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A Review of Termite Risk Management in Housing Construction

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A Review of Termite Risk Management in Housing Construction

Prepared for the

Forest & Wood Products
Research & Development Corporation

by

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A Review of Termite Risk Management in Housing Construction

By Perry Forsythe,

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New South Wales, Australia,

August 2003.

1 Introduction and purpose of the review

Timber has proven to be a cost effective construction solution for detached housing and more recently multi-unit residential construction. Despite this, timber is prone to termite attack and concerns have been raised about the building industry's ability to protect buildings against termite attack (Boyle 2002, Harding 2002a). Unfortunately, these concerns are not helped by media coverage that exaggerates the risk of termite attack (Bayard 2000). In addition, alternative products continue to contest established timber markets by claiming to have better resistance to termites. It is therefore important to protect the image and stature of timber by minimising the risk of termite attack. Primarily, there is a need to close the gap between perceived and actual risk. There is also a need to create a framework that will improve the industry's overall ability to manage the risk of attack. The basic concept is that the level of termite protection should match the level of site risk. Concepts such as "whole-of-house protection" and "integrated pest management" go some way towards meeting technical aspects of this debate. Even so, there is a concurrent need to focus on the people making the decisions as well. The objectives of this review are to:

- understand the actual risk of termite attack on dwellings;
- identify risk points during the life cycle of a house;
- find out about different perspectives from those involved;
- find-out information that all parties – especially homeowners - need to know about managing termite risk.

Prominent themes in the literature helped inform the structure of this review. Important themes and studies relating to the development of approaches to termite management in Australia since 1986 are outlined in Table 1.

Table 1: Developing approaches to termite management in Australia	
Timeline	**Themes of Importance and Related Studies**
1986	**Termites and their economic impact** French (1986) identifies the economic impact of termites to construction. He estimates that termites cause over $100 million dollars in damage to wooden structures annually.
1995	**The probability of termite attack in Sydney** Keith and Dunn (1995) undertook a study of termite attack, utilising findings from 1300 pre-purchase building inspection reports. The report covered detached houses, duplexes and terrace houses in the Sydney region. It is an exploratory study in terms of identifying risk management criteria. It aims to provide a path forward after the recent banning of organochlorine chemical soil treatments.
1996	**Building Code of Australia introduces a national framework for performance based regulation** The Building Code of Australia (ABCB 1996) introduces a performance based regulatory framework in Australia. It acknowledges AS 3660.1 - 2000 (discussed below) as a deemed to satisfy standard. It also facilitates use of alternative methods using other approaches to satisfying performance based criteria.
1999	**Termite survey and hazard mapping** Cookson (1999) maps termite prone areas and identifies factors influencing the risk of termite attack. The study draws on a sample of 5122 dwellings - mainly from large urban centres in Australia. The survey utilizes school children to obtain data from local neighbourhoods. A verification study indicates a high level of accuracy from the study (Cookson and Ahmed 1998). Among other things, the study identifies importance of house age and location in influencing the risk of termite attack.
2000	**Revision of termite management standards "AS3660.1 - 2000"** Standards Australia publish a revised version of AS 3660.1 - 2000 involving a suite of three standards (Standards Australia 2000). The suite aims to achieve "whole-of-house protection" against termite attack. The first two standards in the set involve revisions to previous versions. AS 3660.1 revises design and construction requirements in new building work. AS 3660.2 provides guidelines for inspection once a house is occupied - including procedures for detection, treatment and minimization of termite activity in around buildings. AS 3660.3 creates new methods of assessing the effectiveness of termite protection systems.
2001	**Strategies on how to protect timber markets from termite problems** The timber industry analyses strategic options for managing the risk termites pose to timber markets (MacKenzie 2000). The report includes a review of building standards, regulation and international termite protection methods. The report concludes that the industry should pursue an integrated approach to termite management (IPM). It also advocates increased use of chemically treated timber to resist termite attack in high risk areas.
2002	**National Termite Workshop** A one day industry workshop of 50 industry experts and interested parties is held to develop future directions for termite research and development. Multiple papers identify areas of concern and strategies for responsive action.

Continuation	
Timeline	**Themes of Importance and Related Studies**
2002	**The probability of termite attack in Perth** Reid (2002) undertakes a study - similar to that of Keith and Dunn (1995) - looking at the probability of termite attack, by analyzing pre-purchase building inspection reports in Perth. The sample of 411 mainly relates to central metropolitan residences. The study confirms a number of findings from prior studies. In addition, it indicates that the probability of suffering economic cost from termite attack may be significantly lower than the overall probability of attack.
2002- 2003	**Integrated Pest Management –remedial and preventative methods** Ahmed and French (2003) provide substance to the concept of integrated pest management. They define it as a decision making process for determining the mix of strategies and when they are required, to manage protection against termite attack. Components include identification of species, monitoring and record keeping, damage levels and actions levels. Treatments are not made according to predetermined calendar schedules but when monitoring has indicated unacceptable economic damage. The use of baiting systems for long term structural protection of buildings is advocated as used in the US (Grace and Su 2001). Creffield and Lenz (2001) cite novel options such as "sniffer dogs", microwave detectors and thermal imaging cameras. Integration of physical and chemical barrier systems is also advocated. In contrast, Peters (2002) suggests that IPM may reduce the reliance on chemicals for protection.
2003	**A Model for Predicting Termite Attack** Leicester *et al*. (2003) harness prior research and new research to develop a probabilistic model for predicting the risk of termite attack on houses in Australia. It aims to assist in adopting protection strategies to rationalize cost versus mitigation of termite risk. The model requires field testing before being available for practical use.

The chronology illustrates research and industry trends in Australia over the past 16 years. It shows a move towards risk based approaches to termite management combined with integrated systems for dealing with risk. The following discussion delves further into the quantification and qualification of these issues.

2 Quantifying the risk of termite attack

The risk of termite attack is different for outside property as opposed to inside the house. Tyrrell's (1992) data from building consultants limits most termite damage to fences and landscaping structures. Keith and Dunn (1995) found that fences had the highest incidence of attack and attributed this to the absence of termite preventative construction and the use of vulnerable timbers. Cookson (1999) found the incidence of attack inside the house to be much less than outside - about half to two-thirds as much. Similar findings were identified by both Reid (2002) and Keith and

Dunn (1995) – who both found substantial reductions inside, compared to outside the house.

Inside attack on the house is clearly the main area of concern – especially if economic damage is the main area of interest. The reported incidence of attack inside houses varies but within a fairly tight range. Reid (2002) found the incidence to be 13.9%; Keith and Dunn (1995) suggest the incidence may be as high as 1 in 5 (20%) but reduces to 1 in 10 (10%) for buildings less than 50 years old. Tyrrell (1992) suggests a probability of 25% but this includes both outside and inside figures; he suggests a much lower probability applies internally.

2.1 Risk associated with Age of House/Suburb

Cookson (1999) found that the age of house was the most important indicator of risk. The older the house, the higher the risk of termite attack. As such, the previous figures lack full meaning unless the age of house is taken into account. With regard to this, the average age of houses in Cookson's study was 30 years old; and home-owners occupied houses for an average of 11 years – thus determining the home-owner's memory of termite attacks.

Cookson merged his work with modeling done by Trajstman (1999) and found that the increase in risk could be expressed in terms of a linear relationship with time. Importantly, this relationship existed irrespective of the construction being timber, steel or masonry. Cookson found that over an 11 year occupation of the house, owners experienced a 0.38% increase in risk of attack, per year.

In the same report, Cookson came up with another rate that speculated on the level of risk over the life of the house - rather than the 11 year memory of home-owners. This figure was adjudged to be 1.5% increase in risk per year. It was unclear from the report how this figure was derived so subsequent inquiries were made of Cookson. It was found that the 1.5%/year figure was a guestimate that tried to account for unknown risks (e.g. re-attacks) that might occur outside the home-owner's 11 year occupation of the house. It is unclear why this variation was necessary given that the lineal increase in risk of 0.38%/year already appeared to allow for such factors. For instances, home-owners living in houses of different ages, would provide snapshots over the life of the house (thus including re-attacks). They may also see evidence of past attacks – by virtue of seeing evidence deposited before the 11 year occupation period. As a result, they can comment on a longer period – especially where dealing with economic damage from past periods.

Given the above, the danger in subjectively increasing the risk rate from 0.38% to 1.5% is that it is potentially wrong, and undermines the original unit of measure for termite attacks, which appears to be based on whether an attack has been made on a house, rather than the number of attacks on a given house.

Irrespective of these arguments, there is concern about the size of the increase between the 1.5%/year figure and the 0.38%/year figure. The former is larger by a factor of four and this appears to be excessive given earlier features of the debate. For instance, home-owner memory and the life of the house only differ by a factor of 2.7, thus making it hard to understand the logical behind a factor of 4. Further to this, a 1.5%/year risk would give a 30 year old house a 45% risk of being attacked. This appears too high compared to other studies. After taking these issues up with Cookson, he suggested that the 0.38% figure was a more objective figure, and should generally be used in preference to the 1.5%/year figure.

Keith and Dunn's study (1995) provides further insight about age related risks. In their study, houses up to 30 years old had the lowest incidence of termite attack and houses over 70 years old, the highest. The latter was three times more likely to suffer a history of attack compared to the former group. The authors attribute this to the introduction of organochlorine soil treatments in the early 1960s and believe that it was more effective than methods used in older buildings. Tyrrell (1992) supports these findings – especially for historic buildings – and adds that infestations are difficult to detect in older buildings due to difficulty in accessing under-floor areas.

Keith and Dunn's (1995) investigation also considered the age of suburb. A perceived advantage of this was a more generalisable indicator of risk. They found that older suburbs – especially those close to the Sydney CBD - faired worse than newer suburbs on the periphery of the metropolitan areas.

Reid (2002) also speculated on the effects of older suburbs. For instance Reid found that properties in the central metropolitan area were more susceptible to termite attack than properties in the outer northern area of Perth.

It can be concluded from the above that the risk of termite attack changes with age. The best way to express the change in risk is as a rate of increase per year (e.g. 0.38%/year) because it can be applied to different periods of ownership (e.g. 11 years average ownership x 0.38% = 4.18% risk of attack during ownership).

2.2 The risk of termites establishing a permanent attack on a house

Irrespective of age and incidence of attack, Reid (2002) found that only 1.5% of houses had evidence of live termites thus indicating many attacks were short lived. A reason for this low figure is perhaps in another of Reid's findings which was that many occupants were aware of termite infestations and took steps to have the termites eradicated. Consistent with this, Cookson found that 85% of home-owners who knew they had termites, claimed to have got rid of them by taking action to eradicate them. Treatment of soil and wood were the most successful methods. Ignoring the problem or disturbing the nest was least successful.

From this it can be concluded that home-owners need to be kept aware of the importance of regular and professional termite inspection, as it helps minimize the risk of attack/re-attack.

2.3 Risks associated with types of construction

Cookson (1999) found that the type of house construction was not particularly important in influencing the risk of termite attack. There was no statistically significant difference between timber, masonry or steel walls. Much the same was true for concrete and timber floors - the only exception being that a combination of the two gave a slightly higher incidence of attack than either floor alone – perhaps suggesting problems with detailing. He also found that roofing timbers were less affected then other elements – as did Reid (2002).

Trajstman's (1999) findings were consistent with the above in so far as different construction types didn't significantly influence the risk of attack. Similarly, Keith and Dunn (1995) found full brick construction just as prone to termite attack as lightweight clad framed houses made of timber. They also compared concrete slab on ground construction with suspended timber floors and found that 17.8% of buildings with timber floors were damaged by termites while only 6.2% of buildings with concrete slabs were damaged. In reading these statistics the authors note that many of the timber floored buildings were old, and were constructed at times when termite management methods were uncommon and/or underdeveloped. As a result, this example reflects the previously mentioned importance of age, more than the difference between construction types.

Different types of construction have no real impact on the incidence of termite attack on houses. Even so, faulty or poor installation practices will still have an independent impact on risk of attack. Further, termites will attack plastics, fiberglass, rubber, carpets, linings, cupboards, skirtings, books, artwork windows and doors (DFT 2003), which offer a separate set of features compared to structural elements.

2.4 Termite hazard maps

Cookson's work culminated in the production of a termite hazard map of Australia. It superimposed the incidence of attack over agro-ecological regions. Regions take into account temperature, rainfall, soil structure and vegetation. Termite hot spots may still develop within low risk regions where combinations of conducive soil, vegetation and older buildings occur. The map is based on the "outside" incidence of termite attack on properties (as opposed to inside the house). This has the benefit of allowing risk to be reduced by designing houses to mitigate risks associated with regional locations. A copy of the map is shown in Figure 1 and a simplified version - created by Leicester *et al.* (2003) – is shown in Figure 2.

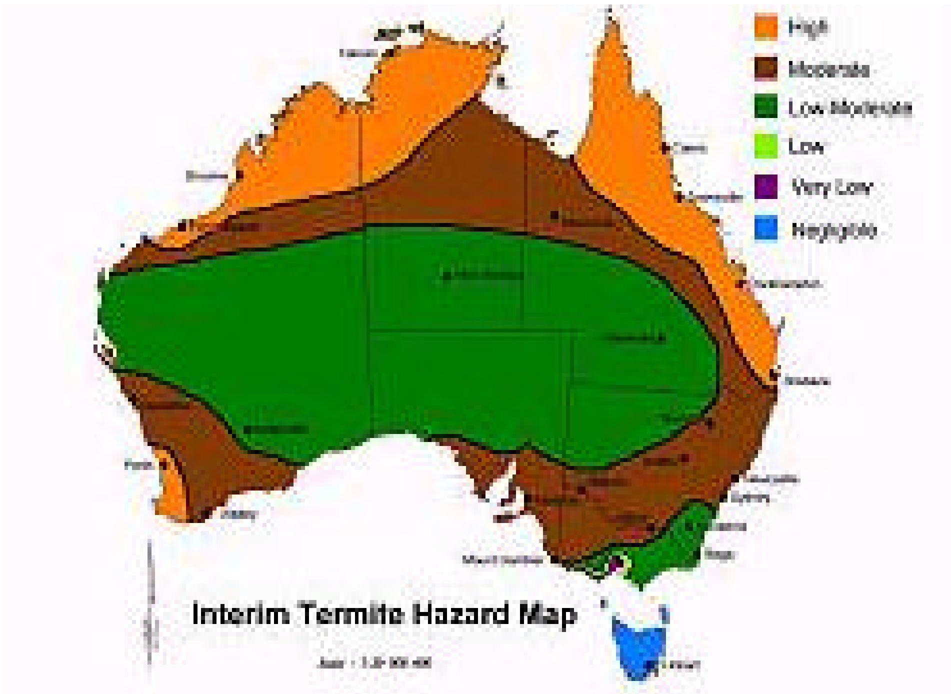

Figure 1: Termite hazard map (Source: Cookson 1999)

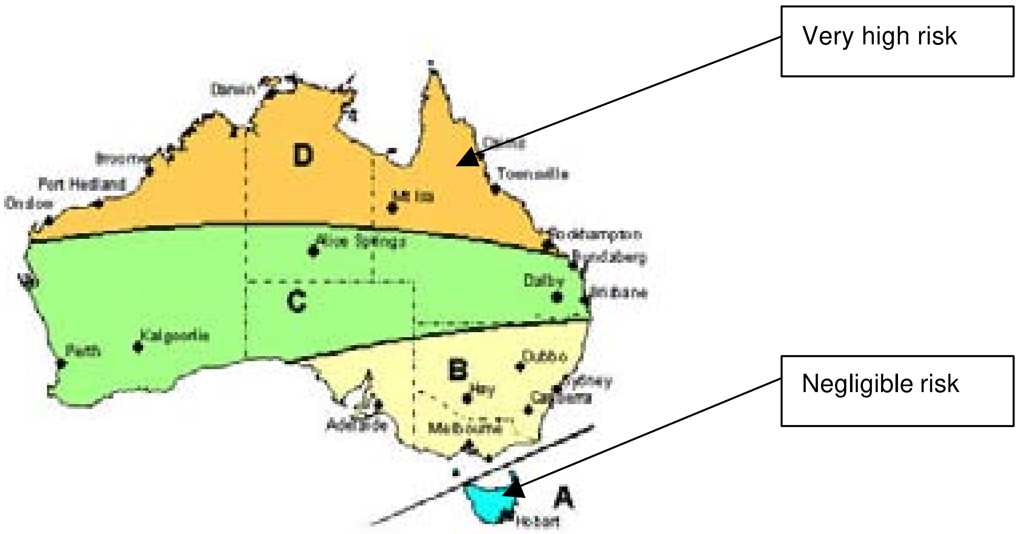

Figure 2: Simplified termite hazard map (Source: Leicester *et al.* 2003)

3 The Economics of Termite Attack

A parallel issue to the previous risk factors concerns the risk of economic attack on houses. This differs from the previous discussion in focusing on attacks causing economic damage to houses. The most economically damaging termite species in Australia are Coptotermes; followed by Schedorhinotermes in Queensland and Broome; and Mastortermes in northern Queensland and Broome (Cookson 1999).

Few studies have explored the risk of economic attack albeit a potentially important area of risk to home-owners. For instance termite attack may be inconsequential if there is no economic cost associated with it. Tyrrell (1993) speculates that only 1% of building structures suffer significant damage. Reid (2002) provides greater detail by pointing out that only 7% of house inspections in Perth called for timbers to be replaced. Placed in context, the houses attacked by termites (i.e. 13.9%) represented only half of the total proportion of houses in Reid's study. This suggests that economic risk may be significantly lower than overall risk of termite attack.

A more global account of the economic cost of attack is provided by Caulfield (2002) who extrapolates broadly from building inspection data. He estimates that 10% of houses in Australia are affected by termite attack and based on assumed costs of treatment ($1500/house) and rectification ($5000/house); the cost of termite attack to Australian buildings is estimated to be $4.0 billion. Though such figures are useful in determining the community wide scale of termite problems, Caulfield's methods of data gathering and assumptions are not well explained. There are many assumptions and these seem to be a result of a lack of detail in the data - thus meaning there must be doubt regarding the validity of his findings. For instance, he purports that 50% of all "vermin" infestations are from termites, but this appears to be an uncalculated guestimate. The treatment and rectification costs also appear to be based on loose assumptions rather than factual data. The purported $4 billion cost appears to have been accumulated over the life of the buildings studied and therefore needs to be presented in a format that reflects this. If this were done, the $4 billion figure could be much lower.

Not withstanding concerns about Caulfield's study, what can be said from the earlier discussion is that the economic risk of termite attack on a given house may be significantly lower than the overall risk of attack (on that house). Further investigation is required to determine if this lower risk is consistently true, and if so, the finding should be used to better characterise risk to home owners. This emphasis on home-owners seems merited given that the risk for termite attack is predominantly borne by them.

4 Viewing Termite Risk Management as a Decision Making Process

Irrespective of the previous indicators of termite risk, risk management can be viewed as a decision making process involving multiple parties. Definition of the decision making process helps identify when different people are involved, their level of technical knowledge, who they talk to and what types of technical solutions apply. By addressing this, there is room to improve on purely technical approaches to managing risk. Generic decision making stages can be synthesized from a number of sources and include:

- Site assessment of termite risk,
- Design and selection of a termite management system i.e. a system matching site risks,
- Construction practices i.e. ensuring the quality of installation,
- Handover from builder to home-owner i.e. ensuring home-owners know what they must do to limit the risk of attack,
- Home-owner maintenance i.e. ensuring home-owners don't defer or neglect maintenance – thus increasing risk of attack,
- Regular inspection i.e. ensuring professional inspection is undertaken at prescribed intervals.

(AS 3660 2000, ABCB 1996, Boyle 2002, Harding 2002b, HIA n.d., Leicester *et al*. 2003, Tyrell 1992)

The above stages are perhaps more meaningfully expressed in terms of a diagrammatic model showing the flow of activities from conception of a house, to on-going maintenance and inspection period (refer Figure 4). The following discussion explores literature relating to stages in the model.

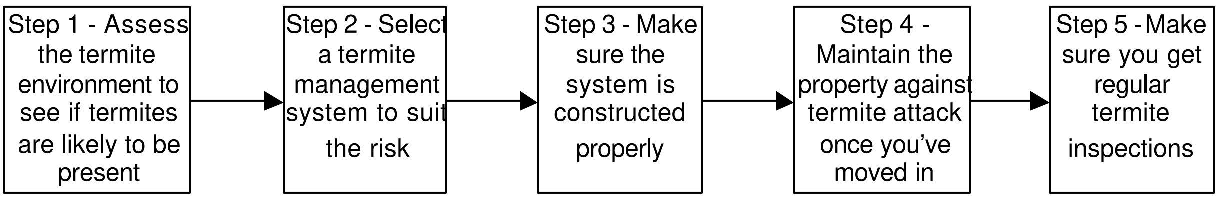

Figure 3: Decision making stages during the life cycle of a house

4.2 Regulatory Influences on Site Assessment and System Selection

Regulations provide the staple influence on site assessment and system selection. The Building Code of Australia (BCA) requires 'primary structural elements' to be protected except where no termite hazard is deemed to exist (e.g. Tasmania). Structural elements can be protected using termite resistant materials[1] and other materials can be used by complying with chemical or physical barrier systems deemed to satisfy the BCA i.e. as defined in AS 3660.

State variations to the BCA require not only primary structural elements to be protected but additional requirements as well. Queensland is a good example, where interior fitout timbers must be protected and if using chemical barriers, a reticulation system must be used. Also perimeter chemical treatment must have 300mm wide concrete cap to protect against damage to chemical soil barriers.

State government watchdog bodies may impose additional requirements. For instance the NSW Department of Fair Trading Department places an emphasis on statutory warranties and in this respect, require "whole of house" protection in accordance with systems described in AS 3360 (DFT 2003).

Professional associations representing the building industry seem to agree with this approach. For instance the Housing Industry Association (c1999) indicates that BCA requirements are insufficient to protect against "due diligence" requirements, and show preference for barrier systems. For similar reasons, Harding's account of the Master Builders Association's position (2002b) asserts that BCA requirements are inadequate and only leave builders at greater risk of litigation from homeowners. As a result, Harding advocates the use of AS 3660 and the need for customers to be included in making decisions about selecting systems in AS 3660.

The main options in AS 3660 are physical and chemical termite barriers.

Physical barriers involve installing an impenetrable material wherever subterranean termites might enter the building from underground. The termite barrier blocks their access forcing them to build a visible mud tunnel over the barrier. Regular inspection is required to detect the mud tunnels which can then be dealt with by a termite inspector. Options under this approach include:

- Sheet metal termite shields – commonly built into the subfloor construction as a continuous barrier below floor level

[1] Naturally resistant timbers given in Appendix C of AS 3660.1; treated timber requirements given in AS 1604)

- Stainless steel mesh systems – commonly built into the subfloor construction as a continuous barrier below floor level, or at the base of walls in slab construction
- Graded stone chip systems – commonly used as a layer around concrete footings
- Concrete slabs as termite barriers - care must be taken to ensure slabs are built to AS 2870 standards. This includes an inspection zone created by an exposed slab edge and care must be taken to ensure slab penetrations are treated to prevent termite entry.

Chemical barriers use termiticides applied using hand spraying equipment or dedicated pipework hidden in the construction - referred to as reticulation systems. The termiticides kill or repel termites as they try to tunnel through the soil before getting to the building. The barriers are commonly applied to the soil immediately around and beneath slabs and footings. Long life chemicals are no longer registered for this use due to the adverse impact they were found to have on health and the environment. These days the chemicals don't last the life of the building, and must be reapplied to maintain protection. This creates the need to maintain access for re-spraying under houses. If this isn't possible, reticulation systems must be used to allow re-application of chemicals.

Despite the wide spread use of both chemical and physical barriers, the Housing Industry Association (1999) point out that there are occasions where a continuous barrier may be difficult or impossible to achieve. The main example is where buildings are constructed against boundaries, preventing inspection and/or re-application of chemicals. In such instances there is a need for the builder to declare limitations of the barrier system to the customer, so that appropriate actions can be taken.

4.3 A Model for Assessing Site Risks and Selecting A Corresponding System

Keating (2002) calls for the development of techniques to enable measurement of site risks and choose a termite management system accordingly. The Leicester *et al.* (2003) termite risk model (2003) attempts to address this need by harnessing Cookson's hazard map and a number of the site risk factors (discussed earlier in the paper).

Using a probability function, Leicester *et al.* (2003) developed a scoring scale for measuring risks and the performance of corresponding termite protection systems. Scoring is based on selecting systems that keep the risk of attack below 20% (over a 50 year house life). Leicester *et al.* (2003) assert that this provides a lower level of risk than that which currently exists, thus theoretically providing a higher level of protection.

Scores for location, age of suburb, distance to nearest boundary, quantity of wood in the garden and under house, house ground contact, type of construction material and exposure of material, are all scored in the model. The total is then used to choose a corresponding termite protection system - one that equals or betters the risk score (*Note: systems include combinations of chemical barriers, physical barriers, post construction inspection regimes and post construction re-application of chemicals)*.

The model is still in development and Leicester *et al*. (2003) identify that it still needs more data to ensure the model is accurate outside major cities. It also requires more data on the performance of different termite barrier systems. It must undergo a verification process among practitioners to ensure its efficacy. If successful, the model would be especially useful in the site assessment and selection of termite management systems (i.e. at design stage of a project).

4.4 Quality of Construction

A system is only as good as the quality of its installation. Quality control of construction comes in a number of forms including:

- Compliance certification by the local council or private certifying authority - The emphasis of this certification is on compliance with conditions of construction approval (Planning NSW, 2003). It ensures that an appropriate system has been used, but doesn't really check that it has been installed properly.
- A "Durable Notice" containing termite management information required by the BCA - This includes the method of termite management, date of installation, where the barrier is installed, its life expectancy and the installer or manufacturer's recommendations regarding the scope and frequency of future inspection. The notice must be fixed in a prominent location advising the building occupant that the system should be inspected and maintained.
- A "Certificate of installation" recommended under AS 3660 (Appendix A) - This contains greater detail than the "Durable notice" but is not mandatory. Where used, it includes details of the termite barrier installed; whether the barrier is a single or integrated system; a diagram showing the location of the barrier; limitations of the barrier or the ability to maintain or inspect it; contact details for further information on the system installed.
- Trade licenses held by contractors - Most licenses focuses on health and safety aspects rather than the quality of workmanship. Queensland is an exception where installers have to attain certain competencies and professional indemnity insurance to provide termite pest services (http://www.bsa.qld.gov.au/). Despite this isolated example, the view has been put forward that in general, licensing requirements are too low and are misdirected – thus

impacting on the industry's ability to assure quality to consumers and manage associated risks (Hellier 2002).

- Membership with trade associations – Associations such as the Australian Pest Managers Association require members to have achieved certain competencies and hold professional indemnity insurance to cover poor work. Professional indemnity insurers are now driving the need for increased competency training and professional development in order to manage the risk of indemnity claims. This is forcing the industry to lift its level of training and overall professionalism (Gibson 2002, Hellier 2002).

Despite the above framework, problems have developed regarding the quality control of installation. To begin with, significant concerns were raised about private certifiers during the New South Wales government inquiry into the quality of building (JSCQB 2002). Problems caused administration of the accreditation scheme to be taken away from the private concerns and into the hands of the government (Ferris 2003).

Harding's (2002b) take on quality issues involve the building industry taking the lead in eliminating "cowboys" from the industry. Boyle (2002) identifies similar concerns about shoddy application of soil chemical applications in Queensland – as found by the Queensland Building Services Authority (2001) during a random testing program in 1999-2000. A large legal case involving the Queensland Building Services Authority versus Pest and Weed Control Services P/L follows a similar line of inquiry (QSBA).

Concerns in the above areas cause Boyle (2002) to call for the development of a simple method of verifying chemical concentration in soil applications. Thorpe (2002) takes a different approach by pointing out that a properly applied chemical barrier will kill and repel termites, but adds that there are many uncontrollable site variables that affect the quality of the installation (e.g. soil alkalinity, render droppings, acid cleaning of brickwork, microbial activity and garden irrigation may all impact). He sees treated timber framing as providing an extra safe guard against attack to assist the level of protection provided by chemical barriers. He also identifies the need of an industry body aimed at improving the quality of pest management - via the dissemination of information and research.

An area of construction that tends to escape scrutiny but nevertheless affects the ability of construction to resist termite attack, is subfloor ventilation. Good ventilation discourages termite activity. Even so, ventilation is typically provided by the bricklayer rather than the contractor providing the main termite management system, and as such, responsibility for the overall quality of the system is divided. Concrete ground slabs forming part of the physical barrier system fall into a similar category. For instance the concretor provides the slab [2] but other parts of

[2] Which must be constructed to AS 2870 requirements.

the system are provided by a specialist termite contractor – again creating divided responsibility for quality.

From the above it can be concluded that construction quality is important as a risk management issue, but may be lacking where there are problems with private certification, where multiple contractors are responsible for the provision of quality; and where contractors are prone to shoddy workmanship.

4.5 The Importance of Homeowners in Risk Management

The role of home-owners as decision makers in risk management has been under-rated. Boyle (2002) believes there has been a general loss of public confidence in termite management systems due to the previously mentioned shoddy work practices. Consumer advocates such as "TAG" (the Termite Action Group) reinforce the above by calling for greater accountability from the supply side of the industry. Broughton (2002) identifies the importance of educating the public as part of a strategic approach to managing termite risk. Vinden (2002) accentuates the importance that bad press can have on the public by citing a UK example where timber framed housing dropped in share from 24% to 7% following a television program illustrating that wood was susceptible to decay and insect attack – thus accentuating the severity of perceptions on market share.

Government watch-dogs such as the department of fair trading in New South Wales (DFT 2003) and the Queensland Building Services Authority (QBSA 2001) both provide comprehensive manuals advising homeowners of termite management options, regulatory requirements, contractual obligations and statutory warranties. The Housing Industry Association provides home-owner information about maintenance and inspection responsibilities in their home-owner's manual. The manual is given to home-owners at handover of the house (by the builder) to help home-owners recognize their maintenance and on-going inspection responsibilities.

It can be concluded from the above that home-owners need information before building that helps arrest concerns about termite attack. At handover they need to be made aware of their responsibilities in limiting the risk of termite attack – ostensibly by being aware of maintenance issues and the need for regular professional termite inspections.

4.5 The Importance of Inspection and Detection during Occupation of the House

As far back as 1935, Synder expounded the virtues of inspections as a means of minimising damage from termite attack. Nowadays, the Building

Code of Australia encourages termites inspections by requiring a "durability notice" to be placed in an accessible location in the building, specifying the recommended scope and frequency of inspections. A similar requirement is contained in the "certificate of installation" mentioned in Appendix A of AS 3660.1 and irrespective of these certificates, AS 3660.2 recommends inspections should be carried out at no greater than 12 monthly intervals.

Despite these recommendations in technical documents, the message isn't necessarily heard or understood by home-owners – thus adding to the previously mentioned need for good communication with home-owners. For instance there is a clear need for creating timely reminders of when inspections are due. There is also a need to let them know that the barrier system only helps to detect termites, not stop them.

On the subject of detection, much of the previous discussion has focused on building in a way that helps detect termite entry. In the future, this could be eased if technology enabled inspection devices that were accurate and sensitive enough, to find the termites without the assistance of purpose built barriers. This level of advancement has yet to happen but options such as thermal imaging, microwave detection, sniffer dogs and baits, are all growing in technical sophistication (Ahmed and French 2003; Creffield and Lenz 2001). Thermal imaging detects hidden nests inside wall and ceiling cavities i.e. active nests give off heat which appears brighter on the imaging camera (Bugeye web site accessed 26/9/03). Microwave detectors involve hand held devices that emit signals penetrating the surface of walls and ceilings, and are able to provide a liquid crystal display when the signal detects termites (Termatrac web site accessed 26/9/03; Dunn 2002).

Such technologies have the potential for a stronger role in the future – especially in terms of providing non-intrusive methods of inspection that are less reliant on purpose built termite barriers. In doing so, these devices are likely to lessen the level of concern about hidden termite attack on houses.

5 Conclusions and recommendations

This review leads to the following conclusions:

- The risk of termite attack can be measured in different ways. Of note, there is a lack of data about the economic risk of termite attack as opposed to overall risk of attack. Reid's (2002) study suggests that the former may be significantly lower than the latter. In terms of risk, this is relevant because home-owners are more likely to be concerned about economic damage as opposed to simply having termites present in the house. **It is recommended** that data be sought to determine if economic risk is lower than overall risk.

- The current body of literature tends to categorise "termite risk management" from different perspectives. Some look at site assessment issues; others at construction quality; still others, at insurance issues. There is no approach that combines these efforts into a common framework. As a result, this review supports managing termite risk by placing an emphasis on the decision making process during the life-cycle of a building. Other factors should "plug-in" accordingly. Under this scenario, home-owners are constantly involved but technical people change during the design, construction and occupation stages of the house. Therefore technical content should not necessarily be the sole focus of risk management. Instead, it should be used to assist informed and coordinated decision making – often involving inexperienced home-owners.

- A model was developed in section **Error! Reference source not found.** that shows decision making stages in the risk management of termites. It aims to be generic in terms of having relevance to all parties involved. For convenience, the model is shown again in Figure 4 **It is recommended** that the model be used to provide an underlying logic to the strategic use of information and technical solutions. By doing this, gaps can be strategically addressed and stakeholders can better understand each other's needs. The further development of this model needs to be undertaken as an on-going task arising from this report. To help develop this, each of the stages shown in Figure 4 are discussed in more detail in the points that follow.

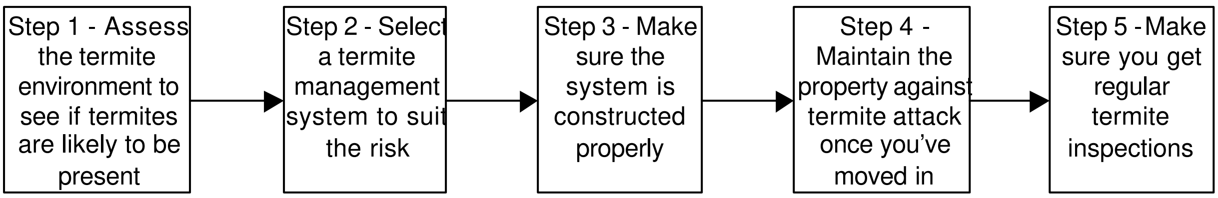

Figure 4: Decision making stages during the life cycle of a house

- Home-owners require information to make informed decisions before starting to build (Step 1). With regard to this, data from Cookson's (1999) study indicates that age of houses is an important factor influencing the risk of termite attack. He found that the risk of attack across Australia increased at a rate of

0.38%/year. In addition, Cookson created a hazard map[3] identifying different risk regions for the incidence of termite attack. These two variables should be cross tabulated to more accurately quantify risk. This would simply enable the increase in risk per year, to be determined for different regions. **It is recommended** that this type of analysis be conducted using existing CSIRO data (i.e. Cookson 1999). The findings should be used as part of the packaging of information defining the risk of attack (i.e. for homeowners and the general public),

- Leicester *et al*. (2003) offer a set of variables that could be used to assist site assessment (Step 1). Some of the variables are well supported in the literature - others less so. **It is recommended** that these criteria be checked for validity among professional termite inspectors before committing to their usage,

- If it is accepted that selection of termite management systems (Step 2) should be made in accordance with levels of site risk, then a shortcoming of the current body of knowledge is the lack of data differentiating the performance levels of different systems. Leicester's work goes some way to addressing this, but until this can be validated, the specification of specific systems to match risk, is left wanting,

- Quality control regarding termite installation (Step 3) may be lacking where there are problems with private certifiers; where multiple contractors are responsible for the provision of quality; and where contractors are delivering shoddy workmanship. **It is recommended** that the industry consider stronger measures where problems have been found to exist. In addition, information provided to home-owners should support industry efforts to improve quality and should direct home-owners towards the best ways of ensuring they get a quality job,

- Home-owners need information at handover to make them aware of their responsibilities in limiting the risk of termite attack (Stage 4). Home-owners also need timely back-up information to remind them when inspections are due (Stage 5). **It is recommended** that such information be produced and distributed accordingly,

[3] Later modified by Leicester *et al.* (2003)

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