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Wyoming Wood Preservation: Category 911L

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Wyoming Editors

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PREPARATION FOR YOUR EXAM

If you are preparing to take the Wyoming Commercial Pesticide Applicator Exam for category 911L, review this manual several times. Please read and respond to the learning objectives in each section.

Exam questions may come from any section of this manual — this includes the glossary.

It is important that you take note of the following:

- You may bring a basic hand-held calculator with you to use during the exam (cell phones and other communication devices are prohibited — **you will be failed** if using your cell phone during the exam).
- Exams are closed book. You will not be allowed to refer to any notes, manuals, or other unauthorized training materials during the exam.
- You must pass each category with a 70% or better to be issued a license.
- Exams can be taken at any University of Wyoming County Extension office — please call your local Extension office to make an appointment.

ABOUT THE WYOMING COMMERCIAL PESTICIDE APPLICATION AND SAFETY TRAINING GUIDE FOR WOOD PRESERVATION

APPLICABILITY

This training manual has been developed to prepare you for taking the pesticide applicator certification test in the category that covers the application of preservatives to wood products before they are put into service. In providing the information you need to know to perform the work of a wood treater, the manual reinforces and builds on the CORE training.

Certification training and tests are designed for people who are seeking initial certification. Therefore, this manual covers the knowledge and skills needed to perform the job of an entry-level wood treater rather than that of a supervisor or plant manager who may have been certified for years.

At any given wood treatment facility, some tasks covered in this manual (e.g., ordering preservatives, preparing wood for treatment) might be done by the wood treater or by someone else. However, you should be knowledgeable of such tasks even if you do not perform them because they have direct bearing on the work you do perform: treating wood products with preservatives.

ORGANIZATION OF THE MANUAL

The content in this manual is divided into nine chapters as follows:

- Chapters 1, 2, and 3 introduce you to basic concepts such as properties of wood and why we treat wood, chemicals and processed commonly used to treat wood, and the treatment standards set by the wood preservation industry.
- Chapters 4 and 5 focus on the wood treatment facility itself. They cover the physical components involved in the wood preservation process as well as what you can do to keep the process running smoothly while protecting yourself, workers, and the environment.
- With the background provided by the chapters described above, Chapters 6 through 9 address the tasks you perform when you actually treat wood. These include preparing wood and chemical mixes for treatment, setting up and monitoring a treatment, handling wood after treatment, and analyzing and recording the treatment results.

Information within a chapter is grouped under headings and subheadings. The appearance of each level of headings remains the same throughout the manual; this format helps you understand how pieces of information are related to others within a chapter.

HOW TO PREPARE FOR THE EXAM

This study guide **DOES NOT** include the knowledge you need to pass other category certification exams.

Topics from the Wyoming Pesticide Applicator Certification CORE manual which may be included on your exam include: first aid, personal protective equipment (PPE), protecting the environment, pesticide movement, surface and groundwater protection, endangered species, application methods and equipment, equipment calibration, pesticide use, pesticide formulations, pesticide applications, and area measurements. The resource for ordering the Wyoming Pesticide Applicator Certification CORE manual can be found at the University of Wyoming Pesticide Safety Education Program website, https://uwyoextension.org/psep/commercial-applicators/training-materials/.

USING THIS GUIDE

At the beginning of each chapter, learning objectives highlight the key information you should understand and be familiar with before taking the Wood Preservation exam.

CHAPTER 1: WOOD AND ITS PRESERVATION

LEARNING OBJECTIVES

After reading this section, you should be able to:

A. Explain why we need to protect wood products from pests.

B. List conditions that make wood more susceptible to pests.

C. Define wood preservation.

D. Define wood preservative.

E. Distinguish between oilborne and waterborne wood preservatives.

F. Distinguish between wood preservatives and treated wood with respect to their regulation under federal and state pesticide laws and regulations.

G. Explain the importance of making effective wood preservation treatments.

H. Give reasons why wood varies in how easy or hard it is to treat.

I. Distinguish sapwood from heartwood, including their effect on treatment by wood preservatives.

J. Describe how wood cells influence the acceptance of preservatives by wood, including differences between softwoods and hardwoods.

K. Explain how air and water in wood cells affect the uptake of preservatives.

L. Give reasons why specifications for wood treatments can vary.

M. Describe the role of each of the following in providing you with the specifications for treating wood:
- American Wood Protection Association and its *Book of Standards*
- International Code Council–Evaluation Service (ICC–ES) and its Evaluation Service Reports
- Your customer
- The preservative label

N. Explain what labeling by reference means and why it is important to the wood treater.

INTRODUCTION

Wood is well suited as a structural material because it is very strong for its weight and can be easily cut into the dimensions you need. It is available in a range of species that can suit a variety of demands such as utility poles, fence posts, marine pilings, lumber, timbers, and plywood. These wood products are used in widely different environments, ranging from above ground to ground contact to both freshwater and marine settings. Wood is highly durable if properly protected from pests and excessive moisture.

PESTS OF WOOD

Wood can be a source of food and/or shelter for many microorganisms and small animals; those which damage the wood are considered pests.

Wendy van Overstreet, shutterstock

Wood fungus

If pests gain access to susceptible wood, they can break down and/or consume its structural components and reduce its service life. The type of wood and how it is used (e.g., in ground contact, in cooling towers) affect its risk of being attacked by different pests. All pests require adequate moisture, so wood that has a high moisture content from being placed in the ground or in direct contact with water is at highest risk of attack from pests. Although as a wood treater you do not deal with pests directly, an awareness of them will help you understand the importance of treating wood properly.

FUNGI

Fungi that attack wood include decay, stain, and mold fungi. Each requires adequate moisture and temperature to attack wood.

Decay fungi

Decay fungi feed on various components of wood and can extend deep into the wood. As they break wood down, it becomes structurally weaker and may need to be replaced. Wood that is in contact with the ground or water is most susceptible to attack by decay fungi.

Stain and mold fungi

Stain and mold fungi do not reduce wood's structural integrity. However, they can reduce the value of wood and the effectiveness of wood preservation. They also increase the permeability of wood; water penetrates the wood more easily, making conditions more favorable to decay fungi that can reduce the service life of the wood product.

INSECTS

Insect pests include termites, wood-boring beetles, carpenter ants, and carpenter bees. Some of these insects eat wood while others only use it for shelter. All, however, destroy wood in the process and, like decay fungi, can weaken the wood and cause it to fail. Subterranean termites and carpenter ants are more likely to attack wood that is in ground contact because they prefer wet or moist wood that does not dry readily, though wood above ground level is not immune.

MARINE BORERS

As their name implies, marine borers will attack wood (such as pilings) that is submerged in salt water or brackish waters (e.g., where a river feeds into a larger body of water). Some bore deeply into wood and greatly reduce its structural strength. Other species make more shallow tunnels, which can make the surface of the wood susceptible to erosion from wave action.

PURPOSE OF WOOD PRESERVATION

Wood preservation is the treatment of wood products with chemicals to protect the wood from pests. To be effective, a treatment must be thorough enough so that there is no exposed, untreated wood available for pests to attack.

The chemicals used are pesticides and are called **wood preservatives**. They are generally classified as **oilborne preservatives** or **waterborne preservatives** based on whether the preservatives are dissolved or dispersed (suspended) in either oil or water. Wood preservatives are subject to federal and state pesticide regulations.

Conversely, the U.S. Environmental Protection Agency (EPA) classifies wood products that have been treated with preservatives as treated articles rather than as pesticides; treated wood is therefore not regulated under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), though its uses may be restricted by state law and/or the preservative label. Also, handling freshly treated wood may pose some health risks; we will describe how you can protect yourself from such risks in Chapter 9, "Post-Treatment Activities."

Effective wood preservation treatments protect wood products from pests and extend the service life of those products. This has two important benefits: environmental and economic.

ENVIRONMENTAL BENEFITS OF WOOD PRESERVATION

Wood is the only renewable building material. It comes from trees growing in forests, which serve environmental and recreational purposes; it is important to conserve and protect this valuable resource. By extending the service life of wood products, wood preservation reduces the frequency with which those products need to be replaced. This helps preserve forests.

ECONOMIC BENEFITS OF WOOD PRESERVATION

Replacing wood products in service can be an involved and expensive endeavor. As an example, consider what is required to replace utility poles. To make new poles, you have to harvest trees, cut them to the proper dimension, peel and dry them, and treat them with preservatives. Then you have to remove the old poles, which could temporarily interrupt communications and electric service for many people. Finally, you have to put the newly produced poles in place. Each of these steps (and the many others we skipped over) costs money, not including any costs resulting from the failure of the original poles (e.g., downed power lines when a pole falls). Reducing the frequency of replacement makes wood products more economical and saves money (and trouble) for people who rely on them.

STRUCTURE OF WOOD

A basic knowledge of the structure of wood will help you understand how preservative gets in and why woods vary in how they receive preservative.

VARIATION IN WOOD

There are several reasons why woods vary greatly in their properties, and therefore in how they are treated with preservatives. These include:

- Differences between species,
- Differences within each tree,
- Where a tree grows, and
- Post-harvest processing of the wood.

Differences between species

There are many different wood species, each with its own characteristics. For example, southern yellow pine and red pine treat much more easily than Douglas fir or hemlock. Likewise, western hemlock and western red cedar are more easily penetrated by preservatives than are red and white spruces. You need to take these differences into account when treating the wood.

Figure 1-1. Effect of sapwood and heartwood on penetration by preservative in round utility pole (top) and sawn member (bottom). Photos: USDA Forest Products Laboratory

Differences within each tree

The wood beneath tree bark can be separated into two zones. Sapwood is the outer, light-colored wood which is physiologically active while the tree is growing. It allows for the movement of water and nutrients through the tree. As the tree grows, new sapwood is formed and the older sapwood becomes heartwood. Sapwood surrounds the heartwood, which is the inner, darker portion of the stem. Heartwood is composed entirely of dead cells in which extractives (biological waste products) are deposited.

These features result in two major differences between heartwood and sapwood: heartwood of some species has greater natural resistance to pests, but sapwood is easier to treat. Southern yellow pine has a lot of sapwood; this explains why it is easier to treat than Douglas fir, which has only a thin layer of sapwood around the heartwood center.

The difficulty in treating heartwood is due to its cells being clogged with extractives and penetration pathways being blocked. After a treatment with wood preservative, round utility poles will have a uniform shell of treated sapwood (darker outer portion in Figure 1-1, top). However, sawn members will get good penetration of preservative where sapwood is prevalent but not where heartwood extends close to the edge (Figure 1-1, bottom; lighter area indicates poor penetration in heartwood).

Where the tree grows

Growing conditions affect the properties of some wood species. In the western United States, for example, coastal Douglas fir is easier to treat than another variety of the same species, interior Douglas fir.

Post-harvest processing

How wood is processed after a tree is felled—especially the extent to which it is dried—affects its properties. For example, Douglas fir poles are commonly incised to increase preservative penetration.

WOOD CELLS

In wood, it is the cells that preservatives penetrate during wood treatment. In hardwoods (trees such as oak and maple whose leaves are shed each autumn), cells oriented parallel to the vertical axis of the tree include fiber tracheids, which provide structural support, and vessels, which transport water and nutrients vertically within the tree. In softwoods (trees such as pine and cedar whose leaves are needles or scales that usually remain on the tree year-round), support and transport are both performed by cells called tracheids, which are also oriented parallel to the vertical axis of the tree. Ray cells lie perpendicular to the vertical axis of the tree and transport liquids and extractives horizontally in both hardwoods and softwoods.

In all trees, the outer part of each cell consists of a rigid cell wall. Small openings in the cell wall, called pits, allow liquids to pass freely from one cell to the next. Pits in some species can be easily plugged by extractives in the heartwood, making the cell wall almost impermeable to liquids and therefore difficult to treat.

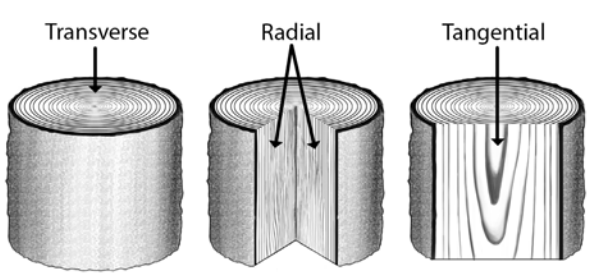

Figure 1-2. Faces of a cut log.

EFFECT OF WOOD STRUCTURE ON TREATMENT

As we mentioned, preservative enters wood through cells—specifically, through cell openings. The more openings there are and the bigger they are, the easier it is for wood to receive preservative. This is another reason why different species and even different parts of the same species of wood treat differently.

The presence and type of cell openings differ among the faces of a wood product. Consider a log that has just been cut from the trunk of a tree (Figure 1-2). The faces exposed on either end of the log are called the transverse faces, and it is on these faces that the open ends of tracheids (in softwoods) or fiber tracheids and vessels (in hardwoods) are exposed. Peeling the bark from the log (or cutting the log lengthwise parallel to the bark) reveals the tangential face, on which the open ends of ray cells are exposed. If you split the log in half lengthwise (or make any cut from the outside to the center), you reveal the radial face, on which open ends of none of the cells mentioned are exposed.

Treatment of softwoods

During a wood preservation treatment of a softwood, preservative will easily enter tracheid and ray cell openings in the two transverse and two tangential faces, respectively, by means of capillary action (as when a sponge soaks up water); preservative enters more easily through the transverse faces. Additionally, preservative that enters the transverse faces will pass through the pits in the cell walls into adjoining tracheids (provided the pits are not clogged with extractives). Less preservative enters wood through the radial faces than through the transverse and tangential faces.

Treatment of hardwoods

In a hardwood, preservative enters transverse faces via vessels and, to a much lesser extent, fiber tracheids. However, because fiber tracheids are sealed cells, the preservative cannot easily move on to other fiber tracheids. As a result, most fiber tracheids remain dry. This can be a concern for the wood treater because fibers provide most of the structural support in hardwoods; leaving them unprotected would allow pests to consume or degrade them and thus reduce the service life of the wood. Some preservatives overcome this problem.

Effect of air and water on treatment

Air in wood cells can be compressed and, to some extent, replaced by penetrating preservative. However, air will ultimately be an obstacle to full impregnation of the wood because preservative cannot occupy space that is taken up by air that remains in the wood. Water inhibits penetration of preservative for the same reason; wood cannot be forced into cells or cell walls that are saturated with water. In later chapters, we will discuss how the obstacles of air and water in wood can be overcome.

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TREATMENT STANDARDS

We've seen in this chapter that there are many species of trees, each with its unique wood structure; wood products of various types and dimensions made from those trees; diverse environments in which wood products are used; and numerous pests that attack wood in service. All these variables affect the risk of pest attack and how the wood is to be treated with preservatives.

The treatment specifications (or standards), including the species of wood, treatment method, preservative to use, and how much preservative needs to remain in the wood after treatment depend on the desired end use of the wood. For example, pest pressure is higher when wood is in contact with soil or water, so the wood would need greater protection from the pests. Therefore, it makes sense that pine used for marine pilings in southern waters would be treated to different specifications than pine used for above-ground construction where it can be protected from constant moisture and pests. The standards or specifications for treatment can come to you from several sources.

AWPA STANDARDS

Many treatment plants will treat wood products according to standards set by the American Wood Protection Association (AWPA). The AWPA is an international, non-profit, technical society. It is the principal standards-writing body for methods, preservatives, and other technologies which protect wood and wood-based products. Each year, the AWPA updates its ***Book of Standards***. The book includes the Use Category Systems Standards U1 and T1 as well as other standards pertaining to the use of wood preservatives. To order a copy of the **AWPA *Book of Standards***, visit www.awpa.com.

Standard U1

Standard U1 (User Specification for Treated Wood) specifies the wood species and levels of treatment needed to ensure that the various wood products perform adequately for a desired Use Category (end use; see the table on the next page). For example, Use Category 4A (UC4A) refers to the use of wood for "Ground Contact, General Use" such as fence posts and telephone poles in areas of less severe pest pressure. Standard U1 allows customers to know what products will suit their needs. Note that the table on the next page is for reference only and is subject to change; consult the current edition of the **APWA *Book of Standards*** for up-to-date Use Category designations.

Standard T1

Standard T1 (Processing and Treatment Standard) contains the requirements for treaters to follow to ensure they produce wood products in accordance with Standard U1. This standard addresses such things as preparing wood for treatment, how to treat the wood, and quality control.

Other standards

The *Book of Standards* also covers quality standards for preservatives, methods for assessing the effectiveness of a treatment, and how to determine the amount of preservative in a treating solution and in treated wood. We will refer to the *Book of Standards* periodically throughout this manual.

BUILDING CODES

The International Code Council–Evaluation Service (ICC–ES) provides another route for gaining building code acceptance of pressure-treated wood. Unlike AWPA, the ICC–ES does not standardize preservatives; instead, it issues Evaluation Service Reports (ESRs) that provide evidence that a building product (such as a 2x6 treated with a particular preservative) complies with building codes.

Some commercially available waterborne wood preservatives are not standardized by the AWPA, but are used to treat wood to meet ICC-ES requirements. In such cases, the preservative supplier will usually provide you with a manual that includes treatment specifications for you to follow to ensure that the treated wood will comply with building codes.

CUSTOMER STANDARDS

In some cases, the treatment standards are provided by the customer. This is especially true with large customers that have very specific uses for the wood products. For example, a railroad company may have its own standards for treating crossties, while a utility company might specify how utility poles must be treated. The customer will typically base their requirements on AWPA Standards or ICC-ES Reports.

THE WOOD PRESERVATIVE LABEL

As mentioned earlier, wood preservatives are pesticides. You've learned in your Core training that you must not use a pesticide in a manner that is inconsistent with its labeling, including (and especially) with regard to where you can use a pesticide and how much you can use. You also learned that labeling includes the label that is attached to the product container (or its packaging) as well as any other requirements or literature provided by the manufacturer.

However, wood preservatives are unique in that their labels might not directly tell you which wood products you can treat or how much preservative to use when you treat them. Instead, many will carry statements telling you to refer to other sources for

SERVICE CONDITIONS FOR USE CATEGORY DESIGNATIONS

Use Category	Service Conditions	Use Environment	Common Agents of Deterioration	Typical Applications
UC1 Interior/ Dry	• Interior construction • Above Ground • Dry	Continuously protected from weather or other sources of moisture	Insects only	Interior construction and furnishings
UC2 Interior/ Damp	• Interior construction Above Ground • Damp	Protected from weather, but may be subject to sources of moisture	Decay fungi and insects	Interior construction
UC3A Above Ground Protected	• Exterior construction • Above Ground • Coated and rapid water runoff	Exposed to all weather cycles, including intermittent wetting	Decay fungi and insects	Coated millwork, siding and trim
UC3B Above Ground Exposed	• Exterior construction • Above ground • Uncoated or poor water runoff	Exposed to all weather cycles including intermittent wetting but with sufficient air circulation so wood can readily dry	Decay fungi and insects	Decking, railings, joists and beams for decks and freshwater docks[1], fence pickets, uncoated millwork
UC4A Ground Contact General Use	• Ground contact or fresh water • Non-critical components	Exposed to all weather cycles, including continuous or prolonged wetting	Decay fungi and insects	Sawn fence, deck, and guardrail posts, cantilevered members extending beyond the building envelope, joists and beams for decks and freshwater docks
UC4B Ground Contact Heavy Duty	• 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	Building poles, round, half- round, and quarter-round agricultural posts, crossties and utility poles (high decay areas)
UC4C Ground Contact Extreme Duty	• 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)

Use Category	Service Conditions	Use Environment	Common Agents of Deterioration	Typical Applications
UC5A Marine Use Northern Waters	• Salt or brackish water and adjacent mud zone which includes Long Island, NY and northward, north of San Francisco	Continuous marine exposure (salt water)	Salt water organisms	Piling, bulkheads, bracing
UC5B Marine Use Central Waters	• Salt or brackish water and adjacent mud zone south of Long Island, NY to the southern border of GA, south of San Francisco	Continuous marine exposure (salt water)	Salt water organisms Including creosote tolerant *Limnoria tripunctata*	Piling, bulkheads, bracing
UC5C Marine Use Southern Waters	• 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
UCFA Fire Retardant Interior	• Fire protection as required by codes • Above ground • Interior construction	Continuously protected from weather or other sources of moisture	Fire	Roof sheathing, roof trusses, studs, joists, paneling
UCFB Fire Retardant Exterior	• Fire protection as required by codes • Above ground • Exterior construction	Subject to wetting	Fire	Vertical exterior walls, inclined roof surfaces or other construction which allows water to quickly drain

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Wood treaters must not knowingly
pressure treat wood commodities
that are not encompassed by the
use categories listed on this
label as set forth in the most
current edition of the AWPA Book of
Standards.

Wood should be pressure treated
in a commercial vessel capable of
physically impregnating the wood and
providing adequate penetration and
retention.

For specific retention rates (amount
of preservative left in the wood),
follow the use instructions in the
AWPA Use Categories listed here: UC
1, 2, 3B, 4A, 4B, 4C, 5A, 5B, 5C.

Impregnation procedures must adhere
to the current specifications of
the preservative manufacturer or
the AWPA. The percent solution to
be used should be based on the
retention specified by the purchaser
and by the treating processes used.
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Figure 1-3. Examples of "labeling by reference" statements from wood preservative labels.

this information. Examples of such label statements are shown in Figure 1-3.

Statements such as those in Figure 1-3 which instruct you to follow guidelines provided elsewhere are called labeling by reference. For example, in cases where the label instructs you to follow AWPA Standards, those standards become part of the product's labeling; therefore, you would have to comply with the appropriate AWPA Standards when you treat wood with the product. When instructions are more vague (e.g., "provide adequate penetration and retention"), it will usually be the customer or preservative manufacturer that specifies how much product to use. Therefore, you should keep copies of the specifications to follow—regardless of their source—in your files along with copies of the product label; refer to them when you treat wood to ensure that you comply with the product's labeling.

CHAPTER 2: METHODS OF WOOD PRESERVATION

LEARNING OBJECTIVES

A. Tell how pressure methods of wood preservation differ from nonpressure methods with respect to application and results.

B. Distinguish between retention and penetration of wood preservatives.

C. For each pressure treatment method (including the thermal process):
- Describe each step in the process.
- Tell how the method differs from the other pressure treatment methods (including steps, uses, and results).

D. With respect to an expansion bath and final steaming:
- Tell why they are used.
- Describe how they ease recovery of oil from the surface of the treated wood.
- Describe the procedure used for each, including where it fits within the empty-cell process.

E. Describe how treating wood by the various methods is influenced by AWPA Standards.

F. Describe each nonpressure method of wood preservation, including its uses, advantages, and limitations.

INTRODUCTION

There are a number of ways to apply wood preservatives. The method used will depend on the wood species and the level of protection it will need to perform satisfactorily in its end use. For example, wood that will be used in ground contact will need long-term protection against decay fungi, whereas wood used for millwork (such as for windows) may only need protection from sapstain and mold while awaiting processing at the lumberyard. For each wood species and end use, the pertinent standards will specify acceptable treatment methods.

Wood-preserving methods can be categorized as follows:
- Pressure processes provide long-term protection by applying preservatives under pressure to force them deep into the wood. The thermal process is considered a pressure treatment because it uses temperature to create a pressure differential that helps preservative penetrate wood.
- Nonpressure processes provide surface protection of the wood that may or may not be long term, as required by the treatment specifications.

PRESSURE PROCESSES USING TREATMENT CYLINDERS

We will provide an overview of pressure processes using treatment cylinders here. In later chapters, we will go into more detail about how to ensure a safe and effective treatment using these methods.

Several pressure processes are used, but the basic principle is the same with each. The wood to be treated (also called the **charge**) is stacked on cars or trams and fed into a large cylinder or pressure vessel (also called a **retort**) into which preservative is pumped until all the open space is filled (Figure 2-1). Then, more preservative is pumped in under pressure; since there is no more open space in the cylinder, the added preservative has no place to go except into the wood.

Figure 2-1. Loading a charge into the cylinder.

Pressure processes force a substantial amount of preservative into the wood as the treatment specifications require. The depth to which the preservative is forced into the wood is called **penetration**. The amount of preservative that remains in the wood after treatment is called **retention**. Both must meet the relevant treating standards (e.g., AWPA, ICC-ES) to ensure the wood is adequately protected.

Four pressure processes are commonly used and are generally categorized based on how much preservative is left within wood cell lumens (i.e., the cavities that the cell walls enclose). The processes are full-cell, modified full-cell, and two variations of empty-cell (Lowry and Rueping). The most significant difference between these four processes is the pressure in the cylinder before preservative is added, as shown in the table on the next page. This difference in initial conditions largely accounts for the difference in the amount of preservative left within the cells.

Initial Conditions of Common Pressure Processes

Pressure Process	Pressure in Cylinder before Adding Preservative
Full-Cell	Stronger vacuum
Modified Full-Cell	Weaker vacuum
Empty-Cell (Lowry)	Ambient air pressure
Empty-Cell (Rueping)	Higher air pressure

Steps in each process can be adjusted as needed to ensure proper retention and penetration and to protect the structural integrity of the wood. The details in each step will vary depending on such things as the preservative, wood species, and end use of the wood and are specified in the *AWPA Book of Standards* (except if a treatment has not been standardized, the details may be in the treatment manual provided by your chemical supplier).

FULL-CELL (BETHEL) PROCESS

The full-cell (or Bethel) process maximizes retention. It is used with waterborne preservatives and for treating timbers with creosote to protect against marine borers. The full-cell process proceeds as follows (see Figure 2-2):

1. The charge is placed in the cylinder.
2. An initial vacuum of at least 22″ Hg (inches of mercury) is applied to remove the air from the cylinder and as much as possible from the wood. This helps draw more preservative into the wood.
3. Preservative is admitted to the cylinder without breaking the vacuum. Depending on the treatment requirements, the preservative might be heated during this step.

4. Once the cylinder is filled, more preservative is pumped into the cylinder against pressure until the wood will take no more preservative or has absorbed the desired amount.
5. Once the pressure period is completed, the pressure is released, preservative is withdrawn from the sealed cylinder, and a short final vacuum is applied. These steps remove excess preservative in or dripping from the charge.
6. The vacuum is released and when the interior of the cylinder returns to ambient air pressure, the door is opened and the charged is removed.

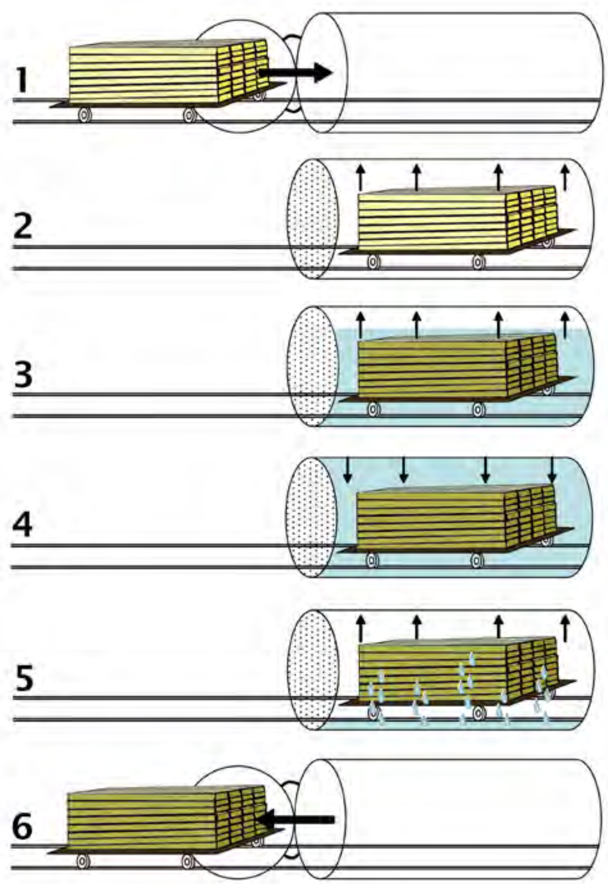

Figure 2-2. Steps in the full-cell (Bethel) pressure-treating process.

MODIFIED FULL-CELL PROCESS

Compared to the full-cell process, the modified full-cell process uses a lower (less strong) initial vacuum of less than 22″ Hg, a higher concentration of preservative in the treatment mix, and often an extended final vacuum. The amount of the initial vacuum depends on the size and species of wood and the desired retention. Air that remains in the wood expands when pressure is released and during the final vacuum. The expanding air expels some of the preservative mix; this is called **kick-back**. (Most of the kick-back occurs when pressure is released and preservative is withdrawn. The final vacuum helps ensure that most of the preservative that drips off the treated wood does so in the cylinder.)

The modified full-cell process leaves the wood lighter because less mix (including water) remains in the wood; the amount of preservative chemical, however, is the same as in the full-cell process because the modified full-cell process uses a higher concentration in the treatment mix. The lighter weight makes the wood easier to handle and reduces shipping costs.

EMPTY-CELL PROCESS

In the empty-cell process, there is no initial vacuum. The process uses the expansive force of compressed air to drive out some of the preservative that is absorbed during the pressure period. It allows for deep penetration with a lower retention. It is the preferred treatment method with oilborne preservatives provided the desired retention is achieved; by using less preservative, the treated wood is lighter and cleaner (e.g., less oily, more easily glued).

Two versions of the empty-cell process are commonly used—the Lowry and the Rueping processes.

Lowry process

The Lowry process differs from the full-cell process only in that there is no initial vacuum; once the charge is sealed in the cylinder, preservative is added at ambient air pressure. This traps the air inside the wood and when pressure is applied, the air is compressed deeper into the wood. When the pressure is released and preservative is withdrawn from the cylinder and during the final vacuum stage, the trapped air expands and pushes preservative out of the wood; this leaves the wood cell lumens relatively empty but the cell walls coated with preservative.

Rueping process

The Rueping process is also similar to the full-cell process except that it begins with pumping air into the cylinder to raise the air pressure. This forces more air into the wood, which compresses the air that is already there. For this reason, the Rueping process is often called "empty-cell process with initial air." With some wood species, the period of initial air may last only a few minutes. With more-resistant species, you may need to maintain the air pressure for up to an hour before adding preservative to the cylinder.

Preservative is then pumped into the cylinder against the elevated air pressure. Once the cylinder is full, preservative is forced in at a pressure greater than that of the initial air. When the pressure is released and preservative is withdrawn from the cylinder and during the final vacuum, the compressed air in the wood cells expands and drives preservative out of the cells. As much as 20% to 60% of the preservative initially forced into the wood can be recovered this way.

Expansion bath and final steaming

With poles and other products where bleeding of preservative oil is objectionable, the empty-cell process may add an expansion bath and/or final steaming to the process. These processes heat the wood so as to further expand entrapped air, forcing more of the air out of the wood. If not removed in the cylinder, this air would bubble and cause preservative to bleed out of the wood after being removed from the cylinder. These processes are used as deemed necessary and the specifics of each (e.g., temperatures, duration of vacuum) will vary depending on the preservative used.

An expansion bath, which follows the pressure period, involves heating the preservative above the press temperature before removing the preservative from the cylinder. In addition to forcing more air out of the wood, an expansion bath lowers the viscosity of the oil at the wood surface; this eases recovery of the surface oil.

Final steaming also eases recovery of surface oil. It may be done after an expansion bath and before the final vacuum. Alternatively, final steaming may be done after what is normally the final vacuum; with the charge still sealed in the cylinder, the vacuum is released and the cylinder is brought back to atmospheric pressure. The charge is then steamed, after which a second vacuum is applied; the duration of each step can vary.

THERMAL PROCESS

In the thermal process, wood is soaked first in heated preservative and then in unheated preservative; thus, the process is also called the hot-and-cold bath. As the wood warms in the heated preservative, air in the wood expands and bubbles out through the preservative and into the atmosphere. Once no more air is escaping, the heated preservative is either allowed to cool or is replaced by preservative that is at a lower temperature; the latter procedure yields better penetration and retention.

The thermal process actually uses the same vacuum pressure principle as pressure processes, although it uses temperature rather than equipment such as cylinders and vacuum pumps. As mentioned, the heated preservative forces air out of the wood. When the wood is transferred to the cold preservative solution, any remaining air in the wood shrinks. This creates a vacuum within the wood, which means the pressure in the wood is now lower than the atmospheric pressure that the preservative is under. This difference in pressure forces preservative into the wood, yielding better penetration and retention than nonpressure methods.

The thermal process is used mainly for treating poles with oilborne preservatives. Wood species treated this way are typically those with narrow sapwood with durable heartwood, such as western red cedar. The AWPA standards identify suitable species and which may be treated along their full length and/or in the butt region alone (the butt region extends from the bottom of the pole to about one foot above the eventual ground line).

NONPRESSURE PROCESSES

Nonpressure processes are especially useful when little protection of the wood is required. However, in cases where the penetration and retention are comparable to pressure treatment, the level of protection should be the same.

BRUSHING, SPRAYING, AND POURING

Some preservatives can be applied to dried wood by brushing, spraying, or pouring. Warm the wood prior to using an oilborne preservative to prevent the oil from congealing. Flood preservative over the wood, allowing it to soak in. Make a second application after the first has dried and soaked into the wood.

Penetration and retention are minimal, and any abrasions can expose untreated wood to pests. Brushing, spraying, and pouring are most widely used for protecting areas of treated wood that have been cut or machined (e.g., when using treated wood in a construction project), thereby exposing untreated surfaces.

DIPPING

Dipping involves immersing wood in a tank of preservative solution for a few minutes or until air bubbles are no longer released from the wood (Figures 2-3 and 2-4). Penetration is very shallow, perhaps only a few millimeters into the wood, and so protection does not last very long.

Figure 2-3. Rough-sawn lumber being dipped.

Figure 2-4. Air bubbles escaping from dipped wood.

Green wood that has recently been felled (e.g., poles, rough-sawn lumber) is often dipped at sawmills to protect it from sapstain fungi until it can be properly dried. (Options for drying wood are described in Chapter 6, "Preparing Wood for Treatment.") Because protection is provided for only a short time, the wood should be dried as soon as possible after dipping.

Dipping is also used for millwork, such as for windows. Dipping provides adequate protection for millwork because the wood will be finished (e.g., stained or painted) and conditions for decay are not severe.

COLD SOAKING AND STEEPING

Cold soaking involves immersing dried wood in unheated, low-viscosity oilborne preservative for several hours or days. Soaking lumber for several hours provides much better penetration and retention than just dipping, though typically not as high as with pressure treatments. When soaking flat-sawn wood products, provide space around each piece to ensure exposure to the preservative.

Steeping is similar to cold soaking, but uses waterborne preservatives.

The diffusion process provides a way to impregnate green or wet wood with waterborne preservatives. The wood is soaked in a preservative solution or a preservative paste is applied to the wood. The preservative then moves from the solution or paste into the moist regions in the wood by diffusion, which is movement of a chemical from an area of higher concentration to an area of lower concentration.

In the vacuum process, dried wood is sealed in a treatment cylinder. An initial vacuum is applied and then the cylinder is filled with a waterborne preservative under vacuum. The vacuum is then released as the wood soaks in the preservative. Finally, the preservative is removed and a final vacuum is applied.

VACUUM PROCESS

Vacuum treatment works well with easily treatable woods and wood products. For millwork, the vacuum process provides better penetration and retention than dipping. The wood also dries quickly so it is soon ready for glazing, priming, and painting. A higher initial vacuum and longer soaking period are used for treating lumber than for treating millwork. Retention is less than that obtained by pressure treatment.

CHAPTER 3: WOOD PRESERVATIVES

LEARNING OBJECTIVES

A. Tell how the AWPA Standards are pertinent to the makeup of preservatives and what wood products are treated with them.

B. Describe how oilborne and waterborne preservatives differ in their effects on treated wood.

C. For each preservative covered in this chapter:

- Tell whether it is oilborne or waterborne.
- Briefly discuss its physical features (e.g., liquid vs solid, suspension vs solution) and (if applicable) the roles of its components.
- Tell whether it is applied by pressure, thermal treatment, and/or nonpressure processes.
- If applicable, tell why it helps to heat it during application.
- Describe its effects on treated wood.
- Indicate the types of pests it controls and/or where treated wood can be used (e.g., above ground, in contact with ground or water).
- Give examples of end uses of treated wood products.
- List any important health and environmental concerns associated with wood preservative products and mixes.

INTRODUCTION

Wood preservatives are applied in liquid form and may rely on solvents to carry the toxic chemical(s) into the wood. The solvents used depend on the unique physical and chemical characteristics of a preservative and the intended end use of the treated wood products. The AWPA Standards provide detailed specifications for the makeup of preservatives and solvents.

Because of their chemical and physical differences, wood preservatives also differ in their uses. For example, some preservatives will protect wood that is in ground contact while others will not. The AWPA Use Category System Standards specify the accepted combinations of preservative (including solvent), wood species and product, and end use.

In this chapter, we'll outline some of the key characteristics and uses of common wood preservatives. As you read the chapter, please keep these important points in mind:

- Before using any wood preservative product, check that it is registered for use. Creosote, for example, is registered for use in Wyoming but not others.
- Health and environmental concerns mentioned in this chapter relate to wood preservative products and mixes (unless otherwise noted); health concerns related to handling treated wood will be discussed in Chapter 9, "Post-Treatment Activities."

OILBORNE WOOD PRESERVATIVES

Preservatives are traditionally grouped into two classes based on the solvent type used: oilborne preservatives and waterborne preservatives.

Oilborne wood preservatives are formulated or mixed with solvents such as petroleum oils and mineral spirits; they are largely used where human contact with the treated wood will be rare. The solvent can affect characteristics of the treated wood such as color, cleanliness (oily to the touch), paintability, and odor. Creosote and preservative solutions with heavy, less-volatile oils adversely affect these traits more than solutions with more-volatile, lighter oils or solvents. However, lighter solvents might provide less protection in some situations, so consider all aspects of the wood's end use when selecting a solvent.

Treatment with oilborne preservatives does not make wood swell. The solvents make treated wood less susceptible to cracks and checking.

Keep in mind that oil-based solvents are flammable and can pose health risks to you. Follow safe handling procedures on product labels.

CREOSOTE

Creosote, a distillate of coal tar, is a brownish black, oily liquid with a heavy, tar-like odor. Although it is sometimes classified as an oilborne wood preservative, creosote is more accurately described as an oil-type preservative. It can be used on its own or in solution with either coal tar or petroleum oil to reduce costs. In the latter case, petroleum oil can make up no more than 50% of the creosote-oil solution.

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Creosote treated utility poles

Application and effect on treated wood

Creosote is used in pressure treatments of both hardwoods and softwoods and is always heated before being pressurized into wood because it is too viscous at normal temperatures to penetrate wood effectively. With a lengthy pressure period, heated creosote can penetrate even hard-to-treat wood. Creosote can also be used to treat poles using the thermal process.

Creosote improves the effective dimensional stability of treated wood, which is helpful in long-term performance of treated wood because there is less cracking and splitting. Treated wood is also oily to the touch and does not take paint well, which could limit its uses. Compared to undiluted creosote, solutions with oil reduce weathering and checking.

Pests controlled and use of treated wood

Creosote is effective against most wood-destroying organisms and has a long history of use. It resists leaching and is not very volatile, so it provides long-lasting protection under varied conditions. Treated wood can be used above ground as well as in contact with ground or water. In warm waters, higher retention or dual treatment with CCA (another preservative described later in this chapter) is needed to protect against marine borers.

The primary wood products treated with creosote include railroad cross ties, utility poles, and dock pilings (marine and freshwater) and timbers. Note that these are all exterior, industrial uses. Creosote-treated wood is not for residential use;

nor is it for use indoors where people are or for use near plants, animals, or food.

Health and environmental concerns

According to EPA, creosote contains compounds identified as possible human carcinogens (cancer-causing agents). Its vapors are irritating to the eyes and respiratory tract; prolonged or repeated excessive inhalation exposure may cause inflammation in the respiratory tract and possibly changes in liver, thyroid, and blood elements. Contact with the preservative can cause skin irritation, burns, dermatitis, or sensitivity to sunlight; prolonged and repeated skin exposure in the absence of recommended hygiene practices could result in skin cancer. Creosote is also toxic to animals and its vapors can harm growing plants. For these reasons, creosote is a restricted-use pesticide.

PENTACHLOROPHENOL

Pentachlorophenol, or "penta," is a crystalline, odorless solid that can be dissolved in light or heavy petroleum oil. The desired end use of the wood will influence the choice of solvent.

Application and effect on treated wood

Penta can only be applied by pressure treatment (including by the thermal process). It penetrates most woods well; for hard-to-treat wood, heating and increased pressure times or using lighter oil solvents can increase penetration. After treatment, crystals may form on the wood surface as penta is exuded and the solvents evaporate. You can minimize this blooming by including nonvolatile liquid in solutions which use a solvent that is prone to evaporation.

The solvent used affects the odor and color of the solution (nearly colorless to dark brown); the appearance, cleanliness, weight, and paintability of the treated wood; and how the wood can be used. For example, while heavier solvents cause more problems with paintability, color, and cleanliness of the treated wood and make it up to 20% to 50% heavier, they allow the wood to be used in harsher environments, such as for ground contact.

Pests controlled and use of treated wood

Penta resists leaching because it is relatively insoluble in water. It protects against decay fungi and insects in wood used above ground, in ground contact, and in freshwater.

Penta is most commonly used to treat utility poles and crossarms. As with creosote, wood treated with penta is not for residential use, nor is it suitable for use in living areas or where contact with plants, animals, or food is likely.

Health and environmental concerns

Penta is a restricted-use pesticide because of concerns that it can cause tumors, birth defects, and cancer. (EPA considers it to be a probable human carcinogen.) Because of the concern over birth defects, pregnant women should avoid all direct exposure to penta. Vapors irritate the eyes and respiratory tract. Contact with penta may cause skin disorders or irritation. Inhalation of concentrated vapors or excessive skin contact with penta may cause fever, headache, weakness, dizziness, nausea, loss of coordination, sweating, convulsions, and low body temperature; prolonged exposure could damage the liver, kidneys, and nervous system. Some formulations may be fatal if inhaled or absorbed through the skin.

Penta is also toxic to plants, fish, and wildlife. Penta is a marine pollutant and is not approved for use in wood products that would be used in marine environments.

COPPER NAPHTHENATE

Copper naphthenate is a viscous, dark-green liquid that can be dissolved in heavy or light oils, though formulations that are emulsifiable in water are also available. Use of lighter oils aids penetration into hard-to-treat species.

Application

Copper naphthenate can be applied by pressure (including the thermal process) and nonpressure methods. The latter includes brushing, such as for treating holes or cuts in treated wood that expose untreated wood; a common use is for brushing cut ends of treated wood for exterior use in construction.

Pests controlled and use of treated wood

Copper naphthenate protects against wood-destroying fungi and insects, though less so against termites. Treated wood can be used for above-ground, ground contact, and freshwater uses. Treated softwoods are used for (among other things) utility poles, greenhouse lumber, seedling trays, posts, piers, and docks while hardwoods are used as railroad ties. Treated wood is unsuitable for contact with food or for use in food gardens.

Health and environmental concerns

Copper naphthenate can cause skin and eye irritation, and prolonged skin contact may cause allergic reactions. Wood treated with copper naphthenate has a strong odor but can be used around growing plants after the volatile solvent evaporates.

OXINE COPPER

Oxine copper (copper-8-quinolinolate or “Copper 8”) is a greenish brown solution that contains copper and nickel in equal amounts. It can be dissolved in a range of organic solvents, but protection is best when heavy oils are used.

Application and effect on treated wood

Oxine copper is used for pressure treatment of softwoods and hardwoods and for nonpressure sapstain control. Solutions are heat sensitive, but oxine copper can penetrate hard-to-treat species fairly well without added heat. Treated wood is odorless and can be paintable.

Pests controlled and use of treated wood

Oxine copper is toxic to wood-destroying fungi and insects and is effective above ground but not when in ground contact. Exterior, above-ground uses include playground equipment and decking. Oxine copper is permitted for use in wood that comes in direct contact with food, such as flooring in meat lockers, food pallets, and crates.

Health and environmental concerns

Oxine copper also comes in a water-soluble formulation. In that form, it is corrosive and can cause irreversible eye damage, so be sure to follow the label requirement for wearing goggles.

WATERBORNE PRESERVATIVES

Waterborne preservatives can be dissolved or suspended in water, though they may have other chemicals added (e.g., ammonia, surfactant) to aid in penetration. Most remain fixed in the wood (i.e., resistant to leaching) after treatment. Because water is the carrier, wood comes out wet after treatment; seasoning checks and warping may occur as the wood dries after treatment.

Almost all waterborne preservatives are applied by pressure, primarily on softwoods because hardwoods are difficult to effectively treat. Examples of treated commodities include timber, posts, building foundations, poles, and piling. Waterborne preservatives are especially suited for lumber because when dry, the treated wood is clean to handle, odorless, and paintable. Some waterborne preservatives can be used in nonpressure applications, such as in dip treatments to protect millwork from sapstain; in some of these applications, the preservatives are used on both softwoods and hardwoods.

We will discuss common waterborne preservatives here. Those containing arsenic and/or chromium are registered for industrial and/or agricultural use only.

CHROMATED COPPER ARSENATE (CCA)

The three components of CCA make it a very effective preservative for many situations. Copper protects against most wood-destroying insects and fungi. However, it does not protect against copper-tolerant fungi. Copper may also leach out of wood that is still wet after treatment. These shortcomings are addressed by including arsenates, which kill copper-tolerant fungi, and chromates, which fix the preservative in the wood in insoluble form (making it resistant to leaching) once the wood is drip-free after treatment.

Application and effect on treated wood

CCA is applied by pressure treatment. Although wood weight may double during treatment with CCA because of the water used as the carrier, the permanent weight gain (after wood is allowed to dry) is less than 2%. This is because the retention, or amount of preservative needed to protect the wood, is so small. Treated wood is green but is clean and odorless and can be painted or glued.

Pests controlled and use of treated wood

CCA protects against wood-destroying fungi and insects as well as most marine borers. However, control of carpenter ants is limited because the ants chew tunnels in wood but do not actually eat it. Treated wood is only moderately protected against pholad marine borers.

CCA-treated wood is used for industrial and agricultural applications above ground, in ground contact, or in fresh- or salt water; examples include utility poles, piles, highway guardrail and sign posts, agricultural fence posts, marine construction, and cooling towers. Most applications where human contact is prevalent (including retail lumber sales) were voluntarily phased out in 2004 due to human health concerns (though EPA determined that a recommendation to remove structures comprised of CCA-treated wood was unwarranted). However, use is still allowed for lumber in permanent wood foundations; structural piles used to support residential structures; and treatment of engineered wood products, such as glue-laminated beams, structural composite lumber, and plywood.

Health and environmental concerns

CCA is a restricted-use pesticide because of health concerns. The concentrate is acidic, so it is corrosive and can cause irreversible eye damage. It can irritate the skin and mucous membranes. Exposure to high concentrations can cause headaches, abdominal distress, dizziness, muscle spasms, and convulsions. Prolonged exposure can

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Medicine Bow National Forest

lead to persistent headaches, upper respiratory irritation, liver damage, anemia, and skin disorders. CCA may even be fatal if inhaled or absorbed through the skin. Chromium and arsenic may also be associated with tumor development. CCA is also toxic to fish and wildlife.

AMMONIACAL COPPER ZINC ARSENATE (ACZA)

The ammonia in ACZA is needed to increase the pH to allow for better penetration of the preservative. After treatment, the ammonia evaporates and the preservative is left fixed in the wood.

Application and effect on treated wood

Unlike other waterborne preservatives, ACZA is heat stable; along with the ammonia, procedures such as steaming and extended pressure at elevated temperatures help ACZA penetrate hard-to-treat species like Douglas fir better than CCA. ACZA is also used on some hardwoods. Wood treated with ACZA is similar in performance and characteristics to wood treated with CCA.

Pests controlled and use of treated wood

ACZA protects against decay, insects, and marine borers. Some uses for treated wood include cross ties and switch ties, highway guardrail and sign posts, posts for farm fencing, utility poles, poles for agricultural construction, plywood, freshwater piling, and marine timbers.

Health concerns

As with CCA, ACZA is a restricted-use pesticide due to toxicity and tumor development concerns related to arsenic. It is corrosive and can cause irreversible eye damage, skin burns, and mucous membrane irritation; prolonged or repeated skin contact can cause allergic reactions. It could even be fatal if inhaled or absorbed through the skin.

ALKALINE COPPER QUATERNARY (ACQ) COMPOUNDS

Alkaline copper quaternary (ACQ) compounds come in different forms, or types. As with ACZA, an ammonia carrier improves the penetration of ACQ Type B into hard-to-treat species; for this reason, it is often used in the western U.S. where native trees are hard to treat. Type D has an amine carrier and is used for easier-to-treat woods such as southern yellow pine. Type C uses both carriers.

Effect on and use of treated wood

ACQ can be used on many softwood species and the range of formulations provide flexibility in treating different species for different uses, both above ground and in ground contact. The color of treated wood varies with the chemical type, from dark greenish brown (fading to a lighter brown) with Type B to lighter greenish brown with Type D. The color of wood treated with Type C varies between Types B and D depending on the formulation.

Health concerns

ACQ concentrate is corrosive and can cause skin burns and irreversible eye damage. Prolonged or frequently repeated skin contact with the amine formulation may cause allergic reactions.

COPPER AZOLES

Copper azoles contain copper along with fungicides from a family of chemicals called azoles; together, they protect wood from insects and decay fungi. The two types of copper azole are called dissolved and micronized (sometimes referred to as dispersed), which refer to how the copper is present in the preservative.

In the dissolved type, the copper metal is liquefied into a solution by the use of a chemical. However, the azoles are lighter than water, so you must agitate the concentrate and the diluted treatment solution to maintain a uniform mixture of the azoles.

In micronized copper azoles, tiny particles of copper are suspended in water. The particles are heavier than water, so you must agitate the concentrate and the diluted treatment solution to maintain a uniform mixture of both the copper particles and the azoles.

Pests controlled and use of treated wood

Copper azoles protect softwoods from wood-destroying fungi and insects. Cooper azoles have largely replaced CCA as the preservative of choice for retail sale of lumber for residential uses.

Health concerns

Copper azoles are corrosive and can cause skin burns and irreversible eye damage.

TEBUCONAZOLE AND PROPICONAZOLE

Tebuconazole and propiconazole are fungicides. In addition to being components of copper azole products, tebuconazole and propiconazole can form a stand-alone product which could be mixed with other wood-preserving chemicals such as quaternary ammonium compounds. The fungicides are also formulated with the insecticide imidacloprid for spray, dip, or pressure treatment to protect wood from wood-destroying fungi and insects; treated products include window and door trim, fascia boards, and millwork.

Health concerns

The exposure concerns will vary by product, with some being corrosive and able to cause irreversible eye damage.

MOLDICIDES

Copper azoles are commonly mixed with moldicides prior to application in order to protect treated wood from mold while it dries on the drip pad or in the storage yard. Moldicides (which include such chemicals as isothiazolinones and chlorothalonil) can also be applied on their own by pressure or dip treatment methods.

Use of treated wood

Treated wood products include lumber, landscape timbers, fences, and decks.

Health concerns

Moldicides can be corrosive and cause irreversible eye damage. Prolonged or frequently repeated skin contact may result in allergic reactions. Moldicides in the isothiazolinone group can also cause skin burns and may be fatal if absorbed through the skin.

INORGANIC BORON (BORATES)

Borates leach readily from treated wood; therefore, the treated wood is suited for use only above ground and where it can be protected from wetting. The high solubility actually aids penetration during treatment, as borates follow the water into the wood's interior.

Application and effect on treated wood

Borates can be applied by pressure treatment. One form, sodium octaborate, is especially water mobile and can penetrate hard-to-treat species with the use of heated solutions, extended pressure, and a diffusion period after treatment.

Borates can also be applied by dip and diffusion treatment and some products may be mixed with moldicide prior to application. Borates are allowed for treating cut ends of treated lumber intended for interior use.

Borates add no color to treated wood and so do not interfere with staining.

Pests controlled and use of treated wood

Borates provide excellent protection against wood-destroying fungi and insects (including termites, wood-boring beetles, and carpenter ants). Pressure treatment of various softwoods for framing lumber in areas with high termite hazard and for cabin logs is common. In the latter case, the wood must be stained to prevent the preservative from leaching out when the logs are exposed to rain.

Health and environmental concerns

Borates can cause mild eye irritation but have low toxicity to fish, birds, and mammals.

ACID COPPER CHROMATE (ACC)

Acid copper chromate (ACC) uses chromium to fix the copper in treated wood.

Application and effect on treated wood

ACC can be applied by pressure treatment to both softwoods and hardwoods. However, like CCA, it is not heat stable, so you cannot use higher temperatures during treatment to increase penetration into hard-to-treat species like Douglas fir and white oak. Treated wood is light greenish brown with little odor, clean, and paintable.

Pests controlled and use of treated wood

ACC protects wood against insects, marine borers, and fungi other than copper-tolerant fungi. It is used in cooling towers and for many of the same uses as CCA except that it provides less protection in ground contact situations. As with CCA, ACC-treated wood may not be used for residential purposes.

Health concerns

ACC is a restricted-use product because chromium compounds may be associated with tumor development. It is corrosive and can cause irreversible eye damage. It can irritate the skin and mucous membranes, and prolonged or repeated skin contact may cause allergic reactions. ACC may even be fatal if inhaled or absorbed through the skin.

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CHAPTER 4: SITE DESIGN

LEARNING OBJECTIVES

A. Explain how features of your wood storage yard can affect the preparation, treatment, and post-treatment quality of wood products.

B. Describe the role of each main component in a wood treatment facility.

C. Describe the features and purpose of a containment system.

D. List design features that can protect your water supply from contamination.

E. With respect to water that must be separated from oilborne preservatives:
- List sources of the water.
- Describe how the water is separated from preservative.
- List options for removing the water from the wood treatment facility.

F. Regarding the Wood Preservative Hazardous Waste Listings Rule:
- Tell what preservatives, processes, and sites are subject to the rule.
- Name, describe, and give examples of the four types of wood treatment byproducts that could be considered hazardous wastes under the rule.
- Describe how you can prevent most of the byproducts from being considered hazardous waste.
- Explain how the rule relates to drip pads.

G. Describe acceptable design features of a drip pad.

H. List the conditions under which a storage yard is not subject to drip pad regulations if preservative drips from treated wood in the storage yard.

I. Explain the meaning and significance of clean closure.

INTRODUCTION

Every wood treatment plant receives wood products, gets them ready for treatment, applies preservative to the wood, and properly stores the treated wood before providing it to the customer. Therefore, all plants have certain site features in common regardless of the wood products, preservatives, and treatment methods used.

Features of a wood treatment facility include:
- Storage yards/sheds for treated and untreated wood,
- Areas and equipment for preparing wood for treatment, and
- The wood treatment facility itself.

We will discuss the activities related to each site feature later in the manual. The goal of this chapter is to give an overview of the components and roles of different features of a wood treatment plant.

WOOD STORAGE YARDS

A storage yard should keep untreated wood clean and dry, which allows preservative to penetrate the wood more readily. Also, limestone dust in the storage yard can get into open dip treatment tanks and may cause some preservatives to precipitate and drop out of solution. A paved or otherwise hard surface that minimizes dust and that keeps the storage yard free of weeds will keep wood clean and dry and help ensure the wood is properly treatable.

The size of the storage yard and whether or not it is under cover will depend on the plant's treatment capacity and how the untreated wood is dried. Wood is often dried before being delivered to the plant. If it hasn't been and is instead air dried at the plant, more space is needed to keep the wood in inventory because air drying takes time.

The storage yard for treated wood should also keep wood clean and dry. This reduces preservative leaching (e.g., of water-soluble preservatives such as borates), makes the wood easier for customers to handle, and reduces the weight of the wood products (thus reducing shipping costs). The size of the storage area needed for treated wood will depend on your plant's treatment capacity and whether or not you store treated wood for your customers.

WOOD PREPARATION AREA

Though preparing and processing wood prior to treatment is generally outside the scope of a wood treater's duties, you need to be familiar with what constitutes the proper condition of wood that you treat. Therefore, this topic will be discussed in detail in Chapter 6, "Preparing Wood for Treatment."

WOOD TREATMENT FACILITY

The layout of the wood treatment facility depends primarily on the preservatives and processes used, though it will vary somewhat even among plants in which those factors are the same.

PRESSURE TREATMENT FACILITIES USING WATERBORNE PRESERVATIVES

As shown in Figure 4-1, the main facility components include:

- A delivery area where preservative is delivered as a liquid concentrate via a tanker truck or railroad car or as a solid.
- A concentrate tank (Figure 4-2) into which newly delivered liquid preservative is pumped or a mix tank in which solid preservative (e.g., some borates) is

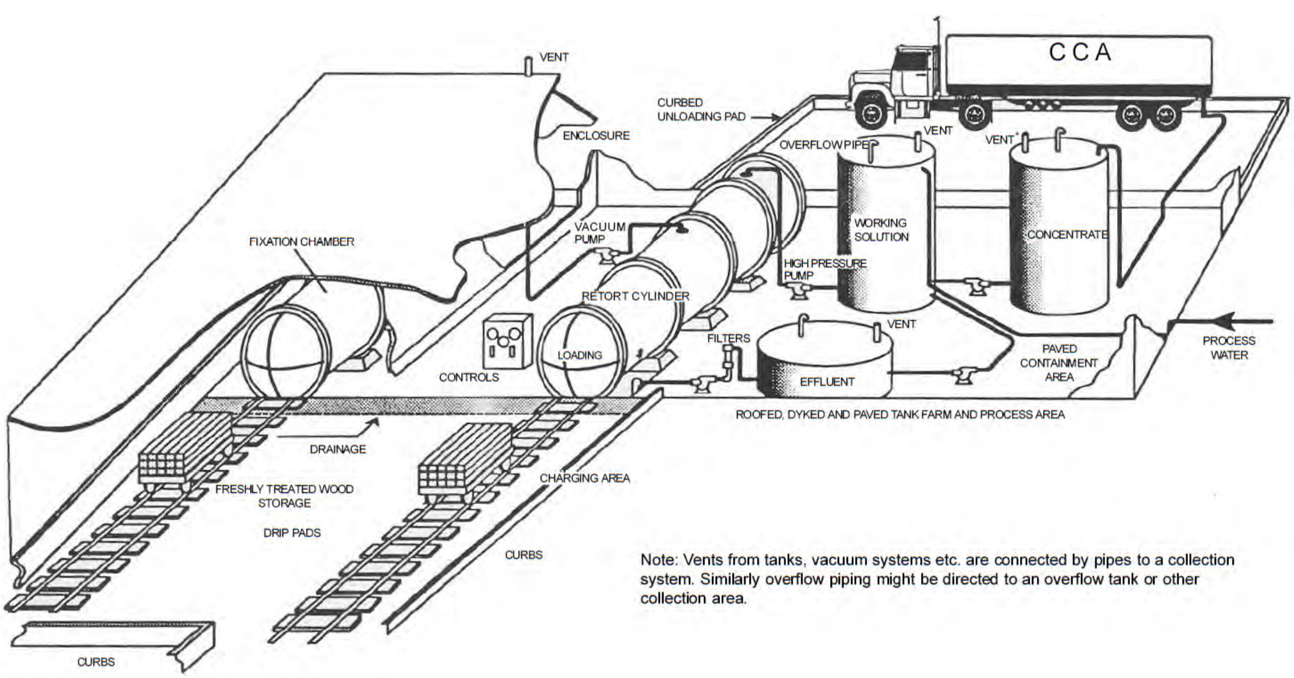

Figure 4-1. Sample layout of a wood treatment plant that uses CCA.

Source: Recommendations for the Design and Operation of Wood Preservation Facilities, 2013, Environment Canada © Her Majesty The Queen in Right of Canada, as represented by the Minister of Environment, 2014. The Environment Canada data is available online, at no cost, by visiting www.ec.gc.ca.

Figure 4-2. Preservative tanks

Figure 4-3. Tote containing moldicide.

dissolved in water, and often a storage area for totes containing additional chemicals used to make up the preservative solution (Figure 4-3).

- A work tank in which a preservative mix is brought to the proper concentration for treating wood. (This is sometimes also called a mix tank.)
- An effluent recovery tank (more often called a collection pit, or catch basin) that collects drippings, leaks, wash water, and other preservative-contaminated waters for reuse in the treatment process.
- A water tank. Contents of the collection pit and/or water tank can be mixed with preservative from the concentrate tank to adjust the volume and concentration of a preservative mix in the work tank.
- A cylinder (Figure 4-4) in which wood is treated under pressure with preservative from the work tank. A cylinder typically has one door with a sump pit directly under it. The pit collects any preservative solution and sludge that comes out of the cylinder when the door is opened at the end of the treatment process.

Figure 4-4. Treatment cylinder (on right)

- In plants that use CCA, a system to collect exhausts from the cylinder reduces the treater's risk of inhalation exposure.
- Rarely, a fixation chamber for accelerating the fixation of some waterborne preservatives in treated wood.
- Vacuum pumps, high-pressure pumps, piping, and line filters associated with providing the treatment process conditions (e.g., initial vacuum, pressure period) and moving preservatives, water, and the treatment mix into and out of tanks and the cylinder.
- Tracks on which trams move wood products into and out of the treatment cylinder (Figure 4-5).
- A drip pad, which extends from the cylinder opening past the tracks on which trams move and as far to the sides as suits the plant's needs. Freshly treated wood is held on the drip pad until it stops dripping excess preservative. The drip pad needs to be covered because precipitation falling on freshly treated wood could leach the preservative out of the wood. We will discuss the drip pad in more detail later in this chapter.
- Office and laboratory space. Some office space might be located outside of the treatment facility, but there is usually some within the facility, especially if the treatment process is computer controlled. Laboratory space is almost always within the facility and is used to determine the concentration of preservative in treatment solution and to analyze samples of freshly treated wood for penetration and retention.

Figure 4-5. Tracks spanning over door pit from drip pad to cylinder.

Containment system

All components of the treatment facility should be on a curbed, continuous, and impervious containment pad that, along with the drip pad, drains into an effluent tank (catch basin). Contents of the effluent tank can be used for make-up water and pumped into the work tank for preparing the preservative mix. This ensures that any preservative or water that may leak or spill onto the pad can be reused rather than escape into the environment or be disposed of as waste.

The facility should be covered to prevent precipitation from adding to and diluting any preservative recovered by the collection system. Finally, the facility (aside from the drip pad area) needs to be heated if the plant is in an area that experiences freezing temperatures.

Water supply

Plants that use waterborne preservatives need a ready source of water for preparing treatment mixes. A water tank (Figure 4-6) is typically filled by pumping water from a well or municipal water supply through a pipe that empties into the top of the tank. Some plants also collect rainwater to use in preparing the preservative mix.

Protecting Water Supply from Contamination. Depending on facility design, a sump that collects some wastewaters might pump its contents into the water tank for use in future mixes. It is therefore important to prevent backflow of potentially contaminated water from the water tank into the well or municipal water supply.

One or more of the following should be in place to prevent contaminating the water supply due to backflow, and may be required by state law:

- A check valve or other backflow prevention at the water source.
- A check valve in the intake line at the top of the water tank.
- An outlet pipe, located below the intake line of the water tank, that would direct overflow into a second water tank before the water level could reach the intake line. This also ensures that there is always an air gap between the intake line and the water level as the water tank gets filled, further protecting against backflow into the water supply.

Water Chemistry. Water chemistry can also be an issue in wood preservation. For example, calcium in hard water might build up in a work tank and be difficult to remove. It can also affect preservative stability in solution. Likewise, well water that is high in sulfur or iron may interfere with some preservative chemicals. If you have issues with water chemistry, you may benefit from using appropriate filters on water intake lines or a water softener.

Figure 4-6. Water tank.

PRESSURE TREATMENT FACILITIES USING OILBORNE PRESERVATIVES

Most of the design requirements for facilities using waterborne preservatives also apply to those that use creosote or oilborne preservatives. However, there are some important differences. Though chemical tanks do not need to be kept within a heated area, facilities treating with creosote or penta require a heat source for warming the preservative and, if applicable, to carry out steam conditioning.

Also, facilities must have equipment designed to separate preservative solution from water that is used in steam conditioning, is extracted from wood during treatment or the Boulton process (described in Chapter 6, "Preparing Wood for Treatment"), is used to clean up leaks and spills, or falls on the drip pad as precipitation. Water that boils out of wood (e.g., during the Boulton process) escapes through the top of the cylinder as vapor; it is then piped to a condenser, and the condensate falls into a collection tank. Water from the collection tank and other sources listed previously is pumped into an effluent tank with an oil/water separator (also called a decant tank). If an effluent tank contains water and oil, the oil will rise to the top and can be sucked off into the work tank. The remaining water can be treated on site to remove contaminants; it can then be evaporated by exposing it to heat or, if you have a permit to do so, discharged to a publicly owned treatment work (POTW).

THERMAL TREATMENT FACILITIES

Thermal treatment uses creosote or penta solutions. Facilities doing thermal treatments differ from pressure treatment facilities in that they have two work tanks—one for hot solution and one for cold solution—and a treatment tank rather than a treatment cylinder. Wood is lifted in and out of the treatment tank rather than pushed in on trams. Chemical, treatment, and effluent tanks are located on curbed containment pads and freshly treated wood is moved to a drip pad.

DIP TREATMENT FACILITIES

The design of a dip treatment facility is a bit simpler than that of a thermal treatment facility. For dip treatment, the work tank and treatment tank are one in the same: the dip tank (Figure 4-7).

The dip tank and the containers in which chemicals are delivered are all within a sloped containment area. Wood is lifted in and out of the dip tank and freshly treated wood is moved to a drip pad. As with the other types of treatment facilities we've discussed, any spills, leaks, drippage, wash water, or precipitation within the containment area and drip pad are collected in a catch basin and pumped back into the dip tank.

DRIP PADS

You likely noticed that each type of wood treatment facility is in a contained area and places freshly treated wood on a drip pad (Figure 4-8). Here, we will discuss the reasons for this and the regulatory requirements for drip pad design. Although all wood-treating facilities are encouraged to have drip pads as discussed here, the information presented below is based on federal regulations that govern drip pads only at wood treatment facilities that produce specific hazardous wastes. We will address those regulations briefly so you will better understand the role of drip pads.

(The EPA considers a waste to be hazardous if it has certain chemical characteristics or poses either human health problems or substantial risks to the environment when improperly managed. Hazardous wastes have special handling, transport, and disposal requirements, which we will discuss in the next chapter.)

HAZARDOUS WASTE LISTINGS RULE

In the 1980s, significant health and environmental concerns arose due to contaminated soil, groundwater, and surface water at wood treatment facilities. As a result, the EPA established the Wood Preservative Hazardous Waste Listings Rule for certain wastes from wood-preserving processes that use penta, creosote, or inorganic preservatives containing arsenic or chromium. (The wastes are referred to as F032, F034, and F035 for plants that use penta, creosote, and inorganic preservatives containing arsenic or chromium, respectively.) This applies to pressure and nonpressure processes

Figure 4-7. Wood loaded onto dip tank platform

Figure 4-8. Covered drip pad

with the exception of wood surface protection for sapstain control. Also, only wastes generated at treatment plants are considered hazardous.

Wood-treating facilities that have switched from using penta, creosote, or inorganic preservatives containing arsenic or chromium to using other preservatives are still subject to the Hazardous Waste Listings Rule until they comply with the rule's requirements for clean closure.

Regulated wastes

The following byproducts of preserving wood with penta, creosote, or inorganic preservatives containing arsenic or chromium are considered to be hazardous wastes subject to the EPA ruling only if they cannot be reclaimed for reuse:

- Spent formulations, which includes any preservative solution left over from a treatment;
- Preservative drippage, which is excess preservative that is kicked back from wood following treatment and free drippage of preservative from freshly treated wood (Figure 4-9);
- Wastewaters, which include any waters (except those which are an integral part of a preservative solution) that come in contact with preservatives, contaminated equipment, or process wastes (e.g., waters from steam-conditioning prior to treatment and water generated from rinsing equipment and the process area); and
- Process residuals (Figure 4-9), which include precipitated preservative solution, sawdust, and wood chips that settle out during treatment and items such as cylinder door gaskets, line filters, and broken tie-down straps that need to be replaced.

Reuse of regulated wastes

Of these potential wastes, all except process residuals are reclaimed for reuse in a well-designed and managed wood treatment facility. Spent formulations are typically returned directly from the treatment cylinder to a storage or work tank. Preservative drippage occurs in the treatment cylinder or on the drip pad, so it is returned to a storage or work tank directly or via the collection pit. Wastewaters, being part of the treatment process or produced within the contained area of a facility, are all directed to the collection pit and then back into the treatment process.

Figure 4-9. Examples of regulated wastes: preservative drippage from freshly treated wood (left) and process residuals, including sawdust, wood chips, and tags in a cylinder (right).

PURPOSE OF THE DRIP PAD

A drip pad consists of a curbed, free-draining base constructed of non-earthen materials and sloped to convey preservative kick-back or drippage from treated wood (as well as any surface water run-on that gets on the pad) to a collection system for reuse. For wood treatment facilities covered by the Hazardous Waste Listings Rule, drip pads are regulated as hazardous waste management units under the federal Resource Conservation and Recovery Act (RCRA). They are exclusive to the wood-preserving industry and are used solely for the collection and temporary accumulation or storage of excess wood preservative prior to the removal of treated wood from the pad. Also, sumps and collection devices used in association with a hazardous waste drip pad are regulated as hazardous waste tanks.

DESIGN STANDARDS

Drip pads must be constructed of materials that have enough structural strength to prevent failure of the unit under the weight of the waste, preserved wood products, personnel, and any moving equipment used in wood-preserving operations. A raised curb or berm around the perimeter is required to prevent wastes from running over the edges of a flat pad. Furthermore, the pad surface must be sloped toward a collection unit, such as a sump or basin, to simplify removal of wastes from the pad.

A stormwater run-on and run-off control system must be used unless the pad has enough capacity to hold precipitation that might end up on it or is protected from precipitation (e.g., covered or indoors).

To prevent wastes from passing through the pad and into adjacent subsurface soil, groundwater, or surface water, a pad must:

Have its surface treated with an impermeable sealer, coating, or cover to meet specific permeability performance standards; and/or

Be provided with an underlying synthetic liner, a leak detection system that must be able to signal releases from the pad at the earliest practicable time, and a leak collection system to remove wastes accumulating on the synthetic liner.

STORAGE YARD DRIPPAGE

Infrequent and incidental storage yard drippage after wood has been removed from a drip pad is still hazardous waste, but the yard is not subject to drip pad regulations provided that the releases are immediately cleaned up in compliance with a written contingency plan developed by the owner/operator. The plan must stipulate how responses are to be conducted and documented, what methods will be used to ensure records are retained for 3 years, and how contaminated media and residues will be managed in accordance with applicable federal regulations.

CLEAN CLOSURE

As mentioned earlier, the hazardous Waste Listings Rule also provides requirements for clean closure of wood treatment plants that have stopped using penta, creosote, or inorganic preservatives containing arsenic or chromium. Clean closure ensures that future wastes produced at the facility will not be contaminated with wastes listed under the Hazardous Waste Listings Rule. Plants which achieve clean closure will not be subject to the rule so long as they use preservatives other than those specified in the rule.

CHAPTER 5: SITE MANAGEMENT

LEARNING OBJECTIVES

A. List sources of personal protective equipment requirements.

B. Indicate two conditions under which you must wear a respirator.

C. Give examples of how you can detect a problem with a pump, valve, filter, or line.

D. Describe the lockout/tagout procedure used when repairing or replacing pumps and valves.

E. Give examples of common problems that can occur with preservative tanks and treatment cylinders.

F. Define and give examples of permit-required confined space.

G. List an employer's responsibilities for protecting employees with respect to permit-required confined spaces.

H. List requirements for maintaining drip pads.

I. Describe drip pad inspection procedures required by the Hazardous Waste Listings Rule.

J. Give reasons why you benefit from reducing the amount of waste your facility generates.

K. Give examples of how you can reduce the amount of waste your facility generates.

L. Describe proper procedures for storage and disposal of solid and hazardous wastes (including satellite accumulation of hazardous waste).

M. Explain the need for emergency planning.

N. With respect to the federal Emergency Planning and Community Right-to-Know Act:
- State the purpose of the Act.
- Tell how you can determine whether you need to comply with the Act.
- Briefly explain what you must do if you are subject to the emergency planning and/or community right-to-know provisions of the Act.

O. Explain the purpose of a contingency plan for large- and small-quantity hazardous waste generators.

P. Tell when and to whom you need to report a spill.

Q. Give examples of how you can prevent spills.

R. Describe ways to clean up and reclaim discharges of preservative within a facility's containment area.

INTRODUCTION

A typical wood preservation plant stores, uses, and reclaims large quantities of chemicals. This situation, along with the waste products that are produced, can pose risks to workers, the environment, and the community; as a result, the wood treater likely has to deal with numerous safety regulations. Also, the equipment used does heavy work, requiring frequent inspection and maintenance. The wood treater's job, then, involves more than just treating wood. In this chapter, we'll discuss your additional duties that relate to managing the facility itself.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

All personnel handling treated wood or handling treating equipment (including poles/hooks used to retrieve charge cables) that has come into contact with preservative must wear the following PPE:

- Washable or disposable coveralls or long-sleeved shirt and long pants,
- Chemical resistant gloves, and
- Socks plus industrial grade safety boots with chemical resistant soles.

All personnel cleaning or maintaining the treatment cylinder gasket/equipment or working with concentrate or wood treatment preservative must wear the following PPE:

- Washable or disposable coveralls or long-sleeved shirt and long pants,
- Chemical resistant gloves,
- Socks plus industrial grade safety boots with chemical resistant soles, and
- A full face shield.

In the event of equipment malfunction, or for door spacer placement, all personnel located within 15 feet of the cylinder opening prior to cylinder ventilation must wear the following PPE:

- Washable or disposable coveralls or long-sleeved shirt and long pants,
- Chemical resistant gloves,
- Socks plus industrial grade safety boots with chemical resistant soles, and
- A properly fitting half mask elastomeric respirator with appropriate cartridges and/or filters.

Figure 5-1. Example of a label's PPE statement, showing how requirements may vary depending on the task involved.

PROTECTING WORKERS

Working with chemicals requires you and your co-workers to follow workplace regulations and to use personal protective equipment. Also, you might work with heavy machinery (e.g., fork lifts), power equipment (e.g., for cutting or incising wood prior to treatment), and electrical systems. You need to be aware of and remain current on pertinent safety training and practice requirements issued by the federal Occupational Safety and Health Administration (OSHA), though we will not address many of them in detail here because they are outside the scope of pesticide applicator training.

PERSONAL PROTECTIVE EQUIPMENT

The minimum requirements for personal protective equipment (PPE) to wear are listed on the preservative label and may vary depending on the task involved (Figure 5-1).

In addition, some plants contract with chemical manufacturers for services (e.g., software development and upgrades for use in the treating process); as part of that, the manufacturers may impose additional PPE requirements for anyone who enters the treatment facility (e.g., plant employees, drivers who deliver chemical). The treatment plant might also have its own set of requirements. Finally, OSHA regulations specify PPE requirements for certain activities or conditions (some of which will be discussed later in this chapter). Whatever the source of the PPE requirements, it is good practice to document the requirements and make sure everyone complies with them.

Generally speaking, it is wise to wear chemical-resistant gloves whenever exposure is possible, such as when you take samples of preservative solution; repair or replace valves, pumps, or filters; clean contaminated equipment; or load or unload wood into the treatment vessel. Protective eyewear is warranted whenever splashes are possible or if you are working on something overhead (e.g., a valve or sensor). You may be required to wear a respirator for some tasks, such as cleaning out tanks or cylinders. Your treatment plant or OSHA might require you to wear a hard hat and/or orange vest when working in some parts of the facility; be sure you are familiar with these requirements.

Know location of emergency showers and inspect them weekly. Run eyewash stations often to make sure the water stream is not plugged (e.g., by hard water sediments).

OSHA and EPA may establish a permissible exposure limit (PEL) for a preservative. The PEL is expressed in micrograms of chemical per cubic meter of air averaged over an 8-hour day. For example, in the treatment of wood with preservatives containing arsenic, EPA has adopted OSHA's PEL of 10 micrograms of arsenic per cubic meter of air. Unless air monitoring shows that the PEL will not be exceeded, wood treatment plant employers must require all employees potentially exposed to airborne chemical to wear properly fitting, well-maintained, high-efficiency filter respirators MSHA/NIOSH-approved for the chemical involved. Such respirators must be worn for the entire period that employees are in the treatment application work area or are engaged in any activity associated with the treatment process. (Comply with fit testing and monitoring requirements in OSHA's rule on respiratory protection, 29 CFR Part 1910.134, which can be viewed online at https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=12716.)

Labels of creosote, penta, and inorganic preservatives containing arsenic or chromium also require you to wear an approved respirator if you are within 15 feet of an opened cylinder door before ventilation criteria are met. We will discuss

Chapter 5

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Mohd Nasri Bin Mohd Zain, shutterstock.com this in more detail in Chapter 9, "Post-Treatment Activities."

INSPECTING AND MAINTAINING EQUIPMENT

Wear the appropriate PPE (e.g., as required by the preservative label) and comply with OSHA regulations and your company policy when you inspect, maintain, repair, or replace any equipment that comes in contact with preservatives.

PUMPS, VALVES, AND FILTERS

Pumps (Figure 5-2), valves, and filters need regular maintenance and occasional repair or replacement. If you contract with your chemical supplier for service, they might train you in these tasks and/or provide repair services.

Pumps

Check the oil level in pumps frequently to avoid damage to the pump motors. At plants using dispersed copper azoles, the pump that moves copper concentrate from the delivery vehicle into the storage tank needs to be cleaned after delivery because copper settles out and the pump could seize up when used next.

Pumps can wear out, so you may have to repack them or replace mechanical seals. Preservative dripping from a pump can indicate a bad seal. If this happens, place a container under the pump so you can collect and reuse the leaking preservative more easily.

Valves

Valves (Figure 5-3) can also go bad. Leaking valves are easy to detect, but other problems require more careful attention. Sometimes, a paddle in the valve goes bad and you will hear it make an unusual noise.

At plants that use computer software to run the treatment process, you may be able to tell from what you see on the computer monitor whether a valve is opening and closing as it should. You should also walk around the plant during a treatment to make sure valves are operating properly. If you see a valve opening or closing slowly, it may need adjusting. A sticking valve may jerk and make a thumping sound as it opens. You might be able to adjust slow and sticking valves with wrenches.

Filters

If pressure is not building up properly, preservative is not being pumped into the cylinder at the

Figure 5-2. Vacuum pump

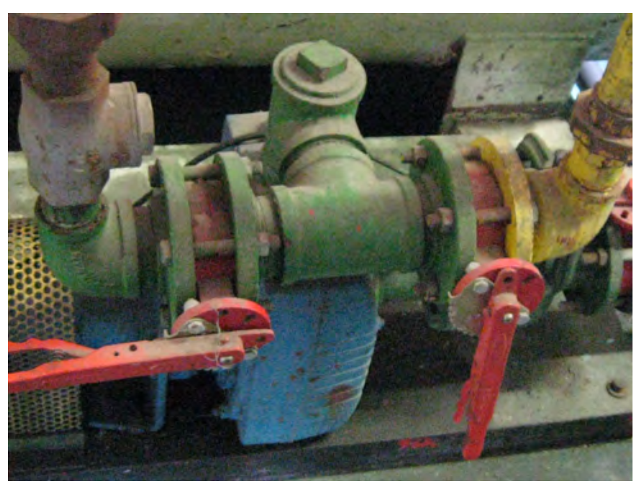
Figure 5-3. Valves on feed lines from work tanks to a cylinder

rate expected, or a pump screeches, it might be that a filter (Figure 5-4) or line is clogged. When you replace a filter, you will want to reclaim any preservative solution trapped in the filter. To do this, hold the filter over a barrel, sump, or drain—anywhere that allows the drips to eventually be directed into the collection pit for reuse. This saves money by saving chemical and by reducing disposal costs. Correcting a clogged line would likely be more involved and more expensive.

If you need to examine or remove a pump or valve to maintain, repair, or replace it, use the lockout/tagout (also called lock and tag) procedure. (Figure 5-5; details are provided in OSHA's Occupational Safety and Health Standards Subpart J 1910.147 at https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9804.)

When working on a pump, for example, you would need to lock the pump's power source in the off position and tag the power source to indicate the pump is down for maintenance. The tag must indicate who took the pump out of service and that the power supply and pump cannot be used until the tag is removed. The person who works on the pump must keep the key so that the power source will not be turned on until the pump is put back or replaced. This protects workers from electrical shock, getting fingers caught in moving parts, and being sprayed by leaking preservative. When working on a valve, the lockout/tagout also prevents preservative from flowing to the valve.

TANKS AND TREATMENT VESSELS

Dip tanks, tanks that hold preservative concentrate or mixes, and treatment cylinders occasionally need repair or cleaning out. Here, we'll discuss some common maintenance issues and related worker safety concerns.

Dip tanks

Hydraulic cylinders that raise and lower a platform into a dip tank may occasionally leak oil into the tank. This usually does not affect the lumber, but you can use absorbent pads or even a boom kit to soak up the oil. When dip tanks need the occasional cleaning, you can pump treatment solution from the tank into a tanker truck, clean out and dispose of the sludge at the bottom of the tank, and return the solution to the tank.

Preservative concentrate and work/mix tanks

A preservative storage or work tank may have an external sight gauge and/or an external valve near the bottom of the tank. Inspect these for leaks

Figure 5-4. Cleaned line filter

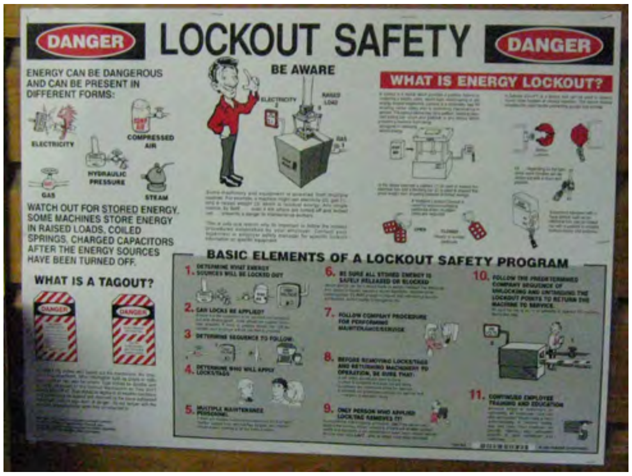

Figure 5-5. Lockout/tagout safety poster displayed in work area.

regularly. You can also close the valve when the tank is not in use to further prevent leaks.

As we discussed in Chapter 3, some preservatives need to be agitated in the concentrate and/or work tank to keep the chemicals in suspension. If blades are used for agitation, the pump that works them might fail. You should notice this relatively easy because the pump will be silent. Use the lockout/tagout procedure and repair or replace the pump. Sometimes, the blades themselves might fail. If you notice the problem right away, one solution would be to use up the contents of the tank immediately and then proceed to repair or replace the blades. Sometimes, you won't know the blades are broken until assays of treated wood indicate there is a problem with the mix (e.g., if wood treated with copper azole contains less azole than it should).

Sensors that indicate the level of preservative in a tank may need to be cleaned periodically because the chemical gets in the sensor and can gum it up. Be sure to wear chemical-resistant gloves and any other PPE you feel is needed to prevent exposure.

Treatment cylinders

The seal of a cylinder door may need to be greased periodically to help maintain the seal. Replace the cylinder door gasket periodically.

The cylinder itself may need to be cleaned out. For example, if you switch preservatives, residues from the one you had been using might adversely interact with the new preservative, so you need to clean out the system to ensure proper treatment. Sometimes, you just need to clear out debris or get to a clogged screen that is not accessible from the outside.

Entry into permit-required confined spaces

Sometimes, someone needs to enter a storage or work tank or treatment cylinder for maintenance, cleaning, or to make repairs (e.g., broken agitation blades, failed welds; see Figure 5-6). Entry into such equipment may require a permit under 29 CFR Part 1910, Subpart J, Section 1910.146 (Permit-Required Confined Spaces). OSHA defines a confined space as one that:

- Is large enough for an employee to enter fully and perform assigned work,
- Is not designed for continuous occupancy by the employee, and
- Has a limited or restricted means of entry or exit.

This definition clearly applies to cylinders and many types of tanks. Further, a permit-required confined space meets the above definition and:

- Contains or has the potential to contain a hazardous atmosphere,
- Contains a material with the potential to engulf someone who enters the space,
- Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section, and/or
- Contains any other recognized serious safety or health hazards.

Your employer must determine whether any spaces in your facility meet the definition of a

Figure 5-6. A welder certified in confined space entry would be needed to repair this broken weld on a track inside a cylinder.

permit-required confined space (also called permit space). If so, your employer must post a sign such as one shown in Figure 5-7 on each permit space to warn you and others of the danger.

With regard to entry into permit spaces, your employer can choose to:

- Prohibit employees from entering permit spaces. In this case, the employer must take steps to prevent employee entry.
- Hire a contractor when entry into permit spaces is necessary. In this case, the standard specifies the responsibilities of both the employer and the contractor to ensure the safety of workers who enter permit spaces. This would include the contractor complying with the permit requirements of the standards.
- Allow employees to enter permit spaces to conduct necessary tasks. This would require the employer to go through the permit process.
- Allow employee entry without a permit provided that the only risk involved is an actual or potentially hazardous atmosphere and that the employer can show that forced air ventilation alone can remove the hazard.

If an employee is to enter a permit space, the standards specify the duties of the person entering the space, the person designated as the entry supervisor, and a third person (the attendant) who must be available outside of the space in case the person entering needs assistance. The standards also require the employer to provide such things as employee training, appropriate personal protective equipment, any equipment necessary for safe entry and exit (e.g., ladders), and rescue and emergency response procedures.

You can view the standards at https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.146. A useful summary is also available at https://www.osha.gov/confined-spaces.

Figure 5-6. Sign posted next to a cylinder door to warn workers that the cylinder is a permit-required confined space.

DRIP PADS

The discussion here on drip pads is specific to those at wood preservation plants that are subject to the Hazardous Waste Listings Rule; that is, plants that use creosote, penta, or inorganic preservatives containing arsenic or chromium, or that formerly used those preservatives but have not met the clean closure requirements of the rule. Drip pads of similar design and operation are used at plants using other preservatives. However, they are not subject to the inspection, documentation, and reporting requirements of the Hazardous Waste Listings Rule discussed below; the frequency and extent of these activities would be up to plant managers and/or your state regulations.

Operating standards

Maintain the drip pad so that it is free of cracks and shows no signs of corrosion or other forms of deterioration. Clean it frequently so that the entire surface is free of obstructions during weekly inspections. Document the date, time, and method of each cleaning and manage the cleaning residues as hazardous waste. (Remember, such waste is hazardous only at facilities subject to the Hazardous Waste Listings Rule.)

Drippage and precipitation must be emptied into a collection system often enough to prevent overflow at the curbed perimeter. Empty collection tanks as soon as possible after storms to ensure adequate capacity for accommodating future precipitation.

Inspections

The types and frequency of inspections depend in part on when the drip pad was built. According to regulation, a pad is considered existing if it was built (or contracted to be built) prior to December 6, 1990. Pads built after that date are considered new. Remember that state regulations (e.g., for state pollutant discharge elimination system [SPDES] permitting) may be more restrictive and encompassing than the federal requirements described here.

Until an existing pad is brought into full compliance with the regulations described earlier, it must be inspected annually by an independent engineer to assess its integrity with respect to protecting human health and the environment. The engineer must also document the extent to which the pad does comply with the regulations.

New or fully upgraded existing pads must be inspected by an independent engineer at time of construction/upgrading to certify that the pad meets design standards.

Regardless of whether the drip pad at your facility is new, existing, or fully upgraded, you must inspect it weekly and after storms to ensure the pad and its associated liquid collection system are functioning properly and to detect any deterioration of or leaks from the units. (Note: inspections must be daily if you neither use leak detection equipment nor document and follow established workplace practices to ensure prompt detection of leaks.) Check joints, seams, and the sealer and monitor the water below the pad if you detect any cracks. Any portion showing deterioration must be removed from service for repairs in accordance with specified procedures in the regulation. If hazardous wastes have been released into the environment, take appropriate cleanup measures; a release may be reportable under the Emergency Planning and Community Right-to-Know Act (EPCRA; discussed in more detail later in this chapter).

MANAGING WASTE

Any waste you generate has to be handled and disposed of. Doing so presents risk of exposure to you and your co-workers, risk of environmental contamination if the waste is improperly contained and disposed of, and sometimes hefty disposal costs. Therefore, reducing the amount of waste you generate and properly storing and disposing of waste are important tasks in managing the treatment facility.

Plants that use creosote, penta, or inorganic preservatives containing arsenic or chromium, or that used to use these chemicals but have not met EPA's requirements for clean closure under the Hazardous Waste Listings Rule must dispose of any waste as hazardous waste. Hazardous waste disposal is expensive, so it is very important to be able to collect and reuse liquids that leak or drip into the contained portion of your facility. Even emergency showers, in place for response to chemical exposure, can be plumbed so that they drain into the collection pit.

REDUCE WASTE

The containment area, including the drip pad, reduces waste generation by allowing you to reclaim preservative that occurs in wastewaters and drippage. You can maximize this benefit by keeping the facility clean.

For example, you can use separate forklifts for handling wood products on the drip pad and in the storage yard (Figure 5-8). Keeping one forklift dedicated to the yard area prevents dirt and mud from being tracked onto the pad; such debris would become waste and would add to waste disposal costs. Likewise, keeping a separate forklift on the pad prevents any preservative that gets on the tires from contaminating the soil in the storage yard; in addition to the risk to the environment that this would pose, such soil would have to be cleaned up and disposed of, again adding to costs. Similarly, cleaning mud or dirt off wood before it is treated prevents these materials from becoming waste on the drip pad or in the treatment cylinder or tank.

Pay attention to details. Do not allow workers to eat or drink on the drip pad or in the containment area because any food and food or beverage containers that are dropped will become waste. To avoid tracking preservative outside the containment area, use a hose to wash off contaminated footwear over a drain that leads to the collection pit.

Some preservative chemicals, such as moldicides, come in reusable totes. When a tote is emptied, recap it, set it aside, and arrange to have it picked up for reuse by the chemical company or distributor. Keep a record of tote deliveries and pickups so you can document their proper handling.

RECLAIM PRESERVATIVE FROM CYLINDER DOOR PIT

A vacuum or sump pump draws liquid out of the door pit for reuse. Depending on how the facility is designed, the liquid could be directed into the cylinder, the work tank, or the collection basin. However, some solids and sludge also collect in the door pit, so you will need to clean these out on a regular basis. When entering the pit, wear chemical-resistant gloves and footwear (perhaps even hip waders or a spray suit). Remove large items such as bits of wood or broken tie-down straps by hand. Any sludge in the pit would have to be removed by shovel.

Place all the solid refuse and sludge in a drum on the drip pad for temporary storage of the waste. It is a good idea to have holes drilled in the drum so that any preservative can leak out onto the drip pad. This practice saves money by allowing you to reuse the preservative and by reducing waste disposal costs, which are based on weight.

SOLID WASTE STORAGE AND DISPOSAL

Waste that is not regulated as hazardous waste is considered solid waste. Process residuals such as wood chips, sludge, and used spill pillows from wood treatment facilities that are not subject to the Hazardous Waste Listings Rule are examples of solid waste. Solid waste can be disposed of in

Figure 5-8. Transferring wood from storage yard to drip pad with two forklifts, one that stays on the pad and one that stays off of it.

sanitary landfills or through the recycling stream; this is less expensive than disposing of hazardous waste, which is why the expensive process of conducting a full clean-out of facilities that handled penta, creosote, or inorganic preservatives containing arsenic or chromium may be more economical in the long run.

Store solid waste in labeled drums, dumpsters, or barrels in a designated part of the facility. Some solid wastes may be used for other purposes. For example, sawdust from wood treated with borates might be able to be used as a fertilizer, though a permit may be required.

HAZARDOUS WASTE REGULATIONS

Hazardous wastes are regulated under the federal Resource Conservation and Recovery Act (RCRA) and your own state's regulations. EPA's Wood Preserving Resource Conservation and Recovery Act Compliance Guide (available on line at https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100MC0U.txt) is a good resource for your industry. Keep in mind it was produced in 1996 and so will not reflect more recent changes in regulations. However, it is good for presenting the regulatory framework for the industry.

Here, we will briefly outline some of the key aspects of federal hazardous waste regulations. For more information, you can also go to https://www.epa.gov/hw or https://www.epa.gov/rcra for general information on RCRA and contact information for answering any questions.

State laws and regulations may be more stringent than federal requirements. Check with the Wyoming Department of Environmental Quality to make sure that you comply with requirements.

Hazardous waste generators

RCRA classifies hazardous waste generators, such as some wood treatment facilities, based on how much hazardous waste they generate on a monthly basis: a facility might be classified as a large-quantity generator, small-quantity generator, or conditionally exempt small-quantity generator. Obviously, the more waste you generate, the stricter the regulations you will be subject to; this is yet another way in which reducing waste will benefit you.

Hazardous waste storage

Designated Storage Area. Store hazardous waste in a designated, contained hazardous waste accumulation area. Mark all containers with hazardous waste labels (Figure 5-9). On each label, write the date on which you begin to accumulate waste in the container within the designated accumulation area or, for containers brought in from a satellite accumulation area (described below), the date on which the container was brought in; this date begins the clock in regard to

how long you may store the waste on site according to the hazardous waste generator requirements mentioned earlier. Inspect containers weekly for leaks or corrosion; replace any that begin to leak. Keep containers closed and sealed except when they are being filled or emptied.

Satellite Accumulation. You may temporarily store limited amounts of hazardous waste in satellite containers adjacent to common sources of waste. For example, you might have a couple of satellite containers near the cylinder door pit to hold waste that you remove from the pit during regular cleanings, and another satellite container on the drip pad to hold dirt or sawdust that you sweep off the pad. The door pit and drip pad would be considered separate satellite waste accumulation areas. Each container must be marked with the words "HAZARDOUS WASTE".

You may only store up to 55 gallons total at any given satellite waste accumulation area, regardless of how many containers you might have at that location. For example, suppose you keep two 30-gallon drums near the door pit. If you fill one drum completely, you can put no more than 25 gallons of hazardous waste into the second; if you add more than 25 gallons to the second drum, you would exceed the 55-gallon limit for that satellite waste accumulation area.

When the 55-gallon limit is reached, mark the container(s) with the date. You will then have 3 days from that date to remove the waste to your designated, contained hazardous waste accumulation area. Remember that once waste is removed to the designated accumulation area, the clock starts ticking with regard to how long you can store the waste on site.

Drip Pads. Drip pads are also designed and used to temporarily store hazardous wastes. See the resources provided at the beginning of "Hazardous Waste Regulations," page 44, for compliance information.

Hazardous waste disposal

To dispose of any hazardous waste, you must have it taken to a licensed hazardous waste management facility by a licensed hazardous waste hauler. Be sure to get proper documentation (e.g., a manifest indicating the contents and weight of the waste) from the hauler when waste is removed from your facility. The plant operator should receive and file documentation that verifies the hazardous waste has reached the licensed disposal facility.

EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW

Many wood preservation plants will be subject to the federal Emergency Planning and Community Right-to-Know Act (EPCRA), also known as Title III of the Superfund Amendments and Reauthorization Act (SARA). This act is designed to help communities prepare responses to accidental releases of certain chemicals. We will give a brief overview here. For more information about SARA Title III and whether you are subject to it, contact your county chairperson; by law, that person must be a member of your area's Local Emergency Planning Committee (LEPC).

As with hazardous waste regulations, keep in mind that state and even county regulations may be more strict than the federal regulations described here. It is your responsibility to become familiar with and comply with state and local requirements.

EMERGENCY PLANNING

The EPA has compiled a list of chemicals designated as extremely hazardous substances. If you use or store one of these chemicals in a quantity at or greater than its threshold planning quantity (TPQ) at any one time, you must contact the State Emergency Response Committee (SERC) and LEPC. SERC and LEPC are Wyoming Office of Homeland Security programs. The LEPC will help you prepare a facility site plan that will enable you and first responders to better deal with a chemical emergency. Update the plan as your inventory changes.

COMMUNITY RIGHT-TO-KNOW

If your inventory of any extremely hazardous substance exceeds its TPQ or 500 pounds (whichever is less) or your inventory of any material listed as a hazardous chemical by OSHA exceeds 10,000 pounds, you will need to supply a Safety Data Sheet (SDS) for each of those chemicals to your SERC, LEPC, and local fire department. You will also have to provide them with Tier II Inventory forms, which provide specific information on each reportable chemical.

SPILL RESPONSE

A spill is any unintended release of a chemical into the environment. The risks that wood preservatives pose to people and the environment were described earlier in this manual. Even if you are not subject to SARA Title III reporting requirements, it is wise to prepare a spill response plan with the local fire department and sheriff's office. Knowing what chemicals you store and where will help emergency responders protect people, the environment, and themselves in the event of a spill or fire at your facility.

IPreech Studio, shutterstock.com

If your facility is a large- or small-quantity hazardous waste generator, you must have a contingency plan in place at the facility that outlines the proper response procedures for minimizing hazards posed by fires, spills, or other unplanned releases of hazardous waste from the facility. Plan requirements are more extensive for large-quantity generators than for small-quantity generators. Details of the precautionary measures are found in the hazardous waste regulations. Often, the chemical supplier will provide a template plan and assist the treater in adapting it for the facility involved. Ensure that employees have access to any treatment facility contingency plans.

A number of wood preservatives, including penta, creosote, inorganic preservatives containing arsenic or chromium, and some copper compounds, are listed as hazardous substances under the federal Comprehensive Environmental Response Compensation and Liability Act (CERCLA). If you spill a CERCLA substance, you must call the National Response Center's toll-free hotline (800-424-8802) if the substance is released into the environment in an amount that meets or exceeds its reportable quantity (RQ), which is listed in CERCLA. Contact Wyoming Department of Agriculture for more information regarding CERCLA.

SPILL PREVENTION

The containment pad, drip pad, and collection pit of a properly designed wood treatment facility form the basis of spill prevention. They prevent leaks to the environment and recover chemical for reuse in the treatment process. Technically, if a chemical or liquid is in a contained area and is reclaimed for future reuse rather than released into the environment, it does not constitute a spill.

The containment pad should be able to hold as much liquid as is held in all water, solvent, and chemical tanks combined. Liquid in the collection pit can be pumped back into storage or work tanks for reuse, depending on facility design. To prevent overflow, dip treatment tanks should be equipped with emergency shutoff valves that close automatically when the solution reaches a certain level in the tank.

CLEANUP OF DISCHARGES WITHIN THE CONTAINMENT AREA

Liquids that leak or drip within the contained area and pad will flow naturally into the collection pit; you can hasten the flow by sweeping or hosing the liquid into a sump or drain that leads to the collection pit. Wear the appropriate PPE, such as a spray suit or chemical-resistant footwear, to protect yourself from splashes.

Plants using oilborne preservatives may use a degreaser to clean up after minor leaks and then hose down the area, with the oil-contaminated water collected in the decant tank. For larger chemical discharges of oilborne or waterborne preservatives, you could use a vacuum pump to direct the preservative into the work tank directly or via the treatment cylinder. You can also use this approach if you place trays under pumps and valves, as leaks are more common there. It is easy to pump the material out of the trays and into the cylinder; you could also pour the trays into the collection basin.

If you use spill pads or other absorbent material to clean up spilled preservative solution, realize that they must be disposed of as waste. Also have a shovel available for spills that occur outside the contained areas, such as incidental dripping in the storage yard or if some preservative concentrate leaks from a delivery vehicle before or after the vehicle is within the contained area.

CHAPTER 6: PREPARING WOOD FOR TREATMENT

LEARNING OBJECTIVES

A. Give reasons why, prior to treatment, wood needs to be:
   - Kept clean
   - Peeled
   - Dried or conditioned

B. List advantages and disadvantages of air drying wood.

C. List conditions and practices that are favorable for air drying wood.

D. Discuss problems that can arise during air drying and what you can do about them.

E. List advantages and potential problems of kiln drying wood.

F. With respect to the two methods for conditioning wood in a cylinder:
   - Give examples of when each is used.
   - Describe how each method works.
   - Tell why wood is sometimes steamed without a vacuum.

G. Tell why wood should be machined after drying but prior to treatment.

H. Explain how the use of waterborne preservatives can affect how wood is machined prior to treatment.

I. With respect to incising, radial drilling, and through boring, tell:
   - What each is and how they each differ
   - Why each is done
   - Why it is important to follow AWPA Standards for incising

J. List reasons for rejecting wood products prior to treatment.

K. Describe methods for determining the moisture content of wood.

L. Given the weight of wood before and after oven drying, calculate its moisture content.

M. Give reasons why wood products might be tagged or marked prior to treatment.

INTRODUCTION

The wood treater's involvement in preparing wood for treatment varies from minimal to extensive depending on plant operations. Regardless, understanding what is involved in preparing wood for treatment will help ensure that you recognize and treat only those wood pieces which will be suitable for the desired end use.

Keep wood as clean as possible prior to treatment. Dirt, dust, and small stones stuck to wood interfere with drying and penetration, become added waste when they fall off on the drip pad or in the treatment cylinder, and can clog lines or damage pumps. Clear lumber of snow and ice, which can inhibit penetration of preservative into the wood. Stacking wood above a clean surface (e.g., stone, pavement) and under cover will help keep it clean.

We will now describe important processes that may be involved in preparing wood for treatment with preservatives.

PEELING

Round or slabbed wood products have bark on them, which needs to be removed. Bark slows the drying of the products, which gives wood-destroying organisms more time to damage them. Also, bark left on wood may fall off during treatment and become waste; impedes preservative penetration into wood (especially with nonpressure treatments); and/or may fall off after treatment, exposing untreated wood to wood-destroying organisms. Even the thin inner bark can impede the penetration of preservative during treatment. Therefore, bark should be peeled such that any strips of inner bark left on the wood are less than 1/2 inch wide (Figure 6-1).

REDUCING THE MOISTURE CONTENT OF WOOD

Because water competes with preservative for space in wood, you need to bring the moisture content

Figure 6-1. Machine peeling of poles. Here, the outer bark has been removed by hand and the inner bark is being peeled by machine. (Photo courtesy of USDA Forest Products Laboratory)

of untreated wood down to a level that will allow adequate penetration and retention of preservative; such a level may be specified as a condition of purchase or as part of the treating facility's quality control program.

You can remove unwanted moisture from wood by exposing the wood to the atmosphere (air drying); to artificially controlled heat, humidity, and air circulation in a kiln (kiln drying); or to certain conditions in a cylinder prior to pressure treating the wood with oilborne preservatives (often called conditioning the wood). Properly removing unwanted moisture can reduce uncontrolled dimensional change (shrinkage) which can lead to warping and cracking of the wood. It also opens up checks in the wood; this allows better penetration and reduces the risk of checks opening up after treatment that could expose untreated wood. Be aware that dried wood may regain an unfavorable moisture content if it is stored where it is exposed to rain or high humidity.

AIR DRYING

Air drying (also called seasoning) is a relatively inexpensive way to reduce moisture content and is acceptable for some commodities. However, variability in drying rates, even within a stack of wood, can make long-term planning difficult. Also, it may be uneconomical to tie up a large piece of land for air drying. Proper procedures for air drying are provided in AWPA Standard M1 (Purchase of Treated Wood Products) and will be discussed briefly here.

Check the moisture content frequently so you can treat wood as soon as it is ready; this allows for faster turnover and lets you use the space in the drying yard more efficiently. If air drying cannot fully season the wood, you may need to kiln dry or condition the wood before treating.

Factors affecting air drying

The initial moisture content of the wood, climatic conditions, species and dimension of wood, and how and where wood is stacked in the yard will determine how long air drying takes.

Fungi. You may need to spray or dip wood with preservative to prevent the growth of stain or decay fungi while the wood seasons. Remember that sapstain fungi increase the permeability of wood. This makes it easier for water to get into the wood, which would hinder penetration and retention. However, it can also cause problems in dried wood; the increased permeability of the sapstained wood could result in too much preservative going into the wood during treatment, which leads to bleeding afterward.

Climate. Climate is a limiting factor; conditions must be favorable long enough to allow air drying to have any effect on moisture content. On the other hand, rapid drying during hot, dry weather often results in checking and splitting of hardwoods. (You can use anti-splitting rods to protect the ends of commodities that are prone to split during drying.) Prolonged high temperatures and humidity can lead to variable moisture content, which might result in staining and even the visible presence of fungi. Wood-boring insects could also become a problem in damp pockets; sawdust will be the most obvious sign of their activity. Even if these pest problems do not arise, variable moisture within the commodity will lead to uneven (and possible failed) penetration and retention of preservative.

Conditions in Storage Area. You can air dry wood in the open or under cover provided that air currents are not obstructed. Avoid areas with high humidity, poor drainage, or poor air circulation. Remove any vegetation in the seasoning yard; growing plants restrict air movement and increase humidity by giving off water vapor from their leaves. Also remove any debris on the wood, as it could harbor or promote pests. Frequently inspect wood stored in air-drying yards for pest problems; for example, termites may attack stacks of untreated wood that remain undisturbed for long periods.

Stacking and Spacing. Stacks of wood being seasoned should be arranged in rows with a minimum of 3 feet between rows and 1 foot between stacks within a row. All stacks should be supported on treated wood or other materials immune to decay. The bottom-most layer of wood in a stack should be at least 1 foot above the ground. AWPA Standard M1 provides layering instructions for stacks of specific commodities (e.g., crossties, round materials). Stacking and spacing wood as discussed in this paragraph ensures there will be sufficient air circulation to season the wood.

KILN DRYING

A kiln (Figure 6-2) is a chamber designed to control temperature, humidity and air flow. Kilns commonly use temperatures of 100°F to 240°F to dry wood. Kiln drying seasons wood in a shorter and more predictable time frame than air drying.

Figure 6-2. A kiln used to dry lumber at a sawmill.

Kiln drying is suitable for all species and is common in regions where climatic conditions can make air drying difficult. Kiln drying may also effectively heat treat, or sterilize, the wood. Take care to use procedures that do not damage the wood. For example, wood that is dried too quickly at high temperature and low humidity can split and crack.

CONDITIONING IN THE CYLINDER

Untreated wood can be conditioned in the cylinder prior to pressure treatment with oilborne preservatives. Two methods are used:

- the Boulton (or boiling-under-vacuum) process, and
- the steaming-and-vacuum process.

AWPA Standard T1 (Processing and Treatment Standard) specifies whether and how these processes can be used on the different wood products and species.

Boulton process

The Boulton process, also known as boiling under vacuum, is used mainly for poles and large timbers produced from Douglas fir where sterilization is required and for creosote treatment of railroad ties. The process relies on making the water in the wood boil so that it evaporates out of the wood. However, wood's strength will be reduced if you heat it to the point where its internal temperature is high enough to make water boil (212°F). To avoid this, the Boulton process makes use of the fact that water will boil at lower temperatures than normal when it is subject to a vacuum.

Untreated wood is placed in the cylinder. The cylinder is flooded with treating solution and the temperature is raised, generally to 180°F – 200°F; this heats the wood, but not to the point where water inside the wood will boil. A vacuum is then applied, which lowers the boiling point of water. This causes water in the wood to boil and be forced out of the wood. The steam is captured in condensers and you can monitor the water recovery; once the rate of water recovery slows sufficiently, you would consider the wood to be conditioned. Once the wood is conditioned, you release the vacuum; you can then treat the wood by one of the pressure processes described in Chapter 2, page 13.

The Boulton cycle duration depends on the wood size and moisture content. You can use the Boulton process to sterilize the wood provided you maintain an adequate temperature for a sufficient time; both factors will vary depending on the wood being treated.

Steaming and vacuum process

The steaming-and-vacuum process is used mainly for poles and large timbers produced from southern pines and other woods whose strength is not reduced by high temperatures. The principle is similar to the Boulton process in that you heat the wood and subject it to a vacuum to boil water out of the wood. The difference is that you subject wood to a vacuum after steaming the wood in the sealed cylinder at no more than 240°F. Once the wood is conditioned, the vacuum is released; you can then treat the wood by one of the pressure processes described in Chapter 2, page 13.

The steaming and vacuum periods used depend on the wood size, species, and moisture content. Though the process is not commonly used anymore, steaming alone (without the vacuum) maybe used for pretreatment removal of ice and snow and for post-treatment cleaning of wood. This process reduces the wood's moisture content slightly and heating the wood assists greatly with penetration. A sufficiently long steaming period will also sterilize the wood.

MACHINING

Wood preservative treatments do not always penetrate all the way to the center of the wood. As a result, cutting into treated wood can expose untreated wood to wood-destroying organisms and reduce the service life of the wood product. Therefore, it is preferable to perform all machining (e.g., cutting to length, boring holes for fasteners, framing) before the wood is treated. If you must do any cutting after treatment, treat exposed wood according to AWPA Standard M4: Standard for the Care of Preservative-Treated Wood Products.

When controlled dimensions are required, the wood must be dried to the moisture content needed for end use before machining and treating the wood. While oilborne preservatives produce little or no dimensional change in treated wood, waterborne preservatives can affect wood dimensions even after the wood is redried to its pretreatment moisture content; you may need to take such a change into account when machining wood prior to treatment with waterborne preservatives.

INCISING

Incising makes a series of narrow holes or slits in wood. Incising prior to treatment improves preservative penetration in species and commodities which are hard to treat (i.e., resist penetration). Examples include cedar and Douglas fir poles and Douglas fir, western hemlock, and western larch ties and timbers. Wood is incised by passing it through equipment that sinks teeth into wood at a predetermined depth, usually 1/2 - 3/4 of an inch (Figure 6-3). Incising works because preservatives usually penetrate wood better along the grain than across it.

Because incising can reduce the strength of wood products, teeth are spaced to allow the desired penetration with the fewest incisions. You can find incising requirements in the appropriate Use Category Commodity Specifications in the AWPA Standards. Note that even proper incising will not guarantee successful retention and penetration; you will still need to sample treated wood to ensure the treatment was successful (see Chapter 9, "Post-Treatment Activities," page 76).

DRILLING AND BORING

Radial drilling involves drilling holes to about a depth of about 3-inches in the groundline region of utility poles prior to treatment (Figure 6-4). Through boring is similar except the drilling extends entirely through the diameter of the pole. As with incising, the idea is to increase penetration of the preservative without reducing wood strength.

INSPECTING WOOD

We will briefly discuss procedures for pretreatment inspection of wood products, which are detailed in AWPA Standards M2 (Inspection of Wood Products Treated with Preservatives) and M3 (Standard Quality Control Procedures for Wood-Preserving Plants). For commercial/industrial products normally subject to written specifications by the purchaser, third-party inspectors may be involved in addition to the treating facility's quality control personnel.

Inspect wood products prior to treatment. Remove mud, ice, and snow that can hinder inspection of individual pieces; these contaminants would also interfere with preservative penetration into wood and create additional waste for disposal. Reject any wood pieces that do not conform to specifications in the relevant standards for the desired end use. Examples of defects that will make a piece unsuitable for the desired end use or proper treatment include excessive checking, cracking, or staining; nonconforming dimensions; machining or manufacture that varies from the provided specifications; improper moisture content; and any signs of decay. Where possible, it is allowable to

Figure 6-3. Incising permits better penetration of preservative. (Photo courtesy of USDA Forest Products Laboratory)

Figure 6-4. Radial drilling groundline area of utility pole prior to pressure treatment.

correct defects such as in machining or moisture content provided such pieces are re-inspected prior to treatment.

MEASURING MOISTURE CONTENT

Electrical-resistance-type moisture meters are often used to measure the moisture content of untreated lumber. Hammer drive the insulated pins into the smallest dimension of a piece, about halfway along its length. Drive the pins in to the depth desired according to the treatment specifications. Small insulation discs can prevent false readings that result when pins are inserted to their full length and their hubs contact the damp surface of the wood.

The number of samples to take vary based on the wood product (see AWPA Standards). If more than 10% or so of the readings exceed 25%, you should redry the wood before treatment.

For poles and ties, the oven-drying method is commonly used to determine the average moisture content. This involves taking core samples to the depth required for preservative penetration (again, see AWPA Standards for more detail). Combine the core samples and weigh them. Then, dry them in an oven at 215°F and weigh them. Continue to dry and weigh them at various intervals until the weight remains constant; at that point, all of the available water has evaporated out of the wood. You can then determine moisture content using the following formula:

$$M = ([W - w]/w) \times 100$$

where M is the percent moisture content, W is the weight of wood before drying and w is the weight of wood after drying.

Figure 6-5. Marking wood with charge number prior to pressure treatment.

MARKING WOOD

Utility poles are branded before treatment. The brand, which is placed so as to be approximately at eye height when the pole is in service, includes the species, treater, year of treatment, size, preservative, and retention.

It is important to keep track of a charge so you can match penetration and retention samples taken after treatment to the charge (in case retreatment is necessary) and to ensure that the treated wood is sent to the proper destination. At some plants, the treater accomplishes this by marking the charge number on the wood prior to treatment (Figure 6-5).

CHAPTER 7: PREPARING THE PRESERVATIVE MIX

LEARNING OBJECTIVES

A. Give reasons why you need to accurately track your inventory of preservative product.

B. Describe methods for telling how much preservative concentrate you have in inventory.

C. List factors to consider when ordering preservatives.

D. List steps to take to protect people and the environment during delivery and transfer of preservative products.

E. Tell which preservatives need to be agitated in the storage and/or work tank to prevent preservative from settling out.

F. Explain why the concentration of preservative in the work tank after a treatment can differ from the concentration in the tank before the treatment.

G. Given the dimensions of a tank and the height of preservative solution in it, calculate the gallons of solution in the tank.

H. For each preservative discussed in this chapter:
- Tell if it is delivered as a liquid or solid.
- Describe the process for getting preservative from the delivery vehicle into a storage or work tank.
- Describe the steps you would take to obtain and analyze a sample of preservative mix to determine the preservative concentration in the mix.
- Describe the process for adjusting the concentration of preservative in the work tank.
- Use the formulas in this chapter to determine what is needed to produce the desired preservative concentration and mix volume for a treatment.

I. Tell why it can be beneficial to send samples of a preservative mix to an independent lab for analysis.

J. Explain why it is important to maintain records of how you prepared a preservative mix.

INTRODUCTION

You need to make sure you have the proper volume and concentration of preservative available and at a suitable temperature before you treat wood. This requires you to:

- Assess your inventory of preservative;
- Order preservative when necessary;
- Receive the preservative and transfer it to a storage, work, or mix tank;
- Ensure proper storage conditions for the preservative(s) you use;
- Determine the preservative concentration and volume in the work tank after the previous treatment;
- Adjust the preservative concentration and volume in the work tank as necessary before beginning a new treatment; and
- Maintain delivery and mix records.

Keep in mind that the desired concentration of preservative in the treating solution is whatever concentration works for your situation. With most pesticides, the product label specifically lists the concentration or range of concentrations (e.g., a certain weight or volume of product per gallon of solution) at which the pesticide can be used. With wood preservatives, however, the important thing is how much product ends up in the wood. This retention will be listed in the AWPA Standards or specified by your customer. Therefore, the desired concentration of preservative in the treating solution is not necessarily listed on the product label; rather, it is the concentration that will provide the needed retention given the treatment method you use and the wood you treat.

Figure 7-1. Tote flow meter

ASSESSING INVENTORY

You need to assess your inventory to know when you need to order more preservative product; this will prevent you from running out and having to delay production until new product arrives. Determining how much you have on hand is as simple as counting containers or units for products such as penta blocks and borates that are delivered in solid form. For tracking inventory of preservatives that are delivered in liquid form, there are several means available.

Moldicides used for dip treatments or for mixing with copper azole generally come in drums or in totes, which are cube-shaped bulk containers. Sometimes, totes are kept on scales so that the weight indicates the relative amount of product remaining. In other cases, flow meters keep track of how much liquid has been drawn from a tote (Figure 7-1); you can then subtract that amount from the amount held in a full tote to calculate how much product remains.

A tank may be equipped with a sensor that measures the pressure at the bottom of the tank; the more preservative present, the greater the pressure. Such sensors are typically tied into a computer that converts pressure to volume. Other tanks are equipped with sight gauges or internal sensors (e.g., sonar, DP cell) that allow you to determine the height of liquid in the tank. Because tanks are cylindrical, you can use this height to calculate the volume of liquid in gallons as follows:

$$\text{Volume in gallons} = \frac{3.1459 \times (\text{cylinder radius in inches})^2 \times \text{height of liquid in cylinder in inches}}{231 \text{ cubic inches per gallon}}$$

For example, if your tank has an inner diameter of 12 feet, its radius would be 6 feet or 72 inches; using the formula above, each inch of height would hold about 70 gallons.

With practice, you'll know how low the height can get before you need to order material; for example, agitation paddles might turn off or be ineffective if the amount of liquid in a tank gets too low. Likewise, you'll come to know how much open space you need at the top of the tank to accommodate a standard delivery of preservative.

ORDERING PRESERVATIVES

The responsibility for ordering preservatives may or may not fall on the wood treater. For example, only certified applicators can purchase restricted-use pesticides such as creosote, penta, and CCA; if the treater is not certified, the treater's supervisor might be the one who sees to it that preservative is ordered when it's needed. Be sure that the ordering process complies with your state's pesticide regulations.

When ordering preservative, also check to see if you need to order oils or moldicides that might also go into the final mix. Your facility might have your supervisor order preservative but have you order these other mix components. Coordinate your efforts to ensure you will have all mix components on hand.

Timing can be important in ordering chemicals. For example, if you do dip treatments in northern climates where you can't treat over the winter, avoid buying product toward the end of the season so you won't have to store so much.

DELIVERY AND MIXING OF PRESERVATIVE

How chemicals are delivered and subsequently handled varies depending on the preservative and, to some extent, the treatment plant setup. We will provide examples of delivery, transfer, and mixing procedures for some of the commonly used preservatives.

DELIVERY AND TRANSFER

In all cases, delivery and transfer should occur within the facility's containment area so any spills can be collected for reuse. Coordinate with the delivery person so you each understand your roles in transferring preservative to your storage tank and in any cleanup activities. You (and the delivery person, if involved) must wear the PPE required by the product label, OSHA regulations, and/or company policy. Document the delivery so you have a record of how much chemical was added to your inventory.

To ensure you have enough room for a delivery in a storage tank, you will need to know the precise volume of liquid in the tank. Use the techniques discussed previously under "Assessing Inventory," page 56. The person delivering liquid chemical may require you to sign a form affirming there is enough room in a tank to accommodate the delivery. The driver may also need to you to sign off that there were no problems with the delivery (e.g., spills). In some cases, the driver will give you a bill of lading and indicate either the weight or volume of chemical delivered. Another approach is for the treater to measure the pre- and post-delivery amounts of chemical in the tanks and give that information to the driver.

MIXING

You need a sufficient volume of preservative mix at the proper concentration to treat a charge. When preservative mix is returned to the work tank after a treatment, both the volume and concentration will likely be different than before. The volume will be less because much of the mix was pressed into the wood during treatment. The concentration may also be different because the wood can take up chemical and solvent (water or oil) in different proportions so that the concentration of preservative changes. In some cases, water can even be added to the solution from the wood as it is treated. Therefore, you often need to adjust the volume and concentration of the preservative mix in the work tank after a treatment before you treat the next charge.

To do so, you will need to know what volume and concentration you are starting with after treating a charge so you can adjust both as needed to prepare the mix for the next charge. Use the techniques discussed under "Assessing Inventory," page 56. to determine your starting volume. To determine your starting concentration, take a sample of what is in the work tank (or on its way back to the work tank from the cylinder) after a treatment. Be sure the mix has been well agitated (e.g., with blades or by pumping the mix from the cylinder into the work tank). When you open a valve to sample the mix, let it run for a little bit first to ensure you get

Chattahoochee National Forest, GA. (© USDA photo by Lance Cheung) a representative sample; reclaim the uncollected preservative by directing it into the collection pit. Also, when preparing the final mix, you will often refer to AWPA Standards rather than the product label; the preservative concentration you prepare for the final mix may depend on the desired retention.

This chapter provides examples of how to determine and adjust the preservative concentration and volume in the work tank. However, keep in mind that the user manual from your chemical supplier will provide formulas, examples, and tables that you can use to manually calculate mixes specific to your needs.

CREOSOTE

Delivery and transfer

When creosote is delivered by railcar, it may be too viscous to pump into your storage tank. If so, you would need to heat the creosote to about 180-200°F in the railcar or in a heat exchanger, depending on how the plant is set up. When the creosote reaches the desired temperature, you can pump it into your storage tank until the desired amount of chemical is transferred. Creosote is often transferred into a work tank that has bayonet coils to maintain the creosote at 180-200°F.

Prepare the final mix

Determine Starting Point. When creosote is pumped from the cylinder back into the work tank after treatment, it might contain more water than it did prior to treatment. This is because hot creosote can cause moisture to come out of the wood during treatment. The amount of water expelled is usually greater when you treat air-dried wood because with unconditioned wood, water escapes during Boultonizing and is taken out of the cylinder by vacuum before the pressure treatment process begins.

For proper treatment of wood, the water content of the creosote needs to be sufficiently low (e.g., below 3% by volume). Regularly check the water content by sampling from a port in the line as preservative is being pumped into the cylinder. For example, one way to do this is to heat 100 ml in a flask equipped with a condenser to recover the vaporized water. The amount of water collected, in ml, will represent the percent water in the work tank solution. Be sure to pour the sample (including any unused portion) into the collection pit for reuse.

If you mix creosote with petroleum oil, you also need to make sure that petroleum portion does not exceed 50%. You can do this simply by referring to inventory records showing how much petroleum and creosote were added to the work tank over time.

Adjust the Concentration of Preservative in the Work Tank. If the water content in the work tank is too high, you can correct this during Boultonizing in the cylinder or by heating the preservative in the tank to evaporate the water.

The petroleum oil content in the work tank could be too high only if you had made a mistake in mixing the solution earlier. This is rare, but you can correct it simply by adding creosote from the storage tank. For example, if the concentration of petroleum oil exceeds 50% (which is 0.50 when expressed as a decimal), you can determine the minimum amount of creosote you need to add to the tank as follows:

$$\text{Minimum number of gallons of creosote to add to tank} = \frac{\text{Percent petroleum oil expressed as a decimal} \times \text{current volume in tank}}{0.50} - \text{Current volume in tank}$$

PENTA

Delivery and transfer

Penta is usually delivered as a concentrate and is pumped directly from the delivery vehicle into the storage tank. However, it is sometimes delivered as a solid block with an iron hook protruding from it. Oil, such as hydrocarbon solvent type A (HSA-14), used to dissolve the penta block is delivered in a tanker truck or railcar.

To get penta blocks into a concentrate solution, use a hoist to put them into a dissolver. Heat oil to about 180 degrees and run it through the dissolver to melt the penta. Open the valve between the dissolver and the penta tank and pump the melted penta into the concentrate storage tank. Once the penta is in the tank, you do not need to heat or stir it.

Some treatment plants will produce a working solution by dissolving a penta block in the treatment cylinder. However, because the working solution is much more dilute than a concentrate solution, this will require a larger volume of oil and, therefore, a cylinder that is especially large. This approach works only for systems that use elevated treatment temperatures, such as for treating western wood species.

Prepare final mix

Determine Starting Point. Determine the percent concentration of penta in the preservative solution using an x-ray fluorescence analyzer. The percentage of penta in a solution is typically the same before and after a treatment. However, due to interactions that can happen in treatment, penta can sometimes drop out of solution; when you add oil to the work tank, the oil's solvency might pull some of this penta back into solution and thus make the solution stronger than you would expect. Therefore, it's good practice to analyze the solution in the work tank after you've added oil to determine the percent concentration of penta; you can then add the appropriate amount of penta concentrate to bring the solution up to the strength needed to treat wood.

Adjust the Concentration of Preservative in the Work Tank. Most treatment plants use computers to determine how much of each component is needed to prepare a desired mix and to operate the pumps and valves involved in transferring components into the work tank from their respective storage tanks. With penta, you will want to enter into the computer the following: the work tank you want to use, the percent penta of the solution in that tank, the oil (if any) you want to use, and the final concentration and volume of mix you want in the work tank. Given this information, the computer will direct the proper amounts of penta and oil into the work tank to bring it to the desired concentration.

Higher concentrations of penta will yield higher retention levels in the wood, assuming the same amount of preservative solution remains in the wood. Sometimes, the goal may be to put less oil in the wood; in this case, you can get the same retention with a higher concentration of penta by using less solution. If you wish to increase penetration, you would need to increase the level or duration of pressure during treatment.

If the computer indicates that there is not enough room in the tank to get to the desired concentration, you can treat with a lower concentration for one charge and bring the concentration up to its desired level for the next charge. This is a reasonable approach since the desired retention can usually be accomplished with a range of treatment solution concentrations.

CCA

Delivery and transfer

CCA is delivered as a liquid concentrate and is pumped from the delivery truck into a storage tank. In some cases, the truck itself is pressurized; once the delivery truck is hooked up to the fill line on your tank, you can open the valve in the line and the CCA is blown out of the truck and into the tank.

Prepare final mix

Determine Starting Point. The percent chemical in a work tank might differ after a treatment because water could get expelled from the wood during treatment or, if the wood is especially dry, water may be disproportionately taken up by the wood. Collect a sample from a valve or port on the work tank and pour some into an analyzer cup. Place this cup into an analyzer to find out the percentage of preservative in the solution.

Adjust the Concentration of Preservative in the Work Tank. Enter the concentration from your analyzed sample into the computer that prepares the mix, along with the final volume of solution you want. The computer will then determine the necessary amount of chemical and water needed from the respective storage tanks to end up with the desired concentration.

Knowing how to calculate and determine how much chemical and water is needed on your own is important because it will allow you to recognize when the computer might be calling for the wrong amounts of chemical and water; such errors can arise if you enter the wrong values by mistake. Without having a feel of what the computer should call for, you could end up under treating a charge or wasting chemical. You can refer to your product manual to determine what you need to add to get the desired mix. (You could also use calculations similar to those described later for copper azoles.)

CCA stays in solution, so the process of returning solution to the work tank and pumping in concentrate and water provides enough agitation to mix the components. If a tank is unused for a long period of time, some facilities choose to recirculate the contents using a dedicated pump that draws from the bottom of the tank and returns contents to the top of the tank.

COPPER AZOLE

Delivery and transfer of copper azole

Copper azole is often mixed with one or more moldicides. The components are stored separately and added to a common work tank to produce the treating solution.

You must agitate copper azoles in the concentrate and work tanks to keep the components properly mixed. Agitation is usually accomplished with large blades attached to a rotating shaft; this can cause dispersed copper concentrate to foam and perhaps leak out the top of the tank, which is why dispersed copper may be formulated with a defoamer or have defoamer added to the tank. However, turning off the agitator briefly allows you to get a more accurate reading of the level of preservative in the tank. Take a reading before and after product is transferred into the tank; the difference between the two readings will equal the amount of product that was delivered.

As with CCA, copper azole is delivered as a liquid concentrate and can be pumped from a truck or blown out of a truck using air pressure. If air is used to blow preservative out of the truck, blowing air

Naruepon Ponglungka, shutterstock

Tanker truck high-pressure valve

can also be used to clear the hose. If it is pumped out, you will want to run the pump briefly after disconnecting the fill line from the truck in order to suck any preservative out of the hose and into the tank. Then, hook up a water hose to the pump, open the necessary valves, and flush the pump out; this will prevent copper from settling in the pump and clogging it, and the water and flushed copper will drain into the collection pit for reuse.

Delivery and transfer of moldicides

Moldicides come in totes or drums, which you can place into storage using a forklift. As we discussed in Chapter 3, "Wood Preservatives," page 19, moldicides can be caustic. Therefore, you will likely need to wear chemical-resistant gloves, a chemical-resistant apron, and a face mask when you hook the totes up for use; check the product label for exact PPE requirements. You can use a quick coupler to connect a tote to the line leading to the work tank; it's as simple as turning a handle one way to uncouple the line from one tote and turn the handle the other way to couple the line to the new tote. However, moldicide sometimes leaks from the handle or fill line during this procedure, so wearing PPE is necessary.

Prepare final mix

Determine Starting Point. Use an x-ray analyzer to sample the preservative solution. If you are using dispersed copper, do not allow the copper to settle in the analyzer cup before analyzing it; if you do,

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the analyzer will overestimate the concentration of copper in the solution. The analyzer indicates the percent copper in the solution, and this is the starting point for adjusting the solution prior to the next treatment.

If your preservative manufacturer provides the service of analyzing your samples, send part of a sample to them for analysis on a scheduled basis (e.g., weekly). This helps ensure you are preparing the mix properly because:

- It provides a check to make sure your analyzer is properly calibrated. If the copper concentration differs between the sample you analyzed and the sister sample the manufacturer analyzed, a manufacturer's rep will come to your facility to recalibrate your analyzer. This ensures that you will be able to mix solution to the proper concentration of copper.
- The manufacturer will be able to analyze the sample for the concentration of azoles and moldicides in addition to copper. If you are getting inadequate agitation in your work tank, azoles will float to the top and dispersed copper may settle. If the manufacturer's analysis shows that the azole concentration is disproportionately low compared to copper's, you will know you need to improve the agitation in your tank to ensure you produce an effective treatment solution.

Adjust the Concentration of Preservative and Moldicide in the Work Tank. Most plants will use a computer program to prepare the final mix. You will need to know the copper concentration in your sample, the volume of mix in the work tank, the desired copper concentration and final volume, and (if applicable) the desired concentration of moldicides (in parts per million, or ppm). Once you enter these values into the computer, it will indicate how much concentrate, water, and moldicide you will need to add to the work tank to get the desired mix. In some plants, pumps and valves are managed manually to get components into the work tank, but in other cases, the computer runs the necessary equipment.

Knowing the calculations involved will allow you to get an idea of how much of each component you need to prepare the final mix. This knowledge will allow you to recognize when the computer's values are unrealistic (such as when you enter in the wrong values by mistake). You will need tables of information from the manufacturer to make these calculations.

Example. Suppose you have 15,000 gallons of solution that is 1.2% copper by weight and you need 17,000 gallons of 1.5% copper by weight. Further suppose that information from your chemical manufacturer's operations manual indicates that a 1.2% solution by weight contains 0.1025 gallons of concentrate per gallon of solution and a 1.5% solution by weight has 0.1287 gallons of concentrate per gallon of solution. How much concentrate and water do you need to add to the work tank to achieve the 1.5% solution? (By converting the percent solution by weight to gallons of concentrate per gallon of solution, the tables in the manual makes it easier for you to determine how much preservative and water to add.)

Step 1: Find out how many gallons of concentrate are in the current solution. To do this, multiply the gallons of the 1.2% solution by the proportion of concentrate per gallon in that solution:

$$\text{15,000 gal of solution} \times \frac{\text{0.1025 gal of concentrate}}{\text{gal of solution}} = \text{1537.5 gal of concentrate}$$

Step 2: Find out how many gallons of concentrate would be in the desired solution. To do this, multiply the desired gallons of 1.5% solution by the proportion of concentrate per gallon in such a solution:

$$\text{17,000 gal of solution} \times \frac{\text{0.1287 gal of concentrate}}{\text{gal of solution}} = \text{2187.9 gal of concentrate}$$

Step 3: Calculate how many gallons of concentrate and water you need to add. Keep in mind that the gallons of concentrate and gallons of water added will equal the total gallons of solution you need to add to the work tank. This requires simple subtraction:

17,000 gal of solution desired
− 15,000 gal of solution in work tank
= 2,000 gal of solution needed

2187.9 gal of concentrate desired
− 1537.5 gal in work tank
= 650.4 gal of concentrate needed

2,000 gal of solution needed
− 650.4 gal of concentrate needed
= 1349.6 gal of water needed

So you will need to add 650.4 gallons of concentrate and 1349.6 gallons of water to produce the desired volume of 1.5% solution in the work tank. (Keep in mind that if you also use moldicides, the volume of water you would need to add would be reduced by the volume of moldicide you need so that the total final volume is still 17,000 gallons.)

If you need to reduce the concentration of copper in the work tank, you only need to add water. Calculate the gallons of concentrate in the current solution as in Step 1 above. Then:

$$\text{Gal of solution required} = \frac{\text{Gal of concentrate in current solution}}{\text{Desired gal of concentrate per gal of solution}}$$

$$\text{Water to add to tank} = \text{Gal of concentrate in current solution - gal of solution already in work tank}$$

Once you are comfortable with the computer's calculations, make sure there is room in the tank for the water and/or concentrate needed before adding them to the tank. After mixing, you should agitate the contents of the work tank to ensure proper mixing; you can agitate the contents using blades, recirculating solution within the tank, or pumping the solution from the tank into the cylinder and back again.

BORATES

Delivery and transfer

Borates are formulated as a powder and come in large, lined bags. You can move bags into storage using a forklift, but you might need a hoist to get them in place for mixing. Use the hoist to suspend a bag over the open mix tank. Then, use a knife to make a cut in the bottom of the bag. Let the powder pour out into the tank. Be sure to wear the PPE required by the product label (including a respirator if conditions warrant) because fine, airborne powder is likely to arise; a fan and/or filtration system over the tank will help reduce your exposure.

From your water tank, add about half as much water as you'll need and agitate the mix. Once the powder seems to be in solution, add more water to bring the mix to the desired concentration. Keep in mind that, depending on facility design, the water source might contain collected wastewaters and could therefore already be a very dilute borate solution; you'll need to know what the concentration is to know how much of the water you'll need to get the desired final concentration.

Depending on concentration and temperature, borates can settle without agitation, so you'll want to transfer the solution from the mix tank into a work tank. There, you could use blades for agitation or just the agitation that results as solution passes from the work tank to the treatment cylinder and back again.

Prepare the final mix

Determine the Starting Point. The concentration of borates in a solution can be determined by measuring the solution's specific gravity. The chemical manufacturer will provide a chart indicating the percent solution for each specific gravity reading.

Adjust the Concentration of Preservative in the Work Tank. The procedure for preparing the final mix is similar to that described for copper azoles except that for a given percent solution, the amount of product is expressed as pounds of product per gallon of solution rather than gallons of product per gallon of solution. Thus, if you have 9,000 gallons of mix and you want to have 12,000, all the volume added will come from water.

Example. Suppose 0.5 pounds of your product per gallon of solution yielded a 5% preservative solution. And suppose you have 9,000 gallons of 4% solution, but you want 12,000 gallons of 5% solution. You would accomplish that as follows:

Step 1: Determine how much product you have in the work tank already. Note that if 0.5 pounds per gallon yields a 5% solution, then 0.4 pounds per gallon would yield a 4% solution.

```
 9,000 gal of solution in work tank
    × 0.4 lbs of product/gal
= 3,600 lbs of product in work tank
```

Step 2: Determine how much product you want in the final solution.

```
 12,000 gal of final mix
× 0.5 lbs of product/gal
 = 6,000 lbs of product
```

Step 3: Determine how much water and product you need to mix and then add to the work tank.

```
6,000 lbs of product desired
 – 3,600 lbs in work tank
    = 2,400 lbs needed

12,000 gal of water desired
  – 9,000 gal in work tank
    = 3,000 gal needed
```

So you need to mix up 2,400 pounds in 3,000 gallons and add it to the work tank.

MOLDICIDES FOR DIP TREATMENT

Delivery and transfer

Products used to dip treat lumber for prevention of mold, sapstain, and bluestain often come in totes, which are handled and connected in a manner similar to that described earlier for the moldicides used with copper azoles. In northern climates where dipping over winter is impossible, the totes need to be stored in a heated area for the winter.

Determine Starting Point. For some sapstain chemicals, the method for determining the concentration is quite different than for the preservatives we've discussed so far. It involves adding drops of chemicals in a particular order to a sample drawn from the tank (Figure 7-2); be sure the tank contents are well agitated prior to taking the sample. The chemicals will cause color changes in the sample. At the end of the procedure, compare the color of the sample to a color chart. The nearest match indicates the concentration of preservative in the tank, expressed as one gallon of product per so many gallons of solution.

The exact process will be specific to the sapstain control product you use. Contact the product manufacturer to find out the process; they will likely supply the chemicals needed and train you in how to analyze samples. Some manufacturers will even make regular visits to analyze samples themselves, just to verify that the process is working properly.

Adjusting the Concentration of Moldicide in the Dip Tank. The desired concentration can depend on weather and workload. For example, higher temperatures and having more green wood waiting for treatment both are conducive to the growth of sapstain fungi, so higher concentrations may be warranted.

Determine the volume of mix in the dip tank. The side of the tank might show the height of liquid in it, or you could lower a measuring rod into the tank.

Figure 7-2. Kit for analyzing dip treatment solutions for preservative concentration.

You can calculate the gallons per inch of height by multiplying the length of the tank (in inches) by the width (in inches) and dividing by 231 cubic inches per gallon. Multiply the gallons per inch by the measured depth (in inches) of solution in the tank to determine the volume of solution. You can multiply this number by the ratio of product to solution from your sample to find out how many gallons of product are in the tank. With these numbers, you can proceed to calculate how much water and product you need to add to the tank to get the desired solution volume and concentration.

Example. Your dip tank holds 125 gallons per vertical inch and the solution is 42 inches deep. From your sample, you've determined that there is one gallon of product for every 155 gallons of solution in the tank. You want to bring the solution up to 50 inches at the same concentration. How much product and water do you need to add to the tank?

Step 1: Determine how much solution is in the tank now and how much you will need.

$$\begin{array}{c}\text{125 gallons/inch}\\ \times\ \text{42 inches in the tank now}\\ =\ \text{5,250 gallons}\end{array}$$

$$\begin{array}{c}\text{125 gallons/inch}\\ \times\ \text{50 inches desired in the tank}\\ =\ \text{6,250 gallons desired}\end{array}$$

You will need to add 6,250 – 5,250 = 1,000 gallons of solution to the tank.

Step 2: Determine how much product is in the tank now and how much product you will need.

$$\text{5,250 gal of solution} \times \frac{\text{1 gal of product}}{\text{155 gal of solution}} = \text{about 34 gal of product in tank now}$$

$$\text{6,250 gal of solution} \times \frac{\text{1 gal of product}}{\text{155 gal of solution}} = \text{about 40.5 gal of product desired}$$

You will need to add 40.5 – 34 = 6.5 gallons of product to the tank.

Step 3: Determine how much water you need to add to the tank.

$$\begin{array}{c}\text{1,000 gallons of solution}\\ -\ \text{6.5 gallons of product}\\ =\ \text{993.5 gallons of water}\end{array}$$

If you want to reduce or increase the concentration in the final mix, you just change the ratio in the second equation under Step 2. For example, if you want a concentration of 1 gallon of product to 160 gallons of solution, the new equation would be:

$$\text{6,250 gal of solution} \times \frac{\text{1 gal of product}}{\text{160 gal of solution}} = \text{about 39 gal of product desired}$$

In this case, you would need to add 5 gallons of product and 995 gallons of water to the tank.

To facilitate mixing of the added solution, you could combine the needed product with some of the needed water in a smaller mix tank first, agitate it, and then pump it into the work tank. Then rinse the mix tank with water and pump that into the dip tank as a way of ensuring that all the chemical has been pumped into the dip tank and to reduce the risk of exposure for the next person who works in the area. After rinsing the mix tank, add the remaining water necessary to bring the dip tank up to the desired level. Finally, you could take a new sample from the dip tank and analyze it as described earlier to verify you have the desired concentration in the tank.

MAINTAIN MIX RECORDS

Maintain mixing records because they can help you troubleshoot things that go wrong during a treatment. For example, if the retention is lower than expected, maybe the mix wasn't prepared properly; knowing this would help you correct the problem for the next treatment (or for a retreatment). Also, the mix record may be part of the required pesticide application record.

At many wood treatment plants, mixing instructions are entered into a computer; then concentrate and diluent are pumped into the work tank as needed. In these situations, the computer program will likely save the mixing instructions, and that can serve as a record. However, it's good to have a backup method to verify the instructions the computer has saved. For example, if you use moldicides, you can check the scale reading before and after mixing as a way of checking that the amount entered into the computer is really what got pumped into the work tank; if there's a discrepancy, maybe there's a problem with a pump. Hand recording your own calculations before typing them into the computer is useful for spotting keying errors; this will make those errors easier to detect, since you will recognize any variation between what you expected to mix and what the computer is calling for.

A harvester shoots a tree through removing its branches in seconds, then the bare tree trunk is cut to the desired length for sale. Kaibab National Forest, Arizona, December 4, 2018. (© USDA Forest Service, Lance Cheung)

CHAPTER 8: PRESSURE TREATING WOOD

LEARNING OBJECTIVES

A. Explain why all the wood in a charge should have the same characteristics.

B. Describe protections for workers:
- When loading a charge into a cylinder
- When sealing a cylinder door shut
- If a cylinder door is not shut properly during a treatment

C. List the steps in ensuring a cylinder door seals tightly.

D. With respect to a preset:
- Explain what it is.
- State what it might be based on.
- Tell why there may be limits to adjustments you can make.

E. Tell what details about a charge you need to know prior to treatment and why.

F. Describe how you can determine the volume (in cubic feet) of wood in a charge.

G. Describe how seasonal conditions and the results of the previous treatment can lead you to alter presets.

H. Tell why it is important to monitor a treatment.

I. Tell when you should end the pressure phase.

J. With respect to gross absorption:
- Explain what it is.
- Tell how you can monitor it during treatment.
- Explain what happens (including actions you can take) if the gross absorption is insufficient when the maximum time for the pressure period (according to the preset or pertinent standards) is reached.

K. Tell what can cause excessive drippage after treatment and how to avoid it.

L. List precautions to take if a problem arises with equipment that is under pressure or vacuum.

M. Give examples of equipment problems that can arise during treatment, including steps to take to correct them.

INTRODUCTION

In this chapter, we will cover some of the treater's duties during the pressure treatment of wood.

LOADING A CHARGE

Properly loading a charge into the cylinder helps ensure proper treatment and protect you and yard workers from chemical exposure and physical injury.

All pieces in a charge should be of the same species. As discussed in the first chapter of this manual, wood species differ in how easily they accept preservative; if a charge includes two species that differ in this respect, you may get good retention in one but not in the other.

Likewise, all pieces in the charge should have the same dimensions (e.g., 2″ x 4″ x 8′ boards) or at least be within a single dimension of each other (e.g., 2x4s and 4x4s); pieces of different dimensions will treat differently. So, as with mixing species, mixing dimensions runs the risk of adequately treating only a portion of the charge.

Figure 8-1. The charge is strapped to trams to keep it in place during treatment.

In pressure treatment operations, the treater or a yard worker straps untreated wood to trams (Figure 8-1), which ride along tracks from the drip pad into the treatment cylinder. The trams may be pushed into the cylinder with a forklift (Figure 8-2) or powered by a winch or pulley system. Wear protective gloves when you disconnect the forklift or winch/pulley system from the trams.

Often, there are removable tracks that span the gap between the drip pad and cylinder. To prevent worker exposure to chemicals, these tracks must be placed/removed mechanically in facilities that use creosote, penta, or wood preservatives containing

Figure 8-2. Using a forklift to push the charge into the cylinder for treatment.

Figure 8-3. Wear appropriate PPE if you handle removable tracks.

arsenic or chromium. Wear protective gloves if you use another preservative and place/remove the tracks manually (Figure 8-3).

SEALING THE CYLINDER DOOR

Once the charge is in the cylinder and you've set any removable track aside, use a hose or long-handled brush to remove any dirt or wood chips from the door gasket and seal area. The debris results each time you open the door after treatment and some preservative solution flows out of the cylinder and into the door pit. Cleaning the gasket and seal area helps ensure a tight seal during the upcoming treatment. Wear appropriate PPE, including an apron and face shield if you wash the door with a hose. Replace the gasket as necessary, remembering to treat it as hazardous waste if required to do so.

After you have cleaned the door seal, close the door securely. To prevent worker exposure in plants using creosote, penta, or preservatives containing arsenic or chromium, cylinder doors must be closed and locked remotely from a control panel that is at least 15 feet from the door. Regardless of the preservative used, the lock rings on a door must be secured when the door is closed.

Doors also are equipped with sensors that prevent the system from operating unless the door is sealed shut. If the sensor detects that the door is no longer secure, it shuts the system down automatically. In some facilities, any preservative in the cylinder would be immediately pumped back into the work tank. Shutting the system down does more than prevent preservative from spilling out of the cylinder; if the door is not properly sealed when the cylinder is under pressure, it could be blown open—or even off—with enough force to put workers at risk of serious injury or death.

SETTING UP THE CHARGE

Each step in pressure treatment processes (described in Chapter 2, "Methods of Wood Preservation," page 13) can be adjusted in length and/or magnitude to provide the proper penetration and retention of preservative. (However, there may be limits to the adjustments you can make; for example, AWPA standards may specify a maximum time and/or pressure for the pressure phase.) Such adjustments are typically combined into presets—specific treatment recipes that have been set up ahead of time and that cover the entire treatment process. For example, a full-cell treatment preset might include the strength and duration of the initial vacuum, time (if any) for atmospheric absorption, maximum pressure, minimum and maximum times at pressure, target retention, release pressure (for blowback), time allowed for release of pressure and blowback, and strength and duration of the final vacuum. Presets are often based on meeting the relevant standards rather than on pesticide label directions.

Presets may be listed in a binder or on the computer. The treater must read the preset specifications and enter the required details about the charge into the computer so that the charge will be treated according to the appropriate preset recipe. Here, we will discuss what the treater does to set up a charge, including entering details about the charge and adjusting the presets as conditions warrant.

DETAILS ABOUT THE CHARGE

The treater needs to enter the following information about the charge prior to treatment:

- Species of wood, which the treater gets from the yard workers or the face tag on the wood;
- Dimensions and number of pieces (to determine cubic feet and board feet);

- Identifying information; and
- Cylinder and work tank to use.

Species of wood

As discussed in the first chapter of this manual, wood species differ in how easily they accept preservative. Therefore, the preset used can depend on the wood species.

Wood dimensions and quantity

The amount of preservative you need to use in a treatment largely depends on the volume of wood in the charge. For example, the volume of preservative mix needed to fill the cylinder before the pressure phase begins depends on how much volume in the cylinder is already taken up by the wood. Therefore, there's no way for you or the computer to know if you've used the right amount of preservative unless you know how much wood (in cubic feet) is being treated.

Once a charge is loaded on trams and ready for treatment, you will have a tally, which tells you the number of bundles or pieces of wood in the charge and the dimensions of each piece. (For wood of any given dimension, such as a 10-foot 2x12, the number of pieces in a unitized bundle will typically be the same.) Enter the information from the tally into the computer; the computer (which will have already been programmed with information on the number of pieces per bundle and cubic feet per piece) will then calculate the cubic feet in the charge. Lumber is measured in board feet (1 board foot = a piece of wood 1-inch thick, 12-inches wide, and 1 foot long), so the computer might calculate this value as well; it is useful for recordkeeping and sales purposes.

Lumber. When entering a tally of lumber into the computer, be sure to enter the nominal dimensions of the wood pieces. With a 2x4 piece of kiln-dried, surface-planed lumber, for example, 2x4 is the nominal size whereas the actual dimensions are 1.5″ x 3.5″. The computer will convert the nominal dimensions to actual dimensions when it calculates total actual cubic feet. (Board feet are calculated using nominal dimensions, so no conversion is needed for that calculation.)

Some facilities treat rough-sawn lumber, boards, fence slats, and timbers that may not have been surface planed or necessarily kiln dried. In this case, you (and the computer) would simply use the actual dimensions of the wood pieces that you are treating.

Round Stock. When you treat round stock, such as poles, posts, and piling, you calculate volume from the length, diameter, taper, and number of pieces (as well as percentage of sapwood, in some cases). For example, with utility poles, the tally will consist of the number, length, and class of poles. Class is based on the changing diameter as the pole tapers from butt to top. Typically, a computer will have the volume of each pole of a particular class and length in its memory and will thus be able to calculate the volume of the charge.

Hand Calculations. Though it can be useful to know how to calculate cubic feet and board feet, few treaters make hand calculations to determine the quantity of wood in a charge. Most often, you will enter the tally into the computer as described

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above. If calculations are done by hand, your treatment manual will contain tables which provide the cubic feet for a given wood product; you can then multiply that by the number of pieces in the charge to get the total cubic feet. For example, your manual might indicate that a traditional kiln-dried and surfaced dimensional 8′ 2x4 contains about 0.292 cubic feet; if you treat 1,000 2x4s, the total cubic feet would by 0.292 x 1,000 = 292 cubic feet.

Entering the Information

Entering information such as the charge number and the treater's and customer's names is important for recordkeeping and quality control purposes. For example, when you assay retention and penetration of a charge (described in Chapter 9, "Post-treatment Activities," page 76), the charge number will allow you to link that assay to the actual treatment details. This will be critical in diagnosing any problems if the assay shows the wood was not treated sufficiently.

Also, utility and railway companies especially may require you to meet their own treatment specifications. In such cases, entering the company name is necessary to ensure the proper preset is selected.

Cylinder and mix tank

If your facility has more than one work tank and/or treatment cylinder, indicate which will be used when you set up the charge. This is important for your records. Also, presets are developed for specific preservative concentrations and cylinder volumes; if you don't enter those values correctly, you may get a treatment failure.

ALTERING THE PRESETS

Presets are developed by management, as a service by the chemical provider, and sometimes by the treater. However, it is usually the treater who adjusts presets as conditions warrant. Seasonal conditions and results from treating the previous charge can lead you to alter a preset.

Seasonal conditions

Presets often need to be adjusted depending on the season. Colder wood can take longer to treat, especially if it is wet or frozen. To ensure proper retention and penetration, you could press for a longer time or at a higher pressure. The latter may not be possible if the preset pressure is already nearing the cylinder's limit. You could also thaw or warm the wood by letting the wood soak in preservative in the cylinder before applying pressure.

In the winter, drippage after treatment may freeze on the wood, requiring you to leave treated wood on the pad until the drips thaw and eventually stop. This will cause a backlog in treating because there is limited storage space on the pad. To minimize this problem, you can run a longer final vacuum in the winter to reduce drippage.

Previous charge

Considering the variety of factors that influence presets—species, dimension, and season, to name a few—some facilities use the results of treating one charge to see if they need to make adjustments for the next charge. For example, if a charge comes out and is dripping excessively, you might run a longer final vacuum on subsequent charges that day. This approach works best if you schedule similar treatments in succession. For example, results from treating 6-inch diameter posts will provide information that is more useful for treating subsequent 6-inch posts than for treating 2x4 boards.

MONITORING THE TREATMENT

Whether a treatment is run entirely by computer or you manually open and close valves and turn

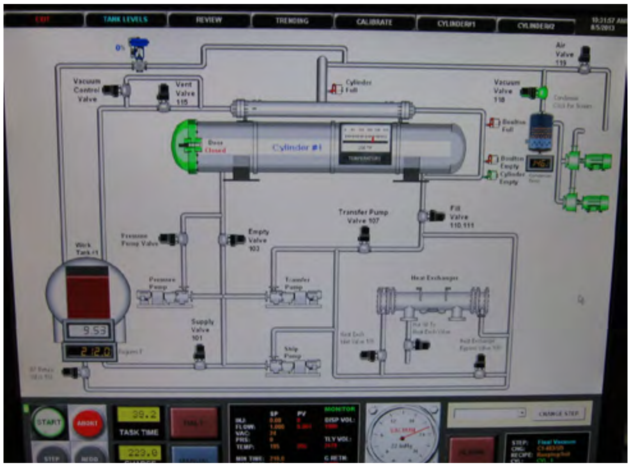

Figure 8-4. Computer screen showing the progress of a pressure treatment.

on pumps yourself, monitoring helps you ensure a proper treatment and detect and correct common problems. If the process is run manually, you need to monitor it so you know when to proceed with the next step. Even with computer-run treatments, however, valves or pumps may fail or line filters might clog and you need to be able to recognize when you need to halt the process and correct those issues.

To properly monitor a treatment, you must understand the sequence and purpose of each stage in the process. (The stages were discussed in Chapter 2, "Methods of Wood Preservation," page 13.) For example, a preset typically specifies that the pressure stage should end after a set maximum period of time has passed or when a specified volume of preservative has been pressed into the wood (called the gross absorption), whichever comes first. You need to realize that the charge might be under treated unless one of those conditions is satisfied; if you don't realize this, you might end the pressure phase too soon.

Computer-run systems typically feature a graphic on the monitor showing the progress of the treatment (Figure 8-4). From this graphic, you can tell which pumps are operating, which valves are open, what the vacuum or pressure is in the cylinder, and the direction in which preservative is flowing. By understanding the process, you can look at the graphic and determine whether or not there are any problems.

ENSURING PROPER RETENTION

You might not get the desired retention if you end the pressure phase too soon. To avoid this, pay attention to how much preservative is being pumped into the cylinder. For example, your treatment manual might say that when the treatment is over, you need to end up with 3 gallons of preservative mix per cubic foot of wood in the charge to reach the desired retention. However, you will need to press more than this into the wood because some preservative will be kicked back during pressure release and the final vacuum (affected by amount and time). Your treatment manual and/or experience can guide you regarding how much preservative you need to press into the wood during treatment.

Monitoring the level in the work tank

To ensure you do not end the pressure phase too soon, record the gallons of preservative mix in the work tank immediately before you begin the pressure phase; write down the gallons if the computer does not record it for you. Then monitor the volume in the work tank during the pressure phase; once the desired volume has been pumped into the cylinder, you can end the pressure phase. (If you use a computerized system, the computer might monitor the work tank level for you.) For example, if the level in the work tank is 3,000 gallons when you start the pressure phase and you want to inject 2,000 gallons into the wood, you (or the computer) would stop the pressure phase when the level in the work tank drops to 1,000 gallons. In this example, 2,000 gallons is the gross absorption; remember that some of this amount will be kicked out of the wood once pressure is released.

Monitoring the level in the work tank allows you to alter the pressure phase if necessary. For example, if the maximum time for the pressure phase (according to the preset) has been reached but the gross absorption is lower than desired, you could choose to extend the pressure period by overriding the preset. (As always, do not exceed the maximum time for pressure that is specified in the appropriate treatment standards.) Extending the pressure period ties up the cylinder longer, reducing the number of charges you can treat, but it could help ensure a quality product.

Dealing with insufficient gross absorption

Sometimes, you might run the pressure phase for the maximum time allowed by the standards and still not reach the desired gross absorption. There are two likely reasons why this could happen:

1. The moisture content of the wood in the charge may have been too high. Remember that water competes with preservative for space in the wood. The treatment will likely fail for inadequate penetration as well as retention; if so, you would have to retreat the charge. You will likely need to dry the wood properly before retreatment, especially if you used a waterborne preservative.
2. The charge might contain more heartwood than usual. Heartwood generally does not treat; therefore, if this is the case, the treatment might not be a failure if analysis for penetration and retention (described in Chapter 9, "Post-treatment Activities," page 76), shows that the sapwood was adequately treated.

PREVENTING EXCESSIVE DRIPPAGE

Keep an eye on the pressure as it is being relieved after the press phase. For example, if you lower the pressure too fast after pressing, the wood may come out looking dry, but could end up dripping excessively. One way this can happen is if you start blowback at too high a pressure, because it causes a sudden drop from high pressure to low pressure.

COMMON PROBLEMS

As treating equipment, plant design, and computer use vary between plants, so will the problems that arise during treatment. We will discuss some of the more common issues along with some plant-specific items to give you an idea of the breadth of issues you might face.

One overriding concern exists at all plants: never work on any equipment that is under pressure or under vacuum; doing so could cause exposure and/or injury. If necessary, shut down the system and bring it to ambient air pressure before beginning repairing or replacing parts. To achieve ambient air pressure, you can manually open a vent valve after shutting off the vacuum or pressure pump.

Clogged filters and lines

As preservative is cycled back and forth between the treatment cylinder and work tank, sawdust, wood chips, and dirt are carried along with it. Line filters (or baskets) and even lines can clog over time. Your first hint might be that the cylinder is not filling with preservative or the pressure is not rising properly. If the pressure pump screeches or howls, it means nothing is going through it. Before you assume there's a clog, make sure all the valves are properly set to the open or closed position. If they are, there must be a clog. Shut down the system, find the problem and fix it, and then restart the process. Fixing line filters can be as easy as removing the debris that forms the clog. Clogged lines would require more extensive remediation.

Valve and pump issues

The pressure on a cylinder's relief valve is powerful and unrelenting. These valves can sometimes blow during the pressure phase, especially with hard-to-treat wood. You would need to shut down the system, relieve the pressure in the cylinder, and repair or replace the valve before continuing.

Problems during blowback

Some cylinders will have a sensor at the bottom that detects wetness; blowback will continue until the sensor is dry. However, sometimes debris can coat the sensor so that blowback doesn't stop when it should. When this happens, air bubbles are blown into the work tank, causing it to rock or vibrate. Force the system to the next step to stop the problem for now; to prevent this from happening again, you might have to clean the sensor after the treatment finishes.

Some products can foam during blowback. If a work tank is not vented, the pressure could force solution out the top of the tank or cause a valve to blow. You can avoid this problem if your work tank has a vent and/or diverts overflow to an adjoining tank.

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CHAPTER 9: POST-TREATMENT ACTIVITIES

LEARNING OBJECTIVES

A. Describe the requirements for protecting workers when opening cylinder doors after treatment with creosote, penta, or a wood preservative containing arsenic and/or chromium.

B. Describe steps you can take to protect yourself when removing a charge from a cylinder.

C. Tell when to place treated wood on and remove it from a drip pad.

D. Tell where you can find the proper procedures for analyzing wood samples for retention and penetration.

E. Tell what to do if a charge does not pass for penetration and/or retention.

F. Describe the procedures for taking and analyzing samples of treated wood.

G. Distinguish between retention by assay and retention by gauge or weight.

H. Regarding analysis of treated wood samples by others:
   - Give examples of parties that might do the analysis.
   - Explain why they would be involved in analyzing samples.
   - Discuss the roles of the American Lumber Standards Committee and the International Code Council's International Accreditation Service in inspecting treated wood.

I. Describe how proper use of forklifts used to handle treated wood can help reduce waste and maintain the integrity of the treatment.

J. With respect to tagging treated wood:
   - Indicate which information may be placed on a tag.
   - Tell where tags are placed on the wood.

K. Give reasons for maintaining records of preservative treatments.

INTRODUCTION

Your responsibilities do not end with the treatment process. You still need to handle the treated wood properly; analyze it to ensure proper penetration and retention; and maintain treatment records.

REMOVING WOOD FROM THE TREATMENT VESSEL

After treatment, the treatment vessel will contain preservative (e.g., drippage in a cylinder) and the wood itself will be dripping preservative. You must take care to prevent chemical exposure when you remove wood from the treatment vessel.

OPENING A CYLINDER DOOR

As described in the previous chapter, "Pressure Treating Wood," page 68, treatment cylinder doors have safety mechanisms in place to ensure they cannot be opened until the cylinder is brought back to atmospheric pressure. In addition, you must adhere to the following guidelines (found on the product label) for preventing chemical exposure when you open a cylinder door after treating wood with creosote, penta, or a wood preservative containing arsenic and/or chromium:

- The cylinder must be ventilated by purging it with at least two fresh air exchanges. An exchange occurs when the air inside the cylinder has been replaced by a volume of fresh air equivalent to the volume of the cylinder when empty.
- You can use an air purge system while the door remains closed or you could use a device that opens and holds the door open no more than 6 inches while activating a vacuum pump to purge the air inside the cylinder.
- If the purging occurs with the door cracked open, you may not be within 15 feet of the door until ventilation is complete unless you wear the PPE (including appropriate respirator) specified on the product label. However, the label only allows you to do this in case of equipment malfunction or to place the spacer that keeps the door ajar.
- Once the two air exchanges have been completed, you may open the door and work within 15 feet of the cylinder.

When you open a cylinder door, excess preservative will drain out into the door pit (Figure 9-1); the amount will increase if you keep the wood in the cylinder longer because there will be more time for drippage to occur. Wear the PPE listed on the label, plus any further protection you feel is warranted.

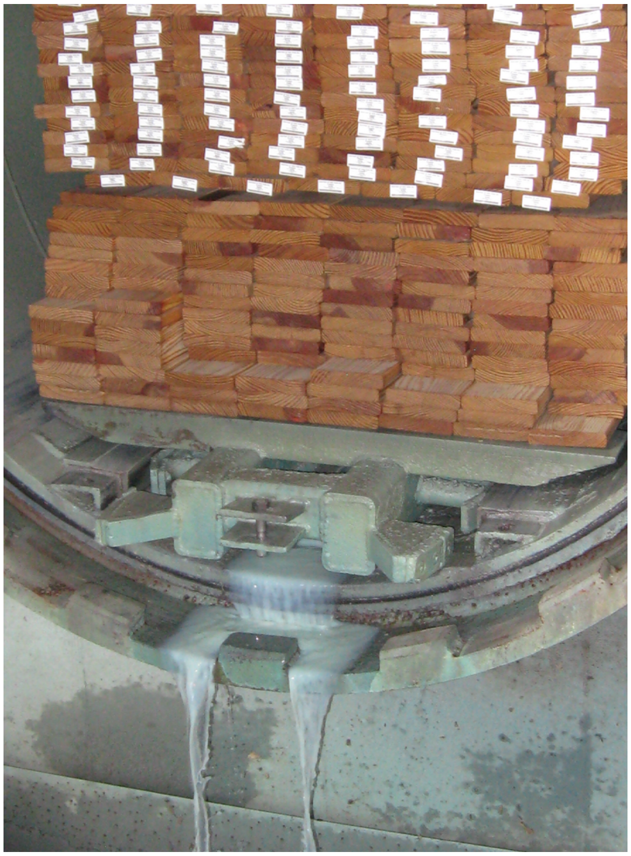

Figure 9-1. Excess preservative draining from a cylinder after treatment.

REMOVING WOOD FROM A CYLINDER

As discussed in the previous chapter, "Pressure Treating Wood," page 68, wear protective gloves if you need to manually place tracks to span the gap between the cylinder and the drip pad. Hook the lead tram from the cylinder to the forklift or pulley/winch system you use to pull the charge out of the cylinder. Check the product label and wear the specified PPE when you handle the charge cables, poles, or hooks used to retrieve charge cables, or other equipment that has contacted the preservative.

As you pull the wood out, remember that the straps holding the wood to the trams could break. Keep a safe distance from the trams because if straps break, wood could spill onto the pad and cause injury. If wood does fall off the trams, wear the appropriate PPE (listed on the pesticide label) for handling freshly treated wood. Wear eye protection even if not required to by the label to protect against splashing drippage.

If straps break inside the cylinder and some wood won't come out, remember that you need to comply with OSHA's regulations for entry into a permit-required confined space (see Chapter 5, "Site Management," page 35). Comply with both OSHA and product label requirements regarding PPE.

REMOVING WOOD FROM A DIP TANK

Wood that has been immersed in a dip tank can be removed after a specified time or once air bubbles have stopped coming out of the wood. Use the hydraulic system to raise the platform from the tank. Hold the wood over the tank until there is little drippage. Then, use a forklift to transfer the wood from the platform to the drip pad.

ANALYZING WOOD FOR PENETRATION AND RETENTION

You need to analyze charges to ensure you achieved proper penetration and retention of preservative. AWPA Standard M2, "Standard for Inspection of Wood Products Treated with Preservatives," provides the details for sampling and analyzing wood samples. The procedures vary depending on the preservative used and the wood products being treated, so we won't outline each procedure here. Instead, we will cover some basic points to keep in mind.

If a charge fails for either penetration or retention, you will have to retreat it. You will likely need to dry the wood properly before retreatment, especially if you used a waterborne preservative.

TAKING WOOD SAMPLES

Sampling usually involves taking a specified number of cores from multiple pieces of wood in the charge soon after the wood is taken out of the cylinder (Figure 9-2). The cores typically extend past the depth of penetration, exposing untreated wood that is susceptible to pests. To prevent pest problems, you need to plug the holes. Your chemical supplier may supply untreated wood plugs that are slightly wider than the sample cores. You can

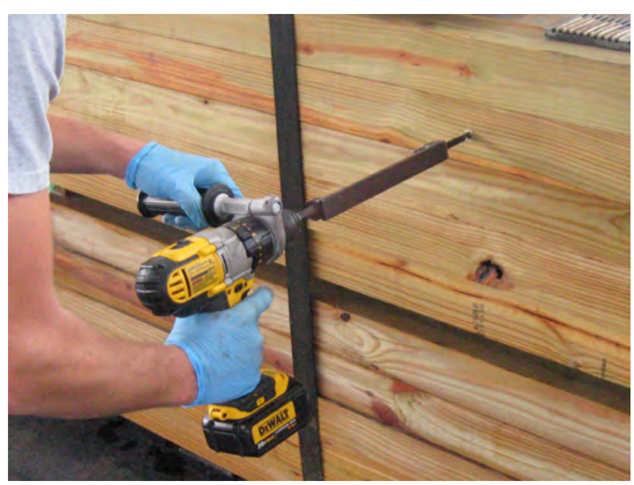

Figure 9-2. Taking core samples from freshly treated wood.

place the plugs in a mesh bag that you fasten to a charge and treat them right along with the charge. After taking core samples from treated wood, use a hammer to tap the treated plugs into holes you just made (Figure 9-3); to reduce your exposure to preservative, use dried plugs that had been treated along with a previous charge.

ANALYZING THE SAMPLES

Most treatment plants will analyze samples from every charge for penetration on site and may analyze them for retention as well. Plants will also have samples analyzed by others.

Analysis on site

Though each facility must purchase the necessary equipment for analyzing samples, the chemicals and procedures you need to analyze samples on site are usually supplied by the preservative manufacturer. Because chemicals and pieces of freshly treated wood are involved, wear appropriate PPE, such as protective gloves and eyewear.

Cores (Figure 9-4) are cut to a length prescribed by the relevant standard and might be treated with a heartwood indicator. The indicator causes the heartwood to be colored differently from the

Figure 9-3. Treated wood plugs (left) are hammered into holes left from taking wood samples (right).

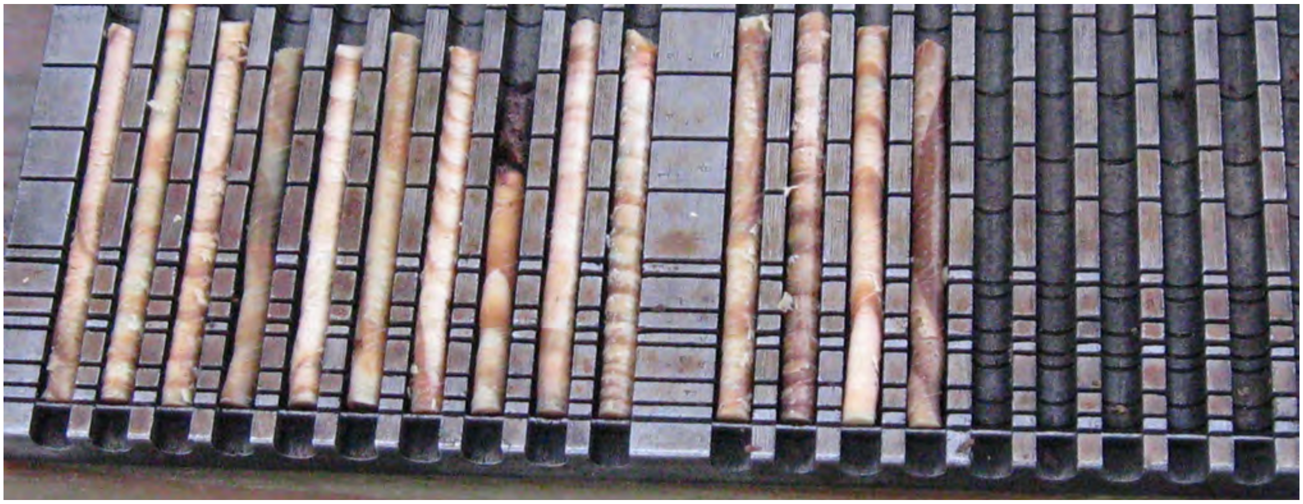

Figure 9-4. Cores from a charge being readied for penetration analysis

sapwood; this is useful because heartwood does not need to be penetrated and also does not get analyzed for retention.

Analyze Cores for Penetration. If needed, you then treat the core with one or more dyes that produce a color change, indicating how deep the preservative penetrated; the dye(s) used will depend on the preservative. You then determine whether each core passed or failed for penetration. For example, a failure may be defined as a core in which more than 15% of its length is untreated sapwood. If more than a prescribed number of cores (e.g., 4 out of 20) show that penetration did not meet the relevant standard, the treatment is considered a failure.

Analyze Cores for Retention. If the charge passes for penetration, you can remove the heartwood from the cores; only sapwood from the cores is analyzed for retention (in pounds of preservative per cubic foot of wood). There are two ways in which retention is measured:

- With most wood products, you will measure the retention only within an assay zone that is prescribed by the relevant treatment standards; this is called retention by assay. For example, a standard for treating 2-inch lumber may specify that the assay zone extends from the surface of the wood to 0.6″ deep, while a standard for utility poles might require you to analyze the retention only in wood that is between 0.5″ to 2″ deep into the pole. Using this example for utility poles, you would discard any part of the cores that came from less than 0.5″ or from more than 2″ deep into the pole before analyzing for retention.
- When you treat railroad cross ties and switch ties, retention is measured using the total amount of preservative and the total cubic feet of the charge. This measurement is called retention by gauge or weight.

If the measured retention does not meet the treatment standard, the treatment is considered a failure, even if the treatment passed for penetration.

Analysis by others

Most wood treatment plants will periodically have a sample analyzed by another party as well. As with analyzing the concentration of preservative in your work tank, having someone else double check your analysis is a way of verifying the success of your treatments and the accuracy of your analysis equipment.

Preservative Supplier. Your preservative supplier has the expertise to analyze samples. If you use their services, ask if you can send samples to them on a regular basis for verification. If they provide this service and find a discrepancy between your results and theirs, they might check your analysis equipment and repair or recalibrate it if necessary. They might also troubleshoot your treatment operation to see if the problem lies there.

Customer. As mentioned earlier in the manual, customers such as utilities and railways might have their own treatment standards that differ from AWPA's. These customers may have their own quality control programs in which they require you to submit full test data with each batch of product supplied. They might also conduct their own spot checks to verify the quality of your products.

Third-party Agency. The American Lumber Standards Committee (ALSC) is a non-profit organization comprised of lumber manufacturers, distributors, users, and consumers. For lumber produced under AWPA standards, Standard T1 stipulates that "treated wood products supplied to construction and consumer markets which are subject to building code requirements shall be audited by third-party inspection agencies accredited by the ALSC." Passing inspection by an independent inspection agency accredited by the ALSC allows you to use the agency's quality mark on your treated products (Figure 9-5). You can obtain the current list of accredited agencies for inspecting pressure-treated lumber at http://www.alsc.org/.

For treated wood produced under an International Code Council–Evaluation Service (ICC-ES) report, the third-party inspection agency must be accredited by the ICC's International Accreditation Service (IAS). As with inspection by an agency accredited by the ALSC, passing inspection by an agency accredited by the IAS allows you to use the agency's quality mark (Figure 9-5); in either case, an agency's quality mark provides consumers with independent verification as to the quality of your product. Also, whether accredited by the ALSC or the ICC's IAS, the third-party inspection agency periodically inspects treated wood for penetration and retention.

HANDLING WOOD AFTER TREATMENT

Once you are sure the treatment provided sufficient penetration and retention of preservative, place the treated wood on the drip pad. Wear label-required PPE when you remove the straps or chains that hold treated wood on the trams (or platform, in the case of dip treatment).

PUTTING WOOD ON THE DRIP PAD

Wood is typically removed from trams or platforms using a forklift. To reduce the amount of dirt getting on the drip pad and the amount of preservative leaving it, use a forklift that always stays on the pad. Avoid spearing the wood with the forklift. Any wood chips produced by spearing would become waste. Also, spearing could produce holes deep enough to expose untreated wood; this would make the wood susceptible to pest damage.

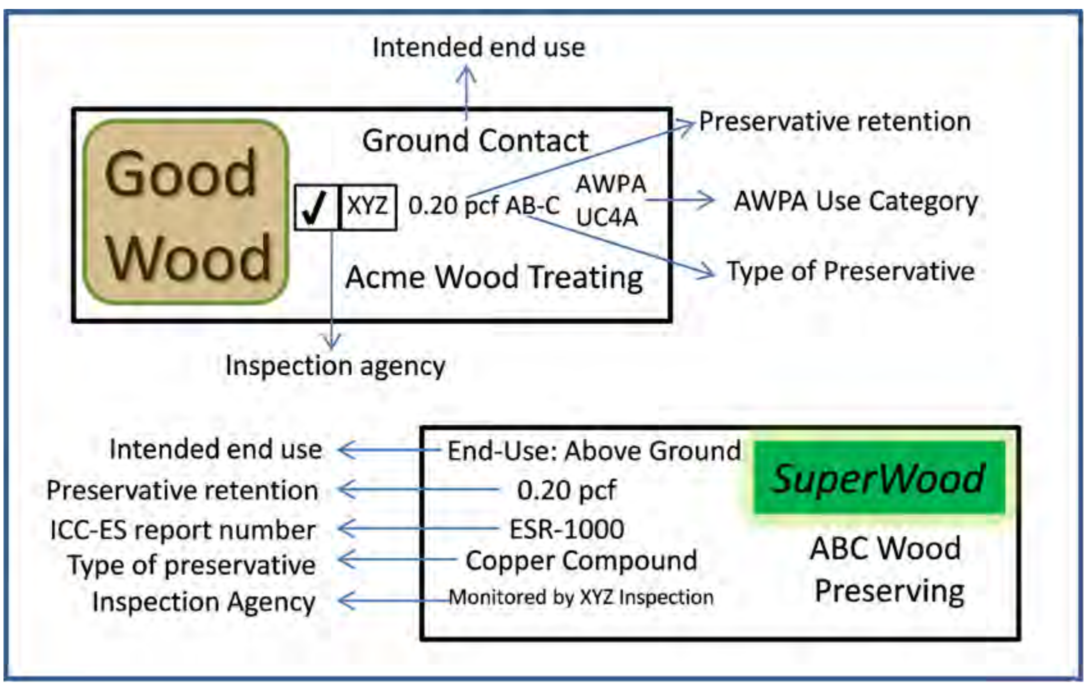

Figure 9-5. Sample format for tags of treated wood inspected by an agency accredited by the ALSC (top) or the ICC's IAS (bottom). (Courtesy of USDA Forest Products Laboratory)

Leave the treated wood on the pad until you determine that dripping has stopped and, for some preservatives, fixation has occurred. The time it takes for wood to stop dripping depends on the treatment, wood species, and weather conditions. For example, dripping may last longer in humid conditions.

MOVING WOOD TO THE STORAGE YARD

Transfer the wood to your storage yard once drippage has stopped. If you use a forklift that remains on the drip pad, you can use it to move the wood to the edge of the pad. That way, a second forklift that is off the pad will be able to pick the wood up and bring it to the yard.

TAGGING THE WOOD

Once the wood is in the storage yard, it can be tagged or stamped to indicate such things as preservative, retention, use, and your company name (Figure 9-6). Lumber is often also tagged with the wood dimensions and the tags might be bar coded for retailers. As described earlier in this chapter, lumber may be tagged with an accredited inspection agency's quality mark (Figure 9-5).

After treatment, utility poles are typically tagged with the same information that is included in the brand (see Chapter 6, "Preparing Wood for Treatment," page 48). The tag is placed on the butt end of the pole to make it easy to view while poles are stacked horizontally in the storage yard and during transit.

Figure 9-6. Tagging lumber after treatment.

MAINTAINING APPLICATION RECORDS

You need to keep a record of each charge that you treat. At a minimum, the information you record must satisfy:

- Your state's pesticide application recordkeeping regulations;
- Requirements set forth by your chemical supplier, your customers, AWPA standards, and/or an inspection agency accredited by the ALSC or ICC's IAS; and
- Your company's policies.

Among the things to record could be date of treatment; name of treater; charge number; treatment method; species, dimension, moisture content, and cubic feet of wood; concentration and gallons of mix used; pounds of preservative used; and the results of your analysis for retention and penetration. Keep records at least as long as required by state law.

Detailed records document that you treated wood properly. If something goes wrong with a charge, the application record allows you to troubleshoot problems because you can track each stage of a treatment. In addition, by looking at records from previous years, you can predict your workload for each month of the upcoming year; this could allow you to stay on top of activities such as ordering chemicals for busy periods and scheduling basic maintenance during slower periods.

WOOD PRESERVATION: A PESTICIDE APPLICATOR CERTIFICATION TRAINING MANUAL FOR WOOD TREATERS, NATIONAL EDITION, DECEMBER 2015, ACKNOWLEDGMENTS

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Nantahala National Forest, North Carolina, 1960. (Forest Service photo by Daniel O. Todd)

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