

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 back-flow 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

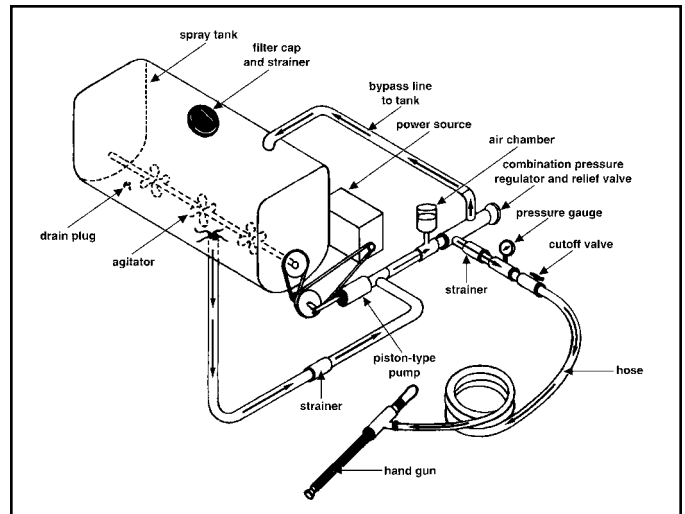


Figure 3.1. A schematic illustration of a simple power sprayer rig.

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.

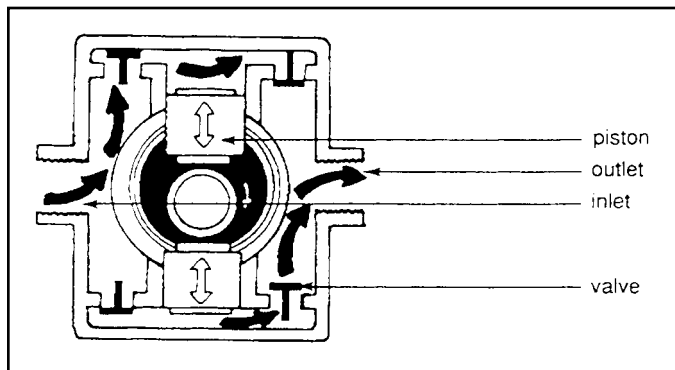


Figure 3.2. Piston pump.

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 valves. 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 may

suddenly 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.

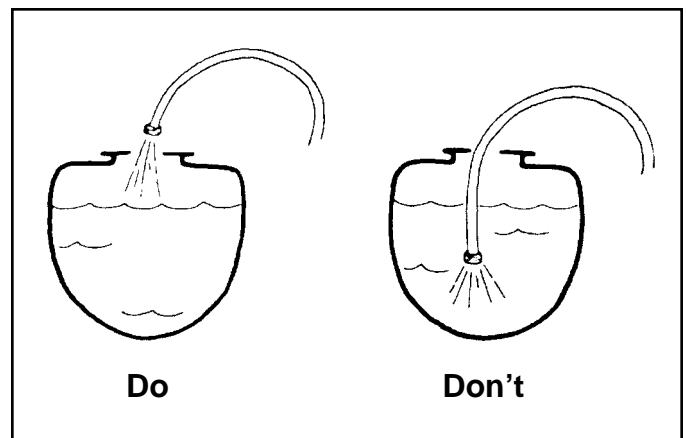


Figure 3.6. Keep hoses out of contaminated water.

2. Water should always be poured into priming pumps. **Never** connect the discharge side of a pump to a water supply.
3. **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.

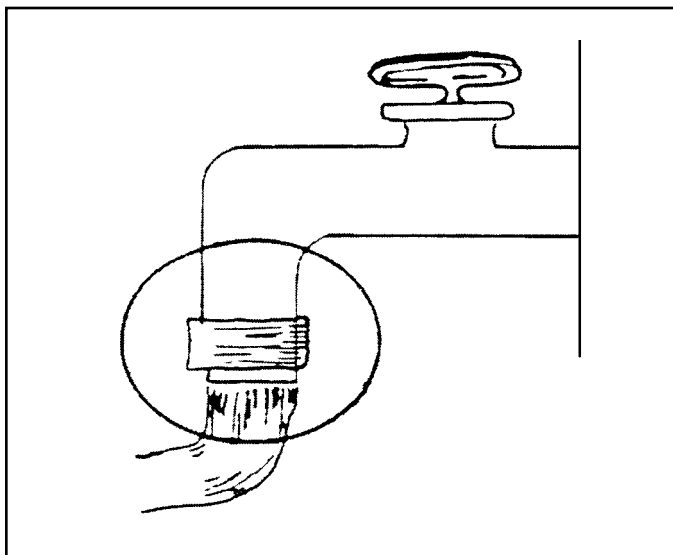


Figure 3.7. A backflow preventer should be installed on the end of the hose connected to the faucet. This helps ensure against accidental contact with contaminated water in spray tanks and contamination of the water supply.

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.

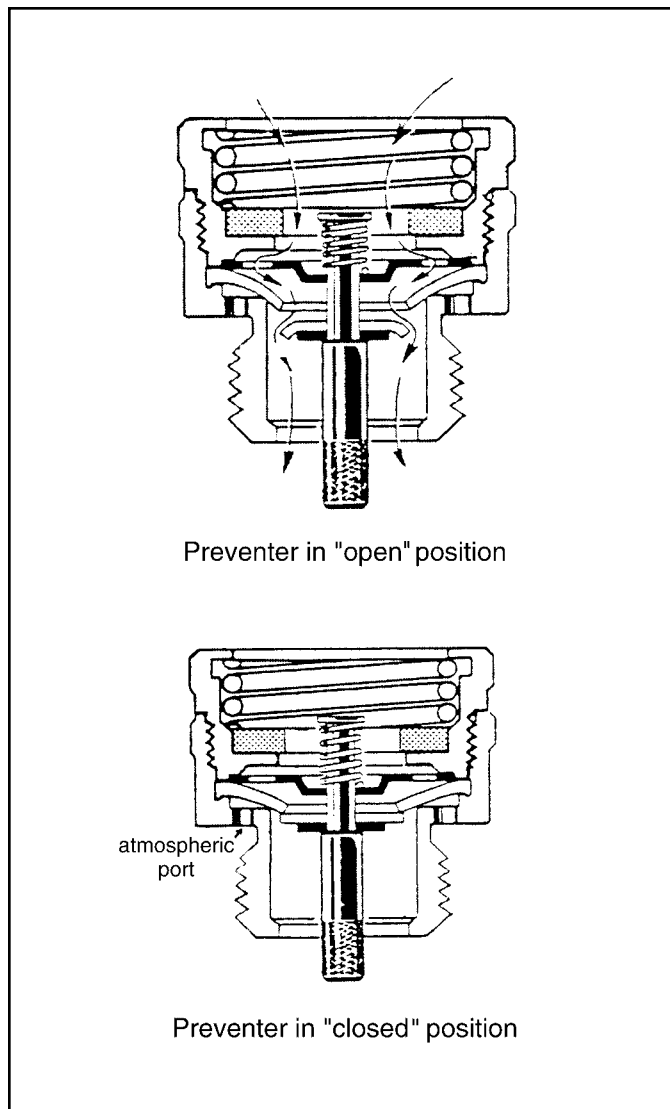


Figure 3.8. Backflow preventer in open and closed positions.

Backflow preventers can be obtained from some pest control suppliers or from plumbing 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 outside or inside of foundation 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.

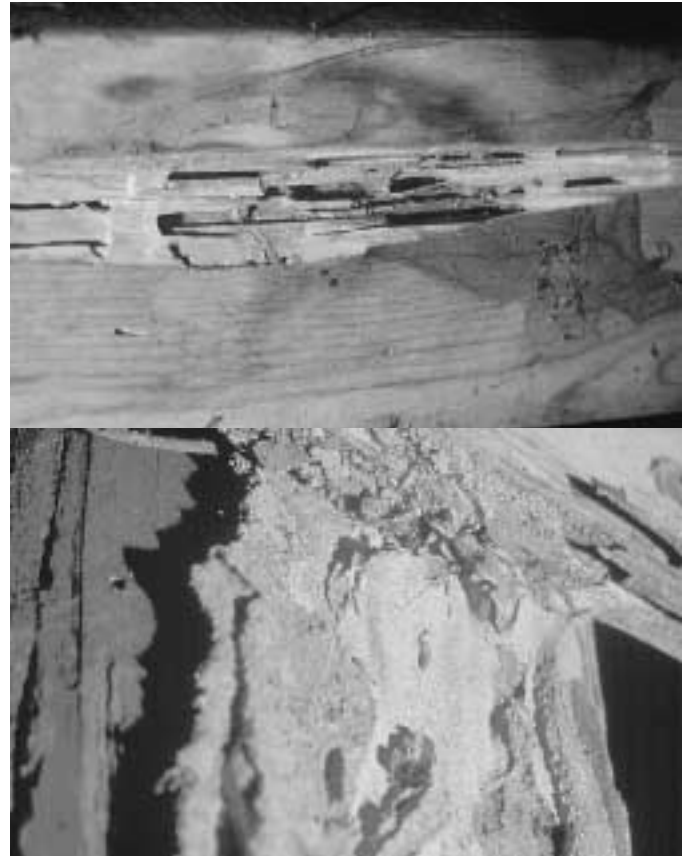


Figure 3.12. Termite damage to wood—galleries may be hidden by only a thin layer of wood (top); the presence of soil, feces, and saliva is a typical sign of termite damage in wood (bottom).

As a general rule, subterranean termites are found at or near ground level. They occasionally occur above the level of first-floor windows, especially in the warmer areas of the country. An inspector must thoroughly examine all of the underparts of a house, including 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 emulsifiable 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 dry-wood 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 Fumigation

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 and

possibly 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 non-repellent, 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 on

whether 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 non-target 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
3

Review Questions

Chapter 3: Equipment and Methods

Write the answers to the following questions and then check your answers with those in the back of the manual.

1-6. Match the following parts of a power sprayer to the appropriate description.

- A. Tank
- B. Pump
- C. Hose
- D. Applicator

- ___ 1. Usually made of PVC and capable of with standing 600 psi or more.
- ___ 2. Used to generate hydraulic pressure to the pesticide directly in the line, rather than pressurizing the tank.
- ___ 3. Should be made of fiberglass or polyethylene to be resistant to the corrosive properties of pesticides.
- ___ 4. Should have a gauge to show the liquid level.
- ___ 5. Various types, including rods and subslab injectors.
- ___ 6. Usually has an inside diameter of 3/8 or 1/2 inch.

7. A typical tank on a power sprayer rig used in termite control has a ___ capacity.

- A. 5-liter
- B. 5-gallon
- C. 100-liter
- D. 100-gallon
- E. 500-gallon

8. Why is it important to match the diameter of hoses to the diameter of couplings?

9. What length of hose is recommended for use in most termite control operations?

- A. 100 to 150 feet
- B. 150 to 300 feet
- C. 300 to 450 feet
- D. 450 to 500 feet

10. Why is proper calibration of sprayers important?

11. What device is used to determine the application or delivery rate of a sprayer? How is it measured?

12. List factors that will affect the output of a sprayer.
13. Which is NOT true of backflow preventers?
- A. There is no chance of backflow occurring when using a backflow preventer, even when the outside pressure greatly exceeds that of the water system.
 - B. They should be installed on the end of the hose connected to the faucet any time water is being used from private or public systems to fill pesticide tanks or equipment.
 - C. Various types of backflow preventers differ in the level of protection offered.
 - D. Pest management professionals should check on what type of backflow preventer will meet local codes and standards.
14. Which statement is true regarding protection of water supplies during a pesticide application for control of subterranean termites?
- A. The discharge side of the pump should be connected to the water supply to prime it.
 - B. The insecticide water hose or faucet should extend into the insecticide or rinse water when filling a spray tank.
 - C. There is no danger of contamination from termite applications when unused and unfilled cisterns or wells are located on a property.
 - D. High water tables can result in contamination of wells after a termiticide application.
15. What is the **most commonly reported** cause of pesticide contamination to water supplies?
- A. Contamination of the public water supply from back pressure.
 - B. Old cisterns or dug wells no longer in use.
 - C. Faults in the sealing of the well.
 - D. Open channels to wells from decayed tree roots.
16. What questions should you ask the homeowner about a well located on the property?
17. If the homeowner with a well tells you that he intends to hook up to the public water supply, you should wait until he fills and caps the private well before applying termiticide.
- A. True
 - B. False
18. List the tools needed to perform inspections for subterranean termite infestations.

19. What are the signs of a termite infestation?

22. Where would be logical places to inspect for subterranean termite infestations?

- A. Places where concrete steps, porches, or concrete slabs join the structure.
- B. Basement and crawl space walls.
- C. Sill plates, floor joists, and subfloors.
- D. All of the above.

23. What are the components of a well designed termite inspection report?

20. Why do termites construct shelter tubes? What do they look like?

24. What are the three areas to consider when preventing termites from invading a new building?

21. Describe how termite damage differs from that of other wood-destroying organisms.

25. List some sanitation practices to prevent termite infestations on a construction site.
26. Which is NOT true about proper structure and construction aspects at a building site?
- Allow sufficient space and ventilation outlets for air movement to keep soil dry beneath houses and crawl spaces.
 - Wooden steps should rest on a concrete base that extends 6 inches above grade.
 - In the final grading, allow at least 6 inches of clearance between the top of the soil and the top of the foundation.
 - The finished grade outside the building should slope toward the foundation.
 - None of the above.
27. Which type of slab-on-ground construction is most susceptible to termite attack?
- Floating slab-on-ground
 - Monolithic slab-on-ground
 - Suspended slab-on-ground
 - None of the above
28. Termites can go through cracks in foundations as small as 1/32 inch.
- True
 - False
29. Which would be an effective barrier against subterranean termite infestations?
- Hollow-block foundation
 - Stainless steel mesh termite shield
 - Floating slab
 - A&B
30. Which is true about sand barriers used in termite prevention?
- It is best to use only large particles of sand.
 - They have no utility in preventing termite infestations.
 - They are more effective than metal termite shields.
 - They are best when used in conjunction with other methods.
 - It is best to use only small particles of sand.
31. Which is true about the use of treated lumber to prevent termite infestations?
- For maximum protection, the wood should be pressure impregnated with creosote.
 - Brushing, spraying, or soaking the lumber with the chemical gives the maximum protection.
 - Chemically treated lumber should be used for the foundation plate, mudsill, and all lumber uses belowground.
 - A & C
 - B & C
32. Treating soil with insecticides to prevent termite infestations will substitute for faulty construction methods.
- True
 - False
33. List places where soil insecticides should be used to prevent termite infestations.

34. Which is NOT true about use of biotermiticides in preventing termite infestations?
- Used alone, they have been shown to be more effective than soil insecticides.
 - Biotermiticides include fungi, nematodes, and bacteria.
 - Nematodes may be applied to the soil or directly into mud tubes.
 - A fungus, *Metarhizium anisopliae*, can be injected into galleries and infested walls.
 - A & D
35. Borates injected into wood for the local control of termites have shown some potential in preventing termite infestations.
- True
 - False
- 36-47. Match the following to the appropriate description.
- Pyrethroids
 - Borates
 - Organophosphates and carbamates
 - Insect growth regulators
 - Biotermiticides
 - Foaming agents
36. ____ A class of compounds containing boron and oxygen.
37. ____ A synthetic chemical that mimics insect hormones.
38. ____ Examples include hexaflumuron, difluben-zuron, pyriproxyfen, and methoprene.
39. ____ Include disease-causing fungi and bacteria and parasitic nematodes.
40. ____ Examples include chlorpyrifos and diazinon.
41. ____ Examples include bifenthrin, cyfluthrin, cypermethrin, deltamethrin, and permethrin.
42. ____ In response to dermal exposure, some people may experience a skin sensitivity called paresthesia.
43. ____ A large family of modern synthetic insecticides similar to the naturally derived pyrethrins.
44. ____ Diffusible properties allow treatment of wood species that cannot be treated well by pressure.
45. ____ All are nervous system poisons ranging in toxicity from slightly to highly toxic.
46. ____ Slow action allows the chemical to be widely spread throughout the colony as termite workers feed and groom one another; environmentally safe and of low mammalian toxicity.
47. ____ A means of delivering termiticide to areas difficult to reach with liquid formulations.
48. List methods for applying borates to wood.
49. Organophosphate insecticides are broken down in humans mainly by the:
- Liver
 - Kidney
 - Blood
 - Skin
50. An example of how an insect growth regulator functions in an insect is by:
- Interfering with respiration.
 - Interfering with mobility.
 - Interfering with molting.
 - Interfering with sight.
51. Describe how foaming agents work.

52. Which is true about fumigants?
- They are safer to use (i.e., less toxic to humans) than many soil insecticides.
 - They have a lot of residual, long-lasting action.
 - They are quick acting and usually eradicate the pest.
 - They are simple to use and do not require any special training.
 - No special license or certification is required to use fumigants.
53. Which is NOT true about fumigants?
- For certain pests/commodities, fumigation is the only practical method of control.
 - Fumigation must not be attempted by one person.
 - Using fumigants requires special training.
 - Occupants of a structure must vacate the building for a number of hours after fumigation.
 - Fumigants do not diffuse well through all parts of the structure.
- 54-57. Match the following types of termite baits to the appropriate description.
- Ingested toxicants or stomach poisons
 - Biotermiticides or microbes
 - Insect growth regulators (IGRs)
54. ____ Products that disrupt termites by causing a specific response or behavior within the colony or by blocking the molting process.
55. ____ Derived from fungi, bacteria, or nematodes; injected into gallery sites.
56. ____ The termite baiting system that has the quickest effect but will likely provide only localized reduction.
57. ____ The termite baiting system that is the slowest acting but has a greater impact on the colony.
58. What features must termite baits have to be successful?
59. What factors limit the effectiveness of biotermiticides?
60. What subterranean termite characteristics enable baits to be spread throughout a colony?
- Social nature and foraging behaviors
 - Swarming and reproduction
 - Caste system and molting
 - Temperature and moisture sensitivity
61. What are belowground monitoring stations used for?
- As stomach poisons.
 - To establish a feeding site.
 - As chitin synthesis inhibitors.
 - To determine where primary reproductives are located.
62. What factors affect the number and placement of bait stations?

63. What is a recommended placement of belowground monitoring stations?

66. Which is NOT true about termite baits?

- A. It takes longer to eliminate a colony with baits than with liquid termiticides.
- B. Baits are a better choice for chemical- or odor-sensitive customers.
- C. Drilling of structural concrete is rarely required.
- D. They can be easily put under slabs or in wall voids where termites occur.
- E. Easy to use.

67. Explain how baits fit into an IPM program.

64. Describe the interceptive baiting strategy. What is the advantage of interceptive baiting over belowground placement of baits in the soil around the structure?

65. Which is true about termite baits?

- A. They require less monitoring than soil termiticides.
- B. They act much faster than soil termiticides.
- C. They are more effective when used alone, without soil treatments.
- D. Active ingredients are generally less toxic than soil termiticides.
- E. All of the above.

