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Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environments

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Abstract

Preservative-treated wood is often used for construction of highway and foot bridges, wetland boardwalks, and other structures in or over water or sensitive environments. In these applications it is important that release of preservative from the wood into the environment is minimized. This publication addresses this concern by describing the various types of pressure-treated wood, reviewing recent research on the environmental impacts of pressure-treated wood, and discussing methods of minimizing potential environmental impacts. Recent research indicates that wood treated with these preservatives does release small amounts of chemical into the environment immediately adjacent to the treated structure, although no adverse biological impacts were observed. Environmental releases from treated wood can be minimized with appropriate treatment practices. These practices include fabricating members before treatment and specifying that the wood be treated using methods that ensure chemical fixation and prevent the formation of surface residues or bleeding. Guidance to specifying such treating practices are offered in this report and in sources such as the Best Management Practices developed by the Western Wood Preservers' Institute. Also, responsible construction practices such as storage of treated wood under cover and containment and collection of construction residue can further reduce the possibility of negative environmental impacts. As with any other construction material, careful specification and responsible use of treated wood will optimize its performance.

Keywords: preservative-treated wood, sensitive environments, environmental impacts, leaching, treatment practices, fixation, construction practices

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Guide for Minimizing the Effect of Preservative-Treated Wood on Sensitive Environments

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Introduction

Preservative-treated wood is commonly used for construction of highway bridges, foot bridges, wetland boardwalks, and other applications where the wood is placed in or over water. Many of these applications place the wood in pristine or sensitive ecosystems. Treated wood is used for these types of applications because it is economical, blends well with the environment, is relatively easy to install, and is durable. The wood is durable because the chemicals in the preservative are toxic to decay fungi and insects. However, these same chemicals that are beneficial in protecting the wood are also potentially toxic to aquatic organisms. This has caused some concern that chemicals might leach out of the wood and accumulate in the environment to harmful levels. Both field and administrative personnel are often asked to justify the choice of treated wood as a construction material, and there is sometimes pressure to reduce or eliminate the use of treated wood in favor of products that are perceived to be more environmentally acceptable. The issue has been difficult to resolve because of the lack of data on leaching and biological impacts of wood preservatives, particularly under in-service conditions (Tippie, 1993, unpublished report). The Federal Highway Administration, under a cooperative National Timber Bridge Research Program, has funded research and publications to address these environmental concerns. This report describes the various types of pressure-treated wood, reviews recent research on environmental impacts of treated wood used in sensitive environments, and discusses methods of minimizing potential environmental impacts.

Types of Treated Wood

With the exception of naturally durable species such as cedar and redwood, wood used in outdoor applications should be

pressure treated with preservatives if it is expected to last more than a few years. Wood preservatives have been used in the United States for more than a hundred years, but in the past few years, several new wood preservatives have been developed. Consumers are sometimes confused about what is in their pressure-treated wood or what type of pressure-treated wood they should be using. Identification of wood preservatives can be simplified by first classifying them as either water- or oil-type, depending on the chemical composition of the preservative and the carrier used during the treating process.

Water-Type Wood Preservatives

Chromated copper arsenate (CCA-C), ammoniacal copper zinc arsenate (ACZA), ammoniacal copper citrate (CC), alkaline copper quaternary compounds (ACQ), copper azole (CBA), and copper dimethyldithiocarbamate (CDDC) are waterborne preservatives that react with or precipitate in the wood substrate and become “fixed” so that they resist leaching. Because waterborne preservatives leave a dry, paintable surface, they are commonly used in residential applications such as decks and fences (Fig. 1). They are also widely used for treatment of poles, piling, and timbers. These waterborne preservatives are primarily used to treat softwood species and are very effective for this application. However, because their cellular structure is different, hardwoods treated with waterborne preservatives may not be adequately protected in some types of exposures. Water-type wood preservatives can sometimes increase corrosion of unprotected metal, and so all metal fasteners used with treated wood should be hot-dipped galvanized or stainless steel. Borates are another type of waterborne preservative, but borate preservatives do not fix in the wood and thus are readily leached if exposed to rainfall or standing water.



Figure 1—Wood treated with waterborne preservatives is often used for decking, such as in this wetland boardwalk.

Chromated Copper Arsenate

Chromated copper arsenate, Type C (CCA-C) is the most widely used wood preservative in the United States. It contains chromium, copper, and arsenic. CCA-C protects against attack by decay fungi, insects, and most types of marine borers. CCA-treated wood is used in decks, fences, poles, piling, and bridge timbers. It is sometimes difficult to obtain adequate penetration of CCA-C in difficult-to-treat species such as Douglas-fir. CCA-C treated wood is widely available at retail lumberyards and is sold under many different trade names. CCA-treated wood typically has a light green color but is often stained or dyed by the manufacturer to various shades of brown. It may also include a water-repellant treatment, which helps prevent splitting and checking when the wood is used on a flat surface, such as decking. CCA-treated wood has little or no odor.

Ammoniacal Copper Zinc Arsenate

Ammoniacal copper zinc arsenate (ACZA) contains copper, zinc, and arsenic. ACZA is a refinement on the original formulation, ACA. ACZA protects against attack by decay fungi, insects, and most types of marine borers. Its uses are very similar to those of CCA-C and include treatment of poles, piling, and timbers. Because of its ability to penetrate Douglas-fir and other difficult-to-treat wood species, it is most widely used on the West Coast. The color of the treated

wood is dark brown to bluish green. The wood initially has a slight ammonia odor, but this dissipates soon after treatment.

Alkaline Copper Quat

Alkaline copper quat (ACQ) is one of several recently developed wood preservatives. It contains copper and a quaternary ammonium compound. ACQ protects against decay fungi and insects but has not been standardized for use in seawater applications. There are two types of ACQ: ACQ Type B (ACQ-B) and ACQ Type D (ACQ-D). ACQ-B is formulated using ammoniacal copper, and like ACZA, ACQ-B is able to penetrate Douglas-fir and other difficult-to-treat wood species and is marketed primarily on the West Coast. ACQ-B-treated wood has a dark greenish brown color. ACQ-D is formulated using amine copper, which gives the wood a light brown color. It does not penetrate difficult-to-treat wood as well as ACQ-B and is most commonly used for treatment of thick sapwood pine species.

Ammoniacal Copper Citrate

Ammoniacal copper citrate (CC) is a recently developed preservative that contains copper and citric acid. The copper protects against decay fungi, insects, and marine borers, and the citric acid aids in the distribution of copper within the wood. Because CC was developed very recently, it is not yet widely used and may not be available in some areas. As with

other preservatives containing ammonia, CC is able to penetrate difficult-to-treat species like Douglas-fir. The color of the treated wood varies from light green to dark brown. The wood initially has a slight ammonia odor, but this dissipates soon after treatment.

Copper Azole

Copper azole (CBA) is a recently developed wood preservative that contains copper, boric acid, and tebuconazole. These three active ingredients work together to protect against decay fungi and insects. CBA has not been standardized for use in seawater. Because CBA was developed very recently, it is not yet widely used and may not be available in some areas. CBA is able to provide good treatment for Southern Pine and hemlock–fir species groups but has not been standardized for use in Douglas-fir. CBA-treated wood has a uniform greenish brown color and little or no odor. It can be painted or stained.

Copper Dimethyldithiocarbamate

Copper dimethyldithiocarbamate (CDDC) is a reaction product formed within the wood after treatment with two different treating solutions. It contains copper and sulfur compounds. CDDC protects against decay fungi and insects, but it has not been standardized for use in seawater. Because CDDC was developed very recently, it is not yet widely used and may not be available in some areas. CDDC is standardized for

treatment of Southern Pine and some other pine species. CDDC-treated wood has a brown color and has little or no odor.

Borate Preservatives

Borate preservatives are salts such as sodium octaborate, sodium tetraborate, and sodium pentaborate that are dissolved in water. Borates are effective preservatives against decay fungi and insects. Borate preservatives are diffusible, and with appropriate treating practices, they can achieve excellent penetration in species that are difficult to treat with other preservatives. However, the borate in the wood remains water soluble and readily leaches out in soil or rainwater. Borate-treated wood can be used only in applications where the wood is kept free from rainwater, out of standing water, and away from ground contact. An example of such a use is in the construction of wooden buildings in areas of high termite hazard. Borate-treated wood is odorless and colorless and may be painted or stained.

Oil-Type Wood Preservatives

The most common oil-type preservatives are creosote, pentachlorophenol, and copper naphthenate. Oil-type preservatives are commonly used for applications such as utility poles, bridge timbers, railroad ties, pilings, and laminated beams such as for bridge applications (Fig. 2). They are less



Figure 2—Oil-type preservatives are often used for treatment of glulam beams, such as in this bridge.

frequently used for applications that involve frequent human skin contact or for inside dwellings because they may be oily or have a strong odor. Because of their oily nature, these preservatives also act as water repellants and can help to prevent checking and splitting.

Creosote

Creosote is made from coal tar, which is a byproduct of the carbonization of coal during coke production. Unlike the other oil-type preservatives, creosote is not usually dissolved in oil, but it does have properties that make it look and feel oily. Creosote contains a chemically complex mixture of organic molecules, most of which are polycyclic aromatic hydrocarbons (PAHs). Creosote is effective in preventing attack by decay fungi, insects, and most marine borers. Creosote is widely used in railroad ties, utility poles, bridge timbers, and piling. It has a dark brown–black color with an oily surface and strong odor. It is very difficult to paint, stain, or seal. It is not recommended for use inside dwellings or areas where it may come into frequent contact with human hands, such as handrails

Pentachlorophenol

Pentachlorophenol is a crystalline solid that can be dissolved in different types of oils. Pentachlorophenol is very effective against fungi and insects but does not protect well against ocean marine borers. It is widely used to treat utility poles, bridge timbers, laminated beams, and fresh water and foundation piling. The appearance of pentachlorophenol-treated wood depends greatly on the type of oil that it is used as a carrier solvent. The wood may have a very light brown color and dry surface if a light oil is used or a dark brown color and somewhat oily surface if a heavy oil is used. Pentachlorophenol-treated wood is generally more durable if a heavy oil is used, so light oil is most often used above ground or in covered structures. Pentachlorophenol itself is odorless, but the odor of the carrier oil may be noticeable near the treated wood. Pentachlorophenol-treated wood should not be used inside dwellings and is generally not recommended for areas where it may come into frequent contact with human hands, such as handrails. It is difficult to paint or stain unless the pentachlorophenol was pressure treated using a light oil as the carrier solvent.

Copper Naphthenate

Copper naphthenate is a mixture of naphthenic acids and copper salts dissolved in oil. It is effective against decay fungi and insects but is not recommended for use in marine applications. Copper naphthenate is not as widely used as creosote or pentachlorophenol, but it is used for the treatment of utility poles and in highway construction. Like pentachlorophenol, the properties of copper naphthenate are dependent on the type of oil used as the carrier. The most commonly used oils are fuel oil and mineral spirits. The color of the treated wood varies from light brown to dark green,

depending on the type of oil and the treating process. The odor of the oil may be noticeable near the treated wood. It is difficult to paint or stain unless the copper naphthenate was treated using a light carrier solvent. Copper naphthenate is not a restricted-use pesticide and can be purchased at retail lumberyards and hardware stores. It is widely applied as a field treatment on end cuts or holes bored into pressure-treated wood during construction.

Restricted Use Pesticides

Some wood preservatives are classified as restricted use pesticides (RUP) by the U.S. Environmental Protection Agency. The restricted use classification means that only certified applicators (that is, pressure treatment facilities) can treat wood with these preservatives. Consumers can no longer purchase these preservatives for field applications. Currently, the RUP preservatives are creosote, pentachlorophenol, and any preservative containing inorganic arsenic (CCA-C and ACZA).

Prior Research on Environmental Impacts

Until relatively recently, there had been little research on release of wood preservatives from in-service structures or on the environmental consequences of those releases. However, within the past decade, several studies on this subject have been done (Appendix A). In each of these studies, the various types of treated wood did release measurable amounts of preservative into the environment. In most cases, the levels of environmental accumulation were low and limited to close proximity to the treated structure. Adverse biological impacts were either not observed (boardwalk and bridge studies) or confined to close proximity to the treated structure (creosote-treated dolphin piling). These studies demonstrate that treated wood can be used in and over aquatic environments with little or no adverse biological impacts. However, it is also apparent that some release of preservative does occur and that reasonable precautions should be taken to ensure that these releases are minimized. The remainder of this paper discusses some of the treatment, handling, and construction practices that can be used to minimize the environmental impacts of treated wood.

Treatment Practices

Prefabrication

Whenever possible, it is desirable to cut wooden members to length and perform boring and other machining processes prior to pressure treatment. This prefabrication increases the durability of the treated structure, as well as helping to minimize environmental impacts. The practice enhances durability because there is less field fabrication, which often breaks the treated shell and exposes untreated wood.

Reducing the amount of field fabrication also helps prevent the discharge of treated sawdust, drill shavings, and other construction debris into the environment at the construction site. It also minimizes the need for treatment with a topical wood preservative at the construction site. The exact dimensions of members and location of connectors are not always known, but in many cases, it is possible to perform some prefabrication. Decking and rail posts are examples of members that can often be cut or bored prior to pressure treatment.

Treatment Processes

The pressure preservative treatment process greatly impacts the subsequent release of preservative from the treated wood. Although treatment processes may seem to be solely the responsibility of the treater, they are also greatly influenced by the specifications and demands of the project engineer and contractor.

Over-Treatment

One example of customer influence on the treating process is the retention, or loading, of preservative in the wood. Retentions that are specified by standards such as the American Wood-Preserver's Association (AWPA 2000) (for example, 0.4 lb/ft³ CCA-C for treated wood to be used in contact with the ground) have been shown to be more than sufficient to prevent decay. Asking the treater to increase that retention based on the "more is better" theory needlessly increases the amount of leachable chemical in the wood without providing a durability benefit. It is rarely good practice to ask for a retention higher than those specified in wood treatment standards. A summary of appropriate retentions for various preservatives in common applications is given in Appendix B.

Retreatment

A similar concern arises with the practice of retreatment of charges that have failed to meet penetration or retention requirements. Although retreatment of failed charges is sometimes allowed in AWPA standards, it can lead to increased bleeding or leaching of preservative. Retreated material should not be used in projects in sensitive environments. If retreated material must be used, an additional inspection should be conducted to select only those pieces that meet the specification.

Surface Residues

Clean surfaces should be specified for the treated product. Through plant maintenance and monitoring of treatment solutions, it is possible to produce treated wood without surface residues. This is true for all types of wood preservatives. Material with surface residue presents an unnecessary environmental and safety risk, and those members should be rejected (Fig. 3).



Figure 3—Wood that has been properly treated and conditioned will not have obvious surface residue like that shown here. Use of treated wood with surface residues unnecessarily increases risks for workers and the environment.

Bleeding of Oil-Type Preservatives

Oil-type preservatives, such as creosote, sometimes bleed or ooze to the surface of the treated wood. This problem may be apparent immediately after treatment, but in some cases, the problem does not become obvious until after the product is placed in service in a location where it is exposed to direct sunlight. The volume of preservative that oozes out of the wood into the environment is typically quite small, but it may appear much larger if it spreads on the surface of standing water. Wood with a visibly oily surface should not be used in projects in sensitive environments or in applications likely to involve human contact (for example, decking and hand rails). When wood treated with oil-type preservatives is specified, it should be made clear that pieces with oily surfaces will not be accepted.

However, the problem of bleeding that occurs later when the wood is placed in service is not as easily detected. This problem is best addressed through the control of treatment processes. Processes used to reduce bleeding vary somewhat, depending on the type of preservative, and treaters typically use a combination of processes to obtain a clean surface. The Western Wood Preservers Institute (WWPI) has developed best management practices (BMPs) for the most common oil-type and waterborne preservatives. The BMPs detail specific treatment procedures to help minimize bleeding from creosote, pentachlorophenol, and copper-naphthenate-treated wood. These BMPs are available at little or no cost (WWPI 1996). The AWPA recently adopted a more general optional standard titled "Guidelines for Minimizing Oil-Type Wood Preservative Migration" (Appendix C) that describes some of the practices and processes used to minimize bleeding.

Both of these documents stress several key points:

- Maintenance of clean facilities and working solutions
- Avoidance of over-treatment
- The use of post-treatment conditioning techniques such as final vacuum, steaming, and expansion baths

It is important that wood be treated in accordance with these guidelines. Although treater compliance with these guidelines is not easily verifiable by the purchaser or end-user, some aspects, such as a final steaming period or expansion bath and the charge retention will appear on the charge report.

Allowing time for proper processing

A common complaint of treaters is that customers demand the treated product on very short notice. This can cause the treater to rush or delete processing steps that improve the final product. This problem is especially relevant to obtaining fixation with waterborne preservatives.

Post-Treatment Processing: Fixation of Waterborne Preservatives

The active ingredients of various waterborne wood preservatives (copper, chromium, arsenic, and zinc) are initially water soluble in the treating solution but become resistant to leaching when placed into the wood. This leaching resistance is a result of the chemical fixation reactions that occur to render the toxic ingredients insoluble in water. The mechanism and requirements for these fixation reactions differ depending on the type of wood preservative. Some reactions occur very rapidly during pressure treatment while others may take days or even weeks to reach completion, depending on post-treatment storage and processing conditions. If the treated wood is placed in service before these reactions are completed, the initial release of preservative into the environment may be many times greater than for wood that has been adequately conditioned. Concerns about inadequate fixation have led Canada and some European countries to develop standards or guidelines for fixing treated wood. The AWPA has recently formed several task forces to consider the development of fixation, or “leaching minimization”, standards for CCA-C and other wood preservatives, but there are not yet nationally recognized standards for fixation of waterborne preservatives in the United States. As for the oil-type preservatives, the WWPI has taken the first steps in this direction with development of BMPs. Although it is important to specify that the bulk of fixation be completed before the treated wood is placed in service, the lack of standards in this area makes such specification difficult, and it is incumbent on the specifier to have a basic understanding of fixation mechanisms.

CCA-C Fixation

Because CCA-C is so widely used, it is the preservative for which we have the greatest understanding of the fixation process. The essence of CCA-C fixation is the reduction of chromium from the hexavalent to the trivalent state and the subsequent precipitation or adsorption of chromium, copper, and arsenic complexes in the wood substrate. Some of these reactions, such as the adsorption of copper and chromium onto wood components, occur within minutes or hours, while others are completed during the ensuing days or weeks. The length of time needed for fixation depends greatly on temperature, and the reactions may proceed slowly when the treated wood is stored outdoors in cool weather (Table 1). Also, increasing amounts of time are required to gain additional degrees of fixation as the process proceeds. For example, approximately 43 hours are required to progress from 90% to 95% fixation at 21°C (70°F), but an additional 100 hours are required to progress from 95% to 99% fixation. Because fixation at ambient temperatures may take an unacceptable amount of time, several techniques are used or have been proposed to elevate the wood temperature and accelerate fixation, including various forms of kiln drying, hot water baths, and steaming. These accelerated fixation methods appear to be quite effective, although care must be taken not to dry the wood too quickly or to elevate the temperature too much, both of which may harm the mechanical properties of the wood. To prevent harm to the wood, the AWPA has developed time-temperature limitations for post-treatment fixation of wood treated with waterborne preservatives (Table 2). Drying is not a prerequisite for achieving fixation in CCA-treated wood.

There is a standard method for evaluating the completeness of CCA-C fixation, commonly called the chromotropic acid test (AWPA Method A3, Section 11 (AWPA 2000)). This method is outlined in Appendix D. The method involves removing an increment core from the treated wood and applying an indicator solution. The core turns a pinkish color if hexavalent chromium is present, which means the wood fails the test because the fixation process is not complete. This test is not yet routinely used within the treating industry, and AWPA standards do not require its use for any commodity. However, it is referenced in the BMPs developed by the WWPI as a test method for assessing fixation. Instructions for the use of this method in the inspection of poles have recently been included in AWPA standards (AWPA Standard M2, Part A, Section 4.5 (AWPA 2000)) and are shown in Appendix D. These inspection instructions would also be directly applicable to piling. Although further efforts are underway to develop more quantitative tests, the chromotropic acid method appears to be an effective and conservative means of determining whether fixation is complete in CCA-treated wood.

Table 1—The approximate time needed to achieve fixation in CCA-treated wood as a function of temperature^a

Wood temperature		Hours to percentage fixation		
°F	°C	90%	95%	99%
<32	<0	— ^b	— ^b	— ^b
35	2	1,071	1,394	2,143
40	4	789	1,027	1,578
45	7	585	761	1,170
50	10	436	567	872
55	13	327	425	654
60	16	246	321	493
65	18	187	243	373
70	21	142	185	285
75	24	109	142	218
80	27	84	109	168
85	29	65	84	130
90	32	50	66	101
95	35	39	51	79
100	38	31	40	62
105	41	24	32	49
110	43	19	25	38
115	46	15	20	30
120	49	12	16	24
125	52	10	13	19
130	54	7.8	10	16
135	57	6.3	8.2	13
140	60	5.1	6.6	10
145	63	4.1	5.4	8.3
150	66	3.4	4.4	6.7
155	68	2.8	3.6	5.5
160^c	71^c	2.3	2.9	4.5
165	74	1.9	2.4	3.7
170	77	1.5	2.0	3.1
175	79	1.3	1.6	2.5
180	82	1.1	1.4	2.1
185	85	0.9	1.1	1.8
190	88	0.7	1.0	1.5
195	91	0.6	0.8	1.2
200	93	0.5	0.7	1.0
205	96	0.4	0.6	0.9
210	99	0.4	0.5	0.7
215	102	0.3	0.4	0.6
220^d	104^d	0.3	0.3	0.5

^aCalculated using the model reported by Chen (1994).

^bNo fixation occurs.

^cMaximum allowable temperature for kiln-drying of CCA-treated wood.

^dMaximum allowable temperature for steaming or water immersion of CCA-treated wood.

Another means of ensuring fixation of CCA-treated wood is through covered storage at the construction site. Once delivered, the lumber can be wrapped in tarps and stored for the time necessary, depending on the temperature, as shown in Table 1. Preferably this storage would occur well away from a sensitive environment.

Fixation in Ammoniacal Preservatives (ACZA, ACQ-B, CC)

Fixation in ammoniacal wood preservatives is not as well understood as that of CCA-C because they are less widely used than CCA-C. In ammoniacal preservatives, the metals are solubilized by ammonia and become insoluble as the ammonia evaporates. Some of the metals appear to simply precipitate within the wood, while others react with the wood structure. Volatilization of ammonia appears to be a key factor in fixation with ammoniacal preservatives, and this can be accomplished through either air drying or kiln drying, or a combination of the two. The use of stickers between layers of wood greatly increases the rate of drying of the treated wood. The WWPI's BMPs for ACZA specify that the treated wood either be air dried for 3 weeks at a temperature above 16°C (60°F) or kiln dried to below 30% moisture content. The air-drying time may be shortened if an in retort ammonia removal process is used (WWPI 1996). Similar practices would be suitable for ACQ-B and CC. Unfortunately, it is difficult to verify that these practices have been followed, because there are not yet any standardized tests or methods for assessing the degree of fixation. As with CCA-C, fixation can also occur after the lumber has been delivered to the job site. For the ammoniacal preservatives, fixation can best be achieved by stickering the material and placing it in an area with good air flow. Although the wood should be covered to protect it from precipitation, it should not be covered in a way that impedes air circulation until after it has dried.

Fixation in Amine Preservatives (ACQ-D, CBA-A)

The fixation processes of the amine wood preservatives are poorly understood. The bulk of fixation appears to occur very rapidly, within a few hours after treatment. There are currently no standards, guidelines, or tests to ensure fixation in these preservatives. It is probable that air or kiln drying of the treated wood will ensure fixation, but such drying may not be necessary. Efforts are currently underway within the AWPA to develop tests for fixation of wood treated with amine preservatives.

Fixation of CDDC

CDDC differs from the other systems in that it is a two-stage treatment and the fixation product is known. A copper compound and a sodium compound are reacted within the wood to form an insoluble chelate. These reactions proceed rapidly, and the wood is likely to be fully fixed within hours of treatment. As with the amine preservatives, there are currently no standards or guidelines to assess fixation in

Table 2—Time–temperature limitations for post-treatment accelerated fixation of wood poles treated with waterborne wood preservatives^a

Limitations for steaming and hot water baths (maximum allowable temperature 104°C (220°F)) ^b	
Temperature (°C (°F))	Time (h)
105 (220)	6
95 (203)	9
85 (185)	12
75 (167)	18
65 (149)	24

^aThey are also generally applicable to piling and lumber. The purpose of these limitations is to prevent harm to the mechanical properties of the wood. Adapted from Standard C4, American Wood-Preservers' Association Standards (AWPA 2000).

^bThere are no time–temperature limitations for kiln- and air-drying (maximum allowable temperature 71°C (160°F); maximum wet-bulb depression 10°C (20°F)).

CDDC-treated wood, but it is highly likely that fixation has occurred before the wood leaves the treating plant.

Construction Practices

On-Site Storage of Treated Wood

Treated material that is shipped to the job site should be stored in an area free from standing water or wet soil. Ideally, it should be above ground on skids or support timbers and covered until used (Fig. 4). If the wood was treated with an ammoniacal preservative such as ACZA, ACQ-B, or CC and still has a noticeable odor, it can be restacked with stickers between the layers to aid in volatilization of the ammonia. In construction of wetland boardwalks, it may be most convenient to divide the material and store smaller quantities at intervals along the intended path of construction. In this case, it is desirable to place untreated bunks into the wetland and then place the treated material on these bunks. Again, the stacks of treated wood should be covered to protect them from precipitation.

Minimizing Effects of Construction Debris

As discussed previously, the amount of field fabrication of treated wood should be minimized by careful prefabrication before treatment. Unfortunately, this is not always practical, and some degree of field fabrication is usually necessary during construction.

Importance of Collecting Construction Debris

If treated wood sawdust and shavings generated during construction are allowed to enter the water below a treated wood structure, they make a disproportionately large contribution to the overall releases from that structure. Because of their greater surface area to volume ratio, release from small wood particles such as sawdust is greater than from the treated wood itself. A recent study developed leaching rate data for construction debris immersed in water and compared that to the release rate from CCA-treated solid wood (Lebow and others 2000). The amounts of copper, chromium, and arsenic released per gram of sawdust or drill shavings were many times higher than the amounts released per gram of solid wood. The effect was greatest for copper, where the average release was initially more than 20 times greater from the particles than from the solid wood (Fig. 5).

The disproportionate leaching from the construction waste is even greater if one considers that the vast majority of treated wood used in construction is not immersed in water; it is used above the water in applications such as decking. Thus, it is meaningful to compare the rate of release from decking exposed to leaching by rainfall to that from construction debris that has been allowed to fall into standing water below the structure. A comparison of this type is shown in Figure 6. This comparison shows that releases of copper, chromium, and arsenic from construction debris discharged into standing water may be more than 30 to 100 times greater than releases from CCA-treated decking supported above the water.

However, despite the much higher release rates from construction debris, they should not be a major concern if reasonable efforts are made to collect them. Because of their much smaller volume compared with the entire structure, the release from a few isolated chips or shavings that escape collection is not likely to significantly increase the overall release from the structure. The key is to minimize the need for field fabrication through prefabrication and then to collect the bulk of construction waste generated at the site.

Methods of Containing Construction Debris

There are many approaches to ensuring that the debris from field fabrication is not discharged into the environment. A few of the most common are discussed here, but the choice of a method depends on the situation and the construction crew. Ideally, fabrication should be done before the member is placed over water (Fig. 7). Tarps are commonly used to contain construction debris in a variety of ways. The large surface area of tarps makes them ideal for collecting sawdust from circular saws and chainsaws. Often a single cutting station is set up over a large tarp, and pieces to be cut or drilled are carried to the tarp for fabrication. If the member to be cut is already incorporated into the structure and cannot



Figure 4—Treated lumber delivered for construction projects should be supported off the ground and covered.

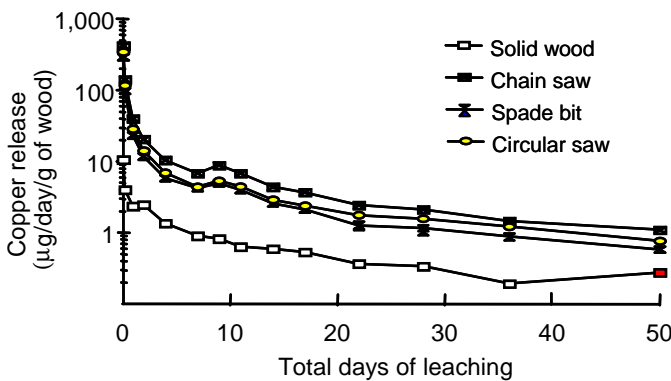


Figure 5—A comparison of the rate of copper leaching from CCA-treated solid wood with that from three types of construction residue. Samples were submerged in water.

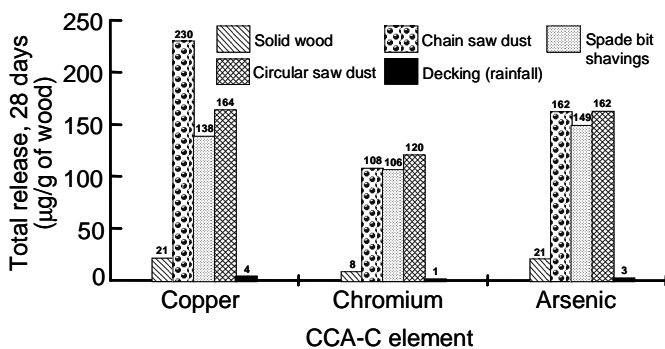


Figure 6—A comparison of the amount of preservative released from solid wood or construction residue submerged in water with that released from decking exposed to rainfall.

be removed, tarps may be spread under that part of the structure before cutting (Fig. 8). The use of tarps to contain sawdust becomes more difficult under windy or rainy conditions. Shavings from drilling holes are generally easier to contain in a small area than is sawdust. Plastic tubs are useful collection devices when drilling holes on-site (Fig. 9).

Regardless of the method used, it is inevitable that collection of construction debris will add some time and expense to a construction project. The importance of collection should be stressed in planning and budgeting for the project so that the construction crew clearly understands that debris collection is an integral part of the construction process.

Field Preservative Treatments of Cuts and Bore Holes

It is important that any untreated wood that is exposed during field fabrication should be treated to prevent decay. However, like the treated wood itself, these field treatment preservatives contain ingredients that could be toxic to aquatic organisms if they are released into the environment in sufficiently high concentrations. And, these field treatment preservatives may not be fixed or bonded to the wood in the same manner as the original pressure treatment. The most commonly used field treatment preservatives contain copper naphthenate, usually at a concentration of 2% copper. A recent study reported that the proportional release of copper from the copper naphthenate coating on deck boards was approximately 20 times greater than that for the copper from the CCA-C pressure treatment (Lebow and Evans 1999).

Accordingly, field treatment preservatives should be applied sparingly, and with care, to avoid spillage. The use of field treatment preservatives is best limited through prefabrication of the wood, which reduces the need for field cutting and drilling. When field treatment is needed, care in application of the preservative should be stressed. Whenever possible, the field treatment should be applied to the member before it is placed in a structure over water. Excess preservative should be wiped from the wood. If the preservative must be applied to wood above water, a tray, bucket, pan, or other collection device should be used to contain spills and drips. Field treatments should not be applied in the rain to wood that is above water. Materials treated with field preservatives should not be placed directly into water unless the treated surface is dry and free of excess preservative. AWPAs Standard M4, Standard for the Care of Preservative-Treated Wood Products (AWPA 2000), gives requirements for field treatment and should be specified for construction projects in or over aquatic environments.



Figure 7—These bridge components are being bored and field treated off-site before being positioned over the water.



Figure 8—Tarps can be used to contain and collect sawdust generated during on-site fabrication.



Figure 9—Plastic tubs are useful for collecting shavings when boring holes on-site.

Use of Absorbent Materials With Oil-Type Preservatives

Even wood properly treated with oil-type preservatives may create an oily sheen when it initially contacts standing water. This oily sheen can be contained and collected by floating an absorbent boom around or downstream from the structure. An absorbent boom will also help to contain any accidental spillage of field-treatment preservative during construction. It is also good practice to have absorbent pads on hand at the construction site in case some of the members were not adequately conditioned and do begin to ooze or bleed preservative. Any absorbent materials that have been used for collection of preservative must be disposed of using appropriate procedures.

Water Repellants and Stains

Wood treated with waterborne preservatives may also be treated with stains to enhance its appearance or with a water repellent to improve dimensional stability. Water repellants help to prevent splitting, warping, and twisting of the treated wood, especially of horizontal members such as decking. Water repellants and stains are sometimes incorporated into the treatment process or may be hand-applied at the construction site. These secondary treatments appear to be beneficial for both increasing longevity and reducing leaching from the treated wood, but as discussed before, field application of finishes must be done with great care in sensitive environments.

Factory-Applied Water Repellants and Stains

Several manufacturers of CCA-C and the manufacturer of ACQ-D offer formulations incorporating a water repellent into the treating solution. This allows the water repellent to be pressure treated into the wood more deeply than would be possible by hand application. It is also likely that the water repellent reduces leaching of preservative out of the wood because it slows movement of water into and out of the wood. CCA-treated wood may also be manufactured with a pre-stain applied to change the color and improve the appearance of the wood. At least one of these products has been shown to have the potential for reducing subsequent leaching of arsenic from CCA-treated decking (Lebow and Evans 1999).

Field-Applied Water Repellants and Stains

Stains and water repellants are commonly brushed, rolled, or sprayed onto the surface of treated wood after construction. In addition to improvements in appearance and longevity, surface-applied water-repellant treatments can reduce subsequent leaching from the treated wood. One study found that

leaching of copper, chromium, and arsenic from CCA-treated fence boards was reduced by more than 50% when a commercial water-repellant finish was brushed onto the wood (Cooper and Ung 1997). However, these surface treatments need to be reapplied annually or biannually for continued water-repellant protection. This requires that they be applied to the in-service structure, directly over aquatic or other sensitive environments. Because it is very difficult to apply these finishes without dripping or spillage into the environment below the structure, these hand-applied finishes are not recommended for treated wood used in sensitive applications. It is possible to apply an initial application to members, in a protected area, before they are installed in the structure.

Cleaning

Only mild cleaning techniques should be used for treated structures in aquatic environments. Commercial deck cleaners and brighteners should not be used because they contain ingredients that may be directly harmful to aquatic life and they have the potential for increasing the release of preservative components. Aggressive scrubbing, power-washing, or sanding should also be avoided since particles of treated wood will be removed from the surface and washed into the water below the structure.

Summary

Although treated wood does contain chemicals that are potentially toxic, studies indicate that there are no measurable impacts on aquatic organisms if the wood is properly treated and installed. The potential environmental impact of treated wood can be minimized by specifying that the wood be treated using methods that ensure chemical fixation and prevent the formation of surface residues or bleeding of preservative. Guidance to specifying such treating practices are offered in this document and in sources such as the Best Management Practices developed by the Western Wood Preservers Institute. In addition, responsible construction practices such as fabrication of the wood before treatment, storage of treated wood under cover, and containment and collection of construction residue can further reduce the possibility of negative environmental impacts. As with any other construction material, careful specification and responsible use of treated wood will optimize its performance.

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Appendix A—Prior Research on Environmental Impacts

In one of the prior studies on this subject (Comfort 1993), chromium, copper, and arsenic levels were measured adjacent to CCA-treated boardwalks at several sites in southern Tasmania. At each site, three soil samples were taken within 150 mm of the boardwalk and three reference samples were removed several meters from the boardwalk. The boardwalks at the sites varied from 1 to 14 years in age; the preservative retention and treating solution formulation were not reported. Levels of copper and chromium adjacent to the boardwalks were significantly elevated in comparison to the control samples but not to extreme levels. Arsenic levels were not found to be significantly elevated above the controls. The highest copper level detected was 49 ppm (controls were between 1 and 3 ppm for that site), while the highest chromium level detected was 88 ppm, approximately 60 ppm above the reference sample. There did not appear to be any relationship between the age of the boardwalk and the levels detected; the highest copper levels were detected around a 1-year-old structure, while the highest chromium levels were detected around the 14-year-old structure (Comfort 1993).

In a recent study that is also applicable to boardwalk decking, investigators collected soil samples from beneath residential decks constructed from CCA-treated wood (Stilwell and Gorny 1997). Substantially higher levels of CCA-C components were detected than in the Tasmanian study. Several samples from under decks contained more than 100 ppm copper, and a maximum level of 410 ppm copper was detected under one of the decks. Chromium concentrations in some samples from under the decks were also more than 100 ppm, and maximum arsenic concentrations of 200 to 300 ppm were reported. Overall, the average copper, chromium, and arsenic levels detected under the decks were 75, 43, and 76 ppm, respectively, while those in nearby control areas were 17, 20, and 4 ppm, respectively (Stilwell and Gorny 1997). The authors also noted that the concentration of CCA components in the soil decreased rapidly with soil depth. In contrast to the Tasmanian study, Stilwell and Gorny did not note an increase in CCA component levels with increasing age of the deck (Stilwell and Gorny 1997).

Neither of these studies evaluated releases in aquatic environments, or the resulting environmental impact, but two other recently initiated projects are addressing these questions. In one project, the Forest Service, the Bureau of Land Management, and industry partners cooperated to conduct a study of the leaching and environmental impacts of waterborne preservatives from wood used in construction of a wetland boardwalk (Forest Products Laboratory 2000). The construction project was considered “worst case” because the site had high rainfall and large volumes of treated wood were used. Separate boardwalk test sections were constructed using untreated wood and wood treated with ACQ-B, ACZA,

CCA-C, or CDDC. Surface soil, sediment, and water samples were removed before construction and at intervals after construction to determine the concentrations and movement of leached preservative elements. Aquatic insect populations in the vegetation, in sediments, and on artificial substrates were also monitored and related to environmental concentrations of leached wood preservative components. During the first year, each of the preservatives evaluated released measurable amounts of copper, chromium, zinc, or arsenic into rainwater collected from the wood. Each preservative also appeared to elevate levels of respective preservative components in the soil or sediment adjacent to the treated wood to varying degrees. In some cases, levels appeared to peak soon after construction, while in other cases, levels appeared to increase during the course of the year. With few exceptions, elevated environmental concentrations of preservative components were confined to within close proximity to the boardwalk. These levels of environmental accumulation did not appear to have any measurable biological impact. Although seasonal fluctuations in insect populations were noted, none of the invertebrate taxa evaluated were significantly reduced in number in the wetlands surrounding any of the types of treated wood.

Following the wetland boardwalk study, Brooks (2000) evaluated the environmental effects of timber bridges treated with either CCA-C, pentachlorophenol, or creosote. In that study, bridges that had been in service for several years were evaluated by comparing upstream and downstream levels of preservative concentrations in sediments to populations of aquatic insects at the same sampling locations. The two pentachlorophenol-treated bridges evaluated by Brooks (2000) were located in forested areas in the states of Washington and Oregon. The Washington site appeared to contain low levels of pentachlorophenol, although the concentrations detected were approaching the lower detection limit of the instrumentation. No biological effects would be expected at those levels, and none were detected in association with this bridge. At the pentachlorophenol-treated bridge in Oregon, four sediment samples were collected from under the bridge or 0.9 m (3 ft) downstream from the bridge. These samples also contained slightly elevated levels of pentachlorophenol. A small decrease in several biological indices were also noted directly under the bridge, but this appeared to be related to differences in stream bottom habitat in comparison to the upstream control. No adverse effects were noted when a bioassay was conducted on sediments removed from under the bridge (Brooks 2000).

Two CCA-treated bridges in Florida were also evaluated, one over a saline bay and the other over a freshwater marsh (Brooks 2000). The bridge over the bay was in the final stages of construction, and the bridge over the marsh had been constructed 2 years earlier. Some samples of sediments removed within 3 m (10 ft) of the newly constructed bridge did contain elevated levels of copper, chromium, and arsenic.

The patchy nature of the elevated samples and the observation of wood chips in the sediments led Brooks to suspect that at least a portion of the elevated samples contained treated wood sawdust. Despite the elevated levels of CCA detected in the sediments, no adverse biological effects were observed. Very slightly elevated copper, chromium, and arsenic levels were also noted in sediments within 3 to 6 m (10 to 20 ft) of the 2-year-old bridge, but again, no adverse biological effects were observed. In this case, the population and diversity of aquatic insects actually appeared to increase with proximity to the bridge.

Brooks also evaluated two creosote-treated bridges located in agricultural areas in Indiana; one had been in service for approximately 2 years and the other for approximately 17 years. In each case, elevated levels of PAH were detected in sediments 1.8 to 3 m (6 to 10 ft) downstream from the bridges, and these levels approached levels of concern for the newer bridge. However, no significant effect on insect populations was noted downstream from the newer bridge.

There did appear to be a reduction in the population and diversity of aquatic insects within 6 m (20 ft) downstream from the older creosote-treated bridge, but the author postulates that this trend was caused by the deposition of maple leaves in this area and was not a response to released PAH (Brooks 2000). This hypothesis is supported by the fact that sediments removed from that area did not adversely affect aquatic invertebrates in a laboratory bioassay.

The release and biological impacts of creosote have also been evaluated for newly installed six-piling dolphins installed in the waters of Sooke Basin on Vancouver Island, British Columbia, Canada (Goyette and Brooks 1998). PAH contamination was detected within 7.5 m (25 ft) downstream from the piling, and significant biological effects were noted within 0.65 m (2.1 ft) of the perimeter of the structure. Slight biological effects were noted in laboratory bioassays of sediments removed from up to 2.0 m (6.6 ft) downstream from the piles but not in the infaunal community (Goyette and Brooks 1998).

Appendix B—Preservative Retention Levels

Creosote, oilborne, and waterborne preservatives and retention levels for various wood products^a

Form of product and service condition	Creosote and oilborne preservative retention (kg/m ³ (lb/ft ³))							
	Creosote	Creosote solutions	Creosote-petroleum	Pentachlorophenol, P9, Type A	Pentachlorophenol, P9, Type E	Copper naphthenate	Oxine copper	AWPA standard
A. Ties (crossties and switch ties)	96–128 (6–8)	112–128 (7–8)	112–128 (7–8)	5.6–6.4 (0.35–0.4)	NR ^b	NR	NR	C2/C6
B. Lumber, timber, plywood; bridge and mine ties								
(1) Salt water ^c	400 (25)	400 (25)	NR	NR	NR	NR	NR	C2/C9
(2) Soil and fresh water	160 (10)	160 (10)	160 (10)	8 (0.50)	NR	0.96 (0.06)	NR	C2/C9
(3) Above ground	128 (8)	128 (8)	128 (8)	6.41 (0.40)	6.4 (0.40)	0.64 (0.04)	0.32 (0.02)	C2/C9
C. Piles								
(1) Salt water ^c								C3/C14/C18
Borer hazard, moderate	320 (20)	320 (20)	NR	NR	NR	NR	NR	
Borer hazard, severe	NR	NR	NR	NR	NR	NR	NR	
Dual treatment	320 (20)	320 (20)	NR	NR	NR	NR	NR	
(2) Soil, fresh water, or foundation	96–272 (6–17)	96–272 (6–17)	96–272 (6–17)	4.8–13.6 (0.30–0.85)	NR	1.60 (0.10)	NR	C3/C14/C24
D. Poles (length >5 m (>16 ft))								
(1) Utility	120–256 (7.5–16)	120–256 (7.5–16)	120–256 (7.5–16)	4.8–12.8 (0.30–0.80)	NR	1.2–2.4 (0.075–0.15)	NR	C4
(2) Building, round and sawn	144–216 (9–13.5)	NR	NR	7.2–10.9 (0.45–0.68)	NR	NR	NR	C4/C23/C24
(3) Agricultural, round and sawn	120–256 (7.5–16)	120–256 (7.5–16)	NR, round (sawn, 192 (12))	6.1–9.6 (0.38–0.60)	NR	NR, round (sawn, 1.2 (0.075))	NR	C4/C16
E. Posts (length <5 m (<16 ft))								
(1) Agricultural, round and sawn, fence	128–160 (8–10)	128–160 (8–10)	128–160 (8–10)	6.4–8.0 (0.40–0.50)	NR	sawn, 0.96 (0.060)	round, 0.88 (0.055)	C2/C5/C16
(2) Commercial–residential construction, round and sawn	128–192 (8–12)	128–192 (8–12)	128–192 (8–12)	8–9.6 (0.50–0.60)	NR	NR	NR	C2/C5/C15/C23
(3) Highway construction								
Fence, guide, sign, and sight	128–160 (8–10)	128–160 (8–10)	128–160 (8–10)	6.4–8.1 (0.40–0.50)	NR	sawn four sides, 0.96 (0.06)	NR	C2/C5/C14
Guardrail and spacer blocks	160–192 (10–12)	160–192 (10–12)	160–192 (10–12)	8–9.6 (0.50–0.60)	NR	sawn four sides, 1.2 (0.075)	NR	C2/C5/C14
F. Glued-laminated timbers/laminates								
(1) Soil and fresh water	160 (10)	160 (10)	160 (10)	9.6 (0.60)	NR	9.6 (0.60)	NR	C28
(2) Above ground	128 (8)	128 (8)	128 (8)	4.8 (0.30)	NR	6.4 (0.40)	3.2 (0.20)	C28

^aFrom table 14–2 in Forest Products Laboratory (1999). Retention levels are those included in Federal Specification TT–W–571 and Commodity Standards of the American Wood-Preservers' Association. Refer to the current issues of these specifications for up-to-date recommendations and other details. In many cases, the retention is different depending on species and assay zone. Retentions for lumber, timber, plywood, piles, poles, and fence posts are determined by assay of borings of a number and location as specified in Federal Specification TT–W–571 or in the Standards of the American Wood-Preservers' Association referenced in last column. Unless noted, all waterborne preservative retention levels are specified on an oxide basis.

Waterborne preservative retention (kg/m³ (lb/ft³))

ACC	ACZA or ACA	CCA Types I, II, or III	ACQ Type B	ACQ Type D	CDDC as Cu	CC	CBA Type A	AWPA standard
NR	NR	NR	NR	NR	NR	NR	NR	C2/C6
NR	40 (2.50)	40 (2.50)	NR	NR	NR	40 (2.50)	NR	C2/C9
6.4 (0.40)	6.4 (0.40)	6.4 (0.40)	6.4 (0.40)	6.4 (0.40)	3.2 (0.20)	6.4 (0.40)	NR	C2/C9
4.0 (0.25)	4.0 (0.25)	4.0 (0.25)	4.0 (0.25)	4.0 (0.25)	1.6 (0.10)	4.0 (0.25)	3.27 (0.20)	C2/C9
								C3/C14/C18
NR	24 (1.5)	24.1 (1.5)	NR	NR	NR	NR	NR	
NR	40 (2.50)	40 (2.50)	NR	NR	NR	NR	NR	
NR	16 (1.00)	16 (1.00)	NR	NR	NR	NR	NR	
NR	12–16 (0.80–1.0)	12–16 (0.80–1.0)	NR	NR	NR	NR	NR	C3/C14/C24
NR	9.6 (0.60)	9.6 (0.60)	9.6 (0.60)	NR	NR	NR	NR	C4
NR	9.6–12.8 (0.60–0.80)	9.6–12.8 (0.60–0.80)	9.6 (0.60)	9.6 (0.60)	3.2 (0.2)	NR	NR	C4/C23/C24
NR	9.6 (0.60)	9.6 (0.60)	9.6 (0.60)	NR	NR	NR	NR	C4/C16
NR	6.4 (0.40)	6.4 (0.40)	6.4 (0.40)	NR	NR	NR	NR	C2/C5/C16
8 (0.50), (NR, sawn structural members)	6.4–9.6 (0.40–0.60)	6.4–9.6 (0.40–0.60)	6.4–9.6 (0.40–0.60)	6.4–9.6 (0.40–0.6)	3.2 (0.20)	6.4 (0.4), (NR, sawn structural members)	NR	C2/C5/C15/C23
8–9.9 (0.50–0.62)	6.4 (0.40)	6.4 (0.40)	6.4 (0.40)	NR	NR	NR	NR	C2/C5/C14
NR	8 (0.50)	8 (0.50)	8 (0.50)	NR	NR	NR	NR	C2/C5/C14
8 (0.50) ^d	6.4 (0.40) ^d	6.4 (0.40) ^d	NR	NR	NR	NR	NR	C28
3.2 (0.20)	4 (0.25)	4 (0.25)	NR	NR	NR	NR	NR	C28

^bNR, not recommended.

^cDual treatments are recommended when marine borer activity is known to be high (see AWPA C2, C3, C14, and C18 for details).

^dFor use when laminations are treated prior to bonding.

Appendix C—Guidelines For Minimizing Oil-Type Wood Preservative Migration¹

(This standard is promulgated according to a consensus procedure and is under the jurisdiction of AWWA Subcommittee P-3) M20-00

1.0 Introduction

1.1 The purpose of this protocol is to provide guidelines for minimizing environmental contamination and human exposure of oil-type wood preservatives contained in pressure treated wood products. This guideline will assist wood treaters in adopting treatment and handling procedures to reduce migration of the pre-servative from the wood and avoid shipment of treated product that may otherwise have a tendency to lose pre-servative from the wood surface.

2.0 Scope

- 2.1 These guidelines apply to wood products pres-sure treated with oil-type preservative systems under the jurisdiction of AWWA subcommittee P3. These systems include the preservatives Standard P1/P13 (creosote), Standard P2 (creosote solution), Standard P3 (creosote -petroleum oil solution) and Standard P8 (oil-borne preservatives). The related standards, which are a part of the preservative systems listed, include Standard P4 (petroleum oil for blending with creosote) and Standard P9 (solvents for organic preservative systems used as carrier oils for the oil-borne preservatives).
- 2.2 These guidelines should be employed in conjunction with a thorough understanding of the AWWA Treatment Standards covering the treated wood com-modities and preservatives specified. There are substantial differences in treatment methods for different species of wood and preservative systems. Where these guidelines may be in conflict with specific provisions of the AWWA Treatment Standards, the Treatment Standards take precedence.
- 2.3 This protocol should only be used after reading and thoroughly understanding the preservative product label. A guideline shall not be used if it contradicts a product label recommendation or if it is prohibited by the product label.
- 2.4 These guidelines do not address the inherent toxicological and environmental properties of the preservatives themselves. These matters are under the jurisdiction of the United States Environmental Protection Agency (US EPA).

3.0 Treatment Guidelines

- 3.1. Prior to treatment all surface debris such as sawdust, wood shavings, and dirt should be removed from wood products.
- 3.2 The treatment cylinder (retort) should be kept clean and free of debris.
- 3.3 Work tanks should be drained and cleaned periodically to reduce the residue and solids present in the treatment solution. Several process techniques may be utilized to maintain a clean working solution. These processes include filtering, turnover of tank inventory, minimizing storage or treating tank levels, and maintaining a high quality supply source.
- 3.4 Wood products should be sorted and treated by charges containing wood of similar sizes, classes, species, species group-ings, moisture contents, conditioning methods, and treatability levels.
- 3.5 Treating solutions should be kept as moisture-free as possible. For preservative systems employing AWWA P9 oils, any free water and accumulated emulsion should be drained from the work tank on a daily basis. Creosote systems should be ther-mally dehydrated on a regular basis to maintain the low moisture content required in the AWWA Standards.
- 3.6 Most all oil-type preservative retention levels are controlled using initial air pressure in the Rueping (empty-cell with initial air) process. Using the lowest initial air pressure to achieve the desired results of treatment will significantly reduce the po-tential for excessive post-treatment preservative loss in a liquid form which remains on the wood surface, commonly called “bleeding.”
- 3.7 Retreating a non-conforming charge with any oil-type preservative greatly increases the potential for preservative migration or exudation from the treated materials. Good quality control practices and treating experience will reduce retreatments and subsequent potential for preservative loss.
- 3.8 Use an acceptable post-treatment cleaning or conditioning process to minimize potential migration of the preservative from the wood. Specific cycles will vary with the wood product, wood species, preservative, retention level, plant equipment and experience in treating a specific commodity.

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Appendix D—Method for Determining the Presence of Hexavalent Chromium in Treated Wood¹

Part I. Chromotropic Acid Test

Scope

When chromotropic acid is complexed with chromium (VI), a pink to purple color is formed. Such visible color does not occur with chromium (III). This method indicates, by the absence of the colored chromotropic acid complex, the presence of 15 ppm or less chromium (VI).

Reagent

Dissolve 0.5 grams of chromotropic acid (4,5-dihydroxy-2,7-naphthalene disulfonic acid) or its disodium salt in 100 ml. of 1N (approx. 5 wt.%) sulfuric acid. This solution should have a shelf life of at least 2 months.

Procedure

Borings for testing should be taken by hand, split and the bit thoroughly rinsed in water between borings.

Borings should be allowed to come to room temperature before testing.

Place the freshly cut boring on a white blotter paper surface, such as filter paper or a white index card.

With a medicine dropper, apply several drops of the chromotropic acid solution to wet the core. Usually 5 to 7 drops per one-inch length of core is sufficient for a core still wet from treatment. If the core is dry, it is helpful to apply 2 or 3 drops of the solution carefully and allow the surface of the core to become saturated before applying the remaining drops. Allow the reaction to continue for at least 10 minutes. Then remove the core and observe the colored complex that has leached onto the blotter; if the blotter is not wet, insufficient solution was applied and the test must be repeated. Any pink to purple color on the blotter indicates the incomplete conversion of chromium (VI) to chromium (III).

Sensitivity for Color

The minimum detection limit for the method is 15 ppm chromium (VI).

Part II. Standard for Sampling a Charge of Poles or Piles²

M2-00

STANDARD FOR INSPECTION OF WOOD PRODUCTS TREATED WITH PRESERVATIVES

PART A

POLES, PILING, TIES, TIMBERS AND OTHER COMMERCIAL/INDUSTRIAL PRODUCTS NORMALLY SUBJECT TO WRITTEN SPECIFICATIONS BY THE PURCHASER

(This Standard is promulgated according to a consensus procedure and is under the jurisdiction of AWPA Subcommittee T-7)

4. INSPECTION AFTER TREATMENT

- 4.5 Reduction of Chromium (VI). When required by the applicable AWPA Commodity Standard or by the purchaser, CCA treated material will be tested for completion of the chemical reduction of soluble Chromium (VI) using Method A3, Section 11.

¹From Standard A3, Determination of Preservatives and Fire Retardants (AWPA 2000). Reprinted with permission. Copyright American Wood-Preservers' Association, 2000.

²From AWPA Standard for inspection of wood products treated with preservatives. Part A. Poles, piling, ties, timbers, and other commercial/industrial products normally subject to written specifications by the purchaser. Sec. 4, Inspection after treatment (AWPA, 2000).

A borer core shall be taken at a point in a plane approximately 300 – 600 mm (1 – 2 ft) below the brand of 5 poles in each charge. The corer bit should be thoroughly rinsed in cool water between borings to minimize contamination and reduce the possible influence of elevated bit temperatures on the indicated presence of hexavalent chromium. The outer 13 mm (0.5 inch) of each core shall be evaluated for the presence of hexavalent chromium. Only cores that are fully penetrated in the outer 13 mm (0.5 inch) and meet the pole penetration requirements shall be evaluated. The jig used for sectioning and splitting the cores shall not be allowed to lie unprotected in the sun. If one (1) or fewer of the cores tests positive for the presence of hexavalent chromium, the charge shall be considered conforming. If three (3) or more cores test positive for the presence of hexavalent chromium, the charge shall be re-evaluated (see table below). If two (2) of the five (5) poles test positive for hexavalent chromium, the charge shall be deemed non-conforming, but the inspector may immediately remove cores from one additional set of (5) poles. The charge may be deemed conforming if none of the second set of poles test positive for hexavalent chromium; otherwise the charge shall be deemed non-conforming and shall not be sampled again until the minimum waiting period has elapsed. During each subsequent inspection of a failed charge, five (5) poles will again be sampled; these five poles shall include any poles that failed during prior evaluations.

Minimum waiting period between inspections for the presence of hexavalent chromium^a

Fixation Temperatures	Minimum Hours Between Tests
Below 20 C (68 F)	24
20 – 35 C (68 – 95 F)	12
35 – 50 C (95 – 122 F)	6
50 – 65 C (122 – 149 F)	3
Above 65 C (149 F)	1.5

^aOriginally Table 1 in standard.