WOOD DECAY IN STRUCTURES AND ITS CONTROL

Use in Conjunction with Truman's Guide or Mallis Guide

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devoloped by
The Wood Destroying Organisms Committees

edited by
C. Douglass Mampe, Ph.D.
Director, Technical Services

NATIONAL PEST CONTROL ASSOCIATION, INC.
8150 LEESBURG PIKE, VIENNA, VIRGINIA, 22180
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National Pest Control Association, Inc.

Edited By
C. Douglass Mampe, Ph.D.
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8150 Leesburg Pike
Vienna, Virginia 22180

1974
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by

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NPCA MEMBER PRICE: $8.00
NON-MEMBER PRICE: $24.00
PREFACE

This Manual was developed by NPCA’s 1973-1974 Wood Destroying Organisms Committee. The Committee met in Kansas City, November 19, 1973. The decision was made at that meeting this Manual should receive top priority. An outline was prepared and work assignments made. The four Committee members, Glenn Burkhalter, Richard C. Green, Wesley K. Lydell, and Al M. Sholar, and chairman, Charles V. Kyle, prepared the initial drafts and met the deadlines.

Without the efforts of these five men, this Manual might not yet be a reality. All sections were reviewed by the 50 correspondents. They provided many valuable comments and suggestions. A final revision, based on these comments, was reworked by the Committee in Raleigh, N.C., July 1 & 2, 1974. All of these efforts are reflected in the Manual.

Special expert assistance was provided by Dr. Robert D. Graham, Oregon State University, Dr. Terry L. Amburgey, U.S. Forest Service, & Dr. Michael P. Levi, North Carolina State University. These three men, all experts in wood decay, gave of their time and knowledge in assisting the Committee in the preparation and review of this Manual. Drs. Amburgey and Levi also attended the final review meeting in Raleigh. On behalf of the Committee, NPCA, and myself, I wish to say a special thanks to these three individuals.

As editor, I wish to thank all of the above as well as those on NPCA staff who contributed to the production of this Manual. This task would have been impossible without such teamwork.

Vienna, Virginia
July 15, 1974

C. Douglass Mampe, Ph.D.
Director, Technical Services
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INTRODUCTION

Wood decay and its control has long been an important part of pest control in some areas. Some pest control operators have been educated in the control of wood decay and have practiced it for many years. Others who deal with termites are familiar with many of the control techniques, but do not recognize their relationship to controlling wood decay.

Wood decay organisms and wood decay in structures are found throughout the United States. The problem is more severe in humid areas such as the Pacific Northwest and Southeast coastal areas. All wood structures are subject to decay, however, and this manual was prepared to assist all PCO’s in understanding the problem and how to deal with it. This will enable them to better serve the public as wood decay can represent a significant loss to homeowners.

The problem may become greater in the future. The heartwood of many native trees has natural durability and is relatively resistant to decay. The supply of heartwood was reasonably abundant 30 years ago. Building practices which often succeeded then would fail today because heartwood is now scarce and sapwood is used extensively. Sapwood has no significant decay resistance, making today’s wooden structures more susceptible than ever to wood decay.

Building design and practices today must be such that the wood stays dry, for this is the principle in controlling and preventing wood decay. Wood that remains dry will not decay, except in those rare instances when under attack by the water-conducting fungus, Poria incrassata.

The Manual provides background on decay organisms and their growth so that the PCO will have a better understanding of his “opponent”. Inspection techniques are discussed. Information on structural modifications and moisture control is presented — and much of it is the same used in controlling subterranean termites. Chemicals are seldom useful in controlling wood decay, but their special uses are discussed in the final chapter.

It is the hope of the Committee that this Manual will enable every PCO to deal with wood decay in structures effectively and as economically as possible. This work can expand the business of those not now engaged in it. It is so closely related to subterranean termite control that often one or more procedures will serve to correct or assist in correcting both problems. The Committee hopes this Manual serves its purpose well.
WOOD PROPERTIES

A brief discussion of wood and its properties is given here. This information and much of the terminology is utilized in later chapters.

**Structure**  A cross section of a portion of a tree is shown in figure 1. This shows the annual growth rings and the relative position of the heart and sapwood. The enlargement of a portion of Figure 1 shows that wood is not a solid material, but is composed of individual cells which are porous.

![Diagram of wood cross section](image)

**FIGURE 1. Cross section of wood.**

The *heartwood* is located at the center of a log. It is composed of old cells that have died and darkened. The darkening is caused by chemicals, some of which provide degrees of durability or resistance to decay. The heartwood functions primarily as a support mechanism for the tree.

During the growing season, new cells are produced just beneath the bark. These living cells form *sapwood*. In the spring, growth is rapid and the cell walls are thin. The summer growth cells are produced more slowly and are more compact. This difference in appearance forms the so-called annual rings. The cells in the sapwood are living and transport the "sap" up the tree. Sapwood has no significant resistance to decay.
Radiating outward from the heartwood are rays. This thin-walled tissue provides a means of lateral communication from the heartwood to the bark. Rays are very prominent in some woods and impart the characteristic grain to "quartered oak". In other woods, such as maple, the rays are barely distinguishable to the naked eye.

The wood cells contain cellulose in the cell walls. This is true of all plant cells. Wood cells, however, undergo a process known as lignification. In this process, a substance called lignin impregnates the cellulose walls, giving wood its hard, rigid characteristic.

**Moisture Relationships**

Freshly cut wood has a very high moisture content. This moisture exists in the center of the wood cells and in the cell walls. Wood that is kiln dried usually contains from 12 to 16 percent moisture by weight. The moisture content of seasoned wood will change if moisture conditions in the environment change.

Movement of water into the cell walls of wood causes swelling of the wood. Movement of water out of the cell walls causes shrinkage of wood. Thus, the size of a given piece of wood will vary with changes in the relative humidity of the air. This is demonstrated graphically in Figure 2.

![Graph of Moisture Content Versus Shrinkage](image)

**FIGURE 2.** Wood shrinkage in relation to moisture content.

Such swelling and shrinkage accounts for sticking doors during damp periods and spaces between floor boards and creaky floors during dry periods.

During shrinkage, the wood dries unevenly. Water evaporates first from cells on the surface and later from cells in the middle of a piece of wood. Thus, the outside of a piece of wood can be shrinking while the inside is still swollen. When drying occurs very rapidly, this differential shrinkage causes stresses within the wood, causing splits, checks, cracks, and warping.

When wood is in equilibrium with air at 100% relative humidity, all the spaces in the cell walls are filled with water and the wood is at its fiber saturation point. The fiber saturation point of wood varies with the wood species, but ranges from 25-35% moisture content.

Above the fiber saturation point, liquid water is present in the center of the wood cells. This only occurs if the wood is in direct contact with liquid water, such as from soil, rain, plumbing leaks, or condensation. High relative humidity alone will not raise the moisture content of wood above the fiber saturation point. This is important, as wood will not decay if it is below the fiber saturation point.
GROWTH REQUIREMENTS AND PROCESSES OF WOOD DECAY FUNGI

Wood decay is caused by simple plants called fungi. Other fungi include mushrooms, molds, and mildews. Fungi lack chlorophyll and must obtain their food from wood and other plant material. These food materials include starch, sugars, proteins, and fats in the wood storage cell; and cellulose, lignin, and other materials in the cell walls of wood.

Growth

Germination of a spore ("seed") and development of thread-like hyphae from the spore initiates fungal growth. The hyphae secrete chemicals called enzymes that break down wood into simpler materials that fungi use as food. The hyphae literally eat their way into wood forming an extensive branching system. Sometimes masses of hyphae, called mycelia (see Plate 1, Figure E) form white "mats" or "fans" on the surface or in cracks. Hyphae of some fungi form thick root-like strands (rhizomorphs) (see Plate 1, figures G & H) which enable them to conduct water long distances to attack normally dry wood, causing so-called "dry rot".

Eventually fruiting structures called sporophores (also known as conks, mushrooms or toadstools) are produced which in turn produce microscopic-size spores by the billions (see Plate I, Figure F). Disseminated by air, water, insects, animal and man, these "seeds" can remain dormant for years until conditions are right for growth.

Requirements for Growth

Fungi require the proper combination of food (wood), air (some), temperature (mild) and moisture (damp) for growth.

Food: Cellulose and lignin that compose the cell walls of plants serve as food for decay fungi. Brown-rot fungi use mostly cellulose leaving a brown, crumbly residue. White-rot fungi use cellulose and lignin.

Stain fungi and molds attach starches, sugars, proteins, and/or fats in wood storage cells. This may cause discoloration of the wood, but has little effect on wood strength.

The sapwood of all species of trees is readily stained or decayed under suitable conditions. Brown-rots usually attack softwoods such as pine, spruce, and fir. White-rots attack hardwoods such as maple and oak. The heartwood of some species, such as cedar, black locust, walnut, redwood, cypress and white oak, contains chemicals that make it durable or resistant to decay. Even these woods can decay under severe conditions. Because of the decreasing supply of large old-growth trees, the supply of durable heartwood timber is steadily dwindling.
Air: Air is seldom a limiting factor for the growth of fungi in wood unless it is excluded by submersion in water or by burial several feet in the ground. This is the case in submerged parts of pilings or pilings buried deeply in the ground. Examples are pilings supporting large buildings and the base of utility poles.

Temperature: Fungi become dormant but are not killed at freezing temperatures, attain optimum growth rates between 60 and 90°F, and are killed when exposed to temperatures between 105 and 150°F for relatively short periods of time. Normal kiln drying schedules sterilize lumber but upon re-wetting, stain and decay can occur. Heating is not the usual method of controlling wood decay fungi in wood structures.

Moisture: Control of moisture in wood is the most important principle in the control of decay for wood will not decay so long as its moisture content is 20% or less. The fiber saturation point for most woods varies by species from 25-35% moisture. Wood will not decay below the fiber saturation point. The 20% figure provides a margin of safety when dealing with wood decay. Kiln-dried or air-dried wood in structures usually contains 12 to 16 percent moisture.

Wood will decay over a broad range of higher moisture contents until it becomes nearly saturated with water. At very high moisture contents, lack of air limits growth of the decay fungus.

From a practical standpoint, temperature-humidity conditions that cause condensation of water on wood, contact of wood with the ground, and contact of wood with rain or water from leaking plumbing or leaking flashing for periods of time all favor decay.

How Fungi Enter Structures

Air-borne spores are the most common source of a wood decay infection. One would expect most wood to become decayed because of the billions of spores that are released by wood decay fungi. This is not the case, however, because all conditions are seldom favorable. Frequently, the wood is too dry. Sometimes the temperature is unfavorable for germination. Even if conditions are favorable, the germinating spores must compete with molds and other organisms.

A less common source of infection is the soil. Decay organisms of all types abound in the soil. From there, they send hyphae out to the wood. This is usually the case where wood members contact the soil.

A third method of entry is through lumber already infected at the time of construction. Some decay fungi occur in living trees; others may have attacked fresh-felled logs or unseasoned lumber. Occasionally, infected lumber from one building is brought into another structure, and the infection spreads.

Unusual methods of infection also occur: such as when a structure is built on, over, or against an old stump already infected.

In all of these cases, however, the wood in the structure must have enough moisture to support wood decay. Even bringing heavily infected wood into the structure will not cause a problem if all wood members dry out and remain below the fiber saturation point. The infection can only spread if the wood remains moist.
DESCRIPTION

One of the most important steps in dealing with wood decay is to recognize the type of fungi encountered. Some fungi cause no loss in wood strength and need very little control, whereas others can cause extensive loss of wood strength.

There are three major types of fungi that attack seasoned wood. These are: Surface-staining fungi, Sap-staining fungi and Decay fungi. Damage caused by white pocket rot is also encountered in structures, but the causal fungus represents no threat to seasoned wood.

Surface-staining fungi

Surface-staining fungi are often referred to as molds or mildews. These fungi produce colorless hyphae within wood and colored fruiting bodies on the surface of wood. The surface may have a pink, yellow, orange, green, gray or black powdery appearance (see Plate I, Figure A). Surface-staining fungi do not cause wood decay per se. Although they grow throughout the sap wood, brushing or light sanding will usually remove the discoloration. Surface-staining fungi do not reduce the strength of the wood, but are a good indication that the surface of the wood contained at least 20% moisture at some time. Although they will not invade dry wood, they do increase the capacity of wood to absorb moisture, thus opening the door for decay fungi to invade the wood.

(Note: Mildews and molds can be removed by scrubbing the surface with a soft brush and a solution of 3 ounces trisodium phosphate, 1 ounce household detergent, 1 quart household bleach, and 3 quarts warm water. After rinsing, repaint the surface with a zinc oxide paint or one containing a fungicide.)

Sap-staining fungi

Sap-staining fungi are commonly referred to as blue stain fungi because they produce colored mycelia deep within the wood, giving it a gray or bluish color (see Plate I, Figure B). They do not cause wood decay, but do penetrate the outer layers of sapwood, thus causing a discoloration that cannot be removed by brushing or sanding the surface. They do not reduce the strength of wood but, like surface-staining fungi, they increase its capacity to absorb moisture. They also indicate that the wood contained more than 20% moisture at one time and the wood should be checked with a moisture meter. The strength of wood fiber products, such as chip board, is reduced by stain fungi.

Decay fungi

Decay fungi are the wood strength reducers and are commonly called "rots" or "dry rots". These fungi, which attack both sapwood and heartwood, produce colorless mycelia. They use the
structural materials of the cells as food, thus producing a weakness in the wood. Advanced decay can be detected readily because of the gross changes in characteristics of the wood. The early stage of decay, which can extend many feet beyond the advanced decay, cannot be determined by visual examination.

Wood decay fungi can be grouped into four classes based on the types of decay they cause. These are: soft rot, white rot, brown rot, and the water conducting rot.

Soft rot is a less severe type of wood decay and seldom encountered in structures. Soft rot fungi attack the wood surface and produce a gradual softening of the wood from the surface inward. They can develop in wood too wet to be attacked by other decay fungi and are usually found in wood exposed to wet conditions such as cooling towers, pulpwood chips, marine habitats, and wood in contact with the soil.

White rot fungi destroy the cellulose and lignin, giving the wood a white, bleached appearance (see Plate I, Figure C). The wood is lighter than normal in color, is stringy when broken, and feels spongy to the touch. The strength decreases gradually, with little loss occurring during the early stages of decay. There is no abnormal shrinkage in white-rotted wood.

Brown rot breaks the wood into small cubical pieces with the cracks perpendicular to the wood grain (see Plate I, Figure D). The wood is brown and crumbly. As decay proceeds, the strength of the wood decreases rapidly. The decayed wood is brown, brittle, and is easily crushed to a powder. The mycelia of brown rots are usually white (see Plate I, Figure E). The fungi get their name from the brown color of the wood attacked. The wood shrinks abnormally upon drying and sometimes collapses. The strength of brown-rotted wood can be reduced significantly before the decay is visible (see Plate I, Figure F). The brown-rotters are the principal cause of building decay in the United States.

Water conducting rot, *Poria incassata*, is a specialized brown rot fungus. It is most often found in new construction or in modifications to old structures. *Poria* is unique among wood-destroying fungi that attack buildings in the U.S. It can conduct water into wood that is below 20 percent in moisture through large water-conducting strands called rhizomorphs (see Plate I, Figures G & H). It, therefore, can attack wood that cannot be attacked by other fungi and, once established, moves quickly to destroy large amounts of wood in a year or two. *Poria* can be recognized by its papery, white-yellow mycelial fans (see Plate I, Figure I), and root-like rhizomorphs. These rhizomorphs are dirty white when young, and turn brown or black as they age. They are usually 1/4 to 1/2 inch wide, but can grow to an inch or more.

*Poria* can conduct water up to 25 feet. Rhizomorphs and extensive mycelial growth away from obvious moisture sources are characteristic of *Poria*. Earth-filled porches are a common source of this fungus.

Fortunately, *Poria* does not occur frequently in structures. It is also very susceptible to drying and cannot survive 32 days of air-drying. Therefore, if the moisture source is removed, this fungus can be easily controlled through drying of the wood.

**White pocket**

White pocket, also known as pock rot or white speck, is caused by the fungus *Fomes pinii*. The damage occurs in living coniferous trees, principally Douglas fir. The damage is often encountered in structures (see Plate I, Figure J), however, and causes the homeowner to raise questions. This decay fungus *does not survive in lumber*, even if the lumber becomes wet. It requires no treatment in structures since it does not represent any future threat to the wood.
INSPECTIONS FOR WOOD DECAY IN STRUCTURES

Purpose

Inspections related to wood decay serve three purposes:

1. To locate active fungal growth;
2. To locate wood decay damage and the extent of such damage; and
3. To locate conditions that are conducive to the growth of fungi.

Signs of wood decay are often present in structures, but determining if such decay is active is often difficult. When favorable conditions are found (i.e., wood moisture content exceeds 20%), one should assume the decay fungus is active; and the necessary steps should be taken to correct such conditions.

The inspection of a property of wood decay should be combined with inspections for wood destroying insects, such as termites, powder post beetles, and carpenter ants.

Equipment

In order to make an adequate inspection for wood decay, the following equipment is necessary:

1. Good flashlight or other portable light and a spare.
2. Moisture meter with a range of at least 15 to 24 percent moisture.
3. Heavy screwdriver or similar tool for probing wood and sounding.
4. Tools for opening accesses into crawl spaces, beneath stucco, and other areas where wood is hidden.

Other equipment which is not always necessary, but often desirable include:

1. Coveralls.
2. Bump hat, knee pads, and gloves for crawl spaces.
4. Ladders for checking external damage and moisture problems.
5. Awl or other sharp tool attached to lightweight pole for probing eaves from ground.
Electric Moisture Meters

Moisture meters will assist you in determining whether or not the moisture content of the wood is high enough to sustain wood decay organisms. Wood having a moisture content below 20 percent is not susceptible to decay.

Moisture meters also can be used to demonstrate to the customer the success of a moisture control program. Readings in critical areas should be recorded before and after control work. If the work is successful, the customer can be shown the decrease in the moisture content of the wood. The moisture meter can be utilized during annual inspections as well, with a permanent record kept of the readings. This will give the customer greater benefit for an inspection fee.

The electrical resistance of wood decreases as its moisture content increases. This is the basis for the operation of the small commercially available moisture meters. They measure the resistance between two needles inserted into the wood and give a direct readout of moisture content. The needles should be inserted into the wood as far as possible.

A number of variables other than moisture content affect the reading of moisture meters. These include:

1. Wood species.
2. Moisture distribution.
3. Grain direction.
4. Chemicals in the wood.
5. Weather conditions.
6. Temperature.

The importance of each is discussed below.

Wood species

The relationship between moisture content and electrical resistance varies with wood species. However, the variations for the soft wood species used in construction in the United States are so small that they can be ignored. If hardwood flooring or other hardwood members are checked, consult the correction factor chart supplied with the meter.

Moisture distribution

A film of liquid water on the surface of wood will cause moisture meters to give very high readings. However, free water on the surface of wood can be seen with the eye; and a moisture meter is not needed to demonstrate that a moisture problem exists.

Grain direction

With resistance moisture meters, the needles should be inserted so that current flows along the grain of the wood whenever possible. At moisture contents below 15 percent, the effect of grain is negligible. At levels above 20 percent, however, readings across the grain may be as much as 2 percent lower than readings parallel to the grain.
Chemicals in the wood

Wood treated with salt preservatives or fire retardants will normally give readings which are higher than the true moisture content of the wood because salts decrease the resistance of the wood. Therefore, meters should not be used on salt-treated wood. Creosote, copper napthanate, and pentachlorophenol do not significantly affect the readings of electric moisture meters.

Some types of glue used in plywood are electrical conductors and may affect the readings of moisture meters. The effect of plywood glue lines may be determined by observing the meter reading as the pins are driven through the glue line.

Weather conditions

If the instrument is taken from cool surroundings into warmer, more humid surroundings, a film of moisture may form on the meter. This can seriously affect readings, but can be recognized by difficulty in adjusting the meter.

Temperature

As the temperature of wood increases, electrical resistance decreases. The change is such that corrections should be applied below 70°F or above 90°F. Corrections are given in the following table.

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Areas To Be Inspected

An inspection for wood decay should extend from the foundation to the roof top of a structure. Backed up gutters and leaking roofs are usually obvious. Moss growing on roofs often maintains a continual moisture problem. Less obvious signs occur closer to grade. Specific points to check are listed below:

*Inaccessible areas* such as difficult to reach roof areas and enclosed crawl spaces, should be opened and inspected if at all practical. This is especially true if exterior signs indicate a moisture or decay problem. If access cannot be gained to certain areas, such areas must be clearly defined and documented.

**INSIDE HOUSE**

1. **Evidence of Floor Settlement**

   Check for evidence of baseboards separating from flooring. This may be caused by decay, insects, or natural settlement of the foundation. Make a note to check for damage in the crawl space.

2. **Decay of Baseboards**

   If this is evident, make a note to check under house to see if decay is present in subfloor and joists. If there is widespread decay under house, suspect *Poria*, and locate source of moisture. (Note: If water stands under a house, particularly in a crawl space having less than 18 inches clearance and little or no ventilation, extensive decay may occur without *Poria* being present.) If there is localized decay under the house, look for plumbing leaks. If subfloor is not decayed, this suggests a water leak in the wall, rain seepage, poor attic ventilation, or improper installation or absence of a vapor barrier in wall.

3. **Blistered Plaster or Paint, Mildewed Walls**

   This is usually caused by excess moisture in the house. It can come from the crawl space, rain seepage, water leaks, poor attic ventilation, clothes dryer not vented outside, or improper installation or absence of a vapor barrier in the wall. (Blistered paint is sometimes caused by painting over greasy spots or by termites.)

4. **Buckled Flooring**

   This is caused by excess moisture in or under the house. It can come from the crawl space (when there is no moisture proof soil cover), plumbing leaks, improper installation of insulation under the floor (the vapor barrier on the insulation should be toward the living area), or window air conditioners whose air streams are directed toward the floor. It is common practice today to use plywood for subflooring. Excess moisture can cause the plys to separate and warp. While this condition indicates a moisture problem favoring decay, wood decay has not necessarily occurred.
5. Presence of Carpenter Ants

Carpenter ants nesting indoors are often associated with excess moisture.

6. Under and Around Kitchen and Bathroom Sinks and Tubs

Plumbing leaks often occur under sinks and bathtubs. Check such areas carefully for evidence of moisture problems. Check grouting around bathtubs. If in poor condition, check beneath for seepage.

7. Buckled Flooring Around Toilets

This indicates a defective sealing ring on the toilet. Flush the toilet (if over a crawl space or unfinished basement) and make note to check beneath the toilet later for leakage.

8. Stall Showers

Stall showers often develop leaks and should be tested. A standard test is to plug the drain, fill the shower with at least two inches of water, and hold it for 15 minutes. (Caution: Do not conduct this test if the shower is above a finished ceiling unless water stains are present on the ceiling — and then get permission first.) Make a note when in the crawl space or basement to check for leaks.

If leaks are found, additional tests may be necessary to determine the source. Filling the shower pan using a bucket and another water source will determine if the pan needs replacement. If the pan is satisfactory, run the shower, but do not direct the spray onto the sides. If the plumbing seems leak free, direct the spray onto the sides of the stall. Cracked tiles often indicate a problem, but some are watertight. Leakage also often occurs around soap dishes set into the tile.

9. Attics

Look for signs of excess moisture and improper ventilation. Leaking roofs often leave water stains on rafters and sheathing. The wood may be dry at the time of the inspection due to lack of rain. Stains indicate a problem does or has existed. Excessive moisture in attics sometimes comes from excessively wet crawl spaces.

OUTSIDE HOUSE

1. Blistered Paint on Siding

This is usually caused by rain seepage or improper installation or absence of a vapor barrier in the wall.

2. Sufficient Crawl Space Vents to Give Cross Ventilation

Vents should be present on at least two sides of the crawl space and near the corners of the house to give cross ventilation.

3. Vents Open

Vents should be open in all but the coldest weather.

4. Lot Graded to Take Water Away From House

If water drains under the house, this may be because of moisture and decay problems. Slight regrading may improve drainage. Drainage can be checked following heavy rains or tested with a hose.
5. Downspouts Placed to Take Water Away From House

If downspouts run water under the house, splashblocks or drain tile can be used to overcome the problem.

6. Foundation Waterproofed

If there is a problem with moisture movement through walls that are below grade in the house, foundation waterproofing may be necessary.

7. Outside Grade Less Than 8 Inches Below Sill Line and Siding

Lower the grade to break all wood-soil contact and inspect sills behind soil carefully. Ideally, there should be 8" between soil and wood.

8. Earth Filled Structure With Less Than 8 Inches Vertical Clearance Between Earth and Sills

Check carefully under house for decay behind these structures: porch, planter, patio, carport. These structures are prime sources of termite and Poria problems. Particular care should be taken when inspecting behind these structures. Where practical, there should be at least 8 inches vertical clearance between wood and soil.

9. Gutters

Should be free of debris and without leaks.

10. Fascia Boards

If stained or obviously decayed, suspect gutters or roof of leaking. Roofing shingles should extend beyond decking.

11. Moss and Lichens on Roof

Moss often grows on roofs in regions having high humidity. Moss holds back water, often creating seepage problems in roofs.

12. Chimneys

Check caulking around fireplaces and chimneys.

13. Porch Slabs

Check slope, using water if necessary, for drainage away from rather than towards house.

14. Caulking Around Windows

This is a critical area when associated with brick or stone veneer. Poor glazing should be noted.

15. Paint Peeling or Delamination of Exterior Doors

This is often caused by rain splash due to insufficient roof overhang or faulty gutters.

UNDER HOUSE

1. Wood Debris or Concrete Forms

Wood debris and concrete forms should be removed as for termite control.

A moisture meter will assist in determining if enough moisture is present for decay fungi to be active. Pay particular attention to areas beneath baths, porches, and unvented corners.

3. Wet Soil or Standing Water

This may be caused by: (a) faulty drainage; (b) lack of foundation waterproofing; (c) leaking plumbing; (d) condensate from air conditioner or duct work.

4. Mold or Stain on Joists or Subfloor

Mold or stain on the joists indicates that wood has been moist enough for fungi to grow at some time. This may have been during construction. Therefore, check to see if the wood has a moisture content above 20 percent. If the moisture content is below 20 percent, the mold and stain can be ignored.

5. Water Stains on Joists, Subfloor or Sills (or Water Present)

If condensation is present, there is a problem. Otherwise, check wood with moisture meter to determine if moisture content is above the critical percent level.

6. Damp Foundation Walls

This can lead to excess moisture in the sills.

7. Clearance Between Joists and Soil In Crawl Spaces Less Than 18 Inches

8. Vapor Barrier on Floor Insulation Against Subfloor

If the vapor barrier on the insulation is towards the soil, the insulation should be reversed. The barrier side of the insulation should be against the subfloor (towards the living area).

9. Wood Piers or Posts

Reporting

All conditions found should be reported and documented. If no decay evidence or moisture conditions are found, the property owner should be so advised. The report should include:

1. The type of rot (water conducting or non-water conducting) and its location.
2. The amount of decay damage and its location.
3. The presence of stain or mold fungi.
4. Conditions conducive to decay.
5. A listing of inaccessible areas.
6. Recommendations for correcting improper conditions. If the PCO does not do the work himself, he should work with the subcontractor to ensure the work is done properly and does not create a new moisture condition.
STRUCTURAL MODIFICATION

In many cases of decay, some structural modification is required. In extreme cases, major alterations may be necessary to protect wood from continual wetting. This may be the case when roofs are improperly designed, crawl space clearance is inadequate over large areas, or untreated wood structural members are exposed to the elements. Such problems often require the services of an architect and a contractor with the PCO acting as a consultant in reference to decay problems.

Cases that can often be corrected by PCO’s involve breaking a wood-soil contact. The soil is a moisture source and, therefore, wood in direct contact is usually subject to decay. Modifications that should be considered are as follows:

1. Sanitation: Remove wood debris, stumps, and other cellulose debris from beneath buildings. Any cellulose product can serve as a reservoir for wood decay fungi, leading to the possibility of decay in structural members.

2. Remove Grade Stakes, etc.: Alterations to posts, stair carriages (horses, stringers), cellar door frames, or wooden floors which are embedded in concrete floors, are frequently necessary wherever basement cellars exist under structures. The sills (soles or plates) of cellar coal bins or of partition walls are often embedded in the concrete floor, or may be fastened to the floor by nailing to dowels or wooden pegs which have been placed in holes drilled in the concrete floor or to wooden blocks embedded in the floor. Grading stakes through concrete floors, spreader sticks in concrete walls, and form boards are hazards. Similar points of soil contact are found in connection with exterior wood work attached to the house, such as the supports and steps of frame porches, platform steps, drop doors or hatchways on cellars, cabinets, fence and gate posts, and garbage and tool sheds.

The alterations required by these situations usually involve cutting off the wood where it contacts the soil and placing concrete between the soil and the wood. This may necessitate the temporary shoring of parts of the structure to remove weight from the wooden member which is to be cut off.

In cutting off wooden members embedded in concrete it is usually advantageous to make the cut at an angle or slope to permit more ready removal of the part embedded. If the member cut in this way carries appreciable weight, it is wise to square it off before setting in on a new concrete base, or to provide some brace to prevent slippage.

It will often be found that the modification of such structures as stair carriages or door jambs will remove the anchorage of the structure formerly provided by the part embedded. In such instances metal straps embedded in the new concrete may be used to provide a new anchorage.
All asphalt felts and other cellulose materials contacting both soil and wood members should be removed. They can conduct moisture and also can serve as a route for *Poria* to infest wood members.

3. Clearance Between Wooden Structures and Soil: A common defect in the relation between grade level and the wooden substructure of a building is lack of proper clearance between foundation sills and floor joists and the soil under a building, as well as under outside trim. Too little clearance may at once prohibit adequate inspection and adequate ventilation.

The common rule is that where it is not necessary or practical to raise a building, then the inside grade shall be lowered by excavating to provide at least 18 inches of clearance between soil and the lowest horizontal members of the substructure. This may necessitate drainage tiles outside the foundation to prevent accumulations. It has been pointed out, however, that in regions with a high water table it is highly undesirable to lower the grade under a structure much below the outside grade, as excessive dampness or even standing water may result. Considerable experience has been cited as indicating that a minimum of 14 inches clearance is adequate.

a. Lower Outside Grade: The outside grade should be at least 8 inches below the sill or siding, whichever is closest to grade. This can be accomplished in several ways as follows:

Structures involving wood sills at or below grade may require the use of some form of gutter to lower the soil or grade line to a point well below the sills.

These gutters are usually made of concrete poured or of preformed concrete slabs set in place. The usual size of preformed slab is 8 inches x 24 inches x 4 inches thick, although 8 inches x 16 inches x 4 inches thick is sometimes used.

Figure 3 represents a simple form of gutter consisting of a row of preformed concrete slabs set on end to serve as the retaining wall, with a gravel fill to hold the slabs in place. This form of gutter is relatively easily and cheaply installed. It does not provide, however, for good drainage away from the building. This factor would be of particular importance in regions of heavy rainfall, especially where the house has no eaves.

A more satisfactory type is that represented by Figure 4 which shows the use of preformed slabs not only as the retaining wall, but for the bottom of the gutter as well. If the joints are properly filled with hot pitch and the floor of the gutter has sufficient slope to drain, this type of gutter will serve to remove excess water as well as to lower the grade. Either of the gutters represented by Figures 3 and 4 should be at least 8 inches wide to provide for ready removal of leaves and other debris. It is important that the bottom of the gutter be at least 8 inches below the foundation sill.

Another type of poured concrete gutter is represented by Figure 5. It will be noted from the figure that it is possible to provide the required minimum of 8 inches between the bottom of the gutter and the sill. The slope of the contact between the gutter and the soil tends to reduce damage from winter frost action. This damage is further reduced by the use of both steel reinforcing rods and steel tie-in rods. A commercial powder-powered tool is available which provides an inexpensive method of inserting steel studs into existing concrete walls.

Figure 6 represents a method for the extensive lowering of grade which in some situations would provide an attractive as well as effective solution to the problem. This type is particularly adaptable where the building rests on a sloping area and the grade adjustment needs to be made only on one side. Be sure the grade between the foundation and retaining wall slopes away from the foundation.

As indicated previously in this section, adequate drainage for the gutters should be provided. The individual situation encountered will dictate the provision that will have to be made for this. Drainage to storm sewers, to a lower grade, to tile or to dry walls are all possibilities.
Figures A – H are reproduced from a slide/script presentation on "Recognition, prevention and control of wood decay in buildings" with the permission of Dr. M. P. Levi, School of Forest Resources, North Carolina State University, Raleigh, N. C. 27607, from whom the slides are available on loan.
A. Dark discoloration on roof sheathing caused by surface-staining fungus.

B. Wood cross section, showing penetration of sap-staining fungus.

C. Damage to wood caused by a white-rot fungus.

D. Damage to wood caused by a brown-rot fungus. Note "checking" across grain.

E. White mycelia of a brown-rot fungus on floor joists.
F. Sporophores of brown-rot fungus in wood beam. Note peeling paint.

G. Rhizomorph of *Poria incrassata*.

H. Rhizomorph and mycelia of *Poria incrassata* on subflooring.

I. Mycelia fan of *Poria incrassata*.

J. White pock rot, *Fomes pini*. 
GUTTER OF PREFORMED SLAB WITH GRAVEL FILL

Scale:
1 in. = 1 ft.

Figure 3
POURED-CONCRETE GUTTER

Scale:
1 in. = 1 ft.

Figure 5
b. **Raising:** Mechanical alteration to break contact of wood with the soil may involve raising of foundations to bring sills above grade. On the West Coast, where stucco construction is widely used, such extensive alterations are of common occurrence.

To provide complete details for the operation of raising foundations for the many types of construction that may be encountered is beyond the scope of this report. It may be said, however, that where foundations must be raised to remove sills from contact with the soil, the minimum height should be 6 inches above grade, and the foundation of solid concrete or solidly grouted concrete block or masonry in cement mortar. The requirements of local building codes must be considered.

The usual method is to remove a few lineal feet of the sub-structure at a time, build up the new foundation to the desired height, and build the new elements of substructure on the new foundation. Where short sections are rebuilt at a time, the problem of shoring to remove weight and the hazard of cracking plaster are minimized. Only in certain sections of the country is it common practice for an entire structure to be shored up and the entire foundation raised at one time.

4. **Dirt-filled Porches:** Frequently, direct contact between soil and wood will be found under dirt-filled porches, terraces, and planters. This condition may be corrected by placing a barrier between the soil and wood or excavating the soil as follows:

a. **Barriers:** Certain types of contacts between wood and soil are most readily broken by establishing a barrier. Dirt-filled porches and terraces, where soil has been brought into contact with the foundation sills, are examples that present a common problem in all parts of the country. A form of mechanical barrier used in certain parts of the country to deal with such situations is the seal-off. Where dirt fills under porches and terraces have brought soil in contact with foundation sills, a barrier of poured concrete or cement-mortared masonry is often installed between the sills and the soil. This method is very extensively used on the West Coast, and particularly in the Los Angeles area, where it is referred to as the seal-off. Experience of many years has indicated the utility of this method under West Coast conditions. It has not been demonstrated that it will prove effective under other conditions, though it may well be considered experimentally.

The seal-off is ordinarily applied by breaking out a strip of the porch terrace floor adjacent to the building and excavating the fill down to well below the top of the foundation itself. The face of the foundation, the cut edge of the floor, and the exposed insides of the cheeks of the porch are then well cleaned. Unless all the wood is commercially pressure treated, flashing should be installed and then concrete poured to fill the excavation to a point where it is flush with the top of the porch floor. Another method is to construct an impervious masonry wall from the footing of the foundation under the porch up to the level of the under side of the porch floor. Figures 7 and 8 illustrate the use of the concrete seal-off and Figure 9 illustrates a masonry seal-off.

Another method, more practical during the construction of a porch, but which may find a place in corrective work on occasion, is to completely separate the porch from the structure as shown in Figure 10. Concrete blocks could be used in place of the concrete foundation. The form between the foundation and the porch can be greased first, making them easier to remove following pouring the concrete.

b. **Tunnelling:** In some areas east of the Rocky Mountains, the construction of a tunnel along the foundation and under the floor of the porch or terrace to permit inspection and breaking the soil-wood contact is common. The procedure in tunnelling must be varied to meet conditions, but the general procedure is as follows:

The entrance openings are usually from the ends of the porch or terrace, but are sometimes made from under the building. In the latter case, the opening should preferably be made
SLAB PORCH BEFORE APPLYING SEAL-OFF

Scale:
1 in. = 1 ft.

Figure 7
under a door or window, as there is less weight on the foundation at these points, and the weight balance of the structure is less likely to be upset.

Where the porch or terrace is at grade, or but little above grade, a serious problem may develop in the accumulation of water in the tunnel during rainy seasons. Some operators have used covered area-ways to prevent surface water flowing into the tunnels. In other cases tile drains to carry the water to storm sewers have been installed. These may usually be constructed at those corners of the house where guttering has downspouts entering drains leading to storm sewers.

Tunnels may present a problem in that the slab floor of the porch or terrace require support to prevent settling or cracking. Such support may be in the form of a few piers of brick or cement block, or may take the form of solid masonry retaining walls on the side of the tunnel next to the unremoved fill. Such walls prevent sloughing of the fill into the tunnel, as well as providing support for the floor. It is sometimes desirable to establish some support close to the foundation — it other words, on the side of the tunnel next to the house.

In this event the support should not be built within 2 inches from the foundation, as too close proximity to the foundation would provide a hidden or difficult to observe access space for termites to build tubes from the tunnel floor to the foundation sills. Provisions should be made that adequate crawl space remains after the installation of supporting piers.

A modification of the usual tunnel is to remove a strip of the porch floor along the house and dig out the fill to a depth that will permit leaving a minimum of 4 inches clearance between soil and the lowest point of potential wood contact in the tunnelled area. In most cases this means excavation to a minimum of 4 inches below the top of the concrete foundation. As mentioned previously, if a brick wall resting on a footing is involved, the clearance should be down to 4 inches below the top of the footing. A retaining wall is then built along the outer side of the tunnels next to the unexcavated fill, and the porch floor is replaced in removable sections, properly supported. This floor may be of preformed concrete slabs, or of iron or steel floor sheets.

In all types of tunnelling one point must be carefully watched. At the points of contact between the foundation and the ends of the porch or terrace (sometimes referred to as the "cheeks") there is likely to be shrinkage on a settling crack. If tunnel entrances are made from the ends of the porch or terrace on the outside, the cheeks should be cut up to the foundation of the house. Then when installing closures or ventilators, care must be used that a hidden access for termites is not thoughtlessly constructed.

5. Access Opening for Crawl Spaces: In some cases, a crawl space will have no access opening. Such should be provided for inspection. A suggested opening is shown in Figure 11. The opening should be at least 18" x 24". The door should be a solid panel or 1/8" mesh aluminum screen. All wood used for the door or framing should be commercially treated.

The areaway of concrete or unit masonry should project 18 inches from the foundation when the depth of the areaway is 12 inches or less. If the depth exceeds 12 inches, the areaway should project 30 inches from the foundation.
The areaway should be 30 inches wide. It should extend at least 2 inches above grade and at least 4 inches below the bottom of the access opening. Four inches of gravel should be placed in the bottom of the access and a cover installed over the areaway. The cover should be waterproof if the door is solid. If the door is screened for ventilation, the cover may be omitted or constructed so as to permit air circulation.

6. Replacement of Damaged Wood: All wood that is structurally unsound should be replaced. If exposed to a moisture condition, it should be commercially pressure-treated.

Most wood decay damage occurs on subflooring and structural members beneath it and fascia boards at roof eaves. Structurally weakened portions can be removed and replaced. Views of typical construction of this type are shown in Figures 12 and 13. Adequate temporary supports should, of course, be provided when structural foundation members are removed.

7. Frame Building On Wooden Posts: In some construction, especially in the south, frame buildings have the sill resting on non-treated wooden posts (piers), which in turn rest on concrete footings. The footing may be very shallow or very deep; and the posts may be set on top of the footing, or the footing may be poured around the posts.

When such construction is encountered, one of the following should be done:

1. Replace all wooden posts with poured concrete, concrete blocks, pressure-treated posts or other decay resistant material.

2. Raise the posts so that they rest on a concrete footing which is even with or above grade and extends at least 4 inches around the post.

3. Or, if for economic reasons neither 1 nor 2 can be carried out, then remove the soil from the footings. Drill holes diagonally down through the posts to reach the center. Inject a pentachlorophenol gel into the holes. The purpose is to completely impregnate each post with the preservative.

8. All-Weather Wood Foundations: In a few areas of the country, a new construction technique is being tried. The foundation is constructed entirely of pressure-treated wood. This may or may not add to the hazard of wood decay in the structure. The decay resistance will probably be related directly to the quality of the pressure treatment.

Even if these foundations prove to be totally decay resistant, the PCO should not overlook the potential decay problems associated with wood members above the foundation.
MOISTURE CONTROL

Controlling excessive moisture is the key to stopping or preventing wood decay. Plumbing and roof leaks are best repaired by specialists in such work. Walls which "sweat" due to the absence of a vapor barrier can be corrected by painting the inside with a vapor-resistant coating.

Most moisture problems associated with wood decay in structures are caused by excessive soil moisture and rain seepage. Procedures that aid in controlling excess soil moisture include: (1) proper drainage, (2) foundation waterproofing, (3) adequate ventilation, and (4) installation of an adequate moisture-proof soil cover in crawl spaces. In some situations, all procedures may be required. Other situations may require only one or two. A thorough inspection to analyze the problem will help you decide what each situation requires.

A. Drainage

1. Roof Drainage

Houses should have gutters and downspouts to take care of roof water from rain and snow, particularly if the roof overhang is less than 18 inches. The gutters and downspouts should be kept free of debris. Where leaves and twigs from nearby trees may collect in a gutter, install a basket shaped wire strainer over the downspout outlet. Gutters and downspouts should be repaired and cleaned when needed.

Downspouts usually have an elbow or shoe on the lower end to discharge the water slightly above the ground and away from the foundation wall. To prevent concentration of water at the point of discharge, use a concrete gutter or splash block to carry the water away. The gutter or block should slope 1 inch per foot, and its outer edge should be flush with the grade.

Disposal of roof water as shown in Figure 14 makes it easy to clear the lower end of clogged downspouts. Roof water can also be piped underground to a storm water drain, dry well, or surface outlet, 15 feet or more from the house (Figure 15). The bottom of a dry well should be lower than the soil level in the crawl space and in earth or rock that drains rapidly.

![Figure 14](image1.png)

FIGURE 14. Correctly installed gutters and downspouts prevent roof water from drenching wet or damp conditions around foundation walls.

![Figure 15](image2.png)

FIGURE 15. Roof water can be routed to a storm water drain or other outlet.
2. Surface Drainage

Crawl spaces can become wet or damp when surface water drains vertically down the foundation walls or where the outside soil slopes toward the buildings. Drainage down the walls can be prevented, and should be minimized.

If the ground is flat or slopes toward the house, it may be built up to a grade level (minimum of 3° pitch) that will drain away surface water. Extend the slope for 10 feet, if possible. Seed it with a good lawn grass, and rake and roll it. Sodding is a common practice and prevents the washing away of a newly graded area during heavy rains.

Where a large area of land slopes toward the house, surface water should be intercepted and rerouted some distance from the house. Dig a shallow, half-round drainage ditch or depression designed to route the water around the house. Sod the ditch or plant grass in it. If a ditch is objectionable, drain tile, with one or more catch basins at low spots may be installed. Landscaping (flower beds, etc.) can sometimes be altered on the up-slope side of the building to deflect surface water around the building. An alternate to changing the slope is to install gutters (see Figures 3, 4, 5 & 6).

3. Subsurface Drainage

Deep, thorough drainage of a house site is important. In poorly drained soil or where the crawl space soil level is below the outside grade level, drain tile should be installed around the exterior of the foundation near the footings or at least on the sides where trouble may occur (Figures 16 and 17).

Four inch drain tile or perforated plastic drain pipe should be used. It should be laid parallel with and at the bottom of the footings. The bottom of the tile must not be lower than the bottom of the footings. If the drain is below the footings, the footings may be undermined. The drain should slope very little, about 1/2 inch per 12 feet. Joints between the tile should be open about the thickness of a knife blade or 1/4 inch, and the top half should be covered with building felt or similar material to keep out dirt.

In normal, porous soil, the tile should be covered with 18 inches of screened gravel. In heavy, non-porous soil, the gravel should extend almost to the top of the excavation. In either type soil, fine gravel should be placed immediately over and around the tile to provide a good bedding and protection.

This footing drain and belt of gravel around the foundation walls should drain off all seepage water and prevent the accumulation of water around the walls. This method is especially suitable on the upper side of a house located on a hillside, because a drainage outlet can usually be located within a short distance. Branch drains may be laid to distribute water over the lawn or away from the house if sufficient slope for gravity drainage is absent.

Under abnormal conditions, it may be necessary to drain deeper than the foundation. In this situation, the drain tile should be placed 4 to 5 feet away from the footings to prevent undermining them.
**Figure 16.** A footing drain prevents the accumulation of water around foundation walls.

**Figure 17.** In very poorly drained soil, the gravel should extend almost to the top of the excavation.
4. Sump Pumps

Where gravity drainage is impossible or impracticable, or where a serious water problem exists, a sump pump may be used to move the water to a level where it can be carried off through a drain tile.

Sump pumps are small, simple, compact units and are installed in a sump or pit at the low corner or other wet spot in the crawl space. To prevent caving in of the sides, line the sump or pit with a length of large drain tile or with concrete or metal. Inlets, or holes should be provided in the lining material to admit ground water. Manufacturers of sump pumps specify the size of sump or pit required for a particular pump.

Sump pumps are designed for automatic operation. If correctly installed and not abused, a pump requires very little attention. Dirt, lint, trash, and other waste can clog the strainer and should be kept out of the pit.

B. Foundation Waterproofing

In some situations, surface and/or subsurface drainage is such that it can more easily be handled by waterproofing the exterior of foundation walls. It is recommended waterproofing be carried out in conjunction with the installation of drainage systems for effective water control.

Waterproofing foundation walls usually consists of removing the back-fill from the exterior of the foundation and applying several coatings of hot or cold asphalt compounds. Added benefits can be had by presenting polyethylene sheeting into the asphalt while soft. Other waterproofing systems are available.

Before excavating along the foundation, it is well to make a chalk mark on the foundation to mark the grade level, so that the top edge of the waterproofing will be at the grade line.

In applying a membrane with asphalt compounds the preparation of the surface is important. The foundation must be dry and brushed free of soil. A stiff brush with a long handle set at an angle may be used and saves work in that it can be used from a standing position. If the face of the foundation is damp and there is not time to allow it to dry by normal evaporation, a flame thrower may be used, provided caution is used in regard to fire hazards.

After the surface has been prepared, a priming coat of asphalt is brushed on. Again a brush with a long handle will enable the workman to avoid tiresome stooping. Several coats should be applied, allowing time between coats for the asphalt to move into the pores of the foundation and to become tacky.

After the final coat is applied, immediately press the polyethylene in place. It should extend to the footing, overlapping it slightly. Air pockets should be pressed out to the extent practical, but it is better to have a few air pockets rather than risk tearing the polyethylene. The sheeting should extend to grade level or slightly above. Finally, the fill is replaced, aiding in holding the sheeting in place.

Many variations of the above described general method may be used. It should be remembered that the asphalt is of as much value as a barrier as the polyethylene. The bond should therefore be continuous and well applied. No harm is done if some of the asphalt overflows the top of the polyethylene, but a poor job will result if it does not come to the top of the polyethylene.
C. Ventilation

To prevent excessive condensation accumulating under a structure, proper ventilation may often be required in addition to drainage and water disposal. To ensure adequate movement of air under a structure, both the size of the ventilators and their placement in relation to prevailing air currents must be considered.

Ventilators are of several types and sizes. They should have a type of opening that admits air movement freely, but prevents admittance of rodents and other animals. In cold regions some means of providing complete closure during cold weather is desirable.

Ventilators should preferably be placed under windows, as this is a point of minimum load on the foundation. They should not be placed where shrubbery on the outside, or part of the substructure on the inside, tend to interfere with air movement. The elimination of dead air pockets is a prime consideration and ventilation should be provided within three feet of any corner.

The amount of ventilation should be adequate for the particular situation involved, and this will be influenced by both regional and local factors. FHA’s Minimum Property Standards call for ventilation to equal at least 1/150 of the soil area of the crawl space without a moisture proof soil cover (i.e., a crawl space with 300 square feet of soil should have at least 2 square feet of ventilation.). Crawl spaces having a moisture proof soil cover need have only a free ventilating area of 1/1500 of the ground area. All such spaces must be cross ventilated.

When computing the number of ventilators needed for a given situation, remember that a one foot square ventilator has less than one square foot of free air space, due to screening, etc. Most ventilators indicate on their label the amount of free air space provided.

Attic spaces should also be ventilated properly. FHA’s Minimum Property Standards call ventilation of attics to equal or exceed 1/150 of the floor area. This amount may be reduced to 1/300 of the floor area if a vapor barrier is installed on the warm side of the ceiling or at least 50 percent of the ventilation is located at least 3 feet above eave or cornice vents.

Note: Certain building codes may use different formulas for computing the necessary ventilation for crawl spaces and attics. These should be followed where applicable.

There may be situations where adequate cross ventilation cannot be achieved with vents alone. Forced ventilation using fans should be considered in such cases. In severe cases of moisture, fans should be considered as a temporary measure while other work is being carried out. This will correct the moisture condition more quickly, even though adequate ventilation can be achieved through the use of vents.

D. Installation of Moisture-Proof Soil Cover

Installation of a soil cover (also known as a vapor barrier, moisture barrier and ground cover) is an important step (and may be the only step) in soil moisture control. Four or six mil polyethylene sheeting, roll roofing, roofing felt, or kraft paper that is plastic-backed or impregnated can be used. Currently, polyethylene is the most economical and is widely used by pest control operators.
Preparation for installation requires a general clean-out of debris from the crawl space. If you have performed a termite treatment in addition to moisture control, this will already have been completed.

There are two general methods of installing polyethylene underneath crawl space houses for moisture control. Figure 18 shows the polyethylene installed in all sections of the crawl space except between the piers. Approximately 150 square feet would be left in a 1200 to 1400 square foot structure.

Figure 19 shows the alternate method. An 18 inch strip is left vacant around the perimeter of the building. If 100% of the soil is covered, the hardwood floors and other wooden areas of the house may shrink excessively if the crawl space is very wet. As a general guide, 70 to 80 percent coverage of the soil surface in the crawl space area should be adequate.

An exception to this rule is in areas such as the coastal area of the Pacific Northwest, or Gulf Coast where the humidity is constantly high. In such areas, the soil cover should cover as much of the soil surface beneath a building as possible. The high humidity will prevent excessive drying of the wood members and subsequent shrinkage.

FIGURE 18

FIGURE 19
Generally, one person can install the polyethylene strips. It is not necessary to anchor the polyethylene except under buildings where people must pass regularly or where the crawl space is subject to strong air currents. In this case bricks, stones, concrete blocks, etc., may be used to anchor the polyethylene. Some use U-shaped "pins" as anchors.

It is recommended that an inspection be made two to three weeks after installation of polyethylene barriers. If shrinkage is excessive, then some soil cover should be removed to expose more soil underneath the building. On the other hand, if the moisture condition inside or underneath the structure is not improving, then more ground space should be covered and other steps taken if necessary.

When crawl spaces are exceedingly wet, it is often wise to dry them out slowly. This will minimize the amount of warping and cracking of wood members (see page 3). Following the correction of moisture conditions, flooring may develop creaks due to shrinkage. The customer should be made aware of the possibility of this problem. It can usually be corrected by setting additional nails into the loose floor boards.
CHEMICAL CONTROL

In-Place Application

Chemicals seldom have a role in corrective treatments of wood decay. If the moisture condition(s) is corrected and the wood permitted to dry, there is seldom a need for chemical applications. On the other hand, if the moisture condition is not corrected, chemical applications are of limited value. Although chemicals applied to in-place wood members may kill decay organisms on the surface of the wood, decay fungi below the surface are unaffected and will continue to weaken the wood. Therefore, chemical applications are not recommended as a part of a wood decay control program, except under one or more of the following circumstances:

1. If the wood is dry and free of fungus, but may be subject to wetting in the future.

2. If pressure treated wood is used, apply to fresh-cut untreated surfaces of pressure-treated wood. Most decay begins on end cuts, making this a critical area to treat.

3. If the economic situation of the customer is such that normally recommended structural modifications are not possible, in-place treatment of infected or susceptible wood members may extend their useful life. In such cases, the customer should be made to realize that eventually the wood must be replaced and moisture conditions corrected for proper solution of the problem.

Pentachlorophenol is the chemical usually used for in-place treatments of wood. It is commercially available as a ready-to-use 5 percent solution in oil and as a 10 percent gel or mayonnaise-like emulsion. The gel formulation (for example Wood-Treat TC) is preferred for this work as it penetrates better. The drier the wood, the better the penetration.

The gel can be applied with a sheepskin mitt (over a long cuffed neoprene, rubber or plastic glove), heavy bristle paint brushes,ure, wooden paddles, spatulas, or similar instruments. Apply it as evenly as possible after the wood has dried in a 1/16” layer for a two inch thick wood member. Use additional gel on thicker members. The gel can also be applied with a caulking gun. Using this method, a bead 1/4” thick and 1/2” wide should be applied for each 2” x 4” equivalent of the member being treated. The gel will completely penetrate even tightly filled joints if sufficient material is used. It will also penetrate 1-1/2” to 2” of sound wood. If deeper penetration is necessary, holes should be drilled and then, following treatment, filled with wooden plugs.
Because of the "creeping" ability of the gel formulation, treatment should extend no closer than 1-1/2" to an adjoining surface or else the gel will creep into it. This is particularly important if roofing papers and similar materials are adjacent to the treated member. The gel may penetrate the member and damage such materials. A bead of gel should not be applied closer than 1-1/2" from the bottom edge of a member or else it may drip off the member.

Pentachlorophenol will damage living plants. Use care when applying to exterior surfaces to prevent drift onto vegetation. For this same reason, sprayers used for application of pentachlorophenol should be reserved for this use. Pentachlorophenol also corrodes some sprayer parts, especially rubber. Frequent cleaning will extend the life of such parts, but will not entirely prevent such damage.

Copper napthanate and zinc napthanate are two other wood preservatives used for in-place applications. Copper napthanate leaves a green color on wood treated. Zinc napthanate, while slightly less effective in preventing decay, is colorless. Both are available under a variety of trade names. They are brushed or sprayed on as solutions containing 24% copper or zinc napthanate (equivalent to 2% metallic copper or zinc).

Use of Commercial Pressure Treated Wood

If moisture conditions cannot be economically corrected, or where wood is subject to constant wetting, such as wood in contact with soil or used in water towers, pressure treated wood should be used. Acceptable preservatives include pentachlorophenol, chromated-copper-arsenates, and ammoniacal-copper-arsenates. The preservatives should be applied under pressure according to the Federal Specification TT-W-571 or equivalent specifications. Such wood is usually available through lumber yards on an order basis, or some stock such lumber.

Pressure treating usually carries the preservative well below the wood surface. However, when pressure treated wood is used, all new saw cuts should have the proper preservative applied to them to maintain the protective barrier, as decay most often enters end cuts.
USEFUL REFERENCES ON WOOD DECAY, ITS PREVENTION AND CONTROL


The following Forest Service publications are available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402:


