

Termite Control - with Experience from the U.S.A.

by

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Summary

A brief overview of termite control is given using specific experiences from the U.S.A. Five major types of termite treatment now prevail: soil applied chemical barriers, in-structure chemical barriers (in-situ applied wood and foundation treatments), physical barriers, treated wood and termite baits.

In general, ‘standalone pretreatments’ or ‘primary treatments’ are often discussed and even required, although in actuality control typically relies on a number of interacting factors. The different termite control systems are discussed as well as some important building code and construction aspects which can help or hinder long-term protection against termites. The different control strategies in current use are explained and the performance of different primary control strategies for different pests and construction types, and possible supplemental treatments are suggested. It was found that no single treatment can perform in all areas and on all construction types and a summary table developed should help specifiers select appropriate protection.

Key words: Baiting Systems, Building Code, Conducive Conditions, Drywood Termites, In-Structure Barrier, Physical Barrier, Primary Treatment, Soil Treatment, Subterranean Termites, Supplemental Treatment, Treated Wood.

Introduction

Termites have been around for an incredibly long time, but in their recent history they have caused a significant amount of physical and economic damage to man-made structures, especially homes. Just how much damage is highly debatable, but there are hard numbers in the U.S.A. on the amount of money spent trying to protect structures from termite damage. The U.S. pest management service industry received about \$1.16 billion U.S. for termite control in 2009 (Specialty Products Consultants, 2009. *Fig. 1*). This is actually down from preceding years, with impact due to the global economic crisis (homeowners have less money to spend on termite protection), the slump in the U.S. housing market (treatments are often done during existing home sales) and construction markets (about half of all new homes built in the U.S.A. receive a termite primary treatment, also called a new construction pretreatment) and a reported reduction in termite activity, especially swarming (Specialty Products Consultants, 2009).

Termites are a broad group of insects. Generally, in wood protection and structural pest control, we simply differentiate between subterranean termites and drywood termites. This works well from a U.S. perspective, although it is somewhat of an oversimplification when we add the rest of the world. Species of termites can infest in different ways and may require simple or difficult control strategies. Climate, of course, plays at least as an important role in termite control as type of construction. So when termite control is considered, climate, types of termites (and other wood destroying organisms) present and construction type must all be considered.

These are always interactive components. Climate varies around the world, and termites are well known to like it wet and warm. The continental United States is quite cold for termites in the North and a bit dry in the West; therefore the highest hazard for subterranean termites is the Southeastern U.S.A. This is reflected by the regions requiring termite treatment via building code in new construction and for

mortgages (Fig. 2); however, the desert subterranean termite *Heterotermes* sp. in the West likes to build mud tubes a lot and causes a significant nuisance, so it still needs control. There are also drywood termites in coastal zones in the South and in Hawaii. Some states – especially Louisiana have *Coptotermes formosanus* Shiraki (Formosan termite) a non-native subterranean termite, which is considered much more aggressive due to both colony size and amount of wood eaten by each individual.

Figure 1.

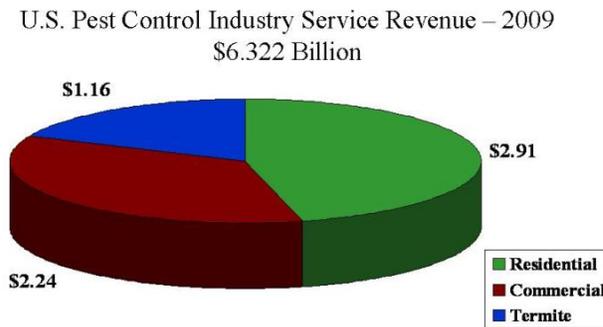
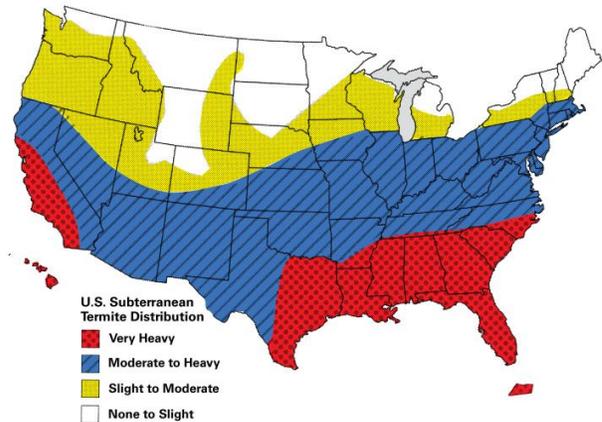


Figure 2. Regions of the U.S.A. Requiring Termite Treatment by Building Code or Mortgage Lender.



Coptotermes is a good genus to study to help us understand climate variations. From various field tests it can be estimated that the amount of damage caused by *Coptotermes* in Hawaii within six months is about the same as that in Louisiana in 12 to 18 months; however, in Japan about three years (e.g., see Morris, et al. 2009) is required to see the same level of damage. The authors suggest that this is due to climate and the relative amounts of time the weather is cold and termites dormant. It has also been suggested that *Coptotermes formosanus* is not active above ground when temperatures drop below 12°C (Ring, 2011, pers. comms.). If this were true, then it could also be expected that an even greater termite hazard would exist where the climate stays even wetter and warmer than Hawaii. In Thailand it is either wet, warm or wet and warm, so it is no real surprise to see the very high level of termite pressure there. Thailand does not have the Formosan termite, but the authors would argue that the entire genus appears to be just as aggressive, and that *Coptotermes gestroi* in Thailand or even *Coptotermes acinaciformis* in Australia are all equally as formidable as Formosans.

What really differs in these various regions of the world is construction type. The U.S., Japan and Australia are all of similar wood frame construction types – traditionally built on a foundation wall (with a crawl space) and moving more to slab on grade. Thailand is primarily concrete and masonry, although this is also true of commercial construction in the U.S. and Japan. Furthermore, traditional Thai construction uses a combination of naturally durable wood with extreme ventilation and is supported above grade – all very good design elements to reduce termite attack and minimize conducive conditions for other wood destroying organisms. This phrase – *conducive condition* – is a good one and is used extensively when inspecting homes for termite damage or its likelihood.

Is the move from crawl space to slab on grade a good one? Crawl spaces have served us very well for hundreds of years and do a good job of reducing conducive conditions – primarily reducing moisture and increasing distance to the ground. Arguably, slab on grade does the opposite and potentially increases risk of infestation; however, the widespread introduction of air conditioning over the last few decades has very negatively impacted performance of crawl space construction by significantly increasing conducive conditions. This occurs when internal temperatures are set lower than ambient or

crawl space dew point. In this situation, continuous condensation can occur in the crawl space, causing mold and decay fungal activity, as well as creating the ideal conditions for termites. In the southern U.S., temperatures inside a structure should not be set lower than 25° C (20° C is common). A very recent move to counter this negative has been the introduction of enclosed or conditioned crawl spaces. Basically the crawl space is sealed – sometimes insulated. This insulation – and indeed any insulation – should be termite resistant and conditioned along with the rest of the house. (Foam board especially is not only very susceptible to termite damage [Fig. 3], but it can also serve as a highway and allow termites entry past some termite control systems.) This is a good approach as it still maintains the height above grade of susceptible materials and also gives a positive passive geothermal effect to the home, cooling it slightly in summer and warming it slightly in winter due to the constant temperature of the ground a few feet below frost line. Reported energy savings of insulated crawl space encapsulation is as high as 20%. However, note that this approach must also now consider radon gas issues as well as the increasing likelihood of rising damp (in the absence of damp proof course) and the increasing difficulty of carrying out termite inspections. Proceed, but with caution, and following thorough installation of termite and decay treatments.



Figure 3. Termite Destruction of and Access Through Insulation Foam Board by *Reticulitermes* sp. in Canada.

Termite Control Methods

In general, builders like to think that one single approach can be a silver bullet and can do all things in all situations. This has led the construction industry towards a path of ‘standalone’ treatments. For example, in the U.S. heavy and moderate to heavy termite hazard areas (Fig. 2), mortgage companies (specifically those backed by HUD or VA) require a standalone termite pretreatment, which is by building code allowed to be a soil treatment (soil barrier), a wood treatment (in-structure barrier) or in some states, a baiting approach. (See HUD 99a and 2006 IRC.) Total structural wood treatment or the use of treated wood for all structural

framing also meets requirements. Reflecting this, the U.S. Environmental Protection Agency (EPA) requires treatments that are a primary barrier termiticide (soil barrier or in-structure barrier) to perform for a minimum of five years and a bait protocol to perform for three years and to be registered and labeled as a ‘primary treatment’. Efficacy studies (field tests) being required to support label claims. A primary treatment is sometimes called a new construction ‘pretreatment’ by the pest management industry – this can be confused with pressure treated lumber though, which is also called ‘pretreated’ by the wood preservation industry. Unfortunately, people want to live in their homes for longer than this, and it also takes longer than five years to pay off the mortgage. In reality, though, there is really no such thing as a ‘standalone’ treatment. Most homes already have building code required architectural features that reduce conducive conditions, including features such as minimum height above grade being more than eight inches (20.3 cm), slope of grade away from home being six inches (15.3 cm) in 10 feet (3.05 m) on all walls, good roof overhang with gutters and pressure treated sill plates (dodi) treated according to the American Wood Protection Association (AWPA) standards (category 1). Disodium octaborate tetrahydrate (DOT) and micronized copper azole (MCA) are now the leading treatments. An organic system based on imidacloprid and azoles is also available.

With a good understanding of the ambient conducive conditions (climate, type of construction and types of termites) and considering contributory factors of construction, an appropriate termite control strategy can be designed. For example, if you have a concrete building, a traditional wood preservative approach is obviously not applicable, and in areas with drywood termites and wood frame construction, it would obviously be pointless to consider soil treatments or bait stations alone.

Some might ask, “Why not build everything with concrete and avoid the problem entirely?” Unfortunately, termites can still eat every other cellulose source in the building, such as paper on sheet

rock, wine bottle labels, hardwood floors and fitted furniture, etc., not to mention the problems from nuisance swarming and mud tubes. There is also the significant environmental impact of using such a high energy and non-sustainable construction material (Fig. 4). Arguably, in many parts of the world, termites are often more nuisance pests (tubing and swarming in structures, etc.) than truly devastating from a structural standpoint. It could also be argued that when termite damage is significant, the conducive conditions were such that fungal decay would have caused the same damage in the absence of termites anyway. In the U.S.A., for example, damage caused by fungal decay is at least as significant as that caused by subterranean termites (Smith & Whitman, 1992), and this is probably the case in many other parts of the world. Mold fungi have also taken on recent significance with a recognition of potential health effects. So with this information, perhaps we should not consider termites by themselves, but as just another wood destroying organism that needs mitigation along with decay fungi and wood destroying beetles.

One state in the U.S.A. does require a double and holistic approach. The building code in Hawaii requires all structural lumber to be treated (typically with DOT), and it requires a chemical or physical barrier under and around the foundations. As a result, the pressure treated structural wood is protected against deterioration by subterranean termites, drywood termites, wood destroying beetles and decay fungi, and the soil barrier prevents nuisance swarming and attack of non-structural cellulosic materials and susceptible non-cellulosic materials (such as sheet rock and foam insulation). It is better, then, to think of primary treatments and also which supplemental treatments might help the long-term performance of the structure and/or reduce the total environmental impact.

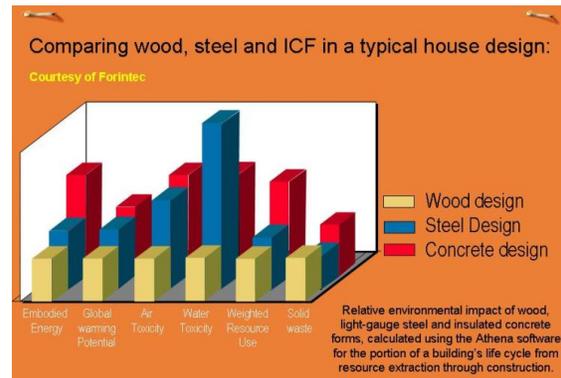


Figure 4. Environmental Impact Comparisons of Different Construction Types.

Soil Applied Chemical Barriers

Soil treatment for subterranean termite protection is one of the oldest methods used in the United States. The goal of the treatment is to apply a uniform chemical barrier in the soil between termites and the structure to be protected. Drilling holes through slabs and injecting termiticide may also be done to establish complete coverage. When termites come into contact with the termiticide, they are either killed (immediately or later) or repelled away from the structure. Termite colonies are so large that it is possible any encounter with some soil treatments will have no impact on that colony's population.

Organochlorines such as chlordane and aldrin became popular termiticides in the 1950s because they were relatively inexpensive and extremely long lasting. Persistence of these chemicals in the soil, as well as health and other environmental concerns led to the eventual removal of organochlorines from the market by 1988 (EPA, 1997). Some organochlorine termiticides, such as aldrin, have shown persistence and high termite mortality up to 28 years after initial application (Grace, et al., 1993).

Removal of organochlorines from the termiticide market led to the use of organophosphates, such as chlorpyrifos and isofenphos, in soil treatments. These termiticides were effective in providing a barrier to termites (Su & Scheffrahn, 1990), but were considerably less long lasting in the environment than organochlorines. Chlorpyrifos and isofenphos have now also been removed from the termiticide market due to public health concerns.

Current repellent termiticides include pyrethroid products with active ingredients such as permethrin and bifenthrin. One study by Su, et al. (1990) indicated that pyrethroids generally resulted in longer persistence in soil. Non-repellent termiticides, such as imidacloprid (such as Premise[®]), fipronil (such as Termidor[®]), chlorfenapyr or chlorantraniliprole are generally considered to be more effective than

repellant termiticides simply because the termites do not detect the chemical and are more easily exposed. Also, typical construction practices often break termite chemical barriers and termites appear unable to look for or find gaps in a slightly incomplete non-repellent barrier system.

Soil treatments may fail to protect structures for many reasons. Extreme care must be taken by the pest management professional to follow label instructions in mixing and applying the termiticide. Soil treatments must be completely uniform and the barrier continuous. Inaccessible areas or other construction practices may result in section of a structure that cannot be treated and are therefore left unprotected against termite infiltration. Gaps in treatment (Forschler, 1994), soil types (Forschler & Townsend, 1996), thickness of termiticide layer (Su, et al., 1995) or termiticide breakdown (Grace, et al., 1993) are among the many situations that may result in treatment breach by termites. The weather can also play a big role – most labels do not allow application onto wet soil or when raining, but especially in the Southeast, this is common practice and difficult to avoid.

The increase in generic formulations is a recent phenomenon of which to be aware. Recent reports also suggest that just because a generic formulation has the same concentration of active ingredient, it does not mean it will perform as well as the original material it copied. Unfortunately, these systems often do not have to generate their own efficacy data and simply cite the original formulations data.

Proper treatment of the soil around and under a structure can provide protection from termites for many years, but in commercial practice this is often not the case. Anecdotal evidence suggests that on average, treatment can be as much as 40% short of label rates. This, together with gaps in treatment, application during rain and the use of generic formulations, might explain the high failure rates of soil applied barriers, which in Florida have been reported to be as high as 67% or two in three homes – with as much as \$20,000 worth of damage in one-year-old homes (Koehler, 1998).

In-Structure Chemical Barriers

(typically in-situ applied wood & concrete treatments)

In the U.S.A. there has been a large-scale move from soil applied chemical barriers to barriers installed within the structure. These now make up approximately 35% of new construction treatment (Specialty Products Consultants, 2009) with more than 1 million homes treated. The leading system (Bora-Care[®]) is a mixed glycol borate that enhances borate penetration into termite mud tubes. Unlike pressure treated wood, Bora-Care not only acts to protect the wood receiving treatment, but also acts as a barrier to prevent termites crossing treated areas (Williams & Amburgey, 2003) to the rest of the house. There also appears to be some baiting performance with borates (Jones, 1991; Nunes, 1994). Applications first started about 10 years ago with treatment of all structural wood components to a height of two feet. In general language and on the HUD 99a form, these systems are called ‘wood treatments’. However, some issues with termite entries into homes through bath traps and plumbing penetrations have led to all termite entry points and some other areas in the foundation being required to be treated to give adequate performance. The effectiveness of the system has been shown on concrete (Smith & Lloyd, 2004). For this reason in this paper, this system is called an ‘In-Structure Chemical Barrier’ although it is often referred to as a ‘wood treatment’ – it is more than that. It must also be pointed out that it is different to a traditional wood preservative treatment by pressure or topical application, both of which protect the wood treated but do not provide a barrier, giving termites access to the rest of the house).

Laboratory tests have shown these are effective termiticides and fungicides. The glycol component has been shown to increase the toxicity of the active ingredient to termites (Tokoro & Su, 1993). Efficacy in field tests in Mississippi and Florida has been good, as have commercial experience across the U.S.A. Efficacy data has been independently reviewed by the Florida Department of Agriculture and Consumer Services (FDACS) (Daiker & Foos, 2006) and by research scientists from Louisiana State University and Mississippi State University, all concluding that performance meets requirements (FDACS) or is at least as good as traditional soil applied chemical applications and is a suitable alternative (Smith, 2004; Ring, 2005; Amburgey, 2006). FDACS actually published all efficacy reviews for all systems used in the state. This is a good resource to check to see whether a product has its own

product-specific efficacy data or is simply citing that of another product. Products not approved in the state probably do not have sufficient data for use, period.

Reasons for success could be the lack of breakdown or dispersal of the material as it is applied in the structure rather than in the soil, or the fact that it is a very visual treatment, and therefore it is easy to do proper treatments and to carry out quality control inspections. The three combined levels of performance as a barrier; a preservative and a bait can also be suggested as a reason.

These treatments have become very popular as they meet the requirements of new 'green' building standards under LEED[®], EarthCraft[®] or the National Association of Home Builders (NAHB). They are considered to have less environmental impact than soil applied chemicals, which go directly into the environment, and to be more sustainable as they last much longer.

Physical Barriers / Non-Chemical Controls

Physical barriers provide a non-chemical approach to termite control. At this point, uniform-sized particles and stainless steel screening are the most commonly used methods in the United States, both installed during construction. Ebeling and Forbes (1988) found that termites cannot tunnel through a layer of moist or dry sand 1.2-1.7 mm in size. They determined sand barriers placed around the outside, inside or both sides of existing foundations protect against termites. Su, et al. (1991) also found that a uniform-sized particle barrier could serve as a physical exclusion device against termites. Two single-sized particle barriers (2.00-2.36 and 2.36-2.80 mm) appeared to be most effective in structure protection (Su & Scheffrahn, 1992). Lenz and Runko (1994) found that a fine mesh of high-grade stainless steel, installed during construction as a continuous horizontal barrier, withstood foraging by several termite species.

Such systems are often selected for use as they are 'non-chemical' (which is not actually technically correct) or because they have less impact on the environment. The latter is especially not necessarily the case with the high energy and other polluting characteristics of manufacture. Longevity is a good reason to use them though, especially as the stainless steel mesh is likely to perform for very long periods, so the sustainability argument is legitimate.

In Hawaii both systems are used to a small degree (Granite Guard[®] and Termimesh[®] being two examples), but in the mainland U.S.A., the cost has been prohibitive. In the last couple of years, however, a partial system with stainless steel mesh has been introduced (Termistop[®]). This can be used in commercial construction in conjunction with an in-structure barrier treatments (such as Bora-Care[®]) even though no wood is present. These treatments may also become popular as they meet the requirements of new 'green' building standards under LEED[®], EarthCraft[®] or NAHB.

Termite Baiting Systems

Issues with using traditional soil barrier treatments for termite protection have already been mentioned. While these chemicals create a barrier, most of them do little to actually impact foraging termites or the termite colonies they come from (Su & Scheffrahn, 1988). Obviously, continuing to find more ways to directly impact those foragers and/or the colony outside the structure (and reduce reinfestations as well) would be beneficial. Since the 1930s, researchers in termite baiting have been striving to do just that with baiting systems.

Baiting systems involve placing stations at specific intervals around a structure. Termites randomly forage by nature and, hopefully, enter a bait station or stations while foraging. The contents of the bait station vary from wood (to be replaced or added to later with bait containing either a slow-acting stomach poison or insect growth regulator) or a mixture of food substrate already containing some toxicant. Termites feed in the station and carry that "food" back to the colony to feed others. It has been suggested that some termite bait systems eliminate entire termite colonies (Su, et al., 1995). Some toxicants act more quickly than others and may result in some termite death, but not colony elimination. Maintenance of the termite bait stations is extremely important and can be labor intensive. If termites do not forage into the stations and feed on the toxicant or insect growth regulator, then no termite protection is being provided to the structure the stations surround. Major systems used in the U.S.A. include

Advance[®] and Sentricon[®].

In the U.S.A., many states do not accept termite baiting systems as primary protection, as they will only protect the structure while they are being maintained; a homeowner may not be able to afford to pay for such maintenance. If payment is stopped, the system is removed and the home no longer has protection. Primary protection on new homes is supposed to last for a minimum of five years, which baiting systems will not do if payment is not continued. Other installed systems are paid in advance by the builder, and so should last whether the home remains under service contract or not. This is an easy fix for baiting systems: they should be allowed to be installed on new construction if the builder pays for the first five years maintenance at time of installation.

With some bait systems and especially in wetter climates, fungal decay has also proven to be an issue with attraction matrices and baits themselves being destroyed by fungal decay before they are eaten by termites (Taylor, et al., 2010). Some companies in Florida have even stopped using them because of this, and new systems are now trying to build in fungal protection.

Treated Wood

Wood preservation or the use of pressure treated wood is allowed in the U.S.A. as a termite preventative both under building codes (2006 IRC) and for mortgage purposes, although it must be noted that it will protect the treated wood but it will not stop termites entering the home. For this reason, an in-structure barrier, soil barrier or other system should also be used (although technically it is not required other than in Hawaii, Florida and South Carolina where state law requires an in situ application by a pest management professional). To comply, it requires that all of the structural wood be sourced as pressure or topically treated wood from a treatment plant or to be treated in-situ with an appropriately EPA registered and labeled system. The use of only pressure treated sill plate does not constitute a treatment to meet this termite protection requirement. Traditionally, pressure treated wood has been used. As mentioned previously, in the State of Hawaii, this is actually required in addition to a barrier. DOT (Tim-bor[®] Industrial and Cellu-Treat[®] are good examples) is the leading preservative used for sill plate treatment across the U.S.A. and for all framing treated in Hawaii due to its cost effectiveness and its ability to provide superior penetration even in refractory species such as Douglas fir (the wood typically used in Hawaii and on the West Coast of the U.S.A.). Some MCA is used for sill plate treatment for convenience, especially in the Southeast, as plants treating mostly wood for exterior decking can readily use the same chemical for sill plate, even though this would be more expensive. Note that wood composites and insulation foam boards can also be protected. Louisiana Pacific and Weyerhaeuser offer systems protected with zinc borate (such as Boroguard[®] ZB), and Perform Guard[®] is a foam insulation protected with DOT. Volume-wise, about 1800 metric tons of DOT is used in Hawaii or on the west coast to treat wood for Hawaiian framing, and approximately the same volume is used in the continental U.S.A. for the treatment of sill plate. Typically, wood framing on the mainland is not pressure treated due to cost, and capacity issues, and only a few homes (possibly 4,000 per year) are topically treated, normally with borate-based systems with added moldicides (main examples include Frame Guard[®], Bora-Care[®] with Mold-Care[®] and Blue Wood[®]).

Selection of Control Strategy

The specifier of the control strategy should first understand construction type (wood frame or concrete/steel), then which pests are present due to climate and geography. For example, in Tennessee, there are subterranean termites but no drywood termites and fungal and decay hazard, especially in crawl spaces. There are also wood destroying beetles. For a wood framed house, you would want to do a soil applied or in-structure barrier and use treated wood (at least for the subfloor). For a concrete building, you could select any of the other treatment types – unless you desire good longevity, in which case you would select an in-structure barrier or a physical barrier.

Using all of the above information, it is apparent that selecting an appropriate control strategy can be complex. *Table 1* below provides a summary to assist in simplifying the decision process.

Table 1. Performance of Different Primary Control Strategies for Different Pests and Construction Types with Possible Supplemental Treatments.

WOOD FRAME CONSTRUCTION (AND WOOD TRUSSES ON CONCRETE OR STEEL)					
Primary Control Method	Subterranean Termites	Drywood Termites	Decay Fungi & Mold	Longevity	Suggested Supplemental treatment
Soil Chemical Barrier	Yes	No	No	3 to 8 years	Wood treatment or baits
Physical Barrier	Yes	No	No	> 10 years	Foundation Barrier wood Treatment
In-Structure Barrier (Concrete and Wood Treatment)	Yes	No	Treated areas only	> 10 years	Whole house wood treatment or Perimeter non-repellent soil barrier or baits
Treated Wood (Structural Framing)	Treated areas only	Treated areas only	Treated areas only	> 10 Years	Foundation barrier, soil barrier, physical barrier or baits
Baits	Only if properly maintained – recommend only as a supplemental treatment	No	No	Whilst being properly maintained	Choose one of the other systems as the Primary control method

CONCRETE/STEEL CONSTRUCTION			
Primary Control Method	Subterranean Termites	Longevity	Suggested Supplemental treatment
Soil Chemical Barrier	Yes	3 to 8 years	Partial physical barrier, foundation barrier or baits
Physical Barrier	Yes	> 10 years	Foundation barrier, perimeter non-repellent soil barrier
In-Structure Barrier (Concrete Treatment)	Yes	> 10 years	Partial physical barrier, Perimeter non-repellent soil barrier or baits
Baits	Only if properly maintained – recommend only as a supplemental treatment	While being properly maintained	Choose one of the other systems as the primary control method

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