Practice Points

NUMBER 14

Wood Preservatives and Pressure-treated Wood: Considerations for Historic-preservation Projects

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Introduction

Wood, an abundant resource throughout most of the world, has been used as a building material for thousands of years. Many historic buildings have been built primarily of wood, and masonry and stone buildings generally have wood elements, both structural and architectural. As a biological material, wood is both remarkably complex and yet quite durable if well constructed and maintained. This Practice Point provides guidance on options for extending the service life of wood used in historic structures. It is assumed that the reader is familiar with basic wood nomenclature and anatomy, so those topics are not addressed here.

Preserving historic wood fabric is critical to historic-preservation projects. Biodeterioration due to fungi and insect attack can be minimized through the design of repairs, construction practices, moisture management, maintenance, and, if necessary, the use of wood preservatives. Moisture is a primary factor in the onset of biodeterioration; if exposure to high levels of moisture cannot be prevented through moisture management and maintenance, the application of remedial wood preservatives or the use of pressure-treated wood may be warranted. The U.S. Secretary of the Interior's Standards for the Treatment of Historic Properties emphasize the importance of retaining the historic character of a property, including distinctive materials, features, and spatial relationships. Existing conditions and the factors that caused the deterioration should be carefully evaluated to determine the appropriate level of intervention needed to extend the service life of the wood elements.

There are two general paths to extending the life of wood in historic structures: non-chemical means (through moisture management and maintenance) and chemical means (through the use of wood preservatives). Wood preservatives are generally grouped into two categories: preservatives used for in-situ, remedial treatment of existing elements and preservatives used for the pressure treatment of new wood used for the replacement of deteriorated elements.

Fig. 1.
Advanced decay of a timber girder and bearing plate. The deterioration was caused by years of exposure to roof leaks and resulted in the bearing plate being crushed. Photograph by Ronald W. Anthony.

In-situ treatments are typically applied to the wood surface and cannot be forced deeply into the wood. However, they can be inserted into the center of large wooden elements via treatment holes, which are then plugged with a dowel to allow for periodic re-applications. These preservatives are available as liquids, rods, or pastes.

Pressure-treated wood, on the other hand, can provide for much deeper and more uniform preservative penetration, depending on the wood species and treatment process. Specifying the correct pressure-treated wood depends on its specific use, such as for interior construction or ground contact. Pressure-treated wood may be considered as a replacement option when either original or developed conditions would result in deterioration of untreated replacement wood, as in below-ground timbers, the spread of termites, or difficult future maintenance due to remoteness or lack of access. To help guide selection of pressure-treated wood, the American Wood Protection Association (AWPA) developed Use Category System (UCS) standards.

Other characteristics of preservatives, such as color, odor, surface oiliness, and potential corrosion of metals, may also be relevant. An overview of the selection of in-situ, remedial treatments and the selection and specification of pressure-treated wood is presented below.

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Fig. 2.
Damage to untreated wood caused by termites after only six months of soil contact in Louisiana. Courtesy of Stan T. Lebow and the U.S. Forest Products Laboratory.

Agents of Wood Degradation

There are many causes of wood degradation, and multiple types of degradation can interact.[1] Decay fungi and insects are the primary agents of biodeterioration of wood in historic structures (Figs. 1 and 2). Appropriately selected and applied wood preservatives can be highly effective in preventing or stopping some types of biodeterioration, but they may be less effective or unnecessary for protection against other degradation mechanisms.[2] Accordingly, some understanding of the causes of wood degradation is necessary when considering treatment options.

Decay fungi and insects require a food source (nondurable wood), oxygen, favorable temperature, and adequate moisture content in the wood for either fungal spores to germinate or insects to penetrate the wood. Wood species that are resistant to biodeterioration are considered naturally durable, due to the build-up of chemical extractives in the heartwood that are toxic to decay fungi and/or insect attacks. The heartwood of redwood, cypress, chestnut, teak, and most cedars are examples of naturally durable wood species. Under the repair or replacement philosophy of using in-kind materials, use of naturally durable wood does not generally comply with the Secretary of the Interior's Standards unless the nondurable species was used in the original construction.

The role of moisture in biodeterioration of wood and especially in fungal decay cannot be over-emphasized. Decay fungi require a moisture content of at least 20 percent to sustain any growth, and higher moisture contents (approximately 30 percent or greater) are required for initial spore germination. Moisture also plays a role in damage by insects, although some insects can attack wood at lower moisture contents than those required by fungus.

Role of Construction and Maintenance in Biodeterioration

Historic structures vary greatly in design, condition, and exposure, but some generalizations can be applied to problem areas in most structures. Significant decay can occur in any untreated portion of a structure where wood moisture content is above 20 percent for sustained periods. Sufficient oxygen, favorable temperature, and elevated moisture are almost always present in wood elements in contact with the ground or with the waterline area of members in water. However, in all climates trapped moisture can lead to decay in wood.

In general, larger wooden members are most prone to developing decay because water becomes trapped inside the wood during precipitation events and because the wood is slow to dry. Liquid water is absorbed rapidly in the end-grain of wood during rain, and subsequent drying can be slowed if air movement is limited. Unfortunately, these conditions are common where wood members are joined by fasteners or located at interfaces with less permeable materials, such as at beam pockets in masonry walls. Decay conditions can also develop in locations where consolidants, epoxies, and impermeable finishes have been used.

Because structural members of most historic structures were usually not treated with wood preservatives before installation, they can be vulnerable to biodeterioration in areas with sustained exposure to moisture. However, the open construction typical of historic structures (where little, if any, effort was made to restrict the flow of air and water vapor), in combination with the likely use of old-growth timber containing substantial heartwood, generally makes the structural framing in historic structures fairly resistant to deterioration. Open construction makes it possible for wood to dry quickly if it gets wet and thus reduces the likelihood of biodeterioration; however, sometimes moisture becomes trapped.

Modern alterations to open constructions, such as the installation of insulation to provide energy efficiency, can increase the likelihood of decay by reducing air circulation (and therefore moisture evaporation) around wood members. Historic structures are likely to have several problem areas, including the following:

- Wood in contact with the ground (Fig. 3)
- Crawl spaces and basements
- Sill beams, wall plates, floor joists, and girders, particularly those in contact with masonry or those that rest on exterior walls
- Exterior millwork, including doors and windows (Fig.4)
- Material interfaces, such as wood with masonry
- Roof penetrations, such as those around chimneys and vents
- Areas of the structure that have been altered, including installation of insulation that reduces air circulation.

The following indicators of potential biodeterioration may be visible on the wood or apparent in the vicinity:

Fig. 3, top left. *Deterioration of wood caused by ground contact. Photograph by Ronald W. Anthony.*

Fig. 4, bottom left. *Deterioration of exterior millwork caused by trapped moisture. Photograph by Ronald W. Anthony.*

Fig. 5, top right. *Moisture stains and visible decay on roof sheathing as indicators of long-term roof leaks. Photograph by Ronald W. Anthony.*

Fig. 6, bottom right. *Vegetation in close proximity to exterior wood elements can lead to decay by producing an elevated moisture environment. Photograph by Ronald W. Anthony.*

- Wood with visible decay
- Wood that exhibits moisture stains (Fig. 5)
- Areas of poor drainage around the structure
- Vegetation against or adjacent to wood elements (Fig. 6).

Non-chemical Approaches to Preventing Deterioration

Non-chemical approaches to extending the service life of historic wood fabric involve changing the exposure environment so that conditions are less favorable for deterioration. These approaches are often the most effective and long-lasting means of wood preservation and should be considered before the application of chemical preservatives. Where compatible with historic-preservation philosophy, standards, and goals, taking measures to protect wood from wetting is generally the most effective approach.

In many structures, the roof is the primary (and sometimes only) defense against moisture intrusion, and thus the integrity of the roof system is critical. Although some roof leaks may be obvious, smaller leaks may go unnoticed for years. Sources of moisture from openings in the roof or siding can occur almost anywhere in a structure and are not always easy to detect. Water stains or general discoloration may be visible, but they may not be immediately adjacent to the place where water enters the structure. In other cases the roof may be intact, but the overhang may not provide adequate protection for either original or replacement structural members. Water running off the roof can also be a source of moisture for lower portions of the structure. Lack of flashing or inadequate flashing is another source of moisture intrusion, especially in structures with minimal roof overhang.

It is also important to assess other possible sources of moisture intrusion. Rain gutters, downspouts, and interior plumbing should be checked for leaks, and their locations noted. Spigots that are located near wood elements, such as cladding or sill plates, should be monitored when in use to identify leaks (such as from a loose hose connection) that could lead to deterioration of structural elements. Overspray from lawn sprinklers should also be assessed, and corrections to the direction and intensity of flow should be made to prevent water saturation of the ground near structural wood members and to prevent other wood elements from getting wet. Leaky plumbing fixtures and pipe connections should also be repaired.

Soil and organic matter in contact with nondurable wood elements can provide ideal temperature and moisture conditions for colonization by fungi and termites. Many vernacular structures were built with wood in direct contact with soil. Other structures may be subject to these conditions as they developed over time through settlement or debris buildup.

Poor drainage around a structure can be mitigated by re-grading the soil or by installing a French drain. Because this work requires disruption and modification of the ground around the perimeter of a historic structure, it may require State Historic Preservation Officer approval and monitoring to document any archaeological material uncovered during excavation. This type of moisture mitigation is quite common for historic structures and can be effective if done correctly. This step should be considered for log buildings and vernacular structures with loose stone or no foundations.

Vegetation can also exacerbate moisture problems. Shade prevents wood from drying after rain and can lead to growth of moss and lichens, which further trap water. Vines and brush growing close to structures increase humidity, slow drying, and in some cases damage roofing or siding. Dropped leaves from dense clusters of vegetation release nitrogen as they decompose, attracting decay fungi. Increased vegetative cover also attracts insects and rodents that can damage wood. Preventing the growth of vegetation or removing it can increase the durability of the structure; however, consideration should be given to historic landscape features.

What Are Wood Preservatives?

When considered in their broadest context, wood preservatives are any substance or material that extends the service life of the wood. Wood preservatives are generally chemicals that are either toxic to wood-decay fungi and/or insects or cause some change in the wood that renders it less vulnerable to deterioration. These chemical preservatives are applied as solids, liquids, or gases. Because most wood preservatives contain pesticides, they must be registered with the U.S. Environmental Protection Agency (EPA). Preservatives in pressure-treated wood undergo a rigorous evaluation before being approved. In contrast, non-pressure preservatives may undergo relatively little review, other than the EPA evaluation of pesticide toxicity. Other wood preservatives, such as those containing water repellents alone, work on the basis of moisture exclusion and do not contain pesticides.

Manufacturers of preservatives that contain pesticides are required to provide information on the type and concentration of pesticide on the product label. Because the term “wood preservative” is applied to a broad range of products, there is often confusion or misunderstanding about the types of products being described, and some degree of specificity is needed.

Using Wood Preservatives and Pressure-treated Wood

Chemical-based wood preservatives and pressure-treated wood can be appealing methods to extend the service life of wood elements, especially when they are marketed as a cure-all for maintenance. Navigating the vast number of products and marketing claims to determine whether a treatment or product is suitable for historic structures can be a daunting task.

For most historic structures, the possible use of wood preservatives or pressure-treated wood arises when there are concerns about the long-term serviceability of the wood elements. If moisture problems and subsequent deterioration were caused by a lack of maintenance, there is generally no need to use preservatives or pressure-treated wood unless the maintenance problems cannot be addressed or the building is to be mothballed for a significant period of time. If the building has poor drainage conditions that cannot be mitigated or if construction or design flaws have led to deterioration, the application of preservatives and the use of pressure-treated wood for repairs may be warranted.

Like many products, wood preservatives have both risks and benefits, and they should be applied only when the benefits outweigh the possible negative consequences. There are problems associated with wood preservatives after their initial application. Treated elements and pressure-treated replacement materials will require regular inspection and maintenance; it is thus important to budget for long-term maintenance costs. It is also important to ensure the compatibility of new treatments with old treatments; in today’s volatile market, new products become available, and older ones are often discontinued. The American Wood Protection Association provides updates on the recommended use of wood preservatives as changes are made by the industry.

Additionally, preservative treatments and pressure-treated materials that contain pesticides and other regulated substances are subject to environmental regulations. As perceptions regarding pesticides change, some products currently available may be restricted. Consideration of future changes in environmental regulations is an essential step when deciding to apply wood preservatives or use pressure-treated wood.

Appropriate Use of Chemical Preservatives

There is no simple answer to the question of what constitutes appropriate application of preservatives, but some general guidelines do apply. The level of moisture is a key consideration. Although there are exceptions for termite and beetle attack, preservatives are not generally needed for wood that can be consistently protected from moisture. In contrast, wood that is moist (over 20 percent moisture content) for sustained periods is vulnerable to colonization by decay fungi and possibly other organisms. The potential for wetting varies with climate, site conditions, and member dimensions. Large members can trap and hold moisture for much longer periods than thinner members. Connections and fasteners that trap moisture also play an important role.

The condition of the wood can indicate the need for treatment. If a member is severely decayed and no action is taken to lessen exposure to moisture, then preservative treatment of the new replacement member may be worthwhile. In contrast, if a member has survived largely intact for decades, then preservative treatment may not be justified unless other factors are expected to contribute to additional risk of deterioration in the future. Some knowledge of local conditions and risks is helpful. For example, if a structure is in a location where Formosan subterranean termites are now present or nearby, there may be more justification for preservative treatment than in the past.

Even when conditions are favorable to deterioration, one must consider whether treatment options will be

Table 1. Application Characteristics for Internal Preservative Treatments (from Stan T. Lebow and Ronald W. Anthony, *Guide for Use of Wood Preservatives in Historic Structures*).

Type of Treatment	Target Retention in Wood (oz/ft^3 or kg/m^3)	Hole Dimensions		Spacing of Treatment Holes	
		Diameter	Length	Posts/Piles	Timbers
Boron Rod	1.7–5, as DOT	5/16–13/16 in. (8–21 mm)	2.5–13 in. (64–330 mm)	7–15 in. (178–381 mm) vertical, 90-120° intervals	6–14 in. (152–356 mm) along the grain, 3–6 in. (76–152 mm) across the grain
Boron/Copper Rod	1.7–5, as DOT	1/4–3/4 in. (6–19 mm)	1.5–5.5 in. (38–140 mm)	Vertical spacing not described. 120° intervals	6–14 in. (152–356 mm) along the grain
Sodium Fluoride Rod	1.4, as NaF	7/16–5/8 in. (11–16 mm)	3–5 in. (76–127 mm)	6 in. (152 mm) vertical, 90–120° intervals	Not described
Borate, Liquid Glycol	1.1, as DOT	Variable	Variable	7–15 in. (178–381 mm) vertical, 90–120° intervals	12–16 in. (305–406 mm) along the grain, 4–6 in. (102–152 mm) across the grain
CuNaph Liquid	0.96–2.4, as Cu	Variable	Variable	Not described	Not described
CuNaph/NaF Liquid	Not applicable	Variable	To cavity	Flood internal cavity	Not labeled for this use
Borate/Copper Hydroxide Liquid	Not applicable	0.5 in (13 mm)	To decay pocket	Flood decay pockets	Flood decay pockets
Borax/Copper Hydroxide Paste	3.7–14.7, as borax + $Cu(OH)_2$	Up to 1 in. (25 mm)	Variable	Not described	Not described
Borax/CuNaph Paste	Not provided	3/4 in. (19 mm)	Variable	24 in. (610 mm) vertical, 90° intervals	Not labeled for this use
Borax, Tebuconazole, Bifenthrin, Oxine Copper	Not provided	Variable	Variable	Not described	Not described
DOT Gel	1.1, as DOT	Variable	To center	12–24 in. (305–610 mm) vertical	12–24 in. (305–610 mm) along grain
Fumigants	Approx 0.01 for MITC-based, unknown for chloropicrin	3/4–7/8 in. (19–22 mm)	Through center, 12 in. (305 mm) minimum for MITC-Fume	6–12 in. (152–305 mm), 90–120° intervals	Maximum of 4 ft. (1.23 m) along grain

effective. Surface-applied treatments, for example, may not be effective in reaching decay-prone areas within large timbers; if the circumstances do not allow for replacing that member with a pressure-treated member or for drilling holes to apply internal treatments, then there may not be sufficient benefit to using preservatives. In this type of situation, other options, such as protecting the wood member from moisture or replacing it with naturally durable wood, may be preferable. If an in-place treatment for decay must be colorless and odorless and have very low toxicity, the current options are limited to borate formulations. However, because borate formulations are leachable, they provide long-term protection only in areas with limited exposure to liquid water. In some cases, it may be more practical to take no action and plan for periodic replacement of members as they deteriorate.

Remedial Preservatives for In-situ Applications

This category includes all types of remedial preservative applications other than pressure treatments. Examples include finishes (paints, stains, linseed oil, tung oil, pine tar, and water repellents, which are not discussed here since they are not regulated as wood preservatives); borate formulations applied by brushing onto the wood surface or being inserted into the wood as a solid rod; and fumigants, which disperse through the wood after being inserted in it. Except for finishes containing a low-level mildewcide, the objective of all of these treatments is to distribute the preservative into areas that are vulnerable to moisture accumulation or are not protected by the original preservative treatment. Remedial chemical treatments are often classified as diffusible preservatives, non-diffusible liquids and pastes, and fumigants.

Selecting the appropriate chemical composition, application dosage, and frequency of application can be quite confusing and may call for someone more experienced with preservatives (Table 1). In-situ treatments cannot be forced deep into the wood under pressure as in the pressure-treatment processes. However, sometimes preservatives can be injected into the center of large members via treatment holes. In-situ treatments are often available in several forms. For example, borate treatments can be applied as liquids, pastes, gels, and solid rods and tend to be among the most commonly used remedial treatments. Manufacturers' application recommendations should be followed. Common remedial preservatives types are summarized below.

Diffusible preservatives, or diffusible components of preservatives, move slowly through water within the wood structure. Because diffusible preservatives do not react with or "fix" in the wood, they are able to diffuse through the wood as long as sufficient moisture is present. The distance or extent of diffusion is a function of preservative concentration, wood moisture content, and grain direction. A concentration gradient is needed to drive diffusion, and concentration can become a limiting factor with surface-applied treatments because the volume of active ingredients applied to the surface is limited. The most commonly

Fig. 7.
Borate rods are available in a range of sizes including the 0.75 inch (19 mm) and 0.5 inch (13 mm) diameters shown here. Courtesy of Stan T. Lebow and the U.S. Forest Products Laboratory.

available diffusible preservatives contain some form of boron.

Diffusible preservatives are often applied to the interior of large, often structural elements where trapped moisture is thought to be a current or future concern. In some situations they can also be applied to smaller elements, such as dimensional lumber, where moisture is an ongoing concern. They are generally easy to apply but do not migrate as great a distance as fumigants and do not migrate through dry wood (typically with less than 20 percent moisture content). The diffusion distance in moist wood is approximately 2 to 4 inches (51 to 102 mm) across the grain and 6 to 12 inches (152 to 305 mm) along the grain. Diffusible treatments are best suited for focusing on specific problem areas, such as near exposed end-grain, connections, or fasteners. Rod-diffusible treatments provide a longer, slower release of chemicals, while liquid diffusible treatments provide a more rapid but less long-lasting dose of preservative (Fig. 7). Paste and gel internal treatments fall somewhere between rods and liquids in regard to speed of release.

The oldest and simplest method for field treatment involves brushing or spraying a preservative liquid onto the wood surface. These treatments are non-diffusible and should not be expected to penetrate more than a few millimeters across the grain of the wood, although those containing boron can diffuse more deeply under certain moisture conditions. Surface-applied treatments may produce an unintended color change over time as the treated wood weathers. Typically, they must be reapplied on a one- to two-year cycle to achieve sustained protection. They will not protect the interior of timbers or even thicker dimensional lumber effectively. They are used most effectively for flooding (saturating) checks, exposed end-grain, or bolt holes. They may migrate several centimeters parallel to the grain of the wood if the element is soaked in the solution. Surface treatments with diffusible components will be washed away by precipitation when used in exposed conditions. However, the loss can be slowed if a water-repellent finish is applied after the diffusible treatment has dried.

Non-diffusible paste surface treatments can provide a greater reservoir of active ingredients than liquids. When used in conjunction with a wrap or similar surface barrier, they can result in several centimeters of diffusion across the grain into moist wood over time. Paste surface treatments are typically used for the groundline area of posts or timbers that are not usually exposed to standing water but can also be applied to the end-grain of connections or under flashing. Most current non-diffusible liquid treatments incorporate some form of copper (such as copper-8-quinolinolate or copper naphthenate).

Fumigant treatments migrate through the wood as a gas and are subject to more restrictions regarding handling and application than other internal treatments. Fumigant treatments are generally more toxic and more difficult to handle than diffusible treatments and are therefore seldom used in historic structures where human contact is likely. Some are considered to be Restricted Use Pesticides (RUPs) by the EPA and require extra precautions. They are usually applied by specially trained and licensed personnel.

Like some diffusible formulations, fumigants are applied in liquid or solid form in predrilled holes; they then volatilize into a gas that moves much greater distances through the wood than diffusible treatments. Fumigant treatments have the potential to move several feet along the grain of the wood. They are used primarily to treat decay inside logs or larger timbers.

Because liquid and granular fumigants are poured into pre-drilled treatment holes, they must be applied from above. Encapsulated fumigants are pre-packaged for convenient application and have the added advantage of allowing holes to be drilled from below; encapsulated fumigants minimize the risk of spillage into water or any other sensitive environments. In order to prevent accidental release of the product into the environment, fumigants should not be applied into voids or application holes that intersect voids or checks. Treated structures should be marked to indicate the presence of fumigants. Caution should be taken when removing wood structures or elements that have been treated with fumigants to prevent exposure to the effects of the chemicals in the fumigant.

Because wood preservatives are defined as pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), they are regulated by the EPA. The EPA and each state have adopted regulations about who can apply pesticides. The EPA regulations provide minimum requirements, and states may have additional requirements. The EPA is most concerned with the RUPs. Two fumigants (chloropicrin and methylisothiocyanate, or MITC) fall into this category. EPA regulations require that applicators be certified to apply RUPs. Other than fumigants, the remedial preservatives for in-situ application described above fall under the EPA's category of general use preservatives and do not require an applicator's license.

Chemical Preservatives and Pressure-treated Wood

The greatest volumes of wood preservatives are used in the pressure treatment of wood at specialized treatment facilities, where bundles of wood products are placed in large pressure cylinders and combinations of vacuum, pressure, and sometimes heat are used to force the preservative deep into the wood.

Table 2. Summary of Use Category System Developed by the American Wood Protection Association (AWPA)

Use Category	Service Conditions	Use Environment	Common Agents of Deterioration	Typical Applications
UC1	Interior construction, Above ground, Dry	Continuously protected from weather or other sources of moisture	Insects only	Interior construction and furnishings
UC2	Interior construction, Above ground, Damp	Protected from weather, but may be subject to sources of moisture	Decay fungi and insects	Interior construction
UC3A	Exterior construction, Above ground, Coated and rapid water runoff	Exposed to all weather cycles, not exposed to prolonged wetting	Decay fungi and insects	Coated millwork, siding, and trim
UC3B	Ground contact or fresh water, non-critical components	Exposed to all weather cycles, normal exposure conditions	Decay fungi and insects	Fence, deck, guardrail posts, crossties, and utility poles (low decay areas)
UC4A	Ground contact or fresh water, non-critical components	Exposed to all weather cycles, normal exposure conditions	Decay fungi and insects	Fence, deck, guardrail posts, crossties, and utility poles (low decay areas)
UC4B	Ground contact or fresh water, critical components or difficult replacement	Exposed to all weather cycles, high decay potential includes salt water splash	Decay fungi and insects with increased potential for biodeterioration	Permanent wood foundations, building poles, horticultural posts, crossties, and utility poles (high decay areas)
UC4C	Ground contact or fresh water, critical structural components	Exposed to all weather cycles, severe environments, extreme decay potential	Decay fungi and insects with extreme potential for biodeterioration	Land and freshwater piling, foundation piling, crossties, and utility poles (severe decay areas)
UC5A	Salt or brackish water and adjacent mud zone, northern waters	Continuous marine exposure (salt water)	Salt water organisms including marine borers	Piling, bulkheads, bracing
UC5B	Salt or brackish water and adjacent mud zone, NJ to GA, south of San Francisco	Continuous marine exposure (salt water)	Salt water organisms including creosote tolerant Limnoria tripunctata	Piling, bulkheads, bracing
UC5C	Salt or brackish water and adjacent mud zone, South of GA, Gulf Coast, Hawaii, and Puerto Rico	Continuous marine exposure (salt water)	Salt water organisms including Martesia, Sphaeroma	Piling, bulkheads, bracing

Pressure-treated wood and the preservatives used in pressure treatment differ from nonpressure (remedial) preservatives in three important ways:

- Pressure-treated wood has much deeper and more uniform preservative penetration than wood treated in other ways.
- Most preservatives used in pressure treatment are not available for application by the public because they are classified by the EPA as RUPs. In some cases, such as with preservatives that have been used historically, including creosote, pentachlorophenol, and chromated copper arsenate (CCA), the EPA considers the preservatives too toxic to be applied by the general public, although the handling and use of the treated wood may be allowed where human contact is restricted (such as in bridge timbers). In other cases, the preservatives may not be highly toxic, but the supplier may not have introduced the product into the retail market.
- Pressure-treatment preservatives and pressure-treated wood undergo review by standard-setting organizations, most notably the American Wood Protection Association, to ensure durability in the intended end use. Standards also apply to treatment processes and require specific quality-control and quality-assurance procedures. In contrast, nonpressure preservatives may undergo relatively little review, other than the EPA evaluation of pesticide toxicity.

When to Consider Using Pressure-treated Wood

The Secretary of the Interior's Standards for the Treatment of Historic Properties are intended to aid in the preservation of the historic materials, features, and spatial relationships of a property or structure. If historic materials must be repaired or replaced, the standards generally require the replacement of material in kind. For wood elements, this typically means using the same species and cut of wood. In most historic structures, the wood used in the original construction and/or repair campaigns was not pressure treated, making the repair or replacement of historic materials with pressure-treated lumber or timber an incompatible solution. However, there may be situations where the use of pressure-treated wood is warranted.

The use of pressure-treated lumber for the repair or replacement of wood members is sometimes warranted where moisture intrusion cannot be mitigated, such as in areas where the wood is in contact with the ground or below grade. The use of pressure-treated wood may also be warranted in cases where, after careful evaluation, it is determined that moisture-mitigation efforts (such as improving drainage, increasing air circulation, or redirecting water flows) will not effectively manage moisture conditions and that continued exposure to moisture is expected. Sill plates, sill beams, and sill logs that rest directly on the ground are common examples of elements where moisture mitigation may not be enough to preserve the timber and where the judicious repair or replacement of elements with pressure-treated wood may help to preserve the structure. With below-grade structural elements, such as basement columns or joists, it may be appropriate to make repairs or replacements with pressure-treated wood.

Some historic structures, such as covered bridges, have wood elements where moisture issues cannot be fully mitigated and where exposure to moisture is expected to continue on a cyclical basis. In such cases, using pressure-treated timber can extend the service life of the structure and should therefore be considered as a viable alternative to repair or replacement with concrete, metal, or other materials that may alter the structure much more significantly than the use of pressure-treated lumber or timber.

Use Category System for Treated Wood

The choice of preservative is generally dependent on the requirements of the specific application. For example, direct contact with soil or water is considered a severe deterioration hazard, and preservatives used in these applications must have a high degree of leach resistance and efficacy against a broad spectrum of organisms. These same preservatives may also be used at lower retention levels specified by AWPA to protect wood with less risk of deterioration, such as wood used above ground. Also, for wood that is partially protected from the weather and thus has less exposure, preservatives that lack the permanence or toxicity to withstand continued exposure to precipitation may be effective. Other formulations may be so readily leachable that they can be used only indoors (Table 2).

Fortunately, the end user does not need to become an expert on specifications for treating wood. The Use Category System (UCS) standards developed by the AWPA simplify the process of selecting appropriate preservatives and preservative retentions for specific end uses. To use the UCS standards, one needs to know only the intended end use of the treated wood. Another table in the UCS standards lists most types of applications for treated wood and provides the appropriate Use Category and User Specification. The User Specification lists all preservatives that are standardized for that Use Category, as well as the appropriate preservative retention and penetration requirements. The user needs only to specify that the product be treated according to the appropriate Use Category. It should be noted that the AWPA UCS standards are not specific to historic preservation; when selecting a wood-preservative option, it is prudent to consider project-specific variables, such as current and future deterioration risks and potential environmental and human health risks, which can vary significantly with the intended use of the site and structure.

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Notes

1. Numerous publications describe the various mechanisms of degradation of wood, which are well summarized in C. A. Clausen's article entitled "Biodeterioration of Wood," included in the Additional Reading list.

2. Mechanical damage and weathering are considered degradation mechanisms and may result in a loss of material and eventual failure of wood elements, but they are not addressed in this Practice Point.

Additional Reading

American Wood Protection Association. *Book of Standards*. Birmingham, Ala.: American Wood Protection Assoc., 2014.

Boyce, J. S., *Forest Pathology*. New York: McGraw-Hill, 1961.

Broese Van Groenou, H., H. W. L Rischen, and J. Van Dem Berg. *Wood Preservation during the Last 50 Years*. Lieden, Holland: A. W. Sijthoff's Uitgeversmaatschappij N.V., 1951.

Clausen, C. A. "Biodeterioration of Wood," in *Wood Handbook: Wood as an Engineering Material*. General Technical Report FPL-GTR-190. Madison, Wisc.: U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, 2010.

Clausen, C. A., and S. V. Glass. "Build Green: Wood Can Last for Centuries," USDA FPL, General Technical Report FPL-GTR-215. Madison, Wisc.: U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, 2012.

De Groot, Rodney C., Colin C Felton, and Douglas M. Crawford. "Distribution of Borates around Point Source Injections in Wood Members Exposed Outside," Res. Note FPL–RN–0275. Madison, Wisc.: U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, 2000.

Graham, S. A. *Forest Entomology*. New York: McGraw-Hill, 1952.

Hansen, Laurel D., and John H. Klotz. *Carpenter Ants of the United States and Canada*. Ithaca and London: Constock Publishing Associates, 2005.

Harris, S. Y. *Building Pathology, Deterioration, Diagnostics, and Intervention.* New York: John Wiley & Sons, 2001.

Highley, T. L., and L. Ferge. "Movement of Boron from Fused Boron Rods Implanted in Southern Pine, Douglas-fir, Red Oak, and White Oak Timbers," *Proceedings, International Research Group on Wood Preservation, 26th Annual Meeting, Helsingor, Denmark.* IRG/WP/95-30061. Stockholm: 1995.

Hunt, G. M., and G. A. Garratt. *Wood Preservation*, 2nd ed. New York: McGraw-Hill, 1953.

Lebow, S. T. "Wood Preservation," in *Wood Handbook: Wood as an Engineering Material.* General Technical Report FPL-GTR-190. Madison, Wisc.: U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, 2010.

Lebow, S. T., and T. L. Highley. "Regional Biodeterioration Hazards in the United States," in *Development of Commercial Wood Preservatives: Efficacy, Environmental and Health Issues. Systems.* T. Shultz, H. Miltz, M. Freeman, B. Goodell, and D. Nicholas, eds. ACS Symposium Series 982. Washington, D.C.: American Chemical Society, 2008.

Lebow, Stan T., and Ronald W. Anthony. *Guide for Use of Wood Preservatives in Historic Structures.* General Technical Report FPL-GTR-217. Madison, Wisc.: U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, 2012.

Loferski, J. R. "Technologies for Wood Preservation in Historic Preservation," *Archives and Museum Informatics* 13 (2001): 273–290.

Love, C. S., C. Freitag, and J. J. Morrell. "Use of Internal Remedial Treatment to Extend Wood Life at the Fort Vancouver National Historic Site." Doc. No. IRG/WP/10-30525. Stockholm: International Research Group on Wood Preservation, IRG Secretariat, 2010.

Morris, P. "Understanding Biodeterioration of Wood in Structures." Booklet prepared with the financial assistance of British Columbia Building Envelope Council. Forintek Canada Corp, 1998.

Nicholas, D. D., ed. *Wood Deterioration and Its Prevention by Preservative Treatments.* Syracuse, N.Y.: Syracuse University Press, 1973.

Park, Sharon C. "Holding the Line: Controlling Unwanted Moisture in Historic Buildings," *Preservation Brief 39.* Washington, D.C.: Technical Preservation Services, National Park Service, U.S. Dept. of the Interior, 1996. http://www.nps.gov/hps/tps/briefs/brief39.htm.

Ridout, B. *Timber Decay in Buildings, the Conservation Approach to Treatment.* London and New York: E. & F. N. Spon, 2000.

Sheetz, R., and C. Fisher. "Protecting Woodwork Against Decay Using Borate Preservative," *Preservation Technotes, Exterior Woodwork Number 4.* Washington, D.C.: Preservation Assistance Division, National Park Service, U.S. Dept. of the Interior, 1993. www2.cr.nps.gov/tps/how-to-preserve/tech-notes/Tech-Notes-Exterior04.pdf.

Singh, J., ed. *Building Mycology, Management of Decay and Health in Buildings.* London and New York: E. & F. N. Spon, 1994.

Watt, D. S. *Building Pathology, Principles and Practice.* Oxford: Blackwell Science, 1999.

Williams, L. H. "Borate Wood-protection Compounds: A Review of Research and Commercial Use," *APT Bulletin* 27 no. 4 (1996): 46-51.

Williams, R. S., and William C. Feist. *Water Repellents and Water-Repellent Preservatives for Wood.* Madison, Wisc.: U.S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, 1999.

Zabel, R. A., and J. J. Morrell. *Wood Microbiology: Decay and Its Prevention.* San Diego, Calif.: Academic Press, Inc., 1992.

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