TERMITE CONTROL

Category 10B

A Guide For Commercial Applicators

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Termite Control

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Category 10b

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Other publications that were helpful in producing this manual include:

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Koehler, P.G., and W.H. Kern, Jr. 1994. *General Household Pest Control, Applicator Training Manual.* University of Florida, Florida Cooperative Extension Service.

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Verrall, A.F., and T.L. Amburgey. 1979. *Prevention and Control of Decay in Homes. U.S. Department of* Agriculture Forest Service anNd the Department of Housing and Urban Development: IAA-25-75.

We also acknowledge illustrations from slides obtained from the Dow Chemical Corporation[3] and the West Virginia Cooperative Extension Service.[4]

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[1]The following illustrations were reproduced from *Truman's Scientific Guide to Pest Control,* 5th ed., copyright by Advanstar Communications, Inc: Figures: (some original drawings by Arwin Provonsha, Purdue University): Figures 2.1, 2.2, 2.3, 2.4, 2.6, 2.9, 2.13, 2.17. 2.18, 2.19, 3.1, 4.2, 4.3., 4.4, 5.3, 5.7, 5.8 and 6.1.

[2]The following illustrations were reproduced from *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects.* U.S. Department of Agriculture Forest Service and the Department of Housing and Urban Development (IAA-25-75): 2.15, 2.16, 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, and 7.8

[3]The following illustrations were reproduced from slides from the Dow Chemical Corporation: Figures 2.7, 2.8, 2.10, 2.11, 2.12, 3.3, 3.4, 3.5, 3.10, 3.11, 3.13, 4.7, 5.1, 5.4, 5.5.

[4]The following illustrations were reproduced from the slide set *Subterranean Termites—The Unwelcome Guests,* 1981, West Virginia Cooperative Extension Service in Cooperation with USDA and USEPA: Figures 2.14, 3.9, 3.12 and 3.14.

Management of Wood-destroying Pests

INTRODUCTION

How to Use This Manual

This manual contains the information needed to become a certified commercial applicator in Category 10b, Wood-destroying Pests. This manual is intended for use in combination with the *ApplyingPesticides Correctly* (Extension Bulletin 825), available through the Ohio State University Publication Office. However, this manual would also be useful to anyone interested in learning more about the management of Termite control.

Category 10b, Termite control, covers the management and control of wood-destroying pests that become problems in and around buildings. The chapters contain basic scientific information as well as guidelines for practical solutions to pest control problems.

The Category 10b certification exam will be based on information found in this booklet. Each chapter begins with a set of learning objectives that will help you focus on what you should get out of the chapter. The table of contents will help you identify important topics and understand how they relate to one another through the organization of headings and subheadings. As you prepare for the exam, read each chapter Questions on the exam will pertain directly to the learning objectives.

The appendices and glossary, at the end of this manual provide supplemental information that will help you understand the topics covered in the chapters. Terms throughout the manual text that are bold and italicized can also be found in the glossary.

This certification manual benefits the applicator and the general public. By learning how to handle pesticides correctly, applicators will be able to protect themselves, others, and the environment from pesticide misuse. For more specific information on how to become a certified applicator in Ohio, go to the Ohio Department of Agriculture's Web site at

<http: \ \ www.ohioagriculture.gov>.

CHAPTER 1

LAWS CONCERNING CONTROL OF WOOD-DESTROYING PESTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Understand why protecting the public and the environment from exposure to pesticides is the applicator's responsibility.
- Know the role of an applicator working in the pest control industry.
- Understand the various state and federal laws that govern pesticide use, handling, and storage.
- Be able to explain the legal responsibilities of a pesticide applicator according to the rules of Regulation.
- Describe the elements that should be included in the basic training of a pest control applicator.

Pest management can be complex. It is a matter of using the right technologies and requires special equipment and safety measures. To be successful, it must be effective and not adversely affect people or the environment. The number and variety of pesticides have increased and pest management professionals need to know more about safety and proper use than ever before. For these reasons, among others, many state and federal laws and regulations have been adopted to help protect the public, the environment, and pesticide handlers from the possible adverse effects caused by pesticide use. In this chapter, you will learn about the state and federal laws that regulate pesticide applicators, particularly commercial pesticide applicators certified in Category 10b, Termite Control. Applicators certified in this category are responsible for pest management in and around structures, including homes, schools, hospitals, businesses, warehouses, etc. It is important that Category 10b pest management professionals understand and keep up-to-date with the laws that affect pesticide application inside or around buildings. Ignorance of the law is never an accepted excuse for a violation.

PROTECTION: THE APPLICATOR'S RESPONSIBILITY

Ultimately, responsibility for protecting the environment from the possible adverse effects of pesticide use rests on the pesticide applicator. Preserving the biological diversity of our planet by protecting the environment contributes to the overall quality of life. Each plant and animal is part of a complex food chain; break one of the links and others are adversely affected. One disappearing plant can take with it up to 30 other species that depend on it, including insects, higher animals and even other plants. Pest management technicians may see their normal work as unlikely to affect the environment, but spills and leaks during mixing, loading, and transporting, or incorrect disposal can lead to pesticides in groundwater or surface water or in the habitat of non-target organisms.

Pest management professionals often service national parks, schools, and other sensitive areas. Category 10b professionals have an even greater responsibility toward the public because they often work in or around buildings, where there is increased risk of exposing people to pesticides. All efforts should be made to achieve pest management goals through minimal use of pesticides in and around buildings. When pesticides are used, they should be applied in a manner that will prevent human contact.

MORE THAN JUST PESTICIDE APPLICATION

To control pests, pest management professionals use many other activities besides pesticide application. These other practices increase the effectiveness of the control program and often reduce pesticide use or make such use a secondary operation of the program.

An important area addressed throughout the manual is communication. Pest management is a service. Pest management professionals must not only know their job but also be able to communicate effectively with their clients. The pest management professional should be able to explain the basic procedures to the client's satisfaction. The client should feel confident that the pest management professional is able to meet his/her pest control needs safely and effectively. Also, the state of Ohio requires that certain information must be communicated to the customer (see the Ohio Pesticide Law).

STATE AND FEDERAL LAWS

The *Applying Pesticides Correctly bulletin* (825) discusses federal and state laws that govern the handling and use of pesticides. Review the core manual and understand how laws and regulations affect pesticide practices and use. These laws include federal laws such as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Occupational Safety and Health Act (OSHA), and the Endangered Species Act. State laws include the These are just some of the laws that affect commercial pesticide applicators. They are briefly described below. Refer to the core manual to learn more about other laws affecting pesticide use and for further details on laws discussed in this chapter. Pest management professionals should keep up-to-date copies of the laws and review their contents periodically. Copies of these laws can be obtained from ODA and from County extension offices.

FEDERAL LAWS

FIFRA

This is the basic federal law administered by the Environmental Protection Agency (EPA) that regulates pesticides—their use, handling, storage, transportation, sale, disposal, etc. FIFRA defines a pesticide as a substance or mixture of substances intended to kill, repel, or mitigate a pest. The Ohio Department of Agriculture (ODA) has a cooperative agreement with the EPA to enforce some provisions of FIFRA in Ohio. Some of the provisions of FIFRA are that the EPA must register all pesticides before they can be sold or used. The pesticides must be classified as either ***"general-use"*** or ***"restricted-use."*** General-use pesticides are those that anyone can purchase without restriction. Restricted-use pesticides can be used only by or under the direct supervision of a certified applicator. FIFRA also stipulates that persons who misuse pesticides (in a manner that is "inconsistent with the pesticide labeling") are subject to penalties.

Endangered Species Act

This act requires the U.S. EPA to ensure that endangered or threatened plant and animal species are protected from pesticides. This act requires each pesticide label to limit its use in areas where these species could be harmed. Category 10b applicators must consider the possibility that endangered or threatened species may be affected by pesticides applied in and around buildings. The Ohio Department of Natural Resources (ODNR) Division of Wildlife administers the Ohio Endangered Species Act (TITLE XV CHAPTE 1518 ENDANGERED SPECIES GENERAL PROVISIONS) and maintains the federal and state endangered or threatened species lists. Michigan applicators who want to be sure they are complying with the act must take the initiative and consult with the ODNR to be sure that there are no endangered or threatened species in their area. One of the goals of pest management is to protect off-target plants and animals from pesticides, whether they are endangered or not.

OSHA

OSHA is administered by the U.S. Department of Labor (DOL). OSHA governs the record-keeping and reporting requirements of all work-related deaths, injuries, and illnesses of businesses with 10 or more workers.

STATE LAWS

THE OHIO LAW

The Ohio Administrative Code Chapter 901:5-11-01 is the state pesticide law that regulates commercial pesticide applicators who perform fumigations.

To become a commercial pesticide applicator for termite control you must take and pass the Core exam and the category specific exam (Termite Control). The definition of termite control in the law is as follows: "**Termite Control means the application of pesticides in or around various structures or to the ground prior to construction of a structure, for the control of termites and other invertebrate wood-destroying insects.**"

THE STATE CERTIFICATION PLAN

The state certification plan is an Ohio Department of Agriculture document that sets forth standards of competency by which the Ohio Department of Agriculture abides. This document governs the way the Ohio Department of Agriculture and the Ohio State University Extension conduct the examination process and the pesticide applicator training programs.

The state certification plan sets the standards of competency for the category of fumigation as follows:

10(b) Termite Control: Commercial applicators shall demonstrate a practical knowledge of:

- wood-destroying insect pest (particularly termites), their biology and methods of spread and establishment
- termite damage and ability to distinguish between it and that of other wood-destroying pests
- pesticide formulation registered for control
- application employed to eliminate and prevent future infestation
- methods of application to avoid food and feed contamination or undue human or domestic animal exposure

PESTICIDE LICENSE INFORMATION

THE APPLICATION PROCESS

The application and fee are valid only for the licensing year noted on the application that is submitted, it cannot be extended to the next licensing year once it is submitted. If all the requirements are not met within the license year listed on the application, then the application is voided and the fee is non- refundable. License fees cannot be transferred from one company to another. When a first time applicant submits the application and fee study material will be sent to assist in preparation for the examinations. Categories are listed on the applications.

The application is only valid for the licensing year in which you have applied. (The year is listed on the application). If you do not meet the requirements within the year that you have applied, then a new application and fee will be required, no refund will be given.

Exams

Examination requirements are: the General-Core examination, which covers the law, regulations, safety, disposal and related topics. An examination for each category is also required. The categorical examinations are specific to what area you will be applying the insecticide, herbicide, fungicide, etc. All examinations consist of multiple choice and some true/false questions. The exams are closed book exams. Exam results are mailed two to three weeks after the test date, **they are not given over the phone. You may also retrieve you exam results from our web site if the exams have been graded, you know your ID used when taking the exam and the correct date the exam was taken.** If you fail the exams, you must wait at least five days to retest. If you need to retest is no additional fee is required. Exams are only valid for one year from the date you pass the exam. If you do not meet the other qualifications for a license within that year, the exams will expire and you will need to retest. Please call the Pesticide Regulation Section at (614) 728-6987 or 1-800-282-1955 to schedule your exam or register online at http://www.ohioagriculture.gov

OSUE NEW SCHOOL

Each year in late February or early March, the Ohio State University Extension offers a Pesticide Applicator School for new applicants.

For additional information, access the OSU web site at: http://pested.osu.edu. This site also provides other licensing information; test sites, recertification sites and study material.

COMMERCIAL RENEWAL AND RECERTIFICATION INFORMATION

Once you have passed the applicable exam for the license and a license has been issued, you are certified for three years. The license must be renewed continuously every year in order to keep the three-year certification valid. You need to renew the license every year (at the end of September), which consists of submitting a renewal application and fee. Additionally you are required to earn recertification credits. These credits can be earned by attending recertification programs across Ohio. From the date you pass the exam and are issued a license, you will have three years to accumulate five hours of recertification credits. This requirement will be repeated for as long as you maintain a license. Failure to accumulate the required recertification credits will result in the need to retest. Once you have been issued a license, you may begin obtaining your recertification credits at any time during the three-year recertification cycle. You must obtain the following requirements for recertification – TOTAL MINIMUM OF FIVE HOURS OF TRAINING CONSISTING OF 1 HOUR OF CORE TRAINING AND ½ HOUR IN EACH CATEGORY YOU ARE LICENSED. HOWEVER IT MUST BE A TOTAL MINIMUM OF FIVE HOURS. If you have met your category requirements you must still make sure you meet the time requirement by attending approved classes whether or not they are in your licensed category.

If you do not meet the recertification requirements of 1-hour minimum in Core and at least ½ hour in your licensed category or categories with a total time of 5 hours before the recertification expiration date listed on your license, then you must retest.

SUMMARY

A number of state and federal laws are designed to protect the public and the environment from the improper use of pesticides. It is the pest control technician's responsibility to understand and to comply with these laws. Category 7B pest management professionals often apply pesticides in public areas. Therefore, they must be particularly sensitive about preventing contact between people and pesticides. Category 7B pest management professionals should be trained in IPM and other methods that limit the use of pesticides while still achieving pest management goals. Regulation 637 outlines the details of this training and other details pertaining to the safe and legal use of pesticides. Proper communication, notification, representation, and record keeping are essential whenever pesticides are used.

CHAPTER 2

THE BIOLOGY OF TERMITES AN OTHER WOOD-DESTROYING PESTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the stages of insect growth and development.
- Understand why knowledge of insect growth and development is an important pest management consideration.
- Be able to identify the various types of termites and other wood-destroying insects and pests.
- Understand the biology of termites—i.e., their development, social order, distribution, and role in nature.
- Know the four categories of termites and how to distinguish between them.
- Know the various castes found among termites, their role in the colony, and how to distinguish one caste from another.
- Understand how termite colonies are formed, what environmental conditions a colony needs, and how the colony maintains these conditions.
- Understand the basics behind termite communication within the colony.
- Be able to identify the type of wood-destroying pest from the signs and symptoms on damaged wood.

THE BIOLOGY OF INSECTS AND THEIR RELATIVES

Living things are divided into the plant kingdom, the animal kingdom, and several smaller kingdoms of microscopic life. Insects are part of the largest group in the animal kingdom—the *phylum* Arthropoda. Arthropods include spiders, mites, ticks, millipedes, centipedes, crabs, shrimp, and insects.

The class Insecta is distinguished from the other arthropod classes by the three body regions—**head**, **thorax,** and **abdomen.** The head bears a single pair of antennae, the thorax bears three pairs of legs and usually wings, and the abdomen contains most of the digestive system and the reproductive organs.

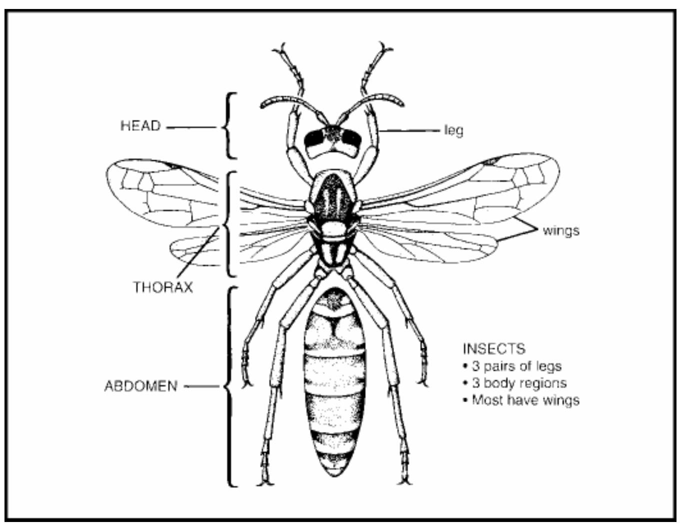


Figure 2.1. The three principal regions and parts of an insect's body, as shown on the paper wasp (Provonsha).

Other Divisions Used in Classification

Classes of arthropods—insects, for example—are divided into **orders.** These are distinct groups whose members look very much alike (e.g., the order of moths and butterflies, or the order of beetles).

Orders are subdivided into **families** made up of related **species.** Species of animals can be thought of as specific kinds of animals. Very closely related species are grouped together in a **genus.** Species or types of animals (and plants) are given scientific names that always consist of two words—the first word is the genus name (the first letter is always a capital); the second is the species name (always lower case). Both are written in italics or underlined (e.g., *Musca domestica).* Well known species also usually have non-scientific names, called "common names" (e.g., "housefly").

GROWTH AND DEVELOPMENT

Growth

The arthropod body is confined in its ***exoskeleton.*** This outer covering can expand only a little at pliable or soft places. It does not grow continuously. Arthropods grow in stages. They form a new, soft exoskeleton under the old one, then shed—or ***molt***—the old one. The new skeleton is larger and allows the animal to grow. The new exoskeleton is white at first, but it hardens and darkens in a few hours. After the molting process, which usually takes place in hiding, the arthropod resumes its normal activities.

Development

Most arthropods hatch as tiny individuals and grow by molting, usually keeping the same appearance until they become adults. However, a spectacular and very important exception occurs in the class Insecta. The insect class is divided into groups according to the way insects change during their development. This change is called by the technical term ***metamorphosis,*** which means "change in form." Three main types of metamorphosis have been identified.

Group 1. Simple Metamorphosis

This group, including the order of silverfish, makes no drastic change in form from juvenile to adult. They simply hatch and grow larger by molting periodically. Only a few orders are in this group.

Group 2. Gradual Metamorphosis

In this group (e.g., termites, cockroaches, crickets, grasshoppers, boxelder bugs, earwigs, etc.), individuals hatch from the egg only partially resembling the adults. The immatures, or ***nymphs,*** do not have wings. Winged insects are always adults. Insects in 14 orders develop in this way. Some of these orders have many species and include many pests. Nymphs and adults are often found together and usually eat the same food.

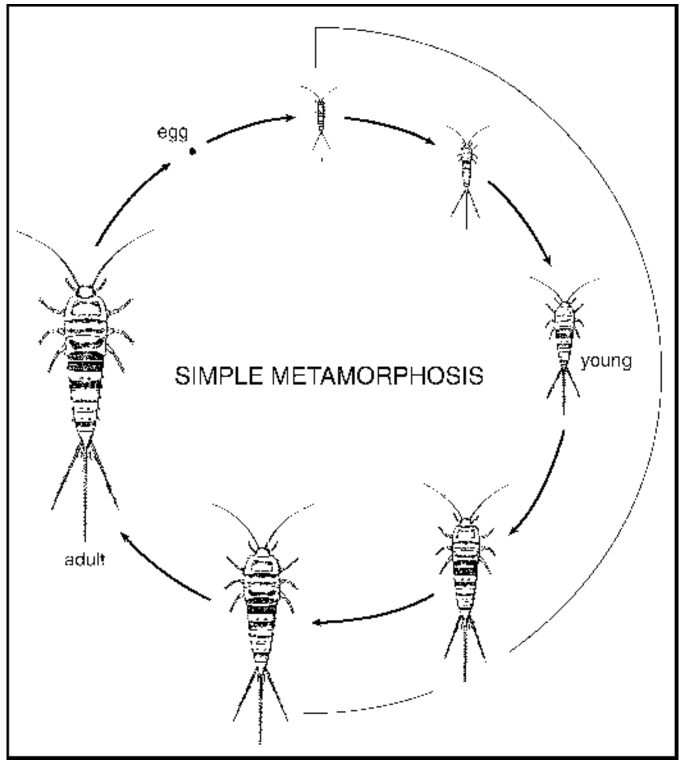


Figure 2.2. Development with simple metamorphosis (example: silverfish) (Provonsha).

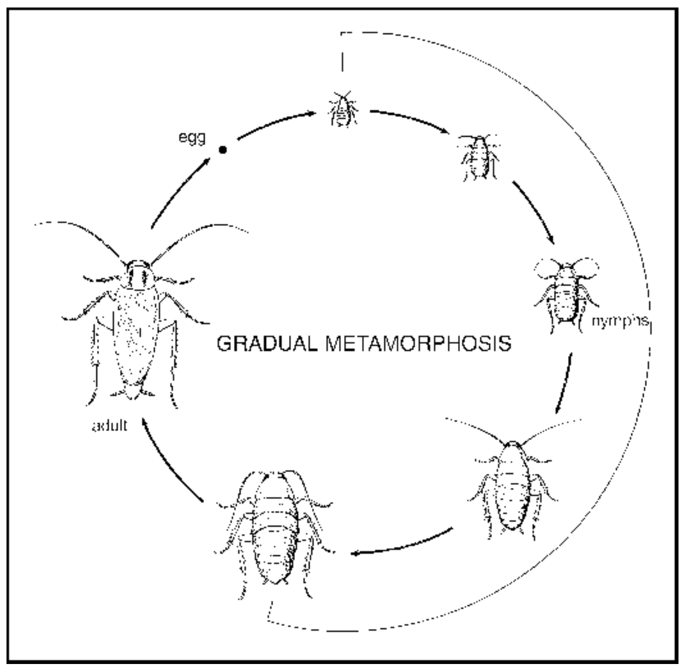


Figure 2.3. Development with gradual metamorphosis (example: cockroach) (Provonsha).

Group 3. Complete Metamorphosis

Insects that develop by complete metamorphosis make a complete change in appearance from juvenile to adult. These nine orders contain the majority of insect species. ***In fact, they number more than all of the other species in the entire animal kingdom!*** This major group includes beetles, moths and butterflies, flies, fleas, and stinging insects (ants, bees, and wasps).

Insects with complete metamorphosis hatch from eggs as ***larvae*** (grubs, maggots, and caterpillars). The mission of the larval stage is to feed and grow. Larvae continue their development through a number of molts until they become mature; then, they change into ***pupae.*** The purpose of the inactive pupal stage is one of change or body rearrangement resulting in a complete change into the adult stage. Reproduction occurs during the ***adult*** stage.

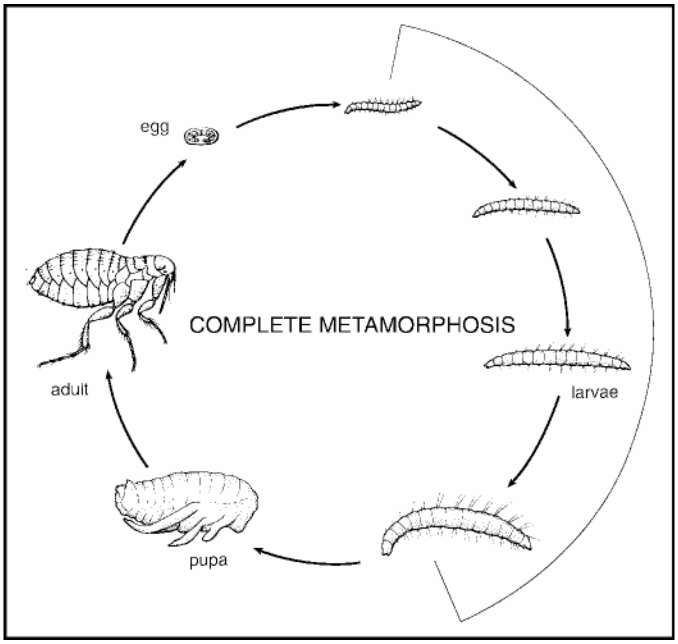


Figure 2.4. Development with complete metamorphosis (example: flea) (Provonsha).

THE BIOLOGY OF TERMITES

termite species living throughout the world, but only about 50 occur in the United States. In nature, termites are considered to be beneficial insects because they help to convert dead wood and other cellulose material to soil. Termites are considered pests, however, when they feed on wooden structures.

Termites harbor a specific kind of ***protozoan*** in their digestive tracts. These protozoans convert cellulose into substances that termites can digest. Without these symbiotic organisms, the termite could not digest the wood it consumes.

Termites live in true social colonies with a division of labor among the various types of individuals. These different types, called ***castes,*** usually consist of ***reproductives, soldiers,*** and ***workers.*** Castes vary considerably among the various species.

Termites develop via gradual metamorphosis from eggs laid by reproductives. Nymphs hatch from the eggs and undergo several molts through which individuals develop into one of the various castes. Termites found in the United States are generally grouped into three categories: **drywood, dampwood, and subterranean.**

TERMITE DISTRIBUTION

Several species of subterranean termites are found in the United States; they live in every state except Alaska (see Figure 2.5). The introduced Formosan subterranean (*Coptotermes formosanus)* is one of the most aggressive and economically important species of termites and has been found along the Gulf of Mexico and Atlantic coasts. Fortunately, it is not established in Michigan. This termite is found mainly in tropical regions but may be moved into more temperate areas through shipment of infested wood. Other subterranean termites of economic importance in the United States include the light southeastern subterranean termite (*Reticulitermes hageni),* the southeastern subterranean termite (*Reticulitermes virginicus),* the Pacific Coast subterranean termite (*Reticulitermes hesperus)*, and the arid land subterranean termite (*Reticulitermes tibialis).* None of these termites have become established in Michigan.

The most common type of subterranean termite found in Michigan is the **eastern subterranean termite** (*Reticulitermes flavipes).* It is thought to be the most common and widely distributed termite in North America.

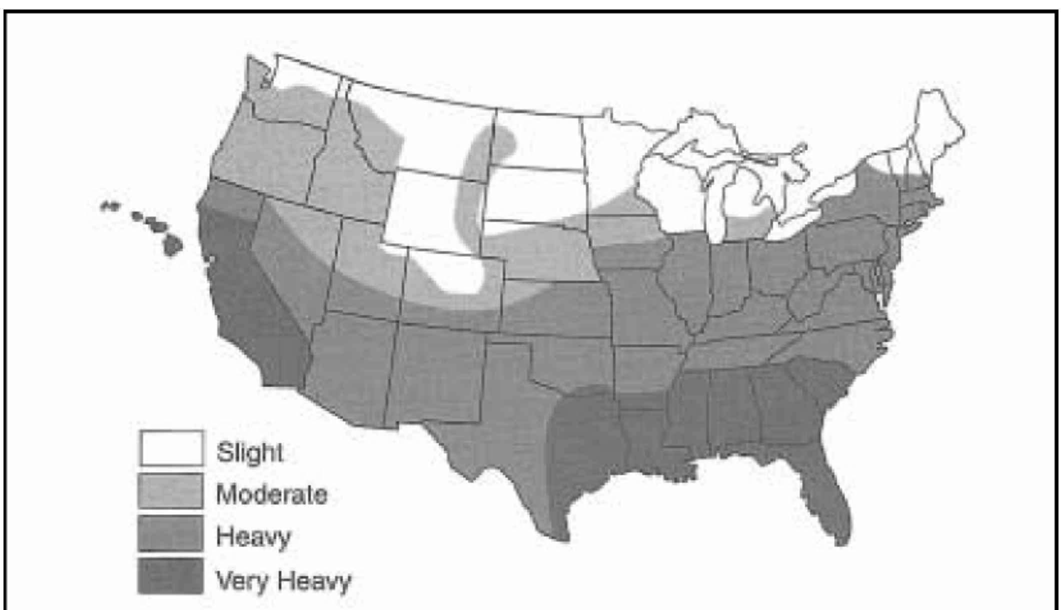


Figure 2.5. Geographic distribution of subterranean termites.

SUBTERRANEAN TERMITES

Subterranean termites nest in the soil, from which they obtain most of their moisture, and feed on any wood in contact with the soil. To reach wood that is separated from the soil, these termites must build a connecting mud tube or tunnel. Four castes can develop from the nymphs of subterranean termites: **workers, soldiers, winged (primary) reproductives,** and **supplementary reproductives** (see Figure 2.6).

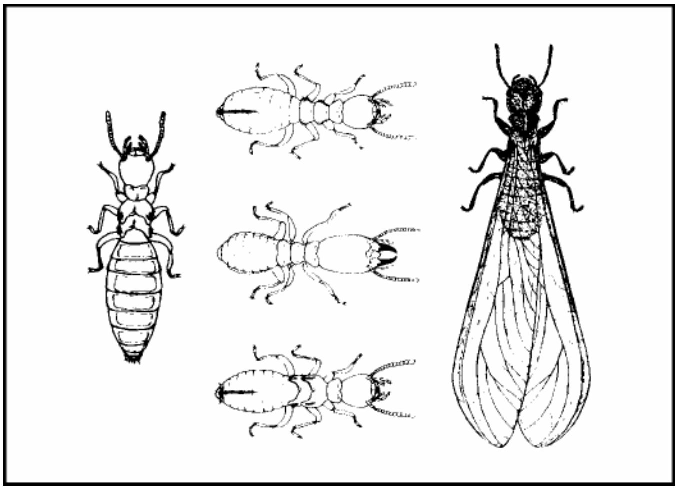


Figure 2.6. Representatives of the castes of the eastern subterranean termite, *Reticulitermes flavipes. Right:* The winged (alate) primary reproductive. These alate forms are the familiar swarmers that often give the first indication that a structure is infested. *Middle row, top:* The sexually undeveloped worker. The members of this caste are the individuals that do the actual damage. Note the complete lack of wing pads. *Middle row, center:* The soldier is greatly modified in head structure and serves a completely specialized function in the division of labor within the colony. It works solely in the defense of the colony and cannot feed itself. *Middle row, bottom:* A developing supplementary reproductive. Note the lengthened wing pads, which are usually the first indication of the development of these reproductives. *Left:* A functional supplementary reproductive. Female supplementary reproductives are thought to be the most important of the reproductive individuals in the subterranean termite colony.

Eastern Subterranean Termites

The colonies of eastern subterranean termites are located in the soil. Their food consists of wood or wood products and other dry plant material. They will also feed within the stems of some of the woody annual plants such as sunflower, dahlia, etc. They attack woody material in contact with the soil. They construct ***shelter tubes*** (often referred to as ***mud tubes)*** over concrete and other inorganic material to reach wood that is not normally in contact with soil.

Primary repro ductives of subterranean termites are the male and female ***swarmers*** or ***alates*** that started the original colony. This is the caste most often seen by homeowners. The winged adults are usually much darker than the other members of the colony. Their bodies are flattened and they have large eyes. All four wings are thesame length and extend more than the length of the body beyond the tip of the abdomen. Both male and female reproductives leave the colony in great numbers (swarms), usually in the spring or fall. These swarms are often the first visible indication that termites are present. As a general rule, swarmers emerge on warm, sunny days when the humidity is high (e.g., often on days following rain showers). Primary reproductives are produced in mature colonies, 3 to 5 years old and older.

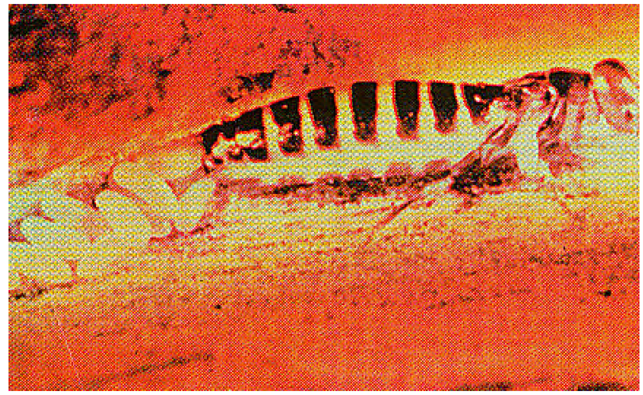


Figure 2.7. The queen subterranean termite is a primary reproductive who resides in the soil. Her only function is to lay eggs.

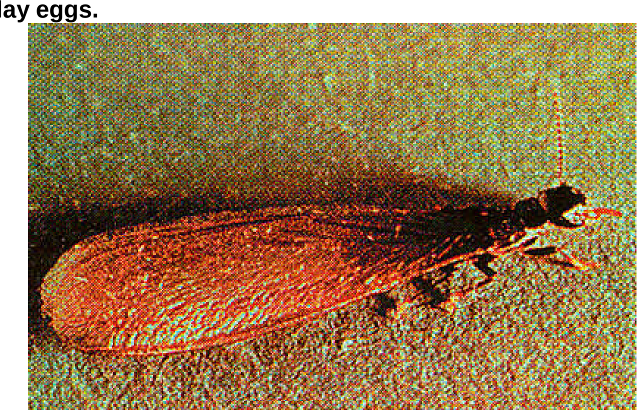


Figure 2.8. Winged primary reproductive swarmer.

Swarmer termites are often confused with flying or swarmer ants. Ants are often seen swarming in and around buildings, so it is important to be able to distinguish between the two so that appropriate control recommendations can be made. There are three ways to separate termites from ants. First, ants have a very thin waist between the thorax and the abdomen; termites are broad-waisted. Second, termite wings are all the same size and shape, whereas the forewings of the ant are larger, longer, and of a different shape than the hindwings. And third, termite antennae are straight; ant antennae are elbowed.

Supplementary reproductives (sometimes referred to as **secondary reproductives)** of both sexes are wingless or have only very short, non-functional wings. These reproductives are developed as needed and quickly replace a primary queen who is injured or dies. They usually develop in addition to the primary queen and

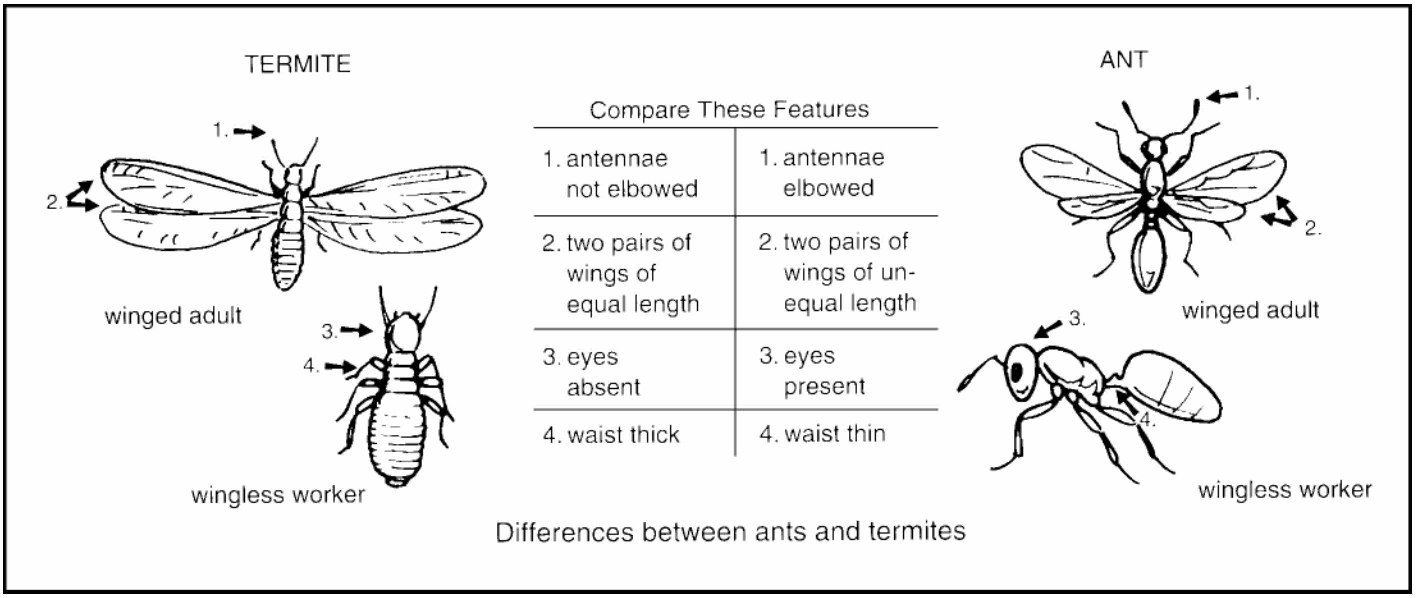


Figure 2.9. Comparison of termites and ants.

become the most important source of eggs in the colony. Supplementary reproductives, with a group of males and workers, may become isolated from the colony and establish a new colony, thus spreading the original infestation without having to swarm.

Workers are the most numerous individuals in a termite colony. They perform all of the work of the colony(foraging, feeding, and grooming of the other castes (including the queen), building and repairing the nest, and making the tunnels. In the process of making nests and tunnels and ingesting food, they chew and eat wood, thus causing the destruction that makes termites economically important. Workers are creamy white, wingless, eyeless, and soft-bodied with chewing mouthparts. Workers are sometimes mistaken for "white ants." They mature within a few months and may live 2 to 3 years.

Workers maintain the shelter tubes and close any breaks in the surface of the wood they are infesting. Termites must maintain this closed system to have a certain level of humidity and to protect themselves from natural enemies. Occasionally a subterranean termite colony may find a source of moisture in the wood—from a leaking pipe or roof, for example—so contact with the soil is no longer necessary.

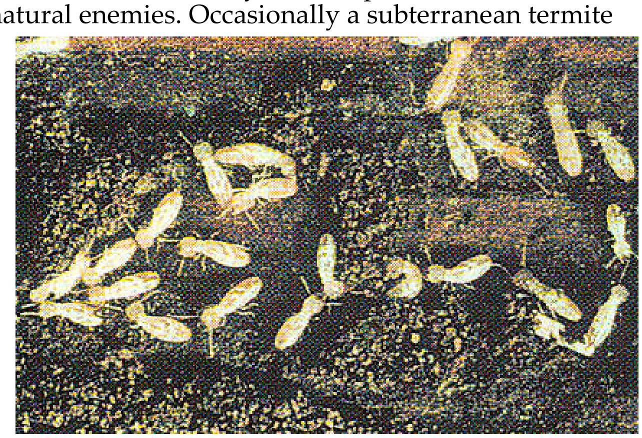


Figure 2.10. Subterranean termite workers in soil. The workers travel to wood, feed, and then bring back ingested wood to the colony.

Soldier termites serve specifically to protect the colony from its enemies. Their heads are large, quite hard and reddish-brown, and have much larger mandibles than are found in the other forms. When openings are made in termite structures, the soldiers gather with their large heads and strong mandibles facing outward and protect the colony from invaders, primarily ants. Like workers, they mature within a few months and may live 2 to 3 years.

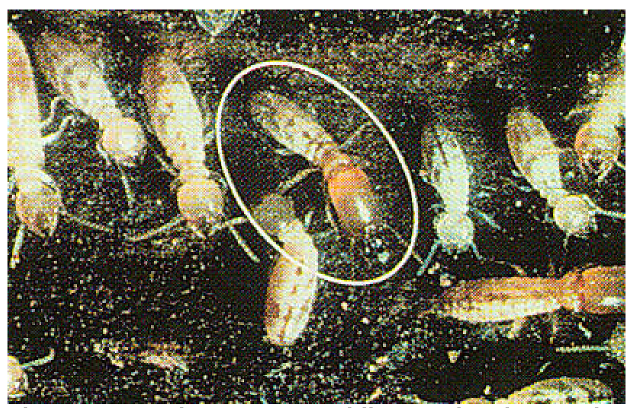


Figure 2.11. Subterrranean soldier termites have enlarged heads with large mandibles.

Colony Formation

A termite swarm is a dispersal flight that contains both male and female reproductives. As the termites fall to the ground after a short, fluttering flight, their wings break off. Males and females pair off and begin excavating a new nest. Subterranean termites usually burrow under trees or decaying wood, or in soil that is in contact with wood. They rarely use crevices in trees to initiate a colony. Many termites in a swarm never find a mate or a homesite. Others are eaten by predators such as birds.

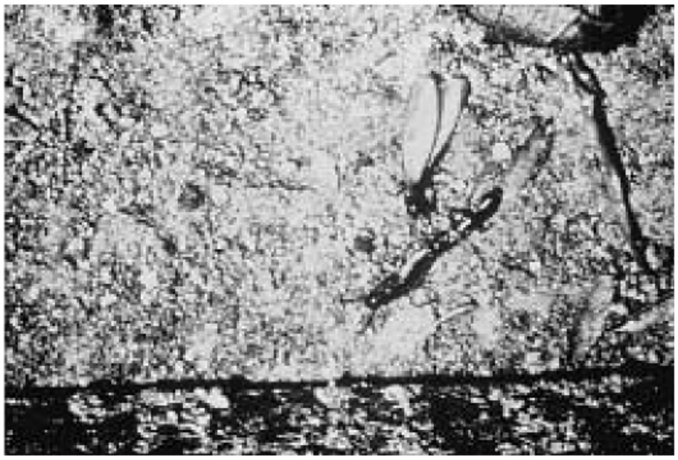


Figure 2.12. Swarmers with fallen wings ready to mate.

Once a pair finds a site and seals themselves in, they will mate and the female (queen) will begin egg laying. The first batch will be small, usually 6 to 12 eggs. Once these nymphs hatch, they begin to eat cellulose and enlarge the colony area. As the number of nymphs increases, the queen will lay increasingly larger numbers of eggs. Reproductive forms usually will not be produced in the first year. It usually takes 2 to 3 years for a newly established colony to begin doing serious damage to structural wood. As the colony grows, the secondary reproductives also begin to lay eggs to supplement those laid by the queen. There is not just one central nest containing one queen. Secondary reproductives may be found throughout the colony.

Another way colonies may be formed is by ***budding*** from a well established colony. Budding occurs when a number of individuals, including one or more secondary reproductives, leave the colony and start a new one.

Stone or concrete building foundations are temporary obstacles to termites. If a crack 1/ 32 inch wide develops in these foundations, termites can enter and move into the wood above unless there is some other barrier. Remember, if distances are short, termites can build shelter tubes across foundations to reach wood. So cracks in concrete, continuous openings in building blocks, utility openings, expansion joints, and wood below soil level offer the best and easiest access for termites.

The Termite and its Environment

Termites require specific environmental conditions to survive (see Figure 2.13). Most times, moist soil or other moist environments provide these conditions. Moisture is critical to termite survival because all castes except the swarmers are soft-bodied insects that lose water rapidly upon exposure to dry air. Thus, an available moisture source is critical to termites. This is why termites construct shelter tubes when they pass over exposed areas. Subterranean termites must maintain contact with the soil unless they have a constant aboveground source of moisture.

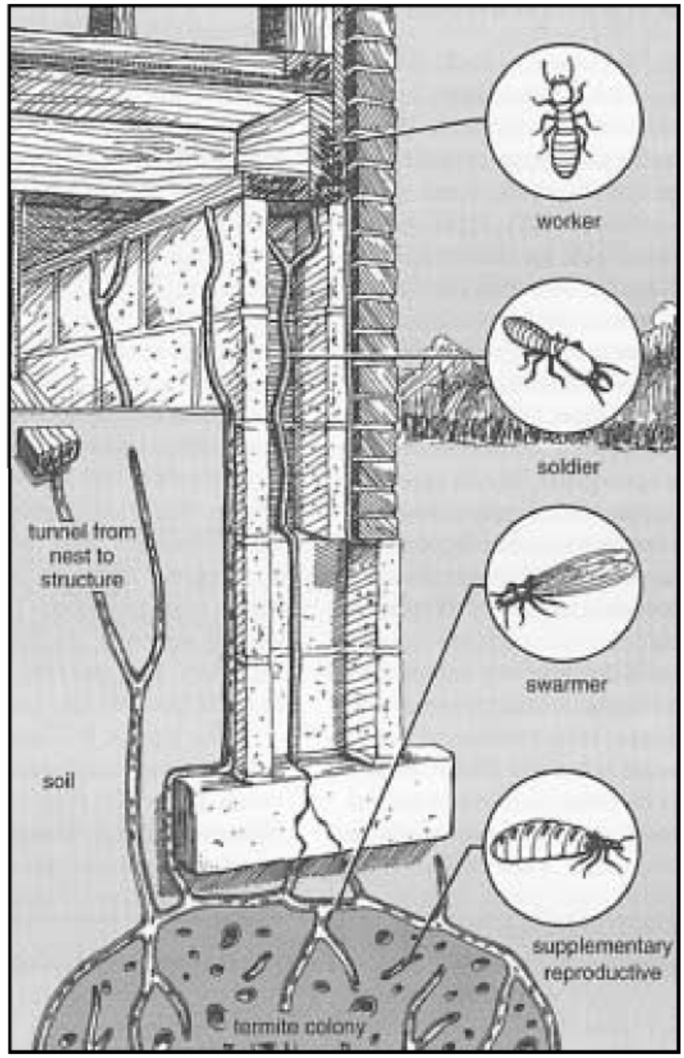


Figure 2.13. The environment of the subterranean termite.

On occasion, free-standing shelter tubes will be built straight down from the infested wood toward the ground if they are in a protected area, such as a crawl space under a house. This usually occurs after a colony has become well established and feeding has progressed some distance from the initial shelter tunnel. In this way, the colony can obtain the necessary moisture without having to travel great distances.

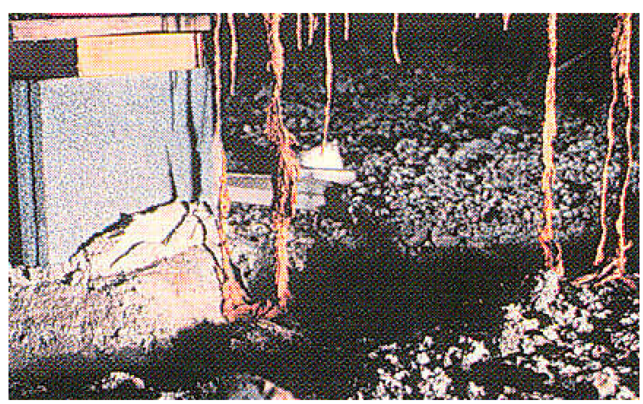


Figure 2.14. Free-standing shelter tubes.

The retention of moisture is not the only important factor associated with water in the life of the termite. The warm, moist conditions that prevail within the closed system of the nest provide an ideal site for the growth of microorganisms, particularly fungi, which provide a source of protein and vitamins essential to the termite. The accumulation of termite fecal material in the nest helps to promote the growth of the fungi.

The termite system is an extremely delicate and well-balanced system. Maintaining the proper levels of temperature and moisture is essential to the survival of the colony. The type of soil also has a great effect on the ability of subterranean termites to flourish. They generally prefer a sandy soil over a clay soil, though they will survive in many types of soil.

Communication in the Colony

Among social insects, communication is needed to maintain efficient social integration and division of labor. The most basic means of communication among termites is chemical (***pheromone)*** communication. In fact, each colony develops its own characteristic odor. Any intruder, be it a termite from another colony, an ant, or any other natural enemy, is instantly recognized as foreign when it enters the colony. An alarm pheromone secreted by the colony triggers the soldier termites to attack and kill the intruder. The intruder is then walled off from the colony with fecal matter. If a hole in the termite workings occurs, it is immediately patched by the workers.

Sound is another means of communication. Termite soldiers and workers bang their heads rapidly on the surface of their mud tunnels or wood galleries when the colony is disturbed. The vibration of the surrounding surface is perceived by others in the colony and they, too, take up the banging activity. Like the alarm pheromones, this activity serves to mobilize the colony defenses.

One of the primary means of communication is ***trophallaxis,*** which is the mutual exchange of nutrients and the transfer of food between colony members. Trophallaxis permits the efficient use of nutrients within the colony, enhances recognition of colony members, distributes chemicals involved in caste regulation, and transfers cellulose-digesting protozoans. Termites exchange food from both the mouth and the hind gut. When termites shed their skin during moltings, they also lose their hind gut contents, including the protozoans they need for digesting wood. To get a new supply, they must feed from the hind gut of other colony members. The feeding of the queens and soldiers by the workers is also a form of trophallaxis.

Worker termites forage continuously for new sources of food. They also forage randomly in many locations throughout their foraging territory, looking for food. When a foraging termite worker finds a source of food, it recruits others to the food source by laying a chemical (pheromone) trail. The more foragers that find the food and return with it to the colony, the more intense the pheromone trail becomes. As the food source is depleted and the foragers no longer deposit the pheromone, the trail deteriorates and eventually is abandoned.

The proportion of the castes in the colony is also regulated chemically. For example, soldiers and reproductives produce chemicals that are distributed to other colony members by trophallaxis. The chemicals inhibit the production of additional soldiers and reproductives. Termites may react to a high level of soldier-produced chemical by killing some of the soldiers. Thus, the needs of the colony are met, and the proper balance of the various castes is maintained. In most subterranean termite colonies, nymphs can molt into workers, soldiers, or reproductives; workers can change into soldiers, nymphs, or supplementary reproductives; and nymphs that have begun developing wing buds may actually lose them with additional molts and return to the worker stage. All these changes are chemically regulated within the colony, depending on its needs.

OTHER TERMITES

Michigan's termite problem is basically caused by subterranean termites. The other groups of termites—drywood and dampwood — are found in the western United States and/or along the southern coastal areas from California to the Atlantic. Unlike subterranean termites, these other termites groups do not require contact with the soil for moisture. They are occasionally introduced into Michigan through furniture or other seasoned wood. A description of these other termite groups and control recommendations are given in case the pest control operator encounters them.

Drywood termites

Drywood termites differ from subterranean termites in three ways:

- Unlike subterranean termites, drywood termites bore directly into wood and make their nests in the wood rather than belowground.
- As drywood termites feed, they cut across the grain of wood, excavating large chambers that are connected by small tunnels.
- Drywood termites produce hard fecal pellets. These hard pellets have six distinct concave surfaces on the sides. These pellets are often pushed out of the colony through small holes in the wood.

Figure 2.15. Drywood termite fecal pellets (approximate length 1/25 inch).

Powderpost termites are drywood termites that produce tiny fecal pellets resembling powder. The ejection of this material from the gallery is usually the first indication of the presence of powderpost termites. Powderpost termites are smaller than other drywood termites but excavate similar galleries and can be controlled by the same methods.

Drywood termites seldom infest buildings in Michigan. Furniture or other seasoned wood shipped from the western or southwestern parts of the United States may be infested with these termites.

Because drywood termites do not require any contact with the ground, treatment is quite different from that for subterranean termites. It consists of covering the structure (i.e., furniture or seasoned wood) with a tight tarpaulin or using a fumigation chamber and fumigating with a toxic gas. In minor infestations, a toxic liquid or dust may be introduced through holes drilled into the excavated chambers. Drywood termites may be killed by holding the infested furniture for 4 hours at 140 degrees F in a heat chamber. Exposing infested wood to 15 degrees F for 4 days will also kill these termites.

Dampwood Termites

Dampwood termites also do not require contact with the soil to obtain moisture, but they do require wood with a high water content. Dampwood termites excavate large galleries, as do drywood termites. But unlike drywood termites, they do not keep these galleries clean of their fecal pellets.

Species of dampwood termites are found along the Pacific Coast, in the southwestern United States, and along the Gulf Coast to Florida. Occasionally colonies may be carried to other parts of the United States, including Michigan, in shipments of lumber. However, dampwood termites are unable to become established in these areas.

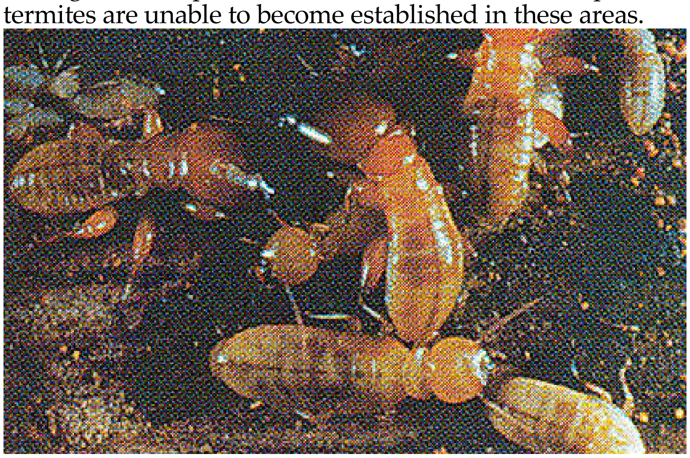


Figure 2.16. Dampwood termites.

OTHER WOOD-DESTROYING INSECTS AND PESTS

Many other insects infest and seriously damage wood. Many of these, such as the various bark beetles and round- and flatheaded borers, are found alive most frequently in seasoned wood. The pest management professional is usually most concerned with those insects that damage seasoned lumber. These insects include representatives of the orders Hymenoptera (horntail or wood wasps, carpenter ants and bees) and Coleoptera (beetles). The members of these two orders develop by complete metamorophis, advancing from eggs to larvae, pupae, and adults.

The characteristics of the damage done to wood by these insects are generally sufficient evidence to identify the insects to their family, but positive identification to genus or species requires examination of the insect itself. Below is a brief description of the wood-destroying pests of primary interest to pest control operations in Michigan. A more thorough discussion of these pests, along with control recommendations, can be found in Chapter 6.

Powder post Beetles

The term ***powderpost beetle***, used in the broad sense, applies to any of the wood-boring species of three closely related families (Lyctidae, Bostrichidae, and Anobiidae) within the superfamily Bostrichoidea. The common name is appropriate because the larvae of these beetles reduce timbers to a mass of very fine, powderlike material (see Fig. 2.17). The adults do very little actual damage to wood, serving primarily a reproductive function. There are certain differences in structure, behavior, and nutrition among these groups, and these differences have led to the separation of the families discussed in further detail in Chapter 6.

Longhorned Beetles

Longhorned beetles are large (1/2 to 3 inches long), conspicuous beetles with long, thin antennae that may be longer than their bodies. They usually lay their eggs on unseasoned, rough-sawn timbers or logs. The larvae, called roundheaded borers, feed in the wood, boring large, oval-shaped holes as they move through it. Infestation usually takes place before the timber is used in structures. The larvae of some species take more than one year to complete their development, so they may still be feeding in the wood after it becomes part of a structure. Damage is usually limited to pine sapwood and can be recognized by the ripples on the surface of the galleries.

The adult beetle will not lay eggs for reinfestation on this type of wood, so control is rarely called for. However, the exception to this is a species known as the **old house borer** (*Hylotrupes bajulus)* (see Fig. 2.18). Old house borers will attack timbers in a building, so they are the only longhorned beetles requiring control measures. The adult is about 3/4 inch long and grayish brown to black with two white patches on its wing covers.

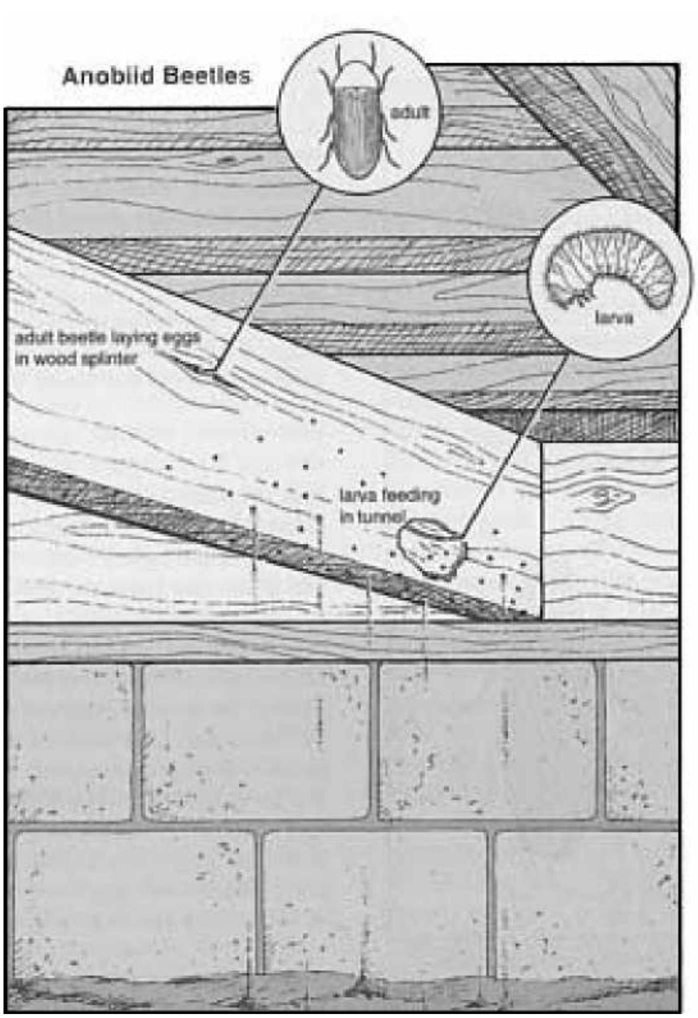


Figure 2.17. Powderpost beetles reduce timbers to a fine, powderlike material; hence their name. This illustration shows an adult and a larva from the Anobiidae family (Shuster and Provonsha).

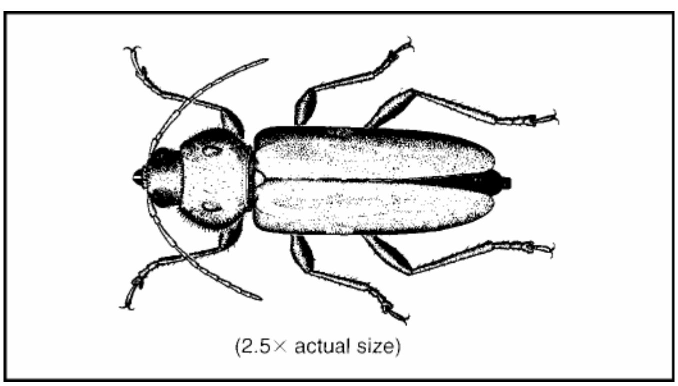


Figure 2.18. The old house borer, *Hylotrupes bajulus*, is one of the longhorned beetles of the family Cerambycidae (Provonsha).

Black Carpenter Ants

Ants of the genus *Camponotus* often nest in wood. There are probably many carpenter ant species in Michigan, but only one poses a major pest problem (the black carpenter ant (*Camponotus pennsylvanicus).* The black carpenter ant varies from 1/8 to 1/2 inch in lengthbecause of the presence in most colonies of both "major" and "minor" workers.

Carpenter ants may construct their nests in hollow trees, logs, posts, porch pillars, hollow doors, and other timbers used in homes. The ants do not consume the wood but simply hollow it out to form cavities for the nest. They are usually attracted to damp, decaying wood, but once the nest is started, they will also excavate sound wood as they enlarge the nest. It is often quite common to find them nesting in existing voids that require no excavation; occasionally they start in an existing void and enlarge it as their need dictates. The presence of carpenter ants suggests the potential for damage to wood.

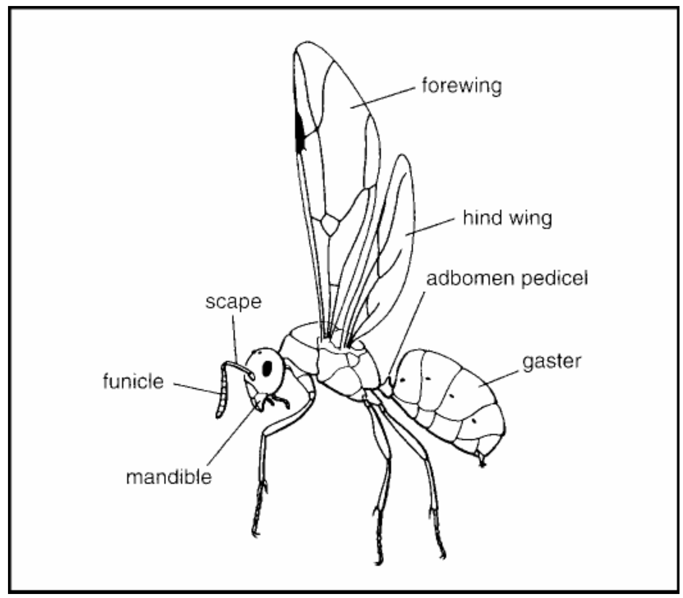


Figure 2.19. An illustration of an ant, showing body parts (Provonsha).

Carpenter Bees

The carpenter bee (*Xylocopa virginica)* resembles a bumblebee in that it is robust and black with some markings of yellow hair. The dorsal surface of the abdomen lacks the yellow hair markings of bumblebees and is mostly devoid of any hair.

These bees are considered pests of wood because they excavate tunnels in softwood as sites for producing their brood. Common nesting sites are posts, fence railings, porch support posts, wall siding, eaves, wooden shingles, windowsills, doors, wooden porch furniture, etc.

KEY TO INSECT DAMAGE OF WOOD-DESTROYING PESTS

1. In processed wood, numerous small holes less than 3/ 8 inch in diameter. If the piece is split open, many frass-filled tunnels can be seen, most of them running with the grain. ....**Powderpost beetles**

- Exit holes 1/ 16 to 1/8 inch in diameter. More advanced galleries running across the grain. Frass consists in part of distinct elongate or bun-shaped pellets. In hard- and softwoods. ....**Family Anobiidae**
- Exit holes vary from 1/ 8 to 3/ 8 inch in diameter. Occasional tunnels go across the grain but mostly with the grain. Fine or coarse frass that tends to stick together; few if any pellets. In hardwoods such as ash, oak, and hickory; sometimes in softwoods ....**Family Bostrichidae**
- Exit holes 1/32 to 1/ 16 inch in diameter in newer or poorly seasoned hardwood lumber. (Common in poorly seasoned lumber.) Frass in tunnels is loose and powdery and contains no pellets. ....**Family Lyctidae**

2. In either processed wood or rough timber, occasional holes, round or elliptical, 1/4 to 1/2 inch in diameter. Irregular and rather extensive tunnels in the sapwood with usually coarse, packed frass. ....**Longhorned beetles**

- Usually heavy damage of this sort in finished wood. Often the only external evidence of damage is one or two oval exit holes .... **Old house borer**

3. In rough, bark-covered wood, small exit holes about 1/8 inch in diameter. Inner side of bark and surface of wood itself "engraved" with galleries (old damage; can't reinfest dried wood; no control required). .... **Bark beetle**

4. Pinholes and slender galleries in sapwood, frequently of southern yellow pine. The burrows and area around them stained dark by the action of fungi (old damage, can't reinfest dried wood; no control required). ....**Ambrosia beetle**

5. No openings (or very few and these are usually sealed over). Extensive galleries run lengthwise, usually in the springwood, and are packed with a hard, mastic-like frass. May infest many old cellulose objects near or in contact with the soil....... **Subterranean termites**

6. Distinct round openings to outside of wood; when split open, it reveals very thorough excavation. Galleries contain considerable amounts of coarse, hard, sandlike frass, each pellet having rounded ends and six longitudinal depressions. No mastic-like frass or very fine powder. ....**Drywood termites**

7. Timbers with extensive galleries that are sandpaper smooth, often with rounded edges, and contain no frass. Coarse sawdust may be found near damage.. **Carpenter ants**

8. Wood with 1/3- to 1/2-inch round holes on side, edge or end, leading into long tunnel (3 to 24 inches). If hole is on side of wood, tunnel turns at right angles and continues with the grain of the wood. .... **Carpenter bees**

Adapted from a release by Department of Entomology, Purdue University, West Lafayette, Ind.

SUMMARY

The class Insecta belongs to the phylum Arthropoda, which includes other non-insect classes (spiders, mites, centipedes, crabs, etc). Insects are distinguished from other arthropods in that they do not keep the same appearance as they grow. Instead, they undergo a ***metamorphosis*** or a change in body shape as they develop from one stage to another.

Termites belong to the insect order Isoptera and undergo gradual metamorphosis. There are several termite species in the United States, but only the eastern subterranean termite (*Reticulitermes flavipes)* is a significant termite pest in Michigan. Four castes develop among termites, with each caste having a specific role in the establishment, defense, reproduction, and maintenance of the colony. It is important that the pest management professional understand termite biology, behavior patterns, and environmental requirements so that the appropriate pest control technique can be applied.

Other wood-destroying pests of economic importance in Michigan include powderpost beetles, longhorned beetles, carpenter ants, carpenter bees, and decay fungi. The pest management professional must become familiar with the damage caused by these pests to properly identify them.

CHAPTER 3

EQUIPMENT AND METHODS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the basic types of equipment used in termite control and how they function.
- Know the various components of power sprayers and how they are used.
- Understand calibration of power sprayers and use of flow meters.
- Know what precautions to take to prevent contamination of drinking water, particularly the use of backflow preventers.
- Know the types of equipment needed, what signs to look for, and where to inspect for termite infestations.
- Know the components of a well designed inspection report form.
- Understand how termite infestations may be prevented.
- Understand the various classes of chemicals used in termite control and the advantages and disadvantages of each.
- Understand how foaming agents are used in controlling termites.
- Understand the advantages and disadvantages of fumigation in termite control.
- Understand how termite baits are used, the various types of bait products available, and the advantages and disadvantages of using termite baits.

The proper selection and correct operation of application equipment is essential to the success of any pest control operation. Problems such as non-uniform coverage and failure of a pesticide to reach the target organisms effectively may be solved, in part, through proper selection and operation. Equipment should be in good condition and heavy-duty enough to get the job done as easily as possible without expensive, time-consuming breakdowns on the job. Spray tanks should be made of durable materials that will not deteriorate when exposed to certain pesticide formulations. Proper maintenance, including regular cleaning and checking of equipment, will help ensure the proper delivery rate of chemical and also its uniform application.

TERMITE APPLICATION EQUIPMENT

The basic piece of equipment used in any termite job is a sprayer with a tank and pump system used to inject termiticides into the soil, wall voids, and other areas to be treated. Table 3.1 is a list of accessories needed along with the spray system. These tools and their selection are left to the individual specialist or company. As new technologies enter the marketplace, pest management professionals must determine which pieces of equipment best fit the needs of the company.

SPRAYER COMPONENTS

Sprayers used in the termite control industry are often referred to as large-volume sprayers or power sprayers. There are many variations in these types of sprayers, but the basic components are: tank, pump and motor, hose, applicator, and accessories (strainers, pressure gauge).

Table 3.1 Typical termite control equipment and accessories for one truck.

Sprayer-related Equipment

- 100-gal. Tank
- 10-gpm pump
- 3-hp motor
- Hose reel
- Treating 3/ 8-in. hose (100 to 200 ft.)
- Shutoff valve
- Backflow preventer
- 3/ 4-in. hose to refill tank (25 to 50 ft.)
- Measuring container
- Can of gasoline
- Funnel
- Kit maintenance tools
- Extra hose washers
- Extra sparkplug
- Spare can of oil

Application-related Equipment

- Electric rotary drill for wall voids
- Electric hammer for concrete floors
- Bits for drill and hammer
- Heat gun for tile; tile cutter
- Extension cord(heavy-duty three-wire type
- 6-ft. extension rods (for subslab treating)
- Subslab injector, side injector tip, flanged treating tip
- Termiticide
- Termiticide label
- Package of vents for foundations
- Mortar mix or cement
- Small sledgehammer
- Crowbar
- Shovel
- Trowel
- Heavy-duty flashlight
- Extra batteries for flashlight
- Saw, keyhole
- Saw, crosscut
- Grounding box
- Grounding tester

Personal Protective (PPE) & Safety Equipment

- Two pairs of coveralls
- Pair of heavy gloves
- Pair of light plastic gloves
- Safety glasses or goggles
- Bump hat
- Respirator
- First-aid kit
- Poison control center telephone number
- Fire extinguisher

Cleanup

- Broom
- Dustpan
- Vacuum cleaner
- Rake
- Mop and mop bucket
- Spill cleanup absorbent
- Clean rags

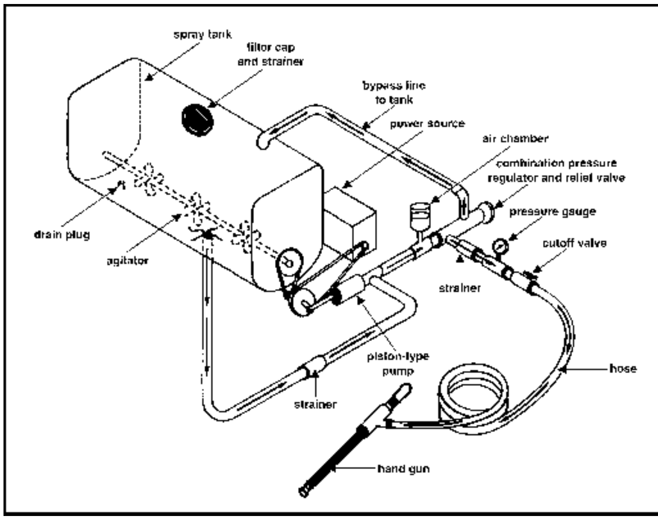


Figure 3.1. A schematic illustration of a simple power sprayer rig.

Tanks

A typical **tank** used for termite control is usually 100-gallon capacity. Some rigs are set up with two 50-gallon tanks (dual systems). Most modern-day tanks are made of fiberglass or polyethylene, which are resistant to the corrosive properties of pesticides. They are usually translucent to allow the applicator to view the level of liquid in the tank. The tank should have large openings for easy filling and cleaning, as well as provision for straining during filling. Similarly, it should have large drains and other outlets sized to the pump capacity. If a dual-tank system is used, the plumbing should provide for agitation and adequate withdrawal rates in both tanks. All tanks should have a gauge to show the liquid level. External gauges should be protected to prevent breakage. Most tanks contain a shutoff valve for holding liquid pesticide temporarily while other sprayer parts are being serviced.

Pumps

The **pump** is used to generate hydraulic pressure (i.e., pressure created by fluids) to the pesticide directly in the line, rather than pressurizing the tank. The liquid is entrapped and pushed out of the line rapidly. There are many types of pumps, varying in size and capabilities. Gasoline or electric motors ranging in power from 3/4 to 7 horsepower are used to drive the pumps.

The types of pumps most commonly used in pest management operations are roller, piston, and diaphragm. **Roller pumps** are among the least expensive and most widely used pumps in the industry. They pump moderate volumes of liquid, 8 to 30 gallons per minute (gpm), at low to moderate pressures (10 to 300 psi). Roller pumps are available equipped with five to eight rollers. The more rollers, the more power to the pump. The smaller roller pump models are often used for termite control because they produce the desired low pressures, they are economical, and they are easily repaired. The recommended operating pressure for termite operations is between 25 and 50 psi at the nozzle.

Piston pumps are the most durable of the various power pumps; they are also more expensive than other types. They deliver low to medium volumes (2 to 25 gpm) at low to high pressures (20 to 600 psi). Piston pumps are used for high-pressure sprayers or when both low and high pressures are needed. The smaller models, such as the twin-piston pump, are commonly used in termite control operations.

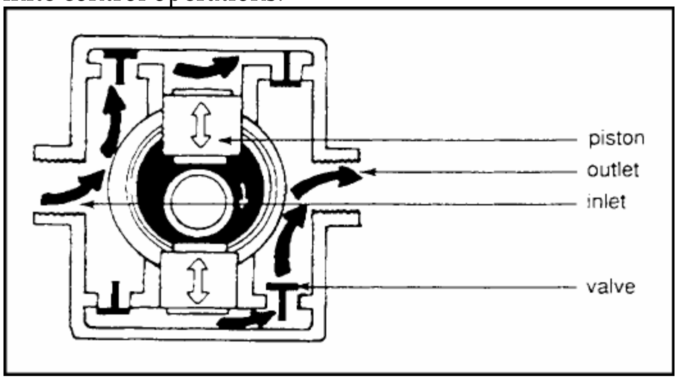


Figure 3.2. Piston pump.

Piston pump cylinders are made of materials such as iron or stainless steel, or are lined with porcelain. The pump casing is usually iron. The piston cups are replaceable and are made of leather, neoprene, or nylon fabric. These materials make the pump abrasion-resistant and capable of handling various types of pesticides, including ***wettable powders,*** for many years. However, when piston pumps do fail, they tend to do so rapidly. Therefore, it is wise to carry a spare pump on the truck.

Piston pumps also create a pulsating or throbbing action that can be damaging to gauges, valves, hose fittings, and other parts. When pulsation is a problem, it is necessary to have a surge tank in the line to reduce the force of the pulsation. A surge tank is a small chamber containing air. It is placed in the discharge line between the pump and the control valve and serves to cushion the peak of the pulses produced by the pump, so that a more even and regular flow is available at the nozzle.

Diaphragm pumps are used when most of the work involves only low-volume, low-pressure applications because diaphragm pumps deliver low volume (1.4 to 10 gpm) at low to moderate pressure (10 to 100 psi). They withstand abrasion from wettable-powder mixtures much better than roller pumps because the spray mixture does not contact any moving parts except the vales. Some solvents may damage the rubber or neoprene diaphragm. The small diaphragm pumps are often used with new portable systems in treating crawl spaces and attics.

Hoses

The hose of a large-volume sprayer is a vital part of the system. The hose must be long enough for the purpose intended, wide enough to carry an adequate flow of liquid, and made of materials that will not be deteriorated by the pesticides.

It is important to use only quality hose and to maintain the hose in good condition. Cheap or worn hoses maysuddenly burst on the job, and pesticides may spill or splash onto people and property or contaminate the environment. Quality power sprayer hoses are usually made of polyvinyl chloride (PVC) and are capable of withstanding working pressures of up to 600 psi or more. PVC hoses are lighter weight than rubber hoses but tend to stiffen in cool weather.

Hoses used in termite operations usually have an inside diameter of 3/8 or 1/2 inch. When choosing hose size, remember that the smallest opening in the spray line determines the actual capacity for delivery, regardless of the size of the hose. Thus, if a hose with a 1/2-inch inside diameter is used with couplings that have an inside diameter of 1/4 inch, the delivery rate of the hose will be that of a 1/4-inch hose. Therefore, it is important to match hoses and couplings properly to deliver the desired volume of spray.

Finally, hose length is also an important consideration. Most professionals use between 150 and 300 feet of hose, which provides extra length when it is needed. **Hose reels,** operated by hand cranks or by an electric rewind motor, enable the professional to handle and manage long lengths of hose.

Applicators

At the end of the hose, various types of applicators with valves are used to apply termiticide. These include **rods, subslab injectors,** and **guns.**

Rods 3 to 6 feet long can be used to apply termiticide into the soil next to the foundation wall. Various small rods are used to inject insecticide into the voids of walls and through concrete slabs.

Figure 3.3. Pest management professional applying termiticide to the soil by long rodding the exterior of a house.

Subslab injectors are used to force termiticide into holes through concrete slabs to the fill underneath. This device is essential because it seals the hole around the application rod; considerable back pressure is frequently encountered, making it difficult to inject a sufficient quantity of chemical. A tapered rubber stopper around the applicator rod can also be used.

It is frequently necessary to drill holes through masonry construction. Small holes can be drilled with carbide-tipped rotary bits in an ordinary electric hand drill.

Application tools are continually being developed and improved. Better soil injection equipment, especially injection tips and flow meters, more practical for termite control, is being produced. More versatile foam application equipment is now available.

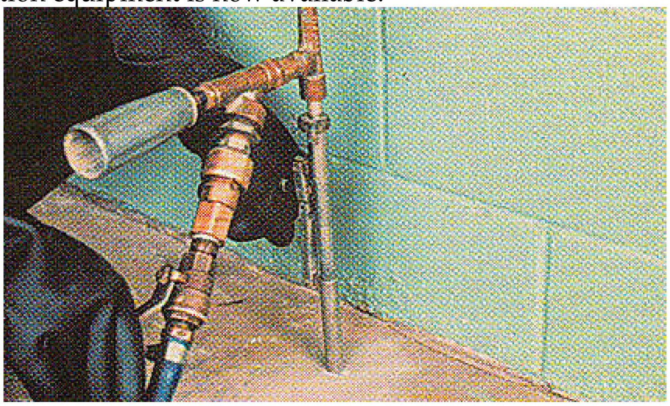


Figure 3.4 A slab injector used to inject termiticide under pressure into an area beneath a slab.

Drills

Various-sized **drills** and **rotary hammers** are used to facilitate application of termiticide by drilling holes through concrete. Large holes are drilled using electric or **compressed air hammers.** As a general rule, rotary hammers drill faster than the non-rotation types because dust is removed from the hole mechanically as it is drilled. Carbide-tipped drill bits are more expensive than steel drills but cut faster and require much less sharpening.

Air hammers have the advantage of rapid drilling speed even with large-diameter drills, and the hammer itself is usually relatively lightweight (making work less tiring for the pest management professional). Electric hammers of comparable specification usually are heavier and drill more slowly than air hammers. Because they do not require the use of a heavy air compressor, they are more portable than air hammers, and they create less dust.

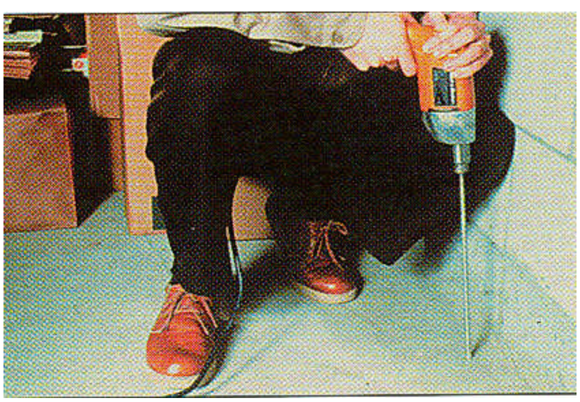


Figure 3.5. Slabs are drilled so that termiticide can be injected through holes to treat the soil beneath.

CALIBRATION OF SPRAYERS

Calibration is the process of measuring and adjusting the amount of pesticide your equipment will apply to a specific area. In structural pest management, much is up to the judgment of the pest control operator. A pest management professional should know that the proper concentration of pesticide is being applied. Without accurate calibration of sprayers, the amount of pesticide delivered will be incorrect. Concentrations exceeding label directions will contaminate the spray area or result in runoff. Less than the recommended dosage might fail to control the pest. Technicians need to look regularly at the output of their equipment. ***Flow meters*** are very helpful for determining the output of the sprayer over time.

Application rates can be determined with the use of a flow meter and a timer. The application rate or delivery rate is generally measured as the amount of time it takes to deliver 1 gallon of liquid per unit area. Delivery rates will vary considerably in termite control operations depending on several factors such as the type of soil termiticides are being injected into (i.e., its composition, compaction, etc.), the method used to inject the insecticide, and the type of construction being treated. Equipment may need to be calibrated for each specialized situation. Flow meters are preferred because they provide the operator with a constant and accurate reading of the delivery rate.

PREVENTING CONTAMINATION OF DRINKING WATER SYSTEMS

Liquids can be drawn into water pipes by siphon action or back pressure. Accidental contamination of entire residential districts has occurred when the drinking water line had a sudden drop in pressure while a sprayer or tank of termiticide was being filled with water from a hose connected to a resident's faucet. The drop in water pressure siphoned the termiticide into the public water supply system. The basic precautions to aid in avoiding this kind of mishap include:

1. ***Never*** permit a water hose or faucet to extend into the insecticide or the rinse water when filling a spray tank or rinsing insecticide application equipment.

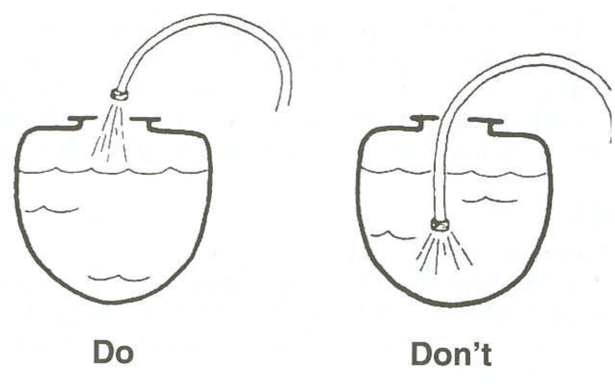


Figure 3.6. Keep hoses out of contaminated water.

2. ***Backflow preventers*** should be used to prevent the contamination of water supplies.

A backflow preventer should be installed on the end of the hose connected to the faucet anytime water is being used from private or public systems to fill pesticide tanks or equipment. It must be located between the water source and the pesticide tanks. Backflow preventers vary substantially in the level of protection offered; select preventers that meet your particular needs.

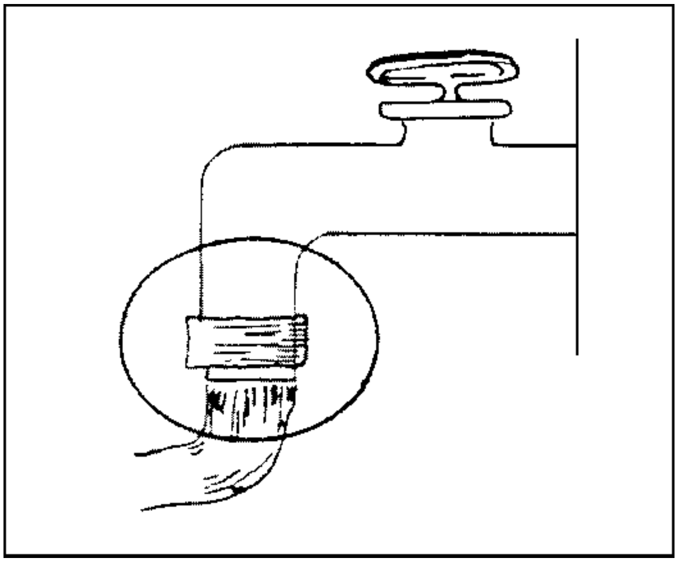


Figure 3.7. A backflow preventer should be installed on the end of the hose connected to the faucet. This helps ensure against accidental contact with contaminated water in spray tanks and contamination of the water supply.

Figure 3.8 shows a backflow preventer in the open and closed positions. When the water is turned off, the valve closes and prevents backflow or back siphonage. If backflow occurs through the hose, the liquid exits through the atmospheric ports (holes in the device as shown in Figure 3.8).

Backflow preventers for hose connection installations should meet the American Society of Sanitary Engineers (ASSE) Standard 1011(Hose Connection Vacuum Breakers. Backflow preventers for hose connections meeting ASSE Standard 1011 are **not** designed to prevent backflow if the back pressure greatly exceeds that of the water system (such as might occur if the hose is connected to the discharge side of a pump). These devices might prevent such backflow for a short period of time, but must not be relied on for this protection. They do protect from back siphonage or low backflow pressure such as might occur if a hose accidentally gets into a spray tank and the tank is above the water system.

Continuous pressure in-line backflow preventers meeting ASSE Standard 1012 will prevent backflow even if the back pressure is high. However, they are designed for permanent installations. Some newer homes' outside spigots have backflow preventers built into the spigots.

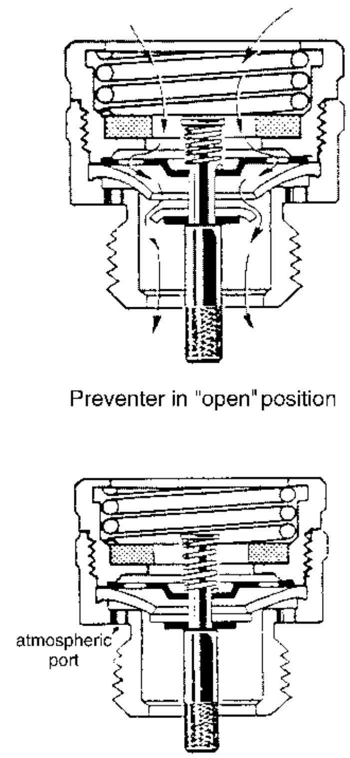


Figure 3.8. Backflow preventer in open and closed positions.

Backflow preventers can be obtained from some pest control suppliers or from plumping supply houses. Advice on local codes and requirements can be obtained from plumbing or health inspectors. ***In the event of water contamination, contact your city, county or state health officials immediately.***

Inspection of Wells

Many termiticide labels refer to applications near wells. Labels of the termiticides contain statements that warn against "contamination of public and private water supplies." The necessity of preventing any termiticide or other pesticide from reaching these water supplies must be clearly understood by those making inspections and recommendations. It is also essential for the technicians actually doing the applications to understand the importance of their work around the structure.

If a well is present on a property, it is important for the person making an inspection to be aware of several problems that could lead to introduction of the termiticide into the water supply:

1. Faulty wells are the most common cause of pesticide contamination reported to the National Pest Management Association (NPMA). Faults in the sealing of the well permit surface water to enter the well, usually along the pipes leading to the building. This type of well is also susceptible to biological (bacterial) contamination.
2. Old cisterns or dug wells that are no longer in use but have not been properly filled are susceptible to contamination from termite applications. Chemicals can accumulate in them and seep into wells or cisterns in use, or into groundwater.
3. Cisterns or wells within the structure can become contaminated. Adequate inspection should reveal this potential problem. **Note:** Many termiticide labels have specific instructions on treatment of structures that contain wells or cisterns.
4. Unusual fill problems or change in surface grade may permit liquid chemical to move by concealed routes to the well.
5. Tree roots often reach water sources. These may also be direct channels for termiticides to follow, especially after the tree or root dies, decays, and leaves an open channel through the soil.
6. High water tables can result in contamination of wells after a termiticide application.

In most of these situations, adequate inspection can uncover a potential problem. The pest management professional must be extremely careful and use expert judgment when performing control procedures. In cases where chemicals have been introduced into wells, even after removal procedures, health departments have sometimes ordered new wells drilled. The cost to the pest management professional can be great in increased insurance premiums, time spent in removal procedures and tests, and loss of customers because of adverse publicity.

As previously noted, inspection is the first and most important step in designing a safe treatment procedure. The owner should be questioned about:

- The well's location from the foundation.
- The depth of the well.
- Where the supply line enters the structure.
- Depth to water.

After obtaining this information, its accuracy should be checked by observation. ***If the homeowner intends to hook up to a public water supply, the termite treatment should be delayed until after that occurs.***

The inspector should note any factors that may influence the decision on type of method to use or feasibility of performing treatment. The common problems listed previously are of particular importance. Also, note particularly:

- The slope of the land or paved surfaces around the house.
- The runoff patterns.
- The type of soil and moisture.
- The depth of foundation footings.

METHODS

Every termite control operation must start with a thorough inspection. Once the nature and extent of the problem have been identified and a thorough inspection report has been filled out, the pest management professional must decide on the appropriate methods required to control the pest problem. The pest management professional must also consult with the client to determine the level of control desired. In many cases, non-chemical methods or less toxic means such as using termite baits may control the problem to an acceptable level. If total pest elimination is desired, it may be necessary to use chemicals. In some cases (e.g., likelihood of well contamination), it may not be practical to solve the customer's problem safely by use of chemicals. Mechanical alterations to the structure, if economically feasible, may be recommended.

INSPECTION

When called to a building in which a subterranean termite infestation is suspected, a pest control specialist must be able to determine whether termites are actually present. Sometimes an active infestation is obvious. Other times the problem may be difficult to see, requiring a great deal of effort and the use of specialized techniques and information to reach the correct diagnosis.

It is important that termite control specialists know and understand building terms, such as ***crawl space, footing, joist,*** and so forth. (See the glossary [Appendix B] for definitions of these frequently used terms, and refer to Appendix D for diagrams of structural members.) Knowledge of these terms is helpful in understanding the following discussion of inspection and treatment for subterranean termites.

In making the inspection, a good, bright flashlight is critical. The inspector must look at each potential trouble spot closely. Often this means entering crawl spaces and other non-basement areas. A satisfactory view cannot be obtained from a distance greater than a few feet. For this part of the inspection, the inspector should wear a pair of coveralls, a bump hat, and gloves. The inspector also

Figure 3.9. Inspection of crawl space for termite infestations (he should also be wearing gloves).

needs to measure the structure accurately. A steel tape, a folding rule, and a rolling measuring device are essential tools for every inspection.

The presence of swarmers or their shed wings almost invariably indicate that a termite infestation is present. To do a proper control job, however, the specialist must not only determine the point from which the swarmers came but also locate all exposed tubes and damaged wood.

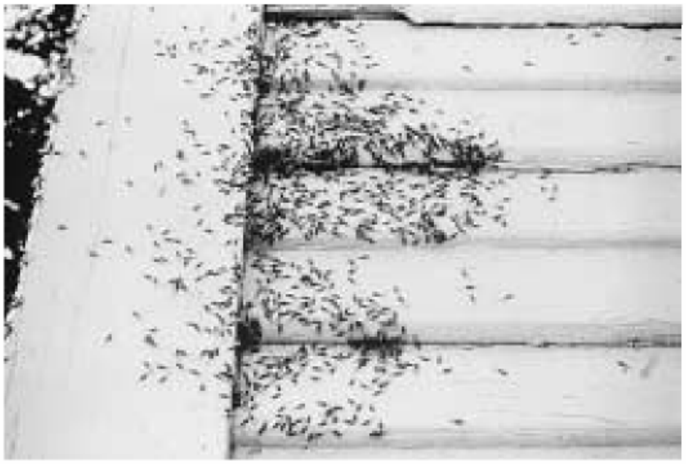


Figure 3.10. The presence of swarmers is often detected by the homeowner as the first sign of termite infestation.

Subterranean termite damage differs from that of all other wood-destroying organisms. These termites usually remove only the soft layers (spring wood) within the annual rings of the wood grain, penetrating the hard layers only to get from one soft layer to another. This frequently leaves a damaged piece of wood looking very much like pages of a book. The most distinctive feature of subterranean termite damage is the presence of a brown mudlike material that lines the galleries in an irregular pattern.

Subterranean termites travel constantly from their nests in the ground to the wood or to other cellulose-containing material upon which they feed. They make these

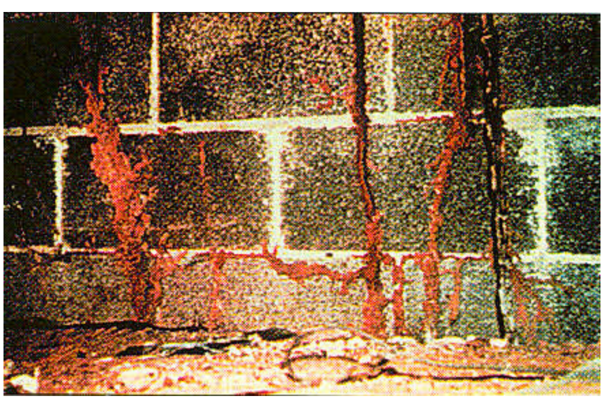


Figure 3.11. To reach wood in buildings, termite workers Often make mud tubes up the out side or inside of founda-Tion walls. These tubes protect the workers from natural Enemies and help provide the moist environment they need.

trips only inside wood or in the mud tubes that they construct. Single tubes, when built in the open, are about the diameter of an ordinary lead pencil.

Termites may excavate the wood so that only a very thin layer of wood is left on the surface between their cavities and the outside. When this layer is broken, they will cover the hole with the same material used to make their tubes. This mixture of soil, feces, and saliva is also frequently used to cover the crack between two boards so that the termites can move about in a protected environment.

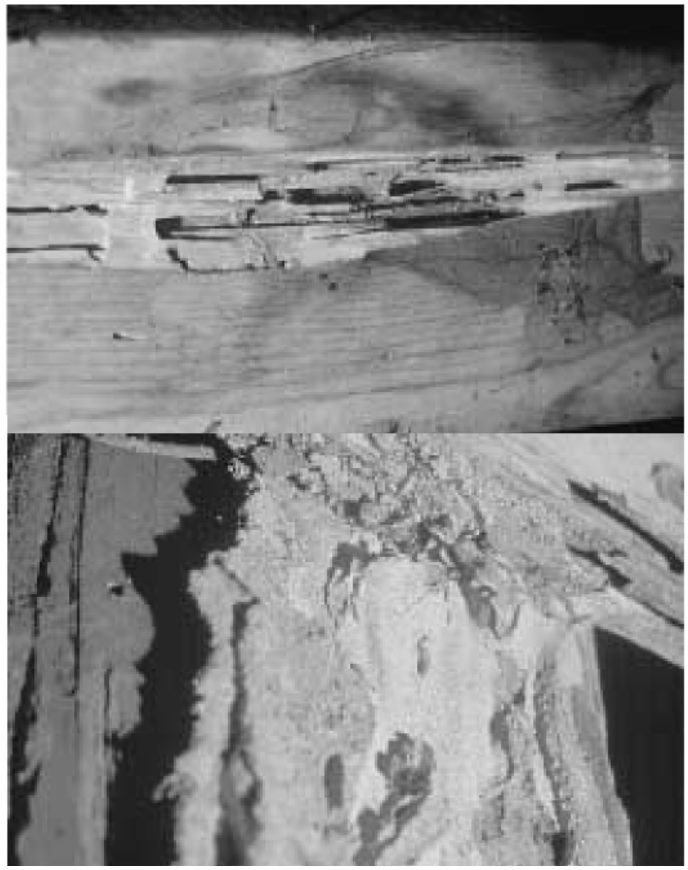


Figure 3.12. Termite damage to wood—galleries may be hidden by only a thin layer of wood (top); the presence of soil, feces, and saliva is a typical sign of termite damage in wood (bottom).

As a general rule, subterranean termites are found at or near ground level. They occasionally occur above the level of first-floor windows. An inspector must inspect the basement and crawl space wall, supporting piers and beams, sill plates, floor joists, and subfloors. Particular attention must be paid to all places where concrete steps, porches, or concrete slabs join with the structure.

Tapping on the wood and listening for the hollow sound of damaged wood (referred to as ***sounding)*** can detect cavities in the wood that are not visible from the surface. Occasionally, it is possible to detect a ticking sound made by the disturbed soldiers within the wood. Tapping does not usually require a heavy object but can be done by using a small hammer or even by thumping the surface of the wood with the knuckles.

Cavities can also be detected by probing the wood with a tool such as a screwdriver, awl, or pocketknife. The small blade of a penknife can be used to probe the wood, leaving scarcely visible marks in it. In some cases, such as certain areas or types of construction, it may be necessary to use heavier tools and/or to probe more deeply.

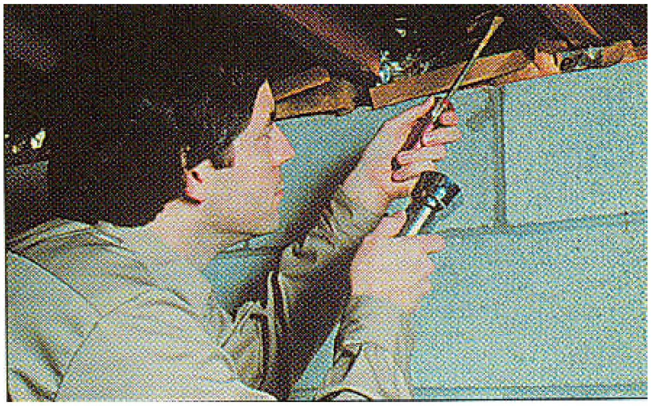


Figure 3.13. Probing the wood with a tool can help detect cavities.

Failure to find live termites does not necessarily mean that they are not present. An inspector must be able to distinguish between new and old termite workings. As a general rule, old mud is dry and brittle and breaks away easily; fresh workings will be moist.

The Inspection Report

To present the results of a termite inspection to the client and to have a work plan for the treatment, it is necessary to make an adequate diagram of the building to be treated together with a sufficient description of the structure and the problems to be solved.

A well designed inspection form allows the inspector to include all pertinent information. Such a form should include cross-ruled paper on which a diagram of the structure can be drawn to scale. This drawing should include the type of construction, all crosswalls, stairways, doorways, porches, stoops, and other parts of the structure that will affect the method of treatment. It is most important that it be drawn accurately and to scale because this may reveal hidden or inaccessible areas, which are often sites of severe infestation and damage.

Each place where live termites are found should be clearly indicated on the diagram. All existing damage, inaccessible areas, and other unusual situations should be indicated. In addition, details of construction should be shown, including:

- The materials of which the outside walls and foundations are made (e.g., concrete block, stone, etc.), and whether the exterior covering extends below grade.
- The places where it will be necessary to drill through the concrete floor, such as in doorways, and driveways.
- Whether the building has a basement or a crawl space or is a concrete slab on grade.
- Recommendations for locations where ventilators should be installed.
- The conditions that may be conducive to termite attack (such as improper grade).
- Other pertinent information.

Individual companies may prefer to include additional items or may find that local conditions are such that additional information is necessary.

PREVENTION

Structures can be pretreated at time of construction to protect them from termite attack. Pretreatment is highly desirable, especially in buildings constructed on concrete slabs, which are very susceptible to termite attack. There are three major considerations when preventing termites from invading a new building:

1. Sanitation of the building site.
2. Structural and construction defects.
3. Barriers (mechanical or chemical).

Sanitation

Remove all tree roots and stumps from the building site before starting construction. Remove spreader boards and grade stakes before concrete sets. Remove form boards and wood scraps from soil before filling or backfilling. Do not bury wood in the backfill, under porches or steps—this may attract termites.

Structural and Construction Defects

Allow sufficient space and ventilation outlets for air movement to aid in keeping soil dry beneath structures with crawl spaces. The finished grade outside the building should slope away from the foundation so water won't collect under the structure. In the final grading, allow at least 6 inches of clearance between the top of the soil and the top of the foundation. Porch supports should be separated from the building by at least 2 inches. Wooden steps

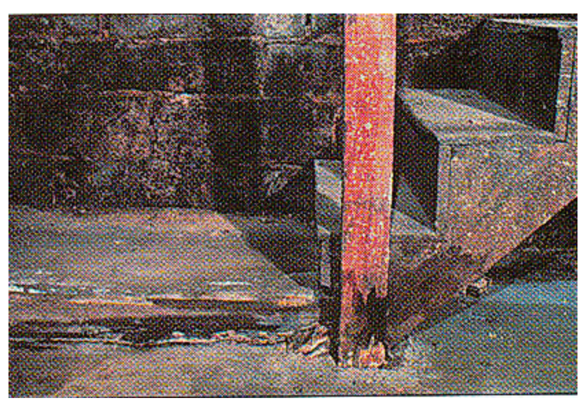


Figure 3.14. To prevent termite infestations, do not allow wood form boards to be embedded in concrete as shown in this basement.

should rest on a concrete base that extends 6 inches above grade. Do not place basement partitions, posts, and stair stringers until the concrete floor has been poured. They should never extend into or through the concrete.

Barriers

Barriers fall into two major categories: mechanical and chemical.

Mechanical barriers

Metal termite shields: Properly designed, constructed, installed, and maintained metal termite shields can give some protection. When properly installed, mainly during preconstruction, stainless steel mesh has been found to be an effective barrier to subterranean termites. Cost may be a disadvantage.

Sand, granite, or **basalt** may have some utility in preventing termite entry into structures. These barriers consist of specific particle sizes that cannot be penetrated by termites when properly installed. The particle size distribution is such that the termites are unable to move through these spaces. Many variables affect the effectiveness of sand barriers, but when used in conjunction with other methods, they can be useful in preventing termite infestations.

Chemical Barriers

Treated lumber: Chemically treated lumber should be used for the foundation plate, mudsill, and all partition framing and furring strips used belowground. For maximum protection, the wood should be pressure impregnated with a preservative. Brushing, spraying, or soaking the lumber with the chemical gives only limited protection.

The use of **borates** (disodium octaborate tetrahydrate) in several formulations to penetrate into wood for the local control of termites has shown potential in preventing infestations. Results in eliminating existing infestations have been variable; thus, the use of borates for controlling established infestations must be evaluated on a case-by-case basis.

Soil insecticides: Treatment of the soil around and under the foundation with one of the recommended soil insecticides is a good method of preventing termite attack. Soil treatment should be used as a supplement to good construction, not as a substitute for it. Treatment is needed in four areas during construction:

1. The entire soil surface under any area to be covered with concrete, including garage and basement floors, entrance platforms and filled porches.
2. The soil beneath those areas that lie adjacent to foundation walls, beneath interior walls, around sewer and utility openings, and at other possible points of entry.
3. Footings and backfill outside foundation walls and inside walled areas where there is a crawl space. Accessible areas such as these could be treated later, but it's easier to do it at construction time.
4. Empty spaces or voids in concrete blocks.

PRODUCTS USED IN TERMITE CONTROL

Examples of termiticides used for soil treatment include cypermethrin, fipronil, fenvalerate, imidacloprid and permethrin. Any of these can be used to establish a chemical barrier that kills or repels termites. Label directions for these materials should be followed closely for the concentration and rate of application to be used. The judgment and experience of the termite specialist is important when selecting the termiticide that best suits the particular type of construction and the soil conditions. Below are descriptions of the various products and classes of chemicals that can be used in termite control.

Pyrethroids

The pyrethroids are a large family of modern synthetic insecticides similar to the naturally derived botanical pyrethrins. They are highly repellent to termites, which may contribute to the effectiveness of the termiticide barrier. They have been modified to increase their stability in the natural environment. They are widely used in agriculture, homes, and gardens. Some examples are bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin.

They may be applied alone or in combination with other insecticides. Pyrethroids are formulated as emusifiable concentrates (EC), wettable powders (WP), granulars (G), and aerosols.

Certain pyrethroids exhibit striking neurotoxicity in laboratory animals when administered by intravenous injection, and some are toxic by the oral route. Systemic toxicity by inhalation and dermal absorption are low, however—there have been very few systemic poisonings of humans by pyrethroids. Though limited absorption may account for the low toxicity of some pyrethroids, rapid biodegradation by mammalian liver enzymes (ester hydrolysis and oxidation) is probably the major factor responsible. Most pyrethroid metabolites are promptly excreted, at least in part, by the kidney.

In response to dermal exposure, some persons may experience a skin sensitivity called ***paresthesia.*** The symptoms are similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area.

Paresthesia is caused more by pyrethroids whose chemical makeup includes cyano- groups: fenvalerate, cypermethrin, and fluvalinate. In addition to protecting themselves from future exposure, persons who have experienced paresthesia should choose a pyrethroid with a different active ingredient, as well as a wettable powder or microencapsulated formulation.

Borates

"Borate" is a generic term for compounds containing the elements boron and oxygen. Boron never occurs alone naturally but as calcium and sodium borate ores in several places in the world.

Borax and other sodium borates are used in numerous products such as laundry additives, eyedrops, fertilizers, and insecticides. Though the mechanisms of toxicity are not fully understood, boron is very toxic to insects and decay fungi that commonly damage wood in structures. At low levels, however, boron is only minimally toxic, and perhaps beneficial, to humans, other mammals, and growing plants. Use of borate-treated wood for construction of homes and their wood-based contents appears to offer many advantages to today's environmentally sensitive world.

Unlike most other wood preservatives and organic insecticides that penetrate best in dry wood, borates are diffusible chemicals—they penetrate unseasoned wood by diffusion, a natural process. Wood moisture content and method and length of storage are the primary factors affecting penetration by diffusion.

Properly done, diffusion treatments permit deep penetration of large timbers and refractory (difficult-to-treat) wood species that cannot be treated well by pressure. The diffusible property of borates can be manipulated in many ways; suitable application methods range from complex automated industrial processes to simple brush or injection treatments. Application methods include momentary immersion by bulk dipping; pressure or combination pressure/diffusion treatment; treatment of composite boards and laminated products by treatment of the wood finish; hot and cold dip treatments and long soaking periods; spray or brush-on treatments with borate slurries or pastes; and placement of fused borate rods in holes drilled in wood already in use.

Organophosphates and Carbamates

These are two very large families of insecticides. Indeed, they have been the primary insecticides for the past 25 to 30 years. They range in toxicity from slightly to highly toxic. They are formulated in all kinds of ways from highly concentrated emulsifiable concentrates (ECs) to very dilute granular (G) formulations.

These insecticide families are similar in their modes of action—they are all nervous system poisons. Insects and all other animals, including humans, have nervous systems that are susceptible. Both insecticide families are efficiently absorbed by inhalation, ingestion, and skin penetration. To a degree, the extent of poisoning depends on the rate at which the pesticide is absorbed. Organophosphates break down chiefly by hydrolysis in the liver; rates of hydrolysis vary widely from one compound to another. With certain organophosphates whose breakdown is relatively slow, significant amounts may be temporarily stored in body fat.

The organophosphates and carbamates replaced the chlorinated hydrocarbons (e.g., chlordane, aldrin, and heptachlor) for all uses, including termite control. Examples of organophosphates are chlorpyrifos for termite control and diazinon for other household pests. An example of a carbamate is carbaryl, also used for household and lawn pests.

Insect Growth Regulators

An insect growth regulator (IGR) is a synthetic chemical that mimics insect hormones. Hormones regulate a wide array of body and growth (physiological) functions. IGRs may interfere with molting, pupal emergence, or body wall formation.

IGRs are often specific for an insect species or a group of very closely related species. They often have delayed effects because they are taken into the insect and stored until the insect reaches the right growth stage. This may range from days to weeks or even months. For example, if the IGR stops the insect from molting and a given insect is exposed just after a molt, it would continue to function normally until the next molt before dying.

In the case of termite control, the slow action of the IGR allows the chemical to be widely spread throughout the colony as the termite workers feed and groom one another.

IGRs are, in general, environmentally safe and have very low mammalian toxicity. Some examples are hexaflumuron, diflubenzuron, pyriproxyfen, and methoprene.

Biotermiticides

Biotermiticides — such as fungi, nematodes, bacteria, and so forth—still need further research and development to maximize their potential. *Metarhizium anisopliae* can be injected into galleries, infested walls, and other moist areas where the humidity accelerates the fungal growth. Several forms of nematodes are sold for termite suppression. Nematodes are applied to the soil or directly into mud tubes. As with all new methods of control, more research is needed to determine the advantages and limitations of such organisms.

Foaming Agents

Foam formulations of soil-applied termiticides can deliver termiticide to areas difficult to reach with liquid formulations. Borates are foamed for application in wall voids. Foams penetrate into hard-to-reach cavities and voids, and they improve termiticide distribution in soils. The most difficult area to achieve uniform and continuous insecticide distribution is under slabs, where the termite control specialist is unable to see the actual deposition of the termiticide.

Foam applications can reduce the need for corrective treatments, especially under slabs. The liquid termiticide is combined with air to create uniform, small-diameter bubbles. The foam carries the liquid termiticide in the spaces between the bubbles. As the foam breaks down it leaves a thin residue on the surfaces it had contact with. The fact that foam is less dense than liquid enables it to dispense uniformly. The foaming agent delays collapse of the bubbles, providing more time for the insecticide to reach desired areas. Underneath a slab, gravity deposits most of the liquid on the soil, with a small portion of the residue on other surfaces (such as the underside of a concrete slab) in the treated areas.

Foam treatments do not replace other soil applications(they supplement these applications so that gaps left by conventional treatments can be successfully treated. Foams are being used to treat—or retreat—critical areas such as unevenly filled porches, which liquids might not reach or cover uniformly. Foams may be used in initial treatments to ensure the most complete termiticide barrier in critical as well as hard-to-reach areas, thus reducing the treatment failures that may occur with the use of soil-applied termiticides alone.

FUMIGATION

Pests that can be treated with fumigation include drywood termites, Anobiid powderpost beetles (usually in softwoods such as floor joists, etc.), Lyctid powderpost beetles (sapwood of hardwoods such as moldings, cabinets, and flooring), and old house borers (sapwood of softwoods in beams, rafters, etc.).

Advantages of Fumigatio n

Fumigation has several advantages over other pest control procedures:

- Fumigants are usually quick acting and eradicate the pest.
- Fumigants diffuse through all parts of the structure or commodity being treated and thus reach pest harborages that cannot be reached with conventional pest control materials or techniques.
- For certain pests/commodities, fumigation is the only practical method of control.

Disadvantages of Fumigation

For several reasons,fumigation may not be the best means of pest control:

- The control achieved through fumigation is temporary. There is no residual action from fumigants, and as soon as the fumigation is completed, the structure or commodity is susceptible to reinfestation.
- Fumigants are toxic to humans and special precautions must be taken to protect fumigators and the occupants of fumigated structures.
- Fumigants must be applied in enclosed areas, so application requires additional labor.
- Fumigation must not be attempted by one person. Additional labor is required.
- Some commodities or pieces of equipment may be damaged by certain fumigants and must be either removed or protected.
- The special training required for all members of the fumigation crew adds to fumigation costs.
- Occupants of the structure being fumigated usually must vacate the building for a number of hours. This may be inconvenient.
- Fumigation requires special licenses and certification.

BAIT TECHNOLOGY AND APPLICATION

There are several termite baits on the market that add to the arsenal of tools available for managing termite populations and protecting structures. Baits work on the principle that foraging termites will feed on a treated cellulose material, which eventually kills the termites andpossibly the colony. The toxic material in the bait must kill slowly enough to allow foraging termites to return to the colony and spread the bait through food sharing (trophallaxis). Because dead termites repel other termites, the toxic material also must kill slowly enough so that dead termites do not accumulate near the bait.

Baits control a colony locally—either eliminating it or suppressing it to the point that it no longer damages a structure. To be successful, the products must be nonrepellent, slow acting and readily consumed by termites. Three main types of bait products are available:

- Ingested toxicants or stomach poisons.
- Biotermiticides or microbes.
- Insect growth regulators (IGRs).

Each type has unique features and is used differently in termite control programs. Ingested toxicants have the quickest effect, though dose dependency and learned avoidance may limit this type of product to termite reduction in localized areas. Biotermiticides, derived from fungi, bacteria, or nematodes, are injected into active gallery sites. They then develop on the infected foraging termites and spread among the colony. Suitable temperature and moisture, early detection, and avoidance are factors that determine this treatment's success. It may provide localized area control or, with optimum conditions, may suppress a colony.

Among the insect growth regulators are juvenile hormone analogs (JHA), juvenile hormone mimics (JHM), and chitin synthesis inhibitors (CSI). These products disrupt the termites by causing a specific response or behavior within the colony or by blocking the molting process. Remember that all insects, including termites, have an exoskeleton made primarily of chitin. To grow, they must periodically shed their chitinous exoskeletons and form new ones. This process is called molting. A chitin synthesis inhibitor slowly builds up in the termite and, the next time a molt occurs, prevents proper formation of the cuticle. IGRs are the slowest acting of the bait types but have greater impact on the colony.

Bait Placement

Baits take advantage of the social nature and foraging behaviors of subterranean termites. Foraging worker termites consume the bait and then share it with the rest of the colony, resulting in a slow colony decline and, depending on the active ingredient, eventual elimination. Belowground monitoring stations (without any active insecticide) are sometime used to establish a feeding site for the foraging termite workers, and then the baited stations are installed. These are often placed every 10 to 20 feet around the perimeter of the building, 2 feet out from the foundation. The number and placement of bait stations vary, depending on the product used, the characteristics of the site, and the amount of termite activity. A station generally contains a cellulose-based material impregnated with an IGR or a slow-acting toxicant. The bait is usually placed inside a tamper-resistant housing.

Other baiting strategies include **interceptive baiting,** in which aboveground bait systems are placed in the path of the termites (in mud tubes or in areas of wood damage and termite presence), so that the termites come in direct contact with the bait. The termites then feed on the bait and recruit other colony members to feed at the station. This approach eliminates the colony more quickly than placing baits in the soil around a structure.

Commercial Baiting Products

Examples of active ingredients included in termite baits are hexaflumuron and diflubenzuron (insect growth regulators), and sulfuramid. Some of these termiticides can be used to provide continuously effective control. Perimeter soil treatments and soil treatments to infested areas used in conjunction with baits (while taking care to avoid contaminating bait placements with soil termiticide) can usually satisfy a customer's desire for an immediate solution and allow time for the bait to provide suppression or long-term colony elimination.

Advantages and Disadvantages

As with any technology, there are advantages and disadvantages to the use of termite baits compared to the use of liquid termiticides.

Advantages of Termite Baits

- They are easy to use.
- Drilling of structural concrete is rarely required.
- Baits are more environmentally friendly than soil drenching with liquid termiticides.
- Active ingredients are generally less toxic than those in soil insecticides.
- Termite baits are a better choice for chemical- or odor-sensitive customers or for customers who have ducts beneath or within slab foundations, have wells beneath or close to foundations, or have rubble foundations.

Disadvantages of Termite Baits

- Bait programs may be more expensive in some cases and may require continual monitoring after colony elimination or suppression has been attained.
- It takes longer to eliminate a colony with baits than with liquid termiticides. Baiting programs may take several months to a year to control infestations, depending on a number of factors that limit termite foraging.
- Baits cannot easily be put under slabs or in wall voids where termites often occur. Thus damage may continue until the entire colony is eliminated.

Pest management professionals should explain the advantages and disadvantages of termite baiting programs to their customers. Total elimination of the colony may not be achieved. Colony suppression rather than total elimination may or may not be satisfactory to the customer. The decision to use baits will depend onwhether the customer will tolerate some level of continuing damage rather than extensive soil treatment.

Baits fit well into an integrated pest management (IPM) program, along with eliminating conditions conducive to termite infestation, judicious use of liquid soil products, and use of wood treatment products. An IPM program will require more frequent visits to the site for monitoring and on-going service. Pest management professionals are strongly encouraged to familiarize themselves with bait technology and future products. Baits are a useful, innovative tool for termite control. They should be viewed as an addition to existing termite control methods, not necessarily a replacement for them.

SUMMARY

Selecting and using the right type of equipment are essential to the success of any termite control program. The equipment must be in good repair, appropriate for the size and nature of the job, durable, and resistant to corrosion by pesticides. Pest management professionals are responsible for protecting themselves and the environment by preventing accidents and spills, harm to nontarget organisms, and contamination of water sources, and by wearing personal protective equipment (PPE). The pest management professional must be familiar with the types of equipment available and their proper use to apply pesticides safely and effectively. Keeping up-to-date with improvements and innovations in pest control equipment and methods will help ensure successful termite control operations.

Pest management professionals must know where and how to look for the presence of termite infestations. Each termite control operation must start with a thorough inspection of the structure and surrounding area. The inspection report should include an accurate drawing of the structure, details on the type of construction and other features, locations for treating termite infestations, areas where water contamination might occur, and other pertinent data. To fill out an inspection report effectively, the pest management professional must have a thorough understanding of building construction and terminology and should have the knowledge to advise building contractors on preconstruction methods for preventing termite infestations.

Finally, the pest management professional must be familiar with the various classes of chemicals used in termite control and know the advantages and disadvantages of each. For every termite control situation, the pest management professional must determine what, if any, pesticide should be applied. The least amount of pesticide should be used that will control the pest to the customer's satisfaction. If use of the pesticide poses a significant risk to people or the environment (e.g., contamination of well water), the customer should be advised of alternative methods.

CHAPTER 4

SOIL TREATMENT FOR SUBTERRANEAN TERMITES

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the basic types of building foundations.
- Understand the techniques used to treat soil for control of subterranean termites.
- Understand how cracks and voids in foundations are treated to control subterranean termites.
- Know the various types of pre- and postconstruction methods for controlling termites.
- Know the techniques used to treat subterranean termite infestations for various types of building construction.
- Understand how termite entry points vary, depending on factors such as foundation type, walls, and flooring.
- Know how to calculate linear feet and square feet and to interpret a termiticide label so that the right amount of termiticide will be applied in both vertical and horizontal treatments.

This chapter discusses termite control procedures used for various types of building construction. It is important to remember that foundations can be of three general types: slab, basement, and conventional (crawl space). Each of these types of construction has structural features that require specialized attention to establish a physical or chemical barrier that prevents termite entry into a building. For example, treatment outside the structure may involve **trenching** and treating or **rodding** to treat the soil on the outside of the foundation, rodding beneath slabs, or vertical drilling and treating of outside slabs, stoops, or porches. Treatments inside may involve trenching and treating the soil along foundation walls in crawl spaces, vertical drilling and treating slab foundations, rodding around bath traps and other utility openings, or treating wood directly. The examples that follow will outline the procedures to use in controlling subterranean termites for these and other elements of construction.

FOUNDATION TYPES

There are three basic foundation types pest management professionals may encounter in termite control operations — **slab-on-ground, crawl space** (including **plenum**

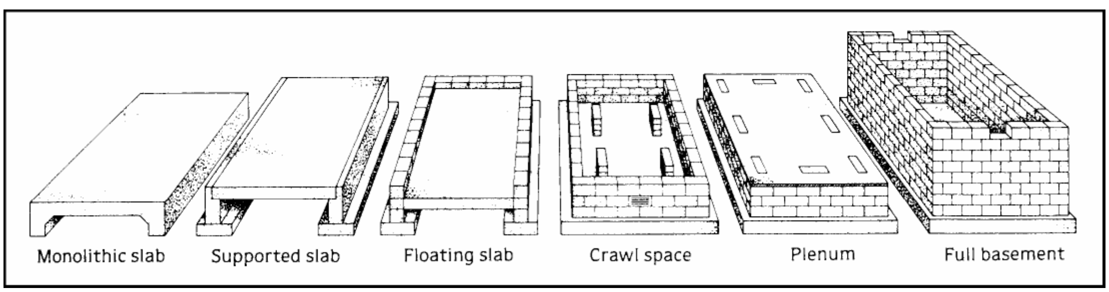


Figure 4.1. Foundation types (Mallis, *Handbook of Pest Control*, 7th Edition).

crawl space) and **basement.** Treatment procedures for each foundation type will differ somewhat. Slab-on-ground construction consists of three types—**floating, monolithic,** and **suspended slab.** Termite entry points vary in each slab type, thus different treatment procedures are required. Plenum crawl space construction will be encountered more rarely and is covered in Chapter 5. Finally, basement construction is common in Michigan and requires special consideration especially where there is a French drain or a sump pump (see Chapter 5).

Slab-on-ground

This type of construction is used extensively. Because of the hazard of drilling through heat pipes or ducts, electric conduits, and plumbing imbedded in the floor, it may be advisable to treat from the outside by drilling through the foundation wall. Mechanical alteration is not usually necessary with this type of construction. The three basic types of slab-on-ground construction are floating slab, monolithic slab, and suspended slab (Figures 4.1-4.3).

In **floating slab** construction, the foundation wall and footing are separated from the slab floor by an expansion joint. The slab floor is concrete; the foundation wall can be a variety of materials, such as solid block, hollow block, or concrete.

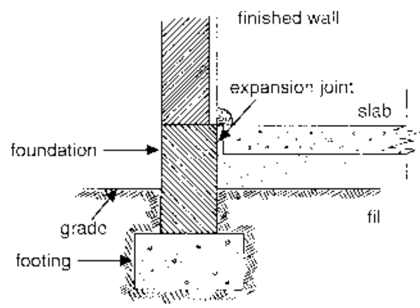


Figure 4.2. Floating slab construction.

In **monolithic slab** construction, the foundation footing and the slab floor are formed as one continuous unit. Concrete is the material used in this type of slab foundation.

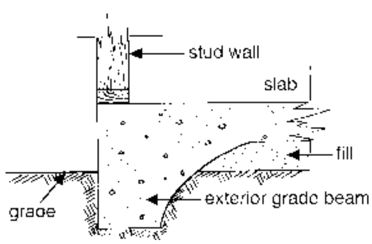


Figure 4.3. Monolithic slab construction.

In **suspended slab** construction, the slab floor and the foundation wall are separate units, with the slab floor extending over the top of the foundation wall. The slab floor is concrete; the material used for the foundation wall may vary.

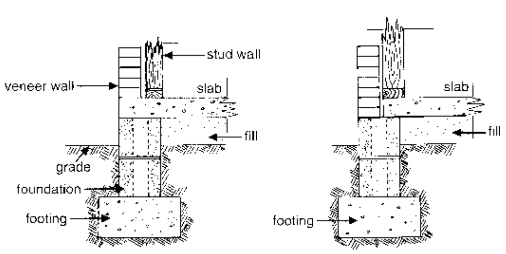


Figure 4.4. Suspended slab construction.

Crawl Space Construction

A **crawl space** is a shallow space below the living quarters of at least a partially basementless house. It is normally enclosed by the foundation wall (see Figure 4.4). Crawl spaces are usually less than 3 feet high with exposed soil underneath. This type of construction is common in many parts of the country. The exposed soil and the short distance to floor joists and sills make crawl spaces an ideal place for termites to find and infest wood.

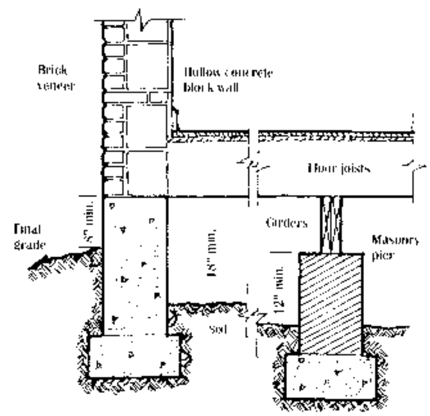


Figure 4.5. Crawl space construction.

Basement Construction

Though buildings with basements are less susceptible to termite attacks than slab-on-ground construction, basements do have their unique areas vulnerable to termite entry. It is important toremember that termites can enter though any crack or crevice as small as 1/ 32 of an inch.

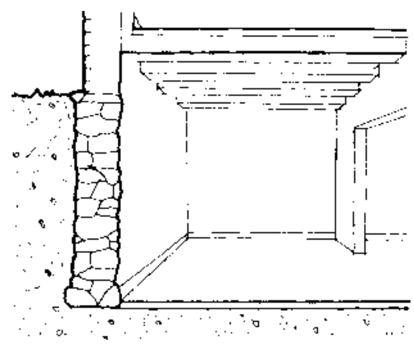


Figure 4.6. Basement construction.

SOIL AND FOUNDATIONTREATING

Soil treating consists of applying termiticides to the soil under and adjacent to a building to create an impervious chemical barrier. A continuous barrier should be established along the inside and the outside of the foundation, under slabs, and around utility entrances.

Traditionally, soil is treated with chemicals to establish a barrier that is lethal or repellent to termites. The chemical must be adequately dispersed in the soil to provide a barrier to all routes of termite entry. A thorough and uniform barrier also prevents the termites that are feeding in the structure from returning to the soil for moisture. This causes their death by either dehydration or contact with residual termiticide.

Effective soil treatment depends on dispensing a sufficient amount of chemical to establish a barrier wherever there are termite entry points in each type of construction. The amount of chemical applied is determined by the concentration of the formulation used and the rate of application specified on the product label.

Proper uniform soil treatment eliminates the need for wood treatment except where there is a moisture source that could sustain the termite colony above the soil level. However, additional wood treatment may accelerate the elimination of infestations.

Foundation treating is the application of termiticide to a foundation to make it impervious to termites. The objective is to place termiticide in all cracks at the footing as well as through cracks in the foundation wall that may lead to the ground outside. Treating the inside of hollow concrete block walls is another example of foundation treating.

PRECONSTRUCTION TREATMENT

The easiest time to apply a chemical barrier is before construction, and pretreatment should be encouraged whenever possible. The soil below all slabs should be treated before they are poured. Treatment should be both under horizontal surfaces and adjacent to vertical surfaces. The concentration and rate specified on the product label must be strictly followed. It is illegal to use less than or more than any rate or concentration specified on the label for preconstruction treatment.

Exterior Soil Treatment

Soil may be treated by rodding or trenching. **Rodding** is the injection of termiticide into the soil through a long pipe inserted at appropriate intervals (4 to 12 inches apart, depending on the soil type and other factors). In this way, termiticide can be carried to the level of the footing. Another method for applying termiticide to soil is by **trenching.** In this method, soil is removed to within about 1 foot above the footing. As the soil is replaced, it is treated with termiticide at the rate of 4 gallons per 10 linear feet for each foot of depth from grade level to footing. Whenever possible and practical, the soil should be saturated with termiticide to the footing.

treatment" or "limited treatment." Many pest management professionals use a combination of trenching and rodding, especially if the footing is very far below grade level.

Figure 4.7. A typical basement treatment will also include trenching and rodding the outside perimeter of the foundation.

Exterior Slab Treatment

An exterior concrete slab that abuts the structure complicates outside treatment. Poured slabs such as sidewalks, patios, and carports should be vertically drilled and treated no more than 12 inches apart. It may be necessary to vary the concentration and volume, as allowed by the termiticide label, to treat thoroughly under slabs.

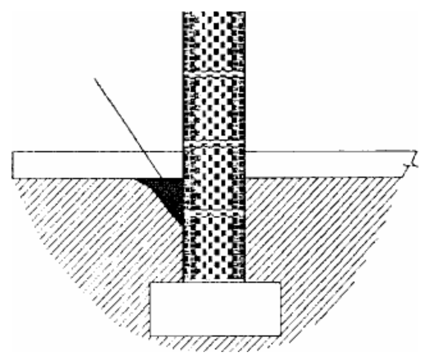


Figure 4.8. Exterior slab treatment (dark shading shows area treated).

Construction

Drill and treat concrete block foundation voids. It is very important that the holes be drilled at a height that is as close to the outside grade level as possible but not above the slab.

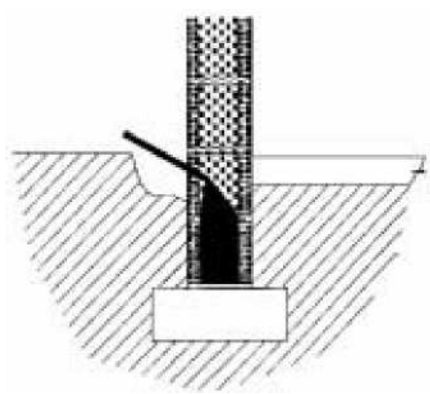


Figure 4.9. Foundation void treatment (dark shading shows area treated).

inside. Every void should be treated in the block. In the event of spillage, the area around all leaky drill holes must be cleaned. After cleaning, fill all holes to prevent exposure to the occupants.

Caution: Special care must be taken to ensure that the chemical does not puddle and flow out over the inside slab floor. If the soil line is above the slab line, it may be necessary to trench below the slab line to safely treat block voids at a point of entry below the inside slab line.

Treatment of Brick or Stone Veneer

Drill and chemically treat brick veneer voids only where the brick ledge is below grade level. Holes measuring approximately 1/4 or 3/8 inch in size must be drilled from the outside into the masonry between bricks and the void chemically treated. Generally, these holes should be drilled in every other brick.

Introduce enough termiticide to completely flood the void to the footing or base. The holes should not be drilled above the top of the foundation for basements or above the level of the interior slab in slab construction unless the slab is at exterior grade level or lower. Use enough pressure to spread the hemical and completely cover the voids. Holes drilled in outside brick walls should be sealed after treatment.

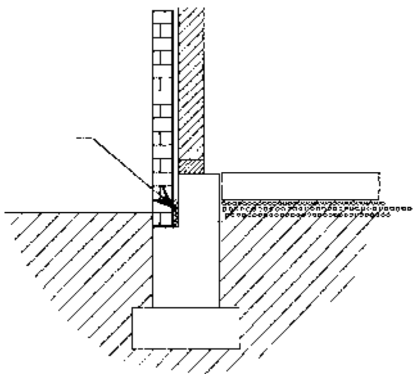


Figure 4.10. Treatment of brick or stone veneer (arrow points to treatment of void).

Where it is not possible to drill and treat below the top of the foundation or interior slab level, it may be necessary to trench and treat the soil to below the brick ledge. This method will eliminate the need to drill and treat the void and also reduce the risk of accidental spillage into the interior of the structure.

Interior Treatment Methods

Soil treatment of the inside perimeter of a slab adjacent to the foundation can be accomplished by any one of three methods: **vertical drilling, short rodding,** or **long rodding.**

Vertical drilling

Vertical drilling is the most common method of interior slab treatment. Vertically drill through the slab floor adjacent to the perimeter foundation with holes no more than 12 inches apart. Inject the termiticide under low pressure so that it will overlap in the soil between holes adjacent to the foundation.

In addition, treat along each support wall and wood partition within the structure. In the case of a masonry support foundation that extends through the floor and rests on a footing, it will be necessary to drill and treat soil adjacent to both sides of the wall. Clean up the drill dust as you proceed. After treatment, be sure to plug the holes and finish the surface in a manner that the customer has previously agreed upon.

Caution: Take special care to identify the location of any heating ducts, water lines, or electrical conduits embedded in the slab before beginning treatment to prevent damage, injury, or contamination.

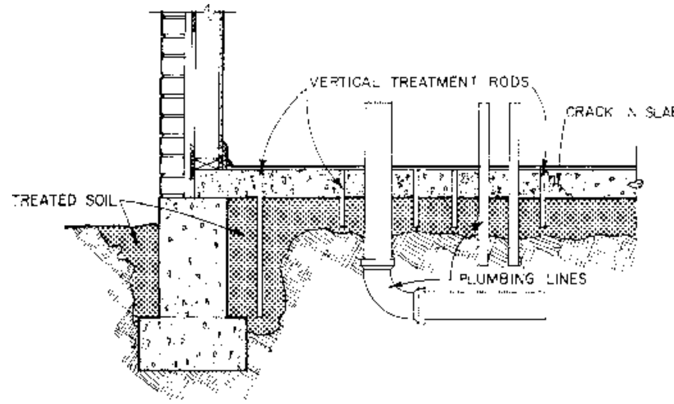


Figure 4.11. Treatment under concrete with vertical drilling at joints, cracks and openings, and around plumbing.

Short Rodding

Short rodding refers to a procedure conducted from outside a structure. Short rodding from the outside may be preferable when no access is available inside. Floor coverings; plumbing such as bathtubs, sinks or showers; cabinets or other furnishings may obstruct access to drilling from the inside. Damage to finished flooring inside the structure may prevent drilling through the slab.

To reach the subslab soil area, drill a series of holes through the foundation about 12 inches apart. Drill through both sides of the concrete into the area precisely below the expansion joint at the edge of the slab. Then, insert the rod into the area to receive treatment. Apply the chemical under low pressure. Saturate as much as possible all of the soil around the expansion joint area. This will cause treatment to overlap in the spaces between the holes and produce a continuous barrier. If you have properly spaced the holes, all important parts of the structure and the soil interface will receive treatment.

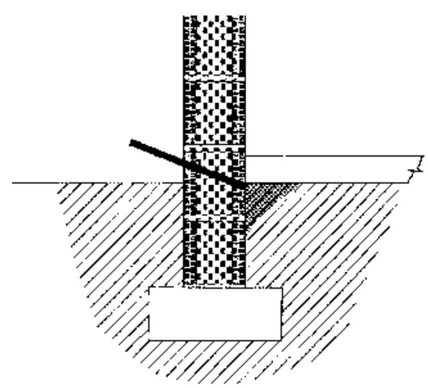


Figure 4.12. Short rodding (dark shading shows area treated).

Long Rodding

Long rodding horizontally through the exterior foundation just below the slab level and under the slab adjacent to the foundation is another treatment method for slab construction where the bottom of the interior slab can be accessed. As in short rodding, it is necessary to determine the precise location of the bottom of the slab to ensure that no untreated soil layer remains above the treatment zone and to allow for easier insertion of the rod for the length of the treatment to be achieved. This method has similar benefits to the short rod method, with the added advantage of possible access behind concrete porches. However, long rodding for any significant distance may leave untreated areas if the rod veers away from the foundation down into the soil.

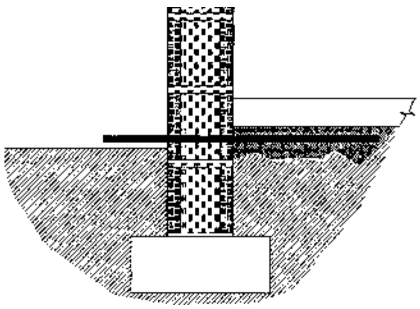


Figure 4.13. Long rodding (dark shading shows area treated).

TREATMENT GUIDELINES—SLAB CONSTRUCTION SPECIAL CASES

Termite treatment guidelines will vary, depending on factors such as the type of slab construction, the foundation type, the materials used for the frame walls or flooring, and the termite entry points under certain elements of construction. Described below are some building construction situations that affect treatment guidelines.

Floating Slab Construction with Concrete Block Foundation and Walls

When the walls and foundation are made of concrete blocks, preventing termite entry through block voids is a primary concern. The block voids need to be treated with termiticide below the soil line.

Termite entry points

In this type of construction, there are three major entry points. Termites may come from the subslab area, up through the expansion joint at the edge of the slab and into the furred wall as shown, and up through a crack in the floor beneath a wood partition. They may proceed up this space to feed on door jambs, window frames, and even the roof.

Termites can gain access into the concrete block voids and travel upwards into the same areas. This allows them access to nearly all of the wood structural members in the house, as well as to any framing and molding.

Another less common method of termite entry is from the outside soil, up over the block surface, into a crack or void in the masonry, and upward through the concrete block voids or directly over into the furred wall. This is more common when there is an attached outside slab such as a sidewalk or carport that abuts the exterior structure, leaving an expansion joint as well as a protected cover for termite activity.

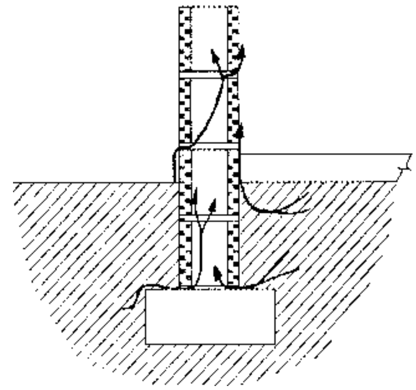


Figure 4.14. Block foundation–floating slab (arrows indicate possible termite entry points).

Treatment procedures

- Trench and/or rod exterior soil.
- Drill and treat beneath exterior slabs adjacent to foundation.
- Treat interior foundation walls by vertical drilling, short rodding, and/or long rodding.
- Vertically drill and treat adjacent to interior walls and partitions, where necessary.
- Drill and treat foundation voids.
- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

Completion

This composite diagram shows the total protection of the structure by thoroughly treating the voids in the concrete blocks, the soil in the subslab area at the expansion joint, and the soil around the outside perimeter of the building. The wood should be treated whenever a need is indicated.

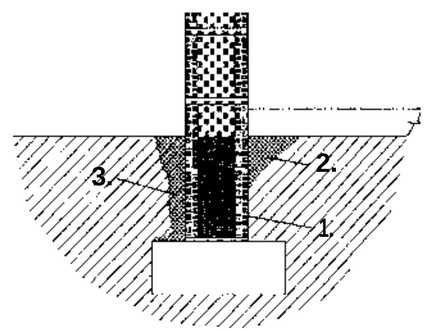


Figure 4.15. Completed treatment of block foundation—floating slab showing treatment of 1. the voids in the concrete blocks, 2. the soil in the subslab area at the expansion joint, and 3. the soil around the outside perimeter of the building.

Floating Slab Construction with Concrete Foundation and Brick Veneer on Wood Frame

In this type of construction, treating brick veneer voids to prevent infestation of the wood frame is a primary concern.

Termite entry points

A solid concrete foundation eliminates some of the voids that commonly permit termite entry, but termites frequently will penetrate up through the slab expansion joint. They also will move from the outside soil area, through the brick veneer, into the void space, and directly into the wood framing.

Less commonly, termites may build tubes up over the exterior brick veneer surface, find openings through the masonry, and gain access to the void space and wood structural members.

Treatment procedures

- Trench and/or rod exterior soil.
- Drill and treat beneath exterior slabs adjacent to foundation.

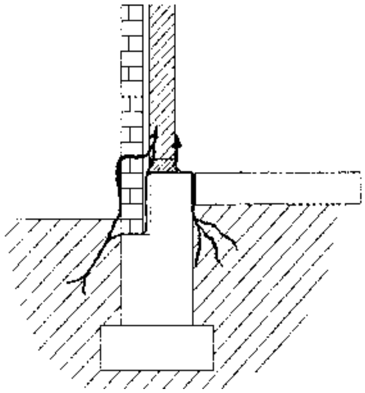


Figure 4.16. Poured foundation—brick veneer (arrows indicate possible termite entry points).

- Treat interior foundation walls by vertical drilling and/or long rodding.
- Vertically drill and treat adjacent to interior walls and partitions.
- Drill and treat brick veneer voids.
- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

Completion

This composite diagram shows the total protection afforded to the structure by thoroughly treating the voids in the brick veneer, the subslab soil area along the expansion joint, and the soil around the outside perimeter of the building to a point lower than the bottom of the veneer.

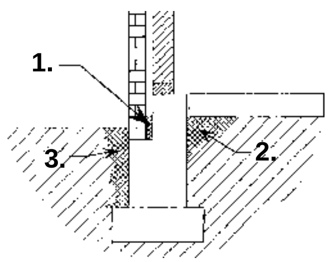


Figure 4.17. Completed treatment of poured foundation—brick veneer showing treatment of 1. the voids in the brick veneer, 2. the subslab soil area along the expansion joint, and 3. the outside perimeter of the building.

Monolithic Slab with Tile or Terrazzo Finished Floor

Terrazzo consists of white or colored grout with ornamental stones divided into sections with brass strips and ground to a smooth finish. This type of floor is common in commercial and institutional buildings and is considered high-quality flooring. The property owner must thoroughly understand the necessity of drilling the terrazzo and the various methods of repairing the drill holes. A sharp bit and steady pressure are required when drilling terrazzo to prevent chipping around the edge of the drill hole. One method is to apply light pressure on the drill while quickly hitting and releasing the trigger. This prevents the bit from jumping about and damaging the surface of the floor.

Terrazzo may be patched by saving the drilling dust so that a portion of the dust can be mixed with quality cement. With experience, the mixture can be made to closely match the original floor. If this method of repair is not acceptable to the property owner, then a professional terrazzo floor company can be contacted to patch the drill holes. How the patching will be done should be established before any drilling is started.

Termite entry points

The arrows indicate the very few possible entry points for termites under a perfectly formed monolithic slab. The figure shows how termites might travel up the outside wall and into the brick veneer, particularly if the brick veneer extends down below the soil line. With concrete block construction, termites would have to come up over the solid foundation and into the block masonry to gain access to the house. Therefore, these areas are not the main source of problems in monolithic slabs. Problem areas are limited to the openings for pipes and plumbing, the soil line, any faults or cracks in the slab, and any grading stakes or other embedded articles that termites might use to gain access through the slab. Void treatment is not necessary unless there is a veneer of brick, stone, or stucco that extends below grade.

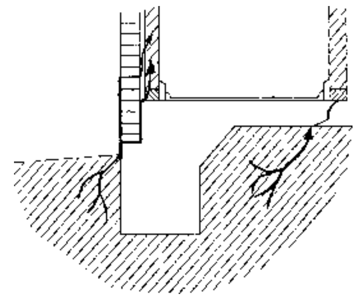


Figure 4.18. Monolithic slab—tile floor (arrows indicate possible termite entry points).

Treatment procedures

- Trench and treat exterior soil.
- Drill and treat beneath exterior slabs adjacent to foundation.
- Vertically drill and treat adjacent to interior partition walls where necessary.
- Drill and treat brick veneer or foundation voids where they extend below outside soil.
- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

Completion

This composite diagram shows the total protection afforded the structure by thoroughly treating the soil around the exterior perimeter of the building to a point lower than the bottom of the veneer and the soil beneath interior wood partition walls. Foundation voids should be treated if they extend below exterior grade level.

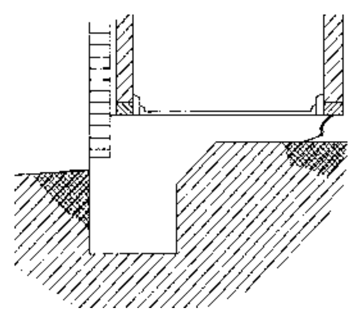


Figure 4.19. Completed treatment of monolithic slab—tile floor (dark shading shows areas treated).

Special considerations—monolithic slabs

Treating soil next to the interior perimeter of the foundation, which is required in almost all other types of construction, may not be necessary in this case. However, soil treatment around the exterior is very important, particularly if there are veneers (such as brick) near the soil line.

Trenching and treating is the most practical method. Remember to treat any backfill.

Rodding does not need to be done because there is no advantage here in deep soil chemical treatment. Wood treatment also is not required unless there is a reason for doing so. No routine treatment of wood is done in monolithic slab construction.

When drilling and rodding, use caution around sewer pipes, heating ducts, plumbing, plenums, electrical wiring, etc.

On monolithic slabs, a very careful inspection needs to be made to determine exactly how termites have gained access and to find those areas where they might gain access. The construction of access plates, doors and panels to permit inspection of the entry points of plumbing, bath traps, conduits, etc., constitutes the major part of treatment to this type of structure, together with soil treatment around the outside perimeter.

Wood Over Slab

To treat the soil under a slab covered by a wood floor, both the wood and the slab should be drilled and treated in a checkerboard pattern to ensure adequate coverage. It may also be advisable to treat the wood with borates. The wooden floor may also need to be removed to facilitate treatment. After treatment, all holes in both the slab and wood floor must be plugged and filled.

TREATMENT GUIDELINES FOR CRAWL SPACE CONSTRUCTION

All cellulose-containing trash and debris must be removed from the crawl space to aid in proper treatment, reduce chances of future attack, and aid in future inspections. Treat the soil adjacent to both sides of foundation and support walls and around piers, plumbing lines, or other points of access by trenching and/or rodding. If the foundations or piers have hollow voids, these areas also must be treated to prevent termite access through a crack in the footing. The soil beneath exterior porches next to the foundation should be treated by vertical drilling, horizontal rodding, or excavation to gain access for treatment.

To control infestations occurring along interior walls or around supporting piers of houses with crawl spaces, dig a trench 6 to 8 inches wide and a few inches deep next to the walls or piers, taking care not to go below the top of the footing. When the top of the footing is exposed, the commercial pesticide applicator must treat the soil adjacent to the footing to a depth not to exceed the bottom of the footing. If the land slopes or if the footing is more than 12 inches deep, make crowbar, pipe, or rod holes about 1 inch in diameter and a foot apart in the bottom of the trench. The holes should go to the footing(this will help distribute the chemical evenly along the wall.

The trench along the exterior foundation wall is also made 6 to 8 inches wide, and up to a foot deep. If needed, holes are also made in the trench bottom, as described for the trench along the interior wall.

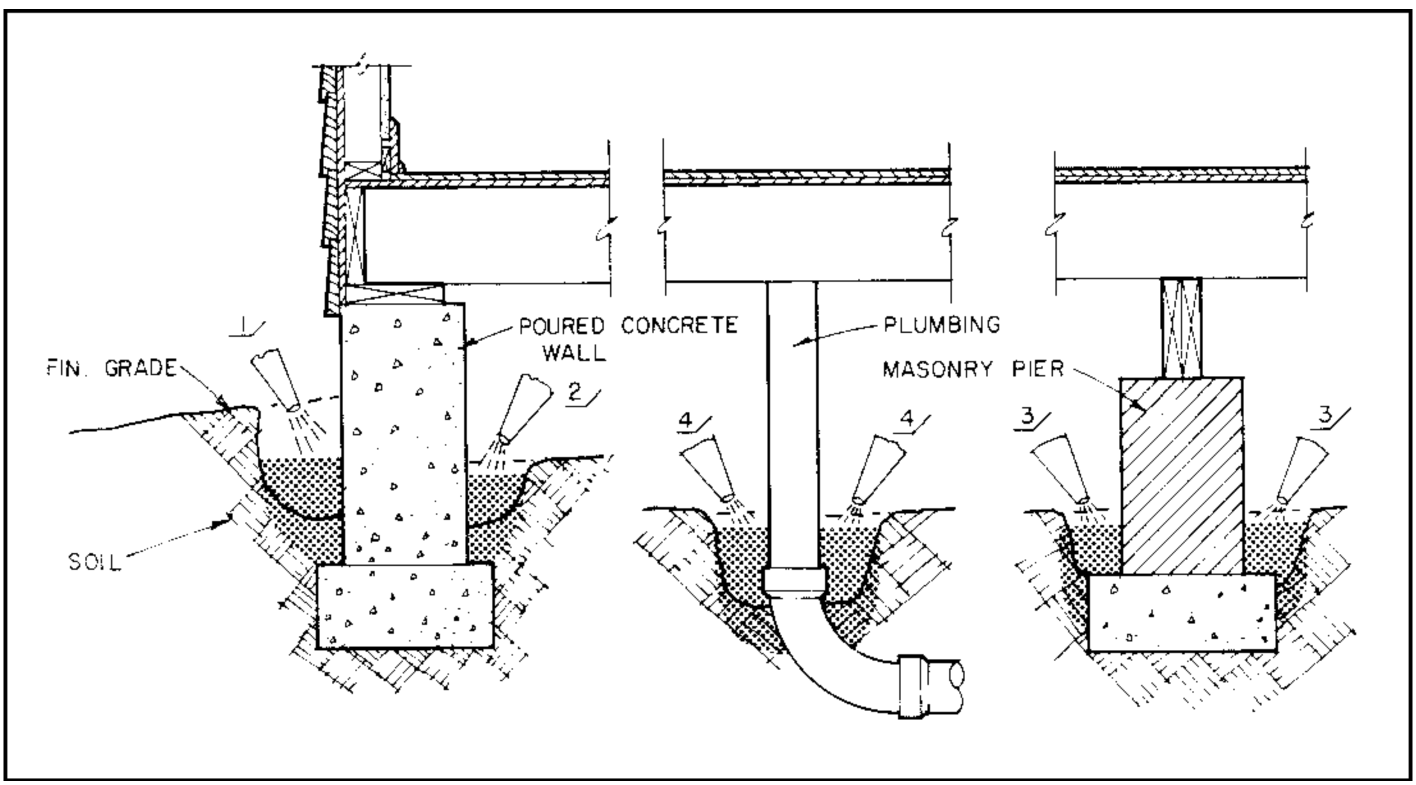


Figure 4.20. Application of chemical to crawl space construction. Soil treatment (1) along outside and (2) inside foundation wall; (3) around pier and (4) plumbing (adapted from USDA).

TREATMENT GUIDELINES FOR BASEMENT CONSTRUCTION

Where termites are coming from beneath the concrete floor in the basement, remove any wood that may extend into the ground, treat the soil, and then seal cracks or holes with a dense cement mortar. When the infestation is located between the floor and wall (expansion joint) or around a furnace, make a series of holes, spaced about 1 foot apart, through which a chemical can be poured or injected. Holes along a wall should be made about 6 to 8 inches from it, so as to clear the footing and reach the soil beneath.

When the infestation occurs along the exterior foundation wall in houses having full basements, it is necessary to treat the soil to a greater depth than is required for other types of houses. The trench is prepared in the same way, but the pipe or rod holes should extend down to the top of the footing to aid in proper distribution of the chemical to all parts of the wall. This is especially important in masonry foundations with numerous mortar joints below grade that may be susceptible to termite attack.

Termite entry points

Typical entry points to basements are marked. These will be the same as in a floating slab construction i.e., up through the slab expansion joint or from the outside soil area through the brick veneer. They may also come up from cracks in concrete slabs and into wooden support members.

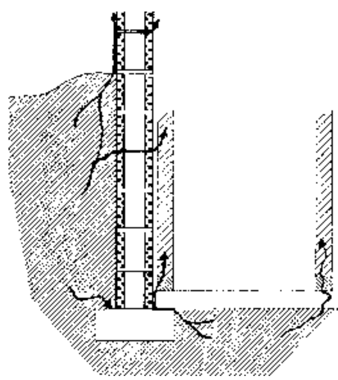


Figure 4.21. Basement construction (arrows indicate possible termite entry points).

Treatment Procedures

- Trench and/or rod exterior soil.
- Drill and treat beneath exterior slabs adjacent to the foundation.
- Treat adjacent to interior foundation walls by vertical drilling.
- Vertically drill and treat adjacent to interior partition walls where necessary.
- Drill and treat any brick veneer voids.
- Drill and treat any foundation voids.
- Treat wood that has accessible termite galleries.
- Repair and plug all drilling holes.

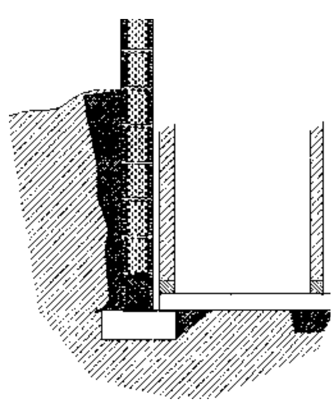


Figure 4.22. Completed treatment of basement construction (dark shading indicates areas treated).

Completion

The composite diagram, Fig. 4.22, shows the total protection afforded by completing the recommended treatment procedures.

Special Considerations—Basements

The soil treatment techniques for basements are the same as described for floating slab construction on the exterior and interior of the structure. If treatment of the exterior soil to the top of the footing is not possible or practical, it will be necessary to indicate clearly to the customer that your treatment is considered either a “spot treatment” or “limited treatment.” Brick and stone veneer should be drilled and treated only if it extends below grade level, and then treatment should be made only below the top of the foundation wall to prevent accidental contamination of the interior. Treat hollow foundations from the interior in the case of unfinished walls, and then only at the bottom course of block just above basement floor level. In the case of a block, rubble, or other masonry foundation wall construction with interior finished walls, use extreme caution in treating exterior soil and voids in the foundation—the termiticide may seep into and contaminate the structure.

RETREATMENTS FOR SOIL APPLIED TERMITICIDES

Never make routine or annual retreatments. Retreatments are generally made only if there is evidence of reinfestation, if the initial treatment was inadequate, or if the chemical barrier has been broken by moving soil around the structure. The retreatment is normally a partial treatment in the areas of infestation or soil disturbance and should be recorded as a partial or spot treatment on the statement of services.

TERMITE CALCULATION PROBLEMS AND SOLUTIONS

Use of a termiticide involves determining the area to be treated in **linear feet** or **square feet.** In some cases, both measures must be determined, depending on the type of treatment (pre- or postconstruction) and construction features. At the end of this chapter, you will find examples that illustrate methods of calculating area and linear measure, as well as linear measure per foot of depth. The examples are illustrations only and are not given as values to be used in determining the volume of water emulsion or solution needed to treat a structure of similar shape and dimension because construction features may vary from site to site. These samples are provided to assist with interpretation of real pesticide labels and with calculation of the right amount of pesticide to be applied to a given area. These problems can be solved using the “Termite-Icide” label following the problems.

SUMMARY

Whenever possible, preconstruction treatment to prevent termite infestations is the best method for controlling termite problems. Whenever pre- or postconstruction treatment is needed, the pest management professional must be aware of the various aspects of building construction to apply termiticide to the appropriate places. The goal is to establish a continuous chemical barrier that will eliminate the termite colony and prevent reinfestation.

PRECAUTIONARY STATEMENTS

Hazards to Humans (and Domestic animals)

CAUTION: Harmful if swallowed, inhaled, or absorbed through the skin. Avoid contact with skin, eyes, or clothing. Avoid breathing dust (vapor or spray mist). Wash thoroughly with soap and water after handling. Remove contaminated clothing and wash before reuse.

All pesticide handlers (mixers, loaders, and applicators) must wear long-sleeved shirt and long pants, socks, shoes, and chemical-resistant gloves. In addition, all pesticide handlers must wear a respiratory protection device (air-purifying respirator with NIOSH approved TC-23C pesticide cartridges) when working in a non-ventilated space. All pesticide handlers must wear protective eyewear when working in a non-ventilated space or when applying termiticide by rodding or subslab injection.

When treating adjacent to an existing structure, the applicator must check the area to be treated, and immediately adjacent areas of the structure, for visible and accessible cracks and holes to prevent any leaks or significant exposures to persons occupying the structure. People present or residing in the structure during application must be advised to remove their pets and themselves from the structure if they see any signs of leakage. After application, the applicator is required to check for leaks. All leaks resulting in the deposition of termiticide in locations other than those prescribed on this label must be cleaned up prior to leaving the application site. Do not allow people or pets to contact contaminated areas or to reoccupy contaminated areas of the structure until the clean-up is completed.

Termite-Icide

Termiticide/Insecticide

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.

Active Ingredient: Pestoff-tri-salicyclic acid:	36.8%
Inert Ingredients*:	63.2%
Total:	100.0%

* Contains petroleum distillates.
Contains 3.2 pounds Pestoff per gallon.

KEEP OUT OF REACH OF CHILDREN
CAUTION
See other panels for additional precautionary information.

XYZ Corporation
Entomology Group
Anywhere, USA

EPA REG. NO. 000000-000
EPA Est. 000000-TX-01
U.S. Patent No. 0000000

Net Contents: 2.5 gallons

Environmental Hazards

This product is highly toxic to bees exposed to direct treatment or residues on crops or weeds. Do not apply this product or allow it to drift to crops or weeds on which bees are actively foraging. Additional information may be obtained from your Cooperative Extension Service. This product is extremely toxic to fish and aquatic invertebrates. Do not apply directly to water or to areas where surface water is present or to intertidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of equipment washwaters. Do not apply when weather conditions favor drift from treated areas.

Physical/Chemical Hazards

Do not use or store near heat or open flame.

DIRECTIONS FOR USE

It is a violation of federal law to use this product in a manner inconsistent with its labeling.

STORAGE AND DISPOSAL

PESTICIDE STORAGE: Store at temperatures above 40 degrees F (5 degrees C).

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

CONTAINER DISPOSAL

Plastic containers: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill or by incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

SUBTERRANEAN TERMITE CONTROL

APPLICATION RATE: Use a 0.5% emulsion for subterranean termites. For other pests on the label, use specific listed rates.

MIXING DIRECTION: Mix the termiticide dilution in the following manner: Fill tank 1/4 to 1/3 full. Start pump to begin bypass agitation and place end of treating tool in tank to allow circulation through hose. Add appropriate amount of Termite-Icide termiticide/insecticide. Add remaining amount of water. Let pump run and allow recirculation through the hose for 2 to 3 minutes. Termite-Icide may also be mixed into full tanks of water, but it requires substantial agitation to ensure uniformity of the emulsion. To prepare a 0.5% water emulsion, ready to use, dilute 1.25 gallons of Termite-Icide with 94.75 gallons of water.

MIXING: For the desired application rate, use the chart below to determine the amount of Termite-Icide for a given volume of finished emulsion:

AMOUNT OF TERMITE-ICIDE
(Gall1ons except where noted)

Emulsion Concentration	Amount of Termite-Icide	Amount of Water	Desired Gal. of Finished Emulsion
0.5%	1 2/3 fl. oz	7.9 pints	1
	6 2/3 fl. oz.	31.6 pints	4
	8 1/3 fl. oz.	39.5 pints	5
	16 2/3 fl. oz.	9.9	10
	0.25	18.75	19
	0.5	37.5	38
	0.75	57.25	58
	1.25	94.75	96
	2.5	189.5	192

Common units of measure:
1 pint = 16 fluid ounces (oz.)
1 gallon = 4 quarts = 8 pints =128 fluid ounces (oz.)
* For termite applications, only use these rates in conjunction with the application volume adjustments as listed in the section below or in the foam or under ground service application sections.

Preconstruction Subterranean Termite Treatment

Pre-Construction Treatment: Do not apply at a lower dosage and/or concentration than specified on this label for applications prior to the installation of the finished grade.

When treating foundations deeper than 4 feet, apply the termiticide as the backfill is being replaced, or if the construction contractor fails to notify the applicator to permit this, treat the foundation to a minimum depth of 4 feet after the backfill has been installed. The applicator must trench and rod into the trench or trench along the foundation walls and around pillars and other foundation elements at the rate prescribed from grade to a minimum depth of 4 feet. When the top of the footing is exposed, the applicator must treat the soil adjacent to the footing to a depth not to exceed the bottom of the footing. However, in no case should a structure be treated below the footing.

Horizontal Barriers: Create a horizontal barrier wherever treated soil will be covered, such as footing trenches, slab floors, carports, and the soil beneath stairs and crawl spaces. For a 0.5% rate, apply 1 gallon of dilution per 10 square feet. Applications shall be made by a low pressure spray (less than 20 p.s.i.) using a coarse spray nozzle. If slab will not be poured the same day as treatment, cover treated soil with a water-proof barrier such as polyethylene sheeting.

Vertical Barriers: Vertical barriers should be established in areas such as around the base of foundations, plumbing, utility entrances, backfilled soil against foundation walls, and other critical areas.
For a 0.5% rate, apply 4 gallons of dilution per 10 linear feet per foot of depth.

Postconstruction Subterranean Termite Treatment

Application Volume:

Volume Adjustment Chart

Rate (% emulsion)	0.5%	1.0%	2.0%
Volume allowed			
Horizontal (gallons emulsion/10 sq. ft.)	1.0 gallons	0.5 gallons	0.25 gallons*
Vertical (gallons emulsion/10 lin. ft.)	4.0 gallons	2.0 gallons	1.0 gallons*

After Treatment:

Cracks and expansion joints

To establish a vertical barrier along cracks and expansion joints in a slab, drill holes through the slab at a 12-inch spacing near one side of the crack or joint and apply a 0.5% emulsion evenly at the rate of 4 gallons per 10 linear feet.

Pipe and Conduit Penetrations

To establish a vertical barrier for pipes and conduits 6 inches or less in diameter, drill a hole through the slab on one side and apply 1 1/2 gallons of 0.5% emulsion. For penetrations in excess of 6 inches in diameter, drill additional hole(s) per each additional 6 inches in diameter or fraction thereof, evenly spaced around the penetration, and apply 1 1/2 gallons of 0.5% emulsion per drill hole.

Bath Trap

Apply 3 gallons of 0.5% emulsion per square foot of opening.

Vertical Barriers

Should be established around foundation walls and perimeter of monolithic slabs.

Attention:

- Do not apply to pets, crops, or sources of electricity.
- Do not allow people or pets on treated surfaces such as carpets until the spray has dried.
- Do not use concentrate or emulsion in fogging equipment.
- Firewood is not to be treated.
- During any application to overhead areas of structure, cover surfaces below with plastic sheeting or similar material (except where exempt).
- Do not allow spray to contact food, foodstuffs, food-contacting surfaces, food utensils, or water supplies.
- Thoroughly wash dishes and food-handling utensils with soap and water if they become contaminated by application of this product.
- Do not treat areas where food is exposed.
- During indoor surface applications, do not allow dripping or runoff to occur.
- Do not apply this product in patient rooms or in any rooms while occupied by the elderly or infirm.
- Do not apply when occupants are present in the immediate area in institutions such as libraries, sport facilities, etc.
- Do not apply to classrooms when in use.
- Do not touch treated surface until dry.
- Not for use in voids insulated with rigid foam.

CHAPTER 5

OTHER TREATMENTS FOR SUBTERRANEAN TERMITES

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know the difference between plenum and non-plenum crawl spaces and how they should be treated for termite control.
- Know how to locate subslab heating ducts and how to prevent termiticide contamination of the air flowing through the ducts.
- Be familiar with situations in basements that require special consideration when applying termiticide and know how to treat each.
- Know the avenues of termite entry for a dirt-filled concrete porch on a frame house and how to control termites in that area.
- Know what should be done to prevent and control termite entry in the case of wooden porches.
- Know how to prevent leaking of termiticide through hollow block, tile, and rubble foundations.
- Know how to apply termiticide safely to soil when wells, cisterns, and other water sources are located on a property.
- Know how to control termite infestations when rigid foam insulation board is present.
- Know what wood treatments are available when soil treatment is not possible in a structure.

Certain features of building construction require special consideration when you are attempting to control termites. In some situations, it may be advisable not to treat with liquid termiticides but to use some other method, such as termite baiting, borates, or mechanical alteration. This is particularly true when liquid termiticides mightcause contamination of air-handling systems or water sources. If a structure or an area may pose problems in treatment, it is advisable to have one person inside to monitor the application while another performs exterior treatment of the soil, brick veneer, hollow block, or rubble foundation.

PLENUM AND NON-PLENUM CRAWL SPACES

Several types of construction are extremely difficult (and occasionally impossible) to treat with termiticides. The plenum concept uses the area under the subfloor (crawl space) as a giant heating-cooling duct. There are no vents or access doors in the foundation; thus, termiticide odor can be circulated with heated or cooled air through the structure. Therefore, conventional liquid termiticide treatment is not recommended. Termite baits may be an option for treating plenum housing.

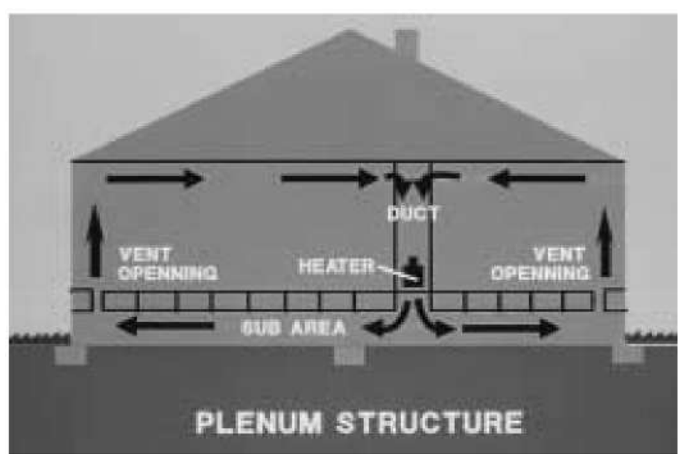


Figure 5.1. Plenum houses use the area under the subfloor as a giant heating/cooling air chamber. Because of this, use of conventional liquid termiticide is not recommended.

In non-plenum structures, air ducts in the crawl area should be examined before treatment. If breaks or leaks at joints are found, they should be repaired before treatment is made. Some air-handling units are located in crawl spaces and draw air from the crawl area. They should be ducted to draw in air from outside the structure before treatment. It is also recommended that all crawl areas have adequate ventilation to prevent the buildup of odor and airborne termiticide residues.

If a structure has inaccessible crawl areas within the foundation, access will have to be created. Visually inspect the area to determine the best method of treatment. If there is sufficient clearance, treatment should be made as in any other crawl area. If there is insufficient clearance between the floor joists and the soil, remove sufficient soil for access and treat the area (see Figure 5.2). It may also be acceptable to drill the floor and treat by rodding or to treat by horizontal drilling and rodding. Vent the area, if possible.

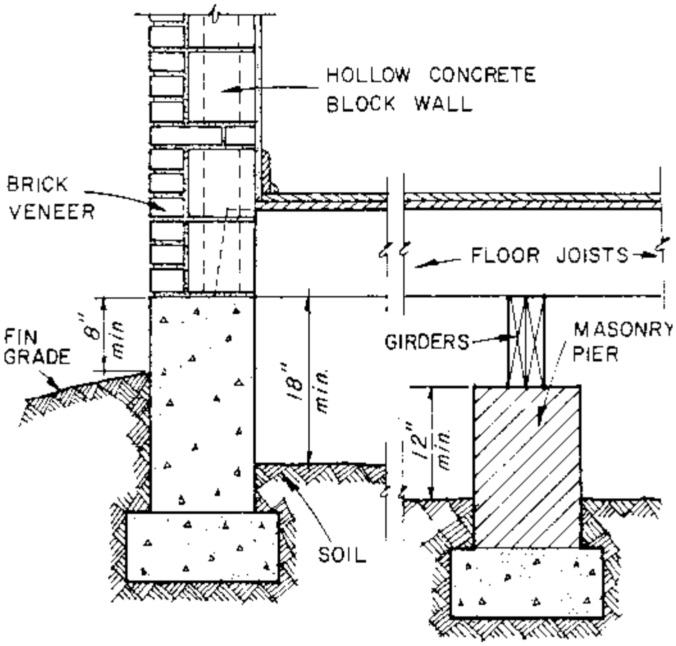


Figure 5.2. Where the superstructure of a building is masonry, provide for adequate clearance between wood and ground both outside and inside the building (adapted from USDA).

SUBSLAB HEATING DUCTS

Another common type of construction that requires special consideration in treating for termites is houses with heating systems under or imbedded within the concrete slab of the structure (see Figure 5.3). The accidental introduction of a termiticide into ducts can result in a serious contamination of the air that flows through these ducts and into living quarters. Termite baits might be a useful alternative in these situations.

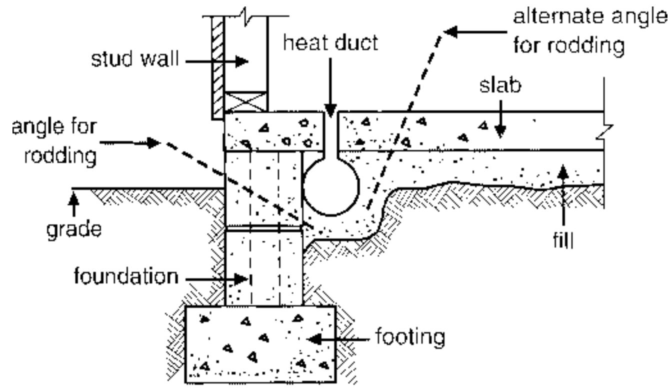


Figure 5.3. Rod treating adjacent to a perimeter heat duct.

Inspect the ducts as much as possible using a mirror and flashlight. If it appears that the ducts are made of material containing cellulose, that they have soil or sand bottoms, that they contain standing water, or that they are not properly sealed, reconsider treatment. Such ducts should be sealed with concrete and an alternative air-handling system installed before treatment. To locate ducts in slabs, turn on the heating system and place damp newspapers over the suspected location of the ducts. The newspapers will begin drying in the areas immediately over the ductwork. (This will not work on carpeted floors.)

Applying termiticide under or around the ducts must be done carefully. Greatly reduced pressure (less than 30 pounds at the nozzle tip) or gravity (percolation) methods should be used. The use of a subslab injector should be limited. If holes are drilled in the interior slab, knowledge of the exact location, directions of the system, and depth and width of the ducts is important. If possible, the pest management specialist will want to get the chemical under the ducts (see Figure 5.3). Reducing the pressure will keep the termiticide from backing up into the duct. Rodding from the outside by drilling the foundation and running a rod in under the ductwork may be the best treatment procedure. Again, knowing the depth of a duct in or under the slab is essential so that the drill or rod does not puncture the duct. Horizontal rodding under the slab is the correct procedure where radiant heat pipes are imbedded in the slab of the structure.

After drilling is completed but before treatment, close off all vents. Turn on the fan for the air system. Check each hole for airflow. If airflow is detected, plug the holes and do not treat them. It is also essential to check periodically during treatment and immediately after treatment for signs of contamination. The heating system should be turned on and checked for odors. If an odor is present, shut off the unit and determine why the odor is present. Odors could be coming from the moist, treated soil beneath the slab. If this is the case, the odors will usually not be strong and should persist for only a day or two. Charcoal filters in heat registers can be used to minimize the odor.

If a strong odor persists, there is probably a termiticide deposit in a duct. This must be cleaned out. An industrial wet vac is the best method to get any liquid material out of the ducts, and charcoal filters should be used over heat registers. Removal of the deposit may require expertise in chemical deactivation. Termiticide manufacturers all have deactivation and odor control information available, and they should be contacted for up-to-date recommendations.

SPECIAL CONSIDERATIONS FOR TREATING BASEMENTS

French drains in basements can be a problem. French drains are used to drain water into a sump, storm sewer or other area. They are usually found around the perimeter of a finished basement. You may want to drill test holes before proceeding with treatment. If there is a sump pump, turn it off and inspect the sump. If water is present, remove some and observe the water level for 15 minutes. If the level of the water rises, delay treatment until a time when the soil is drier. Also observe the sump during the course of treatment for the presence of termiticide. If termiticide is present, remove the contaminated water and dispose of it in a safe and legal manner.

Figure 5.5. If the basement has a sump pump, care should be taken to avoid getting chemical into the "sump" or pit in which the pump sits. This is important because sump pumps usually discharge into non-target areas, such as a driveway, street gutter, or underground sewer.

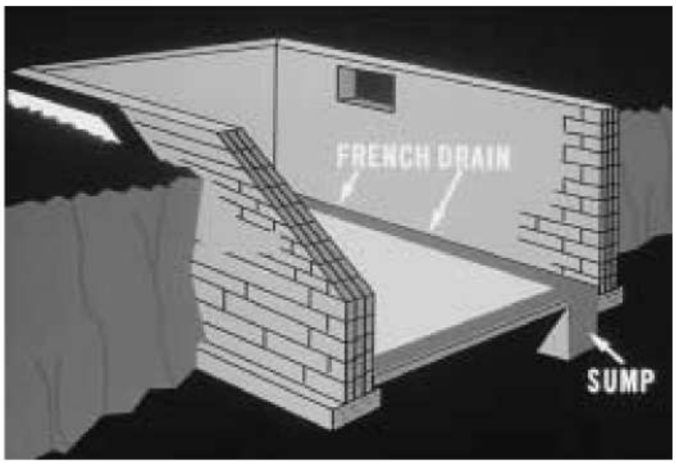


Figure 5.4. A French drain is a below grade drainage system that is level with or beneath the basement floor and usually runs around its perimeter. When water gets into the basement it goes through the French drain and runs into a sump or sometimes outdoors.

One of the most common problems in the control of subterranean termites is wooden members that extend through the concrete in the basement floor (see Figure 5.6). Supporting posts, stair risers, and doorframes are common examples. To correct this, cut the wooden members at least 4 inches above floor level, then remove the portion that extends through the floor. The soil underneath should be thoroughly treated with termiticide, and then concrete poured into the hole and into a form extending to the remaining portion of the wooden members for support. In the case of stairways, it is advisable to make the entire lower step out of concrete, if possible. It is generally undesirable to attempt to treat buried wooden supports by chemical means alone.

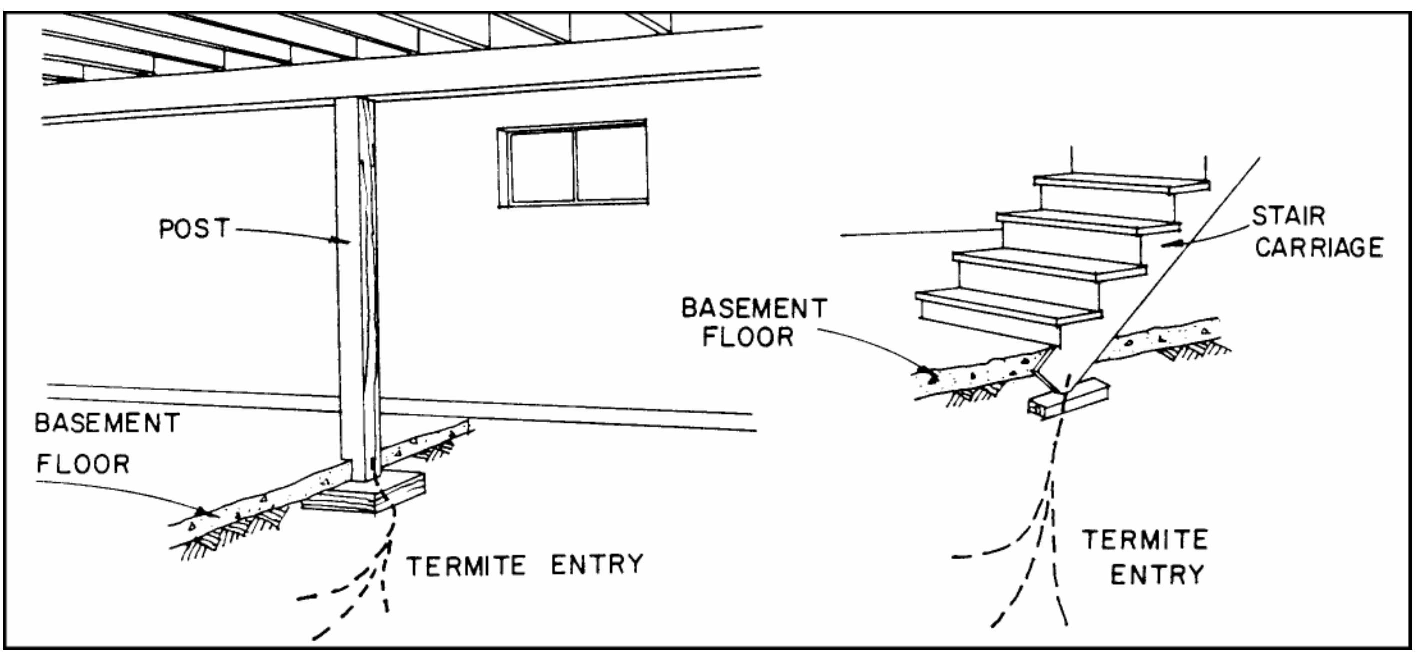


Figure 5.6. Wood post and basement steps extending through concrete (adapted from NPMA).

Before treating in basements, inspect the foundation walls for cracks where seepage of termiticide may occur when the soil outside is treated. If the foundation wall contains cracks or void areas, or if inspection cannot be made, a second staff member should be in the basement to watch for any leakage through the wall while the soil outside is being treated. Also check the basement wall when treating the front and back porches to be sure that the termiticide does not seep over the sill plate. If the basement has an exposed soil floor, cover the treated area with 2 to 4 inches of untreated soil or other impervious barrier after treatment is completed.

Concrete block foundation walls that extend down through the basement floor present a special problem. The usual practice is to drill holes through the floor on both sides of the wall and treat the soil underneath.

Basement windows, with or without outside window wells, are another problem (see Figure 5.7). Normally, the windowsills are close to the ground. If the sills are made of wood, they provide a good source of food for termites as well as being subject to rot. Ideally, wooden sills should be replaced with concrete. Walls with voids in them should be treated with termiticide, starting as close as possible beneath the window to ensure thorough coverage. The ground outside the window should also be treated. Ideally, window wells should be floored solidly with concrete, but they may be treated with termiticide by rodding next to the foundation.

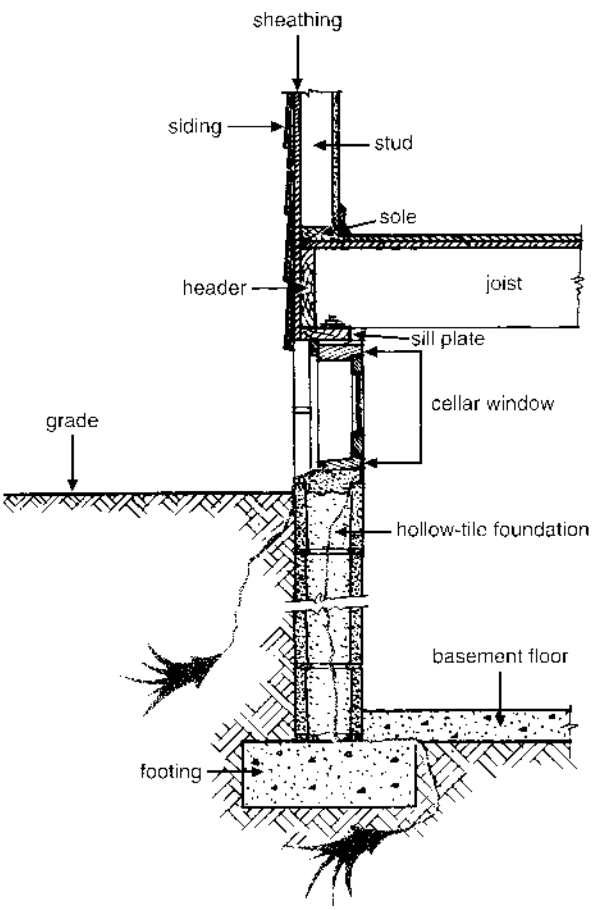


Figure 5.7. An example of a concrete block foundation with basement window. Avenues of termite access are indicated by the heavy arrows in the soil (NPMA).

DIRT-FILLED CONCRETE PORCH ON A FRAME HOUSE

This is a common type of construction throughout the country, and the principles involved apply to stoops and poured outside slabs at ground level, such as sidewalks and driveways (see Figure 5.8).

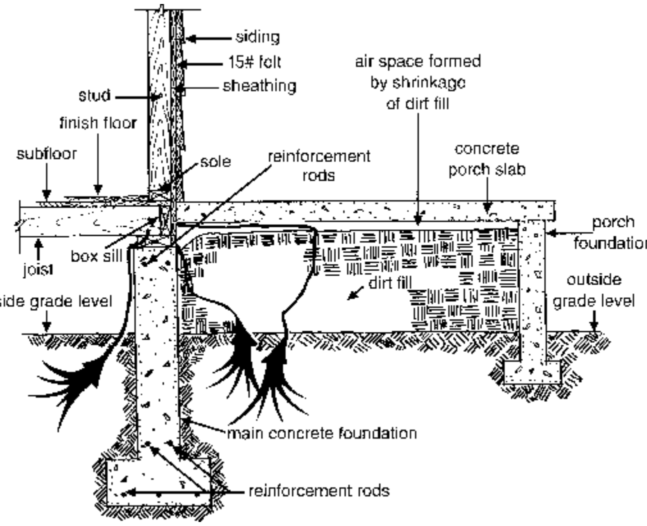


Figure 5.8. A common type of construction that involves a dirt-filled concrete porch attached to a frame house. Avenues of termite access are indicated by the heavy areas in the soil (NPMA).

Soil contact where the porch joins the house should be eliminated by tunneling along the foundation wall and removing the dirt. This is usually done by removing a portion of the porch wall at either or both ends and installing an access door. Soil removal can also be accomplished by knocking out portions of the foundation wall from inside the crawl space and then excavating soil from beneath the porch.

Where the tunneling leaves the porch poorly supported, it is necessary to install supplementary support, such as masonry piers. The soil along the outside of the foundation wall is then treated at the rate of 4 gallons of chemical per 10 linear feet, and the remainder of the accessible soil under the slab is flooded at the rate of 1 gallon of chemical per 10 square feet.

Some recommend that the entire area under the porch should be flooded sufficiently to treat all the soil under the porch. Others do not think this is necessary. If all of the soil is treated, termiticide is applied by drilling vertically through the porch slab at intervals along the porch foundation and at sufficient other points to ensure all the soil under the porch is reached. Foam applications may be of the most value in these situations.

WOODEN PORCHES

Wooden porches with outside ground contact should have all wood cut off above ground level and supporting concrete placed under it. Wherever possible, wooden piers should be removed and replaced with concrete or set on a concrete footing that extends at least 4 inches above grade level. Where this is not possible, treat the soil according to termiticide label directions. The soil all around the base of the pier should also be treated.

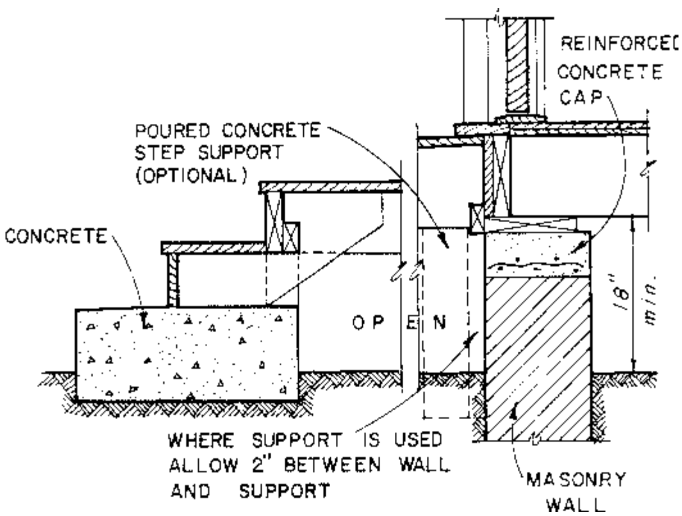


Figure 5.9. Construction of wooden steps of porch to prevent hidden termite entry (adapted from USDA).

HOLLOW BLOCK, TILE, AND RUBBLE FOUNDATIONS

Sometimes termiticide will leak through these types of construction materials or vapor will escape from the uncapped tops of hollow blocks, causing residue problems. If this may be a problem, make sure all cracks and openings are sealed. If the mortar joints of rubble walls are in poor condition, the wall should be sealed with concrete. Low pressure or gravity should be used whenever treating the voids.

WELLS, CISTERNS, AND OTHER WATER SOURCES

It is often difficult to control termites effectively where cisterns or wells exist without contaminating the water supply. Mechanical alteration, baiting, and direct wood treatment should be relied on as much as possible, even though the cost may be high. If soil treating is done, it should be done only sparingly and carefully.

Do not treat the soil beneath structures that contain wells, cisterns, or springs within the foundation walls. Unused wells should be filled, not just capped. The closer a water source is to the foundation, the greater the potential for contamination. In very dry weather, termiticides can move considerable distances along cracks and fissures in the soil. They also can move through small void areas between the soil, pipes, and casings. Swimming pools might be contaminated in the same manner. Sandy soils lessen the potential for these problems. Treat with extreme care adjacent to walls through which any water lines run. If the well is extremely close to the foundation, consider not treating that wall (with the written permission and understanding of the owner). When wells are in the vicinity, be sure to check with the local authorities and comply with any special distance requirements.

A good general practice for treating soil next to foundation walls near wells and cisterns is to remove the soil from the grade to the footing and place it on plastic sheeting. Treat this soil outside of the foundation and let it dry thoroughly. Return the treated soil to the trench.

If the soil around a water pipe is to be treated, remove the soil completely from around the pipe and treat as above. Be sure that the treated backfill is completely dry before placing it in the trench. If the pipe is leaking, postpone the treatment until the leak is repaired. Alternative treatments to consider when well water contamination is a concern include the use of borate wood treatments and/or termite baiting systems.

RIGID FOAM INSULATION BOARD

When buildings contain foam insulation that directly contacts the soil, it is virtually impossible to eliminate termites with a soil treatment.

Building methods that cause problems include:

- Concrete foundations between insulation boards.
- Rigid foam insulation board extending below grade level.
- Foam-filled concrete blocks.

Termites do not eat the foam but tunnel through the insulation to get to wood in the structure. This allows them to avoid contact with soil treatment barriers.

Termite infestations in foam insulation board often are not visible during an inspection. The property owner should remove outside foam to 6 inches above and below grade level to allow for proper treatment and future inspection. In crawl spaces, remove the insulation from the inside foundations in the same manner.

Control may be achieved by trenching and treating soil and backfilling where insulation board has been removed to below grade. This will create a soil barrier that interrupts termite access through the insulation.

Soil treatments will not prevent termite entry into structures that contain foam-filled hollow block foundations because voids cannot be properly treated. Termites can enter through a crack in the footing in this type of construction. The best treatment method for structures with in-ground foam insulation is to use termite baits.

WOOD TREATMENT

Since the advent of soil treatment for termites, there has been little need for extensive wood treatment of structures; however, soil treatment is not possible for all structures, and in such cases the following wood treatment techniques provide some protection from termite attack.

Borates

Borates are applied to wooden structural components in a water-based dilution that is absorbed into the wood fibers. They are applied to prevent termite attack. Because borates are stomach poisons and must be ingested by the termites to be effective, they will not prevent termites from tubing across treated wood to reach untreated portions of the structure. They generally do not have any contact residual effect. Borates are highly soluble in water and can leach out of treated wood. On the positive side, borates are easy to work with and generally considered low hazard. The borates will remain effective in the wood indefinitely if the treated wood is kept dry and out of contact with the soil. In addition to termites, the borates give protection against powderpost beetles and wood-destroying fungi.

Wood Injection

Aerosol or liquid emulsion formulations of residual insecticides can be injected directly into termite galleries where termites are actively feeding in wood portions of the structure. The termiticide will bond with soil particles in the termite galleries as it does in soil to provide some extended residual. Treating wood surfaces with contact residual insecticides provides some short-term barrier effect but will not provide extended protection as does soil application. It may also be possible to inject aerosol insecticides directly into holes drilled in wood, but it is difficult to achieve the complete saturation of all wood fibers necessary to prevent termite attack.

Wood treatment is most commonly used as a supplement to either a soil treatment or termite baiting because of the difficulty in treating all wooden components. Wood treatment can, however, provide limited control where soil cannot be treated because of the risk of groundwater contamination or subslab heating duct contamination.

SUMMARY

To apply termiticides safely and effectively, you need to understand and recognize situations where application of liquid termiticides could lead to contamination of airflow systems or water sources. These situations include plenum crawl spaces, air ducts in non-plenum crawl spaces, subslab heating ducts, drains leading into basement sumps, and wells, cisterns, or other water sources located on a property. The pest management professional must be trained in methods for preventing termiticide contamination and leaks. In some situations, use of liquid termiticides may not be possible and the pest management professional may need to rely on alternative methods such as termite baits, mechanical alteration, and/or wood treatment for control.

CHAPTER 6

OTHER WOOD-DESTROYING INSECTS

LEARNING OBJECTIVES

After completely studying this chapter, you should:

- Know what to advise lumber and construction companies and consumers to do to prevent wood-boring beetle infestations.
- Know the various families of wood-boring beetles and their characteristics.
- Know inspection, management, and control methods for wood-boring beetle infestations.
- Know which longhorned beetle is a structural pest, how to identify it and control it, and how to prevent structural damage.
- Know the signs of carpenter ant infestations and what areas to inspect for excess moisture.
- Know the habits and habitats of carpenter ants and where to inspect for nest locations.
- Know procedures for preventing and controlling carpenter ant infestations.
- Know how to identify carpenter bees and understand their habits and habitat.
- Know procedures for preventing and controlling carpenter bee damage to wood.

Wood-destroying organisms other than subterranean termites cause millions of dollars in damage to wood products each year. These organisms and their prevention and control are discussed here.

PREVENTION OF WOOD-BORING BEETLES

The wood-boring beetles of economic concern include the **true powderpost beetles, false powderpost beetles, furniture and deathwatch beetles,** and the **old house borer.** Most of the procedures that will prevent attack on wood before it is used are the responsibility of those who harvest, mill, or store the wood. Those who use wood must take precautions to reduce the chances of building an infestation into structures and furniture.

Though the pest management professional is usually called in after an infestation is suspected, it is important that this person be a knowledgeable consultant to the lumber and construction industries, as well as to consumers, on the prevention of damage by wood-boring beetles. Steps that can be taken to prevent beetles from infesting buildings include:

- Inspect wood prior to purchase.
- Use properly kiln- or air-dried wood.
- Seal wood surfaces.
- Use chemically treated wood.
- Ensure good building design.

Using kiln- or air-dried wood in construction is one of the least expensive and most practical preventive measures. A few beetle species can survive and reinfest wood that has been properly dried. Sealing wood surfaces with varnish, shellac, or paint eliminates the habitat necessary for egg laying, but it is usually not feasible to seal the surfaces of structural timbers. Using chemically treated wood (treated by fumigation, wood preservatives, or insecticides) will provide beetle-free wood, but using treated wood is usually cost prohibitive. In addition, fumigation will not protect the wood from future infestation. Using good building design and practices such as proper ventilation, drainage, and clearance between wood and soil will tend to reduce the moisture content of wood in a structure, creating less favorable conditions for beetle development. Central heating and cooling systems also speed up the wood drying process.

POWDERPOST BEETLES

Three families of beetles have at least some members that are called “powderpost beetles.” These are the true powerderpost beetles in the family Lyctidae, the false powerderpost beetles of the family Bostrichidae, and the furniture and deathwatch beetles of the family Anobiidae.

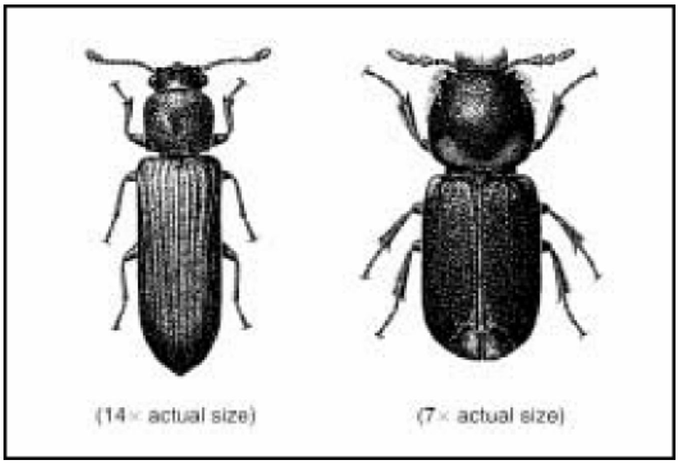


Figure 6.1. Two of the insects referred to as powderpost beeltes . *Left: Lyctus planicollis*, one of the true powder-post beetles of the family Lyctidae. Note the two-segmented antennal club typical of the members of the family. *Right: Scobicia declivis*, a false powderpost beetle of the family Bostrichidae. Note the more cylindrical body shape and the three-segmented antennae characteristic of most members of this family (Provonsha).

They all damage wood in about the same manner and require the same control measures. The surface of infested wood is perforated with numerous small “shot-holes,” each about the size of a pencil lead. Any jarring of the wood causes powder to sift from these holes. Cutting or breaking infested wood may reveal masses of packed powder that is produced by the feeding of grublike larvae and, to a lesser extent, by the adult beetles.

Figure 6.2. Anobiid beetle damage in pine floor joist—note frass being pushed out of old exit holes (USDA Forest Service).

True Powder post Beetles

Family Lyctidae

The **true powderpost beetle** is small, slender, flattened, and reddish brown to black. It varies in length from about 1/ 8 to 1/4 inch long. The female lays her eggs in the pores of the wood. These beetles attack only hardwoods, eating only the sapwood, which contains the starch required in their diet. Once hatched, young larvae bore into the wood. Unlike termites, they are unable to digest cellulose. Consequently, most of the wood eaten passes through the larvae and is left behind as a powdery ***frass.*** Thus, lyctid damage is characterized by the fine powder falling from the surface holes in hardwoods.

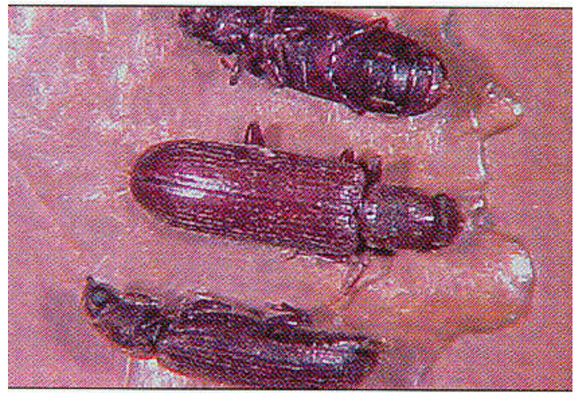


Figure 6.3. True powerderpost beelte adults (Lyctidae)—*Lyctus* spp (H. Russell, Michigan State University Diagnostics Services).

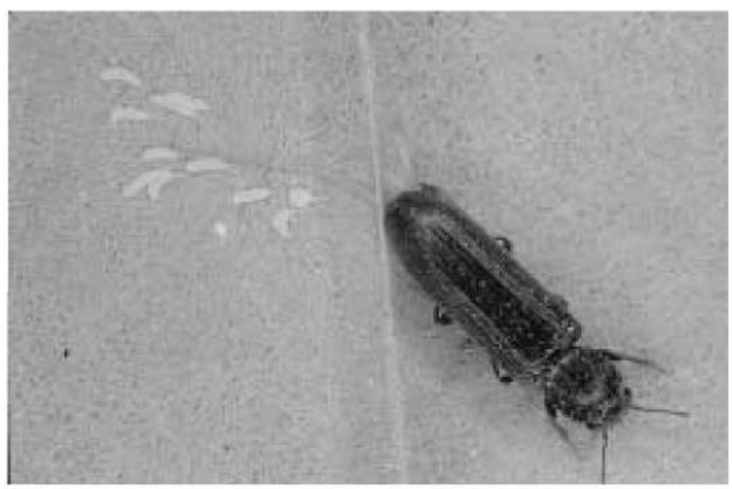


Figure 6.4. True powderpost beetle adult (Lyctidae)—*Lyctus brunneus*—laying eggs between a glass slide and a cardboard (USDA Forest Service).

Figure 6.5. True powderpost beetle adult and larva—*Lyctus brunneus*—by an exit hole (USDA Forest Service).

False Powder post Beetles

Family Bostrichidae

The adult of the **false powderpost beetle** is more robust than that of the true powderpost beetle. Its body is cylindrical with a roughened thorax surface. Its head usually is not visible from above. Color varies from dark brown to black, and length ranges from 1/ 8 to 3/8 inch. Like the true powderpost beetles, it digests the starch in the wood but not the cellulose. However, false powderpost beetles will attack softwoods as well as hardwoods. Unlike lyctid and anobiid beetles, female bostrichid beetles bore directly into wood to lay eggs.

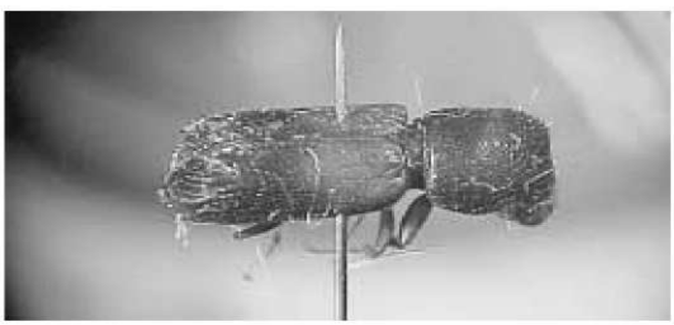


Figure 6.6. False powderpost beetle adult (Bostrichidae)—redshouldered shothole borer, *Xylobiops basilaris* (H. Russell, Michigan State University Diagnostics Services).

Figure 6.7. False powderpost beetle adult (Bostrichidae)— bamboo powderpost beetle, *Dinoderus minutus* (USDA Forest Service).

Furniture and Deathwatch Beetles

Family Anobiidae

Anobiid beetles are usually slightly less than 1/ 3 inch long and red to brown to black. They deposit their eggs in cracks and crevices of all types of seasoned wood, though these beetles seem to prefer the sapwood of softwood trees. Unlike the other powderpost beetles, anobiids have a digestive enzyme that allows them to digest cellulose. An infestation is characterized by a coarse, powdery frass containing bun-shaped fecal pellets.

Figure 6.8. Anobiid beetle adult—*Euvrilletta peltatum* (USDA Forest Service).

Figure 6.9. Anobiid beetle larva—*E. peltatum.* Note frass and damaged wood (USDA Forest Service).

Within this group, the **furniture beetle** will infest structural wood as well as furniture. The **deathwatch beetle** prefers structural timbers in damp areas. Its name comes from the ticking sound made by the adult, which can be heard in the quiet of the night. Joists, subflooring, hardwood flooring, sills, plates, and interior trim are the parts of buildings that deathwatch beetles most frequently attack. In addition, they may damage furniture and other products.

Figure 6.10. Eastern deathwatch beetle (Anobiidae)—*Hemicoelus carinatus* (H. Russell, Michigan State University Diagnostics Services).

Figure 6.11. Lyctid beetle damage in framing around mirror (USDA Forest Service).

Control and Management of Powder post Beetles

Inspection

Periodic inspections are needed to determine the condition of wood and to locate any evidence of attack by wood-destroying beetles.

- Visually examine all exposed surfaces of wood (painted and unpainted); also sound by tapping or probe wood with a knife.
- Interview homeowner or building occupants and ask whether they have noticed any signs of beetle infestation (beetles, holes in wood, frass, etc.).
- Look for evidence of beetle attacks in attics, crawl spaces, and unfinished basements and storage areas. The signs are more likely to be undisturbed in these areas, and the absence of finishes on wood leaves more wood surface exposed to reinfestation.
- Collect beetles, larvae, frass, wood samples, or any other evidence that needs to be closely examined with good light and magnification to determine the identification of the attacking beetles.
- To be certain that the infestation is active, try to find fresh frass, which is the color of newly sawed wood, or live larvae or adults in the wood.

Refer to Tables 6.1 and 6.2 for information on how to identify beetles.

Table 6.1. Comparative biological information on the three families of powderpost beetles.

	Family		
Characteristic	**Lyctidae**	**Bostrichidae**	**Anobiidae**
Size	1/ 12 to 1/5 inch	1/ 8 to 1/4 inch	1/ 8 to 1/3 inch
Shape	Flattened	Cylindrical, roughened pronotum	Oval, compact
Color	Brown to black	Brown to black	Reddish brown
Head visible from above	Yes	No	No
Antennal club	2-segmented	3- to 4-segmented	None
Egg placement of hardwoods	Deposited in pores of hardwoods	Female bores into wood to lay eggs	Laid in cracks or old exit holes in wood
Required moisture content of wood*	6 to 30 percent	6 to 30 percent	13 to 30 percent
Average life cycle	1 year	1 year	1 to 3 years

* Wood found in structures is considered dry with a moisture content less than 20 percent.

Source: M.P. Levy, *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects,* U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

Table 6.2. Timbers attacked by common wood-boring insects.

	Timbers Attacked					
	Unseasoned	**Seasoned**	**Softwood**	**Hardwood**	**Sapwood**	**Heartwood**
Lyctids		+		+	+	
Bostrichids	-	+	-	+	+	
Anobiids		+	+	-	+	-
Round-headed borers	+		+	+	+	-
Old house borers		+	+		+	
Flat-headed borers	+	-	+	+	+	+
Wharf borers		+	+	+	+	+
Scolytids	+		+	+	+	+

Note: + means yes; - means occasionally.

Source: M.P. Levy, *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects,* U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

Habitat Modification

Alteration of environmental conditions might one day be the only procedure necessary to eliminate some infestations of wood-boring beetles. No wood-destroying beetles in buildings develop rapidly in dry wood. If the use of vapor barriers, ventilation, and central heat can dry wood and keep it dry, the use of other control measures may not be necessary. Here are some techniques to reduce favorable habitat for wood-destroying beetles:

- **Moisture meters** can be used to determine the moisture level in the wood. Every effort should be made to reduce the moisture content of the wood to be protected to below 20 percent.
- Where economical and practical, infested wood should be removed and replaced.
- Electric current treatment and heat control may be used in some wood-boring beetle infestations.

Every situation of wood-boring beetle infestation needs to be evaluated before you decide on the treatment method or combination of methods to be used.

Pesticide Application

There are certain similarities in control measures recommended for the control of wood-boring beetles, but in many instances specialized techniques are required. If it can be determined that the damage in a particular instance was caused by one of the true powderpost beetles, it will be necessary to concentrate control activities on articles made of hardwoods. In most cases, this will involve a thorough application of insecticide to all exposed hardwood surfaces.

If the infestation involves bostrichid or anobiid beetles, the scope of the treatment is altered to some extent. Unless the professional can make a definite species determination and thereby establish the various woods subject to attack, it must be assumed that the pest endangers both softwoods and hardwoods. In addition to determining the type of wood being attacked, each problem mustbe analyzed in light of the severity of infestation, the possibility of reinfestation, the area of the structure being attacked, the speed of control needed, and the cost the property owner can bear. Some guidelines follow.

- Residual sprays provide effective control in most cases. Sprays should be applied at low pressure (to reduce splashing) using a flat-fan nozzle to obtain thorough coverage.
- The best penetration to tunnels is provided by a fumigant, but the danger in handling these materials and the fact that they have no effective residual life limit their desirability. Fumigation may be necessary when it is impossible to control powderpost beetles via insecticidal sprays. An example is when the beetles have moved into walls and other inaccessible areas.
- Water-based insecticide emulsions, in most cases, are considered safer and more effective than oil-based emulsions. Oil solutions present a possible fire hazard, greater expense, greater hazard and discomfort to the applicator, and danger of damaging plants near the treatment area.
- Do not allow any treated surface to be walked on or handled until it is thoroughly dry.

In treating finished wood, such as furniture or flooring, it is best to use an oil solution to avoid spotting or in any way changing the appearance of the finish. To be certain the oil-based solution will not damage the finish, apply only a small amount to an out-of-the-way area and allow it to dry before making a complete treatment. Insecticide should be applied to the entire surface of the infested wood using a flat-fan nozzle at low pressure, or by using a soft-bristled paintbrush. If there are only scattered patches of infestation, treat only the infested boards. Avoid overtreating (i.e., until the solution runs off or puddles), particularly on hardwood floors laid over asphalt paper or asphalt-based mastic. The asphalt will be dissolved by excess oil and may bleed through the finished floor. Any excess solution should be wiped up immediately. Be careful not to mar the surface if the spray has temporarily softened the finish. An oil carrier may have a solvent action on some wood finishes. Therefore, keep all objects off treated areas for about 24 hours or until all stickiness has disappeared.

Follow-up

Check for signs of reinfestations of lyctid and anobiid beetles. Bostrichid beetles will rarely reinfest structural timbers.

WOOD-BORING WEEVILS

Family Curculionidae

Though they are not particularly common, several species of weevils will infest structural timbers. Because they are found in wet and rotting wood, they are considered a secondary problem to the wood rot. They are capable of extensive tunneling and will make a wood rot problem far worse.

Weevils are easily recognized by the presence of an elongated snout. The wood-boring weevils are small insects about 1/ 8 inch long. They leave small tunnels about 1/ 16 inch in diameter in the heartwood or sapwood of softwoods, hardwoods, or even plywood.

Control is usually restricted to the removal and replacement of damaged wood. The wood is frequently already damaged by moisture by the time the weevils arrive. It may be appropriate to lower the moisture of the wood in conjunction with an application of borate insecticides, but these decisions will need to be made on a case-by-case basis.

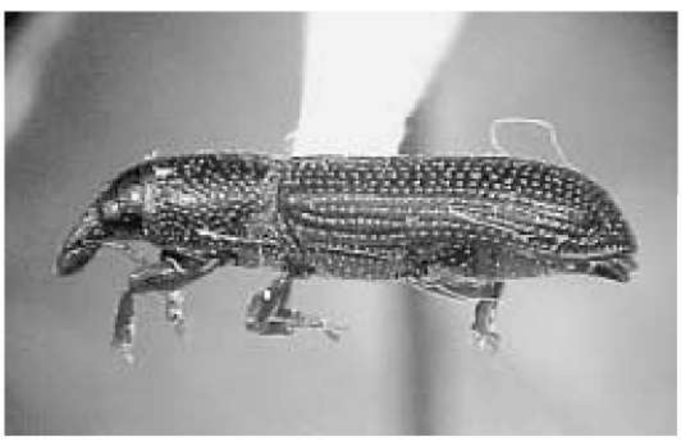


Figure 6.12. Wood-boring weevil, *Cossonus* spp. (H. Russell, Michigan State University Diagnostics Services).

LONGHORNED BEETLES

Family Cerambycidae

Species in this family (more than 1,200 species recorded in the United States) feed as larvae on living trees, recently felled trees and logs, and seasoned lumber. Indoors, the only species of major economic importance that can reinfest dry, seasoned wood is the **old houseborer** (*Hylotrupes bajulus).* Larvae hollow out extensive galleries in seasoned softwood (e.g., pine). The old house borer is frequently a pest of new structures, although it is found in older buildings.

Adults are about 3/4 inch long and grayish brown to black with two white patches on the ***elytra.*** The dorsal surface is densely covered with light-colored hairs. On the ***pronotum*** are two black, shiny bumps. The long, gray hairs surrounding these bumps give an owl-like appearance.

Figure 6.13. Old house borer adult (Cerambycidae)—*Hylotrupes bajulus* (H. Russell, Michigan State University Diagnostics Services).

The beetles of this family lay their eggs in cracks or crevices in bark or on the surface of rough-sawn timbers. The larvae are wood borers. Mature larvae are large, varying from 1/2 inch to 3 or 4 inches long. The body is long and narrow and a light cream color. The rear portion of the head is partly drawn into the body, so that only the mandibles and other mouthparts are easily seen. Larvae are called **round-headed borers.**

The life cycle of the old house borer ranges between 3 and 12 years. Because this beetle has a very long life cycle and can infest the same piece of wood again and again, it

Figure 6.14. Old house borer damage with oval exit hole

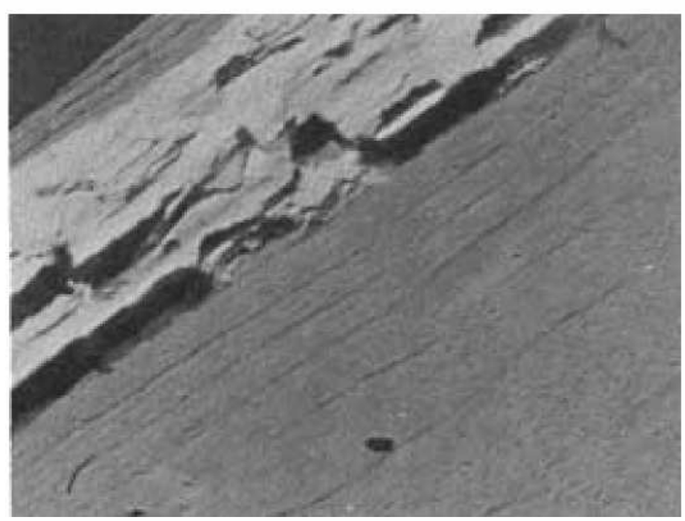


Figure 6.14 Old house borer damage with oval exit holes and powder-filled galleries in interior of wood.

may be many years before serious structural damage is recognized. The exit holes of emerging adults do not occur in very large numbers until the infestation has been established for several years. This, along with the fact that larvae will do extensive feeding without breaking through the surface of the wood, make it necessary to inspect infested wood very carefully to detect old house borer damage. Refer to Table 1 in Appendix C for a comparison of old house borers with other wood-boring insects.

Control and Management of Longhorned Beetles

Inspection

Rough wood should be probed or struck to detect weaknesses or the presence of boring dust. If exit holes are present, they will be broadly oval and about 1/4 to 3/ 8 inch in diameter.

Habitat Modification

A common source of these beetles is firewood brought indoors. Thus, firewood should be brought indoors only when it will be used soon after.

Keeping wood dry will slow down larval development—larvae grow faster in wood that provides a protein source in the form of wood-decaying fungi.

Pesticide Application

Control programs involve only the treatment of softwoods, to which this pest is restricted. Infestations of this beetle often involve extensive excavations, and larvae may be considerable distances from the obvious points of infestation. If the infestation is too widespread for spot treating with residual sprays, fumigation may be necessary. Other long-horned beetles require no control.

Follow-up

Careful and thorough inspection is necessary to determine the extent of a newly found infestation. Old house borers are the only longhorned beetles that will reinfest structural timbers, and damage may not be noticed for several years.

CARPENTER ANTS (*Camponotus* spp.)

There are many species of carpenter ants in North America; few enter structures to forage and fewer nest in structures. But these two habits (foraging and nesting inside), coupled with their large size and vigorous activity, make these invaders impossible to ignore. In Michigan, the black carpenter ant is the primary pest species. As their name implies, carpenter ants work in wood but do not digest it.

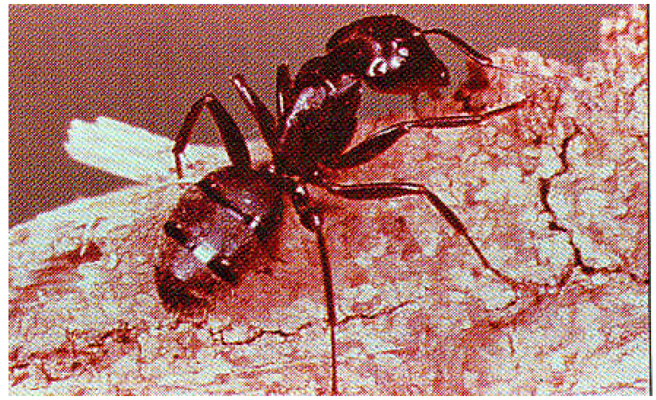


Figure 6.15. Carpenter ant, *Camponotus pennsylvanicus.*

BLACK CARPENTER ANT (*Camponotus pennsylvanicus*)

The workers range in size from 1/ 4 to almost 1/2 inch; the queen is 3/4 inch. Outside workers can be confused with field ants (*Formica),* which do not enter structures. Carpenter ants have an even, smooth, arching profile beginning just behind the head and descending to the waist, or ***petiole,*** which has one ***node.*** Field ants and most other ants have bumps or spines along the profile of the ***thorax,*** particularly near the petiole. The black carpenter ant's abdomen is covered with gray or yellowish hairs, but the basic black color is still obvious. The head and thorax are black in the majority of individuals, but the sides of the thorax and parts of the legs of a few may be dull red.

A carpenter ant colony begins in isolation but not necessarily in wood. This first brood may be under a stone, in a roll of tarpaper, or in innumerable other secretive spots, but the colony soon moves into wood (such as a fallen log, tree hole, stump, or structure wall). When carpenter ant workers excavate nest galleries, they use their jaws as gouges and make tunnels by shaving out small pieces. Unlike termites, they do not eat the wood. It has

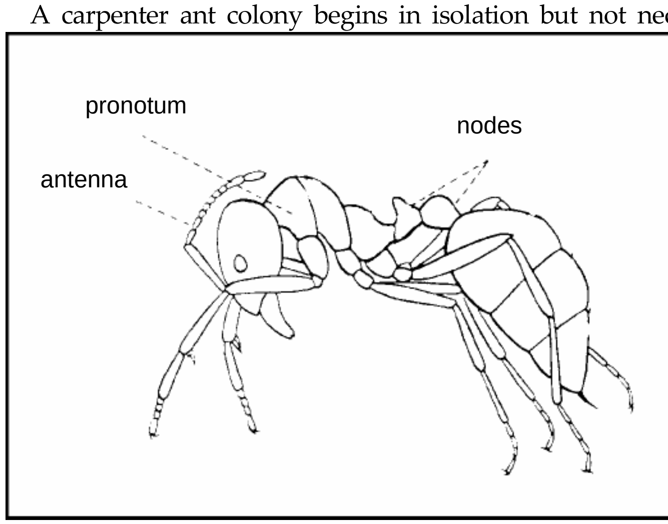


Figure 6.16. Identifying features of ants.

no nutritional value to them, and they discard it by dropping it out of the nest area or by piling in one place and discarding the whole pile later. This pile of carpenter ant shavings, called sawdust, is very soft and is made up of pieces like those a fine chisel would make. Gritty construction sawdust in attics or on sills can be left over from construction or repairs and might suggest carpenter ant shavings to those who do not know the difference. The process of ant gallery excavation results in galleries with very smooth sides. No mud is involved (like that in the tunnels of subterranean termites), and there is no dust or pellets (like those produced by wood borers or dry wood termites), only numerous large, smooth, brown-stained tunnels that provide harborage for the carpenter ant colony (see Table 6.3). A nest or colony might harbor several thousand inhabitants. Large colonies of carpenter ants in critical areas of structures can cause structural damage, but the colony more likely resides partially in structural wood and partially in void spaces (e.g., between roof boards, between studs under windows, or between subflooring and shower bases).

Figure 6.17. Carpenter ant shavings.

The most common outdoor harborage is a living tree with a rotted spot inside. Other common sites are stumps or firewood. The carpenter ant is a valuable link in the reduction of plant cellulose. It is not surprising that mature wooded neighborhoods often have structural carpenter ant problems. New neighborhoods or developments built on cleared woodlots can inherit ant colonies from trees. Some colonies are brought in with building materials. Rustic cabins, summer homes, and park structures will likely become infested sooner or later.

Black carpenter ant workers forage for food such as honeydew, insects, and juices from ripe fruit. Indoors, they like sweets, meats, fruit juices, and moist kitchen refuse. Carpenter ants always prefer a humid atmosphere. Vines on building walls, branches, and telephone wires provide a bridgelike access into structures. Carpenter ants will invade both decayed and new wood inside structures.

ANT AND TERMITE SWARMERS

The swarming of small, dark insects near or inside a structure panics people who fear their homes are infested by termites. Pest management professionals must be able to distinguish between ant and termite reproductives and communicate the differences clearly and confidently to their clients.

Principal differences are:

- ***Ants*** have a complete metamorphosis—that is, they go through the egg, larva, pupa, and adult stages, all of which look different from the others. Ant workers are adults.

  Termites have a gradual metamorphosis. They go through the egg, nymph, and adult stages. Nymphs look like adult workers. Reproductives are dark-bodied.

- ***Ants*** have a thin or "wasp" waist (called the **petiole)** between the thorax and abdomen.

  Termite waists are NOT narrow. Termite bodies are straight-sided with no constriction. Thorax and abdomen blend together.

- ***Ants*** have elbowed antennae. A long, straight segment connects to the head. Remaining segments flex and bend.

  Termite antennae are entirely flexible. They are made of many small segments strung out like beads. Termites wave them in front, using them to touch and feel.

- ***Ant*** reproductives have two pairs of wings. The front pair is wider and markedly longer than the back pair. Often ants have a black dot near the tip of the front wings, and dark wing veins can be seen. Ant wings do not break off easily.

  Termite wings are long and narrow; both pairs are the same shape and almost the same length. Termite wings break off with a touch. If termite swarmers have been crawling, their broken wings litter the swarm area. Termite wing veins cannot be seen with the naked eye.

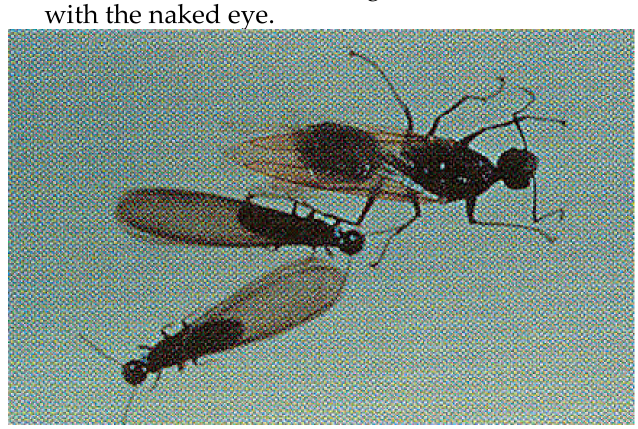


Figure. 6.18. Ant vs. termite reproductives.

Control and Management of Carpenter Ants

Inspection

It is important to discover whether carpenter ants are nesting inside or outside. If nesting inside:

- Their presence usually indicates a moisture problem in the building.
- They may have excavated galleries for harborage in structural wood.

Black carpenter ants are often associated with moisture problems. In the majority of cases, carpenter ants make their nests in wood that has been wet and infested by a brown rot fungus. Dark fungus stains on the wood indicate the presence of such moisture. Moisture in wood can be caused by:

- Improper attachment of wooden additions, dormers, and hollow wooden columns that absorb moisture.
- Patios or porch floors, door sills, downspouts, or grading where water collects or drains toward the structure.
- Regular gutter overflow that pours rainwater down the side of the building as well as back onto roof boards, fascia, soffits, etc.
- Leaking roof valleys.
- Improper ***flashing*** around chimneys, vents, and skylights.
- Improper roofing or holes in the roof.
- Window sills directly exposed to rain.
- Lack of ventilation in any area where moisture accumulates.

Inside, moisture accumulates:

- Around any leaking plumbing or drains (especially shower drains).
- Unvented attics and crawl spaces.
- Unvented dishwashers, washing machines, icemakers, etc.

The many nesting sites, foraging entrances, and food and moisture sources offer clues for inspection and location of the nest. The area where the majority of ant activity is seen may identify a nest site if entry from the outside can be ruled out. Carpenter ants are more active at night, and inspection at that time may be helpful.

Habitat Modification

- Where nests are located inside, remove and replace infested structural wood.
- Stop the intrusion of moisture.
- Caulk and screen actual and potential ant entryways.
- Ventilate areas where moisture accumulates, regrade where necessary, and repair roofing, guttering, etc.
- Recommend trimming trees where branches touch a structure or overhang roofs. Tree removal may be necessary.

Pesticide Application

- Eliminating colonies and nesting sites is a primary way to eliminate carpenter ant infestation.
- Use pesticidal dust or pressurized canned aerosols when nests are in wall voids. Sprays are less effective.
- When indirect treatment is required, liberal placement of acceptable bait stations can be used.
- Dust, spray, or bait can be used on outside colonies (e.g., in tree rot).
- Professionals should evaluate trees with rotted places.
- Honeydew-producing insects involved in feeding carpenter ants should be treated with pesticides (e.g., oils and pesticidal soaps) that will not eliminate parasites and predators.

Follow-up

Carpenter ant infestations often cannot be controlled in one visit. Painstaking inspection is needed to make management effective.

CARPENTER BEES (*Xylocopa* spp.)

Carpenter bees are solitary insects that live only one year. The most common carpenter bee, *Xylocopa virginica,* is distributed throughout the eastern half of North America. This bee is a large insect with a hairy, yellow thorax and a shiny, black abdomen. Superficially, it resembles yellow and black female bumblebees, which are social and more closely related to honeybees. Western carpenter bees are also large, shiny, sometimes metallic, and shaped like bumblebees.

Figure 6.19. Carpenter bee, *Xylocopa* spp.

Carpenter bees bore in wood and make a long tunnel provisioned with pollen for their eggs. They prefer to enter unpainted wood and commonly tunnel in redwood and unpainted deck timbers. They will also go into painted wood, especially if any type of start hole is present. New females reuse old tunnels year after year. They are also attracted to areas where other females are tunneling. Egg laying and tunnel provisioning occur in the spring.

Males hover around the tunnel entrance while the female provisions the nest and lays eggs.

Figure 6.20. Carpenter bee damage.

Males dart at intruders belligerently but they can do no harm—they have no stingers. Because these bees are not social, there is no worker caste to protect the nest. Stings by females are rare.

New adults emerge after the middle of summer and can be seen feeding at flowers until they seek overwintering sites, sometimes in the tunnels.

Control and Management of Carpenter Bees

Carpenter bees drill into the end grain of structural wood or into the face of a wooden member, then turn and tunnel with the grain.

Dust tunnels or inject with pressurized liquid insecticide. Insert a dusted plug of steel wool or copper gauze in the tunnel. Fill the opening with caulk, wood filler, or a wooden dowel. A dusted plug stops new adults that otherwise would emerge through shallow caulking. Caution should be taken, especially if technicians are working on ladders and if they are not experienced with these rather harmless bees.

SUMMARY

Wood-destroying insects other than termites are capable of causing significant damage to structures, furniture, and other wood products. Pest management professionals must be able to distinguish between wood damage caused by termites and damage by other wood-destroying pests. These signs are often characteristic of the pest species involved. Proper identification of the pest species will allow application of the appropriate control techniques. In many cases, habitat alteration (such as reduction of moisture in wood) is all that is needed to control the pest adequately.

APPENDIX A

GLOSSARY

Glossary of Terms for Management of Wood-destroying Pests

ABSORPTION—The movement of a chemical into plants, animals (including humans), and/or microorganisms.

ACTIVE INGREDIENT—The chemical or chemicals in a pesticide responsible for killing, poisoning, or repelling the pest. Listed separately in the ingredient statement.

ACUTE TOXICITY—The capacity of a pesticide to cause injury within 24 hours following exposure. LD_{50} and LC_{50} are common indicators of the degree of acute toxicity. (See also ***chronic toxicity.)***

ADJUVANT—A substance added to a pesticide to improve its effectiveness or safety. Same as additive. Examples: penetrants, spreader-stickers, and wetting agents.

ADSORPTION—The process by which chemicals are held or bound to a surface by physical or chemical attraction. Clay and high organic soils tend to adsorb pesticides.

AEROSOL—A material stored in a container under pressure. Fine droplets are produced when the material dissolved in a liquid carrier is released into the air from the pressurized container.

ALATES—The winged primary reproductives (both male and female) of the termite colony (alate=winged). (See also ***swarmers.)***

ANTI-SIPHONING DEVICE—A device attached to the filling hose that prevents backflow or ***back-siphoning*** from a spray tank into a water source.

ANTIDOTE —A treatment used to counteract the effects of pesticide poisoning or some other poison in the body.

ATTRACTANT—A substance or device that will lure pests to a trap or poison bait.

BACK-SIPHONING—The movement of liquid pesticide mixture back through the filling hose and into the water source.

BACTERIA—Microscopic organisms, some of which are capable of producing diseases in plants and animals. Others are beneficial.

BAIT—A food or other substance used to attract a pest to a pesticide or to a trap.

BARRIER APPLICATION—Application of a pesticide in a strip alongside or around a structure, a portion of a structure, or any object.

BIOLOGICAL CONTROL—Control of pests using predators, parasites, and and/or disease-causing organisms. May be naturally occurring or introduced.

BIOMAGNIFICATION—The process whereby one organism accumulates chemical residues in higher concentrations from organisms it consumes.

BRAND NAME—The name or designation of a specific pesticide product or device made by a manufacturer or formulator; a marketing name.

BRICK VENEER—A facing of brick laid against and fastened to ***sheathing*** of a frame wall or tile wall construction.

BUDDING—Another means (other than ***swarming)*** for termites to form a new colony. Budding occurs when a number of individuals, including one or more wingless secondary reproductives, leaves a well established colony to start a new one.

CALIBRATE, CALIBRATION OF EQUIPMENT, OR APPLICATION METHOD—The measurement of dispersal or output and adjustments made to control the rate of dispersal of pesticides.

CARBAMATES (N-methyl carbamates) —A group of pesticides containing nitrogen, formulated as insecticides, fungicides, and herbicides. The N-methyl carbamates are insecticides and inhibit ***cholinesterase*** in animals.

CARCINOGENIC—The ability of a substance or agent to induce malignant tumors (cancer).

CARRIER—An inert liquid, solid, or gas added to an active ingredient to make a pesticide dispense effectively. A carrier is also the material, usually water or oil, used to dilute the formulated product for application.

CASTE—A specialized form within the termite colony that carries out a particular function within the colony. Termite castes include ***reproductives, workers,*** and ***soldiers.***

CELLULOSE—A polysaccharide that is the chief part of plant cell walls and the main food source for termites.

CERTIFIED APPLICATORS—Individuals who are certified to use or supervise the use of any restricted-use pesticide covered by their certification.

CHEMICAL NAME—The scientific name of the active ingredient(s) found in the formulated product. This complex name is derived from the chemical structure of the active ingredient.

CHEMICAL CONTROL—Pesticide application to kill pests.

CHEMOSTERILANT—A chemical compound capable of preventing animal reproduction.

CHEMTREC—The Chemical Transportation Emergency Center has a toll-free number (800-424-9300) that provides 24-hour information for chemical emergencies such as a spill, leak, fire, or accident.

CHLORINATED HYDROCARBON—A pesticide containing chlorine, carbon, and hydrogen. Many are persistent in the environment. Examples: chlordane, DDT, methoxychlor. Few are used in structural pest management operations today.

CHOLINESTERASE, ACETYLCHOLINESTERASE — An enzyme in animals that helps regulate nerve impulses. This enzyme is depressed by N-methyl carbamate and organophosphate pesticides.

CHRONIC TOXICITY—The ability of a material to cause injury or illness (beyond 24 hours following exposure) from repeated, prolonged exposure to small amounts. (See also ***acute toxicity.)***

COMMERCIAL APPLICATOR—A certified applicator who uses or supervises the use of any pesticide classified for restricted use for any purpose or on any property other than that producing an agricultural commodity.

COMMON NAME —A name given to a pesticide's active ingredient by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names, but each active ingredient has only one recognized common name.

COMMUNITY—The various populations of animal species (or plants) that exist together in an ecosystem. (See also ***population*** and ***ecosystem.)***

CONCENTRATION—Refers to the amount of active ingredient in a given volume or weight of formulated product.

CONTAMINATION—The presence of an unwanted substance (sometimes pesticides) in or on plants, animals, soil, water, air, or structures.

CRAWL SPACE—A shallow space below the living quarters of at least a partially basementless house, normally enclosed by the foundation wall.

CULTURAL CONTROL—A pest control method that includes changing human habits—e.g., sanitation, work practices, cleaning and garbage pickup schedules, etc.

DECONTAMINATE—To remove or break down a pesticidal chemical from a surface or substance.

DEFECT ACTION LEVELS—The maximum levels for defects such as the presence of insect fragments, mold, or rodent hairs in food products allowed by the Food and Drug Administration (FDA).

DEGRADATION—The process by which a chemical compound or pesticide is reduced to simpler compounds by the action of microorganisms, water, air, sunlight, or other agents. Degradation products are usually, but not always, less toxic than the original compound.

DEPOSIT—The amount of pesticide on treated surfaces after application.

DERMAL TOXICITY—The ability of a pesticide to cause acute illness or injury to a human or animal when absorbed through the skin. (See ***exposure route.)***

DETOXIFY—To render a pesticide's active ingredient or other poisonous chemical harmless.

DIAGNOSIS—The positive identification of a problem and its cause.

DILUENT—Any liquid, gas, or solid material used to dilute or weaken a concentrated pesticide.

DISINFECTANT—A chemical or other agent that kills or inactivates disease-producing microorganisms. Chemicals used to clean or surface-sterilize inanimate objects.

DOSE, DOSAGE—Quantity, amount, or rate of pesticide applied to a given area or target.

DRIFT—The airborne movement of a pesticide spray or dust beyond the intended target area.

DUCTS—In a house, usually round or rectangular metal pipes for distributing warm air from the heating plant to rooms, or cold air from a conditioning device, or as cold-air returns. May be embedded in or placed beneath concrete slabs. Ducts are also made of asbestos and composition material.

DUST—A finely ground, dry pesticide formulation containing a small amount of active ingredient and a large amount of inert carrier or diluent such as clay or talc.

ECOSYSTEM—The pest management unit. It includes a community (of ***populations)*** with the necessary physical (***harborage,*** moisture, temperature) and biotic (food, hosts) supporting factors that allow an infestation of pests to persist.

ELYTRA—A pair of thickened, leathery, or horny front wings (found in the beetle family).

EMULSIFIABLE CONCENTRATE—A pesticide formulation produced by mixing or suspending the active ingredient (the concentrate) and an emulsifying agent in a suitable carrier. When added to water, a milky emulsion is formed.

EMULSIFYING AGENT (EMULSIFIER) —A chemical that aids in the suspension of one liquid in another that normally would not mix together.

EMULSION—A mixture of two liquids that are not soluble in each other. One is suspended as very small droplets in the other with the aid of an emulsifying agent.

ENCAPSULATED FORMULATION—A pesticide formulation with the active ingredient enclosed in capsules of polyvinyl or other materials; principally used for slow release.

ENDANGERED SPECIES—A plant or animal species whose population is reduced to the extent that it is near extinction and that a federal agency has designated as being in danger of becoming extinct.

ENTRY INTERVAL—See ***re-entry interva***l.

ENVIRONMENT—All of our physical, chemical, and biological surroundings, such as climate, soil, water, and air, and all species of plants, animals, and microorganisms.

ENVIRONMENTAL PROTECTION AGENCY OR EPA—The federal agency responsible for ensuring the protection of humans and the environment from potentially adverse effects of pesticides.

EPA ESTABLISHMENT NUMBER—A number assigned to each pesticide production plant by the EPA. The number indicates the plant at which the pesticide product was produced and must appear on all labels of that product.

EPA REGISTRATION NUMBER—An identification number assigned to a pesticide product when the product is registered by the EPA for use. The number must appear on all labels for a particular product.

ERADICATION—The complete elimination of a (pest) population from a designated area.

EXPOSURE ROUTE OR COMMON EXPOSURE ROUTE—The manner (dermal, oral, or inhalation/respiratory) by which a pesticide may enter an organism.

FIFRA—The Federal Insecticide, Fungicide, and Rodenticide Act; a federal law and its amendments that control pesticide registration and use.

FLASHING—Strips of aluminum, lead, tin, or copper that are worked into the slates or shingles around dormers, chimneys, and other rising parts of buildings to prevent leaking.

FLOATING SLAB—A type of foundation construction in which the foundation wall and footing are separated from the slab floor by an expansion joint. The slab floor is concrete, while the foundation wall can be a variety of materials, such as solid block, hollow block, or concrete.

FLOW METER—Used to measure the application or delivery rate of a chemical—i.e., the amount of chemical delivered per unit area. Flow meters are useful when ***calibrating*** large-volume sprayers. These meters can also measure the amount of termiticide injected into each hole for subslab applications.

FLOWABLE—A pesticide formulation in which a very finely ground solid particle is suspended (not dissolved) in a liquid carrier.

FOOTING—A masonry section, usually concrete, in a rectangular form wider than the bottom of the ***foundation*** wall or ***pier*** it supports.

FORMULATION—The pesticide product as purchased, containing a mixture of one or more active ingredients, carriers (inert ingredients), and other additives making it easy to store, dilute, and apply.

FOUNDATION—The supporting portion of a structure below the first-floor construction, or below grade, down to and including the ***footings.***

FRASS —Solid larval insect excrement; mixed with wood fragments in wood-boring and bark-boring insects.

FRUITING BODY—The part of the fungi from which the reproductive spores are produced (e.g., conks, mushrooms, etc.).

FUMIGANT—A pesticide formulation that volatilizes, forming a toxic vapor or gas that kills in the gaseous state. Usually, it penetrates voids to kill pests.

FUNGICIDE—A chemical used to control fungi.

FUNGUS (plural, fungi)—A group of small, often microscopic, organisms that cause rot, mold, and disease. Fungi need moisture or a damp environment (wood rots require at least 19 percent moisture). Fungi are extremely important in the diet of many insects.

GENERAL-USE (UNCLASSIFIED) PESTICIDE — A pesticide that can be purchased and used by the general public. (See also ***restricted-use pesticide.)***

GRANULE—A dry pesticide formulation. The active ingredient is either mixed with or coated onto an inert carrier to form a small, ready-to-use, low-concentrate particle that normally does not present a drift hazard. Pellets differ from granules only in their precise uniformity, larger size, and shape.

GROUNDWATER—Water sources located beneath the soil surface from which spring water, well water, etc., are obtained. (See also ***surface water.)***

HARBORAGE—Any place or site that shelters and provides other elements (i.e., food, water) required for survival of a particular organism.

HARDWOOD—Wood from non-evergreen trees such as maple, oak, ash, etc.

HAZARD—See ***risk.***

HEARTWOOD—A cylinder of dark-colored, dead wood in the center of the tree that is no longer active in conducting sap or water.

HERBICIDE—A pesticide used to kill plants or inhibit plant growth.

HOST—Any animal or plant on or in which another lives for nourishment, development, or protection.

HYPHA (plural, hyphae)—usually, one of the threadlike structures of a fungus.

INERT INGREDIENT—In a pesticide formulation, an inactive material without pesticidal activity.

INGREDIENT STATEMENT—The portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

INHALATION—Taking a substance in through the lungs; breathing in. (See ***exposure route.)***

INSPECTION—To examine for pests, pest damage, other pest evidence, etc. (See ***monitoring.)***

INTEGRATED PEST MANAGEMENT (IPM)— A planned pest control program in which various methods are integrated and used to keep pests from causing economic, health-related, or aesthetic injury. IPM includes reducing pests to a tolerable level. Pesticide application is not the primary control method but is an element of IPM—as are cultural and structural alterations. IPM programs emphasize communication, monitoring, inspection, and evaluation (keeping and using records).

JOIST—One of a series of parallel beams, usually 2 inches in thickness, used to support floor and ceiling loads, and supported in turn by larger beams, girders, bearing walls, or foundation.

LABEL—All printed material attached to or on a pesticide container.

LABELING—The pesticide product label and other accompanying materials that contain directions that pesticide users are legally required to follow.

LARVA (plural, larvae)—An early developmental stage of insects with complete metamorphosis. Insects hatch out of the egg as larvae before becoming ***pupae*** (resting stage), and then adults.

LC_{50}—Lethal concentration. The concentration of a pesticide, usually in air or water, that kills 50 percent of a test population of animals. LC_{50} is usually expressed in parts per million (ppm). The lower the LC_{50} value, the more acutely toxic the chemical.

LD_{50}—Lethal dose. The dose or amount of a pesticide that can kill 50 percent of the test animals when eaten or absorbed through the skin. LD_{50} is expressed in milligrams of chemical per kilogram of body weight of the test animal (mg/kg). The lower the LD_{50}, the more acutely toxic the pesticide.

LEACHING—The movement of a substance with water downward through soil.

LIGNIN—a complex structural polymer that imparts rigidity to certain plant cell walls, especially walls of wood cells.

MATERIAL SAFETY DATA SHEETS (MSDS)—These data sheets contain specific information on toxicity, first aid, personal protective equipment, storage and handling precautions, spill and leak cleanup and disposal practices, transportation, physical data, and reactivity data. MSDS are available from manufacturers.

MESOTHORAX—The second segment of an insect's ***thorax.*** One pair of legs and usually one pair of wings are attached.

METAMORPHOSIS—A change in the shape, or form, of an animal. Usually used when referring to insect development.

METATHORAX—The third segment of an insect's ***thorax.*** One pair of legs and often one pair of wings are attached.

MICROBIAL PESTICIDE—Bacteria, viruses, fungi, and other microorganisms used to control pests. Also called biorationals.

MICROORGANISM—An organism so small it can be seen only with the aid of a microscope.

MODE OF ACTION—The way in which a pesticide exerts a toxic effect on the target plant or animal.

MOISTURE METER—A device used to measure moisture content in wood. A moisture content greater than 20 percent indicates conditions that will lead to decay.

MOLT—Periodic shedding of the outer layer (e.g., an insect's ***exoskeleton*** is shed periodically).

MONITORING—On-going surveillance. Monitoring includes inspection and record keeping. Monitoring records allows technicians to evaluate pest population suppression, identify infested or non-infested sites, and manage the progress of the management or control program.

MONOLITHIC SLAB—A type of foundation constructing in which the foundation footing and the slab floor are formed as one continuous unit. Concrete is the material used in this type of slab foundation.

MUD TUBES—See ***shelter tubes.***

MYCELIUM (plural, mycelia)—An aggregation of hyphae of a fungus.

NODE—Nodes are swollen segments found at the narrow connection between the thorax and abdomen of ant species. The nodes may be helpful in identifying ant species—most ant species have one node; others have two.

NON-RESIDUAL PESTICIDE—Pesticides applied to obtain effects only during the time of treatment.

NON-TARGET ORGANISM—Any plant or animal other than the intended target(s) of a pesticide application.

ORAL TOXICITY—The ability of a pesticide to cause injury or acute illness when taken by mouth. One of the common exposure routes.

ORGANOPHOSPHATES—A large group of pesticides that contain the element phosphorus and inhibit ***cholinesterase*** in animals.

PARASITE—A plant, animal, or microorganism living in, on, or with another living organism for the purpose of obtaining all or part of its food.

PARESTHESIA—A reaction to dermal exposure to some pesticides (especially pyrethroids) with symptoms similar to sunburn sensation of the face and especially the eyelids. Sweating, exposure to sun or heat, and application of water aggravate the disagreeable sensations. This is a temporary effect that dissipates within 24 hours. For first aid, wash with soap and water to remove as much residue as possible, and then apply a vitamin E oil preparation or cream to the affected area. Persons susceptible to paresthesia should choose a pesticide with a different active ingredient and/or formulation.

PATHOGEN —A disease-causing organism.

PERSONAL PROTECTIVE EQUIPMENT (PPE)—Devices and clothing intended to protect a person from exposure to pesticides. Includes such items as long-sleeved shirts, long trousers, coveralls, suitable hats, gloves, shoes, respirators, and other safety items as needed.

PEST MANAGEMENT—The reduction of pest populations to tolerable numbers by changing practices, making habitat or structural alterations, and carefully using pesticides to kill pests only when indicated.

PEST—An undesirable organism (plant, animal, bacterium, etc.); any organism that competes with people for food, feed, or fiber, causes structural damage, is a public health concern, reduces aesthetic qualities, or impedes industrial or recreational activities.

PESTICIDE—A chemical or other agent used to kill, repel, or otherwise control pests or to protect from a pest.

pH —A measure of the acidity/alkalinity of a liquid—acid below pH7; basic or alkaline above pH7 (up to 14).

PHEROMONE—A substance emitted by an animal to influence the behavior of other animals of the same species. Examples are sex pheromones (to attract mates) and aggregation pheromones (to keep members of the same species together in a group). Some pheromones are synthetically produced for use in insect traps.

PHOTODEGRADATION—Breakdown of chemicals by the action of light.

PHYSICAL CONTROL—Altering habitat or changing the infested physical structure—e.g., caulking holes, cracks, tightening around doors, windows, moisture reduction, ventilation, etc.

PHYTOTOXICITY—Injury to plants caused by a chemical or other agent.

PIER—A column of masonry or sometimes wood, usually rectangular in horizontal cross-section, used to support other structural members.

POISON CONTROL CENTER—A local agency, generally a hospital, that has current information on the proper first aid techniques and antidotes for poisoning emergencies. Centers are listed in telephone directories.

POPULATION—Individuals of the same species. The populations in an area make up a community. (See ***ecosystem.)***

PRECIPITATE—A solid substance that forms in a liquid and settles to the bottom of a container; a material that no longer remains in suspension.

PREDATOR—An animal that attacks, kills, and feeds on other animals. Examples of predaceous animals are hawks, owls, snakes, many insects, etc.

PRONOTUM—The area just behind an insect's head (i.e., the upper plate of the ***prothorax).***

PROPELLANT—The inert ingredient in pressurized products that forces the active ingredient from the container.

PROTHORAX—The first segment of an insect's ***thorax.*** One pair of legs is attached.

PROTOZOAN —A unicellular animal; termites are dependent on a specific type of protozoan to help them digest ***cellulose.***

PUPA (plural, pupae)—The developmental (resting) stage of insects with complete metamorphosis during which major changes from the larval to the adult form occur.

RAFTER—One of a series of structural members of a roof designed to support roof loads. The rafters of a flat roof are sometimes called roof joists.

RATE OF APPLICATION—The amount of pesticide applied to a plant, animal, unit area, or surface; usually measured as per acre, per 1,000 square feet, per linear foot, or per cubic foot.

READY-TO-USE PESTICIDE—A pesticide that is applied directly from its original container consistent with label directions, such as an aerosol insecticide or rodent bait box, which does not require mixing or loading prior to application.

RE-ENTRY INTERVAL—The length of time following an application of a pesticide when entry into the treated area is restricted.

REGISTERED PESTICIDES—Pesticide products that have been registered by the Environmental Protection Agency for the uses listed on the label.

REPELLENT—A compound that keeps insects, rodents, birds, or other pests away from humans, plants, domestic animals, buildings, or other treated areas.

REPRODUCTIVES—The ***caste*** within the termite colony that is responsible for reproduction and for establishing new termite colonies. Subterranean termite colonies have both primary (winged males and females) and supplementary (wingless [or with short, non-functional wings] males and females) reproductives.

RESIDUAL PESTICIDE—A pesticide that continues to remain effective on a treated surface or area for an extended period following application.

RESIDUE—The pesticide active ingredient or its breakdown product(s) that remain in or on the target after treatment.

RESTRICTED-USE PESTICIDE—A pesticide that can be purchased and used only by certified applicators or persons under their direct supervision. A pesticide classified for restricted use under FIFRA, Section 3(d)(1)(C).

RHIZOMORPH—A thread- or rootlike fungal structure made up of ***hyphae.***

RISK—A probability that a given pesticide will have an adverse effect on humans or the environment in a given situation.

RODDING—A method of applying termiticide. Long rods may be used to apply termiticide into the soil next to the foundation wall. Shorter rods are used to inject termiticide into the voids of walls and through concrete slabs.

RODENTICIDE—A pesticide used to control rodents.

RUNOFF—The movement of water and associated materials on the soil surface. Runoff usually proceeds to bodies of surface water.

SAPWOOD—A lighter colored ring of wood surrounding the ***heartwood*** of the tree that consists of cells that are actively conducting water and sap.

SEASONED—Lumber that has been chemically treated with wood preservatives and prepared for use. (See also ***unseasoned.)***

SHEATHING—The structural covering, usually wood boards or plywood, used over studs or rafters of a structure. Structural building board is normally used only as a wall sheathing.

SHELTER TUBES—Tubes constructed by subterranean termites to help them pass over exposed areas and reach new food sources (cellulose). Termites require a constant source of moisture and the shelter tubes enable this by providing a moist environment and allowing them to maintain contact with the soil. The tubes also serve to conceal the termites and protect them from natural enemies (ants). (Also referred to as ***mud tubes.)***

SIGNAL WORDS—Required word(s) that appear on every pesticide label to denote the relative toxicity of the product. Signal words are DANGER-POISON, DANGER, WARNING, and CAUTION.

SILL PLATE—A horizontal member anchored on top of a masonry wall.

SITE—Areas of pest infestation. Each site should be treated specifically or individually.

SOFFIT—The underside of an overhanging part or member (especially on the roof) of a building.

SOFTWOOD—Wood from evergreen trees such as pines, firs, and spruces.

SOLDIERS—Refers to the ***caste*** within a termite colony that is responsible for the defense of the colony.

SOLUTION—A mixture of one or more substances in another substance (usually a liquid) in which all the ingredients are completely dissolved. Example: sugar in water.

SOLVENT—A liquid that will dissolve another substance (solid, liquid, or gas) to form a solution.

SLAB-ON-GROUND—The type of foundation construction in buildings without basements or crawl spaces. The three basic types of slab-on-ground construction are ***floating slab, monolithic slab,*** and ***suspended slab*** (Figures 4.1-4.3).

SOUNDING—A method of detecting damaged wood by tapping on the wood and listening for a hollow sound, which indicates cavities that are non-visible from the surface.

SPACE SPRAY—A pesticide that is applied as a fine spray or mist to a confined area.

SPOT TREATMENT—Application of a pesticide to limited areas where pests are likely to be found. A method used to avoid contact of pesticides with food, utensils, or people.

SPRINGWOOD—The wood produced early in the season that is of lower density than wood produced later in the season.

STOMACH POISON —A pesticide that must be eaten by an animal to be effective; it will not kill on contact.

SUBFLOOR—Boards of plywood laid on joists, over which a finished floor is laid.

SUMP—A pit, well, or the like in which water or other liquid is collected.

SURFACE WATER—Water on the earth's surface: rivers, lakes, ponds, streams, etc. (See also ***groundwater.)***

SUSPENDED SLAB—A type of foundation construction in which the slab floor and the foundation wall are separate units, with the slab floor extending over the top of the foundation wall. The slab floor is concrete; the material used for the foundation wall may vary.

SUSPENSION—Pesticide mixtures consisting of fine particles dispersed or floating in a liquid, usually water or oil. Example: wettable powders in water.

SWARMERS —The winged primary ***reproductives*** (both male and female) of the termite colony. They leave the colony in swarms, usually in the spring or fall. These swarms are often the first visible indication that a termite infestation is present. (See also ***alates.)***

SWARMING—When winged termite primary reproductives leave the colony in great numbers to mate and start a new colony.

TARGET—The plants, animals, structures, areas, or pests at which the pesticide or other control method is directed.

TERMITE SHIELD—A shield, usually of non-corrodible metal, placed in or on a foundation wall, other mass of masonry, or around pipes to prevent the passage of termites.

THORAX—The middle part of an insect's body between the head and the abdomen. It is divided into three segments—the ***prothorax, mesothorax,*** and ***metathorax.*** A pair of legs is attached to each thoracic region.

THRESHOLD—A level of pest density. The number of pests observed, trapped, counted, etc., that could be tolerated without an economic loss or aesthetic injury. Pest thresholds in structural pest management may be site-specific—for example, different numbers of cockroaches may be tolerated at different sites (e.g., hospitals and garbage rooms). A threshold may be set at zero (e.g., termites in a wooden structure, flies in an operatory).

TOLERABLE LEVELS OF PESTS—The presence of pests at certain levels is tolerable in many situations. Totally eliminating pests in certain areas is sometimes not achievable without major structural alterations, excessive control measures, unacceptable disruption, unacceptable cost, etc. Pest levels that depend on pest observations vary. The tolerable level in some situations will be zero (e.g., termites). Structural pest management programs usually have lower tolerable levels of pests than agricultural programs.

TOXIC—Poisonous to living organisms.

TOXICANT—A poisonous substance such as the active ingredient in a pesticide formulation.

TOXICITY—The ability of a pesticide to cause harmful, acute, delayed, or allergic effects. The degree or extent to which a chemical or substance is poisonous.

TOXIN—A naturally occurring poison produced by plants, animals, or microorganisms. Examples: the poison produced by the black widow spider, the venom produced by poisonous snakes, and the botulism toxin produced by a bacterium.

TRENCHING—A method for applying termiticide to soil. Soil is removed by digging a trench to within about 1 foot above the footing. As the soil is replaced, it is treated with termiticide.

TROPHALLAXIS —A form of communication within the termite colony that involves the mutual exchange of nutrients and the transfer of food between colony members. Trophallaxis permits the efficient use of nutrients within the colony, enhances recognition of colony members, distributes chemicals involved in caste regulation, and transfers cellulose-digesting protozoans.

UNSEASONED—Lumber that has not yet been chemically treated. (See also ***seasoned.)***

USE—The performance of pesticide-related activities requiring certification include application, mixing, loading, transport, storage, or handling after the manufacturer's seal is broken; care and maintenance of application and handling equipment; and disposal of pesticides and their containers in accordance with label requirements. Uses not needing certification are long-distance transport, long-term storage, and ultimate disposal.

VAPOR BARRIER—Material used to retard the movement of water vapor into walls or slabs and to prevent condensation in them. Also a covering used over dirt in crawl spaces. Common materials: polyethylene film, asphalt paper.

VAPOR PRESSURE—The property that causes a chemical to evaporate. The higher the vapor pressure, the more volatile the chemical and the easier it will evaporate.

VECTOR—A carrier, an animal (e.g., insect, nematode, mite) that can carry and transmit a pathogen from one host to another.

VERTEBRATE—Animal characterized by a segmented backbone or spinal column.

VIRUS—Ultramicroscopic parasites composed of proteins. Viruses can multiply only in living tissues and cause many animal and plant diseases.

VOLATILITY—The degree to which a substance changes from a liquid or solid state to a gas at ordinary temperatures when exposed to air.

WATER TABLE—The upper level of the water-saturated zone in the ground.

WETTABLE POWDER—A dry pesticide formulation in powder form that forms a suspension when added to water.

WORKERS—The sexually underdeveloped ***caste*** of the termite colony that is responsible for most of the work of the colony—foraging, feeding, and grooming of the other castes (including the queen), building and repairing the nest, and making the tunnels. They are the most numerous and destructive members of the colony.

ZONE LINES—A symptom of infestation in wood from white rot fungi—thin, dark lines form around the decayed areas.

For the further definition of terms, consult:

Pesticide Applicator Core Training Manual, E-2195, Michigan State University Extension.

The Federal Insecticide, Fungicide, and Rodenticide Act as amended. Public Law 92-516, October 21, 1972, as amended by Public Law 94-140, November 28, 1975, and Public Law 95-396, September 30, 1978.

Federal Register, November 7, 1990, Part II Environmental Protection Agency 40, CFR Part 171, Certification of Pesticide Applicator; Proposed Rule.

Region V Office of the EPA, Chicago, Ill.

Michigan Department of Agriculture State Plan for Commercial and Private Applicators.

Local, state, and national pest control associations.

APPENDIX B

WOOD-BORING INSECTS

Table 1. Characteristics of damage caused by common wood-boring insects

Insect Type	Shape and Size (inches) of Exit/Entry Hole	Wood Type	Age of Wood Attacked*	Appearance of Frass in Tunnels	Reinfests Structural Timber
Ambrosia beetles	Round, 1/50 to 1/ 8	Softwood and hardwood	New	None present	No
Lyctid beetles	Round, 1/32 to 1/ 16	Hardwood	New and old	Fine, flourlike, loosely packed	Yes
Bark beetles	Round, 1/ 16 to 3/ 32	Bark/ sapwood interface	New	Fine to coarse, bark-colored, tightly packed	No
Anobiid beetles	Round, 1/16 to 1/ 8	Softwood and hardwood	New and old	Fine powder and pellets, loosely packed; pellets may be absent and frass tightly packed in some hardwoods	Yes
Bostrichid beetles	Round, 3/32 to 9/32	Softwood and hardwood (bamboo)	New	Fine to coarse powder, tightly packed	Rarely
Horntail or wood wasp	Round, 1/6 to 1/4	Softwood	New	Coarse, tightly packed	No
Carpenter bee	Round, 1/2	Softwood	New and old	None present	Yes
Round-headed borer	Round-oval, 1/8 to 3/8	Softwood and hardwood	New	Coarse to fibrous, mostly absent	No
Flat-headed borer	Oval, 1/8 to 1/2	Softwood and hardwood	New	Sawdustlike, tightly packed	No
Old house borer	Oval, 1/4 to 3/ 8	Softwood	New and old	Very fine powder and tiny pellets, tightly packed	Yes
Round- or flat-headed borer, wood machined after attack	Flat oval, 1/2 or more; or irregular surface groove, 1/ 8 to 1/ 2	Softwood and hardwood	New	Absent or sawdustlike, coarse to fibrous; tightly packed	No

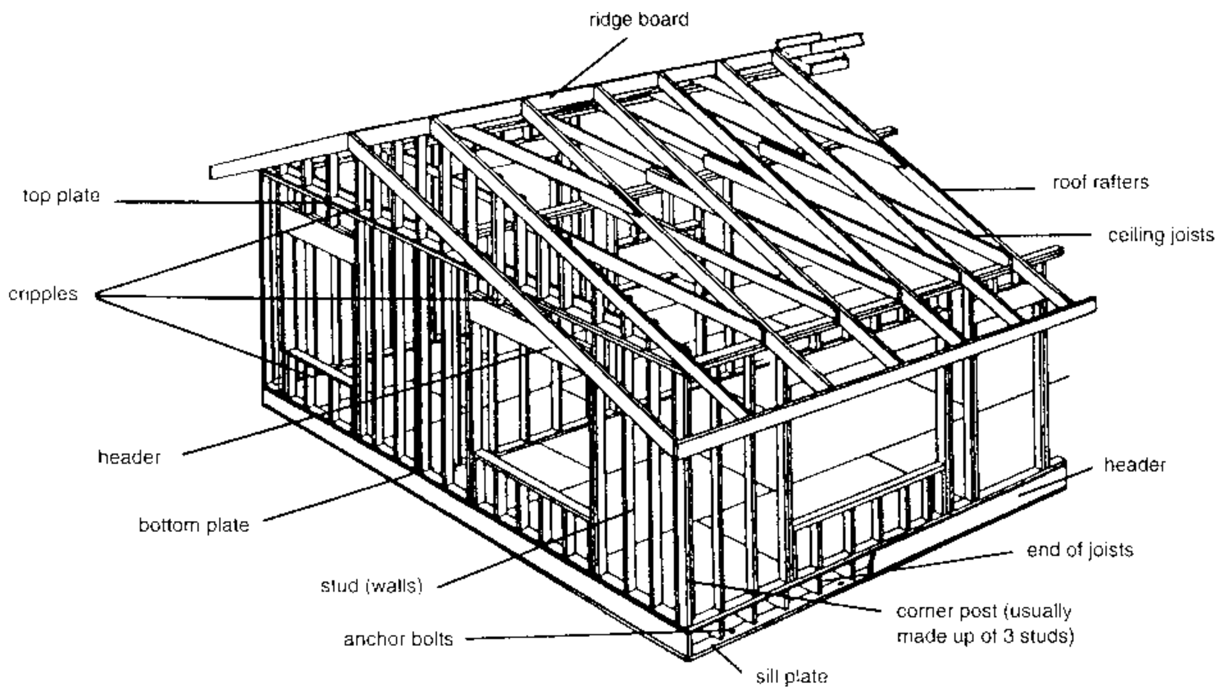
* New wood is defined as standing or freshly felled trees and unseasoned lumber. Old wood is seasoned or dried lumber.

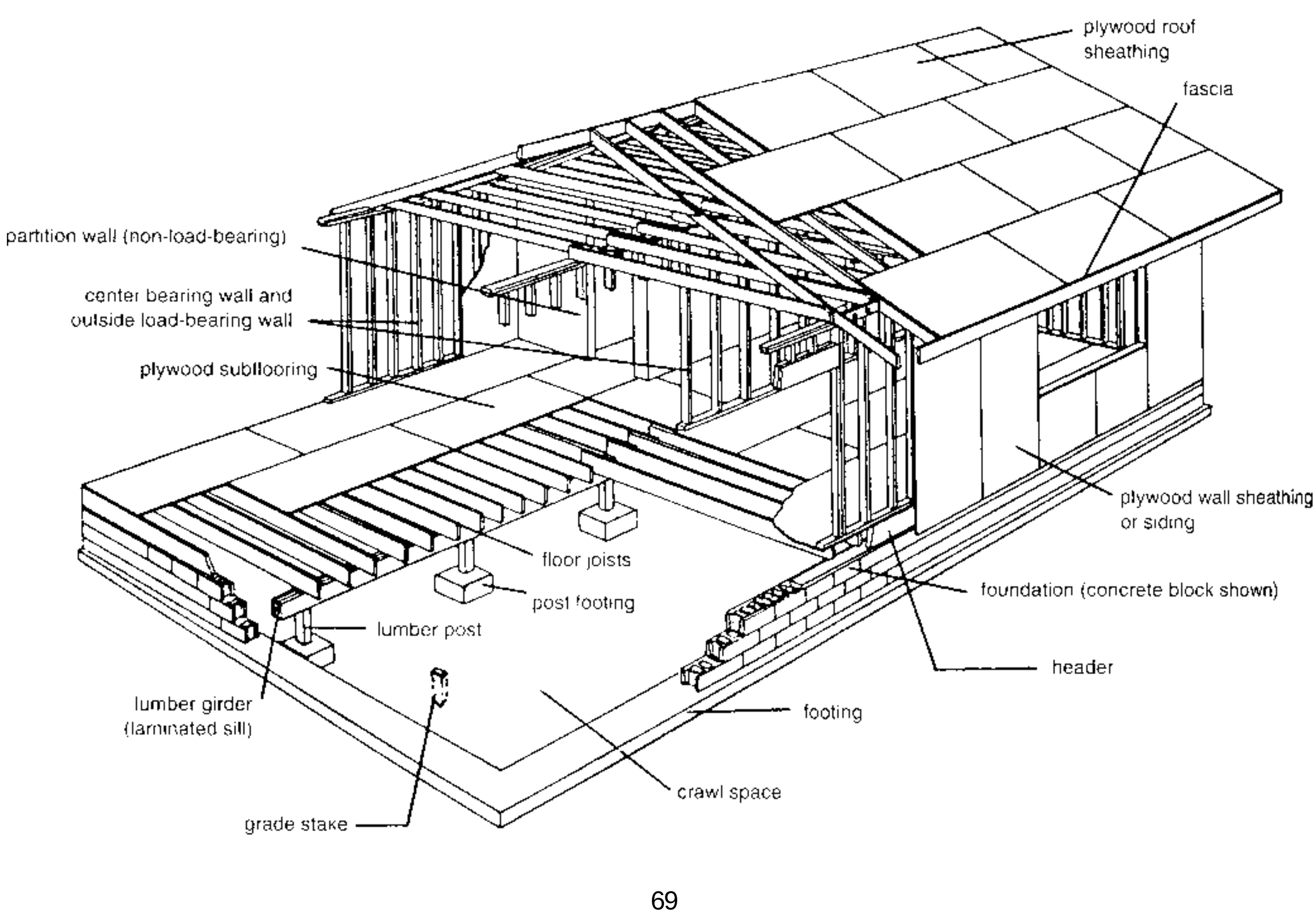
Source: M.P. Levy, *A Guide to the Inspection of Existing Homes for Wood-inhabiting Fungi and Insects,* U.S. Department of Housing and Urban Development, Washington, D.C., 1975.

APPENDIX C

STRUCTURAL AND HOUSING TERMS

Diagrams Identifying Structural Members





APPENDIX D

CONVENIENT CONVERSION FACTORS

Multiply	By	To Get
Acres	0.405	Hectares
Acres	4,047.0	Square Meters
Acres	4,840.0	Square Yards
Acres-feet	43,560.0	Square feet
Acre-feet	1,233.49	Cubic Meters
Acre-feet	43,560.0	Cubic Feet
Acre-feet	325,850.58	Gallons
Bushels	0.0461	Cubic yards
Bushels	1.2437	Cubic feet
Bushels	4.0	Pecks
Bushels	32.0	Quarts (dry)
Bushels	35.24	Liters
Bushels	64.0	Pints (dry)
Bushels	2,150.42	Cubic inches
Centimeters	0.3627	Inches
Centimeters	0.01	Meters
Centimeters	10.0	Millimeters
Cubic centimeters	0.0610	Cubic inches
Cubic centimeters	0.03381	Ounces (liquid)
Cubic centimeters	1.0	Milliliters of water
Cubic centimeters	1.0	Grams of water
Cubic feet	0.0283	Cubic meters
Cubic feet	0.0370	Cubic yards
Cubic feet	0.8040	Bushels
Cubic feet	7.4805	Gallons
Cubic feet	25.71	Quarts (dry)
Cubic feet	28.32	Liters
Cubic feet	29.92	Quarts (liquid)
Cubic feet	51.42	Pints (dry)
Cubic feet	59.84	Pints (liquid)
Cubic feet	62.4	Pounds of water
Cubic feet	1,728.0	Cubic inches
Cubic feet	28,317.0	Cubic centimeters
Cubic meters	1.308	Cubic yards
Cubic meters	35.31	Cubic feet
Cubic meters	264.2	Gallons
Cubic meters	1,000.0	Liters
Cubic meters	1,057.0	Quarts (liquid)
Cubic meters	2,113.0	Pints (liquid)
Cubic meters	61,023.0	Cubic inches
Cubic meters	1,000,000.0	Cubic centimeters
Cubic inches	0.000016	Cubic meters
Cubic inches	0.0005	Bushels
Cubic inches	0.0006	Cubic feet
Cubic inches	0.0019	Pecks (dry)

Multiply	By	To Get
Cubic inches	0.0037	Gallons (dry)
Cubic inches	0.0043	Gallons (liquid)
Cubic inches	0.0149	Quarts (dry)
Cubic inches	0.0164	Liters
Cubic inches	0.0173	Quarts (liquid)
Cubic inches	0.0298	Pints (dry)
Cubic inches	0.0346	Pints (liquid)
Cubic inches	0.0361	Pounds of water
Cubic inches	0.5540	Ounces (liquid)
Cubic inches	16.3872	Cubic centimeters
Cubic yards	0.7646	Cubic meters
Cubic yards	21.71	Bushels
Cubic yards	27.0	Cubic feet
Cubic yards	202.0	Gallons (liquid)
Cubic yards	807.9	Quarts (liquid)
Cubic yards	1,616.0	Pints (liquid)
Cubic yards	7,646.0	Liters
Cubic yards	46,656.0	Cubic inches
Cups	0.25	Quarts (liquid)
Cups	0.5	Pints (liquid)
Cups	8.0	Ounces (liquid)
Cups	16.0	Tablespoons
Cups	48.0	Teaspoons
Cups	236.5	Milliliters
Feet	0.3048	Meters
Feet	0.3333	Yards
Feet	12.0	Inches
Feet	30.48	Centimeters
Feet per minute	0.01136	Miles per hour
Feet per minute	0.01667	Feet per second
Feet per minute	0.01829	Kilometers per hour
Feet per minute	0.3048	Meters per minute
Feet per minute	0.3333	Yards per minute
Feet per minute	60.0	Feet per hour
Gallons	0.00378	Cubic meters
Gallons	0.1337	Cubic feet
Gallons	3.785	Liters
Gallons	4.0	Quarts (liquid)
Gallons	8.0	Pints (liquid)
Gallons	8.337	Pounds
Gallons	128.0	Ounces (liquid)
Gallons	231.0	Cubic inches (liquid)
Gallons	269.0	Cubic inches (dry)
Gallons	3,785.0	Cubic centimeters

Multiply	By	To Get
Gallons of water	0.0038	Cubic meters
Gallons of water	0.0049	Cubic yards
Gallons of water	0.1337	Cubic feet
Gallons of water	3.7853	Kilograms
Gallons of water	8.3453	Pounds of water
Gallons of water	3,785.3446	Grams
Grains	0.0648	Grams
Grams	0.001	Kilograms
Grams	0.0022	Pounds
Grams	0.0353	Ounces
Grams	15.53	Grains
Grams	1,000.0	Milligrams
Grams per liter	10.0	Percent
Grams per liter	1,000.0	Parts per million
Hectares	2.47	Acres
Hectares	10,000.0	Square meters
Hectares	11,954.8	Square yards
Hectares	107,593.2	Square feet
Inches	0.0254	Meters
Inches	0.02778	Yards
Inches	0.08333	Feet
Inches	2.54	Centimeters
Kilograms	0.0011	Tons
Kilograms	2.205	Pounds
Kilograms	35.28	Ounces
Kilograms	1,000.0	Grams
Kilometers	0.6214	Miles
Kilometers	1,000.0	Meters
Kilometers	1,093.611	Yards
Kilometers	3,280.833	Feet
Kilometers per hour	0.6214	Miles per hour
Kilometers per hour	16.6667	Meters per minute
Kilometers per hour	18.2268	Yards per minute
Kilometers per hour	54.6806	Feet per minute
Liters	0.001	Cubic meters
Liters	0.0353	Cubic feet
Liters	0.2642	Gallons (liquid)
Liters	1.0	Kilograms of water
Liters	1.057	Quarts (liquid)
Liters	2.113	Pints (liquid)
Liters	33.8143	Ounces
Liters	61.02	Cubic inches
Liters	1,000.0	Cubic centimeters
Liters	1,000.0	Grams of water
Meters	0.001	Kilometers
Meters	1.094	Yards
Meters	3.281	Feet
Meters	39.37	Inches
Meters	100.0	Centimeters
Meters	1,000.0	Millimeters

Multiply	By	To Get
Metric tons	1.1	Tons (U.S.)
Metric tons	1,000.0	Kilograms
Metric tons	2,204.6	Pounds
Metric tons	1,000,000.0	Grams
Miles	1.6093	Kilometers
Miles	1,609.3	Meters
Miles	1,760.0	Yards
Miles	5,280.0	Feet
Miles per hour	1.467	Feet per second
Miles per hour	1.6093	Kilometers/ hour
Miles per hour	26.8217	Meters per minute
Miles per hour	29.3333	Yards per minute
Miles per hour	88.0	Feet per minute
Miles per minute	26.82	Meters per second
Miles per minute	29.333	Yards per second
Miles per minute	88.0	Feet per second
Milliliters	0.00105	Quarts (liquid)
Milliliters	0.0021	Pints (liquid)
Milliliters	0.0042	Cups (liquid)
Milliliters	0.0338	Ounces (liquid)
Milliliters	0.0676	Tablespoons
Milliliters	0.2029	Teaspoons
Milliliters	1.0	Cubic centimeters of water
Milliliters	1.0	Grams of water
Ounces (liquid)	0.00781	Gallons
Ounces (liquid)	0.03125	Quarts (liquid)
Ounces (liquid)	0.0625	Pints (liquid)
Ounces (dry)	0.0625	Pounds
Ounces (liquid)	0.125	Cups (liquid)
Ounces (liquid)	1.805	Cubic inches
Ounces (liquid)	2.0	Tablespoons
Ounces (liquid)	6.0	Teaspoons
Ounces (dry)	28.3495	Grams
Ounces (liquid)	29.573	Milliliters
Ounces (dry)	437.5	Grains
Parts / million (PPM)	0.0001	Percent
Parts per million	0.001	Liters/cubic meter
Parts per million	0.001	Grams per liter
Parts per million	0.001	Milliliters per liter
Parts per million	0.013	Ounces per 100 gallons of water
Parts per million	0.0584	Grains per US gallon
Parts per million	0.3295	Gallons per acre-foot of water
Parts per million	1.0	Milligrams/ liter
Parts per million	1.0	Milligrams per kilogram
Parts per million	1.0	Milliliters per cubic meter

Multiply	By	To Get
Parts per million	2.7181	Pounds per acre-foot of water
Parts per million	8.345	Pounds per million gallons of water
Pecks	0.25	Bushels
Pecks	8.0	Quarts (dry)
Pecks	16.0	Pints (dry)
Pecks	537.605	Cubic inches
Percent (%)	1.33	Ounces (dry) per gallon of water
Percent	8.34	Pounds per 100 gallons of water
Percent	10.00	Grams per kilogram
Percent	10.00	Grams per liter
Percent	10,000.00	Parts per million
Pints (dry)	0.0156	Bushels
Pints (dry)	0.0625	Pecks
Pints (liquid)	0.125	Gallons
Pints (liquid)	0.4735	Liters
Pints (liquid)	0.5	Quarts (liquid)
Pints (dry)	0.5	Quarts (dry)
Pints (liquid)	2.0	Cups
Pints (liquid)	16.0	Ounces (liquid)
Pints (liquid)	28.875	Cubic inches (liquid)
Pints (dry)	33.6003	Cubic inches (dry)
Pounds	0.0005	Tons
Pounds	0.4535	Kilograms
Pounds	16.0	Ounces
Pounds	453.5924	Grams
Pounds	7,000.0	Grains
Pounds of water	0.0160	Cubic feet
Pounds of water	0.1198	Gallons
Pounds of water	0.4536	Liters
Pounds of water	27.693	Cubic inches
Quarts (liquid)	0.00094	Cubic meters
Quarts (liquid)	0.0012	Cubic yards
Quarts (dry)	0.03125	Bushels
Quarts (liquid)	0.0334	Cubic feet (liquid)
Quarts (dry)	0.0389	Cubic feet (dry)
Quarts (dry)	0.125	Pecks
Quarts (liquid)	0.25	Gallons (liquid)
Quarts (liquid)	0.9463	Liters
Quarts (liquid)	2.0	Pints (liquid)
Quarts (dry)	2.0	Pints (dry)
Quarts (liquid)	2.0868	Pounds of water
Quarts (liquid)	4.0	Cups
Quarts (liquid)	32.0	Ounces (liquid)
Quarts (liquid)	57.75	Cubic inches (liquid)
Quarts (dry)	67.20	Cubic inches (dry)

Multiply	By	To Get
Square feet	0.000009	Hectares
Square feet	0.000023	Acres
Square feet	0.0929	Square meters
Square feet	0.1111	Square yards
Square feet	144.0	Square inches
Square inches	0.00064	Square meters
Square inches	0.00077	Square yards
Square inches	0.00694	Square feet
Sq. kilometers	0.3861	Square miles
Sq. kilometers	100.0	Hectares
Sq. kilometers	247.104	Acres
Sq. kilometers	1,000,000.0	Square meters
Sq. kilometers	1,195,982.7	Square yards
Sq. kilometers	10,763,865.0	Square feet
Square meters	0.0001	Hectares
Square meters	1.308	Square yards
Square meters	10.765	Square yards
Square meters	1,549.9669	Square feet
Square miles	2.5899	Square kilometers
Square miles	258.99	Hectares
Square miles	640.0	Acres
Square miles	2,589,735.5	Square meters
Square miles	3,097,600.0	Square yards
Square miles	27,878,400.0	Square feet
Square yards	0.00008	Hectares
Square yards	0.00021	Acres
Square yards	0.8361	Square meters
Square yards	9.0	Square feet
Square yards	1,296.0	Square inches
Tablespoons	0.0625	Cups
Tablespoons	0.5	Ounces
Tablespoons	3.0	Teaspoons
Tablespoons	15.0	Milliliters
Teaspoons	0.0208	Cups
Teaspoons	0.1667	Ounces
Teaspoons	0.3333	Tablespoons
Teaspoons	5.0	Milliliters
Tons	0.907	Metric ton
Tons	907.1849	Kilograms
Tons	2,000.0	Pounds
Tons	32,000.0	Ounces
Yards	0.000568	Miles
Yards	0.9144	Meters
Yards	3.0	Feet
Yards	36.0	Inches

APPENDIX E

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Notes