United States Department of Agriculture

Protecting Log Homes from Decay and Insects

Stan T. Lebow

Forest Service | Forest Products Laboratory | General Technical Report FPL–GTR–257 | April 2018

Abstract

This report discusses the protection of log homes from decay and insect attack, along with practices for exterior maintenance of these types of homes. Causes of fungal decay and insect attack are discussed, as are some basic building techniques that will minimize biological attack. Selection and handling of logs, preservative treatment, construction details, descriptions of preservative types, and sources of further information are also included.

Keywords: log homes, protection, decay, insects, construction techniques, preservatives, maintenance

Contents

Cover photo: Lolo Pass Visitor Information Center, Powell Ranger Station, Clearwater National Forest, Lolo, Montana.

April 2018

Lebow, Stan T. 2018. Protecting log homes from decay and insects. General Technical Report FPL-GTR-257. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 14 p.

A limited number of free copies of this publication are available to the public from the Forest Products Laboratory, One Gifford Pinchot Drive, Madison, WI 53726-2398. This publication is also available online at www.fpl.fs.fed.us. Laboratory publications are sent to hundreds of libraries in the United States and elsewhere.

The Forest Products Laboratory is maintained in cooperation with the University of Wisconsin.

Protecting Log Homes from Decay and Insects

Stan T. Lebow, Research Forest Products Technologist
USDA Forest Service, Forest Products Laboratory, Madison, Wisconsin

Preface

This publication supersedes FPL General Technical Report FPL-GTR-11, “Protecting Log Cabins from Decay” (1977), and FPL Report Number 982, “Making Log Cabins Endure: Suggestions on Construction, Log Selection, Preservation, and Finishing” (1974). These prior reports provided recommendations for preservative formulation and application that are not currently allowed under U.S. Environmental Protection Agency regulations. However, much of the information on log home construction and design remains of value and was transferred from those earlier reports. Additional information was added on biological attack of log homes and current preservative treatment options. The author acknowledges the contributions made by retired Forest Products Laboratory researchers Roger Rowell, John Black, Lee Gjovik, and William Feist, who authored the 1977 report.

Introduction

Log homes and cabins are attractive, functional structures that continue to be popular in many parts of North America. However, log structures do have several characteristics that can contribute to the potential for deterioration. Because of their large size, logs almost invariably form deep drying checks that allow moisture to penetrate to the center of the log. This moisture is slow to dry, increasing the likelihood that conditions will be conducive for decay and insect attack. In many structures, the logs at corners also protrude to such an extent that they have minimal protection from the roof overhang, and the large area of exposed end-grain allows moisture absorption. The bottom courses of logs are also prone to wetting either from wind-blown rain or splashing from water draining off the roof.

In protection of log homes, both design and maintenance are important. In many cases, the potential for biodeterioration can be minimized with design and construction practices, and a cabin should be well planned before the building starts. A good set of plans and acquaintance with cabin-building skills are essential. Helpful resources on log cabin construction, decay control, and insect damage are listed in the sources of additional information at the end of this report. A log home must be designed to stay dry, including protection from rain and ground moisture. Where moisture accumulates, decay fungi can flourish. Many moisture problems can be eliminated with proper roof overhang, roof eaves, and concrete, brick, or stone foundations with good drainage. Moisture usually becomes a problem because of poor design, careless workmanship, and poor maintenance. Dry wood does not decay and is less susceptible to insect attack. Therefore, the main principles of preventing deterioration are to use construction techniques that keep the cabin dry. When this is impossible, the use of preservative-treated wood is recommended.

Causes and Control of Decay and Insect Damage

Fungal Damage

Deterioration of wood by decay fungi is a threat to the longevity of a log structure. There are several classes of fungal damage.

Sapstains cause almost no strength losses in wood but create objectionable color changes in wood. They also cause increased permeability in wood, allowing moisture to settle and inviting more decay organisms. Sapstains may go deep into the log and cannot be removed easily (Fig. 1).

Figure 1. Sapstain fungi grow deeply into the wood but die after the wood dries and do not cause structural damage.

Mold discolorations, on the other hand, are usually surface stains and can be removed by brushing or shallow planing (Fig. 2). As with sapstain, mold on the exterior of a structure is largely a cosmetic problem.

Soft rot fungi cause a more severe type of wood degradation. As they grow, they cause a slow surface deterioration, which is characterized by breaks across the surface fibers. The transition between the rotted wood and the sound wood beneath is very abrupt. Soft rot fungi prefer very moist environments, such as wood placed in direct contact with the soil or with masonry exposed to precipitation.

Figure 2. Mold fungi grow on the wood surface and do not cause structural damage.

Figure 3. Brown rot fungi can cause serious structural damage to log homes if sufficient moisture is present in the wood. Often, the damage is concealed within the log and the first exterior sign of decay is a fungal fruiting body (inset photo).

Typical brown and white rot fungi are the most severe types of wood rotters and can cause extensive damage. They cause rapid decay with great reduction in the strength of wood and often with little visible outward evidence (Fig. 3). It is these wood-deteriorating fungi that necessitate the use of preservative treatment of wood for specific parts of a log structure.

Insect Damage

There are a number of wood-boring insect species that can cause damage to log structures. In the southeastern United States and other humid coastal regions, in particular, insects are more likely to be an issue than in other parts of the country. Termites are the primary wood-attacking insect in much of the United States; structures should be monitored to identify potential infestations by closely examining for bore holes, frass, mud tubes, live insects, or other evidence of activity. A number of termite species can damage wood in log homes, including subterranean termites, drywood termites, and dampwood termites. The eastern native subterranean termite is the most common wood-attacking termite in the United States and is found in every state except Alaska. These termites require moist wood to survive and typically damage the interior core of wood members first; therefore, an infestation often goes unnoticed until the damage has become severe. Subterranean termites tend to consume softer earlywood first, leaving latewood in ridges around their galleries. These termites often enter wood members through wood in contact with the soil, but they can survive in wood with no soil contact provided the wood remains moist. A common visual indicator of subterranean termites is the presence of mud shelter tubes on the surface of the wood or heavily channeled wood compacted with mud (Fig. 4). Termite shelter tubes can cross mortar and brick. Prolonged infestation can lead to a significant loss of wood cross section and structural integrity.

The Formosan subterranean termite is an invasive termite species larger and more aggressive than native North American subterranean termites. Native to southern China, Taiwan, and Japan, Formosan termite populations were established in South Africa, Hawaii, and the continental United States by the mid1900s. A highly destructive insect species, Formosan termites live in extremely large colonies that can contain up to several million termites with a foraging range up to 90 m (300 ft) in soil. Because of its population size and foraging range, the presence of Formosan termites poses serious threats to wood structures, particularly along the Gulf Coast, southern California, and Hawaii. There may be little to no external evidence of infestation; Therefore, log homes in states known to have active Formosan termite populations should periodically be closely inspected to identify potential termite activity.

Figure 4. Support member with brown rot decay and termite mud tubes (Photo credit: Rachel Arango, USDA Forest Service, Forest Products Laboratory).

Figure 5. Carpenter ants often reveal their presence with piles of sawdust and frass.

Drywood termite infestations have been recorded in Alabama, Arizona, California, Georgia, Florida, Louisiana, Mississippi, New Mexico, North Carolina, South Carolina, Texas, and Utah. Drywood termites do not require contact with soil or other sources of moisture within the wood. Colonies can reside in nondecayed wood with low moisture contents. Drywood termites live in small social colonies with as few as 50 to as many as 3,000 insects for a mature colony. They remain entirely above ground and do not connect their nests to the ground with mud tubes or galleries. Typically, the first sign of a drywood termite infestation is dry fecal pellets collecting at or near the base of wood members. The fecal pellets are hard, angular, less than 1 mm long, and vary in color from light gray or tan to very dark brown. Interior galleries tend to be broad pockets or chambers connected by smaller tunnels that cut across latewood. Irreparable damage to wooden elements can be caused by drywood termites in 2 to 4 years, depending on the size of the element and the size of the infestation.

Dampwood termites, most commonly found along the Pacific Coast, have been identified in California, Montana, Nevada, Oregon, and Washington. Some less destructive dampwood termite species also live in Florida. Although typically not as destructive as subterranean termites, with ideal conditions, they can cause significant damage. Dampwood termites are larger than subterranean termites, and unlike subterranean termites, usually build their colonies in wood that is already in the early stages of decay. As long as the wood has a high moisture content, the colony will not require contact with the ground. In relatively sound wood, the galleries tend to follow the softer earlywood; however, if decay is more advanced, the galleries tend to become larger and cut through harder latewood. Fecal pellets tend to be the same color as the wood being eaten and, in very damp wood, stick to the sides of the galleries in amorphous clumps.

Another wood-boring insect species, the carpenter ant, is widely distributed and can cause damage to log structures. Carpenter ants prefer moist wood but once established can colonize adjacent dry wood. Carpenter ant infestation is most typically identified by the presence of large (6- to 13-mm- (0.25- to 0.5-in.-) long) ants that can range in color (depending on species) from dull black with reddish legs and golden hairs covering the abdomen to a combination of red and black or completely red, black, or brown. Damage to the wood is typically in the interior, but there may be piles of fibrous, sawdust-like frass in or around checks and splits (Fig. 5). Galleries within the wood generally follow the grain.

Carpenter bees can also damage wood in historic buildings. Carpenter bees have a world-wide geographic range and vary in size and shape from small, 6-mm- (0.25-in.-) long bees to large, hairy bees that resemble non-wood-boring bumblebees. Typically, only the larger species of carpenter bees create nesting galleries in solid wood and pose a risk to exterior wood surfaces of log structures. In the United States, seven species of large carpenter bees range across the southern states from Arizona to Florida and along the east coast as far north as Virginia. These large carpenter bee species are, on average, 13 mm (0.5 in.) or longer and can range in color from yellow to black. Carpenter bees create large entrance holes (Fig. 6), but their shallow tunnels typically do not cause significant structural damage in logs.

Several types of wood-boring beetles can cause damage in log homes, but the most destructive are powderpost beetles. Unlike decay fungi, powderpost beetles are capable of attacking wood that is well below the fiber saturation point, which allows them to attack members in log cabins that

Figure 6. Carpenter bees resemble bumble bees and create large entrance holes (Photo credit: Rachel Arango, USDA Forest Service, Forest Products Laboratory).

Figure 7. Powderpost beetle infestations produce fine, flour-like powder below small exit holes.

are protected from direct wetting. Powderpost beetles lay their eggs on the surface of sapwood of the desired species, typically hardwoods. The eggs hatch into larvae that tunnel into the wood, leaving little evidence of their presence inside the wood. The larvae tunnel extensively through the wood for periods extending from months to multiple years. After the larvae have obtained a sufficient amount of energy, they pupate to become adults. These adults then exit the wood, leaving small round exit holes and fine powder on the wood surface. This is often the first visible sign of an infestation (Fig. 7). The inside of powderpost-damaged wood tends to be crumbly and powdery. Another type of beetle that can be problematic, especially along the Atlantic Coast, is the old-house borer. Most wood preservatives can prevent attack by most types of beetles, but surface treatments may not be effective against existing infestations. Finishes may be as effective as wood preservatives in preventing attack by the most troublesome types of beetles.

Building to Prevent Decay and Insect Attack

Selection and Handling of Logs

Type of Wood

Cedar, spruce, pine, fir, and larch are often used for log cabin construction because of uniform diameters, slight taper, and availability. Other species commonly available in local areas may also be adaptable. Many of the logs available on the market today are obtained from small trees and consist primarily of sapwood, which has very little natural resistance to decay. The heartwood of some species, such as cedar, has natural decay resistance, but usually, only old-growth, slow-grown trees contain substantial heartwood. Other species whose heartwood is known to have natural durability include redwood, baldcypress, black walnut, osage-orange, white oak, black locust, and Pacific yew. These woods, however, are generally not used for logs in buildings because of their high value for other products, their scarcity, and their small or irregular log shape. The lack of natural durability of many logs used today requires certain precautions to give the structures the necessary added resistance to decay and insect attack. In some cases, low wall logs, foundation logs, and sill logs should be pressure-treated with a preservative. This precautionary measure will give the log structure extra protection in crucial areas that are prone to wetting.

Log Preparation

Green logs—A log cabin can be built with green logs, but construction techniques are limited. Mixed horizontal and vertical log placement cannot be done because of the differences in final dried dimensions. Windows and doors should not be fitted until the logs have dried to an equilibrium moisture content. It is recommended that logs be dried before construction begins.

Unpeeled—Logs with the bark left intact are almost impossible to protect from deterioration over long periods of time (Fig. 8). The bark slows down drying of the logs to such an extent that some decay in the interior is almost certain to occur before the log becomes fully seasoned. Furthermore, bark encourages the attack of insects such as bark beetles and some wood borers. Because of these insects and loosening by shrinkage, the bark usually falls off or is easily knocked off in patches after a short period of time. For these reasons, unpeeled logs are not recommended for log cabin construction.

Peeled—Practically all log structures are built with peeled or debarked logs because of the ease of building and maintenance, easier preservative treatment, greater durability, and aesthetic appearance. The remainder of this report presupposes that peeled logs are being used. Cutting and peeling of the logs can be done during the cold months so that some drying can take place before the warm weather. Although logs are usually more difficult to peel in winter

Figure 8. Leaving bark on cabin logs increases likelihood of insect attack and slows drying.

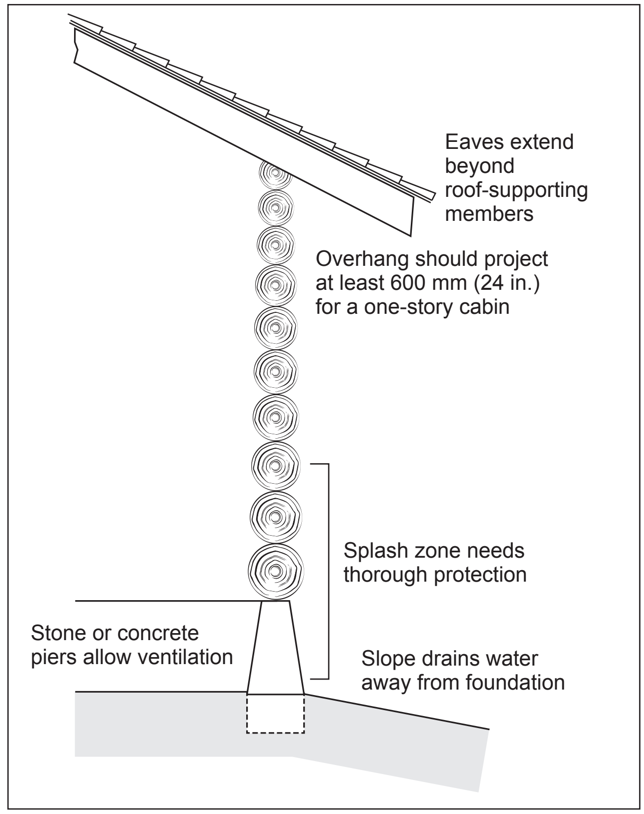

Figure 9. Good construction techniques work together to minimize wetting and lessen the likelihood of decay or insect attack.

than in spring or early summer, the protection afforded against fungi and insects by winter peeling more than offsets the extra labor. The peeled logs should be piled off the ground in the open allowing air to circulate freely around each piece. Six months of air-drying is recommended. If possible, the logs should be stored in an open shed or shelter that protects against driving rains. This is most important when drying those hardwood logs that have little or no natural decay resistance. To avoid stain and mold during the warm part of the year or in mild climates, the freshly peeled logs can be sprayed with an antisapstain preservative solution. These preservatives are intended to provide temporary protection until the logs are dry; they are most commonly used to protect green lumber in sawmills. The preservatives used in antisaptain chemicals include copper-8-quinolinolate, 2-(thiocyanomethylthio) benzothiozole (TCMTB), isothiazolone, didecyldimethylammonium chloride (DDAC), propiconazole, tebuconazole, chlorothalonil, and 3-iodo-2-propynyl butyl carbamate (IPBC). Only formulations with current U.S. Environmental Protection Agency (EPA) registration should be used, and they should be applied in accordance with directions on the labeling. Treatment should be done within a day of peeling, as staining usually begins quickly under warm weather conditions. The logs should remain piled and properly separated by stickers until seasoning is complete.

Construction and Design Considerations

In most cases, the construction of log homes and cabins must conform to applicable building code requirements. This section discusses design and construction factors that can affect log home durability, but for specific details readers should refer to building codes and documents such as ICC-400, Standard on the Design and Construction of Log Structures (See sources of additional information).

Foundation

Of first importance in protecting a log cabin from decay or insect damage is the foundation (Fig. 9).

Drainage—Good drainage will help keep the foundation dry. Storm water should not be allowed to accumulate around the foundation or under the building. The cabin site should be graded or ditched so that water drains away from the building. Eave troughs, downspouts, and wide eaves will direct the water away from the cabin and therefore will help greatly in keeping the foundation dry.

Piers and posts—Log cabin builders sometimes take the course of least resistance and lay the bottom logs directly on or close to the ground. Placing untreated wood in direct contact with the ground is one of the surest ways of hastening its decay. When wood is placed in contact with the ground, the soil moisture has direct access to the wood and keeps it constantly damp (Fig. 10). This dampness sets up conditions that are most favorable for growth of the fungi that cause decay. Good building practice dictates that bottom logs or sills be placed 300 to 450 mm (12 to 18 in.) above the ground on foundations that will keep the wood dry. Stone or concrete foundations or piers are excellent.

Ventilation—Good ventilation beneath the floor is important because it keeps the soil and wood dry. Foundation posts or piers allow good ventilation unless the spaces between

Figure 10. Placing logs directly on the ground ensures that decay will occur.

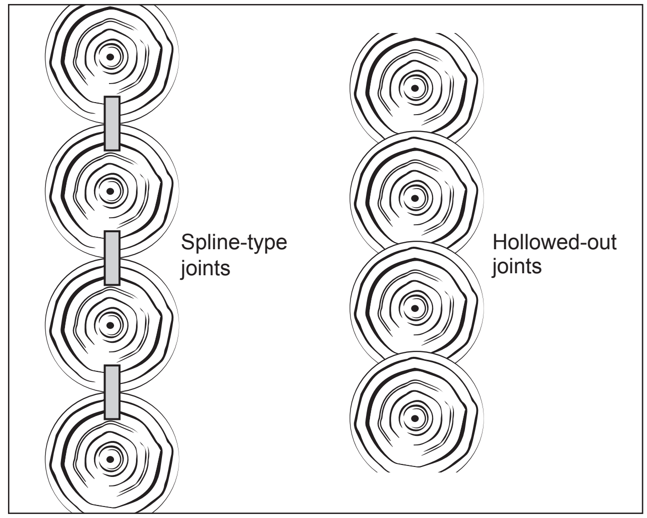

Figure 11. Various joint techniques are used to help prevent water from settling between logs.

them are filled solid. If solid foundation walls are preferred to piers, generous openings should be provided at frequent intervals to allow good air circulation. When solid foundation walls are used on damp sites, a soil cover of heavy-grade roll roofing or polyethylene sheeting will help to prevent moisture evaporation from the soil and thereby decrease the decay hazard. If the building is used throughout the year in the colder parts of the United States, good ventilation will cause cold floors in the winter. This may be prevented by insulating the floor under the cabin and boarding up the openings in cold weather. Openings should be uncovered during the rest of the year.

Termites—In some parts of the country, termites cause considerable trouble with log cabins. Masonry or similar foundations, 450 to 600 mm (18 to 24 in.) high and free from cracks, will offer only limited protection from termite attack. When bricks are used, the joints should be filled with a cement mortar dense enough that termites cannot tunnel through it. Hollow block foundations should be capped with a layer of reinforced concrete at least 100 mm (4 in.) thick. If termites are very active, they may build mud tunnels over the treated wood or masonry foundation to enter the untreated wood above. A common method of protection is the application of a soil poison (an EPA-registered pesticide) around the foundation.

Walls

In putting up the walls of a log cabin and in framing the window and door openings, care should be taken to avoid forming crevices where water can accumulate and soak into the wood. Fittings should be made as tight as practicable, and they should be supplemented by caulking at places most likely to take up water. Storm water does little harm to the cabin if it can run off quickly. However, if the water is caught in joints, crevices, or checks, it will soak into the wood and the wood will dry out very slowly. Decay may easily start in these damp areas. In constructing the cabin, major cracks or checks in the logs should be placed pointing down so they will not entrap water. The joints between logs are of special concern because they are possible water-trapping zones. It is important, therefore, that they be suitably chinked. Tight joints may also be obtained by cutting deep grooves accurately in the top and bottom surfaces of each log and inserting a spline or by hollowing out the underside of each log carefully to fit the log beneath (Fig. 11).

Roof

A wide roof overhang is one of the most effective features that can be built into a log cabin. It helps combat decay in walls and foundations and around doors and windows. Good projection of eaves and slope of the roof will divert much rainwater that would otherwise flow over the walls. The greater the pitch of the roof, the faster the rainwater moves down, projecting the water farther away from the house. Recommended projection is not less than 450 mm (18 in.) but preferably 600 mm (24 in.) for a one-story house and not less than 600 mm (24 in.) but preferably 915 mm (36 in.) for a two-story house. The wider overhangs are particularly desirable in areas of high rainfall. Roof-supporting members of logs or of sawn lumber should not project beyond the eaves. If they do, they will easily become wetted and will be susceptible to decay (Fig. 12).

Preservative Treatment

If a log cabin is properly designed, constructed, and maintained, it should give satisfactory service with a minimum of preservative treatment. This is especially true in the colder and drier parts of the country. In some cases, however, log cabins may benefit from preservative treatment. The term “wood preservative” is applied to a broad range of products, and there is sometimes confusion

Figure 12. Support members extending beyond the roof overhang will eventually become wet enough to decay.

or misunderstanding about the types of products being described. In this report, the term preservative is used for treatments that contain a fungicide or insecticide and whose primary purpose is to protect wood from decay fungi and insect attack. In contrast, finishes are usually applied primarily to enhance the appearance of the wood and to protect it from moisture, mold, and mildew. This report focuses on preservatives but provides additional sources of information on finishes at the end.

Wood preservatives are generally chemicals applied as solids, liquids, or gases that are either toxic to wood-degrading organisms or cause some change in wood properties that renders the wood less vulnerable to degradation. Most wood preservatives contain pesticide ingredients and therefore must have registration with the EPA. However, some preservatives, such as those based on water repellents, work on the basis of moisture exclusion and do not contain pesticides. Preservatives that do contain pesticides are required to provide information on the type and concentration of pesticide on the label. It is important that wood preservatives be used in accordance with label instructions.

Types of Preservatives

Although many preservatives effectively prevent decay and insect attack, their suitability for various applications may depend on other characteristics such as odor, color, type of solvent, and resistance to weathering. For example, the interior surface of the logs become part of the indoor living environment, and this must be considered when selecting a preservative. Solvent-based preservatives may have a strong odor, which limits their use to only exterior applications.

Borates have the advantage of being able to diffuse into moist wood, but their solubility becomes a disadvantage when wood is fully exposed to precipitation or liquid water. Many waterborne preservatives have little long-term odor, but those containing copper impart a greenish blue or brown color. The appropriate chemical for treatment and the appropriate treatment procedure may also depend on the design of the structure, geographic location, drainage, and wood species used.

Wood preservatives are also characterized by their method of application; pressure or nonpressure. Pressure-treatment preservatives represent the largest volume of wood preservatives in commercial use, but some are not readily available for nonpressure application. Nonpressure preservatives include some of the same liquid preservatives used in pressure treatment as well as additional liquids, solids, pastes, and gels. They may be applied to log cabin members before, during, or after construction. The objective of all these treatments is to distribute preservative into areas of a structure that are vulnerable to moisture accumulation and/or not protected by the original pressure treatment. A major limitation of in-place treatments is that they cannot be forced deep into the wood under pressure as is done in pressure-treatment processes. However, they can be applied into the center of large members via treatment holes.

Methods of Application

Pressure Treatment

In this process, bundles of wood products are placed into large pressure cylinders and combinations of vacuum, pressure, and sometimes heat are used to force the preservative deep into the wood. Pressure-treated wood has much deeper and more uniform preservative penetration than does wood treated in other manners. Lower logs or logs exposed to moisture may benefit from pressure treatment. A soaking procedure with a preservative solution on the lowest two or three logs may be satisfactory, although pressure treatment may be preferable depending on the height of the foundation and extent of roof overhang. Currently, pressure treatment of logs used in cabin construction is typically limited to borate preservatives, and this whole-log pressure treatment may not have been reviewed for other types of preservatives. However, borates are leachable, and many log structures include porches, railings, and support posts external to the main shell that are less protected by the roof overhang. These components are more vulnerable to decay and insect attack, and pressure treatment with a nonleachable preservative is warranted (Fig. 13). The Appendix discusses the characteristics of pressure-treatment preservatives that may be available for these applications.

Diffusion Treatment

In diffusion treatments, water-soluble preservatives move from the wood surface and through the water present in the logs. Diffusion treatments are most effective after the

Figure 13. External components such as deck railings that are not protected by the roof overhang should be pressure-treated with a long-lasting wood preservative.

logs are partially seasoned and drying checks have begun to form. If the logs are too wet, they may not absorb sufficient preservative and drying checks that form later may not be protected. If the logs are too dry (below 15% to 20% moisture content), there is not enough moisture for the preservative to move through the wood. For diffusion treatment, the logs may be brushed, sprayed, or immersed in the preservative solution and then stacked to dry. Immersion treatment is preferred because it allows the logs to absorb more preservative. After treatment, the logs should be protected from precipitation to avoid having the preservative washed from the log surface. Boron formulations such as disodium octaborate tetrahydrate (DOT) are used for diffusion treatments.

Soaking or Steeping

Substantial preservative penetration can be achieved in some wood species by immersing logs in preservative solution for extended periods (days or even weeks). The logs should be as dry as practical prior to soaking to increase solution uptake and to encourage check formation prior to treatment.

Brief Soaks or Dips

Because precipitation is readily absorbed by the end-grain of logs and because the ends of logs often have less protection from the roof overhang, log ends are common areas of decay development. Soaking or dipping the outside ends of logs in a water-repellent preservative can help to provide protection to these vulnerable areas.

Treatment of Cut Surfaces

Log cabin components treated by any of the methods described may need to be cut and trimmed to fit into the structure or to form millwork such as window sills. Such cut surfaces will expose untreated wood, which will provide entrance for decay fungi. All cut surfaces that will be exposed to the weather must be treated on-site by brushing or dipping in a preservative solution.

Exterior Finishes

Finishes can help maintain the appearance of log cabins, and in some cases, water-repellent finishes are helpful in prolonging the efficacy of diffusible preservative treatments such as borates. Penetrating finishes have the very distinct advantage of not failing by blistering or peeling, as does varnish or paint, and are therefore very easily maintained or refinished. They may incorporate a fungicide and inhibit the growth of fungus (mildew), which is the primary cause of graying of wood. Penetrating pigmented stains change the color of wood and are less natural in appearance than the preservative finishes but typically need less frequent reapplication than clear finishes. Film-forming exterior varnishes are not recommended because of their short life when fully exposed to the direct sun and because of the difficulty in refinishing. Maintenance of an exterior finish, even without a preservative, will also lessen the likelihood of powderpost beetle infestation. Sources of additional information on selecting and applying finishes are provided at the end of this report.

Protecting and Maintaining Existing Homes to Prevent Decay and Insect Damage

The key to preventing decay is to minimize moisture exposure with good building design and maintenance of water drainage systems. Application of wood preservatives is generally less effective than controlling exposure to moisture. Building design may be difficult to alter in an existing structure, but eave troughs and downspouts can be added and should be monitored for leaks or similar problems. Plugged eave troughs and downspouts can channel large amounts of water directly into a structure. Drainage around the home should also be maintained, and automatic sprinklers should be adjusted so that they do not spray the cabin walls. Dense vegetation against cabin walls can slow drying after rain events, and firewood or woody debris near the cabin can trap moisture and serve as a source of insect attack (Fig. 14).

Log homes should be inspected periodically for signs of decay or moisture. The critical areas are the lower portions of windows and doors, joints between boards, exposed end-grain, and the lowest two or three logs (ground splash zone). If conditions that can lead to moisture intrusion are suspected and cannot be remedied, application of wood preservatives can help to prevent and stop the progression of decay. Wood preservatives do not repair or strengthen damaged wood and are of little value in wood that is already badly decayed.

Figure 14. Firewood or other wood debris piled against cabin walls increases the likelihood of decay and insect attack.

When preservatives are applied, it is important to determine if they are likely to reach the parts of the logs in which decay is likely to occur. With the exception of logs that are in direct contact with the soil or masonry, most decay in log homes occurs inside the logs where moisture has become trapped. Finishes that contain a water repellent and a preservative help to protect the wood surface and can help to prevent decay by slowing water absorption into the ends of logs. However, these finishes do little to prevent or control decay that can become established inside the logs unless they contain a diffusible preservative (boron) that can move more deeply into the wood. Treating the interior of logs generally requires drilling holes into the wood and applying preservatives to the holes. Combinations of both exterior and interior treatments may be needed to prevent decay in log homes.

Internal Treatments

Diffusible internal treatments generally do not move great distances through the wood; therefore, their location and spacing is important. Although they could be used to treat the length of logs, they may be better suited for protection of specific vulnerable areas where moisture is suspected. Typically, wood moisture contents of at least 20% are thought to be necessary for boron diffusion to occur. The most common diffusible preservatives are based on the use of some form of boron, although some formulations also contain copper. The concentration of actives is usually expressed as percentage DOT, although concentration is sometimes reported as percentage boric acid equivalents (BAE) or boric oxide (B_2O_3) equivalents. Borate treatments are available in a range of forms, including pastes, gels, thickened glycol solutions, and solid rods (Fig. 15).

Figure 15. Examples of boron rods that can be placed into holes in cabin logs.

An advantage of boron rods is that they can be applied into upward sloping holes (such as near log ends) to minimize visibility. Boron rods applied to aboveground timbers generally need to be placed no more than 75 to 150 mm (3 to 6 in.) apart across the grain and 150 to 300 mm (6 to 12 in.) apart along the grain. Liquid borates may be applied in a similar manner to rods, except that their use is generally limited to holes oriented downward. The concentration of boron in the liquid treatments is not as great as that in the rods, but the potential for diffusion is greater at lower wood moisture contents. The liquid borates also provide protection more rapidly than the rods, but the duration of protection is more limited. Liquid borates also allow more flexibility in the size of the treatment hole, and in some cases, it may be desirable to drill many small holes instead of a few large holes. The liquids can be readily applied to smaller treatment holes with squeeze or squirt bottles. Alternatively, both rods and liquid borate can be added to the same hole. This approach can provide both an immediate boost of liquid boron as well as the longer-term slow release from the rod, but it does require drilling a larger treatment hole than would otherwise be necessary. Liquid borates have also been injected into small treatment holes in horizontal timbers using a low-pressure sprayer with the nozzle pressed tightly against the treatment hole to prevent leakage. Under these conditions, a diamond pattern has been recommended, with 300 mm (12 in.) between holes along the grain and 100 to 150 mm (4 to 6 in.) across the grain.

Gel and paste products may also be applied as diffusible internal treatments in a manner similar to liquids and rods. Depending on the properties of the individual product, they may be applied to holes that are horizontal or even oriented upward. Application to treatment holes is typically accomplished with use of a caulking tube and caulking gun. In theory, these formulations provide somewhat of a compromise between the liquid formulations and the solid rods, with slower distribution than the liquids but more rapid distribution than the rods. However, there is little published research comparing the penetration or longevity of these formulations with that of the other formulations.

External Treatments

Preservatives brushed or sprayed onto the wood surface generally do not penetrate more than a few millimeters into the wood, although greater movement is achieved when they are applied to the end-grain (the ends of logs). Copper naphthenate and oxine copper are examples of preservatives available for surface treatment. However, copper naphthenate has a strong odor, which can be a concern when applied to large surface areas. In most cases, it may be more practical to limit application of these preservatives to specific problems areas. Finishes containing preservatives are another type of external treatment, although they typically contain relatively low levels of preservative.

Diffusible borate solution can also be applied to the wood surface and can achieve deep penetration into logs under some conditions. The greatest benefit is achieved by flooding checks, cracks, and other openings, potentially allowing diffusion into decay-prone areas where water precipitation has become trapped within the wood. Because of this, it is often desirable to apply the solution after a prolonged dry interval, when checking in the wood is at a maximum. Borates applied to the wood surface can be rapidly depleted if the wood is exposed to precipitation or other forms of liquid water. Borate depletion from exposed members can be slowed (but not completely prevented) with application of a water-repellent finish after the borate treatment has dried. This may necessitate tarping or otherwise protecting the cabin walls until they have dried sufficiently to allow application of the water-repellent finish. Use of preservative-based water repellent can provide further protection against mold and mildew on the wood surface. This process can be repeated after the wood surface loses its water repellency.

Maintenance of an exterior finish is an effective way of preventing initial powderpost beetle attack. After an infestation occurs, surface sprays with insecticides can be helpful in limiting damage. Although larvae inside the wood will not be affected, they will be killed when exiting the wood surface, and future attack can be prevented. Liquid borates can be used for this purpose, but in exposed areas, precipitation may flush borate from the wood surface soon after application. Other products containing synthetic pyrethroids (permethrin, cypermethrin, and cyfluthrin) are somewhat more resistant to leaching but should still be applied during the time when beetles are emerging (late winter to spring in most parts of the United States) for greatest efficacy. These products must be applied in accordance with EPA labeling, and professional application may be necessary.

Summary

Wood is a biodegradable material, which means that log cabins can potentially be damaged by fungi and insects. However, the risk of damage can be greatly decreased by keeping the moisture content of the wood below 20%. Control of moisture through design, construction practices, and maintenance is by far the most effective way to limit decay and insect attack in log cabins. A foundation system that keeps the wood well above the ground and a roof overhang that limits wetting from wind-blown precipitation are especially important design considerations. Postconstruction maintenance of the exterior finish, roof covering, gutters, and down spouts are also critical. If moisture problems and subsequent deterioration are caused by a lack of maintenance, they should be addressed by updating the maintenance instead of applying wood preservatives, unless the maintenance issues cannot be addressed. Application of wood preservatives may be of benefit if wetting is expected to occur over the long term. The type of preservative and treatment method depends on the requirements of the specific application. Pressure treatment provides the most thorough protection but is generally limited to borate preservative for log cabin logs. External components not protected by the roof overhang are especially vulnerable and in most cases will need to be pressure-treated with nonleachable preservatives to provide long-term protection. Nonpressure preservative application can occur before, during, or after construction. Partially dried whole logs may be immersed in borate solutions for diffusion treatment. Borate spray applications to moist wood can also result in substantial boron penetration. Brush- or spray-applied nondiffusible liquids should not be expected to penetrate more than a few millimeters across the grain of the wood and are most efficiently used to flood checks, exposed end-grain, bolt holes, etc. They may move several centimeters parallel to the grain of the wood if the member is allowed to soak in the solution. Surface treatments with diffusible components will be washed away by precipitation if used in exposed members. However, their loss can be slowed if a water-repellent finish is applied after the diffusible treatment has dried. Internal treatments are liquids, solids, or pastes applied to the interior of larger members where trapped moisture is thought to be a current or future concern. Diffusible internal treatments move through moisture in the wood. They may be best suited for focusing on specific problem areas such as near exposed end-grain, connections, or fasteners.

Sources of Additional Information

Log Cabin Protection and Maintenance

Bomberger, B.D. 1991. The preservation and repair of historic log buildings. Preservation Brief #26. Washington, DC: National Park Service. 16 p.

Davis, J. 2004. Log home care and maintenance: Everything you need to know to buy, maintain, and enjoy your log home. Guilford, CT: Globe Pequot Press. 165 p.

Forintek. 2003. Protecting and finishing log buildings. A wood protection fact sheet. September 2003. Quebec, Canada: Forintek Canada Corp.

Renfroe, J. 1995. The log home owners manual: a guide to protecting and restoring exterior wood. Kirkland, WA: Wood Care Systems. 135 p.

Schroeder, G. 2012. The log home maintenance guide: a field guide for identifying, preventing, and solving problems. Woodstock, VT: Countryman Press. 184 p.

Taylor, A.M.; Quarles, S.L.; Vail, K.M. 2007. Wood protection for log home owners. Extension publication PB1767-1M-5/07. Knoxville: University of Tennessee. 24 p.

Log Cabin Construction

Chambers, R.W. 2003. Log construction manual: the ultimate guide to building hand-crafted log homes. River Falls, WI: Deep Stream Press. 272 p.

ILBA. 2015. Effective practices and methods for hand-crafted log home construction. Montebello, Quebec: International Log Builders Association.

Mackie, A.B. 1997. Building with logs. 8th ed. Buffalo, NY: Firefly Press. 128 p.

Musick, M. 1999. Alaska log building construction guide: building energy-efficient, quality log structures in Alaska. Anchorage, AK: Alaska Housing Finance Corporation. 199 p.

Decay and Insect Attack

Arango, R.A.; Green, F.; Hintz, K.; Lebow, P.K.; Miller, R.B. 2006. Natural durability of tropical and native woods against termite damage by *Reticulitermes flavipes* (Kollar). International Biodeterioration & Biodegradation. 57(2006): 146-150.

Clausen, C.A. 2010. Biodeterioration of wood. In: Wood handbook: wood as an engineering material. Centennial ed. Gen. Tech. Rep. FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 14.1-14.16. Chapter 15.

Hansen, L.D.; Klotz, J.H. 2005. Carpenter ants of the United States and Canada. New York: Cornell Press. 224 p.

Moore, H.B. 1979. Wood inhabiting insects in houses: their identification, biology and control. Washington, DC: U.S. Department of Agriculture, Forest Service, and U.S. Department of Housing and Urban Development. 133 p.

Morris, P. 1998. Understanding biodeterioration of wood in structures. Booklet prepared with the financial assistance of BC Building Envelope Council. Quebec, Canada: Forintek Canada Corp.: 23 p.

Peterson, C.; Wagner, T.L.; Mulrooney, J.E.; Shelton, T.G. 2006. Subterranean termites: their prevention and control in buildings. Home and Garden Bulletin 64. Washington, DC: U.S. Department of Agriculture. 38 p. https://www.fs.usda.gov/treesearch/pubs/26674.

Scheffer, T.C.; Verrall, A.F. 1973. Principles for protecting wood buildings from decay. Res. Pap. FPL-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory.

Shupe, T.S.; Lebow, S.T.; Ring, D. 2008. Causes and control of wood decay, degradation and stain. Research & Extension Publication No. 2703. Baton Rouge, Louisiana: Louisiana State University Agricultural Center: 27 p.

St. George, R.A. 1973. Protecting log cabins, rustic work, and unseasoned wood from injurious insects in the Eastern United States. USDA Farmers Bull. 2104. Washington, DC: U.S. Department of Agriculture. https://archive.org/details/CAT31108227.

Williams, L.H.; Johnston, H.R. 1972. Controlling wood-destroying beetles in buildings and furniture. USDA Leaflet 558. Washington, DC: U.S. Department of Agriculture.

Wood Preservatives

De Groot, R.C.; Felton, C.C.; Crawford, D.M. 2000. Distribution of borates around point source injections in wood members exposed outside. Res. Note FPL-RN-0275. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 5 p.

Lebow, S.T. 2010. Wood preservation. In: Wood handbook: wood as an engineering material. Centennial ed. Gen. Tech. Rep. FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 15.1-15.28. Chapter 15.

Lebow, S.T.; Anthony, R.W. 2013. Guide for use of wood preservatives in historic structures. Gen. Tech. Rep. FPL-GTR-217. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 59 p.

Sheetz, R.; Fisher, C. 1993. Protecting woodwork against decay using borate preservative. Electronic Document. Preservation Technotes, Exterior Woodwork Number 4. Washington, DC: Preservation Assistance Division, National Park Service, U.S. Department of the Interior. http://www2.cr.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Exterior04.pdf.

Finishes

Knaebe, M. 2013. Alternatives to the Madison formula, the original do-it-yourself semitransparent stain. FinishLine. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 2 p.

Knaebe, M. 2013. Finishes for wood decks. FinishLine. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 2 p.

Williams, S.R. 2010. Finishing of wood. In: Wood handbook: wood as an engineering material. Centennial ed. Gen. Tech. Rep. FPL-GTR-190. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory: 16.1-16.39. Chapter 16.

Williams, R.S.; Feist, W.C. 1999. Selection and application of exterior stains for wood. Gen. Tech. Rep. FPL-GTR-106. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 9 p.

Williams, R.S.; Feist, W.C. 1999. Water repellent and water repellent preservative finishes for wood. Gen. Tech. Rep. FPL-GTR-109. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 12 p.

Codes and Standards

AWPA. 2017. U1-17. User specification for treated wood. In: Book of standards. Birmingham, AL: American Wood Protection Association.

ICC. 2012. ICC 400-2012: Standard on the design and construction of log structures. Falls Church, VA: International Codes Council. http://shop.iccsafe.org/icc-400-2012-standard-on-the-design-and-construction-of-log-structures-2.html.

Appendix—Description of Pressure-Treatment Preservatives

The preservatives listed here are appropriate for treatment of external components of log structures, such as support posts and railings, but are not necessarily recommended for treatment of logs that extend into the interior of the structure. Refer to the standards of the American Wood Protection Association for the most current preservatives and treatment levels.

Treatment of Whole Logs or Other Applications Protected from Liquid Water

Borates (SBX): Borate compounds are the most commonly used unfixed water-based preservatives. They include formulations prepared from sodium tetraborate, sodium pentaborate, and boric acid, but the most common form is disodium octaborate tetrahydrate (DOT). DOT has higher water solubility than many other forms of borate, which allows the use of higher solution concentrations and increases the mobility of the borate through the wood. With the use of heated solutions, extended pressure periods, and diffusion periods after treatment, DOT is able to penetrate relatively refractory species such as spruce.

Applications Aboveground and Not Part of the Cabin Interior

The preservatives listed in this section generally may not provide long-term protection for wood used in direct contact with soil or standing water but are effective in preventing attack in wood exposed aboveground, even if it is directly exposed to rainfall. Most exterior portions of a log home would fall into this category. A typical example of this type of application is decking.

Copper HDO: Copper HDO (CX-A) is an amine copper water-based preservative that has been used in Europe and was recently standardized in the United States. The active ingredients are copper oxide, boric acid, and copper-HDO (Bis-(N-cyclohexyldiazeniumdioxy copper)). The appearance and handling characteristics of wood treated with copper HDO are similar to the other amine copper-based treatments. It is also referred to as copper xyligen. Currently, copper HDO is only standardized for applications that are not in direct contact with soil or water. For more information, see http://www2.basf.us/woodpreservatives/index.htm.

EL2: EL2 is a waterborne preservative composed of the fungicide 4,5-dichloro-2-N-octyl-4-isothiazolin-3-one (DCOI), the insecticide imidacloprid, and a moisture control stabilizer (MCS). The ratio of actives is 98% DCOI and 2% imidacloprid, but the MCS is also considered to be a necessary component to ensure preservative efficacy. EL2 is currently listed in the American Wood Protection Association (AWPA) standards for aboveground applications only. The treatment is essentially colorless, and the treated wood has little odor.

Oxine Copper (Copper-8-quinolinolate): Oxine copper is an organometallic preservative comprised of 10% copper-8-quinolinolate and 10% nickel-2-ethylhexoate. It is characterized by its low mammalian toxicity and is permitted by the U.S. Food and Drug Administration for treatment of wood used in direct contact with food (for example, pallets). The treated wood has a greenish brown color and little or no odor. It can be dissolved in a range of hydrocarbon solvents, but a light solvent similar to mineral spirits is most suitable for the exterior components of log structures and is sometimes used for treatment of the aboveground portions of wooden bridges and deck railings.

Propiconazole-Tebuconazole-Imidacloprid: Propiconazole-tebuconazole-imidacloprid (PTI) is a waterborne preservative solution composed of two fungicides (propiconazole and tebuconazole) and the insecticide imidacloprid. PTI is currently listed in AWPA standards for aboveground applications only. The efficacy of PTI is enhanced by the incorporation of a water-repellent stabilizer in the treatment solutions, and lower retentions are allowed with the stabilizer. The treatment is essentially colorless and has little odor.

IPBC/Permethrin: A light solvent-based formulation containing IPBC as the fungicide and with the addition of permethrin as an insecticide is currently in commercial use and was recently standardized for pressure treatment by the AWPA. The ratio of IPBC to permethrin in the treatment solution is 2:1. This formulation has been listed by AWPA for treatment of glue-laminated timbers used in a manner in which they are exposed to weather but coated or installed in a way that prevents prolonged wetting (AWPA Use Category 3A). The treatment is clear, and the treated wood has little noticeable odor once the solvent has evaporated.

Applications in Contact with the Ground or Aboveground with High Decay Hazard

These preservatives exhibit sufficient toxicity and leach resistance to protect wood in contact with the ground, fresh water, or in other high moisture, high deterioration hazard applications. Preservatives listed in this section are also effective in preventing decay aboveground.

Alkaline Copper Quat: Alkaline copper quat (ACQ) contains copper and a quaternary ammonium (quat) compound. Multiple variations of ACQ have been standardized. ACQ-A has a ratio of 50% copper oxide/50% quat, whereas ACQ types B, C, and D have 67.7% copper oxide and 33% quat. ACQ type B is an ammoniacal copper formulation, ACQ type D is an amine copper formulation, and ACQ type C is a combined ammoniacal–amine formulation with a slightly different quat compound. The multiple formulations of ACQ allow some flexibility in achieving compatibility with a specific wood species and application. When ammonia is used as the carrier, ACQ has improved ability to penetrate into difficult-to-treat wood species. However, if the wood species is readily treatable, such as southern pine sapwood, an amine carrier can be used to provide a more uniform surface appearance.

Copper Azole: Copper azole formulations combine copper with tebuconazole and propiconazole. The copper is either solubilized in ethanolamine (CA-B and CA-C) or ground to very small particles (micronized) and dispersed in the preservative (MCA and MCA-C). The micronized formulations have become the most commonly used preservatives for treatment of the lumber used in residential decking. However, the solubilized formulations may have some advantages in treating wood species that are resistant to preservative treatment. Copper azole (CA-C) is very similar to CA-B, but one-half of the tebuconazole is replaced with propiconazole. The appearance of copper-azole-treated wood is similar to that of wood treated with other waterborne copper formulations, although wood treated with the micronized formulations is generally lighter in color.

KDS: KDS and KDS type B (KDS-B) utilize copper and polymeric betaine as primary active ingredients. The KDS formulation also contains boron and has an actives composition of 47% copper oxide, 23% polymeric betaine, and 30% boric acid. KDS-B does not contain boron and has an actives composition of 68% copper oxide and 32% polymeric betaine. KDS is listed for treatment of commodities used aboveground and for general use in contact with soil. The listing includes treatment of common pine species as well as Douglas-fir and western hemlock. The appearance of KDS-treated wood is similar to that of wood treated with other alkaline copper formulations (light green–brown), but KDS may also be formulated with incorporated pigments to produce other shades. It has some odor initially after treatment, but this odor dissipates as the wood dries.