Nebraska University

Subterranean Termites: Handbook for Home Owners

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Preface

"Subterranean Termites - a Handbook for Homeowners" is a practical reference for persons who have had little or no training in insect identification, biology or control methods. In these workshops, we emphasize a common sense approach to dealing with termites and termite control. This handbook has subsequently been revised annually, this being the 2006 version.

The authors are familiar with the scientific literature, and they understand just how easy it would have been to overwhelm you with technical information. Our goal was to translate scientific jargon into everyday English and to write this handbook in an interesting style that is easy to read and understand. If you study this handbook from cover to cover, you will be better able to understand termite biology and behavior and should be able to successfully select and work with a pest control company to control termites infesting your home.

"Subterranean Termites - a Handbook for Homeowners," can be purchased from University of Nebraska-Lincoln, Extension, in Lancaster County Office, 444 Cherrycreek Road, Lincoln, NE 68528-1507, Phone (402) 441-7180. An order form can be found at: http://pested.unl.edu/termite/terordfm.htm

May 2006

Chapter 1
Introduction

Subterranean termites in the United States cause several hundred million dollars worth of damage every year! This includes the cost of controlling them and repairing damage to structures - including our homes. Based on the complexity of today's treatments (both chemical barriers and baits) and the potential consequences of an inadequate treatment, we believe: 1) a skilled professional is needed to implement effective termite treatments, 2) homeowners should work with a reputable pest management professional (PMP) who is experienced with termite treatments, and 3) homeowners should not attempt to treat their homes for termites themselves.

A holistic approach to managing termites includes building houses resistant to termites, taking measures to prevent termites by eliminating conducive conditions and having regular inspections to monitor your home for their presence. Understanding termite biology and behavior and knowing the advantages and disadvantages of different treatment approaches will help you make better pest control decisions. Agricultural pest management specialists have used this approach for years. This multiple tactics approach is called Integrated Pest Management or IPM.

The basic components of IPM are:

1. Identify and understand the biology and behavior of termites - Chapter 2,
2. Determine if control is needed - Chapter 3,
3. Consider preventative measures - Chapter 4,
4. Know the available control measures, evaluate them and make decisions about them - Chapters 5-10,
5. Implement your chosen control measure - Chapters 6 and 7; and,
6. Evaluate the effectiveness of your control efforts - Chapter 3.

Integrated Termite Management

The barrier method using liquid termiticides was the standard termite treatment for much of the 20th century. In 1952, chlordane became available and was the overwhelming termiticide used for more than 35 years; its use was discontinued in 1987. It was replaced by chlorpyrifos (Dursban, discontinued in 2005) and a number of synthetic pyrethroids which are still available for use as termiticides. Studies have shown pyrethroids are very repellent to termites, but are not very toxic. Non-repellent products Premise and Termidor came on the scene in the 1990's and are still in use today and comprise the majority of the liquid termiticides used today.

The elimination of chlordane lead to increased research and development by chemical manufacturers to fill an empty niche. This effort resulted in the development of bait products. The earliest bait was an insect-growth regulator, Sentricon, registered in 1994. The advent of effective bait systems has given a new dimension to termite control that was lacking earlier.

Another type of treatment is to treat structural wood directly with borates, which wicks into the wood to protect it from termite tunneling and feeding.

As time has passed, termite control manufacturers have focused their efforts on finding lower-toxic products and methods of controlling termites. This search for safe and effective, novel treatments will continue.

The bottom line: today's termite control professionals and homeowners have real choices about effective treatments they didn't have 20 years ago.

Concern about Indoor Air Quality

Today's consumers are concerned about possible detrimental effects of termiticides on their families and pets. Because of this concern about termiticide, many consumers are interested in "biological" or "natural" products such as nematodes, pathogenic fungi, insect growth regulators (IGR's) and borate products. As a result, less intrusive, natural and other innovative termite control products are becoming more readily accepted by many consumers. Unfortunately, science is still scrambling to catch up with some least-toxic approaches and some tried for termites, have limited effectiveness.

Construction

Understanding the myriad of historical and recent construction practices is an important component of termite control. When doing conventional barrier treatments, pest management professionals (PMP's) have had to contend with rubble or stone foundations, wells, drain tiles, plenums, wood foundations and common wall construction. On occasion, construction problems can confuse even the most experienced PMP.

The emphasis on energy-efficient structures has

resulted in new problems. The use of rigid foam for insulation around the exterior foundation of homes and other buildings has increased. This rigid foam insulation makes traditional barrier treatments difficult, if not impossible.

Air-tight construction has resulted in increased concerns about air quality.

Cellulose-based mulch products, such as shredded bark placed around the home, can increase termite activity around the outside of the home.

The information presented in this handbook is not intended as an endorsement of any one product over another or the use of one treatment approach. The uniqueness of each structure may make one treatment approach preferable than another, but these are decisions that must be left to you.

Structural anomalies, the location and severity of an infestation, expedience and cost of control and your own attitudes about termiticide safety are all factors you will need to consider.

As with any major decision affecting your home, we recommend you read and understand as much as possible before you make a decision about termite control. Discussions with pest control company personnel may be helpful, but there is often disagreement about which treatment approach should be used. Sometimes companies are biased toward procedures they are experienced in doing or selling to their clients. You need to sift through conflicting advice and make your best decision. We have written this handbook to help you get started.

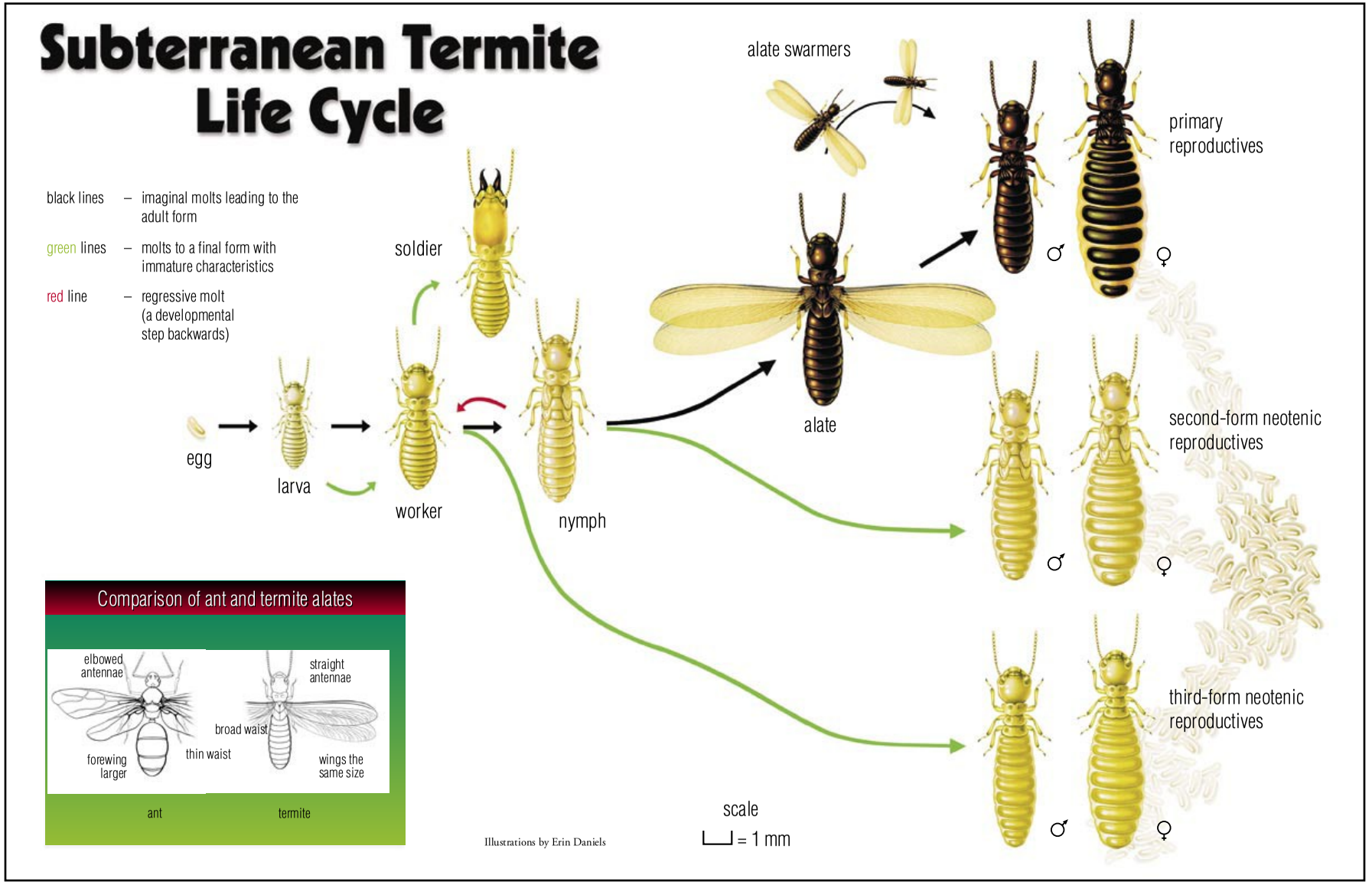


Figure 2-1. This diagram shows each newly hatched termite can develop into any one of a number different castes depending on the changing needs of the colony.

Chapter 2

Termite Identification and Biology

There are over 45 different species of termites found in the United States. Only two species, the eastern subterranean termite *(Reticulitermes flavipes)*, and the arid land subterranean termite *(R. tibialis)*, are native to Nebraska. This chapter will concentrate on subterranean termite identification, biology and behavior, factors critical to making appropriate decisions about termites and termite control.

Identification

Termites are insects. They have three main body parts: head, thorax and abdomen. On their head, termites have a distinctive pair of straight antennae that look like small beads connected together. Since insects don't have a nose to "smell" their environment, antennae are used as scent organs, along with other sensory organs on various parts of their body.

The thorax is subdivided into three segments and is the part of the body where movement is based. As other insects do, termites have three pairs of legs—one attached to each segment on the thorax. The winged reproductives (swarmers) have a pair of nearly identical wings attached to the last two thoracic segments (see figure 2-1). These nearly identical pairs of wings give termites their scientific name; the termite order Isoptera, comes from *iso* meaning equal and *ptera* meaning wings. The termite workers and soldiers do not have wings.

The abdomen is where the digestive, respiratory, circulatory and reproductive systems are located. The termite digestive system is interesting, because termites require gut symbionts, bacteria and protozoans that have the ability to break down cellulose into simpler components the termites can digest. Without these microorganisms in the gut, termites would not be able to feed on wood. These microorganisms are passed to the larval termites through the process of trophallaxis, the exchanging of body fluids. The importance of trophallaxis will be discussed later.

The reproductive system of the queen is also remarkable. After mating, the abdomen of a queen enlarges, and she becomes an egg factory. A mature queen of some species is capable of producing up to 10,000 eggs per week; that's over three million eggs in a year! Since she can live for a decade or longer, she can produce an amazing 30–60 million eggs in her lifetime. Neither workers nor soldiers have the capability to lay eggs and are sterile.

Ants versus Termites. People sometimes confuse ants with termites because both live in the soil and their winged forms are similar in appearance. Termites and ants

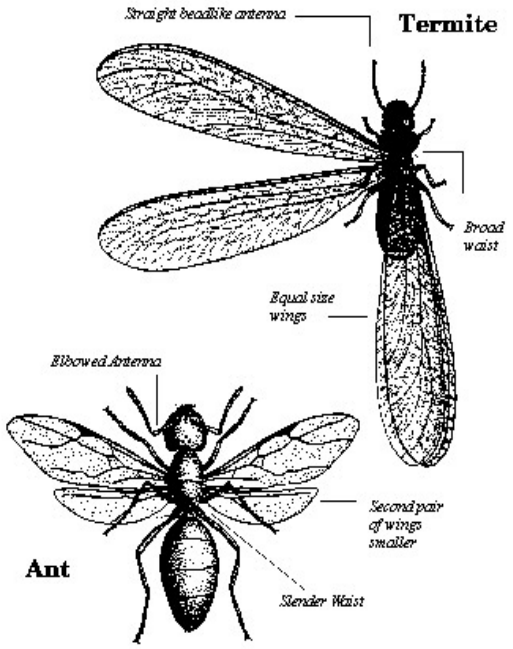


Figure 2-2. Winged ant and termite swarmer.

can also swarm at the same time of year, which adds to the confusion. Upon closer examination, there are several key differences in the appearance of these two distinctly different types of insects.

1. Termite workers are white to greyish, whereas ants are darker in color. Swarming termites are dark, often black in color. These are the termites often confused with ants.
2. Termites have straight bead-like antenna; ants have "elbowed" antennae.
3. Ants have a constricted "waist" where the thorax and the abdomen are connected; termites have an abdomen that is broadly joined at the thorax.
4. Finally, winged ants have forewings (the first pair) larger than the hindwings. Winged termites have two pairs of wings equal in size and appearance.

Even though they are similar in appearance and live in the soil, ants and termites are enemies because many ant species are predators of termites.

Social Behavior. Another way termites are similar to ants is both are truly social insects. True sociality in insects is found only in the Hymenoptera (ants, bees, some wasps) and Isoptera (termites). These social insects are among the most successful insects in terms of being able to exploit their environment.

Grooming Habits. Communication between termite colony members is essential for a colony to function properly. The queen produces chemical messages that are transferred to all members of the colony. The spreading of chemical messages is done through a frequent activity called anal trophallaxis, the exchange of fluids from the anus to the mouth. Workers lick and groom the queen and then feed and groom other colony members. This is a less than appealing behavior, but it is a very efficient way of transferring chemical messages throughout the colony.

Trophallaxis also serves to transfer microorganisms that live in the gut to all members of the colony. The baiting systems rely on trophallaxis to distribute bait throughout the colony.

Caste System. A termite colony is highly structured and has castes that perform distinctly different duties. There are three castes that vary in form and function. Recent studies indicate the caste system in termite colonies is very dynamic.

Reproductive Castes. The reproductives produce all other members of the colony and play an important part in dispersal and formation of new colonies. There are three types of reproductives in a termite colony: the primary, secondary and tertiary reproductives.

Primary Reproductives. When a colony is very successful, some nymphs (indicated as "larvae" in figure 2-1) will develop wing pads, and at the final molt, turn dark and emerge as fully-winged adults — the future "swarmers". When environmental conditions are right, often after a period of rainy weather, winged swarmers will travel through the mud tubes wingless workers have built. Instead of shunning the light like worker termites do, they break through the tubes, pour out of the soil, and fly off to start a new colony. In Nebraska, eastern subterranean termites usually swarm in April or May, often occurring after a rainy period when the ground is soft.

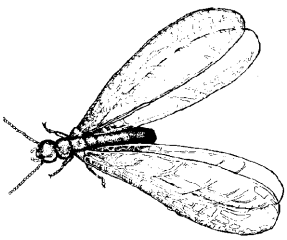


Figure 2-3. Termite "swarmer" reproductive.

After the "nuptial flight," the males and females pair on the ground, and their wings break off at a line of weakness near their base. Courtship involves tandem running, where termite pairs run on the ground with the male closely following the female. When the queen finds a suitable nesting location, they stop and excavate a small chamber in the soil and mate.

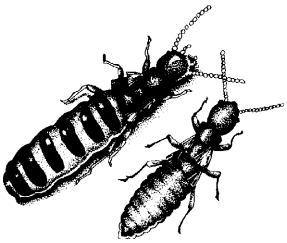


Figure 2-4. Queen termite (left) and king termite.

During the first few years, a termite colony grows slowly. Studies have shown that after two years, there may be only a few hundred colony members.

It typically takes four to ten years for a new subterranean termite colony to produce swarmers, longer if conditions are unfavorable.

When termites swarm inside a home, it often means the worker termites have found a way inside and there are mud tubes connecting the colony with the structure. It can indicate a serious termite problem.

Secondary Reproductives. When a colony gets very large, the queen cannot lay enough eggs to keep up with the colony's demand, so sexually competent females and males are produced called secondary reproductives. The female secondary reproductives lay fewer eggs than the queen, but there can be hundreds of secondary reproductives in an established colony. Because of their numbers, they are the most important source of new eggs and allow the termite colony to increase rapidly in size. They are also important because the reproductive needs of the colony can be entirely taken over by these secondary reproductives if the queen dies.

The secondary reproductives are smaller than the queen, but larger than the workers. Both males and females lack membranous wings, but some have tiny wing buds.

The colony consists of a main colony, where the primary queen lives, and satellite units, where the secondary reproductives are laying eggs. These are linked together by a network of underground tunnels. Over time, these units may become isolated from one another to the point where the termites no longer interact. This type of colony expansion is called "budding", where a number of workers or secondary reproductives can be cut-off from the main colony and form a new, self-sufficient colony.

Tertiary Reproductives. When part of the colony is "cut off" from the queen, fully developed workers can become reproductives. This process occurs "on-the-spot" requiring no interaction with the queen or the original colony. The resulting ergatoid (tertiary) reproductives are wingless and look like big workers. They can produce two to three times more eggs than primary queens, however, this accelerated reproductive rate may be short-lived. Research is on-going to learn more about this process.

Worker Caste. Workers are the most numerous caste in a termite colony and are white or cream-colored, soft-bodied and prone to desiccation (dehydration). They are also blind and wingless. To prevent desiccation, they live underground, inside wood or inside the mud tubes that they construct. They are rarely seen unless infested wood is examined or mud tubes are broken open.

Most termite workers spend their entire lives feeding and maintaining the colony. Workers forage for all the food that feeds the entire colony. They also construct mud tubes, excavate chambers and repair the nest when damaged. They feed all the colony members and groom and take care of the young nestmates. The young workers

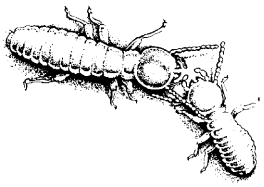


Figure 2-5. Worker termite (left) and immature termite.

Figure 2-6. Soldier termite.

stay in the colony, caring for the eggs and nymphs while grooming and feeding others. The older, stronger and larger workers construct the nest and forage for food. Termite workers reach maturity within a year and can live about two years.

Soldier Caste. In strong colonies, some nymphs will develop into wingless, light-colored termites with large heads and brown, well-developed jaws. They are larger than workers. These soldier termites defend the colony from attack by ants or other termites. The soldiers are much less numerous than the workers. They hide within the mud tubes and in the nest and will not be seen unless the wood or mud tubes are disturbed.

Biology

Temperature. Like other insects, termites are "cold-blooded," meaning termites live and forage in the soil at a temperature comfortable for them and will not be found where the temperatures are too cold or too hot. During the winter, in northern areas of the U.S., termites cannot cross a frost barrier to forage at the soil surface but may be active deeper in the soil. When temperatures warm in the spring and summer, termites will be found near the soil surface.

This temperature effect means firewood stacked outdoors cannot have active termites in it in the middle of the winter when temperatures are below freezing. It also means many termite infestations in Nebraska are seasonal and are active only between March/April through October/November. Another fact is termites are not likely to find bait stations placed at the soil surface during colder months of the year, although the termites may be active at deeper soil levels.

Heated basements can create an environment where termites, having entered the basement through cracks in the foundation below the frost line, can feed year round undetected and uninterrupted by cold winter conditions. This, coupled with our inclination to finish our basements by covering walls and ceilings, creates optimal conditions for termites to do serious damage and remain active throughout the year.

Moisture. To maintain a moist environment above the ground, workers continually carry moist soil above ground for use in constructing mud tubes. This termite "mud" is tiny particles of soil, wood or debris cemented together with saliva and fecal matter. In addition to building tubes, termites leave mud in wood they have excavated. This mud is so characteristic that termite-damaged wood can be readily identified even if no termites are found with it. Active termite tubes are kept moist to maintain a high humidity in the gallery system.

If the wood above the ground is moist enough, subterranean termites can survive and multiply indefinitely with no direct-ground contact. These above-ground colonies are called "satellite colonies." Since they require a regular moisture source, these above-ground colonies are quite uncommon. The presence of secondary queens or tertiary reproductives can be a sign of a satellite colony. Treating an above-ground satellite colony is difficult because barrier treatments nor baits placed in the soil, will eliminate their feeding. To eliminate a satellite colony requires you first solve the water problem allowing the colony to live above the ground.

Because of moisture needed by termites, houses with water problems near the foundation and overgrown vegetation too close to the house, may be more at risk. More information can be found in Chapter 4, Preventing Termite Damage.

Searching for Food. Researchers have traditionally thought termites move "randomly" in the soil. This was because it is virtually impossible to see how these soil-dwelling insects actually travel in the soil. But recently, studies have shown termites actually move in very predictable ways. Scientists have discovered their movement is much more efficient than if it was merely random. As they travel away from the colony, termites construct branching tunnels in a radial pattern similar to the spokes in a wheel. This pattern evenly divides and sub-divides the search area so the termites cover it as completely as possible.

Termites probably don't detect wood from appreciable distances because the soil environment doesn't allow chemical cues to travel very far. They certainly can't "tell" where your house is. We think termites find food by almost "bumping" into it during their foraging activities. Termites also tend to travel along below-ground objects, like roots, stones, basement foundations, pipes and other objects because it is easier to follow these objects than to tunnel through soil. They may avoid areas that are extremely compacted.

Termites respond to environmental cues, like temperature and moisture gradients. During Nebraska's winters, they move down into the soil because they cannot cross the frost barrier. During dry periods, termites move deeper into the soil or seek artificially moist areas—for example, in well-watered gardens. During the summer in Nebraska, termites will be found in the upper soil levels where most roots are found.

Once termites find food, they will stop and feed. More termites will be sent to the food-rich area. Marginal food resources may be abandoned, although, once they have a connection with a food source, they will be able to find the food again if needed. During the winter, some food

resources will be abandoned because of cold conditions, but feeding may resume the following spring or summer. Seasonal feeding is why inspections during the winter are not as likely to find live termites as in the late spring or summer.

If termites come across a physical barrier in the soil, like a basement foundation, they may either move horizontally along it, or they may move vertically up the foundation. If they find a crack in the foundation greater than 1/64-inch, they may explore it. If their mud tube becomes exposed to dry air, they may stop and change direction to avoid desiccation.

Food Preferences. The main nutritional ingredient in the food termites eat is cellulose, the hard structural component of wood and other plant tissues. Termites will feed on nearly any source of cellulose, including wood, roots, twigs, mulch, paper, cardboard and fabrics made of cotton and other plant-based materials. Subterranean termites have been found infesting living trees, but it is unclear whether they destroy living tissues or are feeding only on dead areas.

Subterranean termites tend to prefer softer woods over hard wood, but no untreated wood is completely resistant to termite attack. They typically eat the softer spring wood and leave the harder summer wood which results in the wood being hollowed out between the growth rings. Termites are most attracted to wood partially decomposed and attacked by fungi; studies have shown they thrive on decaying wood. Wood that is on or in the soil or has been saturated with water is much more suitable for termites than dry, structural wood. Some types of wood (redwood, cypress, junipers) are more resistant to termites because of naturally occurring substances in them. However, during the weathering process, the repellent substances (oils and resins) leach, and the wood loses its resistant quality.

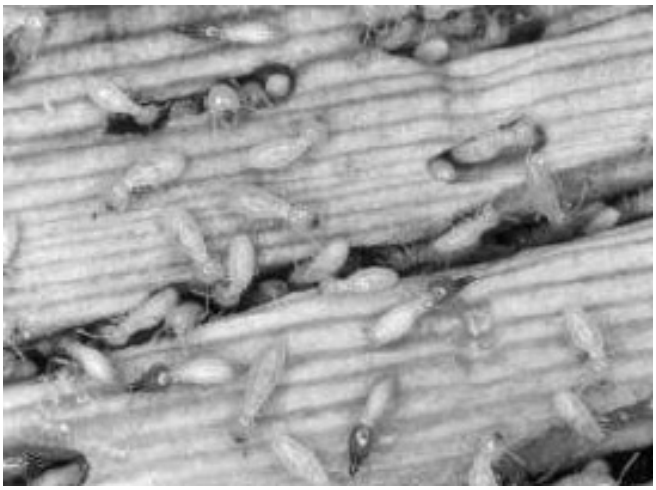


Figure 2-7. Termites feeding on wood.

Even though termites feed on cellulose, they can penetrate and damage non-cellulose materials, including plaster and drywall, stucco, plastics, neoprene and rubber. Termites will damage vinyl swimming pool liners, pool filters and heater lines. Softer metals, such as lead, copper and aluminum, have been damaged as well as linoleum, asphalt, PVC pipes and rigid board insulation constructed of polystyrene (Styrofoam®).

Damage. The amount of damage termites can do to a structure depends on a number of factors.

1. Colony size. It should be obvious the more termites that feed on the structure, the more damage that is done. Within a colony, it is not likely all the termites are feeding on only one source of wood. Alternative food sources in the area, like dead tree stumps and roots, mulch and woodpiles, increases the number of food sources for termites.

What is the size of a termite colony? A lot of researchers have attempted to calculate how large termite colonies are. This is no small task, because of the underground nature of termites. One expert—Michael Potter, University of Kentucky—has concluded the sizes and foraging ranges of termite colonies are highly variable. Some colonies have been estimated to have hundreds of thousands to millions of individuals with a foraging range of up to half an acre in size. Other termite colonies are smaller and may have only 10,000 individuals that may travel less than 20 feet. Because they are highly variable, it is difficult to generalize about the size of an "average" termite colony.

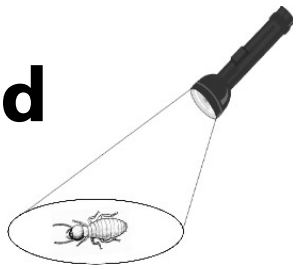
2. Duration of feeding. In northern climates, like Nebraska, many termite infestations may be seasonal, unless of course, termites have entered the structure below the frost line.

3. Type of termite. Some termites have greater appetites than others. For example, the Formosan termite found in the southern U.S. is much more aggressive and eats more than the subterranean termites found in Nebraska.

There are few studies that have documented the damage from subterranean termites in the Midwest. Most of this kind of research comes from southern states. A 1996 research study in Georgia monitored wood consumption by subterranean termite colonies by putting pieces of wood below the ground. This study examined 60 termite colonies over a three-year period. The researchers found the average amount consumed per colony was equivalent to one five-inch section of pine 2x4 each year. If this study were done in Nebraska, we would expect this amount to be less, because of the climate differences already discussed. In addition, subterranean colonies in Nebraska may be larger or smaller than the ones (average less than 100,000 termites) that were looked at in Georgia.

Chapter 3

Detecting Termites and Their Damage



It has been estimated 17–20 percent of Nebraska homes have either had a termite infestation sometime in the past, or will have a termite infestation sometime in the future. Because of this, it is extremely important to carefully examine every home for termites or termite damage. This is the only way to detect the presence of termites and prevent future structural damage. The authors suggest every home be inspected annually by a qualified termite inspector. However, we also believe homeowners should be forever diligent and always "be on the lookout" for termite activity. The homeowners, after all, live in the house 24 hours-a-day. They are the "ideal" inspectors because they are the most familiar with all parts of the house.

This chapter provides the necessary information so the average homeowner can successfully inspect their homes for termites and/or termite damage.

What is Needed for the Inspection?

Whether done by you, the homeowner or a professional inspector, the number one thing required for a successful termite inspection is careful thought (use your head!). Termites try to stay hidden. Everything they do hides their existence. You must use everything learned in this chapter to help detect their presence.

Essential items needed to do an inspection are a bright flashlight; a flat-bladed screwdriver; a pencil, clipboard, graph paper and a tape measure. The flashlight allows the inspector to examine all the "nooks and crannies" where termites hide. The screwdriver is used for probing (more later on this). The other items are for constructing an accurate scale drawing of the house.

Some other useful items are a hard hat to protect your head in low clearance areas, a pair of gloves and coveralls to protect your hands and clothing, a trim prybar and hammer for removing trim boards, baseboard or other wood coverings, and a ladder or step ladder for easier access of some areas within the house.

Additional "high end" items sometimes used by professional inspectors include a moisture meter, a fiber optic viewing device, microwave pestfinder and termite-sniffing dogs. The moisture meter can detect high moisture inside walls without opening the wall. High moisture is a good indication of termite activity. The operator must receive special training before the meter can be used properly. A BoreScope (fiber optic device) allows the inspector to visually look into void areas for evidence of termites. The pestfinder allows the inspector to "beam" microwave signals through walls to "see" termites and other wood destroying insects. The termite-sniffing dogs are used to literally "sniff out" the termites.

Inspection Targets

The inspector is primarily looking for two things: live termites and signs of termites. If any of these are spotted, we suggest hiring a professional inspector to assure nothing is overlooked. Live termites are sometimes spotted outdoors when soil is disturbed around wood that touches or penetrates into the soil. Live termites are also sometimes seen during remodeling activities or if a termite mud tube is disturbed. The other time you may see live termites is during swarming (see Chapter 2).

There are three main signs of termites that can be seen during an inspection: shed termite wings and/or dead swarmer termites, termite mud tubes and termite damage. During the swarming season, termites shed their wings. These wings become very important as an indicator of termites. The wings can be anywhere (inside or outside), but a good place to start looking is in window sills. The wings/dead swarmer termites will also sometimes fall into spider webs.

Figure 3-1. Swarmers in a window sill.

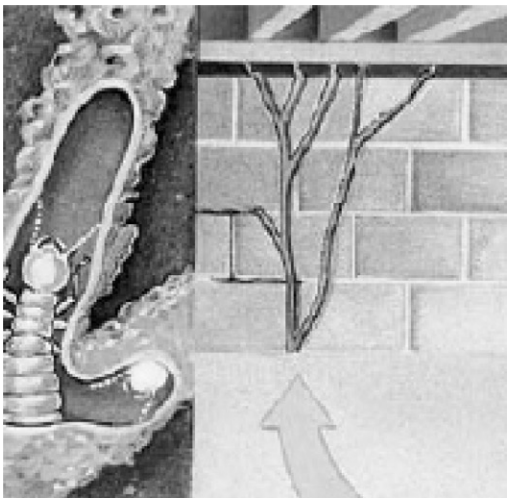


Figure 3-2. Termite mud tubes.

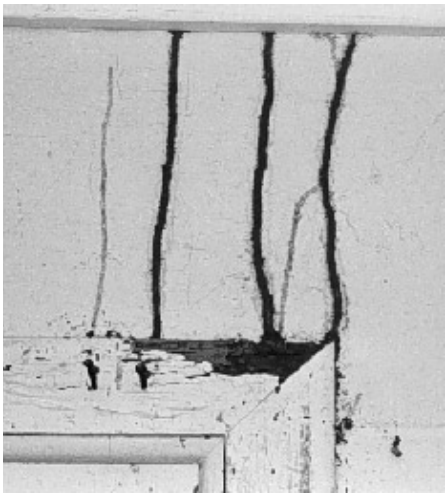


Figure 3-3. Termite mud tubes above a door frame.

Termite Mud Tubes

Mud tubes (also called shelter tubes) are constructed by worker termites (see Chapter 2). These tubes are an obvious indication there is termite activity in the area. These tubes will be evident anywhere there is a connection between the termite colony in the ground and any wooden food source. The tubes can be constructed on the surface of concrete, metal, wood, plaster, brick or almost any other material. They can be inside cracks (termites can fit through any opening 1/64th of an inch wide or wider) in concrete or wood, inside building materials such as insulating materials and wooden supports or between walls or floors in "void" areas.

There are several types of shelter tubes: utility/working tubes, exploratory/migratory tubes, suspended/drop tubes and swarming tubes.

Utility tubes are often very wide. They carry hundreds to thousands of termites daily. Typically, the utility tube has "lanes" inside, with some "lanes" handling termite traffic going up and some "lanes" handling termite traffic going down. These "lanes" are not as well organized as our highway system, but the termites do tend to stay in well organized caravans as they move up and down the tube. Termites moving up are carrying mud and water from the soil for use in further tube construction, whereas termites moving down are carrying food (wood and cellulose material).

Exploratory tubes are usually only about two termite-widths across. These tubes are constructed to facilitate "finding" food sources. These tubes have been seen traveling 15 feet or more above ground (tubing over metal or concrete) to reach a desirable food source. Freestanding exploratory tubes can be 3–5 feet up from the soil surface. Exploratory tubes can be built from the food source down to the soil. Suspended/drop tubes are a special type of exploratory tube that are constructed to add more access tubes to and from an existing food source.

Swarming tubes are side branches constructed off existing tubes. The end of the swarming tube is opened to the atmosphere at the time of swarming.

Termite Damage

Termite damage can be either inactive or active. It often takes an experienced inspector to tell the difference. Termites can damage softwood and hardwood lumber products, masonite paneling, composition siding and other construction materials within a house. They can also damage such cellulose materials as books, paper, cardboard, wallpaper and the paper covering on drywall.

The wood or cellulose that has been infested with termites is usually damp and invaded by fungi. Termites feed in the larger, softer areas of the wood first (between the tree growth rings of the wood). The resulting damage appears "lattice-like." As the wood is eaten, the empty spaces are replaced with soil. Wood is rarely completely eaten and the size and shape of the wood is maintained. Usually they only eat about 10–20 percent of the total wood volume. Termite

Figure 3-4. Termite-damaged wood.

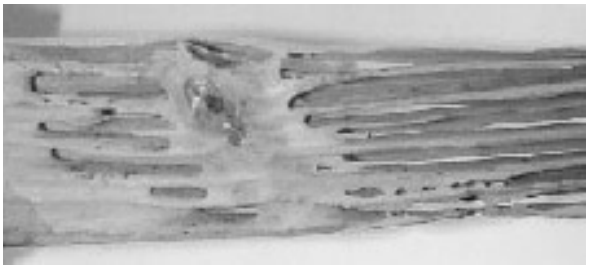


Figure 3-4. Carpenter ant-damaged wood.

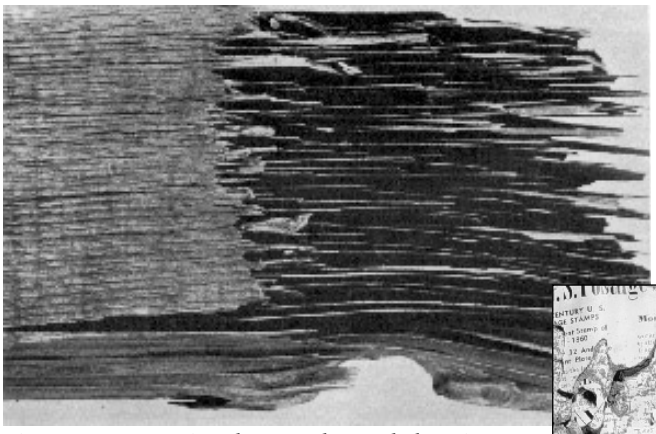


Figure 3-5. Termite-damaged wood showing termites' preference for the soft wood parts.

damage is easily distinguished from other insect or rot damage.

Carpenter ant damage is distinctly different from termite-damaged wood. Occupied galleries are kept very clean, resulting in the surface having a "polished" look (see Figure 3-4). These ants prefer to infest wood that is moist and rotting and will sometimes use wood that has been "hollowed out" by termites. They push sawdust and other debris out of their galleries, often resulting in a cone-shaped pile accumulating just below the nest entrance.

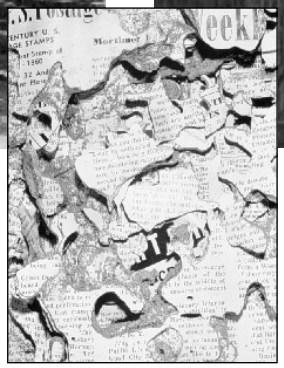


Figure 3-6. Termite-damaged paper.

Figure 3-7. Termite-damaged paneling.

Probing and Sounding

Tapping exposed wood by firmly hitting parallel to the grain with a screwdriver (probing) is an important technique used during termite inspections. If the wood has been damaged, the blade of the screwdriver will penetrate into the wood. Tapping wood by hitting with the blunt end of the screwdriver (sounding) is another technique used. Sounding will tell you where the wood may have been damaged. The inspector will hear a hollow or dull sound indicating possible hidden termite damage. If either probing or sounding indicates possible hidden damage, probe further for tunnels, galleries or termite mud termites leave behind as they feed.

Figure 3-5. A screwdriver is a useful tool for inspections.

Where Should You Look for Damage?

Termites usually do more damage to areas closer to the soil. Therefore, the most commonly infested areas in homes are exterior walls, areas near cracked foundations/slabs, sill plates and joists, walls common with garages/additions and areas near porches. However, if there is a problem that creates a buildup of moisture, like a plumbing leak or leaky roof, the termites may gravitate toward these areas (more about moisture problem areas in Chapter 4).

Quick Inspection Guide

What do I need?

- Flashlight
- Flat bladed screwdriver

What are the signs of termites?

- Shed termite wings and dead swarmer termites
- Termite mud tubes
- Termite damage

Where do I look for damage?

- Window sills are a good place to look for termite wings.
- Wings and dead swarmers often fall into spider webs.
- Mud tubes are evidence of an active termite infestation.
- Termites can damage softwood and hardwood lumber products, paneling, siding, books, cardboard, wallpaper and paper covering on drywall.

- The most commonly infested areas are exterior walls, near cracked foundations, sill plates and joists, walls next to garages and areas near porches. Also places where moisture builds up such as plumbing leaks and leaky roofs.

How do I find the termites?

- Tap exposed wood by firmly hitting parallel to the grain with a screwdriver.
- If the wood has been damaged, the blade of the screwdriver will penetrate into the wood.
- Tapping the wood by hitting with the blunt end of the screwdriver will help you hear hollow or dull sounds indicating possible hidden termite damage.

What do I do if I find live termites?

- Use a tweezers to carefully pick up several of the insects.
- Place them in a small container and close the cover tightly.
- Bring the sample to the Termite Workshop or your local county extension office for identification.

The Inspection

- Look for wood-soil contact areas.
- Be especially wary of foundation walls that are of hollow-block construction. Termites frequently enter wood through the voids in the blocks and are very hard to detect.
- Check each room inside for damage, decay and excessive moisture.
- Look at baseboards and around door/window frames.
- Look for termite-damaged wood and/or water stains.
- Check all walls, ceilings and floors.
- Look for cracks in the baseboard (could indicate excessive moisture and/or feeding damage).
- Look for raised paint or wallpaper (termites can eat paper and leave paint behind).
- Look for ripples in paneling and wallboard (caused by moisture/termites).
- Look for drywall ripples or tiny holes in surface of drywall or wall paper (termites seal holes with mud after emerging through the paper).
- Probe wall plates (board at bottom of walls) with a screwdriver.
- Pry back the baseboards and window/door trim boards if possible, especially if you suspect termites and/or moisture problems.
- Probe sill plates and joists with the grain of the wood using a screwdriver every foot or so.
- Check for structural sagging, buckling, or settling.
- Check for improper ventilation in crawlspaces and correct if necessary.
- Note plumbing and utility fixture entrances and passages through the basement floor and the foundation.
- Look around showers and tubs.
- Be sure to check closets as well.
- Walls constructed of stone, concrete, cinder blocks, hollow tile, or brick may develop cracks through which termites can pass to sills and other wood members; carefully inspect such walls.
- Check plumbing for leaks/condensation.
- Spend extra time inspecting areas around porches. Earth-filled porches and steps account for more cases of termite attack than any other building feature.
- Check all perimeter walls carefully. Check wood paneling and other wall finishings on basement walls, wood partition walls and other wood construction in the basement that extends from masonry to the sills or joists.
- Look for moisture problems—proper grading, down spouts, poor drainage.
- Check sheathing of eaves, chimneys, and vents.
- Record the outside dimensions of the house. Compare outside dimension of house with inside measurements to determine if there are any hidden areas that may provide access to your home for termites.

Remember

- Termites are constantly foraging, just because you didn't find termites last year doesn't mean that you won't find them this year.
- Lots of things can help to make it easier to inspect for termites or provide a sign they are present: use of termite shields, establishing 6-8-inch gaps between soil and wood parts of the house, and eliminating vegetation near the exterior foundation (more on this in Chapter 4).
- The average home takes two hours to completely inspect.
- Inspect your home at least once a year.
- Even if an infestation is found, the inspection should be complete and thorough to ensure all points of entry and damage have been found.
- A light infestation may escape detection even with careful inspection.
- Termite workers attempt to remain concealed.

Figure 3-8. Termite-damaged wood. A mud tube has been opened, exposing a worker termite.

Chapter 4
Preventing Termite Infestations

Since termites are most active in the soil, the basement is often the place termites infest. When we build homes with basements, we keep them warm in the wintertime. This means termites entering a basement below the frost-line can remain active and continue feeding even when the weather is very cold outside. The only basement impervious to termites is one completely sealed and that has no cracks in it; a rarity, because there is nearly always a crack somewhere in the foundation or basement slab. Foundations help prevent termite infestations, but most foundation types have special problems associated with them.

Basement Foundations

Poured Concrete Foundation. This is the most difficult foundation for termites to find a way through, but only if walls have no cracks in them. Remember that termites can enter through very small cracks. To make concrete more termite proof, builders should reinforce the poured concrete with steel rods to prevent opening of joints or cracks due to shrinkage.

Block and Brick Foundations. These basement foundations are at risk because cracks often develop as the foundation ages. With hollow blocks, termites can enter through a crack and follow the hollow spaces vertically and enter a house virtually undetected. Where hollow block masonry is used on new construction, it should have a solid capping of four inches of reinforced concrete.

Crawl Space. Crawl spaces are often insufficiently ventilated, which makes them ideal environments for termites to tube vertically. In many crawl spaces, the space between the soil level and horizontal timbers is inadequate to prevent termite tubing. Experts recommend an 18-inch vertical distance between the soil and structural wood.

Slab. Slab construction results in structural wood timbers fairly close to the soil level and makes this type of construction at high risk of termite infestations. Common construction techniques serve to create termite entry into the structural part of the home. When framing walls, builders often nail lumber to the slab with a nail gun. Nailing into the slab may weaken the slab and create cracks that allows termites to have easy access to construction lumber.

Finished Basements. Finished basements are a problem because inspection is so difficult. Termite inspectors will not give complete assurance a structure is free from termites because termites might be active behind finished walls and impossible to see. To make a finished basement more termite proof, consider the following:

- Finished basement walls should be supported on a concrete base rather than nailing lumber into the basement slab, which often results in cracking. Nailing lumber into foundation walls may also cause cracks.
- Repair cracks in basement walls, floors before covering.
- Use pressure-treated lumber in all below-ground construction (see the Termite Resistant Materials section, later in this chapter).

Eliminate Conducive Conditions

Like other animals, termites need food and water to survive and thrive. Subterranean termites are most plentiful in natural woodlands where there is an abundant supply of both. They rarely need to feed on wood above the ground because so much wood on or in the ground is readily available. In northern climates, cold winter temperatures limit termite activity because, like other cold-blooded organisms, termites aren't active when the temperature is below 50 degrees F or so. They cannot cross a frost barrier during the wintertime, so much of the termite activity in Nebraska occurs between April and October.

When we build houses, we clean up most of termites' natural sources of food so the wood that we leave for them is the wood in our homes. Unlike the abundance of wood lying on the ground in woodland settings, the wood in structures is usually not that easy for termites to find. Termites must find cracks in basement foundations or concrete slabs to allow them access to construction timbers. When traveling in dry air, termites construct and travel in mud tubes and avoid desiccation by keeping the tubes moist. Understanding the importance of food and moisture in termite survival will help you understand conditions conducive to termite infestations and take actions which may prevent infestations.

Eliminate Wood to Ground Contact. Studies have shown about 90 percent of structural termite infestations can be traced to wood that is in contact with the soil. Wood-soil contact provides termites easy access to food and water from the soil, and frequently, a hidden way into the structure. Wood siding, latticework, door and window frames and other wood should be at least six inches above the grade level. Eliminating wood-soil contact can require regrading or pulling soil or mulch away from the foundation.

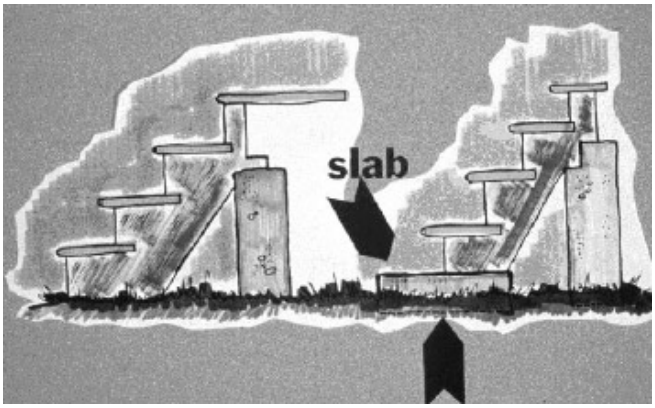


Figure 4-1. Avoid direct wood to soil contact.

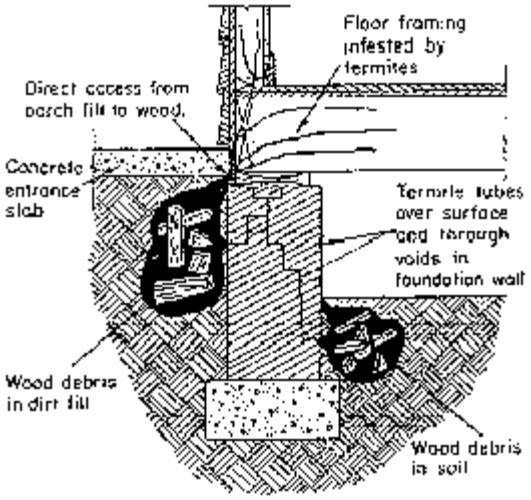


Figure 4-2. Termite colonies can develop in wood debris.

When inspecting your property, look for areas that wood and soil are in direct contact. Consider the following:

- Wood posts and other structural elements should never penetrate concrete floors (basements and slab construction homes, garages). Replace with metal posts but be sure to remove all wood imbedded in the concrete.
- Be sure to check basement windows and frames. They should be made of metal or pressure-treated wood.
- Outdoor wood porches and steps should be supported by a concrete base, at least six inches above grade.
- Where wood-to-soil contact cannot be eliminated, treated wood should be used. For more information, see the Pressure-Treated Lumber section, later in this chapter.

Remove Wood Debris. All wood or cellulose material left on or below the soil surface provides a convenient source of food for termites. Construction debris in the form of wood scraps as well as stumps, roots, cardboard boxes and newspapers should be removed from under and around the building. Be sure to check under crawl spaces and porches. In new construction, wood scraps should never be buried in the fill (Figure 4-2). Stack firewood above the ground on a cement slab and store the firewood away from the house.

Remove Vegetation and Mulch. Shrubs, vines, trellises and other dense vegetation should be removed from the side and foundation of the house. Vegetation traps moisture, which is attractive for termites. Dense vegetation makes it more difficult to inspect the house and detect their presence. Plants near the house also may need watering, which brings moisture close to the foundation and may increase termite activity.

What About Mulch? Mulching with shredded wood or bark chips around bedding plants, trees and shrubs is used because mulch is attractive, holds moisture, insulates soil from extreme temperatures, and prevents weed growth. However, mulch also serves as a food source for termites. In addition, the moisture-holding properties of wood/bark chips and insulation may increase the attractiveness to termites in mulched areas. How should you manage mulch next to your home to prevent a potential termite problem?

Studies at the University of Maryland compared different types of mulch, including pea gravel. Researchers found termite activity was greater under all types of mulch compared with bare soil, because soil moisture was greater in the mulched areas. Based on these studies, they concluded it is best to have bare soil next to foundations. This reinforces the need to slope soil away from the house and use gutters and downspouts to move rainwater away from the house and keep the foundation area dry.

Termite prefer solid pieces of wood over mulch. Many experts suggest using no more than three to four inches.

The type of wood mulch may also influence termite feeding. Cedar, cypress and redwood mulches may be somewhat resistant to termites initially because these woods have resins that may make them less palatable. However, over time, these resins leach into the soil. According to Michael Potter, termite researcher at the University of Kentucky, "no wood or plant-based material is immune to termite attack."

Because insecticides quickly break down under ultraviolet light, spraying insecticides on mulch to prevent termite activity is of little value and not recommended.

Eliminate Moisture Problems. Termites are more likely to infest a structure if the soil around it is constantly moist. Make sure water drains away from the building. Check to make sure gutters and down spouts are in good repair and divert water away from the building.

Roof or plumbing leaks can enable termites to survive and colonize structures above the ground without soil contact. A termite inspector may be able to detect such moisture problems in the wall with a moisture meter.

Humid conditions in a crawlspace can promote termite problems because termites are able to construct longer mud tubes. Humidity in crawlspaces can be reduced

by providing adequate ventilation and creating a vapor barrier. Most building codes call for one square foot of vent opening per 150 square feet of crawlspace area. Vapor barriers can be created by covering the soil with 4-6 mil polyethylene sheets.

Remedy Difficult or Unusual Construction Problems. Termite infestations can get started because of the way a building is constructed. Sometimes unusual construction will make it difficult or impossible to treat with a chemical barrier. Remodeling portions of an existing home may prevent future termite problems.

Increase Crawlspace Clearance. A condition that promotes termite infestations is inadequate clearance between the soil surface and the structural wood above a crawlspace. Too little clearance makes it difficult to inspect properly. In addition, it is easier for termites to tube over the foundation to get to the wood. A minimum of 18 inches should exist between horizontal timbers and the soil. You may need to excavate soil to achieve this distance.

Replace Dirt-filled Porches and Steps. A significant percentage of failed chemical barrier treatments are related to dirt-filled concrete porches or steps. This construction problem brings the soil in the porch or steps above the exterior wall of the building and near the structural wood of the house. When termites have entered the home from this construction problem, it can be particularly difficult to treat it properly. One possible solution is to remove and replace the porch or steps.

Eliminate Stucco or Brick Below Grade Level. Stucco or brick veneer that extends below the soil level is another way termites can get into a structure because a crack may form between the brick veneer or stucco and the structure. It may be necessary to excavate soil away from the foundations or remove lower rows of brick.

Remove or Replace Rigid Board Foam Insulation. Since the early 1980's, the use of rigid foam insulation has increased in new home construction to increase energy efficiency. By 1992, 50 percent of all new construction contained some type of foam insulation. Panels of this type of insulation are typically installed on interior or exterior foundation walls, but all construction types (slabs, crawlspaces and basements) are likely to contain rigid board insulation. Termite problems arise when exterior insulation panels extend below the soil line because termites may tunnel undetected through or behind it into the structure. Termites living behind these foam panels can avoid the chemical barrier, and chemical treatments cannot penetrate the foam because it resists wetting. Methods of controlling termites behind below ground insulation are difficult at best, and some companies may refuse to use a barrier treatment on structures with foam insulation or provide no guarantee of treatment. One remedy is to excavate and remove the insulation panels. Another option might be to use or replace insulation panels with panels impregnated with boric acid.

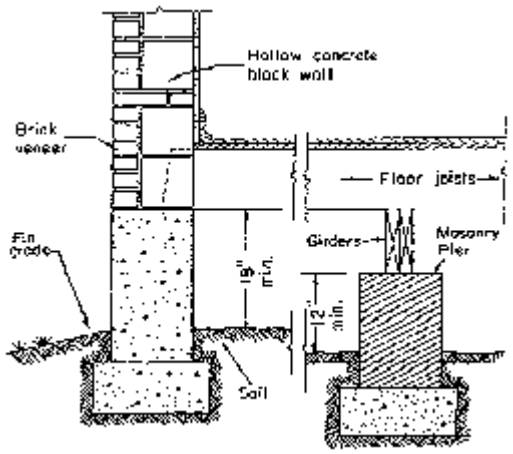


Figure 4-3. Provide adequate clearance between wood and soil.

Termite Resistant Materials

Pressure-Treated Lumber. One way to prevent termite damage is to use pressure-treated wood whenever wood comes within six to twelve inches of the soil. It is a good idea to use pressure-treated wood when finishing basements. There are excellent reasons for using pressure-treated lumber. Pressure-treated wood is resistant to termites and decay so its use extends the life of our forests.

There are several types of treated wood the homeowner is likely to encounter.

Creosote. Creosote-treated wood was the first developed and is still used for railroad ties, highway bridges and marine structures like docks and sea walls. Used railroad ties are often sold to homeowners who use them as inexpensive landscape timbers. Creosote-treated wood should be resistant to insect feeding and decay although railroad ties may house carpenter ant colonies because carpenter ants do not feed on the wood, but tunnel into it to build a colony.

Chromated Copper Arsenate (CCA). CCA pressure-treated wood has a greenish cast and is highly resistant to termite infestation and decay. Invented in 1933, CCA-treated wood has been widely available since the 1970's; literally millions of decks have been built of CCA-treated wood. The copper acts as the main fungicide and also provides some protection against termites. Arsenic provides protection against termites and copper-tolerant decay fungi. Chromium helps to bond and "fix" the chemical components to the wood. The problem is arsenic is a known carcinogen.

The Environmental Protection Agency and the leading companies in the wood-preservative industry came to an agreement to remove all residential use and sales of wood products treated with CCA (Chromated Copper Arsenate) ended as of January of 2004. However, CCA-treated wood products will be still available for use in some industrial,

highway, and agricultural applications. These uses will include wood used as poles, piles, guardrail posts, and wood used in saltwater marine exposures.

This decision by manufactures to phase out the use of CCA-treated wood for residential structures has people asking what to do with existing structures made from pressure-treated wood. The EPA does not suggest tearing down structures made of CCA-treated wood. Many feel that applying coatings and sealants to the wood might minimize any chance of exposure to arsenic, although this is a topic of some debate. According to the EPA, people should take common sense precautions, especially when it comes to children. Kids should wash hands after playing on structures and keeping food from direct contact with CCA-treated wood.

Alkaline Copper Quaternary (ACQ). This treated wood has been used successfully for more than 10 years. Although it looks like ordinary pressure treated lumber, ACQ does not contain chromium or arsenic which is used in CCA-treated lumber as a preservative. Instead, it is a mix of copper and a quaternary ammonium compound, nicknamed quat. The copper-quats work together to protect the lumber from a wide range of rot and decay. Quats are fungicides that attack decay organisms. ACQ treated wood has been tested and found to have performance characteristics similar to wood treated with CCA. Preserve®, Preserve Plus®, and NatureWood® Preserves are brand names for ACQ pressure-treated wood. Preserve Plus® is ACQ pressure-treated wood with a built-in water repellent. More types of wood treated with ACQ is available.

Copper Boron Azole (CBA). CBA is a copper-based preservative with an organic fungicide. The treated wood is a dark honey brown color and turns a silver-gray after it weathers. The brown color can be restored by lightly sanding the outer layer. Wood products treated with Copper Azole have been used effectively around the world since 1992. Copper Azole is a fixed preservative approved for full exposure to above ground, ground contact and freshwater applications. It provides long-term resistance to termites and fungal decay in ground contact and aboveground applications. CBA treated wood can be used for most applications where CCA is used such as decks, walkways, gazebos, picnic tables, play structures, etc. It is not approved for wood foundations. Wolmanized Natural Select™ is a brand name for CBA-treated wood.

Borates. Borates are also effective at protecting wood from decay under the right circumstances, however they are very different chemicals. The copper-based preservatives chemically bond to the wood — in other words, they are "fixed" in the wood and cannot diffuse throughout the piece nor can they wash out. This means copper-based treated wood can be used outdoors or even submerged in water. Borate, on the other hand, is diffusible — in other words, it doesn't lock onto the wood like copper-based preservatives. The advantage of diffusion is borate's ability to keep moving deeper into the wood after pressure treatment. The disadvantage is that borate can leach out of treated wood that is continuously exposed to water. Borates are approved only for above-ground applications that are continuously protected from water, such as sill plates and other enclosed structural framing.

How long will treated wood last? It depends on the use and location. For best results, it is important that you use a treatment level (retention) appropriate to the end use. Thus, for an above-ground application (e.g., flooring) 0.25 per cubic foot ACQ is suitable. For ground-contact applications, 0.40 per cubic foot ACQ is appropriate.

Table 1. Minimum recommended ACQ retentions for various applications.

Application	Retention (lbs./cu. ft.)	Uses
Above ground decking using Sapwood species (Southern pine, ponderosa pine, red pine, radiata pine, and caribbean pine)	0.15 + water repellent	Decking, hand rails, spindles, trellises, gazebos, fence boards
Above ground decking using Heartwood species (Douglas fir, western hemlock, hem-fir, lodgepole pine, jack pine and redwood)	0.25 + water repellent	
Above ground - general use	0.25	Framing lumber, trim & fascia, flooring, sill plates
Ground contact	0.40	Deck support posts, fence posts, landscaping, piers, docks
Critical structural members	0.60	Permanent wood foundations, timbers, building poles

Other Options

Resistant Woods. Naturally resistant woods include redwood, cypress and cedar. These woods are somewhat resistant to termites, although they are not as resistant as treated lumber. For maximum termite and rot resistance, it is important to use the heartwood where resistant compounds are concentrated. Construction common grade wood contains sapwood and, like any nondurable wood, would only last a few years with ground contact.

Plastic and Composite Materials. There are two types of lumber products made from recycled plastic. One is 100% plastic. The other type is a composite material made from recycled plastic and waste wood fiber, like sawdust.

Unlike traditional lumber, plastic and wood composite lumber needs no maintenance or sealing. Plastic lumber does not splinter, rot, chip or warp and is impervious to insects. Like wood products, it can be sanded and fastened using traditional tools and methods. Plastic lumber is commonly available in three grades, hollow, solid, and structural solid. Hollow grade plastic lumber can be used for light-load applications such as low-load deck surfaces, fences, and shutters. Regular solid grade plastic lumber can be used for medium-to-light load applications, such as deck surfaces and planters. Structural grade plastic lumber has a 20% fill of fiberglass to provide superior strength and reduce the expansion and contraction properties.

Composite products have guarantees ranging from 10 to 50 years. Even though plastic wood may cost more initially than traditional wood, there can be long term savings due because of the low maintenance and longevity.

Termite Shields. Metal termite shields are more common in the southern U.S. where there is a higher likelihood of termite infestation. Termite shields are not used very often in northern climates but could be installed by home builders. These shields will not protect a structure from termites but, when properly installed, force termites to tube around them and make tubing more evident. They would be very expensive to install in existing structures.

Termite shields are sheets of a non-corroding metal placed between the concrete or solid masonry walls and structural wood. To be properly installed, lengths of metal should be carefully overlapped and soldered or riveted to form a continuous shield around the foundation. It should be emphasized that termite shields will not protect a structure from termites but force termites to tube around them where the tubes will be more visible. To be useful, regular inspections are needed and additional control methods may be needed.

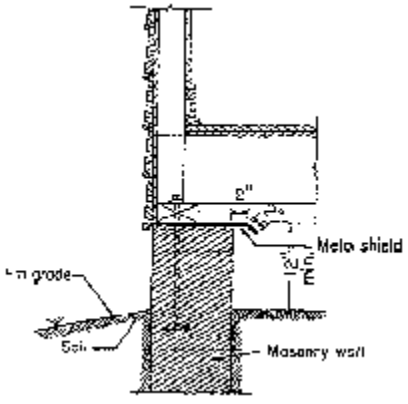


Figure 4-4. Termite shield over uncapped masonry wall.

Sand (or crushed stone) Barriers. In the late 1950's, two researchers discovered that subterranean termites were unable to tunnel through sand of a specific particle size. This discovery suggested that surrounding a structure with sand could prevent termite entry into a home. Sand or crushed stone barriers can be applied in crawl spaces, under slab foundations, and next to foundation walls.

However, not just any sand or crushed stone will prevent termites. The size of the sand or crushed stone particles is critical to the success of a barrier. Sand/crushed stone size should be no larger or smaller than that able to sift through a 16-mesh screen. Particles smaller than 16-grit can be carried away by termite workers; larger particles can support tube construction. Sand or crushed stone barriers are routinely done on new construction in Australia and Hawaii. In the continental U.S., some companies in California are providing treatments, but this novel treatment has not been used much in the rest of the U.S.

Stainless Steel Mesh. Another physical barrier is stainless-steel wire mesh. Research has shown it is extremely effective, even in very high termite areas. Currently a company in Australia is marketing mesh (0.45 mm x 0.86 mm) in 100-foot stainless steel wire rolls and used during building construction. It can be shaped and fitted around pipes, posts, foundations and trenches. Because of cost, it has limited utility in post construction applications and will probably be used mainly in custom-built homes.

Steel Studs. Steel studs used during new construction or remodeling can help reduce the risk of termite infestation. If the walls contain metal instead of wooden studs, the termites can't damage them. However, termites can build mud tubes on the metal studs to gain access to wood in other parts of the house.

Concrete home. One of the latest trends in new home construction is the use of concrete. Not only is the concrete used for basement walls and foundations, but it is now being used in whole house wall, ceiling, floor, and roof construction. The poured concrete house comes very close to a "termite proof" home. Keep in mind that if any wood in used in the construction of the house and if termites are in the soil surrounding the house, the termites can potentially find the wood.

Chapter 5
Termiticides: Termite Control Chemicals

What is a chemical? Everything around us, the earth, air, even our bodies are composed of chemicals. The smallest part of a chemical is called an atom. When atoms exist in a pure state, the substance is called an element. Oxygen, hydrogen, nitrogen, and carbon are some of the most common elements. When two or more elements are combined chemically, they are called compounds. Water, a common compound, has two hydrogen atoms and one oxygen atom (hence, H_20).

Animals and plants are composed of chemicals; most of which are very complicated chemical compounds. The chemistry of living things is known as organic chemistry because they are composed primarily of the organic elements carbon, hydrogen and oxygen. To some people, the word organic means that something is natural or grown in the absence of synthetic fertilizers and pesticides. For our purposes, organic refers to a chemical compound containing the organic elements.

Pesticides are chemicals that either control pests or prevent the pests from causing damage or infesting an area. If the pest is a weed, we use a herbicide; if it controls rodents, it is called a rodenticide. Fungicides control fungi, insecticides control insects, and termiticides control termites. Most termiticides are organic compounds that are synthesized by chemists and manufactured by chemical companies. There are a few, however, that are made from plants, minerals or non-organic elements that have the ability to control termites.

Termiticide Formulations

An active ingredient is the specific chemical in a pesticide product that "does the dirty work". An active ingredient is mixed with less toxic inert ingredients. The mixture of active and inert ingredients is called a pesticide formulation. The directions on the label tell the applicator how to use a pesticide formulation. Since control is often based on how the termiticide is used, a homeowner who is interested in having an effective treatment should read and understand the label directions.

There are a number of termiticide products that are labeled for termite control in and around homes, apartments, and dwellings. In this section, we will describe the formulations that are used for termite control.

Liquid Formulations

Emulsifiable Concentrates (EC). Emulsifiable concentrates are uniform mixtures of the concentrated active ingredient, oil-based ingredients and other ingredients. When the EC is diluted in water, the active ingredient and oil droplets are suspended uniformly throughout the water. EC's are normally opaque or milky in appearance. Emulsifiable concentrates can be toxic to plants and are easily absorbed through the skin. Certain oil-based ingredients that are used with EC formulations cause the strong smell that we often associate with pesticides.

Many of the termiticides labeled for chemical barrier treatments are emulsifiable concentrates. They are usually either organophosphates or synthetic pyrethroids. See the relevant sections in this chapter and Appendix A for more details.

These termiticides are also labeled for surface applications to wood for controlling termites and other wood destroying insects. Soil barrier treatments and wood treatments are discussed in detail in Chapter 6.

Water Miscible Liquids. Liquid miscible liquids are mixable in water. The concentrated active ingredient is able to dissolve in water or alcohol. These formulations resemble EC's but do not become milky when diluted with water. Water-miscible liquids are labeled as water-soluble concentrates (WSC), liquids (L), soluble concentrates (SC) or solutions (S). An example of a termite control product that is a water miscible liquid is Bora-Care™, a boric acid product used to treat wood.

Dry Formulations

Dusts (D). Dust formulations contain an active ingredient plus a powdered dry inert substance like talc, clay, nut hulls, or volcanic ash. The inert ingredients allow the dust formulation to store and handle well. In the home, dusts should be used only in locations where the inhabitants will not stir the dust, move it around, or inhale it.

Wettable Powders (WP or W). These are dry, finely ground, powdery formulations. They look like dusts, but a wetting agent has been added to the other

ingredients to help them to mix with water. Wettable powders form a uniform mixture of particles rather than becoming dissolved when added to water. A wettable powder formulation registered for termite control as a barrier treatment is Premise® 75 (imidacloprid).

Baits (B). A bait formulation is an edible or attractive substance mixed with a toxicant. When baits are used against termites and other social insects, the most effective baits will contain active ingredients that have low toxicity and cannot be detected by the foraging insects. It is important that a lethal dosage of the bait toxicant is passed throughout the colony to affect all the colony members. Since termites eat cellulose, paper is often used as the carrier for termite baits.

In 1994, Dow AgroSciences received EPA registration for hexaflumuron, an insect growth regulator. Since then, there have been several additional bait products that have been registered for termite control. In 1996, FMC introduced FirstLine®, a bait that uses sulfluramid as its active ingredient. In 1998, Exterra Termite Interception and Baiting System® was registered by Ensystex, Inc. The bait ingredient of this system is diflubenzuron (commonly called Labyrinth), another insect growth regulator. The most recent ingredient to be registered is noviflumuron, also by Dow AgroSciences. You can be sure that there will be many more baits appearing on the market over the next several years. Bait products will be discussed in detail in Chapter 7.

Miscellaneous Formulations. There is another termite product that has an unusual formulation. Jecta® is a borate that is formulated as a gel to be applied with a syringe into cracks of wood. More information about borates is found later in this chapter.

Foaming Agents. Foams may be used as part of a chemical barrier treatment to help distribute the termiticide in areas that might be difficult to treat. Foam results when air is forced into the termiticide mixed with a foaming agent.

The use of foaming agents is a developing technology in termite control. The foam is a compact mass of air bubbles separated from each other by a liquid film; air makes up about 85 percent to 95 percent of the foam. There are "wet" and "dry" foams depending on how much water is used in the mix. After a few minutes to hours after application, the foam breaks down into a liquid as the bubbles collapse.

The foam helps distribute insecticide in areas that are difficult to treat, such as under slabs and outside steps, around rubble foundations, behind veneers, and in voids found in walls, chimneys, and masonry. Most of these sites are treated blindly. Foams will disperse around obstructions and will better fill a void. Once the foam has spread into the desired area, the solution drains from the mass of bubbles downward into the fill. This can will result in a more complete, uninterrupted treatment barrier.

Termiticide Classes

Chlorinated Hydrocarbons: Banned A few of the better known chlorinated hydrocarbons are DDT, aldrin, dieldrin, heptachlor, and chlordane. Throughout the 1970s and 80s, the EPA banned most chlorinated hydrocarbons in the United States because these insecticides persisted in the environment and accumulated in the fatty tissues of animals. The last chlorinated hydrocarbon to be used for termite control was Chlordane. Chlordane was withdrawn from the market by its manufacturer in 1988. It persists in the soil so long that there still may be houses protected from termites by a chlordane treatment that was done before 1988. These insecticides should not be used in termite control.

Organophosphates (OPs): OP's are generally more toxic to vertebrates (including humans) than the chlorinated hydrocarbons, but they are much less persistent in the environment. Until recently, chlorpyrifos was used extensively for termite application. Chlorpyrifos barriers are non-repellent to termites and kill termites quickly on contact. This action results in many dead termites near the point of contact with the barrier. It is thought that the dead termites deter other termites from the treatment zone.

However, the Environmental Protection Agency revised the risk assessment for chlorpyrifos and reached an agreement with the registrants to eliminate and phase out certain uses of chlorpyrifos. All uses of termiticide formulations containing chlorpyrifos have been phased out.

Botanicals: Naturally Occurring. Botanicals are natural insecticides, made from plant extracts. When processed and concentrated, these botanical insecticides are similar to synthetic insecticides. Some people believe that natural-occurring botanicals are safer to use than synthetic insecticides. This is not necessarily the case. Nicotine sulfate, a botanical derived from tobacco plants, is more toxic to mammals than many other synthetic insecticides.

A botanical insecticide used to control some insects is pyrethrum, a natural compound that comes from the chrysanthemum plant. Pyrethrum has low toxicity to mammals but causes very fast knockdown and rapid paralysis in the target insects. Because pyrethrum breaks down very quickly in the environment, it is not very useful as a termiticide.

To increase the effectiveness of pyrethrum, chemists have synthesized similar, more stable compounds in the laboratory. These laboratory-created insecticides are known as the synthetic pyrethroids and a number of these chemicals are long-lasting enough to be useful for termite control.

Synthetic Pyrethroids. Dozens of synthetic pyrethroids have been identified and synthesized. A few

used in termite control include fenvalerate, permethrin, cypermethrin and deltamethrin. (Notice the "thrin" part of the name of many of these common names.) Chemists have made these compounds more stable and more persistent than natural pyrethrum. A chemical, like piperonyl butoxide, is often added to the synthetic pyrethroid to further increase its effectiveness.

When used against termites, synthetic pyrethroids are highly repellent but kill very few termites. Instead, termites avoid the areas where these chemicals have been applied. Pyrethroids are very toxic to fish so precautions must be taken to prevent these chemicals from getting into streams and other surface waters.

Compared with some formulations, there is less odor associated with synthetic pyrethroids, and they may be preferred for inside treatments, like drilling through slabs or basement walls. Even though the odor may be less, the solvents in synthetic pyrethroids sometimes trigger asthmatic attacks in persons who have respiratory problems.

Chloronicotinyls. This class of non-repellent termiticides was introduced in 1996 when Premise® 75 became available as a barrier treatment. The active ingredient of Premise® 75 is imidacloprid, which acts by attaching to specific binding sites at the nerve endings of termites. Because warmblooded animals have fewer of these receptor sites, imidacloprid has a very low toxicity to mammals, when compared with organophosphates and synthetic pyrethroid products.

Unlike synthetic pyrethroids, that are readily detected in the soil, termites do not detect imidacloprid and tunnel into treated soil. After contacting imidacloprid, termites soon stop feeding, become disoriented, and eventually die. The termites exposed to lower concentrations of imidacloprid are left susceptible to naturally occurring pathogens in the soil and later die from diseases.

Phenyl pyrazoles. This is a new class of non-repellent termiticide. Fipronil was made available as a termiticide during 2000. After five years of testing, results indicated that fipronil provided 100 percent protection against termite attack at several USDA field testing locations in the United States. This active ingredient is sold under the name Termidor®.

Pyrroles. Chlorfenapyr is a slow acting, non-repellent termiticide. The slow acting action allows time for the termites to transfer the chlorfenapyr to other colony members. It was introduced into the termiticide market in 2002 as Phantom®. Termites pick up chlorfenapyr via ingestion and through contact. The activity via the oral route is excellent, and the contact activity is roughly equal to that of organophosphates. The mode of action is novel among termiticides. After chlorfenapyr enters the termite, it keeps the termite from generating its own energy. As a result, the exposed insect will die.

Fluoroaliphatic Sulfonamides. The fluoroaliphatic sulfonamides are relatively new, especially as termiticides. Sulfluramid is a slow-acting stomach poison. There are two termiticide products containing sulfluramid: FirstLine® Termite Bait Stations (FMC Corp.) and Terminate (Spectracide Corp). Both products are formulated as termite baits. Sulfluramid use results in termite colony suppression, not colony elimination.

Trifluoromethyl aminohydrazones. Hydramethylnon is the active ingredient in a termite bait system called Subterfuge®. Hydramethylnon acts to inhibit the production of energy inside the insect. Insects killed by these chemicals die on their feet, basically "running out of gas".

Hydramethylnon has a relatively low toxicity to mammals. When hydramethylnon is eaten, the termite colony is suppressed. The speed that the colony is suppressed depends on the amount of bait that is eaten.

Inorganics.

Borates. There are several products labeled for termite control that have a compounds containing boron as their active ingredient. Boric acid and disodium octaborate tetrahydrate are chemical forms of boron. The borates are used to treat the surface of wood, either as a preventative or remedial treatment. These products work because the borate penetrates wood and is ingested by termites as they attempt to eat the wood. Boric acid has been known to successfully kill insects for decades, but little is known about its mechanism of activity. The most accepted hypothesis is that boron kills intestinal microorganisms that allow insects to digest their food.

Borates are formulated as a liquid (Bora-Care™), or a powder (Tim-bor®) that are mixed with water and applied to the surface of wood. It is also formulated as a gel, Jecta®, that is injected with a syringe into posts, poles and high risk areas through cracks in the wood or predrilled holes. Borates have also been impregnated into rigid foam and fiberglass insulation products.

Microbials

Nematodes. Insect-eating nematodes are tiny parasitic roundworms that naturally live in the soil. They are sold for termite control. However, there is a problem when using nematodes for termites control. In laboratory studies, the nematodes killed termites, but these results have not been repeated in conditions such as in a termite infested home. In addition, applications of nematodes have not been shown to prevent termite infestations.

Based on the lack of effectiveness under real conditions, nematode products should not be considered a practical, effective method of termite control.

Pathogenic Fungi. Many species of fungi live in the soil and some infect and kill insects that live there. It has been known for many years that a fungal pathogen, Metarhizum anisopliae, naturally kills termites. This

pathogen has been studied extensively and is now marketed as a termiticide called BioBlast™; however, this product is not currently registered for use in Nebraska. Infection occurs when the fungal spores germinate, penetrate the termite's body, and grow inside the body. Studies have shown that this disease is highly infectious. After termites become infected, the spores are quickly spread to other colony members. However, once termites start dying, noticeably sick termites are shunned by healthy termites. This behavior reduces the further spread of the disease. Studies have shown that if 10 percent of colony members can become infected initially, it is likely that the remaining 90 percent of the colony will be infected.

These pathogenic fungi are not applied as a barrier or a bait treatment. Instead, they are applied as a suspension of fungal spore particles that act as a contact termiticide, except the infected termites don't die immediately. It must be applied so that it gets right onto the termites, not just their environment. For the whole colony to become infected and possibly eliminated, this pathogen must be applied to as many termites as possible. When used correctly, this pathogen can be very effective to control termite colonies that are colonizing the wood itself, such as some drywood species.

At the present time, the *Metarhizum anisopliae* pathogen is less likely to effectively control subterranean termites because it is nearly impossible to infect enough foraging termites to get the infection started. A second problem is that it has no long-lasting residual activity. After the termites die, the fungal spores also die. In addition, this pathogen is not like anything else available on the market and needs special application and handling techniques. It needs to be stored properly and will not be effective if tank-mixed with insecticides. This fungi pathogen has its best chances of use in subterranean termite control, when used in conjunction with baiting programs applied directly to foraging termites, or in sensitive environments where more toxic chemical treatments cannot be used.

Insect Growth Regulators

Insect growth regulators are a group of compounds that alter growth and development of termites and other insects. They are much less toxic to humans and other nontarget organisms than the majority of termiticides. These synthetic biochemicals cause abnormal growth and/or development and either kill the termite outright or prevent it from reproducing. This group of termiticides are most often used in termite baiting technologies, to be discussed in Chapter 7. Hexaflumuron and noviflumuron (Sentricon®) and diflubenzuron (Exterra® and Advance®) are two IGRs currently registered by the EPA and labeled for termite control. All belong to the group of IGRs that are called Chitin Synthesis Inhibitors, which means that they inhibit the growth of chitin, which is the main component of the insect exoskeleton (insect "skin" or "shell"). Because only insects, other arthropods and fungi contain chitin, these hormone mimics are more specific to insects than other termiticide treatments that effect the nervous system, for example. This makes them more environmentally friendly and safer for humans and other nontarget animals.

Repellency vs. Non-repellency

Termites are affected differently by termiticides, depending upon the way the termiticides are applied (soil, surface of the wood, bait), and by the unique characteristics of each termiticide class or group. Soil-applied termiticides are designed to provide a protective barrier between the termites and your house. You might wonder if it is best to use a repellent or a non-repellent liquid barrier termiticide. Chloronicotinyls, phenyl pyrazoles, and pyrroles are relatively new non-repellent to the termite termiticides compared to the older synthetic pyrethroids that are highly repellent to termites. Research evidence has accumulated over the last several years indicating that the newer non-repellent termiticides *are more effective* than repellent termiticides at protecting your home from termites.

Non-repellent termiticides are not detected by termites. Because they don't know it's there, the termite workers forage freely in the treated soil. However, because non-repellents are slower to kill and termites that contact the chemical in the soil carry it back to the colony on their bodies. Every other termite that the original termite touches will itself become "infected." This is known as the so called "transfer effect" or "domino effect." Because these newer non-repellent termiticides are lethal to termites at very low doses, the transfer from contaminated termites to "clean" termites can result in the eventual weakening or elimination of the colony.

Termiticide Testing

All soil applied termiticides must pass a two-step process before EPA will register the product. Compounds are first screened in the laboratory, and from among those tested in the lab, only a very few ever make it to field testing. Field testing is done at testing facilities in Arizona, Florida, Mississippi, and South Carolina. The test sites represent dry, subtropical, and mild climates, as well as different soil types. These field testing locations represent a "worst case scenario" for the termiticide. If it can provide protection against termites under these conditions, it is a good indication that it will also perform well in most other conditions across the United States. Termiticides are evaluated for as long as they remain effective against subterranean termites. These tests provide the information necessary to register and label soil termiticides in the U.S. A summary of these tests is provided at the end of chapter 6.

Unlike chemicals used for barrier treatments, baits have not had rigorous testing to determine their effectiveness. Since there are no performance guidelines, at the present,

persons should be somewhat skeptical regarding claims made about these bait products. In the future, performance criteria will be established for both new and existing bait products and products lacking performance data will be required to generate additional data and/or adjust their claims. In the meantime, be cautious about outlandish claims that seem to be too good to be true.

How Long Do They Last?

Recent studies have shown that all registered soil applied termiticides disappear over time. In one extensive study, it was found that after 5 years less than 10 percent of the initial application rate remains. The loss of termiticide in soil could be the result of individual peculiarities at each treatment site. Evidence indicates that some microbes "eat" termiticides, which could explain part of the disappearance. Some termiticides disappear because chemical reactions in the soil break the termiticide molecules into smaller, less effective pieces. Soil conditions that are known to affect termiticide degradation include the acidity of the soil, the amount of organic matter present, and the soil type (clay, silt, sand). Whatever the cause, it should be assumed that the concentration of termiticide will be less each year following the application.

Chapter 6
Conventional Termiticide Treatments

The chemical treatment of soil around and under foundations of buildings to protect them from termite attack is the conventional approach that has been in common use for at least 50 years. The treatment results in a chemical barrier that repels or kills termites as they tunnel into or near the treated area. The ability of the barrier to withstand the efforts by termites to enter the structure is influenced by several factors that are discussed in the next section.

Factors Affecting Termiticide Application

The soil type and its moisture content affect the penetration and stickiness of liquid termiticides. If the soil is excessively wet, there is a chance of termiticide runoff and a chance that the chemical will not penetrate into and/or stick to the soil. In frozen or excessively dry soil, termiticides are repelled and puddling occurs, resulting in poor distribution of the termiticide. All liquid termiticide labels prohibit applications to be made into water-saturated or frozen soil.

Mechanical disturbance of treated soil breaks the continuity of the termiticide barrier and increases the possibility of termites crossing the barrier. When the soil under a slab is treated, the termiticide penetrates less than 2 inches, with the majority of the termiticide being found in the top 3/4 of an inch. Therefore, very little disturbance of the treated soil can be tolerated. A slab-foundation site freshly treated during construction, for example, should be protected from rain and evaporation, unless the concrete is to be poured the same day. Treatment of the outside of foundation walls during construction should be done after all grading and other soil disturbances have been completed to avoid disrupting the continuous barrier.

Liquid termiticides are not easily moved or disturbed once dry in the soil. Since they don't dissolve in water, movement from the soil is not a problem. However, there is a slight risk of contaminating a well or other water supply if liquid termiticides are applied to adjacent soil that either contains layers of gravel or tends to crack severely during periods of drought. In these situations, the soil should not be treated by trenching and rodding. Instead, it should be treated using the treated backfill method.

Methods of Application

The objective of applying a termiticide to soil is to provide an unbroken chemical barrier between the wood in the structure and termite colonies in the soil. Thus, the termiticide must be applied thoroughly and uniformly to block all routes of termite entry. Treatment must be done around all pipes, utility conduits, foundations, and footings that contact the soil. Application procedures will depend on the soil type, grading, water table, presence of drainage tile, and the location of any wells in the area. The design of the structure, location of the colony, severity of infestation, and the termites' behavior must also be considered. The overall principle in conventional termiticide barrier termite control is to make it impossible for termites to move between their colony in the ground and the wood in the structure. Three common methods of applying termiticides to soils are broadcast spraying, subslab injection, and trenching/rodding. A low-pressure broadcast spray may be used to apply termiticides as a preconstruction treatment before slabs are poured or as a postconstruction treatment of inaccessible crawl spaces.

Trenching and rodding involves digging a narrow trench and then rodding into the soil at the bottom of the trench. The trench is also flooded, and the excavated soil is mixed with termiticide as the soil is replaced into the trench. The trench is dug right next to the face of the foundation wall or the masonry-work footing of any supporting posts or piers. The trench should never extend below the top of the footing of the foundation wall. Depending on the depth from the soil surface to the top of the footing, trenching may be done alone.

Rodding the soil is accomplished by applying the termiticide through hollow steel tubes inserted into soil at the bottom of a trench. A rod is usually made of a pipe, ½ of an inch in diameter and between 4 to 8 feet long, with a handle and shut-off valve at one end. The other end is fitted with a perforated tip to disperse the liquid laterally as well as downward. The termiticide is applied as the rod is moved slowly downward, allowing the termiticide to spread. The rod is never pushed down and then brought up as the termiticide is applied. To assure that an excessive amount of termiticide does not accumulate at the bottom of the rodding point, the termiticide is not applied as the rod is brought back up through the soil.

Exterior Perimeter Treatments

Recently, "exterior only" and "exterior mostly" treatments are being advocated by some pest management professionals. The method calls for applications of the newer non-repellent termiticides either as exterior perimeter treatments alone or as exterior perimeter treatments plus selected "hot spot" treatments. The hot spots are either locations within the structure that show signs of termite activity or locations that are likely to show signs of termite activity in the future. Not all termiticide labels allow the use of this method. Those that do legally allow it, generally recommend a "full" treatment. Research results indicate that this method has great promise; however, we do not currently recommend it. Instead, we recommend a complete, exterior and interior barrier application to protect the entire structure if choosing the conventional soil application of termiticides as discussed in this chapter.

Termiticide Applications Before and During Construction

The ideal time to chemically protect a structure from subterranean termites is before and during construction of the foundation. This should be used in conjunction with good construction practices, not as a substitute for them. It is particularly important when using concrete slab-on-ground construction (such as with a slab home or a basement or garage with a concrete slab floor). In addition to slab-on-ground houses, two other basic construction types (crawl space houses and full-basement houses) are discussed in the following sections.

Slab-on-Ground Houses

Since they are especially susceptible to termite attack, this type of building should be protected by treating with a termiticide during construction. Soon after the sand, gravel or dirt fill have been installed and tamped, the entire area is treated before the concrete slab is poured.

Horizontal Barriers. The termiticide is applied over the entire underslab area and also under any attached porches, terraces, carports, and garages where the fill consists of sand, soil or unwashed gravel (Figure 6-1). Hollow block voids are injected with termiticide to create a continuous barrier. The termiticide should be applied so that it reaches the footing.

Vertical Barriers. Trenching and rodding along the inside and outside of the foundation, including porches and patio is used to apply the termiticide. (Figure 6-2).

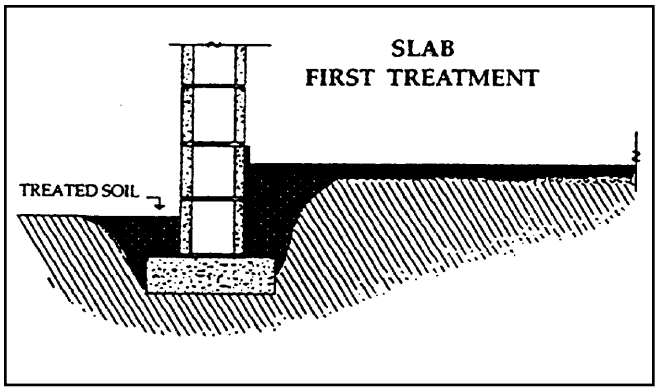


Figure 6-1. Termiticide treatment of the fill material prior to pouring a concrete slab protects wood in the building from termite attack.

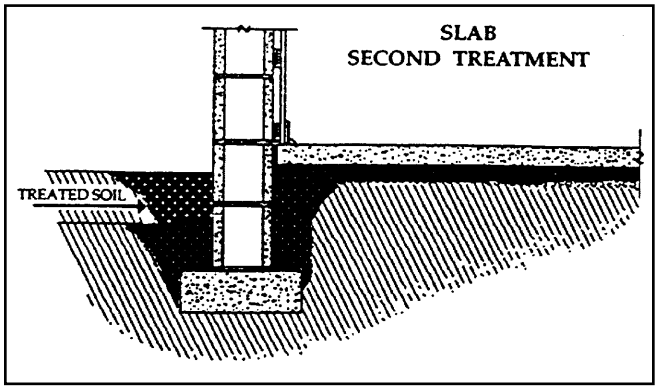


Figure 6-2. Application of a termiticide to soil around the foundation.

Crawl Space Houses

Crawl spaces are low, less than 3 feet high, and usually have exposed soil. The exposed soil, short distance to floor joists and sills, and unkept nature make crawl spaces an ideal habitat for termites. The termiticide selected should produce little or no odor because exposed treated soil in a crawl space can become a smelly nuisance if low-odor termiticides are not used.

Mechanical Alterations. Any pieces of wood left on top of the soil should be removed; contractors will often leave construction debris in crawl spaces. Capping the soil with a layer of concrete will prevent swarmers from emerging. The soil should be treated before the cap is poured to form an effective barrier. The crawl space should be vented to help minimize moisture and odor buildups. It is recommended that the total area of vents be equal to 1/150 of the total area of the crawl space.

Soil Treatments. The soil adjacent to foundation walls are treated by trenching and rodding along the inside of the foundation (Figure 6-3).

A horizontal barrier across the surface of the crawl

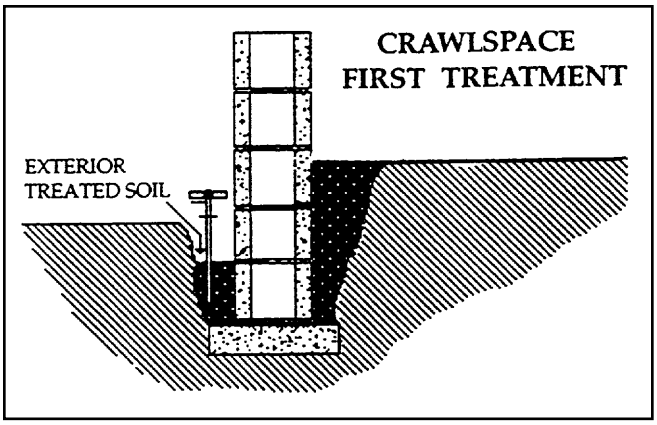


Figure 6-3. Preconstruction treatment of inside and outside foundation perimeter.

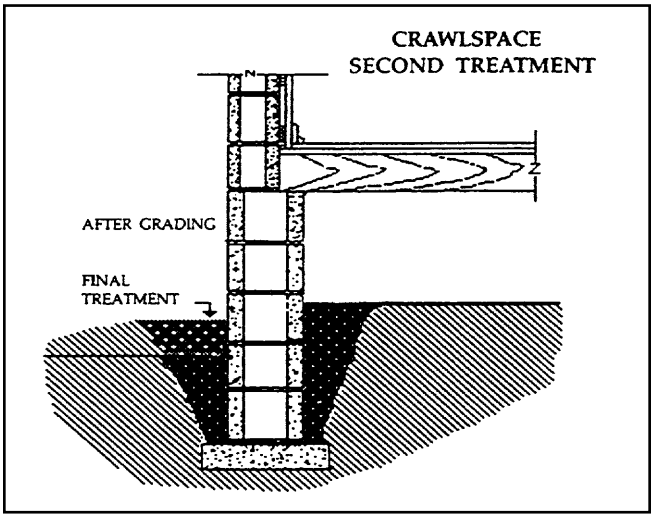


Figure 6-4. Second treatment after the final grading.

space is created by applying the termiticide over the entire surface area. If buried wood cannot be removed, the termiticide should be injected under the soil surface near the wood. The treated soil is sometimes covered with a layer of polyethylene plastic.

Trenching and rodding along the outside of the foundation is also done, including areas such as porches and patios. When the top of the footing is more than 12 inches below the surface, trenching and rodding is done to the top of the footing (Figure 6-4).

Full-Basement Houses

The application of a termiticide to a typical house with a basement is done in the same manner as recommended for slab-on-ground construction.

Soil around the foundation, piers, utility lines, and load-bearing walls is treated with termiticide by trenching and rodding. Where there are hollow block foundations or voids in masonry foundations, these are treated as well. The termiticide is applied so it reaches the top of the footing. Prior to laying the slab, termiticide is applied to the sand or gravel fill to create a horizontal barrier just as with the slab-on-ground house.

Special note: If the concrete slab cannot be poured the same day, the treated soil is usually covered with a waterproof cover, such as polyethylene sheeting. This will protect the treatment from adverse weather.

Controlling Existing Termite Infestations

Even when careful planning was done before construction and excellent construction practices were used, and all efforts to avoid moisture-buildup problems have been made, termite infestations can still occur. Infestations also sometimes occur in structures where barrier applications of termiticides were done during construction. Ridding existing termites from these structures, along with making them resistant to future infestation, should be the major goal of the pest control company using the termiticide barrier application method. Often, buildings become infested because, during or after construction little or no attention was paid to the preventive measures that would have made the structures more resistant to termites (see Chapter 4: Preventing Termite Infestations). It is in such buildings that termites can cause heavy damage if left untreated.

To control termite infestations in existing buildings, the pest control company will use many of the same principles as were already discussed for new buildings. It is best to eliminate favorable conditions that aid the development of termites near the structure and conditions that permit the passage of termites from the soil to the wood of the building. This is important because termites in the woodwork of a building will die if they are prevented from maintaining contact with the soil or other sources of moisture.

Termiticide Applications

In addition to controlling existing termites, a continuous chemical barrier will prevent future termite attack. Greater caution is required, however, because of the presence of plumbing, duct work, and electrical wiring, and because the building is probably occupied by people and/or pets. During application, the pest control technician should have an assistant constantly checking for leaks in the basement or other areas where termiticides should not enter.

Slab-on-Ground Houses. Termite infestations in houses built with a slab on the ground present serious control problems. It is difficult to place termiticides in the soil beneath such floors, where they will be effective. Applications are made by subslab injection, trenching and rodding, or both. Treating is done along the outside of the foundation and, just beneath the slab on the inside of foundation walls. Treatment will also be done just beneath

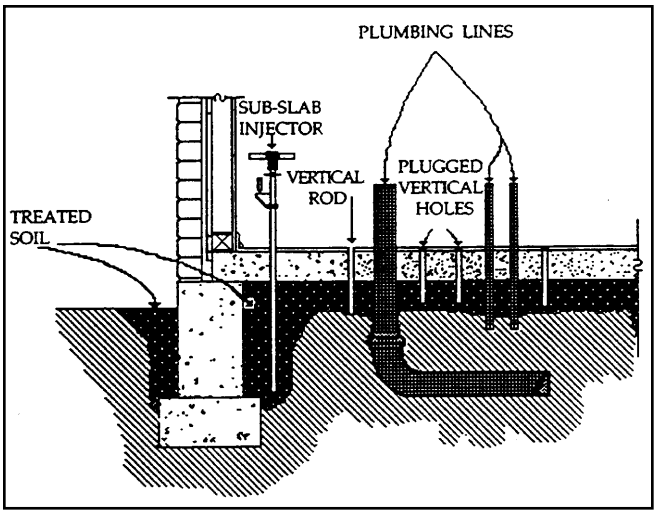


Figure 6-5. Treatment under concrete slab with vertical rodding at joints, cracks, and openings around plumbing.

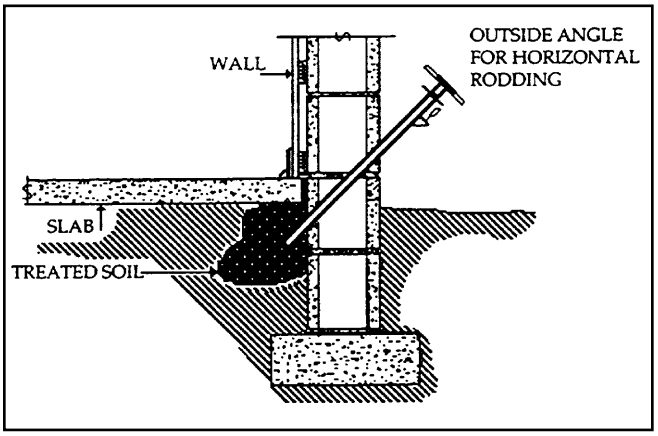


Figure 6-6. Horizontal rodding through exterior wall.

the slab along both sides of interior footings and supported walls, along interior partitions, and along all cracks and expansion joints.

One way to treat soil beneath slabs is to drill a series of vertical holes through the concrete slab. The holes are made about 6 inches away from the wall and approximately 12 -18 inches apart to ensure a continuous termiticide barrier of the underlying soil (Figure 6-5).

Termiticides should NOT be applied until the termite control technician has located heat or air conditioning ducts, vents, water and sewer lines, and electrical conduits. Extreme caution is taken to avoid contaminating these structural elements and airways. If termiticides were injected into duct systems, you could be exposed to the termiticides.

Another method of slab treatment is for the technician to drill through the exterior foundation walls to the soil just underneath the slab. The termiticide is then introduced through these holes. This method, most often used under bathrooms or kitchens, is complicated and requires the use of horizontal rods (Figure 6-6).

Structures with Ducts in the Slab. Applying a termiticide to an existing structure with intraslab or subslab air circulation ducts must be done with great care. Intraslab ducts are completely encased in the slab (Figure 6-7). The ducts of a subslab system rest on a vapor barrier, with the concrete poured on top (Figure 6-8). Puncturing a duct or allowing termiticide to leak into these ducts results in serious problems.

If your home has air ducts in the slab, some additional procedures should be used by the pest control company that is conducting the treatment. They should attempt to locate a diagram or blueprint of the duct systems, determine what the ducts are constructed of, and how tight the joints are. Measurements of the depth, width, and location of the ducts should be made. Inspection of the ducts should be done carefully, using a mirror and a

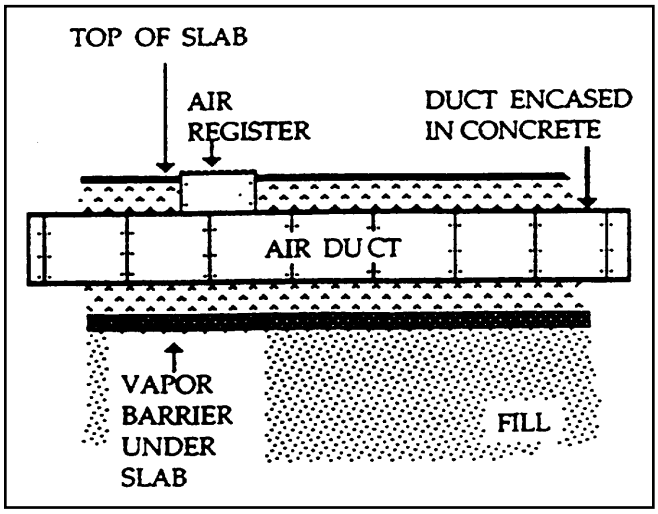


Figure 6-7. Intraslab air duct system.

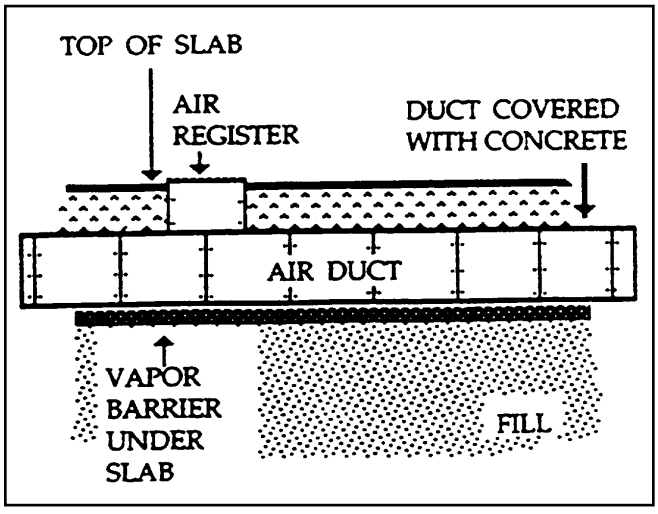


Figure 6-8. Subslab air duct system.

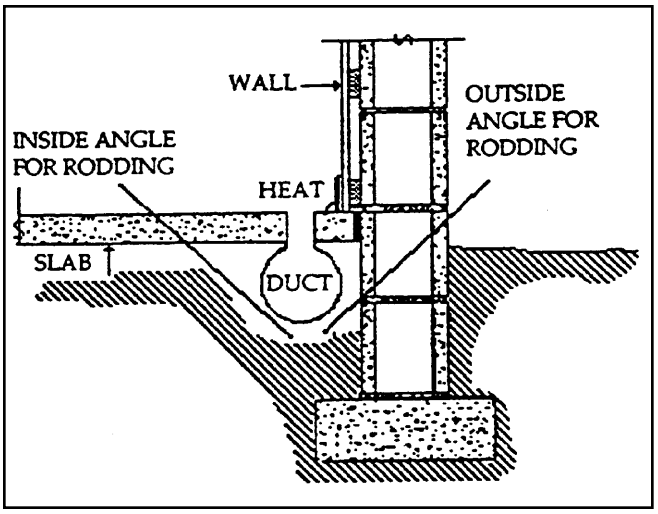


Figure 6-9. Subslab perimeter heat duct showing the angles needed to rod the termiticide system.

flashlight, for soil deposits and evidence of breaks in the ducts. Swarmers coming from the ducts also indicates a break in the integrity of the duct work.

The termiticide needs to be applied beneath the slab, under or around the ducts. Subslab injectors are made for injecting the chemical beneath the slab. The pest control technician will drill the holes carefully (Figure 6-9) so they do not puncture the ducts.

During and after treatment, the ducts must be checked for signs of the termiticide. The heating system should be turned on and checked for odors. If an odor is detected, the system should be turned off, and the source of the odor determined. Leakage in the ducts must be removed.

Raised Cement Porches, Terraces, Entrance Slabs, Sidewalks, and Driveways. All of these that are either filled with soil or are directly on the soil must have the soil next to the foundation treated. Treatment is done by drilling through the concrete or tunneling under the concrete next to the foundation wall.

Crawl-Space Houses. Buildings with crawl spaces can be treated easily and effectively. In general, trenching and rodding is done adjacent to and around all piers and along both the inside and outside of all foundation walls. Piers, chimney bases, and utility entrances are also treated. Broadcast applications in crawl spaces of existing structures are only allowed if the crawl space is inaccessible.

Basement Houses. Where footings are greater than 1 foot of depth from the grade to the bottom of the foundation, application is made by trenching and rodding. Areas along the outside of foundation walls and, if necessary, beneath the basement floor along the inside of foundation walls, as well as along interior load-bearing walls, conduits, and piers should also be treated.

Foundations with Holes, Cracks, Voids, or of Stone or Rubble. Stone and rubble foundations, found mainly in older structures, are particularly susceptible to termite attack primarily because of gaps between the stones. The gaps may never have been filled with mortar or the mortar may have deteriorated. Termites can exploit these gaps and tunnel within the wall. Additionally, the floor joists may be close to the fill, as in the crawl space, embedded into the foundation, or a porch or crawl space without ventilation may exist, which results in damp soil and an ideal hidden location for construction of mud tubes.

Termiticide Treatments. Interior (soil under the floor) and exterior termiticide applications down to the footing are essential. When soil treatments on the exterior are done, seepage into the structure must not be allowed. Trenching, treating the excavated soil, and then shoveling the treated soil back into the trench will lower the risk of termiticide seepage into critical areas of the structure. Even so, the pest control technician or their helper should be inside watching for leaks during the application.

Multiple Brick, Concrete Blocks, Hollow Tile, etc. Holes are drilled horizontally through mortar joints into void areas where hidden termite tunneling may be occurring. The termiticide is injected so that it reaches the top of the footing. Basement construction of multiple-brick foundations should be treated below grade level from the inside and above grade level from the outside.

The voids in hollow-tile walls run horizontally so a termiticide treatment cannot reach below the point of treatment. The tile must not be drilled through directly because it is easily cracked. A thorough grade-level termiticide application to obtain good soil coverage on both sides of the foundation (i.e., where there is a crawl space) is one of the best methods of treatment. This is also true for fieldstone foundations. Little can be done to treat voids so complete treatment of the soil is of the utmost importance. Fieldstone foundations must be patched and all cracks and voids must be filled before treatment.

Houses With Wells, Cisterns, Springs or High Water Table or Near Ponds, Lakes or Streams. The technicians must apply the termiticide without contaminating water supplies. They should take special precautions if wells, cisterns, or springs are located near the treatment area. They must know and comply with the restrictions placed on termiticide applications by state or local pesticide regulations regarding the minimum acceptable distance between wells and sources of pollution.

The well's location, distance from the structure, depth and location of the supply line must all be recorded during the original inspection. It is especially important to locate water wells and cisterns because the well may be buried and cannot be seen.

Treatment Procedures Near the Well and Supply Lines. The soil nearest the well should not be treated by trenching and rodding. As the areas along the foundation are trenched, the soil should be placed on a waterproof

tarp. The termiticide is then applied to the soil on the tarp, mixed, and the treated soil is then placed back into the trench. This is called a treated backfill application.

Extreme care is needed when applying a termiticide around the water supply line. The termiticide may follow the pipe and reach the well. The supply pipe should be uncovered from the structure out toward the well for a short distance so that seepage along the pipe can be seen. The treated soil method discussed earlier should be used to apply the termiticide along the foundation near the supply pipe.

Treatment Odors

One complaint about some termite treatments is the odor that can remain afterwards. Although the termiticides themselves have little odor, the oil-based ingredients, and related compounds in the formulation can create odors. Under certain conditions these odors can be strong, offensive, and long lasting. To prevent odor buildup, the structure must be ventilated. Windows and doors should be opened, and fans can be used to circulate air. Activated charcoal filters can also be used in place of existing filters to trap odors as the furnace circulates air in the house or attached to the ventilation fans. Dehumidifiers are sometimes used to reduce moisture and enhance the drying process.

Crawl spaces pose special problems. Vents should be installed if they are not present. If there is excess moisture or dampness, the pest control technician should postpone treatments until the soil dries. If a clump of soil squeezed in your hand retains its shape without flaking or falling apart, the soil is probably too wet. Remember, it is forbidden to apply termiticides into saturated or frozen soil.

If odors persist for more than a week, special procedures may be needed. Odor-masking or odor-eliminating products are available. These products are used during the termiticide application by adding them directly to the spray tank or at anytime following the completion of the application whenever odors linger. If odors continue to persist, there may be a more serious problem, and you may need to contact the local health department for advice.

Table 6-1. Number of years non-repellent termiticides remained effective in concrete slab tests at four sites plus the average of all sites, applying the EPA guidelines.

Product (active ingredient) (% a.i.) [Years in Trial]	Arizona	Florida	Mississippi	South Carolina	Average
Chlorfenapyr (Phantom) (0.125%) [10 years]	10	1	1	6	4.5
Chlorfenapyr (Phantom) (0.25%) [10 years]	10	10	2	5	6.8
Fipronil (Termidor 80WG) (0.06%) [12 years]	12	12	12	12	12
Fipronil (Termidor 80 WG) (0.125%) [12 years]	12	12	12	12	12
Fipronil (Termidor SC) (0.06%) [7 years]	7	6.5	7	7	6.9
Fipronil (Termidor SC) (0.125%) [7 years]	7	6.5	7	7	6.9
Imidacloprid (Premise 75) (0.05%) [14 years]	14	6	2	10	8
Imidacloprid (Premise 75) (0.1%) [14 years]	14	13	2	5	8.5

Conventional Termiticide Field Testing Summary

Remember from chapter 5 that the US Department of Agriculture Forest Service does liquid termiticide testing at 4 locations (Arizona, Florida, Mississippi and South Carolina). To evaluate the results, EPA guidelines are used. The guidelines require no termite penetration through the treated soil in any plot for at least five years before a termiticide will be registered.

The USDA Forest Service employs two methods for testing soil-applied liquid termiticides, the ground board test and the concrete slab test. Each test method is replicated 10 times at each of the 4 sites. The ground board test consists of a pine board centered in a 17x17-in. plot of exposed treated soil. The concrete slab test simulates a preconstruction treatment. It consists of a 17x17-in. plot of treated soil covered by a 21x21-in. concrete slab. A covered 4-in. pipe extends through the center of the concrete. The pipe contains a pine block placed on the treated soil.

In both tests, data are collected annually on the amount of damage to test blocks and the presence of termites and mud tubes in attacked plots. Damage is read using the Gulfport scale, where 0 = no damage, 1 = nibbles to surface etching, 2 = light damage with penetration, 3 = moderate damage, 4 = heavy damage and 5 = block failure.

The number of years that termiticides remained effective reported in tables 6-1 and 6-2 (pages 10 and 11) are for the concrete slab tests only. To remain effective, no damage to the board can occur.

Table 6-2. Number of years that repellent termiticides remained effective in concrete slab tests at four sites plus the average of all sites, applying the EPA guidelines.

Product (active ingredient) (% a.i.) [Years in Trial]	Arizona	Florida	Mississippi	South Carolina	Average
Bifenthrin (Biflex TC) (0.06%) [20 years]	16	20	7	10	13.3
Bifenthrin (Biflex TC) (0.125%) [20 years]	10	9	2	20	10.3
Cypermethrin (Demon TC) (0.25%) [24 years]	4	10.5	3	4	5.4
Cyermethrin (Demon TC) (0.5%) [24 years]	4	4.5	7	12	6.9
Permethrin (Dragnet) (0.5%) [28 years]	13	4	5	4.5	6.6
Permethrin (Dragnet) (1.0%) [28 years]	15	15	5	10.5	11.4
Permethrin (Torpedo) (0.5%) [26 years]	11	6	3	1.5	5.4
Permethrin (Torpedo) (1.0%) [26 years]	19	25	3	6.5	13.4

Chapter 7
Termite Baiting Technologies

Although chemical barrier treatments continue to be the most common procedure used for controlling subterranean termites, termite baiting is becoming more and more popular. The reliance on soil-applied termiticides, coupled with their potential for environmental contamination and possible health risks in sensitive environments, have generated interest in the development of alternative termite control technologies, including termite baits.

Termite baits are intended to injure the termite colony directly. The bait is an attractive food source for termites, but the location of the baits is found by termites through their normal food-searching activities. Unlike conventional soil-applied termiticides, the effect of baits is not immediate, and control may not occur for many months.

Recall from Chapter 2 that subterranean termites are social insects, and the colony members constantly groom each other. This grooming behavior spreads the bait's active ingredients throughout the colony. To be effective, the bait toxicant must be non-repellent and act slowly to allow plenty of time for termite workers to transfer it to the rest of the colony. Moreover, the bait toxicant must be attractive enough to ensure that termites will feed on it in spite of other competing food sources. By this process of transferring food from one colony member to another, it is expected that all termites in the colony will eventually receive enough bait to cause death.

Figure 7-1. Termite activity detected using wood to monitor for their presence.

Figure 7-2. Sentricon® bait in use.

Sentricon Colony Elimination System® (Dow AgroSciences). The Sentricon System uses one of two active ingredients. Recruit® II contains the IGR, hexaflumuron and Recruit III® contains the IGR noviflumuron. Recruit IV®, designed to replace Recruit III®, also contains noviflumuron. Recruit IV® offers more noviflumuron in each bait tube, and a new bait matrix in the form of cellulose briquettes. Both ingredients in the Sentricon System are similar to diflubenzuron (Exterra®), these chemicals interfere with termite molting. Inground stations are deployed around a structure at specific intervals. An aboveground station, Recruit AG, Recruit III AG or Recruit IV AG, is used in conjunction with the inground stations when termites are accessible within the structure. Use of the Sentricon® system requires manufacturer-sponsored training, and it is available only to selected commercial structural pest management professionals. Three steps are used in the Sentricon® system:

1.Termite Monitoring: The termite activity is detected by installing untreated monitoring stations around exterior perimeter of the building. The stations are installed at approximately 10-15 feet intervals and 12 to 18 inches away from the foundation. Sometimes the stations can be installed in locations that are conducive to termite activity. The stations are usually checked monthly.

2.Placing Baits: Once termites are detected, the untreated baits are replaced with baits containing either hexaflumuron or noviflumuron. The termites are carefully dislodged and placed in new treated bait stations so that they will resume feeding and reunite with their colony members. Bait stations are replaced as required until no further termite feeding is observed.

3. Follow-up Monitoring: The treated baits are replaced with untreated baits after assuring that no termite activity is detected. Subsequent monitoring is required to make sure that termites have been controlled. The monitoring intervals may be monthly/bimonthly in the beginning and three to four months later.

Nebraska Research: The University of Nebraska has used the Sentricon® system in both commercial and residential environments and has successfully controlled termites in both.

For more specific details about the product:
Phone: 1-800-686-6200
Web: http://www.Sentricon.com/

Hex-Pro™ Termite Baiting System (Dow Agrosciences). The Hex-Pro™ System contains the IGR hexaflumuron. Recall that the Sentricon™ system also contained this active ingredient. The Hex-Pro™ System differs from Sentricon™ in that Hex-Pro™ can be purchased by any licensed pest control professional. The same general steps that are followed for Sentricon™ are also followed when the Hex-Pro™ system is installed. 1. Termite Monitoring, 2. Placement of Baits, and 3. Follow-up Monitoring.

Figure 7-5. Hex-Pro® System.

Nebraska Research: No research has been conducted in Nebraska, however, the research done for Sentricon indicates that this product should perform very well in Nebraska.

For more information about the product:
Phone: 1-800-352-6776
Web: http://www.hex-prosystem.com/

Advance® Termite Bait System (Whitmire Micro-Gen). Advance® uses an inground monitoring-baiting system. The active ingredient in Advance® is diflubenzuron. Diflubenzuron is an insect growth regulator (IGR) that kills immature termites by interfering with the molting process. Adult termites, including reproductives and soldiers, are not affected directly because adults do not molt. When the pest control technician finds that termites are feeding in the "termite inspection cartridge" in the top of the station, the inspection cartridge is replaced with a bait cartridge containing diflubenzuron in a bait matrix.

Figure 7-3. Advance® promotional advertisement.

Nebraska Research: No research has been conducted in Nebraska.

For more information about the product:
Phone: 1-800-777-8570
Web: http://www.wmmg.com/

Exterra® Termite Interception and Baiting System (Ensystex, Inc.). Exterra® uses an inground monitoring-baiting system. The active ingredient in Exterra® is diflubenzuron (Labyrinth®). Diflubenzuron is an insect growth regulator (IGR) that kills immature termites by interfering with the molting process. Adult termites, including reproductives and soldiers, are not affected directly because adults do not molt. When the pest control technician finds that termites are feeding on the wood "interceptors" in the station, diflubenzuron-treated cellulosic bait matrix is inserted into the station. Based on Ensystex's research data, they presume that termite colony elimination may occur if immature workers are killed and foraging stops. Ultimately soldiers and reproductives will die from starvation because they are not fed by the workers. Exterra has been labeled for use around buildings that are under construction in place of a conventional soil applied treatment.

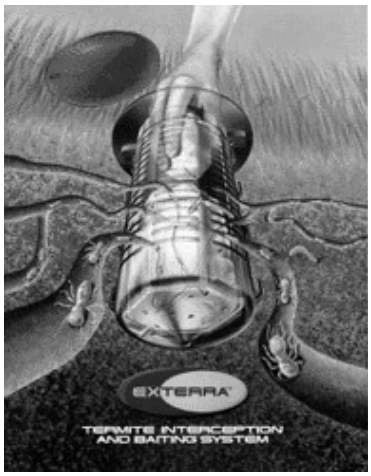


Figure 7-4. Exterra® promotional advertisement.

Nebraska Research: No research has been conducted in Nebraska. There is no research available to help understand the potential field performance of Labyrinth® to control subterranean termites.

For more information about the product:
Phone: 1-888-Exterra (398-3772)
Web: http://www.ensystex.com/

Subterfuge® Termite Bait (BASF Corporation). The bait Subterfuge® contains 0.3 percent of the active ingredient hydramethylnon, a chemical that interferes with energy production inside the insect. Hydramethylnon has a low toxicity to mammals but is highly toxic to fish and must not be used where it can be washed out of the bait stations into ponds, lakes or streams.

This system has not been well marketed by the manufacturer, BASF Corporation. Subterfuge Termite Bait® stations are placed directly in the ground in areas of known termite activity. It is intended to use as a supplemental or alternative to conventional methods for controlling termite infestations in and around buildings and wooden structures.

According to the label, Subterfuge® can also be used as a preventative treatment. BASF states that the bait matrix has been found to be a preferred food source,

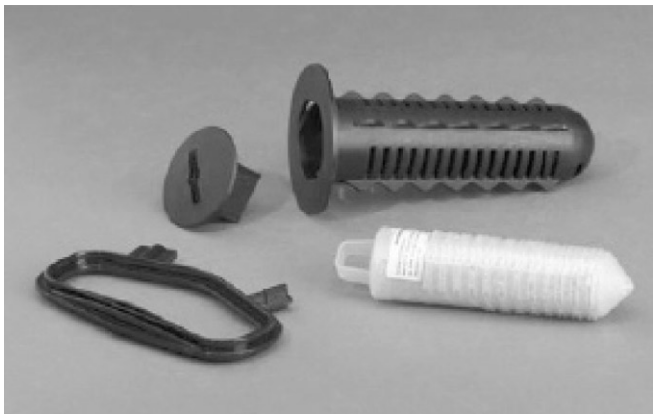


Figure 7-6. Subterfuge® bait station and bait tube.

and hydramethylnon has been shown to be effective in controlling communal or social insects. Continued feeding will result in population suppression and control. However, BASF makes no claims as to the effectiveness of the Subterfuge® Termite Bait and says that risks associated with its use shall be assumed by the user.

Nebraska Research: No research has been conducted in Nebraska, and there doesn't seem to be any independent research to determine the effectiveness of this product.

For more information about the product:
Phone: 1-800-545-9525

FirstLine® Termite Defense System (FMC Corporation). FirstLine® is a baiting system that uses two types of stations. Aboveground (AG) stations are applied directly to accessible active infestations. Inground stations (GT) are placed in areas of known or suspected termite activity. The active ingredient in FirstLine® is sulfluramid, a slow-acting stomach poison that interferes with termite cellular energy-production activities. The sulfluramid is incorporated into a cellulosic matrix. FMC has indicated that termite baits are one of the components of their Termite Defense System that includes inspection, moisture management, food source management, and selective use of liquid termiticides. There have been several field trials with limited results. So far, FirstLine® has not been shown to protect structures when used as a stand-alone treatment. FirstLine® should not be considered as a suitable replacement for conventional termiticides.

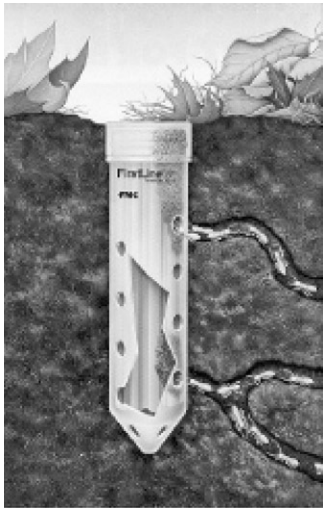


Figure 7-7. FirstLine® promotional advertisement.

Nebraska Research: Termite mortality occurs under laboratory conditions where there are no other food sources available. Laboratory data indicated that 100 percent termite death was observed in 14-15 days. In a field study, continuous feeding was recorded at 4 of 9 locations indicating that colony food-searching behavior was apparently not affected by the bait treatment. At times, there was some feeding avoidance, but with bait station adjustments, feeding resumed. Although FirstLine® appeared to reduce termite colony populations and termite damage, it cannot be concluded that the termites were controlled by using bait alone. The University of Nebraska Termite Research Project has not implemented the entire Systematic Termite Control Program as proposed by FMC in any of our research projects.

For more information about FirstLine®:
Phone: 1-800-321-1FMC
Web: http://www.fmc-apgspec.com/firstlin.htm

Consumer Bait Products. A "Do-It-Yourself" bait product has become available to homeowners: Spectracide's sulfluramid-based bait, **Terminate®**. Product labeling recommends that users have their homes inspected by a pest control professional, an approach widely seen as important to preventing termite problems. More importantly, according to the product labeling, Terminate® is not intended to be used in place of a liquid treatment when termites have been found to be infesting the house. Therefore, the University of Nebraska is not recommending the use of this product against termites by homeowners in Nebraska.

Fig. 7-8. Terminate® package.

Nebraska Research: No research has been conducted in Nebraska.

Bait-Barrier Combination Treatments

Some pest management professionals are applying combination treatments that use baits and barrier applications. A combination of barrier and bait treatments may be appropriate in some situations.

Be sure that your pest management professional has fully explained all possible approaches, including combining soil-applied termiticides and baits, if it seems appropriate. For example, if you have a known "hot spot" of termite activity in a basement window sill, you might choose to have a barrier treatment in that one location to have immediate impact on termites in that area. At the same time, baits may be installed to eventually achieve suppression or elimination of the termite colony.

Chapter 8
Understanding the Termiticide Label

University of Nebraska–Lincoln Extension recommends that you acquire a copy of the product label for any termiticide a business plans to use to treat your home. You should become familiar with how the product should be used. Knowing and understanding the information contained in termiticide labels will help during the termite control decision making process. Termiticide labels, like all pesticide labels, can be very complicated and sometimes difficult to understand.

Licensed Applicators

The following statement can be found on each soil applied termiticide label: "For use by individuals/firms licensed or registered by the state to apply termiticide products. States may have more restrictive requirements regarding qualifications of persons using this product. Consult the structural pest control regulatory agency of your state prior to use of this product." This statement means that the manufacturer intends that this product only be used by certified pesticide applicators with training and experience in structural pest control.

Precautions

All soil-applied termiticide labels contain consistent precautionary statements that are designed to protect residents, bystanders, and pets. When treating adjacent to an existing structure, the applicator is required to do several things. First, before the termiticides are applied, he/she must check for cracks and holes in the foundation to prevent leaks. Next, during the termiticide application, he/she is required to advise residents to remove pets and occupants if any leaks appear. Then, after the application is complete, he/she needs to check for leaks and clean up any spills or leaks that are found. Finally, if any leaks are found, he/she must prevent people and pets from entering the treated structure until clean up is completed.

Use Directions

The product *Directions for Use* contains suggestions for what the pesticide applicator "should" do and also contains the legal requirements for what the pesticide applicator "must" do. Some examples are listed below and discussed briefly.

Efficacy. Minimum application concentrations and volumes are defined on termiticide labels. In Nebraska, the applicator cannot legally use less than the label recommended preconstruction treatment concentration. Typically two application rates are listed on the label. The standard minimum rate and a higher rate for use where severe termite infestations occur. The higher rates may also be used in combination with half the volume when soils will not accept the volume required at the standard rate. In Nebraska, all termiticides MUST be applied at or above the minimum concentration stated on the label for preconstruction treatments.

Saturated or Frozen Soil. Termiticides must NEVER be placed into soil that is water saturated or frozen OR while precipitation is occurring. This is because the termiticide won't disperse properly under these conditions.

Wells or Cisterns. Applicators must be very careful around wells or cisterns. All precautions must be taken to avoid contaminating wells or cisterns. If the structure has a well or cistern inside, the applicator is required to remove any soil that is to be treated, apply the termiticide, and then replace the treated soil. If the structure is adjacent to a well, cistern or other body of water, then all precautions must be taken to limit contamination risks. If possible, all pipes coming from the well into the structure should be exposed before the termiticide application begins. The treated backfill technique is to be used whenever possible.

Plugging of Holes. All holes made during the termiticide treatment must be plugged with non-cellulose plugs or covered by a material that cannot be penetrated by the termiticide such as concrete patch.

Construction Workers. Before making a preconstruction application, the termiticide applicator is required to notify the contractor of the intended application sites AND advise workers to leave the area until the termiticide has absorbed into the soil.

Preconstruction Foundations. During preconstruction foundation applications, if the foundation is deeper than 4 feet, the termiticide can be applied as backfill is replaced, OR application can be done using the trench and rod technique, as for postconstruction applications.

Postconstruction Foundations. All postconstruction foundation applications of termiticide must be done using the trench and rod technique, to the top of footing, OR a minimum of 4 feet.

Postconstruction Treatment of Crawl Spaces. The treatment of crawl spaces depends on whether they are accessible or inaccessible. Accessible crawl

spaces are treated the same as foundations. Inaccessible crawl spaces are treated the same as with accessible crawl spaces if possible, OR a horizontal barrier can be applied to the soil surface. It may be necessary to drill through the foundation wall or through the floor above to accomplish the soil surface treatment.

Voids. The most common example of a void is the hollow block empty space that is created when the foundation wall is constructed. All voids in hollow block must be drilled into and treated. The termiticide applicator is required to clean up all leaks prior to leaving. Voids insulated with rigid foam are NOT to be treated because the termiticide will not disperse into the space properly.

Foam Treatments. Instructions for use of foaming agents are also included on the label. The proper dosage, dilution rates, and expansion ratios are given. Knowing this information, the termiticide applicator can make better, more effective foam applications.

Retreatments. Retreatments for both pre- and postconstruction termiticide applications can only be done if there is clear evidence of reinfestation or if the soil barrier has been disrupted and/or breakdown of the termiticide has occurred.

The label is the law. If you observe a termite treatment that is done contrary to the label directions, contact the Nebraska Department of Agriculture (402) 471-2394 to report the incident. It is against the law to apply pesticides contrary to the label.

Regulatory Perspective

The Nebraska Department of Agriculture (NDA) is charged by the Nebraska Pesticide Act with administration of pesticide regulations in the state. The Act allows the NDA to certify and license pesticide applicators, register pesticides for sale and use, and enforce application standards by people who use pesticides. The Act does not include language related to home/termite inspections or consumer protection, making it difficult to address these concerns when they relate to improperly applied termiticides.

A structural inspection that fails to identify a termite infestation, or one that incorrectly identifies a nonexistent infestation, is obviously a concern. Unfortunately, there are no laws in Nebraska that specifically deal with structural pest inspections. This is considered an unregulated industry, and the NDA is unable to get involved in disputes of erroneous pest inspection reports unless the situation involves an improperly applied pesticide.

The Federal and State pesticide laws derive their enforcement authority from what a pesticide label says. Both laws mandate that users of pesticides follow all label requirements, and that any deviation from those directions likely constitutes a violation of the law. For example, if a termiticide label indicates **what** a complete house treatment is, the customer contracts for a complete treatment. However, if the applicator of the termiticide fails to apply the termiticide following the directions for a complete treatment, the NDA has the authority to take enforcement action against the applicator for failure to follow all label directions. The NDA does not have the authority to determine issues related to a breach of contract (such as in the case where different prices are charged or the applicator fails to perform some function unrelated to the actual application of the termiticide).

Minimum Concentrations

All termiticide labels have concentrations listed on the label. The Nebraska Pesticide Act also stipulates that termiticides must be applied at least at the minimum concentration listed for preconstruction treatments, even for postconstruction applications. The consequences of applying a weaker concentration than the label minimum is that the structure may not be protected from foraging termites for very long, creating the need for retreatments more frequently than may be necessary.

What is a Complete Treatment?

The question of what is or is not considered a **complete** treatment is frequently asked. As of 2005, the NDA still enforces this concept based on what a termiticide label indicates is complete. If a termiticide label fails to specify what a **complete** treatment is, the NDA's position is that it includes, at a minimum, application of the termiticide in such a manner as to create a continuous barrier between the structure and the termites, including treatment of the structure's foundation and all other places where termites can enter the structure, such as crawl spaces, hollow steps, basement floors, and wall voids. The NDA is in the process of developing a written interpretation of termiticide terminology that will then be used as a technical guidance document for questions of this nature.

Termite bait systems also have federally approved and state registered labels that applicators must follow. To install and/or monitor bait stations in a manner contrary to the label is considered a violation of the Act.

Is Sole Use of Baits a "Complete" Treatment?

The NDA refers to the label for the bait system for this answer. If the bait system indicates that it can adequately be installed as a complete treatment, the applicator/installer of that system must comply with the product's warranty (that the product will protect the structure). However, most bait system labels are including disclaimers that the bait system should be used in concert with other conventionally applied termiticides to be considered a complete treatment.

What about retreatments?

Conventional liquid termiticides are required by Federal law to indicate that complete retreatment of the structure can only be done under certain circumstances. Unfortunately, these requirements fall short of fully

explaining the conditions under which a complete treatment can again be made. In Nebraska, the NDA has determined that complete retreatments can be made if clear evidence of termiticide failure is observed in a majority of the structure, and that the termiticide used for retreatment is of a different chemistry than the one that failed, unless the retreatment is part of a product warranty requiring retreatment with the same product. Again, this concern will be addressed in the technical interpretations being developed by the NDA (mentioned in the complete treatment section).

Mandatory Statements

The NDA can enforce and does enforce "mandatory" label language. Words such as "must", "shall", and "always" are mandatory in that they direct the user of the product to do or not to do something. The following are some examples of "mandatory" label language:

1. The dilute insecticidal emulsion ***must*** be adequately dispersed in the soil to ***establish a barrier*** between the wood and the termites in the soil.

2. The service technician ***must*** be familiar with current termite practices such as trenching, rodding, subslab inject, etc. These techniques ***must*** be correctly employed to control infestations by subterranean termites.

3. ***Do not*** apply at a lower dosage and/or concentration than specified for applications prior to the installation of the finished grade.

4. The applicator ***must*** trench and rod into the trench or trench along the foundation walls and around pillars and other foundation elements.

5. Trenches ***must*** be a minimum of 6 inches deep or to top of footing.

6. All holes in commonly occupied areas into which _____ has been applied ***must*** be plugged with a noncellulose material or covered with an impermeable cover.

7. Create a horizontal barrier ***wherever*** treated soil will be covered by a slab.

8. Vertical barriers ***must*** be established in areas such as around the base of foundations, plumbing, utility entrances, back-filled soil against foundation walls and other critical areas.

9. ***Provide thorough and continuous coverage*** of the area being treated.

10. Special care ***must*** be taken to distribute the treatment evenly.

11. Retreatment for subterranean termites ***can only*** be performed if there is clear evidence of reinfestation or disruption of the barrier due to construction, excavation, or landscaping and/or evidence of the breakdown of the termiticide barrier in the soil.

Optional Statements made on Termiticide Labels

The NDA is not able to enforce "optional" label language, such as "may", "should", or "recommend". This language is considered more of a guidance to the user and is often not enforceable unless the action is clearly an industry standard practice or obviously needed to perform a correct treatment. The following are some examples of "optional" label language:

1. Establish a treated barrier (horizontal and/or vertical ***as needed***).

2. _____ ***should*** be applied in a manner to provide a continuous chemical barrier to prevent termites from attacking the wood to be protected.

3. _____ ***should*** only be applied by licensed technicians familiar with trenching, rodding, short rodding, subslab injection, etc.

4. Horizontal barriers ***may*** be established in areas intended for covering such as floors, porches, etc.

5. Vertical barriers ***may/should*** be established around the base of foundations, plumbing, back-filled soil, etc.

6. Emulsion ***should*** be mixed with the soil as it is being replaced in the trench.

7. Application ***may*** be made by trenching and rodding into the trench or trenching.

8. When rodding from grade or from the bottom of a shallow trench, rod holes ***should*** be spaced in a manner that will allow for application of a continuous chemical barrier.

9. Treatments ***should*** include both sides of foundation and around all piers and pipes.

10. When rodding, rod holes ***should*** be spaced in a manner that will allow for a continuous chemical treated zone, not to exceed 12 inches.

11. Treatment ***may*** also be required beneath the slab along both sides of interior footing-supported walls.

12. To apply a treatment under the slab…it ***may*** be necessary to drill through the slab or exterior foundation.

13. ***May*** be treated to provide a continuous chemical treated zone in the voids at the footing.

Chapter 9
Are Termiticides Dangerous?

Since termiticides are used to kill living termites, they are hazardous to termites and closely related organisms. The toxicity of each termiticide is different and related to its unique chemical structure. Some termiticides can be very toxic to humans, but others are not very toxic at all. Most termiticides are considered to have low to moderate toxicity. Care must be taken to avoid exposure to you, your family, and your pets. It is best for the termiticide applicator to strategically place termiticides to reduce risk to you and your family.

What is Toxicity?

To do its job, a termiticide must control the termite. By their nature, termiticides are toxic and must be handled with care. You can tell the toxicity of a product by reading the signal word (**Table 9-1**) and looking at the symbol on the label. Termiticides can enter the human body three ways: 1) through the mouth (orally); 2) by absorption through the skin or eyes (dermally); and 3) by breathing into the lungs (inhalation).

Danger/Poison and a skull-and-cross-bones symbol appear on the labels of all products that are highly toxic orally, dermally, or by inhalation. There are only a few products approved for termite control that have this signal word on their label.

Warning is the signal word required on the labels of all products that are moderately toxic orally, dermally, or by inhalation, or that cause moderate eye and skin irritation.

Caution is the signal word required on the labels of all products considered slightly toxic to relatively nontoxic orally, dermally, or by inhalation, or that cause slight eye and skin irritation. All labels must bear the statement, "Keep out of reach of children."

Signal word: DANGER. If the termiticide label contains the **DANGER** signal word, the applicator is required to wear long-sleeved coveralls over a long-sleeved shirt and long pants, socks, chemical-resistant footwear and gloves, a respirator, and protective eyewear.

Signal word: WARNING. If the termiticide label contains the **WARNING** signal word, the applicator is required to wear long-sleeved coveralls over at least a short-sleeved shirt and short pants, socks, chemical-resistant footwear and gloves, and protective eyewear. A respirator is also required when handling termiticide concentrate or when working in a non-ventilated space.

Signal word: CAUTION. If the termiticide label contains the **CAUTION** signal word, the applicator is required to wear a long-sleeved shirt and long pants, socks, shoes, and chemical-resistant gloves. A respirator is also required when working in a non-ventilated space. Protective eyewear must be worn when working in a non-ventilated area or when rodding or sub-slab injecting termiticides.

Table 9-1. Termiticide label signal words and relative toxicities.

Signal Word	Toxicity	Oral Lethal Dose (Ave. Adult Human)
Danger/Poison	Highly Toxic	Few drops to 1 teaspoon
Warning	Moderately Toxic	1 teaspoon to 1 tablespoon
Caution	Low Toxicity	1 ounce to more than a pint

The idea of managing risk is expressed by the Risk Formula:

Risk = Toxicity x Exposure

Having an understanding of the toxicity of a product and the potential for personal exposure allows risk to be lowered. No matter how toxic a termiticide is, if the amount of exposure is kept low, risk can be held at an acceptably low level. The toxicity of a termiticide can't be changed, but risk can be managed, and you can help manage your risk.

Relative Termiticide Toxicities

There are other ways that allow you to compare termiticide toxicities. In the process of getting a label approved by the EPA, a pesticide manufacturer must determine the mammalian toxicity of the pesticide. Since companies cannot experiment on human beings, they use laboratory rodents to determine the lethal dose (LD) of the pesticide.

An oral LD50 is the amount of pure active ingredient (in milligrams/kilogram of the animal's body weight)

that results in 50 percent mortality to laboratory rodents when administered orally. From the results of many experiments, we can compare the LD50 of insecticides and other chemicals. Understanding what an LD50 means can be initially confusing. A highly toxic substance has a low LD50 because is takes a small amount of the substance to kill the test animal. Conversely, a less toxic compound has a higher LD50. The LD50 of each product is one piece of information that can be found on its Material Safety Data Sheet (MSDS). Unfortunately, there is no standardization in the chemical industry. Some MSDS sheets show the LD50 of the formulated product; others may give the LD50 of the pure active ingredient.

Table 9-2 can be used to compare the relative toxicities of some termiticides and other substances commonly found around the home. Please note the low LD50 of acetone (fingernail polish remover), one of the most dangerous products in the home. Remember that a low LD50 means high toxicity.

Cancer

The World Health Organization estimates that 75-85 percent of all cancers are related to environmental exposure to pollutants, smoking, and diet. It is understandable that many people are concerned about cancer risks of chemicals used inside the home. **Table 9-2** do not address cancer risks, but the results of carcinogenicity tests can sometimes be found on MSDS sheets. MSDS sheets are readily available for professional-use pesticides. Ask your pest control representative for a copy.

Table 9-2. This tables can be used to compare the relative toxicities of some termiticides and other substances commonly found around the home. LD50 is measured in mg/kg of a body weight. A low LD50 means high toxicity.

The LD50 (mg/kg of a body weight) of some substances found around the home.		
Substance	**LD50**	**Use**
absolute alcohol	10,600	veberage, preservative
ethylene glycol	8,540	antifreeze
vitamin A	7,910	vitamin
salt	3,750	food additive
aspirin	1,000	drug, pain
ibuprofen	626	drug, pain
caffeine	355	ingredient in coffee, colas
warfarin	323	rodenticide, anticoagulant
acetone	10.7	fingernail polish remover
nicotine	0.3	constituent in tobacco
LD50 OF SOME INSECTICIDAL SUBSTANCES		
Active Ingredient	**Oral LD50**	**Class**
diatomaceous earth	nontoxic	desiccant
M. anisopliae	>5,000	biological agent
hexaflumuron (Sentricon)	>5,000	insect growth regulator
permethrin (Dragnet)	>4,000	synthetic pyretroid
noviflumuron (Sentricon)	>3,160	insect growth regulator
sodium borate (BoriCare)	2,550	mineral
sulfuramid (FirstLine)	>500	fluoroaliphatic sulfonomide
imidacloprid (Premise)	424	chloronicotinyl
bifenthrin (Talstar)	375	synthetic pyrethroid
chlorpyrifos (Dursban^{TC})	135	organophosphate
fipronil (Termidor)	97	phenylpyrazole
cypermethrin	79	synthetic pyrethroid

Source: The Merck Index, 12th edition, 1996

What to do if a Termiticide Poisoning Occurs

Get medical advice quickly if unusual or unexplained symptoms appear during the application or later the same day. Insecticide poisoning symptoms are often similar to flu symptoms (headache, fatigue, dizziness, nausea, stomach cramps and diarrhea). A person who may have been poisoned should not be left alone. Do not let anyone get dangerously sick before calling a physician or going to a hospital. It is better to be too cautious than too late. Take the insecticide container (or the label) to the physician. The key is rapid treatment; as time continues to elapse after exposure, the chances for survival decrease.

If the common emergency telephone number is available in your area, immediately call 911 whenever an insecticide poisoning is suspected. Concurrently, the call may be connected to The Poison Center at Children's Memorial Hospital in Omaha. They will be able to provide specific directions on procedures to follow until emergency personnel arrive. If the common emergency telephone number is not available in your area, contact:

1. **The Poison Center, 1-800-222-1222**
2. **The nearest hospital**
3. **A physician**

Always wash exposed skin of the victim with a detergent and plenty of water. Skin irritation can result from continuous exposure if not treated. If clothing has been contaminated, particularly by an insecticide that is readily absorbed dermally, remove it immediately.

Even though termiticides are usually carefully applied, accidents can happen. Be prepared. Get a Hotlines Card (available from University of Nebraska–Lincoln Extension, EC-2501) and keep it with you at all times. Do not hesitate to contact medical authorities if any symptoms of termiticide poisoning occur. It is better to be safe than sorry.

Most of the chemicals used to control termites are much less toxic than some other insecticides used for other applications. When applied properly, they are unlikely to cause any problem for the homeowner.

Always Wear the Right Stuff!

Even though homeowners don't apply termiticides themselves, they do sometimes apply pesticides to their lawns, gardens, and inside their homes. For that reason, the information in this appendix has been included.

It is important for homeowners to protect themselves when applying pesticides. Minimizing exposure is an important first step toward reducing the risk of pesticide poisoning. The type of personal protective equipment or PPE needed depends on the toxicity of the pesticide being used and the formulation (i.e., liquid, wettable powder, etc.). Some labels specifically state that certain items of clothing, equipment, eye wear, footgear and gloves, must be used. Others carry no statement at all. In general, the more toxic the pesticide, the greater the need to use PPE.

Which PPE is Right?

Reasonable precautions should always be taken. Remember that liquid pesticides are often more hazardous to use than dry formulations and that extra protection is warranted while mixing or loading pesticides. Recognize that in cases where there will be prolonged exposure to the spray or where the application is being made indoors, you should use extra protection.

Protective Clothing. Any time you are using pesticides, you should wear at least a long-sleeved shirt and long-legged pants or coveralls (woven fabric) that fully cover your arms and legs. Select garments made of cotton instead of cotton/polyester blends. Shoes and socks should also be worn. Avoid sandals, thongs, and cloth or canvas shoes to minimize exposure of the feet to liquid pesticides. Leather shoes are suitable while using most pesticides.

Protect Your Head, Eyes & Hands. Protection for your head is advisable, especially if you will be applying pesticides over your head. In general, a wide-brimmed, easily cleaned hat that will keep pesticides away from the neck, eyes, mouth and face is adequate. Avoid hats with cloth or leather sweat bands as these will absorb pesticides. Baseball-style caps have hatbands that absorb and retain pesticides.

Pesticides are readily absorbed through the eyes and can cause eye damage. Use goggles or a face shield whenever such a statement is found on the label. Gloves are often needed for mixing, loading, and applying pesticides. Unlined, liquid-proof neoprene, butyl, PVC or nitrile gloves with tops that extend well up on the forearm are the best. Avoid lined gloves because the lining can absorb the chemicals and is hard to clean. Latex gloves, commonly used by medical personnel, do not provide adequate protection. Avoid cotton and leather gloves because they can also absorb pesticides. In most cases, wear gloves under the sleeves to keep the pesticide from running down

the sleeves and into the glove. When working with hands over your head, roll glove tops into a cuff, to deter pesticide from running down the gloves to your forearms.

Protect Your Lungs. The lungs and lining of the respiratory system readily absorb pesticide dusts and vapors from the air. Respiratory protection, therefore, is essential whenever the label calls for it. Respiratory protection is recommended during mixing and loading, even if not required by the label. A cartridge respirator is suitable when exposure will be intermittent.

Respirators used while applying pesticides should be approved by the National Institute of Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA). Be sure to read and follow the manufacturer's instructions for use and care of the respirator. Filters, cartridges, and canisters must be approved for pesticide use (those designated as removing and trapping organic vapors) and must be replaced at proper intervals. Inspect and test respirators before use, to insure a snug fit against the face. Exposed parts of the mask must be cleaned after each use, and the cartridges should be stored in an airtight container.

Protective Clothing Care

When working with pesticides, you should wear clean clothing daily. It is best to reserve one set of clothing for pesticide work if possible. Launder and store pesticide contaminated clothing separately. Clothing that becomes wet from pesticides should be removed immediately! Fast action will reduce your exposure to the pesticide. Destroy clothing (including shoes and boots) saturated with concentrated pesticides. Waterproof and chemical-resistant hats, gloves, boots, and goggles should also be washed daily and hung to dry. Test gloves for leaks by filling them with water and gently squeezing.

Wash Up!

Good personal hygiene is essential. Soap and water is cheap insurance against pesticide contamination. Wash your hands and face often when working with pesticides. Never smoke, eat, drink, or use the toilet after handling pesticides without first washing your hands! Shower immediately after using pesticides and before changing into clean clothes.

Pesticide Handling, Storage and Disposal

Pesticides are valuable pest management tools, and like any tool, they must be used carefully and responsibly. Read the label to determine the best way to handle pesticides.

Even when proper procedures are followed, pesticide spills can occur. Knowing what steps to take in the event of an pesticide spill will allow you to respond quickly and properly. Once the spill has been cleaned up, you should read the label for additional directions. Remember, always wear proper protective clothing when dealing with pesticide spills and to clean up your equipment and clothing when you are finished.

As soon as pesticides arrive on your property, store them in a locked and posted cabinet where children cannot get to them. Pesticides should never be stored in a garage, basement, or other unlocked locations in your home. Read the label for correct storage procedures.

Proper rinsing of pesticide containers reduces a potential source of pollution of soil, surface and ground water. When pollution occurs, plants and animals may be harmed and water supplies affected. Prevention of environmental pollution is always better and less expensive than cleanup.

When an empty liquid pesticide container is disposed of according to label directions, it must be properly rinsed. We recommend triple-rinsing plastic and non-pressurized metal containers that have contained liquid or wettable powder formulations. For empty aerosol, bait or dust containers, follow label directions for proper disposal.

Chapter 10
Economics of Termite Control

Properly done termite treatments are expensive. How can you make sure you're getting the most for your money? In this chapter, we will give you some tips about how to make the best possible decision to protect your home.

Choosing a Pest Control Company

It is important to resist the tendency to panic and make decisions too quickly before you have all the facts at hand. Too often, people panic when confronted by high pressure scare tactics of some pest control sales personnel. As in other businesses, pest control "salespeople" receive bonuses and sales commissions for bringing additional business to the pest control company. The first step is to resist any high pressure sales and take some time to understand all your options.

There are differences in termite bids and treatments. One of the most bewildering experiences is when there are hundreds of dollars difference between bids from different companies. The company with the lowest bid may be cutting corners to give you that low bid. Clients often report that nationally known companies bid the highest. This shouldn't be surprising because there are higher costs associated with owning a franchise. You need to be critical about what you are told, read as much as you can, filter through all the information, and do your best to make a final decision about treatments. It is also your responsibility to watch the pest control personnel do the treatment. They will be less likely to cut corners if you ask questions and watch them work.

In Nebraska, termites work slowly and are most active from about April through October. Spend a significant amount of time, at least several weeks gathering information. The time that you spend gathering information could save you hundreds of dollars and/or get you a better treatment.

You will need to have your house inspected. Once termites or termite damage is found, some inspectors may not thoroughly look for other infestations or damage. The inspector may move directly into a selling mode, figuring that this is his best shot at making his sale. This first inspection is very important, and the inspector needs to thoroughly inspect your home, looking for evidence of termites, termite damage, and structural problems that might complicate a treatment.

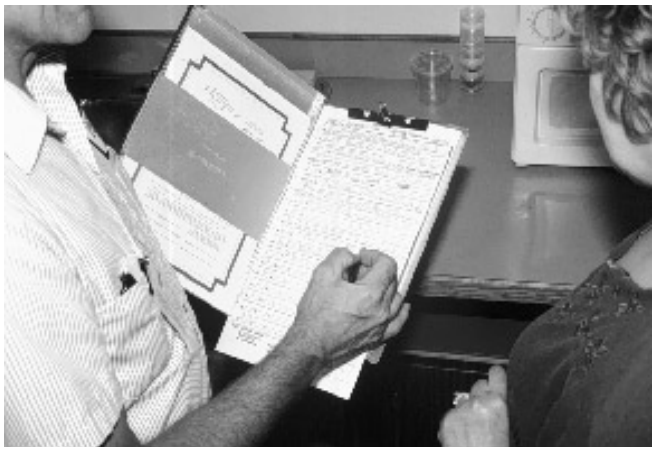


Figure 10-1. Choose a pest control professional that you trust to work with.

Information Gathering

Next, you will need to gather information to help you decide whether or not to treat your home and, if you decide to have it treated, what pest control company to hire. Before making any decisions, you need to do the following: 1) find out if there are live termites doing damage to the structure, 2) understand how each company will treat your situation, 3) investigate the knowledge, ability and experience of the person(s) who will actually do the application, and 4) determine whether the bids are reasonable, based on the size of your house. In addition, you will want to work with a company that has built a good reputation and has insurance in case there are any problems with the treatment.

Inspection. Arrange to have 4 - 5 professional pest companies inspect the structure and estimate the cost of the termite treatment. Request that all bids be put in writing and detail all aspects of the treatment. Make sure you have answers to the following questions and those on the next page:

1. Were live termites found? Where?
2. How extensive is the damage?
3. Is the damage old or new?
4. Is there evidence of a previous treatment? Is there anyway to determine when the treatment was done?
5. How much damage is evident? (Because damage is often hidden, further investigation may be needed beyond the capabilities of the pest control company. You may need to hire of a structural engineer to assess the full amount of damage to the structure.)

The answers to these questions may help you decide whether or not to have a termite treatment done or whether a partial or full treatment is needed. We generally recommend treating the structure only if termites are found inside the house. However, you should understand that evidence of termites and damaged wood can be in inaccessible areas that make it difficult or impossible to detect. There will be a clause on the inspection form that releases the inspector from finding termites or termite damage in hidden locations.

We generally don't recommend using a barrier as a preventative treatment. Some situations make treating the structure questionable. For example:

- If live termites are found in the yard (mulch or a stump) or the neighbor's house or garage, it does not make sense to treat. Instead, we recommend regular termite inspections.
- If damage is present, but there are no signs of an active infestation, it would be wise to have the entire structure inspected during the summer when termites are most active.
- If termites are present and it is evident that the structure was previously treated, you should try to find out when the treatment was done and whether it was chlordane. Prior to 1988, chlordane was the most widely used barrier treatment. Since chlordane was so long lived, a chlordane barrier may still be effective. It is wise not to interfere with a chlordane barrier unless active termites are in the structure. Then, only a partial treatment might be needed. Again, a complete inspection is needed to evaluate the situation.

Inspections most likely to find termites should take place from May–September. During the winter, termites often abandon their infestation because of the difficulty crossing the frost barrier.

Treatment Timing. In the case of a real estate transaction, it is the lending institution that requires a termite inspection of the property. The lending institution wants to make sure termites are not devaluing the home in case the owner defaults on the loan. It is also prudent for persons who purchase properties without borrowing money from a lending institution to have the property inspected for termites.

If termites are found during the course of a real estate inspection, the lending institution will probably require the property be treated before they lend money for its purchase. This can be a problem if the soil is frozen or saturated because a person who injects termiticide into the soil will be in violation of the label. Usually, the pest control company will treat the interior of the structure and wait on the exterior injection until soil conditions are appropriate. Although the terms of each real estate transaction vary, typically the person buying the property pays for the termite inspection, and the owner of the property pays for the treatment.

If termites or termite damage are found during the fall or winter, treatment (both chemical barrier and bait) can often be deferred until spring without having much more damage occur. This is because, in many infestations, termites must cross the frost barrier to gain entry into the structure. However, when termites enter a structure below the frost line, they can continue to feed and be active throughout the year even in the wintertime. In these cases, some treatment to prevent entry may be needed.

The Bidding Process. To discriminate between companies, ask each company to describe in detail the precise procedures that will be taken to treat the structure. Make sure they have answered the following questions:

1. What chemical will be used? What application rate (volume of diluted chemical) and concentration (percentage) will be applied? What pump pressure will be used? Current research as determined a slow rate of application (<25 psi) will be best. Ask for a copy of the termiticide label(s) that will be used.
2. Where will the chemical be applied? How deep around the basement?
3. How and where will holes be drilled to incorporate the chemical?
4. What special techniques will be used in areas where floor covering is present?
5. How will inaccessible areas and/or voids be treated?
6. How will the injection points (holes) be sealed?

The instructions for properly applying termiticides are given on all termiticide labels. You will need to compare answers to the questions, above, with the label to make sure that the company is using the proper technique to give the best treatment. In our experience, mistreatment occurs with one or more of the following scenarios:

A. **The termiticide is not concentrated enough.** If the insecticide is diluted with too much water, there may be too little insecticide to be effective. A recent change in the Nebraska law sets a minimum concentration for termiticide applications to existing structures. This minimum is the same concentration given on the termiticide label for preconstruction applications. For best protection, extension recommends that the maximum concentration allowed on the label be used for repellent termiticides. For non-repellent termiticides, the lower concentration will be adequate.

B. **The volume of termiticide is too low.** The volume of the chemical needed to give an adequate barrier is specifically given on the label (usually 4 gallons per 10 linear feet per foot of depth). If this volume used is less than given on the label, it will difficult, even impossible, to get a barrier with no gaps in it. It may be a violation of the label for a termite control company to use less volume than is given on the label.

C. **The barrier around a basement foundation is not deep enough.** According to recent changes on the label, the termiticide must be injected four feet deep or to the

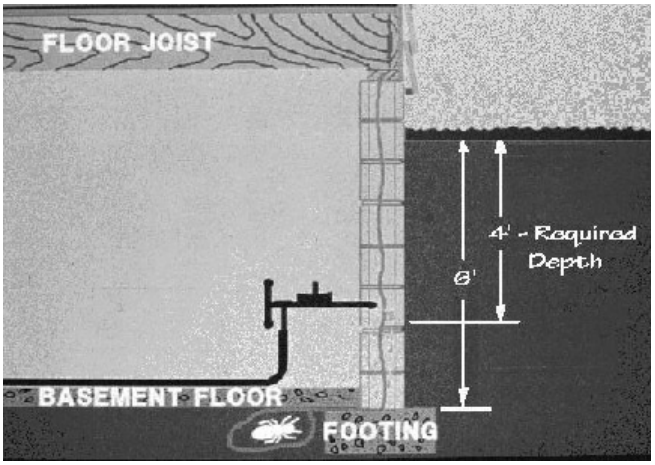


Figure 10-2. For best protection, the termiticide should be injected to the basement footings.

basement footings, which ever is less. Termiticide injected only four feet deep may not completely protect a home that has a deep basement because termites can go under the chemical. For best protection, extension recommends that the termiticide be injected to the basement footings.

D. **Injection holes are not spaced closely enough together to provide an overlapping barrier.** Some termiticide label directions are quite specific as to the distance injection holes should be spaced (i.e., Termidor), but others give a wide choice to the pest control professional as to what spacing should be used.

E. **Trenching is not done.** (See Chapter 6). The termiticide labels are quite specific in requiring trenching and rodding, but trenching is a time-consuming process. Some pest control technicians may completely omit the trenching procedure, which will give a more complete barrier treatment.

Environmental and Safety Concerns. You also need to ask what application methods will be practiced to insure a safe treatment for your family.

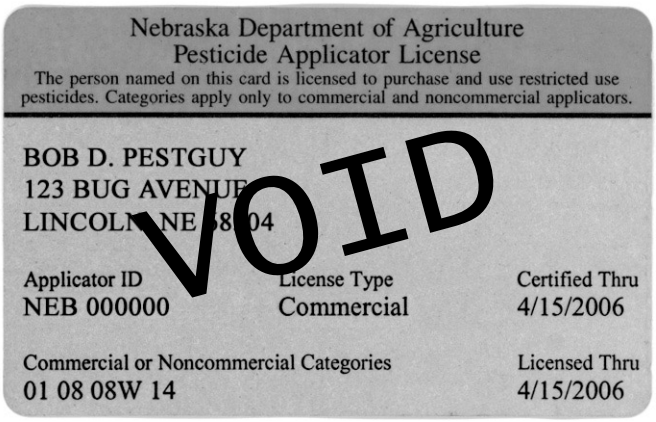
When the termiticide is being injected outside around the basement perimeter, will a second pest control technician be in the basement to make sure the chemical is not running through the foundation walls? This does not happen often but can. EPA regulations (1997) state that people present in the structure must be notified in the event of accidental leakage, and, after the application, the applicator is required to check for leaks. The label requires the termite control technicians to clean up areas if the chemical was left in areas other than that prescribed on the label before they leave the application site. In addition, all drill holes must be plugged after treatment.

Be wary of a company that says that it will be too dangerous for you to be at home during the termite treatment. With proper protective clothing, it should not be too dangerous for you to watch and observe the treatment.

References and Qualifications. Ask the pest control company for several references. Ask for the names of persons who have had a treatment by the company done within the last year. Call the references but understand that the company would not give you names of references if they thought there was a problem. Also, call the Better Business Bureau. The BBB will not make recommendations, but they can tell you if there have been any unresolved complaints against a specific company. When checking with the BBB, you should remember the pest control business is one that can tends to generate complaints, and most companies will try hard to resolve a problem to remove a complaint. Find out what type of insurance the company has. Liability insurance will cover accidents if you should sue the company.

What are the qualifications of the persons actually doing the treatment? Many times, the person who represents the company in the inspection and bidding process is not the same person who will be doing the treatment. All other things being equal, the most important factor is the competency of the person(s) who are actually doing the treatment because the placement of the insecticide is critical for the treatment success. How long has this person been in the pest control business? How many termite treatments has he/she done?

Persons in Nebraska doing termiticide applications for hire must be licensed by the Nebraska Department of Agriculture (NDA) which means that they are trained and have passed an examination. All licensed individuals have received a green and red card and must carry it when doing applications. You should feel free to ask to see their card.


Nebraska Department of Agriculture
Pesticide Applicator License
The person named on this card is licensed to purchase and use restricted use pesticides. Categories apply only to commercial and noncommercial applicators.

BOB D. PESTGUY
123 BUG AVENUE
LINCOLN, NE 68504

VOID

Applicator ID	License Type	Certified Thru
NEB 000000	Commercial	4/15/2006

Commercial or Noncommercial Categories	Licensed Thru
01 08 08W 14	4/15/2006

There is an exception to this rule. A person can work under the "direction supervision" of a licensed individual for 60 days before he/she needs to become licensed. This is called the "60-Day Rule". This special provision allows for an unlicensed applicator to be in-training while he/she is studying to take the test. Each person working under the 60-Day Rule, must submit an application form to NDA within 10 days of the first pesticide use. The name and license number of the supervising pesticide applicator must be given on the application form.

Before any treatment is done, you should ask to see the licensee's card. If the person does not have a card, this could indicate that the person hasn't had much experience doing termite treatments, and you should be concerned. Before any application begins, contact the Nebraska Department of Agriculture Pesticide Program at (402) 471-2394 to make sure the person has submitted the application form to legally apply pesticides under the 60-day rule.

If the 60-day application form has been submitted, you may still want to express your concern to the pest control company about an inexperienced person treating your house. If the Department of Agriculture has not received a 60-day application form from this individual, then this person may be in violation of Nebraska's Pesticide Law. Either way, you may feel better if his/her direct supervisor is present during the application.

Why Does It Cost So Much?

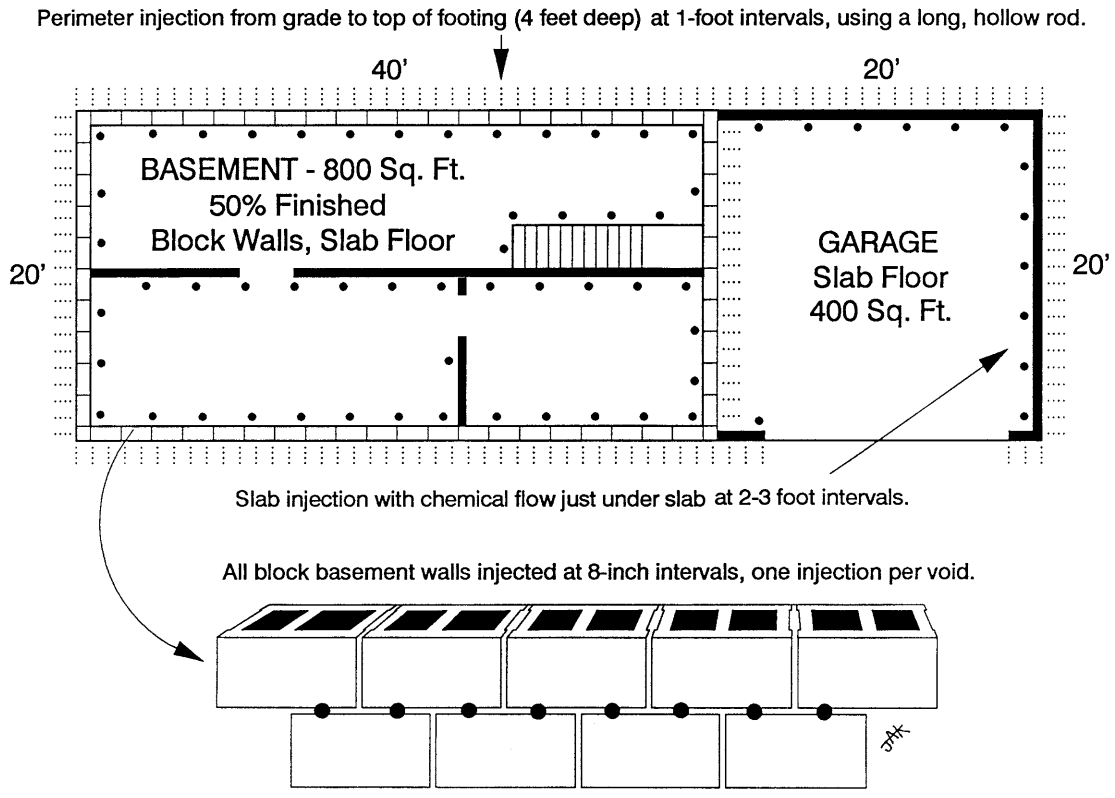
The strategy of a barrier treatment is to establish a continuous insecticide barrier between the colony in the soil and the wood in the home. To properly treat a house, insecticides must be applied in the soil around the foundation. In addition, insecticides must be injected into the soil, into hollow block walls, and under basement and garage floor slabs. Since proper treatment includes the use of specialized equipment and large quantities of diluted insecticide, we don't recommend that an untrained homeowner attempt a termite treatment.

Termite infestations often cause much consternation because treatment is expensive. Homeowners ask, "Why does it cost so much?" The rest of this section will attempt to answer this question.

To look at differences between chemical costs, we will examine four different registered chemicals commonly used in termite treatments. To estimate the cost of the insecticide, we will be using the most appropriate labeled volume, concentration (i.e., how much insecticide is added to the water), and the depth of placement based on proper application techniques used for termite treatments of each chemical used in the examples. Although a similar exercise can be done for preconstruction treatment, our example will use a preexisting home with a basement, four feet into grade, and an attached two-car garage built on a concrete slab.

The cost of a termite treatment includes the expense of the insecticide used, labor, equipment, and other costs. To calculate the cost of insecticides, we must first determine the total amount of diluted insecticide that should be used.

Example House with Basement, 4' into grade, and an attached two-car garage



Traditional Complete Treatment

	DILUTED LIQUID OUR HOUSE:	DILUTED LIQUID YOUR HOUSE
HOUSE:		
Basement perimeter: 120 linear ft of trenching/rodding, 4 ft deep (includes common garage wall)		
Labeled rate=0.4 gallons/linear ft/ foot of depth		
Our rate=0.4 gallons/linear ft/ft depth x 120 linear ft x 4 ft depth =	192 gal.	_____
Block treatment: 120 linear ft.		
Rate=0.2 gallons/linear. ft x 120 ft. =	24 gal.	_____
Basement slab: 180 linear ft		
Rate= 0.4 gal/lin. ft x 180 ft. =	72 gal.	_____
GARAGE:		
Slab: 50 linear ft (do not include door space or common wall)		
Rate= 0.4 gal/linear ft x 50 ft. =	20 gal.	_____
Perimeter: 50 linear ft. (do not include door space), 1 ft deep		
Rate= 0.4 gal./linear ft x 50 ft. =	20 gal.	_____
Total insecticide needed, based on the label directions	328 gal.	_____

Perimeter Only Treatment (Termidor 80WG amd Termidor SC)

	DILUTED LIQUID OUR HOUSE:	DILUTED LIQUID YOUR HOUSE:
HOUSE:		
Basement perimeter: 120 linear ft of trenching/rodding, 4 ft deep (includes common garage wall)		
Labeled rate=0.4 gallons/linear ft/ foot of depth		
Our rate=0.4 gallons/linear ft/ft depth x 120 linear ft x 4 ft depth =	192 gal.	_____
GARAGE:		
Perimeter: 50 linear ft. (do not include door space), 1 ft deep		
Rate= 0.4 gal./linear ft x 50 ft. =	20 gal.	_____
Total insecticide needed, based on the label directions	212 gal.	_____

35% less chemical used if pest control company and owner agree that a perimeter-only treatment is needed.

Cost of representative termiticides needed for the previous example as of April 2005:

Repellent Products:

Studies show that, as the concentration of repellent termiticides decreases in the soil over time, repellent products lose their effectiveness over time. This may result in termites penetrating the barrier and re-infesting structures. Repellent products do not adversely affect the colony. For maximum long-term effectiveness, we recommend using the highest labeled rates for repellent products. For effectiveness data of repellent products, refer to Table 6.2, Chapter 6, page 31.

bifenthrin (Talstar One™)
Labeled dilution range: 0.06% - 0.12%
Lowest dilution rate: 0.06% = 0.75 gal Talstar One + 99.25 gal water = 100 gal diluted Talstar
Pest control company cost for 0.75 gal Talstar One = $121.00
Total cost at the 0.06% dilution: **328 gal. x $121/100 gallons = $396.88**

Increase the concentration to 0.12% and the cost of the termiticide in our example is $793.76
We do not recommend the use of repellent termiticides like Talstar One as a perimeter-only product.

permethrin (for example, Permethrin TC®)
Labeled dilution range: 0.05 - 0.10%
Lowest label dilution: (0.05%) = 1.25 gal + 98.75 gal water = 100 gal diluted Permethrin TC®
Pest control company cost for 1.25 gallon jug Permethrin TC: $92
Total cost at the 0.05% dilution: **328 gal. x $92/100 gallons = $301.76**

Increase the concentration to 0.10% and the cost of the termiticide in our example is $603.52
We do not recommend the use of repellent termiticides like Permethrin TC as a perimeter-only product.

Non-Repellent Products:

Studies have shown that, as the concentration of non-repellent termiticides decreases in the soil over time, non-repellent products do better in maintaining their effectiveness than repellent products. Because termites cannot detect presence of non-repellent products, termite may transfer termiticide to colony mates adversely affecting the vitality of the colony. In most situations, a complete treatment using lowest dilution rates will adequately protect the structure. For effectiveness data of non-repellent products, refer to Table 6.1, Chapter 6, page 10.

fipronil (Termidor® SC)
Labeled dilution range: 0.06 - 0.12%, but studies show 0.06% is effective for use in most applications.
Lowest dilution: 0.06% = 78 oz + 99.25 gallons water =100 gallons diluted Termidor® SC
Pest control company cost for 78 oz Termidor SC = $163
Total cost of complete barrier treatment at 0.06% dilution: **328 gallons x $163/100 gallons = $534.64**
Total cost of perimeter only treatment at 0.06% dilution: **212 gallons x $163/100 gallons = $345.56**

fipronil (Termidor® 80 WG)
Labeled dilution range: 0.06 - 0.12%, but studies show 0.06% is effective for use in most applications.
Lowest dilution: 0.06% = 4-2.6 oz packs + 100 gallons water = 100 gal diluted Termidor® WG
Pest control company cost for 4-2.6 oz packs Termidor® 80 WG = $160
Total cost of complete barrier treatment at 0.06% dilution: **328 gallons x $160/100 gallons = $524.80**
Total cost of perimeter only treatment at 0.06% dilution: **212 gallons x $160/100 gallons = $339.20**

imidacloprid (Premise® 75)
Labeled dilution range: 0.05 - 0.10%
Lowest labeled dilution (0.05%) = 4-2.25 oz packets + 100 gallons water = 100 gallons diluted Premise 75
Pest control company cost for 2-2.25 oz packets = $136
Total cost for complete barrier treatment at 0.06% dilution: **328 gallons x $136/100 gallons = $446.08**
As of May 2005, Premise® 75 is not labeled as a perimeter only product.

Labor. What is the approximate labor costs in our hypothetical example? For this treatment, we estimate the time requirement for two applicators to be 10-12 hours. This hour requirement is based on the time it takes to drill holes, the quantity of liquid that must be injected, sealing of the holes, and any other "finishing" work that must be done. The total bid price also will include cost and upkeep of the equipment used, safety equipment, and overhead, and profit for the pest control company. In addition, reputable pest control companies carry liability and other insurance policies that are a significant expense. We believe that for most companies, the costs associated with labor, equipment, overhead, and insurance will be greater than the cost of the insecticide for a typical treatment with a basement. We have calculated a realistic estimate for this treatment to be $1500-$1800. Since many houses are larger than this small house example, estimates for termite treatments can easily be $3,000 or more.

Why are there variations in the bids for termite treatments? While some costs will be similar, especially when the same chemical is used by different companies, there can be variations in hourly rates paid to workers, variable insurance rates, and various overhead costs. Large companies may also get volume discounts on chemicals that smaller companies cannot get. What happens if the bid you get is lower than the cost of the chemical that should be used? A very low bid suggests that a company may not be applying the labeled insecticide rate (i.e., volume) for proper treatment or that the chemical may be diluted with too much water. Both of these situations can reduce the effectiveness of the treatment. Conversely, very high bids do not insure a "better" termite treatment. Differences in the sizes of the home and their structural oddities will result in different insecticide amounts and labor requirements for each termite job.

In our example, we have described how a complete barrier treatment should be done. Some termiticide applications require more labor than others because the label requires injections to be no more than 12-inches apart. For example, the Termidor label requires 12-inch rodding which may increase the cost of labor by 50 percent compared with other termiticides that allow 18-24-inch injections. To make Termidor more competitive with other termiticide products, some companies are proposing to do an exterior-only treatment, which would save them labor and some cost of the termiticide. Homeowners should understand what the treatment includes before making a final decision.

It has been suggested that an exterior-only treatment using non-repellent termiticides may be as effective as a complete exterior and interior treatment using either a repellent or non-repellent termiticide. Several university termite researchers are conducting exterior-only treatment experiments using the non-repellent termiticides fipronil (Termidor) and imidacloprid (Premise). Although the results are generally positive, only three years of research has been conducted and it is not known what the ultimate length of protection will be with exterior-only treatments.

One researcher, Dr. Roger Gold, Texas A & M University reported that exterior-only treatments using fipronil (Termidor) did not stop termite feeding when termites had entered the structure through the center of the house (bath trap area) prior to the treatment being applied. This was presumably because the termites did not encounter the exterior chemical barrier. These results suggest that a partial treatment leaves various points of termite entry unprotected. Because of this and the difficulty in detecting all points of termite entry, we recommend a complete barrier treatment, (exterior perimeter and interior) for the best protection of your home.

Making Decisions

This is the toughest part. You can sift through all the information and hire a company to do the treatment and still end up with a problem situation that might not be the company's fault. Sometimes structural problems or environmental problems exist that make a good treatment difficult or impossible.

Making sure it gets done right. How do you ensure that the maximum concentration will be used, and that the chemical will be injected deeply enough? The only way to know for sure is to be at home during the treatment, watch, and take notes. You might also have a loaded camera ready in case something doesn't seem right. Ask questions. How large is the insecticide tank, for example? Observe how many times it is filled during the course of an application. This will tell you how much volume of chemical is used. How many gallons/packets of concentrated insecticide are added to each full tank? This will tell you the concentration that is being used. On each termiticide label, there is a table that tells the applicator how much insecticide to add to a specific amount of water for the exact concentration level. Get a copy of the label to verify the concentration being used.

Warranties. Before you sign anything, be sure to read the fine print. Most of us believe that a warranty is guaranteeing a quality of work or workmanship. In the case of termite treatments, you can think of a warranty as being similar to termite insurance. The company may offer a warranty for a year. After that, you will need to pay an annual inspection fee that is typically 1/10 of the cost of a treatment. If termites are found during the time you are under warranty, the company will retreat in the area where termites were found (this is called a spot treatment). They will not completely retreat your home because it is assumed that the treatment was done correctly, but there is an inadvertent break in the barrier to allow termites entry to the house. In many cases, a warranty is void after a certain number of years. Whether or not you choose to

carry a warranty depends on how much risk you wish to assume.

Insurance. We have heard about companies that say they are offering termite insurance, usually to the buyer of a home after a clean inspection for a real estate transaction. Often this "termite insurance" seems reasonably priced. What will happen if you get termites? Will you get a complete barrier treatment, or will the company only do a spot treatment in the area where the termites have been found? A spot treatment may be of little value because the termites could enter the structure somewhere else. If you decide to invest in termite insurance, make sure that a complete treatment (either chemical barrier or bait) will be given to you. Otherwise, the insurance is of little value.

Economics of Bait Treatments

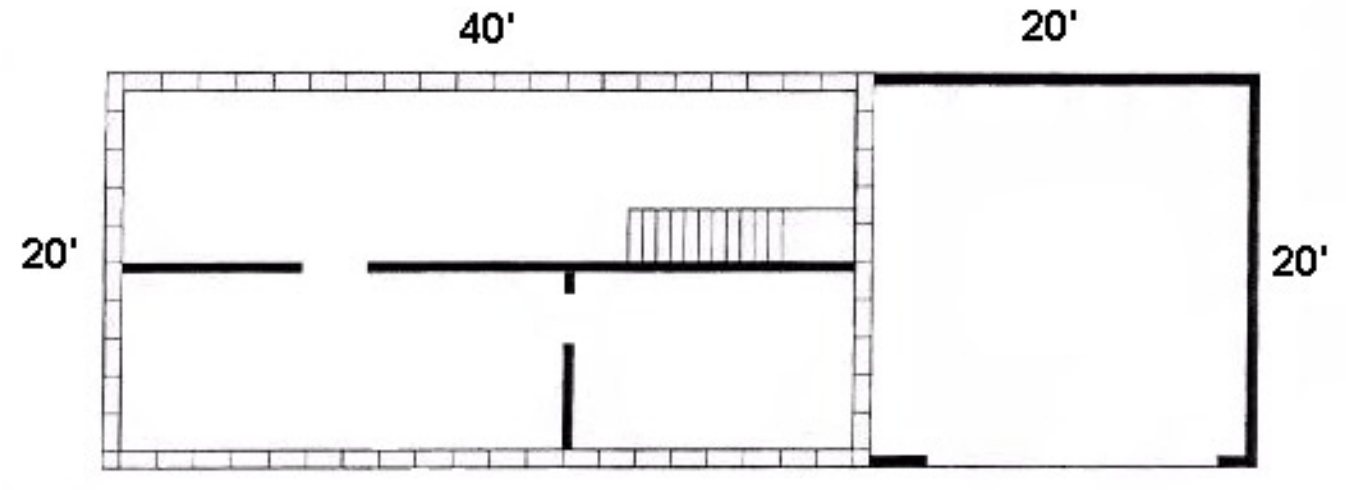
Bait treatments often cost as much as barrier treatments do. Why does a bait treatment cost so much? Obviously, there isn't the high cost of chemicals, but the users of this new technology are paying for the research and development costs that the manufacturer had with the bait. The pest control company also has a large investment in training employees to learn how to use the bait. Someone must check the bait stations and install the baits on an ongoing basis. A sophisticated computer system may be used to keep track of all the bait stations and record information.

According to recent information from pest control companies, the cost of bait treatments is about $9–$10 per linear foot. Multiply $10 by the perimeter of your house and that will be a good guess as to what a bait treatment will cost you. This cost will approximate the cost of a well-done chemical treatment. As time passes and there are more bait products competing for the market, the price could go down.

Warranties/Insurance of Bait Treatments. Regardless of the claims made by the manufacturer, there is no guarantee that the termite colony will be eliminated when baits are used. A problem with bait treatments is that a homeowner could spend thousands of dollars and if the termites do not feed on the wood or bait in the bait stations, the colony is not eliminated nor is the house protected. You should ask each company what you have paid for in the event that termites don't feed on the wood or bait in the bait stations.

Some companies may offer a warranty against future damage to your home. The problem with this type of warranty is proving when the damage occurred. It is possible to determine future damage only if you can document the extent of existing damage. With the exception of a newly constructed house, it is nearly impossible to prove when the damage occurred. Collecting on this type of warranty would be difficult. Be cautious.

	ESTIMATED COST OUR HOUSE:	ESTIMATED COST YOUR HOUSE:
Perimeter: 160 linear ft		
Common estimate: 160 x $10/linear ft =	$1600	_____



Total Perimeter = (40+20) + (40+20) + 20 + 20
= 160'

Summary

Termite treatments are expensive, and when done properly, the cost is justified because of the significant cost of chemical or bait, equipment, labor, and expertise to do the job right. The difference between a good treatment and a poor one is often the persons who actually do the treatment. When choosing a pest control company ask about the qualifications and experience of the persons who will do the treatment.

Baits or Barriers?

The treatment you choose depends on your situation.

Buildings that have a history of frequent reinfestation or have structural oddities that interfere with the successful implementation of a conventional termiticide barrier application are the best candidates for a bait treatment.

Homeowners who are strongly opposed to having floors drilled or who are strongly opposed to the use of pesticides might be happier with a bait treatment. Although conventional termiticide barrier applications pose no significant hazard to humans, pets or the environment, some individuals are still apprehensive about this approach.

Homeowners on limited budgets may find the cost of conventional barrier treatments less expensive than bait treatments.

Homeowners with a serious termite infestation or those involved in a real estate transaction may be better candidates for the application of a termiticide barrier.

People living in attached housing like condos or townhouses where the entire structure cannot be treated might be smarter to choose the conventional termiticide barrier approach.

Even though there is an over-the-counter bait product available, we recommend that homeowners work with a competent pest control professional if they have termite problems.

Which approach is best?

Barrier Termiticides

Advantages:

- May be less expensive
- Application method well understood
- "Tried and true"
- Control may be faster, an important consideration in real estate transactions

Disadvantages:

- More disruptive and intrusive
- Higher risk from some chemicals
- Termiticides sometimes break down rapidly in soil
- Barriers may fail
- Termiticides must be applied carefully to ensure a proper barrier
- Certain structural features can make successful barrier treatments difficult or nearly impossible

Termiticide Baits

Advantages:

- Fewer environmental/health risks
- Less disruptive and intrusive - no drilling
- May destroy entire colony (but no way to verify this)
- An alternative to chemical barriers for difficult-to-treat structures

Disadvantages:

- May be more expensive
- More complicated; PMP's need special training
- Longer to take effect, not practical for real estate transfers. Damage may continue unless some measures are taken to prevent entry.
- Passive control, depend on termites "finding" the bait.
- Not possible to ensure that the colony has been destroyed.

Problem Structures

Example 1. Houses that have heating ducts imbedded under the basement floor (a plenum construction) may be extremely difficult to treat. You may not even find a company that is willing to treat because of the increase possibility of contaminating the home. In this case, you may want to use a bait treatment.

Example 2. An older home that has an old cistern or well close to the foundation or a house that is close to a stream or lake. It may be impossible to do a barrier treatment because of the possibility of contaminating the well or water. One solution might be to plug the well or cistern with bentonite clay and fill it with soil. After it is filled properly, a chemical treatment may be done with no harm to the environment. For more information regarding how to plug a well, contact your local extension office.

Another solution is to treat the soil near the foundation, cistern or well using the treated backfill method. As these areas are trenched, the soil should be placed on a waterproof tarp. The termiticide is then applied to the soil on the tarp, mixed, and the treated soil is then placed back into the trench. Many pest control companies would rather not treat using this method because of the extra labor involved and may not want to treat at all because of the potential liability should the water supply become contaminated.

Example 3. A home that has had gravel, rocks, or other large pieces thrown into the fill next to or underneath the foundation. Achieving a good barrier treatment may be impossible unless the rubble is removed. Again, this is a situation where it might be more reasonable to use a bait treatment.

Appendix A
Termiticides for Subterranean Termite Control in Nebraska: 2007

Current Registration Information Available On-line at: http://www.kellysolutions.com/NE/pesticideindex.htm

Conventional Chemical-Barrier Termiticides

Brand Name	Chemical Name	Manufacturer	Action on Termites
Aggreszor® WSP	Imidacloprid	Speckoz, Inc.	Non-repellent
Baseline® Pretreat	bifenthrin	FMC Corporation	Repellent
Biflex® SFR	bifenthrin	FMC Corporation	Repellent
Bisect® L	bifenthrin	Loveland Products	Repellent
Centerfire® WSP	Imidacloprid	Bayer	Non-repellent
Covert®	permethrin	Loveland Products	Repellent
Cypercede®	cypermethrin	Loveland Products	Repellent
Cypermethrin G-Pro	cypermethrin	Gro-Pro	Repellent
Demon® TC, MAX, WP	cypermethrin	Syngenta	Repellent
Dragnet® SFR	permethrin	FMC Corporation	Repellent
Garant® Pro WSP	imidacloprid	Cheminova	Non-repellent
I-Maxx® Pro	Imidacloprid	Univar	Non-repellent
Imida E-Pro WSP	Imidacloprid	Etigra LLC	Non-repellent
Onyx®	bifenthrin	FMC	Repellent
Permethrin G-Pro	permethrin	Gro-Pro	Repellent
Permethrin Plus-C	permethrin	Univar	Repellent
Permethrin Pro	permethrin	Micro Flo, Co.	Repellent
Phantom®	chlorfenapyr	BASF Corp	Non-repellent
Prelude®	permethrin	Syngenta	Repellent
Premise®	imidacloprid	Bayer	Non-repellent
Prevail®	cypermethrin	FMC Corporation	Repellent
Probuild® TC	cypermethrin	Syngenta	Repellent
Speckoz Bifenthrin	bifenthrin	Speckoz, Inc.	Repellent
Talstar One™	bifenthrin	FMC Corporation	Repellent
Termidor® WG, SC	fipronil	BASF	Non-repellent
Wisdom® TC	bifenthrin	Amvac Chemical	Repellent

Termite Baiting Termiticides

Brand Name	Chemical Name	Manufacturer	Action on Termites
Advance™ Compressed	diflubenzuron	Whitmire Micro-Gen	Insect Growth Regulator
*Exterra™ (Labyrinth™)	diflubenzuron	Ensystex	Insect Growth Regulator
FirstLine™	sulfluramid	FMC Corporation	Stomach poison
Hex-Pro™ (Shatter™)	hexaflumuron	Dow AgroSciences	Insect Growth Regulator
*Sentricon® (Recruit IV™)	noviflumuron	Dow AgroSciences	Insect Growth Regulator
Subterfuge™	hydramethylnon	BASF Corp	Stomach poison
Terminate™	sulfluramid	Spectrum Grp.	Stomach poison
Terminex T-Max II™	diflubenzuron	Terminix International	Insect Growth Regulator

***Authorized operators only**

Wood-Protection Termiticides

Brand Name	Chemical Name	Manufacturer	Action on Termites
Bora-Care®	sodium borate	Nisus Corporation	Feeding deterrent
Jecta® Diffusible	sodium borate	Nisus Corporation	Feeding deterrent
Tim-Bor Industrial®	sodium borate	U.S. Borax, Inc.	Feeding deterrent
Tim-Bor Professional®	sodium borate	Nisus Corporation	Feeding deterrent

Other products containing boric acid or sodium borate : Armor-guard, Board Defense, Boracide Borate Powder, CB Borid Turbo, IN-CIDE Pest Control Insulation, Nibor D, Penetreat, and Timbersaver PT.

Other Termiticides

Brand Name	Chemical Name	Manufacturer	Action on Termites
Impasse Termite Blocker®	cyhalothrin	Syngenta	Impregnated plastic, repellent

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