic threshold value for each termite species and preservative under test is the lowest retention which prevented a mean mass loss of more than 5%.

Data generated in these laboratory tests cannot be used solely to establish commercial retention levels, but may be used to support field data. In addition the laboratory data may be used as a basis for establishing retentions for field testing.

FIELD TERMITES

HAZARD CLASS H2

Note: These test procedures are also suitable for establishing termiticidal efficacy of insecticides which may be included in formulations for treatment to Hazard Class H3, provided it can be shown that the insecticidal components will not be leached out. It will also be necessary to test the preservative in a direct ground contact field test where termites are active for Hazard Classes H4 and H5. A minimum of one of the two test procedures shall be required.

DRUM TECHNIQUE

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be a minimum of 25 x 25 x 100 mm sapwood. In the case of H2F treatments, the cross section of test specimens will be the maximum size to be produced commercially. Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%.



Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention for each termite species or vacuum oven control. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested. H2 treatments shall achieve full sapwood penetration, while more limited penetration is accepted for H2F envelope treatments (e.g. treated by spray or dip). Test specimens with full sapwood penetration shall be weighed before and after treatment allowing calculation of individual piece retention. For H2F treatments, the retention and penetration of the



candidate preservative in the envelope treated zone of spare test specimens shall be confirmed by chemical analysis.

H2F test specimens docked after treatment may be tested with ends retreated or not. Retreatment is to

be carried out by the process that would occur commercially. If retreated, then a trial is needed to show that termites cannot enter test specimens when an unsealed end abuts another test specimen's treated surface.

A minimum of three retentions of each candidate preservative shall be tested. Retentions may be based on the threshold value or on any other values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a basis on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

FIELD TERMITES

HAZARD CLASS H2 - CONTINUED

PRE-TEST CONDITIONING OF TEST SPECIMENS

Test specimens shall be dried in vacuum ovens at 40°C and -95 kPa for five days to remove any residual solvents and volatiles.

Envelope (H2F) treated test specimens shall be exposed to natural weathering outdoors for a minimum of four weeks. Test specimen orientation will not be altered during this time. The uppermost exposed face with most UV and weathering exposure shall remain identifiable during field testing to aid inspection. H2 treated test specimens do not require UV conditioning. Note that artificial UV conditioning methods are currently being considered, that may replace this natural UV weathering step.

Test specimens being tested by this procedure for H3, shall be leached prior to vacuum oven drying. Test specimens shall be vacuum-impregnated with water for 30 min. and allowed to remain for a further 30 min. in a container with at least three times the volume of water as of specimens. Water shall be drained from the containers and replaced with an equal amount of clean water. The containers shall be placed in a shaking water bath maintained at 35°C for 5-7 days with the water changed daily during five of the days. Specimens shall then be placed on drying racks for two days to surface dry.

EXPOSURE

Test specimens shall be exposed to at least one species of subterranean termite. If only one species is to be used then the preferred species is to be *Coptotermes acinaciformis*. However, if the preservative is intended for use North of the Tropic of Capricorn then *Mastotermes darwiniensis* also shall be used.

The test shall occur within, for example, a 20 L steel drum. At the bottom of the drum a layer of highly susceptible timber substrate (e.g. *Populus* spp.) 8-12 x 70-120 x 140 mm shall be tightly packed on their ends. Two circular sections of a termite-resistant mesh, e.g. galvanised weldmesh (25 mm square openings), with the test specimens sandwiched between shall be placed on top. Test specimens shall be randomly arranged and care taken to avoid contact with each other. A further layer of susceptible substrate shall be placed on top of the weldmesh. Prior to placement in the drum the susceptible substrate shall be dipped in water. The volume of susceptible timber substrate shall be equal

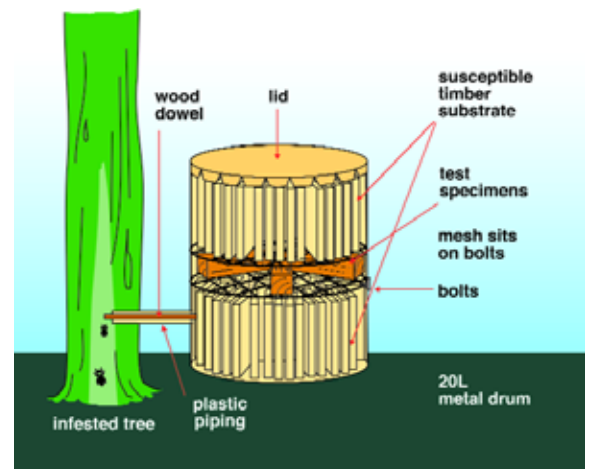


Figure 2. Field exposure to subterranean termites using the drum technique.

or greater than the volume of test specimens to be exposed. A lid shall seal the drum. All drums shall be connected to infested trees or to other experimental drums, which are known to contain infestation of the target species of termite. Connection shall be via a 150 mm length of PVC piping (15 mm diameter). A 200 mm wooden dowel (6 mm diameter) shall be placed inside the piping to aid termite access into the drum (Fig. 2). Insulation of the drum may be required to encourage termite activity. The test duration shall be a minimum of 16 weeks.

PERFORMANCE CRITERIA

At the conclusion of the exposure period, test specimens shall be returned to the laboratory and cleaned. Test specimens shall then be visually rated for any termite attack using a scale which estimates the amount of wood remaining.

APPROVAL CRITERIA

When the candidate preservative has a mean rating equal to or above an estimated 95% wood remaining then the lowest of the retentions meeting this criterion will be recommended for approval. For H2F treatments, test specimens must be rated as either sound or with superficial attack/grazing only, i.e. attack by termites must not breach the depth of the treated envelope.

LUNCH-BOX TECHNIQUE

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be a minimum of 25 x 25 x 100 mm sapwood. In the case of H2F treatments, the cross section of test specimens will be the maximum size to be produced commercially. Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention for each termite species or vacuum oven control. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested. H2 treatments shall achieve full sapwood penetration, while more limited penetration is accepted for H2F envelope treatments (e.g. treated by spray or dip). Test specimens with full sapwood penetration shall be weighed before and after treatment allowing calculation of individual piece retention. For H2F treatments, the retention and penetration of the candidate preservative in the envelope treated zone of spare test specimens shall be confirmed by chemical analysis.

H2F test specimens docked after treatment may be tested with ends retreated or not. Retreatment is to be carried out by the process that would occur commercially. If retreated, then a trial is needed to show that termites cannot enter test specimens when an unsealed end abuts another test specimen's treated surface.

A minimum of three retentions of each candidate preservative shall be tested. Retentions may be based on the threshold value or on any other values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of

proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a basis on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF TEST SPECIMENS

Test specimens shall be dried in vacuum ovens at 40°C and -95 kPa for five days to remove any residual solvents and volatiles.

Envelope (H2F) treated test specimens shall be exposed to natural weathering outdoors for a minimum of four weeks. Test specimen orientation will not be altered during this time. The uppermost exposed face with most UV and weathering exposure shall remain identifiable during field testing to aid inspection. H2 treated test specimens do not require UV conditioning. Note that artificial UV conditioning methods are currently being considered, that may replace this natural UV weathering step.

Test specimens being tested by this procedure for H3, shall be leached prior to vacuum oven drying. Test specimens shall be vacuum-impregnated with water for 30 min. and allowed to remain for a further 30 min. in a container with at least three times the volume of water as of specimens. Water shall be drained from the containers and replaced with an equal amount of clean water. The containers shall be placed in a shaking water bath maintained at 35°C for 5-7 days with the water changed daily during five of the days. Specimens shall then be placed on drying racks for two days to surface dry.

FIELD TERMITES

HAZARD CLASS H2 - CONTINUED

EXPOSURE

The specimens are segregated into two main groups, (i) blocks impregnated with similar concentrations in each container, and (ii) a mix of blocks impregnated with the full range of concentrations in each container. Specimens of each treatment regime are randomly selected, and placed at random, within a plastic rectangular "lunch-box" container (210 x 120 x 75 mm) which has a conduit (25 mm diam.) glued into the 210 mm side, perforated with holes (5 mm diam.) for the termites to gain access into the container. The containers are inserted into active colonies in above-ground mounds, or placed in steel drums in which natural populations have been aggregated in large numbers, or within trees and tree stumps. The test duration shall be a minimum of 16 weeks.

PERFORMANCE CRITERIA

At the conclusion of the exposure period, test specimens shall be returned to the laboratory and cleaned. Test specimens shall then be visually rated for any termite attack using a scale which estimates the amount of wood remaining.

APPROVAL CRITERIA

When the candidate preservative has a mean rating equal to or above an estimated 95% wood remaining then the lowest of the retentions meeting this criterion will be recommended for approval. For H2F treatments, test specimens must be rated as either sound or with superficial attack/grazing only, i.e. attack by termites must not breach the depth of the treated envelope.

BRICK-ASSEMBLY TECHNIQUE

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be a minimum of 25 x 25 x 100 mm sapwood. In the case of H2F treatments, the cross section of test specimens will be the maximum size to be produced commercially. Specimens shall

be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention for each termite species or vacuum oven control. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested. H2 treatments shall achieve full sapwood penetration, while more limited penetration is accepted for H2F envelope treatments (e.g. treated by spray or dip). Test specimens with full sapwood penetration shall be weighed before and after treatment allowing calculation of individual piece retention. For H2F treatments, the retention and penetration of the candidate preservative in the envelope treated zone of spare test specimens shall be confirmed by chemical analysis.

H2F test specimens docked after treatment may be tested with ends retreated or not. Retreatment is to be carried out by the process that would occur commercially. If retreated, then a trial is needed to show that termites cannot enter test specimens when an unsealed end abuts another test specimen's treated surface.

A minimum of three retentions of each candidate preservative shall be tested. Retentions may be based on the threshold value or on any other values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a basis on which to assess the candidate.

FIELD TERMITES

HAZARD CLASS H2 - CONTINUED

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF TEST SPECIMENS

Test specimens shall be dried in vacuum ovens at 40°C and -95 kPa for five days to remove any residual solvents and volatiles.

Envelope (H2F) treated test specimens shall be exposed to natural weathering outdoors for a minimum of four weeks. Test specimen orientation will not be altered during this time. The uppermost exposed face with most UV and weathering exposure shall remain identifiable during field testing to aid inspection. H2 treated test specimens do not require UV conditioning. Note that artificial UV conditioning methods are currently being considered, that may replace this natural UV weathering step.

Test specimens being tested by this procedure for H3, shall be leached prior to vacuum oven drying. Test specimens shall be vacuum-impregnated with water for 30 min. and allowed to remain for a further 30 min. in a container with at least three times the volume of water as of specimens. Water shall be drained from the containers and replaced with an equal amount of clean water. The containers shall be placed in a shaking water bath maintained at 35°C for 5-7 days with the water changed daily during five of the days. Specimens shall then be placed on drying racks for two days to surface dry.

EXPOSURE

Test specimens shall be exposed to at least one species of subterranean termite. If only one species is to be used then the preferred species is to be *Coptotermes acinaciformis*. However, if the preservative is intended for use North of the Tropic of Capricorn then *Mastotermes darwiniensis* also shall be used.

The test shall occur within, for example, a 6 L plastic container. Test specimens shall be randomly arranged and alternated with highly susceptible feeder specimens (e.g. *Populus* spp.: 25 x 25 x 100 mm). Test specimens and feeder specimens shall be separated by corrugated cardboard. All

containers shall be placed on hollow masonry bricks (100 mm thick). The bricks shall be on timber-filled trenches, which are known to contain infestation of the target species of termite. Wooden pegs (200 mm long) aid termite access through the bricks and into the containers (Fig. 3). Each container shall be covered with insulating material and secured with soil. The test duration shall be a minimum of 16 weeks.

PERFORMANCE CRITERIA

At the conclusion of the exposure period, test specimens shall be returned to the laboratory and cleaned. Test specimens shall then be visually rated for any termite attack using a scale which estimates the amount of wood remaining.

APPROVAL CRITERIA

When the candidate preservative has a mean rating equal to or above an estimated 95% wood remaining then the lowest of the retentions meeting this criterion will be recommended for approval. For H2F treatments, test specimens must be rated as either sound or with superficial attack/grazing only, i.e. attack by termites must not breach the depth of the treated envelope.



Figure 3. Field exposure to subterranean termites using a brick-assembly technique.

LABORATORY DECAY

HAZARD CLASSES H3, H4 AND H5

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use: It may be necessary to utilise both softwood and hardwood substrates.

TEST SPECIMENS

Test specimens shall be sapwood with a minimum dimension of 20 (radial) x 10 (tangential) x 20 (longitudinal) mm. Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention for each fungus or sterile control. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a broad guide on which to assess the candidate. Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated blocks. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF SPECIMENS

Test specimens shall be placed in jars and vacuum impregnated with water. The volume of water in the jars shall be at least three times the volume of the specimens. The jars shall be placed in a shaking water bath maintained at 35°C for five days with the water changed daily. Specimens shall be dried in a vacuum oven at 40°C and -95 kPa for 5-7 days with the water in the jars changed daily during five of the days. The weathered specimens shall be reconditioned to 12% m.c., weighed (or weighed at 0% m.c. following vacuum oven drying at 40°C), and sterilised, for example, by γ -irradiation.

BIOASSAY

Test specimens shall be exposed to both brown-rot and white-rot fungi. At least five (for Australia) or three (for New Zealand) different species of fungi selected from the following list shall be used. The selection shall include at least one brown-rot and one white-rot fungus.

Brown-rot fungi

Coniophora olivacea
Coniophora puteana
Serpula lacrymans
Fomitopsis lilacino-gilva
Gloeophyllum abietinum
Antrodia xantha
Antrodia vaillantii
Neolentinus lepideus
Paxillus panuoides
Postia placenta
Polyporus verecundus

White-rot fungi

Perenniporia tephropora
Pycnoporus coccineus
Lopharia crassa
Trametes versicolor

Strains of the above species may be specified to suit local exposure conditions.

PREFERRED METHODOLOGY

Decay tests shall occur in soil jars. Each jar shall contain 150 g of soil moistened to at least 100 % water holding capacity. Two susceptible sapwood veneer feeder strips previously soaked overnight in 1% malt extract solution shall be placed on the soil in each jar. The jars shall be autoclaved for 1.5 hours. The feeder strips shall then be inoculated with the chosen fungi. One set of jars shall be left uninoculated as a sterile control, to determine if there is any mass loss or gain not attributable to fungal attack.

LABORATORY DECAY

HAZARD CLASSES H3, H4 AND H5

After the fungi have grown sufficiently on the feeder strips (~10 days) the test specimens shall be placed into the appropriate jars. Each jar shall contain two replicate specimens or one specimen if the preservative is volatile (e.g. creosote). Specimens shall also be placed into sterile control jars. All jars shall be incubated at 25°C and 75% RH for 12 weeks (the exception of *S. lacrymans* which requires incubation at 20°C).

Specimens shall then be removed from jars, reconditioned to 12% m.c., weighed (or weighed at 0% m.c. following vacuum oven drying at 40°C) and adjusted to accommodate changes recorded in sterile controls to obtain individual mass losses. The test will be valid, for those brown-rotting fungi that produce a mean mass loss of more than 40% in the softwood untreated controls, and for those white-rotting fungi that produce a mean mass loss of more than 15% in the hardwood untreated controls. Decay is controlled when mean mass loss is 3% or less.

PERFORMANCE CRITERIA

The toxic threshold value for each fungus and preservative under test is the lowest retention which prevented a mean mass loss of more than 3%.

Data generated in these laboratory tests cannot be used solely to establish commercial retention levels, but may be used to support field data. In addition the laboratory data may be used as a basis for establishing retentions for field testing.



FIELD DECAY AND TERMITES

HAZARD CLASS H3

A minimum of one of the three test procedures described in this Section shall be required. If efficacy against termites is to be established as well as decay resistance, the decking test may be used and an exposure site where termites are active should be selected, such that untreated controls are attacked. The untreated controls for the decking test will be replaced as and when they fail in order to check continuity of the termite hazard. A separate test for termite attack as described in the H2 field protocols may be used.

DECKING TEST

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.



TEST SPECIMENS

If softwood, test specimens shall be nominally 40 x 90 x 1000 mm clear sapwood. The minimum test specimen size shall be 20 x 70 x 300 mm. If hardwood, with a thin sapwood band, the width and depth of the specimen shall be the maximum achievable from sawn timber to contain maximum sapwood only specimens. Alternatively, test specimens may contain both sapwood and heartwood, but then, evaluation of the sapwood of spare unexposed samples will be necessary to confirm penetration and retentions determined by weight uptake. Specimens shall be cut to size prior to treatment and have a moisture content between 10-15%. For softwoods, both ends shall be sealed with an impervious coating. A hole to take a 50 mm nail shank or a screw fitting shall be drilled 25 mm from each end of specimens. All specimens shall be finished to smooth condition. Sufficient specimens shall be treated to each preservative retention of reference and candidate preservative to permit selection of ten exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each candidate preservative (CP) shall be tested. Retentions may be based on the threshold value or on values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative (Ref.) selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. Reference test specimens shall be treated to 1.0x, 0.5x, 0.25x of approved retention for the preservative selected and shall be referred to, respectively, as Ref. 1, Ref. 2, Ref. 3 levels (see Field Preservative Assessment-Approval Criteria on page 30).

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

EXPOSURE FRAMES

Exposure frames shall be two pieces (bearers) of 100 x 100 mm or 100 x 75 mm timber either preservative treated to H4 retention or highly durable species. Spacing pieces 100 x 25 mm or 75 x 25 mm shall be fixed to each bearer. One spacing piece shall be treated timber (approved H3), the other, untreated non-durable timber. Note these may have to be replaced from time-to-time as and when they fail.

FIELD DECAY AND TERMITES

HAZARD CLASS H3 - CONTINUED

FIXING SAMPLES

Decking samples shall be nailed to the spacing pieces through the pre-drilled holes. There shall be a 5 mm gap between each fixed decking specimen. Ten untreated, or in the case of non-water based preservatives, solvent only treated, specimens shall be included in each test.

PERFORMANCE CRITERIA

Each specimen shall be inspected at least annually, typically at the interface between the piece and the spacing pieces, and rated for decay and termite attack (if appropriate) using any internationally recognised system.

APPROVAL CRITERIA

See Field Preservative Assessment-Approval Criteria on page 30.

L-JOINT TEST

This test shall be used to assess formulations which will be used to treat commodities in their final shape and form.

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.

TEST SPECIMENS

The following specimen preparation procedures are to be carried out before preservative treatment.

Test specimens shall be L-shaped with a mortise and tenon joint (Fig. 4). Test specimens shall have at least 25 mm sapwood at the thickest point and all joints shall be machined as a single piece and finished to a smooth condition.

Specimens shall be cut to size prior to treatment, and have a moisture content between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of ten exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

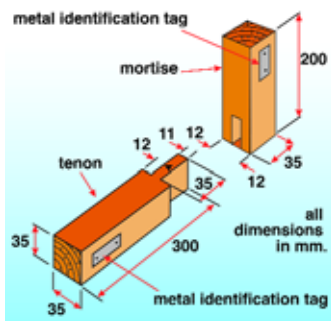


Figure 4. The L-joint specification.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each candidate preservative (CP) shall be tested. Retentions may be based on the threshold value or on values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.



A reference preservative (Ref.) selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. Reference test specimens shall be treated to 1.0x, 0.5x, 0.25x of approved retention for the preservative selected and shall be referred to, respectively, as Ref. 1, Ref. 2, Ref. 3 levels (see Field Preservative Assessment-Approval Criteria on page 30).

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate making, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

EXPOSURE

Assembled L-joint specimens shall be painted with an acrylic primer and two (white) acrylic top coats over the outside of each assembled test piece, leaving the internal joint as bare wood. Once dry, the paint finish coating over the joint shall be broken by

FIELD DECAY AND TERMITES

HAZARD CLASS H3 - CONTINUED

pulling the joint apart and reassembling prior to exposure. Fresh cut exposed ends (away from the joint zone) are to be sealed with an impervious bitumastic type sealant. The joints shall be exposed on weathering racks facing north at least 900 mm above ground level, 500 mm above vegetation and sloping at 10° to the horizontal.

PERFORMANCE CRITERIA

Each specimen shall be inspected at least annually, at the unpainted internal surfaces of the tenon member, and rated for decay using any internationally recognised system.

APPROVAL CRITERIA

See Field Preservative Assessment - Approval Criteria on page 30.

FLAT PANEL TEST

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.

TEST SPECIMENS

If softwood, test specimens shall be a minimum of 75 x 200 x 25mm clear sapwood. If hardwood, with a thin sapwood band, the width and depth of the specimen shall be the maximum achievable from sawn timber to contain maximum sapwood only specimens. Alternatively, panels may contain both sapwood and heartwood, but then, chemical analysis of the sapwood of spare unexposed samples will be necessary to confirm retentions that were based on weight uptake. Specimens shall be cut to size prior to treatment, and have a moisture content between 10-15%. All specimens shall be finished to smooth condition. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of ten exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each candidate preservative (CP) shall be tested. Retentions may be based on the threshold value or on other values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.



A reference preservative (Ref.) selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. Reference test specimens shall be treated to 1.0x, 0.5x, 0.25x of approved retention for the preservative selected and shall be referred to, respectively, as Ref. 1, Ref. 2, Ref. 3 levels (see Field Preservative Assessment - Approval Criteria on page 30).

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

FIELD DECAY AND TERMITES

HAZARD CLASS H3 - CONTINUED

EXPOSURE

Exposure frames shall be supported at each end, at least 500 mm above ground and be of durable timber substrate or other biologically resistant framing. Specimens shall be placed on racks at an angle of 45°, facing north, and the bottom edge of the specimen on and against non-durable (sapwood or class 4 heartwood) timber supports. The supports provide a moisture trap and, when they commence decaying, a source of inoculum.

PERFORMANCE CRITERIA

Each specimen shall be inspected at least annually, typically at the interface between the specimen and the spacing pieces, and rated for decay using any internationally recognised system.

APPROVAL CRITERIA

See Field Preservative Assessment - Approval Criteria on page 30.

ACCELERATED FIELD SIMULATOR (SOIL BED) DECAY

HAZARD CLASSES H4 AND H5

The Accelerated Field Simulator (AFS) provides an accelerated in-ground test method against decay fungi. AFS testing provides a severe decay hazard, often dominated by soft rot that can be difficult to duplicate in soil jar bioassays. AFS results are not a substitute for field trials, so that evidence of a concurrent field test must be provided to support registration. As the AFS is a decay trial, evidence of termite resistance shall also be provided through H3 or H4 field tests.

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use, and if hardwoods are expected to be commercially treated, they must be included in this test.

TEST SPECIMENS

Test specimens shall be a minimum of 20 x 20 x 100 mm clear sapwood. Specimens shall be cut to size prior to treatment and have a moisture content between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of ten exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each candidate preservative (CP) shall be tested. Retentions may be based on the threshold value or on other values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative (Ref.) selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. Reference test specimens shall be treated to 1.0x, 0.5x, 0.25x of approved retention for the preservative selected and shall be referred to, respectively, as Ref. 1, Ref. 2, Ref. 3 levels (see Field Preservative Assessment-Approval Criteria on page 30).

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF TEST SPECIMENS

Test specimens may be artificially weathered prior to exposure. In this case, test specimens shall be placed in containers and vacuum impregnated with water. The volume of water in the containers shall be three times the volume of the specimens. The containers shall be placed in a shaking water bath maintained at 35°C for 5-7 days with the water changed daily for five of the days. Specimens shall be dried in a vacuum oven at 40°C and -95 kPa for five days.

EXPOSURE

Soil beds shall be at least 500 mm deep, and comprise lower layers of coarse pumice or gravel, and upper layers of soil that will pass a 4 mm sieve. Relative humidity shall be a minimum of 80%, and temperature 25-30°C. For each new test, the top 150 mm of soil at least shall be replaced with fresh soil. The soil beds shall be maintained throughout the test period at the field water holding capacity of the test soil being used.

Test specimens shall be randomly arranged in rows spaced at least 50 mm apart. The specimens shall be

ACCELERATED FIELD SIMULATOR (SOIL BED) DECAY

HAZARD CLASSES H4 AND H5

a minimum of 50 mm apart within rows. The specimens shall be buried half to three-quarters of their length in soil. All specimens shall be returned to the same position, orientation, and depth after inspection.

PERFORMANCE CRITERIA

Each specimen should be inspected every six months, and rated for decay using any internationally recognised system.

APPROVAL CRITERIA

Calculate the retention to be recommended for approval from the Field Preservative Assessment-Approval Criteria on page 30, and then add a 50% safety margin to the calculated retention. Justification for removal of this safety factor can be obtained through field testing. The approved retention based upon AFS results shall also be reviewed when field test results become available.

FIELD DECAY AND TERMITES

HAZARD CLASSES H4 AND H5

This procedure assesses both decay and termite resistance and thus the field site(s) should provide both types of hazards. Untreated controls or other test specimens shall show evidence of both decay and termite attack during the life of the test. For end use in New Zealand the termite requirement is not necessary.

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use, and if hardwoods are expected to be commercially treated, they must be included in this test.

TEST SPECIMENS

Test specimens shall be a minimum of 20 x 20 x 500 mm sapwood. Eucalyptus species may be of natural rounds greater than 40 mm in diameter. Specimens shall be cut to size prior to treatment, and have a moisture content between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of ten exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each candidate preservative (CP) shall be tested. Retentions may be based on the threshold value or on other values specified by the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative (Ref.) selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. Reference test specimens shall be treated to 1.0x, 0.5x, 0.25x of approved retention for the preservative selected and shall be referred to,

respectively, as Ref. 1, Ref. 2, Ref. 3 levels (see Field Preservative Assessment-Approval Criteria on page 30).

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

EXPOSURE

Test specimens shall be randomly arranged in rows spaced at least 300 mm apart to allow for, where appropriate, grass-cutting between rows. The specimens shall be a minimum of 300 mm apart within rows. The specimens shall be placed half to two-thirds their length in formed holes. The soil shall be compacted firmly around the specimens. Specimens shall not be installed by driving with a hammer into unprepared soil. All specimens shall be returned to the same position, orientation, and depth after inspection.

PERFORMANCE CRITERIA

Each specimen shall be inspected at least annually for the first five years, and rated for decay and termite attack using any internationally recognised system appropriate,

APPROVAL CRITERIA

See Field Preservative Assessment-Approval Criteria on page 30.



LABORATORY MARINE BORERS

HAZARD CLASS H6

TIMBER SPECIES

The timber species shall be representative of the country or region of proposed end-use.

TEST SPECIMENS

Test specimens shall be sapwood with a minimum dimension of 5 (radial) x 10 (tangential) x 25 (longitudinal) mm.

Specimens shall be cut to size prior to treatment, and have a moisture content of between 10-15%. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention for each borer species. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each preservative shall be tested. Specimens shall be weighed before and after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis.

A reference preservative selected from those currently approved in the relevant standard for the country or region of proposed end-use shall be used. It is intended that this preservative will monitor the overall procedure and serve as a broad guide on which to assess the candidate.

Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

PRE-TEST CONDITIONING OF SPECIMENS

Test specimens shall be placed in jars and filled with water. The volume of water in the jars shall be three times the volume of the specimens. The jars shall be placed in a shaking water bath maintained at 35°C for 14 days. The water shall be changed ten times over the 14 day period. Specimens shall be dried in a vacuum oven at 40°C and -95 kPa for five days. Specimens shall then be placed in jars and filled with seawater. The volume of seawater shall be three times the volume of specimens. The jars shall be placed in a shaking water bath maintained at 35°C for seven days and the seawater changed five times.

BIOASSAY

Test specimens shall be exposed to *Lyrodus pedicellatus* and/or *Limnoria tripunctata* in separate aquaria. The marine borer populations shall include fresh specimens collected from the sea within two months prior to exposure. Aquaria shall contain larger panels of untreated pine so that borers have an alternative food source and breeding site. Specimens shall be exposed for a minimum of one year. If specimens are exposed for more than one year, aquaria shall be again supplemented with fresh borers from the sea. Aquaria may operate as a closed recirculating system (in which case seawater shall be changed regularly), or an open system if a direct supply of seawater is available. Salinity shall be maintained at 30-35 parts per thousand, and temperature at 24°C for *L. tripunctata* and 20°C for *L. pedicellatus*.

Specimens shall be placed on the aquaria floor (for *Limnoria*) or just below the water surface (for *Lyrodus*), and arranged in a randomised pattern.

PERFORMANCE CRITERIA

At the end of test, specimens shall be examined under a dissecting microscope or X-rayed to determine depth and extent of attack. Toxic threshold values for the preservative under test are the lowest retention that prevents significant attack.

Data generated in this laboratory test cannot be used solely to establish commercial retention levels for H6, but must be combined with sea trial data.

FIELD MARINE BORERS

HAZARD CLASS H6

TIMBER SPECIES

The timber species shall be representative of the country of proposed end-use.

TEST SPECIMENS

Test specimens shall be sapwood with a minimum dimension of 25 x 25 x 300 mm. Eucalyptus species may be of natural rounds greater than 40 mm in diameter. Specimens shall be cut to size prior to treatment, and have a moisture content between 10-15%. Any holes required for the attachment of specimens to exposure frames shall be drilled prior to treatment. Sufficient specimens shall be treated to each retention of reference and candidate preservative to permit selection of a minimum of six exposure specimens per retention. In addition, a similar number of specimens shall be used as untreated and, where applicable, solvent controls. Retentions shall be within $\pm 10\%$ of the target mean.

PRESERVATIVE TREATMENT

The treatment process used to treat specimens shall be commensurate with the type of preservative being tested, achieve full sapwood penetration, and permit accurate calculation of individual piece retention.

A minimum of three retentions of each candidate preservative (CP) shall be tested. Retentions may be based on the threshold value or on any other values at the discretion of the supplier.

Specimens shall be weighed before and after treatment and their width, depth and length dimensions measured after treatment to allow calculation of preservative retention. Retentions shall be checked by chemical analysis. Immediately after treatment, specimens (excluding untreated controls) shall be wrapped in an appropriate material, e.g. aluminium foil, polyethylene film, etc., or enclosed in a container with restricted ventilation, sufficient to allow, for example, chemical fixation to occur, while at the same time preventing the growth of moulds on treated specimens. After this period specimens shall be air-dried for a minimum of two weeks.

Retentions shall be segregated during these procedures.

MARINE BORER EXPOSURE

The exposure site shall provide a hazard consistent with the expected hazard in service.

Test specimens shall be attached to resistant frames. The frames shall be constructed so as to minimise abrasion and avoid the effects of corrosion. Bolts shall also be corrosion resistant. Specimens within the frame shall be separated with spacers and randomly arranged. Test specimens shall be positioned to hang just below low tide level. If exposure to *Sphaeroma* is sought, specimens shall be suspended at mid-tide level.



FIELD MARINE BORERS

HAZARD CLASS H6 - CONTINUED

PERFORMANCE CRITERIA

Each specimen shall be inspected annually and rated for attack using any internationally recognised system. Marine borer types on each specimen shall be recorded.

The following is an example of an inspection rating system for treated wood that may be used:

- 4.0 = No attack. Serviceable.**
- 3.5 = Light attack, i.e. a few small patches of *Limnoria* to 3 mm deep, 1 to 6 small *Sphaeroma* or *Martesia* holes (for minimum stake size above), or teredinids totalling 1-80 mm in length. Serviceable.**
- 3.0 = Light-moderate attack. Serviceable.**
- 2.5 = Moderate attack. Serviceable.**
- 2.0 = Moderate-heavy attack. Specimen beginning to alter in outline (at least in patches) with *Limnoria* to 6 mm deep, or wood between *Sphaeroma*, *Martesia* or teredinid holes easily broken. In practice, specimen would be in need of physical barrier protection.**
- 1.5 = Heavy attack. In need of repair.**
- 1.0 = Heavy-severe attack. Unserviceable.**
- 0.5 = Severe attack. Unserviceable.**
- 0.0 = Destroyed or missing from frame. Unserviceable.**

APPROVAL CRITERIA

See Field Preservative Assessment - Approval Criteria on page 30.

FIELD PRESERVATIVE ASSESSMENT

APPROVAL CRITERIA

This appendix describes field and marine preservative assessments, which involve comparison of the candidate preservative (CP) with a reference preservative (Ref.), already approved for the relevant service condition. In order to expedite the field assessment, these comparisons are made at retentions lower than those expected to provide long-term effective service. Minimum field exposure is fixed, not in years, but by the time taken for the candidate preservative to reach a score relative to the reference preservative.

REFERENCE PRESERVATIVE

Specimens shall be treated with the reference preservative at three retentions:

- Ref. 1 The approved retention level
- Ref. 2 One-half of the approved retention level
- Ref. 3 One-quarter of the approved retention level

CANDIDATE PRESERVATIVE

Specimens shall be treated with the candidate preservative at no fewer than three retentions.

APPROVAL CRITERIA

When Ref. 3 reaches less than 70% mean soundness, the lowest CP retention which scores above 70% mean soundness can be submitted for approval for use at four times this retention. The test will continue until Ref. 2 reaches 70% mean soundness. At that time, the lowest CP retention which scores above 70% mean soundness, will be recommended for approval for use at two times this retention. Similarly proportioned conversion factors shall be applied when the reference preservative retentions tested vary from those mentioned above (i.e. they are not strictly one-quarter, one-half or the actual approved retention level).

The test will continue on the above basis for a period which provides a high degree of confidence that CP will perform as well as Ref. 1.



