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# Recommendations for the Design and Operation of Wood Preservation Facilities, 2013

Technical Recommendations Document

**Prepared by**

Environment Canada

In collaboration with

The Pest Management Regulatory Agency of Health Canada

Wood Preservation Canada



Canada 

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# **Recommendations for the Design and Operation of Wood Preservation Facilities, 2013**

Technical Recommendations Document (TRD)

December 2013



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Environment Canada

In collaboration with  
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&  
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Ce document est également disponible en français sous le titre *Recommandations pour la conception et l'exploitation des installations de préservation du bois, 2013 : document de recommandations techniques*.

This guidance manual (also referred to as the 2013 TRD) may be cited as follows:

The 2013 TRD is available on Environment Canada's website at the following address:

<http://www.ec.gc.ca/pollution/default.asp?lang=En&n=8A0440A3-1>

Environment Canada. 2013. Recommendations for the design and operation of wood preservation facilities, 2013: technical recommendations document. Available from Environment Canada website. 444 pages.

(It supersedes the five 1988 EPS reports [EPS 2/WP/1, EPS 2/WP/2, EPS 2/WP/3, EPS 2/WP/4 and EPS 2/WP/5] and the previous versions of the binder of the same name that were published in March 1999 and in [April 2004](#).)

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## Foreword

Wood exposed outdoors is subject to degradation by various organisms, including fungi, insects and marine borers. The impregnation of wood with preservative chemicals retards or prevents its destruction by these agents. By design, such preservative chemicals must be toxic to the target organisms. However, their use may also affect non-target biota and the environment, unless proper safeguards are taken. Like many other industrial chemicals, wood preservatives require proper handling to prevent hazards in the workplace and during transportation and storage, as well as to avoid emissions from the process and the treated product.

In 1984, Environment Canada, as part of a federal strategy to protect the environment and human health from potentially toxic commercial chemicals, evaluated use practices within the wood preservation industry. The Department subsequently initiated a technical steering committee to develop technical recommendations for facility design and operations.

The objectives were to develop recommendations that would outline practices to

- reduce or eliminate the release of wood preservative chemicals to the environment; and
- minimize the exposure of workers to wood preservative chemicals.

The development process, which included the participation of representatives from federal and provincial government agencies, the wood preservation industry, forest industry labour unions, and workers' compensation boards, concluded with the publication of five technical recommendations documents (TRDs) in 1988 (1, 2, 3, 4, 5). The documents covered good practices for pressure treatment with each of the major wood preservatives then in use: chromated copper arsenate (CCA), ammoniacal copper arsenate (ACA), pressure treatment with pentachlorophenol (PCPP), thermal treatment with pentachlorophenol (PCPT) and creosote. These documents have since been widely applied in Canada to the construction of new facilities

and the upgrading of existing wood preservation facilities. In addition, international technical guidance documents for the preservation industry have made use of information contained in the Canadian TRDs from 1988 (6, 7, 8).

The measures recommended in the 1988 TRDs were based on knowledge of the existing technology and the properties of the preservative chemicals at the time of their development. However, since the publication of the 1988 TRDs, a variety of new and modified operating technologies have been developed, environmental compliance criteria have changed, and knowledge of the properties of the chemicals has been expanded. Hence, it was deemed necessary to review the TRDs, update information where appropriate, and include any new technologies to take advantage of improved design and operational practices.

In response to the need to update the 1988 TRDs, Environment Canada and the Canadian Institute of Treated Wood (CITW), now known as Wood Preservation Canada (WPC), initiated development of a single revised TRD, which was published in March 1999 (9). A review of the 1988 TRDs was organized by CITW and was undertaken by industry members. The industry comments were compiled by Frido Consulting. Relevant industry information, as well as additional information from the open literature or from experts and regulatory agencies, was also used to update the recommendations. The document underwent four draft stages, each entailing reviews and comments by industry, as well as by federal and provincial regulatory personnel. It was finalized by a technical coordinating committee.

As indicated above, the 1988 recommendations were presented in five comprehensive documents. These have been found to be user-friendly in format and general content. However, there were many subjects and recommendations common to all, leading to duplication. To eliminate such duplication, the 1999 TRD included all preservatives and treatments in a single manual. Although the 1999 manual followed the contents and format of the 1988 TRDs as closely as possible, general background information and recommendations applicable to all preservatives were separated from information specific to individual preservatives. This structure made information about individual preservatives easier to find and facilitates the addition of new preservatives and any other incidental information.

On a parallel track, Environment Canada and Health Canada developed a process for managing environmental toxic contaminants under the *Canadian Environmental Protection Act (CEPA)*. The process involved identifying CEPA Toxic<sup>1</sup> substances and the development of a risk-management strategy through a Strategic Options Process (SOP). The SOP addresses the releases of CEPA Toxic substances used by the wood preservatives as listed in Table 1:

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<sup>1</sup> CEPA Toxic refers to meeting the definition of Toxic as per s. 11 of CEPA and s. 64 of CEPA 1999



**Table 1: List of CEPA Toxic Substances Used in Wood Preservatives**

<b>CEPA Toxic Substance (1999)</b>	<b>Wood Preservative</b>
Chromium VI Inorganic arsenic compounds	Chromated Copper Arsenate (CCA) Ammoniacal Copper Zinc Arsenate (ACZA)
Polycyclic Aromatic Hydrocarbons (PAHs), Creosote-impregnated waste materials	Creosote
Polychlorinated dibenzodioxins (Dioxins) Polychlorinated dibenzofurans (Furans), Hexachlorobenzene (HCB)	Pentachlorophenol (PCP)

Following publication of the 1999 manual (1999 TRD) and the SOP report the industry proceeded with a voluntary program to implement the recommendations at all wood preservation facilities in Canada. The goal of the program was to have all facilities adopt the recommendations of the TRD by 2005. To meet this goal, the TRD Implementation Program was developed with the following steps:

- Two rounds of information sessions were held across Canada to inform wood preservation facilities about the program.
- A baseline assessment, referred to as Assessment 2000, was conducted at every facility to determine the level of adoption of the TRD.
- Each facility was required to submit an implementation plan by December 31, 2001, which would describe how it intended to correct deficiencies from Assessment 2000.
- On December 31 of years 2002 to 2005 inclusive, facilities were required to submit annual update reports to demonstrate continual improvement towards the 2005 goal.
- Random assessments were conducted to determine whether the implementation plans were executed as intended.

The program generated questions and additional knowledge regarding best management practices. As a result, the 1999 TRD was revised and the 2004 updated document was published.

The 2004 updated manual maintained the format and content of the 1999 version. It included new chapters on the preservatives alkaline copper quaternary (ACQ), copper azole (CA-B) and inorganic boron, which were newly registered in Canada. Ammoniacal copper arsenate (ACA) was replaced by the preservative ammoniacal copper zinc arsenate (ACZA). As well, the manual contained design and operational measures to enable safe operations in wood preservation facilities in terms of worker exposure and health risks as well as environmental impact (10).

Following the December 31, 2005, deadline to adopt the TRDs, final audits of every facility in the voluntary program were conducted to verify the level of adoption of the TRD as part of the

SOP-TRD<sup>2</sup> implementation program. A total of 53 facilities were audited from early 2005 until November 2006. The overall range of national adoption of the TRD for all preservative facilities was found to be 59% to 99%, with an average of 87%. At that time, 37 of 53 plants (70%) had adopted at least 99% of the recommendations, with another 10 plants (19%) at an adoption rate of over 95% (10).

As the audit results showed, the targeted 100% adoption rate was not entirely met, in large part due to a lack of information, e.g., for workplace and site monitoring, or due to a lack of medical programs or misinterpretation of TRD requirements. A significant impact on the industry had occurred during the switch from CCA to the new water-borne preservatives for residential applications. Nevertheless, the audits showed that significant progress did occur towards achieving the goals (11). The efforts to meet the requirements of the TRD were significant, with capital expenditures at several individual plants that exceeded \$1.5 million. As well, considerable in-house efforts were implemented to upgrade documentation, training and monitoring programs. It can be said that since 2000 there have been significant positive changes made by the industry with regard to operations and monitoring (11).

The 2007 Final Report, “*Summary of the Results from the Final Audits of the SOP-TRD Implementation Program for the Canadian Wood Preservation Industry*,” (11) has shown that the wood preservation industry has largely adopted a responsible approach by following the TRD for all preservatives. In the spirit of environmental responsibility and sustainable development, the members of Wood Preservation Canada (WPC) and certain non-members have endorsed a set of principles to govern their attitude and action in environmental matters, including a commitment to “assess, plan, construct and operate facilities in compliance with all applicable regulations,” including the TRD. They have developed a self-regulation program under which facilities are certified by the Canadian Wood Preservation Certification Authority (CWPCA) (12).

In 2011, the Pest Management Regulatory Agency (PMRA) modified the labels for creosote, pentachlorophenol, chromated copper arsenate and ammoniacal copper zinc arsenate to require, that operational procedures at wood preservation facilities be consistent with the TRD.

Environment Canada has taken this opportunity to update the 2004 TRD to incorporate some of the recommendations from the 2007 SOP-TRD Final Report and to ensure it reflects current best management practices. The 2013 revision is a modernised document meant to provide clarity, uniformity between similar pesticides and detailed recommendations to ensure better comprehension and consistency.

**N.B. This document contains links to non-Environment Canada sites. Please note that Environment Canada has no control over the quality of the content on these sites. The links are provided simply as a service. Environment Canada is not responsible for incorrect or misleading data.**

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<sup>2</sup> SOP-TRD: Wood Preservation Sector Strategic Options Process (SOP) for CEPA toxic substances, 1994.

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11. Final Report, Summary of the Results from the Final Audits of the SOP-TRD Implementation Program for the Canadian Wood Preservation Industry, Prepared for

Environment Canada, TRD Assessment/Implementation Working Group  
Manufacturers/Treaters, Steering Committee, Wood Preservation Strategic Options Process  
and Wood Preservation Canada by FRIDO Consulting ,G.E. Brudermann, M.Sc.F and D.E.  
Konasewich, PhD, P.Eng., April 10, 2007.

12. Wood Preservation Canada, 202-2141 Thurston Drive, Ottawa, Ontario, K1G 6C9,  
<http://www.woodpreservation.ca/>

## Acknowledgements

The 2013 TRD was collaboratively updated by Environment Canada, Wood Preservation Canada (WPC) and Pest Management Regulatory Agency of Health Canada. The guidance and assistance provided by the representatives of these organizations are greatly appreciated.

This manual is based and largely relies on the information contained in the preservative-specific TRDs issued in April 1988. Those documents were co-authored by Dr. D.E. Konasewich and Dr. F.A. Henning of Envirochem Services, whose excellent work is acknowledged.

Special thanks are extended to Ian Macdonald from WESA Inc., all WPC members, and personnel from Environment Canada who contributed to the revision of the 2013 TRD and shared information on current industry practices, best management practices and best available technologies.



# Acronyms

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ACGIH	American Conference of Governmental Industrial Hygienists
ACQ	Alkaline Copper Quat
ACZA	Ammoniacal Copper Zinc Arsenate
BEIs	Biological Exposure Indices set by ACGIH
BMP	Best Management Practices
CA-B	Copper Azole, Type B
CCA	Chromated Copper Arsenate, Type C
CCME	<a href="#"><u>Canadian Council of Ministers of the Environment</u></a>
CCOHS	<a href="#"><u>Canadian Centre for Occupational Health and Safety</u></a>
<i>CEPA 1999</i>	<a href="#"><u><i>Canadian Environmental Protection Act, 1999</i></u></a>
CSA	<a href="#"><u>Canadian Standards Association</u></a>
E2 plans	Environmental Emergency (E2) plans under the <i>Canadian Environmental Protection Act, 1999</i>
EIHWHRMR	<i>Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations</i> under the <i>Canadian Environmental Protection Act, 1999</i>
HC	<a href="#"><u>Health Canada</u></a>
MSDS	Material Safety Data Sheets
NIOSH	<a href="#"><u>National Institute for Occupational Safety and Health</u></a>
OSHA	<a href="#"><u>Occupational Safety and Health Administration</u></a> , US Department of Labour
PAH	Polycyclic Aromatic Hydrocarbon
PCP	Pentachlorophenol
PCPA	<a href="#"><u><i>Pest Control Products Act</i></u></a>
PEL	Permissible Exposure Level set by the OSHA

PMP	Preventative Maintenance Program (see <a href="#">Appendix II</a> )
PMRA	<a href="#">Pest Management Regulatory Agency</a> of Health Canada
PPE	Personal Protective Equipment
SOP	Strategic Options Process
TDGR	<i>Transportation of Dangerous Goods Regulations</i> under the <i>Canadian Environmental Protection Act, 1999</i>
TGD	<a href="#"><i>Technical Guidelines for the Design and Operation of Wood Preservation Facilities</i></a>
TLVs	Threshold Limit Values set by ACGIH.
TRD	<a href="#"><i>Technical Recommendations Document for the design and operation of wood preservation facilities</i></a>
WPC	<a href="#"><i>Wood Preservation Canada</i></a>



# Glossary

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## Backflow preventer:

One way valve system that is installed on the water intake pipes of the facility to avoid cross-contamination due to reverse flow.

## CEPA Toxic Substances:

A substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that:

1. have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
2. constitute or may constitute a danger to the environment on which life depends; or
3. constitute or may constitute a danger in Canada to human life or health (section 64 of CEPA).

## Charge:

All of the wood treated in one cylinder or treating tank at one time.

## Check valve:

Check valve, is a mechanical device, a valve, which normally allows fluid, liquid or gas to flow through it in only one direction.

## Facility:

The facility refers to the entire treating operations including all buildings, equipment, structures and stationary items associated with treating that are owned or operated by the same company and that function as a single integrated site.

## Fixation:

A physical and chemical process whereby a wood preservative system is rendered leach resistant in both water and soil applications in such a way that the active ingredient or ingredients maintain fungal/insecticidal efficacy. It is a binding chemical reaction with the wood cell wall and the active ingredient. Fixation only applies to CCA preservative.

## Fixation chamber:

A containment chamber where the process of fixation is carried out.

## Hydrogeology:

Hydrogeology is the area of geology that deals with the distribution and movement of groundwater in the soil and rocks of the Earth's crust (commonly in aquifers).

## Marine:

Adjective relating to the sea or ocean. Refers exclusively to saltwater environments.

**Plant:**

The Plant refers to the impregnation treatment area for one preservative which includes the cylinder(s) (retort), vats and/or open treating tanks, the chemical mixing area, the drip pad, the chemical storage area, the stabilization kiln and/or the accelerated fixation area.

**Pesticide Label:**

The Pesticide Label is a label that conveys information required by the Pest Control Products Act (PCPA), or its related regulations, to accompany a pest control product. This includes requirements for adherence to directions on application rates, personal protective equipment storage and disposal.

**Seasoning:**

A natural or controlled process for reducing the moisture content of wood in preparation for treatment with a wood preservative.

**Stabilization:**

A physical and chemical process whereby a wood preservative is rendered leach resistant (to a lesser degree than fixation) in both water and soil applications in such a way that the active ingredient or ingredients maintain fungal/insecticidal efficacy. The leaching resistance greatly vary depending on the pesticide, its application and the use of the treated products (contact with water).

**Toxicity:**

Refers to any harmful effect of a chemical on an organism—including humans—or the environment. Organisms or the environment can be exposed to wood preservatives in three basic forms: as pure active ingredients, as formulations or as treated wood. Toxicity can cause effects in both the short (acute toxicity) and long term (chronic toxicity).

**Wood Preservation Pollution Prevention Planning Notice:**

Commonly named: [Notice Requiring the Preparation and Implementation of Pollution Prevention Plans in Respect of Inorganic arsenic compounds, Hexavalent chromium compounds, Polychlorinated dibenzodioxins, Polychlorinated dibenzofurans and/or Hexachlorobenzene Used by Wood Preservation Facilities](#). (Canada Gazette, October 22, 2005).

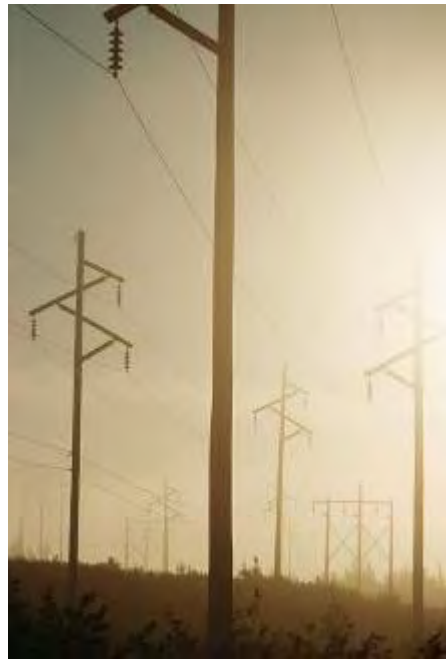
**Wood preservative:**

A chemical or combination of chemicals for protecting wood against deterioration from decay, insects, marine borers, fire, weathering, absorption of water, and/or chemical action.





# Part I



[Explanatory Note](#)

[General Background Information](#)

[Chapter A    General Recommendations for all  
Wood Preservatives](#)



## Explanatory Note

The *Recommendations for the Design and Operation of Wood Preservation Facilities, 2013*, is known as the *Technical Recommendations Document 2013* (2013 TRD). This 2013 TRD is a revision of the 2004 version. The 2013 revision was to clarify recommendations from previous editions and to add additional information that was detailed in the TRD associated document (*Technical Guidelines for the Design and Operation of Wood Preservation Facilities, 2004*). The revision provides clarity, web references, and uniformity between similar preservatives and details recommendations to ensure comprehension and consistency from facility to facility. The general background information has been separated from Chapter A of the 2004 version in order to keep only design and operational recommendations in the 2013 TRD Chapter A. The new Chapter A can be used as a generic chapter for future registered preservatives that are not yet included in the 2013TRD.

**Chapter A must always be used in conjunction with the other preservative-specific chapters when applicable.**

The [Canadian Environmental Protection Act, 1999 \(CEPA 1999\)](#) is an important part of Canada's federal environmental legislation aimed at preventing pollution and protecting the environment and human health. The goal of CEPA 1999 is to contribute to sustainable development—development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs. The risk management of the toxic substance used in the wood preservation sector was developed under CEPA 1988 and CEPA 1999. The exercise led to the development of the *Technical Recommendations Document* to prevent pollution and protect the environment and human health effects associated with such facilities. The recommendations are consistent with good pollution prevention practices and environmentally sound management.

The target audiences for this 2013 TRD are the owners and operators of wood preservation facilities and those who are designing new facilities or retrofitting existing ones. In many instances the document contains general summary information on topics such as potential environmental and human health hazards and environmental effects potentially associated with exposure to these preservatives.

**Please note that you are required to comply with all municipal, provincial, territorial and/or federal legislation that applies to the work being carried out in relation to this technical recommendations document 2013 TRD.**

Although the recommendations do reflect currently available best practices, local regulatory authorities may want to deviate to accommodate local conditions. The recommendations contained in this 2013 TRD may not be the only options available for attaining the stated objectives, and other recommendations for site-specific conditions may be more suitable. When programs are developed for a particular facility, the recommendations provided may be modified if it can be demonstrated that an alternative approach, more suitable to the facility conditions, would be equally effective for attaining the objectives. Provincial regulation of wood preservation facilities and industrial operations, in general, vary across Canada. Each facility should consult with all authorities that may have jurisdiction over it and its operations.

The Pest Management Regulatory Agency (PMRA) is the federal agency that is responsible for the regulation of wood preservatives in Canada. Under the *Pest Control Products Act* (PCPA), wood preservatives are required to be registered and used as per label requirements established under the PCPA. Labelling requirements are based on scientific data on occupational exposure, toxicology, and environmental chemistry and ecotoxicology associated with wood preservatives. In 2011, the PMRA amended the labelling requirements for several CEPA toxic wood preservatives ([Re-evaluation Decision RVD2011-06, Heavy Duty Wood Preservatives: Creosote, Pentachlorophenol, Chromated Copper Arsenate \(CCA\) and Ammoniacal Copper Zinc Arsenate \(ACZA\)](#)). These amendments stipulate that, as of November 2013, operational procedures in facilities using these preservatives must be consistent with the *Recommendations for the Design and Operation of Wood Preservation Facilities: Technical Recommendations Document (TRD)*. The 2013 TRD is also intended as the core reference document for all other wood preservation facilities using non-CEPA toxic preservatives. Adoption of the 2013 TRD should minimize potential environmental and human health effects associated with wood preservation facilities.

The pesticide label is a label that conveys information required by the [Pest Control Products Act](#) (PCPA), or its related regulations, to accompany a pest control product. This includes requirements for adherence to directions on application rates; personal protective equipment; storage and disposal. Each facility is responsible for keeping available a copy of the most recent pesticide label for each registered pesticide used within the facility. The pesticide labels should be provided by the pesticide manufacturer and be available to the operators. Subject to regulations under the PCPA, all registered products must be handled, stored, transported, used or disposed in accordance with the information on a pesticide label. Any other document or specification may require additional or more protective measures; they may not be less protective.

As information may change over time, facilities must ensure that all information is current. At a minimum, annual reviews of content by the facility manager or designated health and safety individual are recommended.

Electronic copies of pesticide labels may be obtained from the Health Canada website: <http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>.

For all purposes of interpreting and applying the law, users should consult the [Acts as passed by Parliament](#), which are published in the “Assented to” Acts service, [Part III of the Canada Gazette](#) and the annual Statutes of Canada.

The above-mentioned publication is available in most public libraries. Official versions of the statutes and regulations can also be found at the Department of Justice website – Justice Laws website at: <http://laws.justice.gc.ca/>. The law as stated in the above-mentioned publications will prevail should any inconsistencies be found in this guidance document.



## General Background Information



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# 1 The Need for Wood Preservation

## 1.1 Introduction

Wood preservation is the pressure or thermal impregnation of chemicals into wood to a depth that will provide effective long-term resistance to attack by fungi, insects and marine borers. By extending the service life of timber, wood preservation reduces the harvest of valuable forestry resources, reduces operating costs in industries such as utility and railroads, and ensures safe conditions where timbers are used as support structures. In addition to industrial and commercial application, a significant part of the treated wood volume is used for residential construction to protect homeowners' investments and provide outdoor living spaces that are a desired part of the Canadian way of living.

The chemicals predominantly used in Canada for wood preservation are as follows:

- aqueous formulations of arsenic, copper and chromium; borate; or copper, in combination with organic pesticides
- pentachlorophenol in petroleum oil
- creosote and creosote/petroleum oil mixtures

## 1.2 Wood Deterioration

Timber is subject to several types of deterioration following its removal from the forest. Wood-decaying fungi and insects drastically reduce the usefulness of unprotected lumber and other forest products. Decay reduces wood to its basic components: carbon dioxide and water. This may happen quite rapidly depending on the exposure conditions. As an example, untreated red pine posts were found to be serviceable for only 4.5 years, whereas creosote-treated posts lasted between 40 and 48 years under the same conditions (1). Similarly, railway ties used in North America would have an average life of five years without treatment, whereas treated ties under normal service conditions last in excess of 30 years. Protection is also needed against wood-boring insects. For example, termites are responsible for extensive damage to wood in storage and in service in southern Ontario and on the Pacific Coast. Marine structures, such as untreated dock pilings along North American coasts, can be destroyed by marine borers in less than one year. In contrast, properly preserved wood structures in marine waters are reported to perform for 30 to 45 years (2).

The main enemies of wood, and the wood destroyers of greatest commercial importance, are decay fungi. The growth of these fungi is dependent upon the temperature, moisture content, oxygen level and nature of the wood. Wood products such as construction lumber, railway ties, bridge timbers, fence posts and utility poles, are usually in direct contact with moist soil or in locations where moisture collects and cannot readily evaporate. When there is no practical means of controlling the moisture, oxygen level or temperature, the options for the protection of such wood products are limited to the application of chemicals, which prevent fungal growth by making the wood unsuitable as a food source. Simultaneously, the treatment can also protect the wood from other wood-destroying organisms, such as insects and marine borers.

### **1.3 Wood Preservation Chemicals**

The preservation of wood by chemical means can be traced back over 4000 years, to the time when the Egyptians apparently used bitumen to treat wooden dowel-pins in the stonework of temples (3). During the Roman Empire, tar, linseed oil, oil of cedar and mixtures of garlic and vinegar were used for the preservation of wooden statues. Charring of wood surfaces and soaking in brine, alum, arsenic or copper salts were other methods used in Roman times and in the Middle Ages (4). Investigations to define alternative wood preservation agents were reported in the late 1600s. Efforts escalated during the 1800s, when economic considerations, prompted by the need for durable wooden ships and railway ties and trestles, spurred the search for effective preservatives and application methods (5). A review of the many chemicals and chemical formulations used historically can be found in the above references and in texts such as those written by Hunt and Garratt (6) and Wilkinson (7).

Creosote and the full-cell treatment process have been used since the early 1800s, whereas the empty-cell processes were introduced in the first decade of the 20th century. Pentachlorophenol and the water-borne arsenical preservatives became of commercial significance in Canada during the 1950s and 1970s respectively. Current research has yielded not only modifications to existing formulations and treatment technologies but also the introduction of new preservative chemicals. The voluntary withdrawal of chromated copper arsenate (CCA) from residential markets in 2003 prompted the introduction of new organometallic preservatives, namely alkaline copper quaternary (ACQ) and copper azole (CA-B).

The choice of wood preservatives depends upon the character of the wood to be treated, the anticipated service and the properties of the chemical or formulation. Wood preservation formulations must

- protect against attacking organisms;
- be able to penetrate wood;
- remain in the wood for the length of the intended service;
- be chemically stable;
- be safe to handle;
- be economical to use;
- not weaken structural strength; and
- not cause significant dimensional changes within the wood.

Other factors that determine selection of chemicals or formulations include fire resistance, colour or odour, paintability, corrosiveness, electrical conductivity and environmental considerations.

In Canada the predominant wood preservative chemicals or formulations are as follows:

Aqueous based formulations for residential use:

- ACQ (alkaline copper quaternary) - ACQ-treated products include lumber for patios and fencing in residential construction.
- CA-B (copper azole) - CA-B-treated products include lumber for patios and fencing in residential construction

- Borates - Uses are for wood components in interior applications.

Aqueous based formulations for commercial & industrial use:

- CCA (chromated copper arsenate) - CCA-treated products include agricultural fence posts, foundation lumber and plywood, utility poles and construction timber.
- ACZA (ammoniacal copper zinc arsenate) - ACZA-treated products include marine structures and construction timbers. At the time of publication, this preservative was not in use in Canada.

Oil based formulations for commercial & industrial use:

- PCP (pentachlorophenol) - PCP-treated products include utility poles and cross-arms.
- Creosote - Uses include treatment of railway ties, utility poles for export, and pilings and timbers for marine applications.

The development of alternative chemicals for wood preservation is the subject of ongoing research. The use of alternative chemicals will depend on industry and safety evaluations, and on approval under the PCPA, administered by HC's PMRA.

## **1.4 The Value of Wood Preservation**

In 2010, the Canadian wood preservation industry sold, in total, \$874 million Canadian dollars worth of treated product (industrial and residential) (8). Controlled studies have shown that wood preservation enhances the lifetime utility of wood by a factor of 5 to 10 or more, depending on the species, end use and efficacy of the treatment. This emphasizes the considerable contribution that the wood preservation industry makes to forest conservation (9).

Substituting alternative materials (such as steel, concrete or plastics) for treated wood in industrial applications (not including residential) could increase material costs to users.

## **2 Overview of Wood Preservation Facilities**

### **2.1 *The Canadian Preservation Industry***

There were 55 wood preservation facilities operating in Canada in 2011. All facilities had pressure treatment plants and three facilities employed both pressure and thermal treatments. Many CCA facilities migrated to ACQ or CA-B when CCA was withdrawn from use in residential application in 2003. In 2011, 30 facilities used CCA and only 16 used it as their sole preservative. ACQ and/or CA-B were used by 33 facilities, while 11 facilities used them as their sole preservative (10). Only 10 facilities were using oil-borne preservatives, creosote and/or PCP. In 2011, 23 plants were involved in multi-preservative operations, compared to 13 in 2000 (10).

Treatment facilities exist in all provinces except Prince Edward Island and Labrador. The early facilities were conveniently located to serve the railways. However, newer facilities are concentrated in areas where there is great demand for consumer lumber, which represents more than 50% of the total industry output (11). In 2011, the provinces with the most active facilities are British Columbia with 14, Ontario with 12 and Quebec with 11 (10).

### **2.2 *Description of Current Plant Designs***

#### **2.2.1 General Plant Designs**

Wood preservation facilities generally consist of four components (11):

- yards for storage of untreated and treated wood;
- wood processing facilities (peelers, framing lines, kilns, etc.);
- impregnation facilities; and
- offices, laboratory space.

The size of storage yards can vary significantly depending on the facilities' treatment capacity and the manner of drying the wood. Air seasoning requires a large storage space. However, facilities that process wood, particularly for the residential market, may employ kiln drying, which requires less white wood inventory space. The storage cycle of treated wood is generally short, necessitating only a limited yard or shed area. Facilities that provide storage for their customers—for example, the major railways and utilities—are an exception.

Wood processing equipments may include pole peelers, saws, framing lines, sorting tables, incisors, kilns and stackers. Railway tie plants are equipped with special boring and incising machines.

The designs of impregnation facilities are specific to the treatment process employed and the preservatives used. A more detailed description can be found in the relevant preservative-specific sections.

### 2.2.2 Preservation Processes

Preservation processes are aimed at injecting requisite amounts of preservative liquids deep into the wood to provide long-term protection against wood destroyers. In North America, the majority of preserved wood is treated by pressure impregnation processes. Thermal treatments are of secondary importance.

The applied treatment parameters for all processes are limited by the directions for use on the registered pesticide labels. The CAN/CSA O80 (12) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

Also, special requirements are contained in the *Best Management Practices for the Use of Treated Wood in Aquatic and Other Sensitive Environments* issued by *Western Wood Preservers Institute, Wood Preservation Canada, the Southern Pressure Treaters' Association and the Southern Forest Products Association*. The purpose of the Best Management Practices (BMP) is to place enough preservative into a product to provide the needed level of protection while also minimizing use of the preservative above the required minimum industry standard to reduce the amount potentially available for movement in the environment (13). These BMPs were developed in order to reduce the amount potentially available for movement into the environment.

#### *Wood Conditioning*

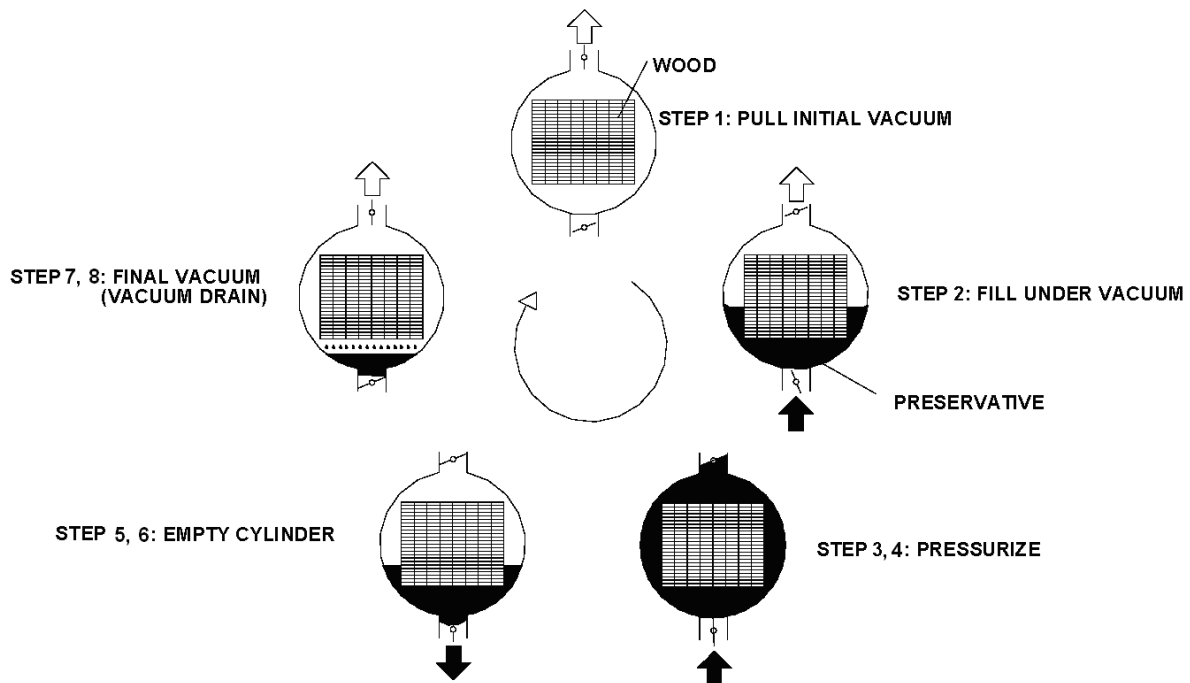
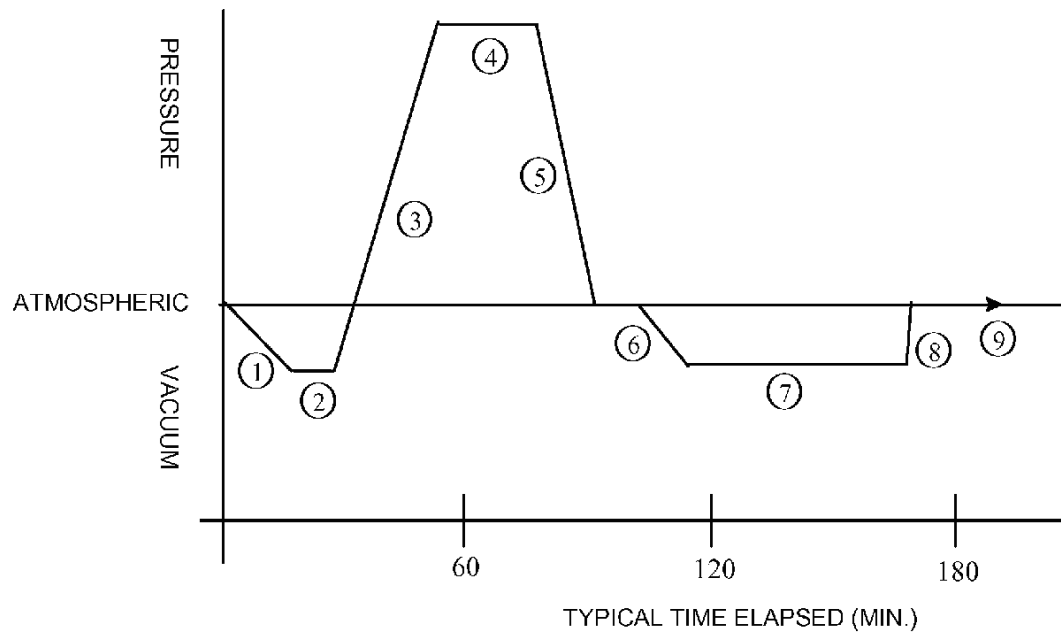
Before wood can be successfully impregnated with preservatives, the bark has to be removed and the moisture content reduced by a process involving drying or conditioning. This may be achieved by air seasoning, kiln drying or by a process carried out in the treatment cylinder, for example, a steam/vacuum process or boiling-under-vacuum (Boultonizing) in the presence of the treating solution. The method chosen depends on the wood product, specifications, the available equipment, desired moisture levels and the preservative used. For example, kiln drying is most common for lumber destined for the residential market; air seasoning is most economical for large commodities, such as ties, timbers and poles; a steam/vacuum process is preferred for poles to be treated with PCP/oil; and Boultonizing is common with ties and marine pilings to be treated with creosote or creosote/oil solutions.

Sawn wood, which generally exposes refractory heartwood, requires “incising” to enable good preservative penetration. Incising is a process whereby the wood surfaces are punctured by toothed rollers. Various incising patterns are available to ensure good penetration without causing undue structural damage. Individual pieces are generally cut to final size and shape prior to treating to ensure good preservation of all exposed faces. Machining after treatment may expose untreated wood, in which case subsequent field treatments must be applied. Even properly applied field preservation cannot protect such exposed wood as effectively as either pressure or thermal treatments.

#### *Full-cell (Bethell) Process*

The full-cell process was introduced in 1838. It is the only process employed for treatments with CCA and the other water-borne preservatives, as well as for creosote (Figure 1).

**Figure 1 The Full Cell (Bethell) Pressure Treatment Process**



**Process Steps:**

1 Initial vacuum

2 Fill with preservative

3 Pressure increase

4 Pressure impregnation cycle

5 Pressure release

6 Preservative pump-out

7 Final vacuum

8 Vacuum release

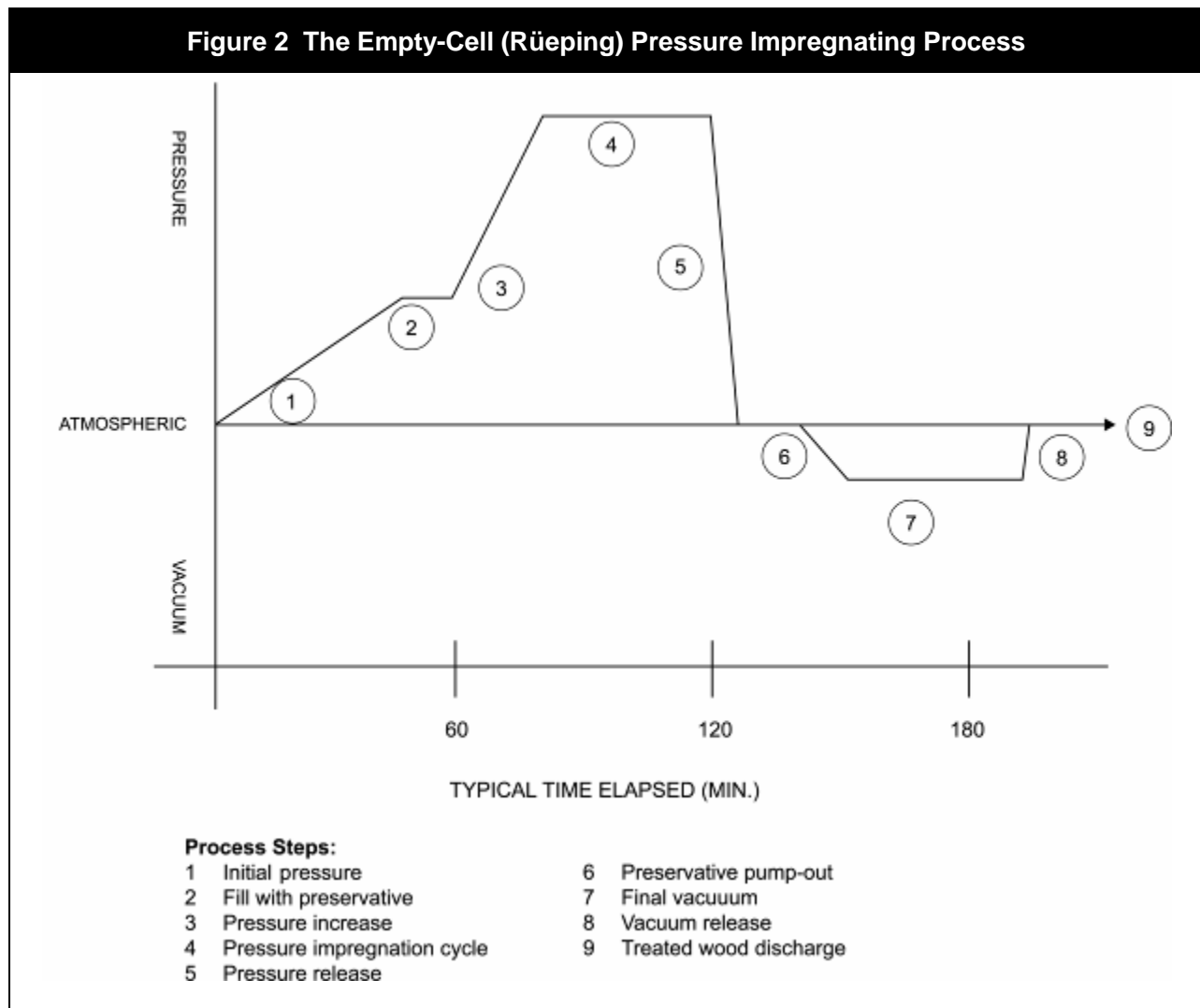
9 Treated wood discharge



After a wood charge is placed into the pressure cylinder, the treatment process commences with the application of an initial vacuum for 30 minutes to an hour. The preservative solution is then admitted to the cylinder, while maintaining the vacuum. In case of the water-borne preservatives, the solution is at ambient temperature, whereas oil-borne preservatives are heated (70 to 90°C). After the cylinder is filled, pressure is applied, usually to a maximum of 1040 kPa, and held until a predetermined amount of preservative has been injected into the wood. This pressure cycle may take from 30 minutes to several hours. At that point the pressure is released and the excess preservative is returned to a storage tank for use on subsequent treatments. The impregnation stage is usually followed by a final vacuum in the case of CCA and the other water-borne preservatives or an expansion bath and a final vacuum in the case of creosote. These processes remove excess preservative from wood subsurfaces and are aimed at rendering the product surfaces as dry as possible.

### *Empty-cell Processes*

This category includes two processes, the Rueping and the Lowry, both of which are used with creosote and pentachlorophenol for treatment of utility poles, railway ties, posts and construction lumber, and timber. The processes are designed to give deep penetration, while minimizing preservative retention (Figure 2).



The Rueping process applies an initial air pressure (200–500 kPa for 15 minutes) to the wood charge in the cylinder prior to admitting the preservative. The pressure compresses the air inside the wood. Hot preservative is then admitted to the wood without releasing the air pressure. The pressure is increased to a typical maximum of 1040 kPa and held until predetermined solution absorption has been achieved. When the pressure is released at the completion of the impregnation cycle, the compressed air in the wood expands and expels excess preservative. This effect, which is called the “kickback,” is usually enhanced by a quick final vacuum. Excess preservative is returned to storage for use in subsequent treatments.

The Lowry process is similar to the Rueping process, except that no initial air is applied and the preservative is admitted at atmospheric pressure. The remainder of the process continues in the same manner as the Rueping process. There is usually a smaller amount of preservative recovered by the kickback in a Lowry process.

#### *Thermal Treatment Process*

This process is applied with PCP/oil solutions for the pole butt treatment of dry utility poles. A pressure vessel is not required to carry out the process. The lower ends of poles (butts) are impregnated with preservative in upright, open-top tanks. During the cycle, dry wood is first immersed in hot preservative (88 to 113°C) for a minimum of six hours (hot bath). Thereafter, the hot preservative is quickly replaced by cooler preservative for at least two hours (cold bath). Excess preservative is returned to the storage tank.

#### *After-impregnation Processes*

Treatment cycles are followed by a final vacuum, which equilibrates internal pressure, removes air and preservative from the surface fibres of wood and, in the case of oil-borne treatments that use elevated temperatures, cools the wood. For creosote and PCP, a final vacuum may not be adequate to create clean surfaces. In these cases, the impregnation cycle may be followed by an expansion bath or a final steam cycle, both of which add a final vacuum step. These processes can be quite effective, but the final steam cycle creates large volumes of contaminated water that must be treated to meet all discharge criteria.

#### *Storage After Treatment*

Treated wood, removed from the cylinder, is stored on a drip pad until preservative drippage has stopped. The duration of this storage may vary from hours to days. Alternatively, most CCA treatment plants now carry out an accelerated fixation process to ensure that the preservative chemicals are highly leach resistant. Such a process entails a heating cycle, usually in the presence of high humidity. Fixation chambers are employed or the process may be carried out in drying kilns (14). When fixation has been verified, the treated wood may be transferred to a designated yard area for storage until shipment or it may be directly loaded for immediate shipment.

### 2.2.3 Current Treatment Plant Designs

#### *Water-borne Preservation Plant Designs*

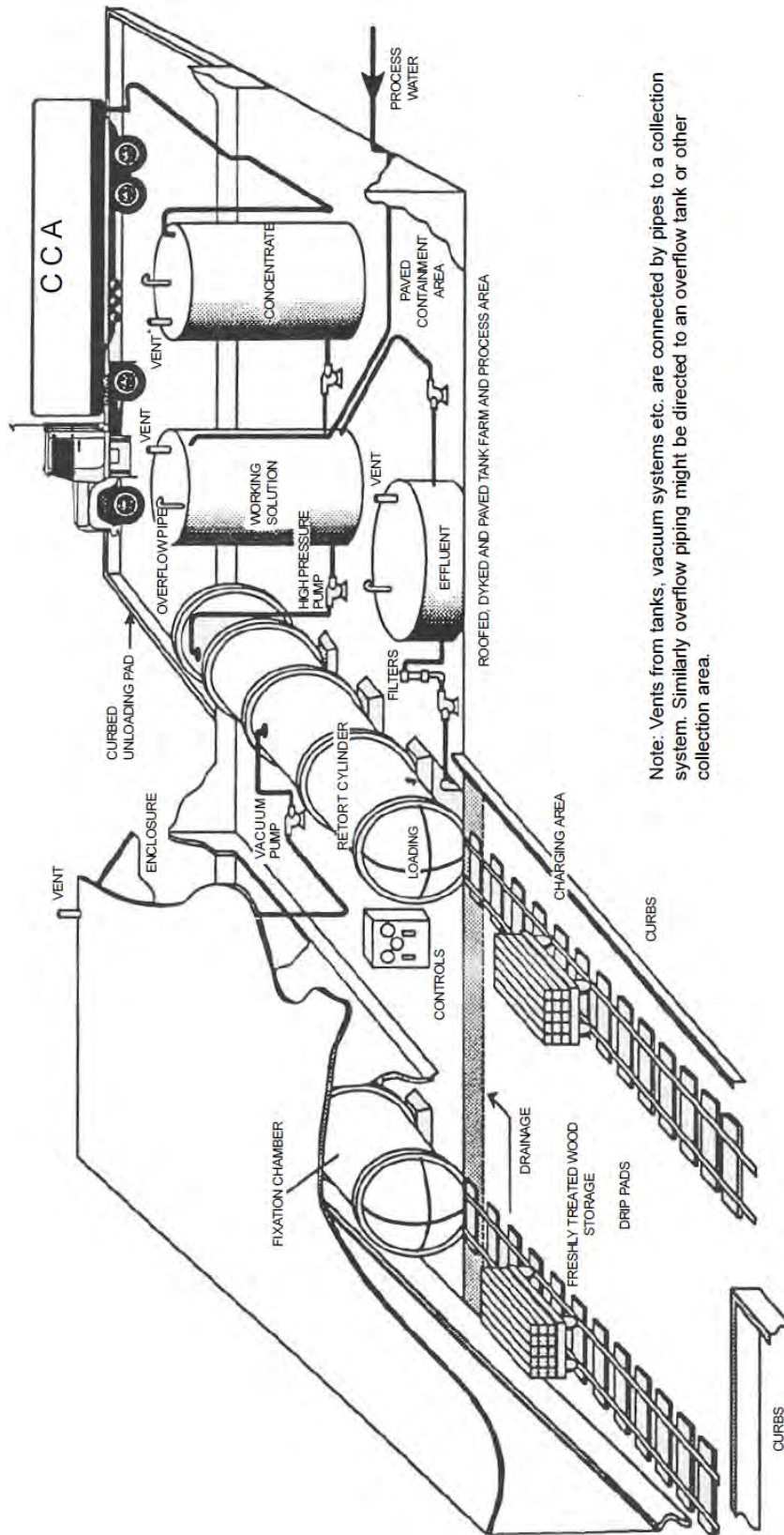
Water-borne preservation plants, like CCA or ACQ, are housed within a heated building (11). Figure 3 is a schematic view of a typical CCA plant. The major difference from other water-borne preservation plants, as shown in the figure, is the presence of a fixation chamber. The pressure vessel, also called a retort or cylinder, is commonly 1.8 m in diameter and 24.4 m long. The wood is normally charged and discharged through a single door by means of trams that run on tracks. Other designs use conveyors to move wood in and out of the cylinder and may involve doors at either end to insert and remove the wood. Pumps are provided to apply process conditions (i.e. vacuum or pressure) as well as to transfer liquids from and to the cylinder and between tanks. A tank farm typically includes a concentrate tank, one or more tanks for working solutions, and an effluent recovery tank or makeup water tank. The process controls and instrumentation vary in sophistication, depending on the degree of automation. Most water-borne preservation plants have systems that are fully automated to control the impregnation process parameters. A number of plants have heated storage areas for recently treated wood and facilities for accelerating the fixation or stabilization of the preservative components in the treated wood (14, 15).

The full-cell treatment process, used to apply the preservative in water-borne treatment plants, consists of the following steps:

- application of an initial vacuum to remove air from the wood cells;
- flooding with working solution and pressurization (up to 1040 kPa) until the target retention level is achieved;
- draining of the excess working solution (to the working tank for reuse with subsequent charges); and
- application of a final vacuum.

The specific treatment times and pressures are dictated by the species of wood, the type of wood product (e.g. plywood or poles) and the moisture content of the wood. A predetermined range of process parameters is defined by the applicable treatment standards (12), and quality control tests are carried out to ensure that the product meets the minimum quality standard. Once the treated wood is withdrawn from the treating cylinder, it is either subjected to a fixation process or stored on-site for periods that generally range from days to months for stabilization. The fixation and stabilisation process requires a sealed drip pad and a roofed area. This is essential, since the preservatives are water soluble and would leach at various concentrations when exposed to precipitation with the exception of CCA that is leach resistant due to the fixation process. Paved or concrete flooring often have roofs over all or portions of the treated wood storage area to reduce or eliminate exposure to the elements.

**Figure 3 Conceptual Drawing of a CCA Treatment Facility**



Note: Vents from tanks, vacuum systems etc. are connected by pipes to a collection system. Similarly overflow piping might be directed to an overflow tank or other collection area.

**Figure 3 Conceptual Drawing of a CCA Treatment Facility**

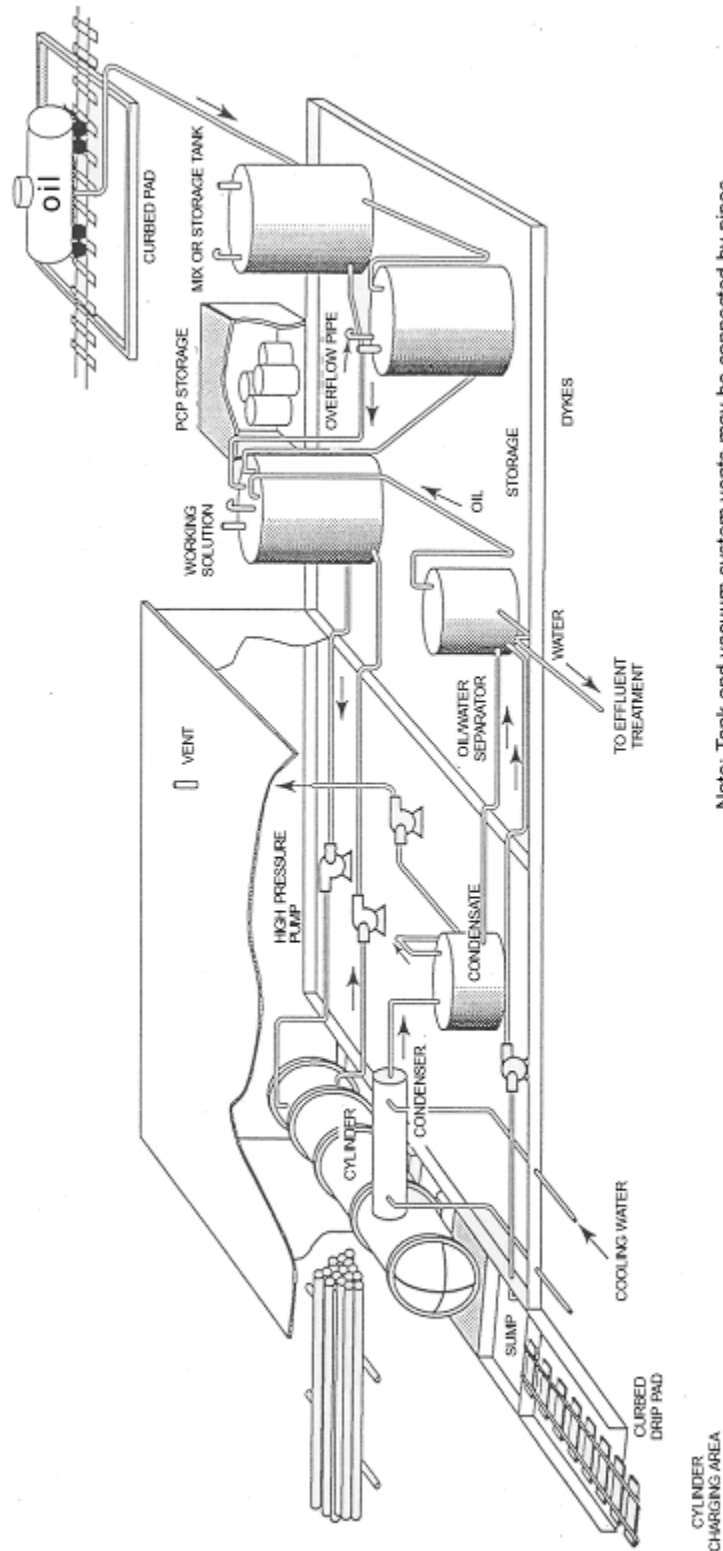
### *Creosote and PCP Plant Designs*

Creosote and PCP/oil solutions are often used interchangeably in the same treatment facility. Hence, plants using these preservatives have a similar layout (Figure 4). The pressure cylinders are usually somewhat larger than those used in water-borne preservation plants (2.1 m in diameter and 36.5 m in length). Tank farms are generally placed outdoors, and tanks are equipped with internal heating devices. The production equipment, including the cylinder, pumps, condensers, controls and effluent treatment systems, is housed within a treating house. Facilities treating with PCP or creosote solutions require a heat source for warming the preservative and to carry out specific processes, such as steam conditioning. When treating with PCP, either an autoclave or a designated mix tank is used to dissolve the solid preservative in a suitable oil solvent. Effluent treatment facilities may consist of an oil/water separator, a flocculation system and carbon filtration. An air filtration system to collect exhausts from treatment vessels, vacuum systems and tank vents may also be part of the installations. The vacuum systems are equipped with condensers and condensate collection tanks.

### *Thermal Butt Treatment Plant Designs*

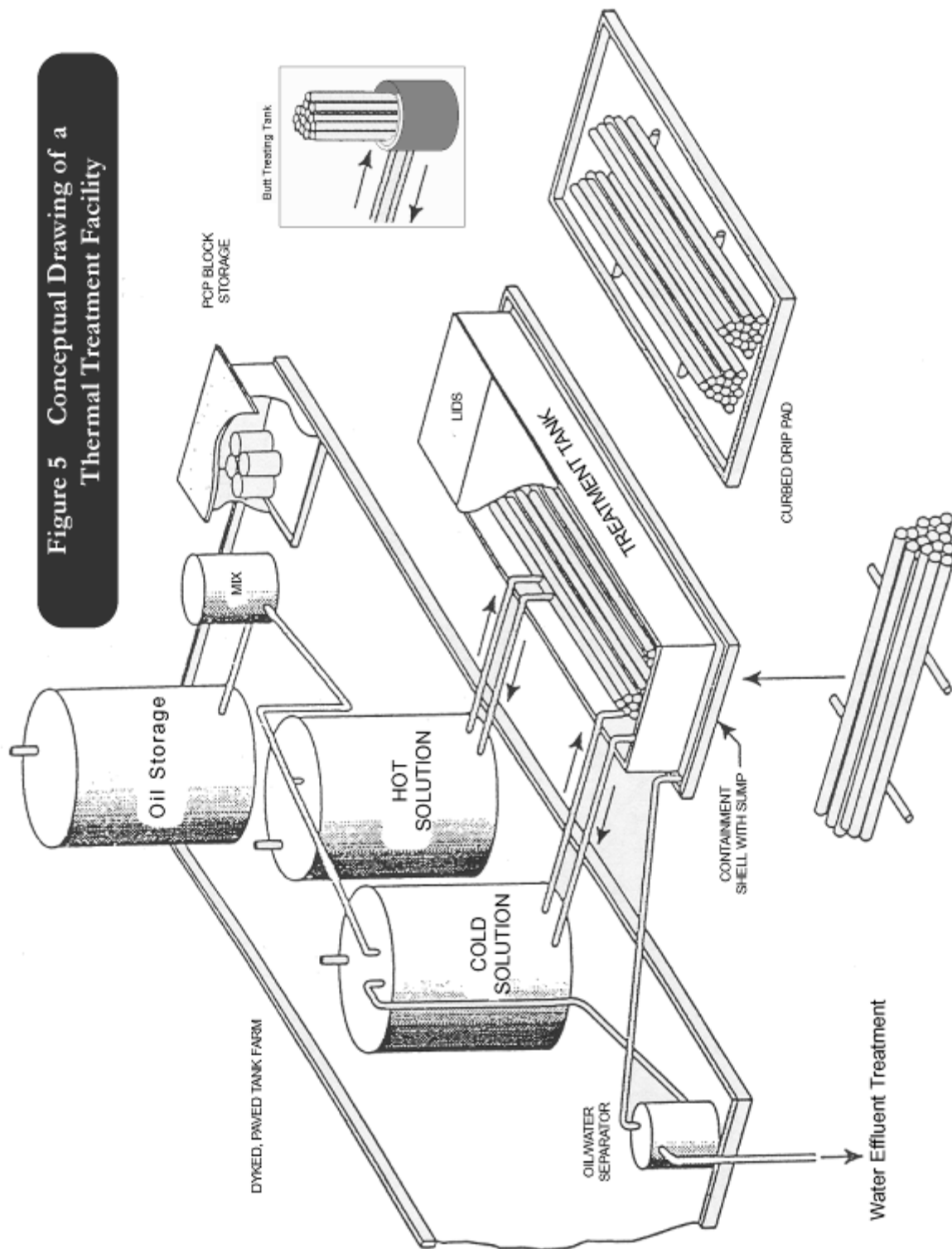
As Figure 5 shows, thermal butt treating plant facilities have less sophisticated impregnation equipment and process controls than pressure treatment facilities. The treatment vessel is a vertical open-top tank, which should be provided with spill containment. The tank farm contains a PCP/oil mix tank, as well as oil storage and hot and cold preservative solution storage tanks. Transfer pumps are used to remove solution from the treatment vessel and transfer it to the storage tanks. The effluent treatment system may involve oil/water separation, flocculation and carbon filtration.

**Figure 4 Conceptual Drawing of an Oil-Borne Pressure Treatment Facility**



**Figure 4 Conceptual Drawing of an Oil-Borne Pressure Treatment Facility (Creosote or PCP/Oil)**

Figure 5 Conceptual Drawing of an Oil-Borne Thermal Treatment Facility





### 3 Overview of Preservative Properties

The commercial preservatives used in Canada have a long history of success in preserving a large variety of wood products. Each preservative is effective in preventing wood deterioration, and each one has physical and chemical properties that make it suitable for one or more specific products. No one preservative is considered suitable for all possible product applications; each has found a niche of preferential use.

The preservatives in use have a range of physical, chemical and toxicological characteristics that determine their potential for causing harm and, therefore, the best modes of handling them during operation.

#### 3.1 Toxicity, Hazards and Risks

A substance will be considered for scientific assessment if federal, provincial or international programs have identified it as potentially harmful to the environment or human health.

A substance is considered toxic if, after rigorous scientific assessment and based on a decision taken under federal programs, it either conforms or is equivalent to “toxic” as defined in the *Canadian Environmental Protection Act, 1999* (CEPA 1999) (16).

Under section 64 of CEPA 1999, a substance is considered to be toxic if it is entering or may enter the environment in a quantity or concentration or under conditions that

- (a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity;
- (b) constitute or may constitute a danger to the environment on which life depends; or
- (c) constitute or may constitute a danger in Canada to human life or health (16).

In most wood preservatives, the active ingredients are combined with other substances—most commonly solvents. These preservative formulations may exhibit different physical and toxicological properties than the undiluted preservative (active ingredients in their pure form). This factor needs to be taken into account when proposing recommendations for proper designs and operational practices.

#### 3.2 Human Health Concerns

Wood preservatives can be harmful to humans if not properly handled. The exposure routes by which they can enter the human body are inhalation (vapour, dust, aerosol, etc.), ingestion (solid, liquid), ocular exposure and through the skin (vapour, liquid, solid). Exposure limits are given for individual preservatives in Part II – Preservative-specific Information and Recommendations. Such limits are usually also contained in the material safety data sheets (MSDS) issued by chemical manufacturers.

**Plant operators should obtain references to or copies of relevant MSDS from their preservative supplier and must follow the requirements written on the pesticide label.**

### **3.3 *Environmental Concerns***

The properties of a preservative chemical or formulation are also important in determining its environmental fate and its potential for contaminating the treatment facility and other sites. A preservative can enter the environment in many ways, such as by spillage or leaching, as effluent, or through air emission. Subsequently it may be subject to a wide variety of processes that may eliminate it from the environment completely, modify it into breakdown products that are more or less harmful, or transfer it to another environmental medium (17, 18).

The main physical-chemical properties that determine the movement of a chemical in the environment (17) are as follows:

- solubility in water and in organic solvents;
- vapour pressure;
- adsorption/desorption in soil or sediment;
- stability;
- partition coefficient between octanol and water; and
- reactivity with co-contaminants and soil microbes.

## 4 Description of Part II Chapters Structure

The following chapters of Part II of this document are structured in the same way for uniformity regardless to whether the preservatives are containing CEPA toxic substances or not.

Content is described as follows:

- 1 Production and Use
- 2 Physical and Chemical Properties
- 3 Environmental Effects
- 4 Human Health Concerns
- 5 Description of Preservative Applications and Potential Chemical Discharges at Wood Preservation Facilities
- 6 Protection of Personnel
- 7 Design Recommendations
- 8 Operational Recommendations
- 9 Waste, Process Emissions and Disposal
- 10 Environmental and Workplace Monitoring
- 11 Transportation of Preservative Solids, Solutions and Wastes
- 12 Environmental Emergency Notification and Contingency Planning

The 2013 TRD includes a new general chapter (Chapter A) as template for new wood preservatives that are introduced to the marketplace.

Chapter A must be used in conjunction with the other preservative-specific chapters (Chapters B to I) when applicable.

## 5 References

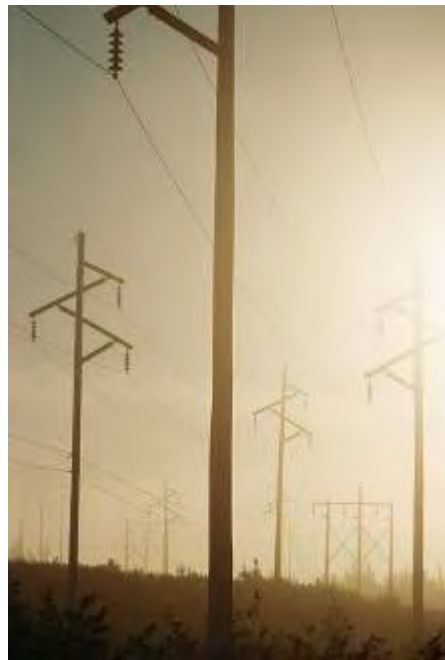
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# CHAPTER A

## General Recommendations for All Wood Preservatives







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## OBJECTIVE

The *Recommendations for the Design and Operation of Wood Preservation Facilities, 2013*, known as the *Technical Recommendations Document* (2013 TRD) establishes best management practices for the design and operation of wood preservation facilities. Ultimately, the 2013 TRD should be used to develop a facility-specific worker safety and environmental protection program.

Chapter A can be used for general information and recommendations and can be used as a template for newly registered preservatives that have no preservative-specific chapter. Chapter A suggests an approach for identifying and mitigating the risk of exposure to people and to the environment based on precautionary principles and best available technology. The following general recommendations are fundamental measures to be used in conjunction with Part II – Preservative-specific Information and Recommendations.

Throughout Chapter A, each completed table is applicable to every preservative used. For all newly registered preservatives that are not explicitly listed in the 2013 TRD, Chapter A should be used for the design and operation of the treatment facility, and each template table must be completed for the new registered preservative. Consult with your industry association or contact Environment Canada for more information on how to complete Chapter A templates for newly registered preservatives.

If the preservative is already part of the 2013 TRD, please use the appropriate chapter of Part II in combination with the completed tables of Chapter A.

Each chapter of Part II – Preservative-specific Information and Recommendations is structured in a similar way to Chapter A.

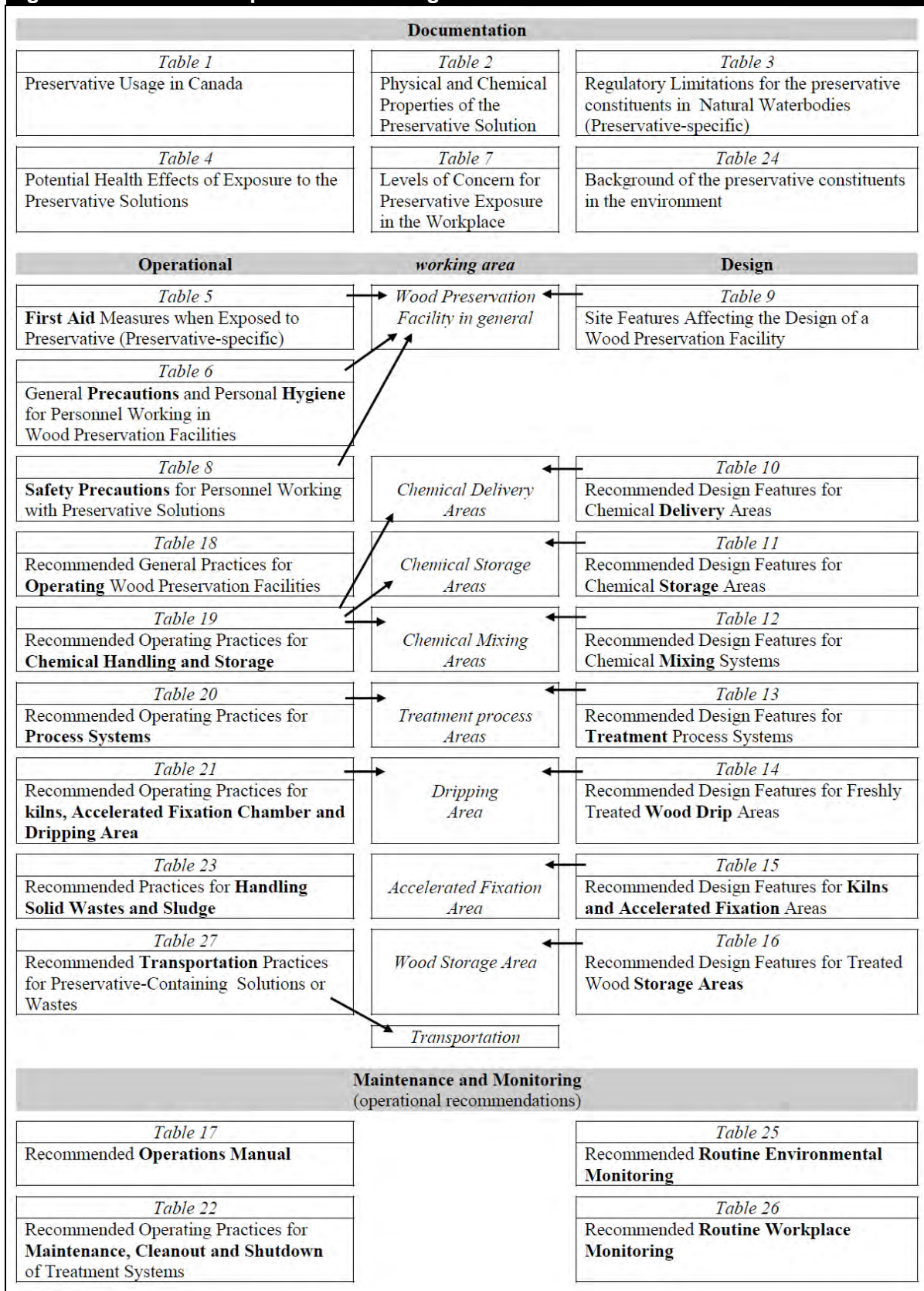
Users should keep a precautionary approach in mind when developing a worker safety and environmental protection program to minimize the risk of harm to the public or the environment.

The following are suggested steps to consider:

- Documentation
- Understanding the wood preservation process
- Understanding the chemical behaviour
- Identifying the potential risk of exposure
- Proposing realistic cost-effective mitigation measures
- Training
- Implementing measures
- Monitoring
- Providing feedback and revising the program

Figure 1 presents an overview of the subject areas covered by the operational and design objectives in Chapter A. It is based on the typical handling and use of preservatives. Figure 1 provides a graphic summary of the title of each recommendation table in this chapter and the relationship between the tables.

**Figure 1: Overview of Operational & Design Recommendations for Preservation Facilities.**



# 1 Production and Use

This section presents and describes the general properties of wood preservatives and the general process of application. The information on major products treated in Canada and the use of the product should be presented in the order to help identify the life cycle of the treated product.

Basic information on preservative usage is summarized in **Table 1**:

**Table 1. Preservative Usage in Canada**

(Preservative-specific)

Feature	Characteristics
<b>Treated wood use limitations in Canada</b>	(e.g. authorized for residential usage, commercial or industrial) (e.g. plywood, round fence posts, construction timbers, utility poles, railway ties)
<b>General process of application</b>	(e.g. pressure or thermal treatment)

This information is provided by the pesticide manufacturer and can be found on the pesticide label attached to the containers. (1) This information is also available from the Health Canada's website at <http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>.

The applied treatment parameters for all processes are limited by the directions for use on the registered pesticide labels. The CAN/CSA O80 (2) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

The CAN/CSA O80 series of Standards identifies which preservative systems and retentions have been found to be effective in protecting wood products under particular service conditions. It provides the most comprehensive set of wood preservation requirements for Canadian conditions and is recommended for use by producers of all types of preservative-treated wood. Treatment to this CSA standard is both voluntary (industry) and mandatory (code requirements) and ensures that wood is suitable for use in exterior construction. The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure and thermal impregnation). The subjects covered include materials and their analysis, pressure and thermal impregnation procedures, and fabrication and installation to put treated wood into service (2).

## **2 Physical and Chemical Properties**

Before using a wood preservative, the following characterization should be identified and understood.

### **2.1 General Properties**

Physical and chemical properties of the wood preservative should be gathered and documented and stored on –site. This information can usually be found on the pesticide label and material safety data sheets (MSDS), which are provided by the manufacturers (3). Electronic copies of pesticide label are also available from the Health Canada website, at <http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>.

Table 2 provides the suggested format to document the physical and chemical properties (if applicable) of the wood preservatives.



**Table 2. Physical and Chemical Properties of the Preservative Solution**  
(Preservative-specific)

Identification		
Common synonyms:		
United Nations (UN) Number <sup>1</sup> :		
Transportation and storage information		
Delivery format: <i>(e.g. liquid concentrate, bags, drums)</i>	Storage temperature: _____	Placards: _____
_____	Inert atmosphere: _____	Check with : Transport Canada. <a href="http://www.tc.gc.ca/eng/tdg/safety-menu.htm">http://www.tc.gc.ca/eng/tdg/safety-menu.htm</a>
Concentration delivered: _____	Venting: _____	Check with : The PMRA. <a href="http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php">http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php</a>
Concentration working solution: _____	Containers/materials: _____	
Classification: _____	Hose-piping/materials: _____	
Physical and chemical properties		
Physical state: _____	Solubility: _____	Flash point: _____
Molecular weight: _____	pH: _____	Explosive limits: _____
Proportions of active ingredients: _____	Vapour pressure: _____	Specific gravity: _____
Density: _____	Floatability: _____	Appearance: _____
Typical preservative retention in treated wood: _____	Freezing point: _____	Colour: _____
	Boiling point: _____	Odour: _____
	Melting point: _____	
Hazard data		
<b>Fire</b>	<b>Reactivity</b>	
- Extinguishing data: _____	- With water: _____	
- Fire behaviour: _____	- With common materials: _____	
- Ignition temperature: _____	- Stability: _____	
- Burning rate: _____		

Secondary tables can be added to document other essential, important and substance-specific elements of the wood preservative.

<sup>1</sup>UNECE, UN Model Regulations, Part 3 Dangerous goods list and limited quantities exceptions = [http://www.unece.org/trans/danger/publi/unrec/12\\_e.html](http://www.unece.org/trans/danger/publi/unrec/12_e.html)

**Table 2.1.\* Physical and Chemical Properties of a Preservative component** (if applicable):  
(Preservative-specific)

Physical and chemical properties
...

\* The decimal needs to be changed for subsequent tables (2.2, 2.3, etc.).

## **2.2    *Stabilization and Fixation of the Preservative***

In order to minimize leaching of the preservatives to the environment, treated wood with water-borne preservatives undergoes the process of stabilization or fixation. Throughout the 2013 TRD, stabilization requirements are provided for most wood preservatives, and fixation requirements are provided for CCA (in Chapter B of the 2013 TRD).

Fixation refers to a physical or chemical process whereby a wood preservative system is rendered leach resistant in both water and soil applications in such a way that the active ingredient or ingredients maintain fungal/insecticidal efficacy (2).

Stabilization is similar to fixation; however, there is no chemical reaction involved in the process to fix the mobility of the preservative in the wood. Following a specific period of dripping time after treatment, a simple drip-free visual verification is usually involved to check the stabilization of the treated wood. The minimum period of dripping is generally 48 hours under adequate conditions. Factors that may influence the duration of the stabilization/fixation process include concentration and formulation of the preservative, air flow, humidity, wood species involved, temperature and moisture content.

Prior to application, the users should have a good understanding and maintain documentation of the stabilization/fixation process, its requirements, the quality control method, the potential airborne emissions and the appropriate precautions to minimize risk of exposure.

To improve and gain better understanding of the stabilization/fixation process, a log book should be maintained to document the air flow, temperature and humidity of the accelerated fixation chamber or stabilization kiln.

### 3 Environmental Effects

This section provides references to the guidelines and requirements for water quality, air and soil quality that the users of wood preservatives should be aware of.

Wood preservatives may be delivered in various forms including ready to use mixture or in separate solutions that will require mixing at the wood preservation facility. Therefore, it is important to document and be aware of potential environmental effects of these individual solutions as they are handled at different concentrations and/or states. The breakdown products should also be known and assessed for environmental effects as they can potentially be more toxic to the environment than the parent compound.

#### 3.1 Aquatic Toxicity

Users of wood preservatives should know that Environment Canada is responsible for the administration and enforcement of the pollution prevention provisions (section 36) of the *Fisheries Act*, which prohibits the deposit of deleterious substances in water frequented by fish unless the deposit is authorized by regulation under the Act. Operators of wood treatment facilities should note that the use of an approved chemical, even in accordance with the label, should not result in a contravention of Section 36(3) of the *Fisheries Act* (*"no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish or in any place under any conditions where the deleterious substances or any other deleterious substance that results from the deposit of the deleterious substance may enter any such water"*). Any discharge which results in the release of a deleterious substance in water frequented by fish must be reported and corrective measures taken. In the event of a discharge of deleterious substances in fish bearing water, the general prohibition in *subsection 36(3) of the Fisheries Act* would apply.

For most wood preservatives, there are regulatory guidelines or objectives for the constituents of the preservative in the natural environment. Regulatory guidelines or objectives are developed by various federal and provincial departments and agencies. The users of wood preservatives should document and be aware of these regulatory guidelines or objectives.

The following provides a list of references that provide users with specific limits, objectives and benchmarks:

- Water Quality Guidelines of the *Canadian Environmental Quality Guidelines* by the Canadian Council of Ministers of the Environment (CCME)
  - <http://www.ccme.ca/>
  - <http://st-ts.ccme.ca/>
- *Guidelines for Canadian Drinking Water Quality*, 2010 by Health Canada  
[http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/2012-sum\\_guide-res\\_recom/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/2012-sum_guide-res_recom/index-eng.php)
- Foreign organizations

- *National Primary Drinking Water Regulations* by the Environmental Protection Agency of United States: <http://water.epa.gov/drink/contaminants/#List>
- Great Lakes Water Quality Agreement of the International Joint Commission United States and Canada: <http://www.ijc.org/rel/agree/quality.html> (see appendix 1, inorganic)

Additional resources include:

- Environment Canada
  - <http://ec.gc.ca/eau-water/default.asp?lang=En&n=87922E3C-1>
- Health Canada
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- Provincial ministries of the environment
  - (see [Appendix I](#))
- NRC Research Press
  - <http://www.nrcresearchpress.com/>
- United nations environment programme (UNEP)
  - <http://www.unep.org/>
- World Health Organisation
  - <http://www.who.int/en/>
- Food and Agriculture Organization of the United Nations
  - <http://www.fao.org>
- European Environment Agency (EEA)
  - <http://www.eea.europa.eu/>

Depending on local requirements, the location, the facility may be required to comply with specific water quality guidelines or objectives for specific purposes (e.g. drinking water quality objectives, national water quality guidelines, cross-jurisdictional commitment and etc.)

Although the *Canadian Water Quality Guidelines* are broadly applied and measured to assess and manage water quality in Canada, these guidelines should not be regarded as blanket values for national environmental quality (4). Variations in environmental conditions such as natural background concentration, site-specific aquatic conditions and sensitivity of receptor species in the local area have the potential to influence the applicability of these water quality guidelines across the country. Therefore, it may be necessary to establish site-specific limits that account for local environmental conditions.

A site-specific threshold concentration of a specific chemical can be established by conducting toxicity testing that incorporates the conditions of the receiving environment (see 3.1.1) or it can be based from previous studies in the literature if the test conditions are similar to the local site.

**In addition, most provinces and some municipalities may have additional objectives or guidelines that may differ from the national guidelines and objectives to account for the specific environmental conditions in their respective jurisdiction. Users of wood preservatives should check with their respective jurisdictions for additional guidance.**

Table 3 can be used to summarize the local regulatory requirements and objectives to preserve aquatic quality in natural water bodies.

**Table 3. Regulatory Limitations/Guidelines for the Preservative Constituents in Natural Waterbodies**

(Preservative and facility-specific)			
Element	Limit value (mg/L)	Basis of the Requirement	Organization
<b>EXAMPLE:</b> Arsenic	Maximum: 0.05 mg/L	Protection of human health	International Joint Commission
	Maximum: 0.01 mg/L	Protection of human health Objective: < 0.005 mg/L	Health Canada
	Fresh water: 0.005 mg/L Marine: 0.0125 mg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME)

*Refer to following chapter for more examples.*

These environmental guidelines and objectives for toxic substances in aquatic environments are subject to change from time to time. A periodic review of these guidelines and objectives is recommended.

### 3.1.1 Site & component-specific toxicity

As mentioned above, site-specific limits may be necessary to establish for local environmental conditions when existing guidelines and objectives are not applicable.

It might also be necessary to develop local limits when a potentially toxic pesticide component has no regulatory limit established.

The toxicity test methodology used must be recognised by federal and provincial authorities in order to be acceptable by the authorities. Environment Canada has a series of biological test methods and guidance documents that are available at: <http://www.ec.gc.ca/faunescience-wildlifescience/default.asp?lang=En&n=0BB80E7B-1>

The American Public Health Association has water testing and monitoring methods in the *Standard Methods for the Examination of Water and Wastewater* that are commonly used by the industry (<http://www.standardmethods.org/>).

The American Society for Testing and Materials (ASTM) also has methods that may be suitable for a specific aquatic toxicity test (<http://www.astm.org/index.shtml>).

The Organisation for Economic Co-operation and Development (OECD), has testing methods of chemicals and principles of good laboratory practice: (<http://www.oecd.org/chemicalsafety/testingofchemicals/>)

The International Organization for Standardization (ISO) has developed voluntary International Standards that give state of the art specifications for products, services and good practice including testing methodology. (<http://www.iso.org/iso/home.htm>)

Such testing can be appropriately developed with the help of a specialised local laboratory. The laboratory should be an accredited facility of the *Canadian Association for Laboratory Accreditation Inc. (CALA)* (<http://www.cala.ca/>).

Environment Canada recommends conducting acute lethality testing (to determine if a discharge is deleterious to fish in bearing water) on representative organisms of the food chain, namely fish (secondary consumer) and invertebrates (primary consumer)

Most commonly used species for performing acute lethality testing are:

- Fish
  - Rainbow trout (*Oncorhynchus mykiss*, formerly named *Salmo gairdneri*)
  - Fathead minnows (*Pimephales promelas*)
  - Threespine Stickleback (*Gasterosteus aculeatus*)
- Invertebrate :
  - Daphnids (*Daphnia magna* and/or *D. pulex*)
  - Benthic invertebrate

Most of the standardized methods used to perform toxicity tests describe general or universal conditions and procedures using a variety of test materials. Additional conditions and procedures are stipulated which are specific for assessing samples of chemicals, effluents, elutriates, leachates, or receiving waters.

Additional sublethal test methods on a plant or algae (primary producers) are available on the mentioned above Environment Canada website to determine chronic lethality effects.

The following summary table provides an example template for results of acute toxicity tests.

**Table 3.1 Aquatic Toxicity of specific components**

Description of the physical parameters of water used for testing (e.g.: hardness, pH...)			
Element / Component	Concentration (mg/L)	Effect (toxicity test) <i>example</i>	Reference (author, year) <i>example</i>
A	• 0.YY	• 96-h LC <sub>50</sub> * Rainbow trout	John and al. 1989
B	• 0.ZZ	• 96-h LC <sub>50</sub> * Fathead minnows	Tom and Boyes 2004
		•	

\*LC<sub>50</sub> is defined as the estimated concentration which results in death of 50% of the fish test population within 96 hours.

## 3.2 Air Pollution

Airborne pollution from wood preservation facilities is usually specific to some process within the plant and is rarely an issue outside the facility. Air pollution from wood preservative facilities can be generated as vapour/gas, aerosols and/or contaminated dust. Section 4 addresses the potential health effects of exposure and Section 5 addresses the potential air emissions.

As mentioned in Section 7 on design recommendations, interior tanks should be vented to the exterior or into a dedicated overflow tank and then to the exterior. There should never be any venting directly into the workplace.

When working with vaporous pesticides solutions it is recommended to channel all vents to an air pollutant control device like a scrubber to ensure that air quality respect the limits prescribes by the local authorities.

### **3.3 Soil Contamination**

Soil contamination could potentially be an area of major concern if no effective mitigation measures are in place. Contaminated soil could contaminate nearby water bodies and drinking water sources due to runoff and can be spread by vehicular traffic and wind. Sections 7 and 8 present the design and operational recommendations to minimize soil contamination.

The *Canadian Environment Quality Guidelines* published by CCME contains specific guidelines on soil quality for the protection of environmental and human health, guidance on contaminated site-related activities and developing and maintaining the Canada-wide Standard for Petroleum Hydrocarbons in soil and the requirements under it. The *Canadian Environmental Quality Guidelines* is available at:

<http://ceqg-rcqe.ccme.ca/>

EC has standardized soil toxicity tests for soil invertebrates (springtails and earthworms) and plants available at:

<http://www.ec.gc.ca/faunescience-wildlifescience/default.asp?lang=En&n=0BB80E7B-1>

Soil contamination can take place over a long period of operation by accumulation and also from spills events. Spills are defined and are usually easily contained. Small inputs of contaminants distributed on a large area over a long period of time are very hard to contain and to treat.

Without proper design equipment and proper operational procedures, risks of bioaccumulation of contaminants are greater. During major storm events or freshet, washout rain can create erosion and expose potential contaminated sediments from lower levels and transport them downstream into waterbodies or into underground water sources. A good environmental monitoring program is a recommended solution to detect areas of small contamination. With proper preventive and corrective actions, it is possible to avoid potential accumulation of soil contaminant.

In addition, most provinces have additional objectives or guidelines that may differ from the national guidelines and objectives to account for the specific environmental conditions in their respective provinces. Users of wood preservatives should check with their respective provinces for additional guidance.

To learn more on Environmental Monitoring, see Section 10 of this Chapter.

### **3.4 Reporting to Environmental Programs**

Wood preservation facilities may be required to report to the National Pollutant Release Inventory (NPRI) of Environment Canada or other provincial reporting program if the facilities meet the reporting thresholds. NPRI was established under the *Canadian Environmental Protection Act, 1999* to collect data on substances of concern in Canada. Certain type of activities conducted in the wood preservation facilities may trigger specific reporting requirements. For example, wood preservation using pentachlorophenol is required to report on Part 3 substances under NPRI.



To confirm whether submission of an NPRI report to EC will be required, the proponent should contact the NPRI office at 1-877-877-8375 or [inrp-npri@ec.gc.ca](mailto:inrp-npri@ec.gc.ca).

For the latest reporting thresholds and requirements, please consult the NPRI website:  
<http://www.ec.gc.ca/inrp-npri/>.

## 4 Human Health Concerns

The primary safety objective of the industrial use of any chemical or preservative is to minimize worker exposure, ideally so that natural intake levels are not exceeded. If safeguards are not provided or implemented, a variety of human health effects may occur depending on the duration and manner of exposure, concentration of chemicals, chemical forms (valence), and the varying metabolic sensitivities of individual workers.

It is important to identify the chemicals of concern from that particular preservative, its natural concentrations and the potential adverse human health effects that may result from exposure. The severity of adverse health effects vary by dosage, duration and route of exposure (e.g. skin contact, ingestion, inhalation) and the sensitivity of the individual.

Several organizations provide resources that are available on workplace safety and chemical exposures at workplace:

- Provincial Agencies ([see appendix 1](#))
- Workplace Hazardous Materials Information System (WHMIS)
  - <http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index-eng.php>
  - [http://www.ccohs.ca/oshanswers/legisl/msds\\_lab.html](http://www.ccohs.ca/oshanswers/legisl/msds_lab.html)
- Health Canada
  - <http://www.hc-sc.gc.ca/ewh-semt/index-eng.php>
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- Health Canada's Pest Management Regulatory Agency (PMRA)
  - <http://www.hc-sc.gc.ca/cps-spc/pubs/pest/decisions/rvd2011-06/index-eng.php>
  - <http://www.hc-sc.gc.ca/cps-spc/pest/index-eng.php>
- Canadian Centre for Occupational Health and Safety (CCOHS)
  - <http://ccohs.ca>
- American Conference of Governmental Industrial Hygienists (ACGIH):
  - <http://www.acgih.org/tlv/>
- Office of Pesticide Programs (United States Environmental Protection Agency)
  - <http://www.epa.gov/pesticides/index.htm>
- Occupational Safety & Health Administration (OSHA)
  - <https://www.osha.gov/workers.html>
- Agency for Toxic Substances and Disease Registry (ATSDR)
  - <http://www.atsdr.cdc.gov/substances/index.asp>
- World Health Organization
  - <http://www.who.int/ipcs/en/>
  - [http://www.who.int/ipcs/assessment/public\\_health/arsenic/en/index.html](http://www.who.int/ipcs/assessment/public_health/arsenic/en/index.html)
- International Labour Organization, ICSC Card database
  - <http://www.ilo.org/dyn/icsc/showcard.home>
- National Research Council of Canada
  - <http://www.nrc-cnrc.gc.ca/eng/index.html>

Material safety data sheets (MSDS) and the pesticide label also contains information about potential health effects associated from the exposure and safety precautions about handling of a particular preservative.

Provincial occupational health and safety regulatory agencies have set Occupational Exposure Limits (OELs). These OELs differ from province to province but have a basis in the threshold limit values (TLVs) and biological exposure indices (BEIs) for chemical exposures in industrial settings. These limits and indices indicate exposure at or below the level which does not create an unreasonable risk of disease or injury. Provinces may have different values than the most current American Conference of Governmental Industrial Hygienists (ACGIH). Get informed with your local authorities.

According to the ACGIH, (<http://www.acgih.org/tlv/>)

TLVs® and BEIs® are determinations made by a voluntary body of independent knowledgeable individuals. They represent the opinion of the scientific community that has reviewed the data described in the documentation, that exposure at or below the level of the TLV® or BEI® does not create an unreasonable risk of disease or injury.

TLVs® and BEIs® are not standards. They are guidelines designed for use by industrial hygienists in making decisions regarding safe levels of exposure to various chemical substances and physical agents found in the workplace. In using these guidelines, industrial hygienists are cautioned that the TLVs® and BEIs® are only one of multiple factors to be considered in evaluating specific workplace situations and conditions. (5)

Simplified definitions that will be useful for establishing workplace exposure monitoring programs include:

1. Threshold limit value - Time weighted average (TLV-TWA): the TWA concentration for a conventional 8hr/workday, 40hr/week work schedule
2. Threshold limit value - [Short-term exposure limit](#) (TLV-STEL): spot exposure for a duration of 15 minutes, that cannot be repeated more than 4 times per day
3. Threshold limit value – Ceiling limit(TLV-C): absolute exposure limit that should not be exceeded at any time

Some individuals could be more sensitive to the exposure of certain chemicals and wood preservatives. Regular medical surveillance of workers that are exposed to certain preservatives and hazardous chemicals should be required. Section 6.4 provides additional recommendations on the biological monitoring of exposed workers.

Prior to employment, workers should be notified of the potential risks and effects of preservatives. A pre-employment check-up that is specifically designed by an occupational physician to verify that they are not medically sensitive to any of the chemicals used at the facility should be conducted. The information should not be used to bar workers from employment but to ensure that proper precautions are applied.

The following template provides an example of a summary table on potential health effects.

**Table 4.0 Potential Health Effects of Exposure to the Preservative Solutions**  
(Preservative-specific)

		Possible health effects	
Exposure Category (Route of Entry)	Type of exposure	Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) with limited to no health effect			
• Element	mg/day		
Skin contact			
Eye contact			
Exposure to airborne contaminant or dust			
Ingestion			

**Table 4.1\* Potential Health Effects of Exposure to the Preservative Component**

Exposure Category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
...			

\* The decimal needs to be changed for subsequent tables (4.2, 4.3, etc.).

## **4.1 Special Sensitivity**

Natural sensitivity to the toxic effects of pesticide exposure varies. Some workers may be especially sensitive, including individuals with pre-existing skin problems, a history of liver or kidney disease, or a history of metabolic disorders caused by conditions such as diabetes or thyroid disease (6, 7). Prior to employment, workers should be informed of any potential effects and potential particular sensitivities. The information should not be used to bar workers from employment but to ensure that proper precautions are applied.

## 5 Description of Preservative Applications and Potential Chemical Discharges at Wood Preservation Facilities

The type and amount of chemical discharges from wood preservation facilities will be dependent on the design of the plant, the type of preservative(s) being applied, the sequences of the process and the operational practices in place. In order to identify, assess and evaluate the risk of exposure of workers and the potential chemical discharges from the facility, it is important to document and maintain a process plan and detail descriptions of each process. This chapter provides an overview of the common treatment process of a typical wood preservation plant.

### 5.1 Description of Process

A conceptual diagram should be prepared and maintained to document the wood treatment facility and its process flow of the fluid and pesticide. Examples are provided in Figure 1 of each preservative-specific chapter and in Figure 3, 4 and 5, Section 2.2.3 of Part 1 – General Background Information.

Detail descriptions should be included for each step of the process, such as the following:

- Delivery and receiving of raw materials and primary products (e.g. wood, preservatives, other products)
  - Access point
  - Schedules of delivery
  - Delivery format (e.g. liquid concentrate, bags, drums)
  - Unloading drums, totes, concentrates, bulk, or solid preservative or constituents
    - Equipment used, manipulation of the concentrates
    - Safety measures, personal protective equipment (PPE), alarms, catchment, lighting...
  - Wood unloading method
  - Preservative storage
  - Size of machinery
  - ...
- Wood conditioning
  - Dryers
  - Storage area
  - Sorting, piling and strapping area
  - ...
- Preparing work solutions
  - Unloading concentrates from drums, crates, bags...
  - Chemical mixing
  - Machinery / Equipment required
  - Equipment elements (valves, opening access, engine...)
  - ...
- Preservative application
  - Machinery required
  - Equipment requirement

- Equipment elements (valves, opening access, engine,...)
  - ...
- Quality assurance / quality control
- Removing treated charges from cylinders
- Methodology for fixation or stabilization
- Handling treated lumber
- Handling and maintaining any contaminated equipment
- Storage of treated product
- Recuperation system
- Cleaning cylinders, kiln, fixation chambers or storage tanks
- Waste storage and handling
- ...

Technical information related to the treating process should also be documented:

- Typical preservative retention in the wood product and variation on associated methodology
  - By species (spruce, fir, pine...)
  - By dimensions
  - By wood moisture content
  - ...
- Maintenance and /or possible modification to existing equipment
  - Welding
  - New type of material
  - ...
- Sampling procedures
- Laboratory procedures
- If a preservation facility is using more than one preservative, appropriate precautions should be taken and strictly followed. This might include the following:
  - Complete flushing of one preservative from cylinders, piping and sumps before introduction of the second preservative
  - Modification of procedures and training update
  - ...
- ...

If a preservation facility is using more than one preservative, it is important that the procedures of the change over from one preservative to the other be well defined and documented.

This may include, but is not limited to, the following:

- Use of other equipment
- Blocking access to equipment (safety or contamination purposes)
- Adding a complete flushing of one preservative from cylinders, piping and sumps before introduction of the second preservative
- Colour coding pipes, containers and/or specific area for different preservatives
- Review and maintenance of necessary PPE
- Review of security measures and equipment
- Procedures, training
- ...

## 5.2 **Potential Chemical Discharges**

Potential chemical discharges could occur to water, air or soil, as well as possible transfers to material or equipment depending on the plant design and operational procedures. The discharge can vary in quantity and in state (e.g. gaseous, liquid or solid).

At every major step of the process, an analysis should be done to identify the potential sources. It should factor in normal operation conditions, extreme operating conditions and potential accidents that may occur.

Potential discharges that should be considered include the following:

### *Liquid Discharges*

Preservatives and its process chemicals require water or other liquid as a solvent. Due to the toxicity and cost of the preservatives or process chemicals, ideally the facility should use closed loop treatment systems that contain, collect and reuse the chemical mixture to the greatest possible extent.

Closed systems may include the following types of equipment:

- paved or concrete containment surfaces
- dyking of major process components including the cylinder and tanks
- containment surfaces for chemical drips from treated wood in storage, stabilization/fixation, or drying areas
- collection sumps to receive residual preservative
- cartridge filters to remove dust and wood debris from contaminated liquids entering the system
- holding tanks for filtered solutions
- ...

Some liquid streams that may not be possible for re-use include the following:

- condensates removed from the wood during conditioning or vacuum application
- condenser cooling water
- water released by the wood during the treatment cycle
- washwaters for oil-borne facilities
- spills, overflows and leaks
- stormwater runoff from unpaved or unroofed areas or yard soil contamination
- spills from hose ruptures during the unloading of trucks
- spills from piping failure
- spills from damage of waste drum
- drippage from lumber that was removed from the drip pad too soon
- ...

All attempts should be made to re-use these streams in the treating process, however, if this is not possible the streams must be treated prior to discharging to natural environment. In addition, the liquid discharges may be subjected to certain conditions, limits or requirements that are enforced by the local, provincial and federal authorities

### *Solid Wastes*

Solid waste generation at wood preservation facilities may include the following:

- cartridge filters and traps
- broken treated wood
- sludge from tanks, sumps, fixation/stabilization chambers/kilns and pressure cylinders
- sludge from wastewater treatment processes
- contaminated soils
- containers, wrappings, wood lath, stickers and pallets
- dust, sawdust, debris
- ...

### *Air Emissions*

Potential sources of air emissions include the following:

- exhausts, mists and vapours from kilns
- exhausts, mists and vapours from tank vents
- mists and vapours from vacuum pump exhausts
- mists and vapours from opening of retort cylinder doors and tank hatches
- vapours from freshly treated charges
- exhausts, mists and vapours from stabilization kiln or accelerated fixation process
- ...

[Section 9](#) provides additional information on air-emissions control and discharge disposal.

The conceptual diagram mentioned in 5.1 that identifies the potential release points from the process could be used for training purpose.

Activities are usually analyzed individually. Other potential risks may arise when activities are analyzed in conjunction with multiple simultaneous activities. A review of the conceptual diagram with dynamic activities in mind may help identify other potential chemical discharges.

In case of accidental releases, prompt containment or emergency procedures should be applied and appropriate authorities should be contacted promptly (see [Section 12 – Environmental Emergency Notification and Contingency Planning](#)).



### **5.3 *Potential Effects of Chemical Discharges***

The actual impact of any liquid discharge, solid waste or air emission depends on many factors, including:

- the location of the facility relative to ground or surface waters
- the location of the facility to potential receptors
- the amount released
- the frequency of releases
- contingency measures in place at the facility.

Variables that may affect the health and safety of the workers at the wood preservation facility include:

- Ambient concentrations
- Ambient conditions
- Frequency of exposure
- Duration of exposure
- Availability, usage and effectiveness of the protective measures during period of exposure.

Information about the potential health or environmental effects are provided by:

- Health Canada's Pest Management Regulatory Agency (PMRA)
- Office of Pesticide Programs (United States Environmental Protection Agency)
- National Research Council of Canada
- World Health Organization
- International Labour Organization
- Environment Canada
- Chemical suppliers
- Consultants
- Industrial hygienists

## 6 Protection of Personnel

### 6.1 First Aid, Precautions and Hygiene

Precautions and personal hygiene measures should be put in place to minimize the contact with the preservatives by the workers.

Potential routes of exposure of the preservative solids or solutions by the workers include:

- Ingestion
- Skin/eye contact
- Inhalation of vapours/ mists/ dusts
- Other routes



The degree of exposure and severity of the effects can be minimized if appropriate protective measures are in place. Table 6 provides practices on general precautions and hygiene measures.

Signs and symptoms of chronic illness related to long-term wood preservative exposure should also be known, documented and made available to employees. Long-term effects from frequent low concentration exposure may be difficult to document but should nevertheless be taken into consideration.

The severity and rapidity of effects to human health is usually greater with higher concentrated solutions or solids. These factors and the severity of symptoms diminish as the solution is more diluted. The general rule for dealing with exposure is as follows: **the higher the concentration of a preservative to which a worker is exposed, the greater the need to provide appropriate protective measures and immediate response if contact occurs.** If there is any doubt as to the concentration of a solution that a worker comes in contact with, the strictest response measures should be used (e.g. same as for the most concentrated form).

First aid measures should be retrieved from the pesticide label should be reviewed periodically with the chemical supplier and/or a qualified occupational hygienists or occupational physicians to ensure the information is up to date. Any additional measure that may be present on the MSDS or that is required by the provincial authority should be used.

A summary of the first aid response plan similar to Table 5 should be documented and available on site and –preferably with the first aid materials. General precautions and personal hygiene requirements are included in Table 6.

A first aid program should be in place and should include certified first aid personnel at the facility who are familiar with current response measures. A first aid program should be included and training and periodic drills on emergency procedures should be carried out to evaluate the effectiveness of the program and so that all employees are familiar with the procedures. First aid stations should be located in convenient locations that are accessible to all employees and clearly marked. Safety equipment should be maintained and supplies should be replenished.

Barrier devices (e.g. masks, gloves, a CPR pocket mask, etc.) should be made available to minimize the pass on and transfer from the injured person to the first aider.

**Table 5. First Aid Measures when Exposed to Preservative**

(Preservative-specific)

<b>Most concentrated form</b>		
<b>Exposure</b>	<b>First action</b>	<b>Second action</b>
Eye contact	(e.g. flush eyes with water)	(e.g. Get medical attention)
Skin contact		
Inhalation		
Ingestion		
Chronic symptoms requiring medical referral		
<b>Mixed solution</b>		
<b>Exposure</b>	<b>First action</b>	<b>Second action</b>
Eye contact	(e.g. flush eyes with water)	(e.g. Get medical attention)
Skin contact		
Inhalation		
Ingestion		
Chronic symptoms requiring medical referral		

For all medical attention, always have the pesticide label and MSDS in your possession to properly inform health personnel.

**Table 6. General Precautions and Personal Hygiene for Personnel Working in  
Wood Preservation Facilities**

(All Preservatives)	
General Precautions	
Objective	Recommendations
Ensure that workers are familiar with all aspects of preservative usage.	<ul style="list-style-type: none"> <li>• Provide documentation (including pesticide product labels) and training to educate workers about the chemical properties of, hazards of exposure to, and emergency procedures associated with use of the preservative.</li> <li>• Appropriate workers should be trained on the <i>Workplace Hazardous Materials Information System</i> (WHMIS) and the <i>Transportation of Dangerous Goods</i>. (TDG).</li> <li>• Implement preventive measures to minimize ingestion or inhalation of, and skin or eye contact with, preservatives, preservative solutions and contaminated waters.</li> </ul>
Ensure that workers are using the appropriate protective equipment.	<ul style="list-style-type: none"> <li>• Refer to PPE in <i>Table 8</i>.</li> </ul>
Ensure that first aid can be applied when necessary.	<ul style="list-style-type: none"> <li>• Install and regularly check emergency eyewashes and showers.</li> <li>• Provide all necessary first aid equipment for first response as indicated in Table 5 (refer to Part II - Preservative-specific Information and Recommendations).</li> <li>• Ensure that first aid is always available from qualified (trained) personnel.</li> <li>• Ensure first aid personnel are familiar with updated emergency response procedures.</li> <li>• Identify medical contacts that are readily available during all working hours.</li> </ul>
Implement personal hygiene practices that minimize potential exposure to preservatives.	<ul style="list-style-type: none"> <li>• Do not carry, store or consume food or drink in working areas (e.g. areas where preservatives are stored or used, or where freshly treated wood is stored).</li> <li>• Do not carry or smoke cigarettes in working areas.</li> <li>• Wash hands thoroughly before leaving working areas and before eating, drinking, smoking or using the toilet facilities.</li> <li>• Do not expose cuts or abrasions to preservatives.</li> <li>• Wash skin immediately if contact with preservative solutions occurs.</li> <li>• Get immediate first aid if skin or eyes contact preservative solutions. Even small contact exposures should receive immediate cleaning and treatment.</li> <li>• Change outer clothing immediately if splashed with preservative solutions.</li> <li>• Change clothing daily if any incidental contact with the treatment chemical occurs.</li> <li>• Wash contaminated clothing separately from other clothing.</li> <li>• Wear impermeable footwear in all working areas. Preservative solutions may penetrate leather shoes and apparel.</li> <li>• Shower daily immediately after work before leaving the plant (for all CEPA toxic preservatives).</li> <li>• All work clothing and boots should be left at the facility.</li> <li>• Discard clothing that has been drenched or heavily contaminated with products solution or concentrate.</li> <li>• Discard properly all absorbent material used for spill as soon as possible.</li> <li>• For reasons of prudence it is suggested that pregnant women and children under 14years old not be exposed to high risk of exposure and not be allowed within the perimeter of the facility plant.</li> </ul>

## 6.2 Regulatory Controls

Regulatory limits for worker protection are found in provincial regulations and are called Occupational Exposure Limits (OELs). Most of these values are based on the threshold limit values (TLVs) and biological exposure indices (BEIs), recommended by the American Conference of Governmental Industrial Hygienists (ACGIH, <http://www.acgih.org/tlv/>)

The pesticide label and MSDS contains information with respect to the requirements for controls including personal protective equipment and practices necessary to use the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures which may enhance, but not reduce, protection.

**Always consult with your provincial and local authorities to know the applicable regulatory requirements.**

Table 7 provides a template that can be used to summarize the regulatory limits on TLVs and/or BEIs applicable to your facility. The table should be reviewed periodically to ensure the information is up to date.

**Table 7. Levels of Concern for Preservative Exposure in the Workplace**

(Location specific)

Route of entry	Concerns (Solution and/or components)	Regulatory TLVs and/or BEIs Recommendations/comments
In every case	Appropriate protective measures should be used by worker. Refer to Table 8.	
Skin contact <i>N.B. All constituents of the solution should be taken into consideration. Contact with additives can also be harmful.</i>	(e.g. : <b>Solution X:</b> Corrosive, can be absorbed by the skin <b>Constituent Y:</b> Carcinogen)	(e.g. Provide full face protection)
Eye contact		(e.g. Provide full face protection, not regular safety goggles)
Inhalation		(e.g.: Provincial Occupational Exposure Limit (OEL) or ACGIH threshold limit (TLV): ___mg/m <sup>3</sup> Provide NIOSH-approved respiratory protective equipment)
Ingestion		(e.g. Prevent inadvertent ingestion by applying following personal hygiene precautions: a)..., b)..., )

Under the federal *Pest Control Products Act* all pesticides, including all wood preservatives, are required to be registered and to carry a pesticide label issued by Health Canada's Pest Management Regulatory Agency. Pesticide labels contain specific requirements for the handling

and use of the preservatives as well as the protective measures that apply. These requirements from the PMRA also apply to moldicides, which are considered “antimicrobial” pesticides.

### **6.3 *Safety Precautions***

Safety precautions should be part of the worker protection program and this should be part of the employee training program to ensure safe workplace practices for each activity during the treatment process.

The facility must comply with the requirements for personal protective equipment (PPE) found on the registered pesticide label. Any additional PPE that may be present on the MSDS or that is required by the provincial authority should be used. Minimal PPE requirements are provided in Table 8 and additional requirements specific per preservative are provided in Part II – Preservative-specific Information and Recommendations, Table 8, under the appropriate chapter.

**Table 8. Safety Precautions for Personnel Working with Preservative**

(All preservatives – also consult Part II – Preservative-specific tables)

Activity	PPE & operational recommendations
For all activities	<ul style="list-style-type: none"> <li>• Must wear properly fitting, well-maintained and efficient PPE for all preservatives, additives and solvent as identified in the respective pesticide label (or MSDS for additive).</li> <li>• Must NOT wear jewellery that may cause work related injuries and can become a source of contamination or an instrument to wear and tear on PPE.</li> <li>• Must respect Provincial Health and Safety Code requirements</li> <li>• Should not wear contact lenses</li> <li>• Thoroughly clean protective equipment after each use, when applicable.</li> <li>• Discard clothing that have been drenched or heavily contaminated with products solution or concentrate.</li> <li>• Secure the work area: access and vehicle circulation.</li> <li>• It is preferable to always have a standby attendant present when there is high risk of exposure.</li> <li>• Emergency equipment should be accessible and functional at all times.</li> <li>• First aid personnel must be available.</li> <li>• Working personnel should have proper training.</li> <li>• Working procedures must be followed.</li> <li>• <b>Minimal PPE when working under dry condition:</b> Wear heavy-duty impermeable* gloves, chemical goggles and impermeable shoes.</li> <li>• <b>Minimal PPE when risk of getting wet from preservative:</b> Wear full face protection, appropriate NIOSH-approved respiratory equipment, impermeable* gauntlets, impermeable* rain suit and impermeable* shoes or boots.</li> <li>• <b>Minimal PPE when working in an enclosed environment with pesticides:</b> Wear Self-contained NIOSH-approved Breathing Apparatus (SCBA) if working in an enclosed environment</li> <li>• <i>To select the proper respiratory equipment, you can consult with your chemical suppliers, the provincial work safety agency or your Industrial hygienist.</i></li> </ul>
Unloading bulk containers (solid or liquid).	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear protective apparel, including chemical goggles, full face protection, impermeable* gauntlets, coveralls, impermeable aprons, socks and impermeable shoes or boots.</li> <li>• Ensure good ventilation</li> <li>• Prohibit foot or vehicle traffic between the point of delivery and the transport vehicle.</li> <li>• Place “DANGER” signs at each end of the transport vehicle during unloading operations.</li> <li>• Ensure that at least two individuals trained in handling the preservative are present at all times during unloading operations (i.e. at least one person other than the truck driver; this person may include forepersons, supervisors and management employees).</li> <li>• Ensure that all connections are secure and leak-tight.</li> <li>• Provide emergency eyewash and shower in the immediate unloading area.</li> </ul>
Preparing work solutions.	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear full face protection, impermeable* gauntlets, coveralls, impermeable aprons, socks and impermeable shoes or boots for all operations involving direct exposure to preservative concentrates.</li> <li>• Ensure good ventilation</li> <li>• Thoroughly clean and hose down the work area following solution preparation.</li> <li>• Dispose of debris and empty containers in accordance with Section 9 of this 2013 TRD.</li> <li>• Thoroughly clean protective equipment after use.</li> <li>• Provide emergency eyewash and shower in the immediate area.</li> <li>• Reuse all rinse waters for work solution preparation.</li> </ul>

**Table 8. Safety Precautions for Personnel Working with Preservative (continued)**

Activity	PPE & operational recommendations
Sampling procedures	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear eye protection and impermeable* gauntlets when sampling preservative <u>solutions</u></li> <li>• <b>PPE:</b> Wear full face protection and impermeable* gauntlets when sampling preservative <u>concentrates</u>.</li> <li>• <b>PPE:</b> Wear impermeable* gloves and goggles when taking borings from freshly treated wood.</li> <li>• Wash gauntlets and goggles immediately after completing sampling.</li> <li>• Use sample containers approved for the application and any shipment.</li> <li>• Wash the outside of sample containers immediately after sampling solutions.</li> <li>• Wash hands thoroughly after all sampling operations.</li> </ul>
Cleaning cylinders, stabilization kiln, fixation chamber or storage tanks. Removing load jams	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear appropriate NIOSH-approved respirators (or self-contained breathing apparatus if working in an enclosed environment), impermeable* gauntlets, rain suit and impermeable boots during all vessel entries.</li> <li>• Follow all standard precautions for vessel entry (as per provincial health and safety regulations). If confined spaces as per provincial definitions, must apply confined space program, permits and procedures.</li> <li>• Conduct confined space air sampling if applicable and flush vessels as required to establish safe entry conditions, or use an approved self-contained breathing apparatus prior to entry.</li> <li>• Always have a standby attendant present and provision for continuous outside communications.</li> <li>• Collect and store contaminated waste material in sealed and labelled drums.</li> <li>• Wash all protective equipment immediately after use</li> <li>• Shower after completion of cleanup tasks.</li> <li>• Reuse all rinse waters for work solution preparation.</li> </ul>
Removing treated charges from cylinders.	<p>Retort opening</p> <ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear appropriate NIOSH-approved respirator if preservative concentrations are above regulatory values or concentrations are unknown and impermeable* gauntlets during door openings.</li> <li>• <b>PPE:</b> Wear impermeable* gauntlets, apron or rain suit, face shield or goggles, and boots if there is potential for getting wet by the preservative solution.</li> <li>• <b>PPE:</b> If door opening is totally automatic and operator is protected from exposure** by shield or wall; wear impermeable* gloves and goggles during door openings.</li> </ul> <p>Entering the cylinder:</p> <ul style="list-style-type: none"> <li>• Conduct confined space air sampling if applicable</li> <li>• <b>PPE:</b> Avoid breathing preservative mists. Wear appropriate respirator equipment.** <ul style="list-style-type: none"> <li>• If retort oxygen levels do not meet regulatory values or the concentration is unknown, the attendant entering the cylinder should wear a self-contained full-face respirator mask (breathing apparatus), impermeable coveralls, boots and gauntlets.</li> <li>• If retort oxygen levels meet regulatory values; wear appropriate NIOSH-approved respirator, impermeable coveralls, boots and gauntlets.</li> <li>• Regulatory values are from provincial authorities and can refer to ACGIH and/or OSHA standards if applicable***</li> </ul> </li> </ul> <p>Moving loads:</p> <ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear impermeable* gauntlets when moving loads of freshly treated wood.</li> <li>• <b>PPE:</b> Wear impermeable* gauntlets, apron or rain suit, face shield or goggles, and boots if there is potential for getting wet by the preservative solution.</li> <li>• <b>PPE:</b> If removing charge is totally automatic and operator is protected from exposure by shield or wall; wear impermeable* gloves, goggles, during door openings.</li> </ul>



**Table 8. Safety Precautions for Personnel Working with Preservative (continued)**

Activity	PPE & operational recommendations
Handling treated lumber.	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear impermeable* gloves when treated lumber is dry.</li> <li>• <b>PPE:</b> Wear impermeable* gauntlets, aprons and boots if there is potential for coming in contact with preservative liquid solution.</li> <li>• <b>PPE:</b> Wear appropriate NIOSH-approved Breathing Apparatus (SCBA) if treated wood is handled in enclosed areas (eg. boxcars) and do not meet regulatory values or the concentration is unknown.</li> </ul>
Handling and maintaining contaminated equipment.	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear an impermeable* apron, gauntlets and boots if there is potential for coming in contact with preservative liquid solution.</li> <li>• Specific equipment exposed to direct chemical contact is a source of potential exposure; appropriate PPE must be assessed depending on the situation (e.g. charge cables handling, movement of bridge rails)</li> <li>• Thoroughly clean equipment prior to handling.</li> <li>• Drip trays should be free of liquid prior to maintenance work.</li> <li>• Reuse all rinse waters for preparing treating solutions for water borne preservative.</li> <li>• Also refer to <a href="#">Appendix II</a> – Preventative Maintenance Program</li> </ul>
Welding	<p>Welding can produce toxic fumes.</p> <p>The following protective measures should be undertaken in addition to the precautions for handling and maintaining contaminated equipment:</p> <ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear an approved respirator where required and provide effective local exhaust ventilation during welding to prevent potential exposure to toxic fumes.</li> <li>• Obtain proper approval before welding.</li> <li>• Block or disconnect any preservative intake before initiating welding operations.</li> <li>• Completely drain and thoroughly rinse tanks or lines prior to welding operations.</li> <li>• Ensure that equipment is completely dry from cleaning solvent residues.</li> <li>• Ensure good general ventilation of the work area.</li> <li>• Comply with all additional provincial workplace safety rules.</li> </ul>

\* Heavy-duty, lined polyvinyl chloride, rubber, nitrile/PVC, neoprene, or polyethylene. Depending on the preservative used, the appropriate material is used to ensure the PPE is impervious to all wood treatment chemicals used.

\*\* An initial workplace monitoring program as suggested in Section 10.2, Table 26 of this Chapter A will have determined the need for respirator use. The results of the program are assumed to be indicative of conditions in subsequent facility operations, unless procedural or design changes have occurred.

\*\*\*ACGIH: American Conference of Governmental Industrial Hygienists

OSHA: Occupational Safety and Health Administration (OSHA), U.S. Department of Labor

[http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=9992](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992)

[http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=9993](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9993)

## 6.4 Biological Monitoring of Exposed Workers

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the health and safety measures. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is strongly recommended and is achieved using established procedures for determining the presence of the preservatives, their components and other toxic chemicals used at the facility. Biological monitoring is not a simple medical assessment for fitness. These procedures may include hair, urine and/or blood testing when possible. Note that biological monitoring might not be able to detect all preservative ingredients and solvents used. In cases where chemical indicators are not detectable, the monitoring of potential symptoms of exposure effects should be conducted. These

procedures may include x-rays, nasal and skin evaluation and/or blood testing. Refer to Table 26 – Recommended Routine Workplace Monitoring in Section 10.2 of this chapter.

Monitoring programs should be carried out and interpreted by qualified occupational hygienists or occupational physicians. Proper documentation of the monitoring result is recommended, and results should be assessed by qualified occupational hygienists or occupational physicians periodically. If there is concern due to confidentiality issues and/or sample handling procedures, these can be addressed and resolved by a joint management-worker committee.

A comprehensive occupational health and safety program is important for worker health and safety. Two components of such a program are environmental and worker health monitoring, which may be used to assess worker exposure to wood preservatives.

**Since occupational health and safety is under provincial jurisdiction, the appropriate local workers' compensation board or department of labour should be contacted for specific requirements for wood preservation facilities.**

Users may also consult the following organization for further information:

American Conference of Governmental Industrial Hygienists (ACGIH); Refer to the latest Biological Exposure Indices (BEIs®):

<http://www.acgih.org/tlv/>

Canadian Centre for Occupational Health and Safety (CCOHS)

<http://www.ccohs.ca/>

The National Institute for Occupational Safety and Health (NIOSH)

<http://www.cdc.gov/NIOSH/>

Occupational Safety and Health Administration (OSHA)

<http://www.osha.gov/>

Recommendations for biological monitoring of the workplace and the environment are presented in Section 10 of this chapter.

## 7 Design Recommendations

This section outlines considerations on site selection and design features of wood preservation facility. These recommendations are intended to:

- Minimize the risks of direct contact of the preservatives by on-site personnel
- Minimize the risks of releasing preservatives to the environment
- Minimize the risk and impacts of accidental releases

The *National Fire Code of Canada* (NFCC) establishes requirements (known as “acceptable solutions”) that address the safety, health and fire protection of residential, commercial and industrial building and facilities in Canada. Some of the following recommendations make reference to sections/subsections/articles of the NFCC 2010 edition that met specific objectives. Additionally, it is also recommended to refer to the *National Fire Code of Canada 2010* for the following (8):



- Ongoing maintenance and use of fire safety and fire protection features incorporated into the buildings
- Identifying activities that might cause fire hazards in and around buildings
- Limitations on hazardous contents in and around buildings
- Fire safety at construction and demolition sites

### 7.1 Site Selection Purpose

Preliminary assessment of an industrial site involves an evaluation of technical site characteristics (e.g. hydrogeology, topography and soils conditions) and of socio-economic and geographic factors (e.g. cost, land use and availability, proximity to raw materials, markets and transportation routes). Subsection 7.2 provides recommendations on site features that can affect the eventual impact of a chemical release from wood preservation facilities.

In many cases, site-specific condition and characteristics may impose constraints including some of the recommendations to the design of facility. Recognizing these constraints early on in the design phase is important to ensure that these recommendations can be adopted fully.

### 7.2 Site Selection Assessment Factors

This section describes the important site-specific conditions and characteristics to be considered and design features that should be included in a wood preservation facility in order to:

- minimize the potential of contaminating groundwater and surface water;
- minimize the exposure of chemicals by on-site personnel; and
- facilitate full and partial decommissioning of the facility.

### 7.2.1 Regional Geology

Federal and provincial surveys provide geological information in many parts of Canada. The following geological information is important site-specific conditions that should be obtained:

- Texture of unconsolidated material – (e.g. fine-grained material is more likely to retain chemical contaminants than coarse material.);
- Depth to bedrock – (e.g. shallow soils imply a limited ability to retain spilled chemicals.);
- Aquifer recharge and discharge zones – (e.g. potential for hydraulic connections to regional groundwater and sensitive surface water bodies should be considered.); and
- Discontinuities such as faults, fissures, joints, fractures – (e.g. discontinuities may cause “short-circuiting” of a contaminant plume.).

### 7.2.2 Soils

Soil properties should be assessed as it affects the potential of leaching.

Physical properties to consider include: depth, permeability, texture, water-holding capacity and shrink-swell potential, etc.

Chemical properties to consider include: cation exchange capacity, anion exchange capacity, organic carbon content, and iron and aluminium oxide content, etc.

Soils with high amounts of organic carbon will have a higher capacity for sorption of neutral organic compounds, soil with high anion exchange capacity will provide greater retention of dissociated phenols, and those with high cation exchange capacity will provide greater retention of organic bases. Soil with high anion exchange capacity, high levels of aluminium oxides, and/or high levels of calcium compounds will enhance the retention of arsenate and chromate anions, while soil with high cation exchange capacity, high clay content and high organic matter will enhance the retention of the copper cation.

Soil depth and soil types are routinely indicated on soil or geology maps. Although the available maps may not indicate the exact soil composition of a small site (e.g. 2 ha), they can be used for the purpose of preliminary assessment.

### 7.2.3 Hydrogeologic Description (including subsurface geology and water table)

Published maps and reports on regional geology and soils are adequate references for establishing subsurface hydrogeology at the preliminary site assessment stage. However, site-specific hydrogeological data will be required if one or more of the following conditions are identified during preconstruction assessment:

- the site is located over a shallow, unconfined aquifer;
- the site is located over an aquifer used for a potable or irrigation water supply; and
- the aquifer has hydrogeological connections with other aquifers in the area and/or regional groundwater flow patterns.

The requirements for additional information should be discussed with the appropriate regulatory agency

#### **7.2.4 Topography**

Topographical information is easily obtained from published government maps. In general, steep sites are not recommended due to runoff problems and erosion. However, topography is a site selection parameter that can be addressed by facility design. In general, slope gradients in between 1% and 10% should present fewer concerns on runoff and erosion. Upland flat and terraced landforms are more desirable locations for treatment facilities. Floodplains are acceptable if they lie above the 100-year flood level; otherwise special design provisions should be implemented.

#### **7.2.5 Climate**

Climatic variables, such as precipitation (form, historical 1-hour and 24-hour maximums, and annual total amount), temperature regime and wind patterns influence chemical loss and leaching in the subsurface during storage of treated wood. Climatic variables can also influence conditioning needs for wood prior to preservation treatment and can affect worker exposure to emissions. Information on such climatic variables is generally available from Environment Canada. However, definitive criteria are difficult to establish for climatic influences. For example, the amount of precipitation will influence leaching potential, but this parameter can be alleviated by selecting sites with soils of low permeability and/or by introducing compensating design features at the facility (roof).

#### **7.2.6 Proximity to Sensitive Area**

Additional mitigation measure on the design and operation will be required for wood preservation facilities that are located adjacent to water bodies (e.g. lake, river, marine water), above drinking or irrigation water aquifers, agricultural land and food and beverage manufacturing facilities.

Desirable minimum distances between facilities and sensitive water bodies depend on a number of factors previously mentioned such as soil type, regional geology, topography and climate. If a selected site is adjacent to water bodies frequented by fish and/or by migratory birds, the design plans should be reviewed by both Environment Canada and Fisheries and Oceans Canada. In any case of a site located adjacent to a sensitive environment, it is recommended that users contact their local provincial and federal authorities to inform them and to learn more about the nature of the site and any additional requirements and/or applicable permitting processes (9).

### **7.3 Selection Procedures**

In the process of selecting a site best suited to building a wood preservation facility, environmental protection measures as well as its associated cost should also be factored into the site selection decision-making process. On the basis of economic considerations alone, a less suited site environmentally-wise might be more desirable. However, the cost of adding additional

environmental protection measures on a less well-suited site could potentially require significant costs. This trade off should be considered when selecting a site. In addition, requirements and application process among local municipal, provincial and federal regulatory agencies may be different; therefore, it is recommended that these agencies to be consulted and informed.

Table 9 provides examples of site characteristics and the degree of environmental mitigation measures that should be considered. In that table, the cost of adapting design and operational measures to mitigate environmental risks are likely to be lower for sites that are more suitable (slight).

These site features and the degrees of mitigating design/operational measures are based on site criteria suggested by various investigators (8, 10).

**Table 9. Site Features Affecting the Design of a Wood Preservation Facility**

(All Preservatives)		
Site features	Suggested degree of mitigating design/operational measures	
	Slight	Severe
Soil texture	Loam, silty loam, silty clay loam, clay loam, sandy clay	Gravel
Permeability (cm/h)	< 0.5	> 50
Topography (% slope)	0–9	> 30
Soil depth to bedrock (cm)	> 200	< 60
Depth to groundwater (cm)	> 200	< 60
Flooding	None	Frequent (> once/20 years)
Drainage	Slow	Very rapid
Distance to surface water body (lake or river)	Depends on interaction with other site features (e.g. permeability of soil)	Directly adjacent

## 7.4 Recommended Design Features

Tables 10 to 16 provide the objectives and recommendations on the design features of a wood preservation facility that use a typical process in handling and application of preservatives, as presented in [figure 1](#). All new and existing wood preservation facilities should be designed to meet all the objectives and apply all the recommendations presented in Tables 10 to 16 or apply alternative measures that meet the equivalent level of protection while taking into considerations site-specific conditions. For example, alternative measures may include automation machines that will lower the exposure to the pesticide by on-site personnel. Automatic door opening and closing of the autoclave can be a cost-benefit.

Note that roofing is recommended for several process areas. However, galvanized roofing may increase the toxicity of storm water runoff from mobilized zinc. Particular caution with such roofs should be exercised at sites near water bodies or in areas of low pH precipitation.

**Table 10. Recommended Design Features for Chemical Delivery Areas (All Preservatives)**

Delivery format	Design feature	Recommendations
<b>Bulk liquid</b> (delivered by truck or rail tanker)		
	<b>Objective:</b>	Provide an off-loading area that enhances spill prevention and containment.
	<b>National Fire Code of Canada 2010</b>	<ul style="list-style-type: none"> <li>For flammable and combustible liquids, refer to acceptable solutions in Division B, Subsection 4.1.6 – Spill Control and Drainage Systems, Section 4.7 – Bulk Plants, and Section 4.11 – Tank Vehicles.</li> <li>Install acceptable provisions for electric bonding to prevent static as per the NFCC.</li> </ul>
	<b>Off-loading pad</b>	<ul style="list-style-type: none"> <li>Provide an impervious pad that drains to a containment area.</li> <li>Secondary containment<sup>1</sup> for pads is required.</li> <li>Design to prevent settling or cracking of the pad.</li> <li>All delivery and transfer equipment should be contained with curbs or dykes (e.g. piping and entire concentrate truck)</li> <li>Ensure containment for a worst-event spill (e.g. 1 truck load).</li> </ul>
	<b>Sump</b>	<ul style="list-style-type: none"> <li>Provide a tertiary containment for sumps (e.g. steel lining or other suitable materials or devices) in addition to the concrete containment and impermeable liner or coating.</li> <li>Provide overflow protection if sump is not in containment area (e.g. install independent high-level alarms).</li> </ul>
	<b>Surfaces</b>	<ul style="list-style-type: none"> <li>Seal surfaces to prevent leakage and make them easier to clean.</li> </ul>
	<b>Joints</b>	<ul style="list-style-type: none"> <li>Provide liquid-tight joints.</li> </ul>
	<b>Drip control</b>	<ul style="list-style-type: none"> <li>Provide local drip catchment to minimize contamination of the containment system.</li> <li>Provide for wash down of minor drips or spills with recovery of washwater (or infiltrating precipitation) for reuse.</li> </ul>
	<b>Access</b>	<ul style="list-style-type: none"> <li>Locate off-loading area away from high yard traffic routes.</li> <li>Restrict access to all unnecessary personnel during delivery.</li> </ul>
	<b>Delivery system piping</b>	<ul style="list-style-type: none"> <li>Install permanent delivery systems with rigid, accessible, visible delivery lines (not buried).</li> <li>Protect delivery systems from mechanical damage.</li> <li>Provide mechanically secure connections between the tanker and delivery hook-up point.</li> <li>Flexible hosing used for Tank car/truck unloading requires shielding.</li> <li>Clearly identify all delivery lines.</li> <li>Use top delivery to concentrate storage tanks.</li> </ul>

<sup>1</sup> Secondary containment can be addressed with the use of appropriate sealant coatings. Provincial requirements for secondary containment may apply.

**Table 10. Recommended Design Features for Chemical Delivery Areas (continued)**

<b>Delivery format</b>	<b>Design feature</b>	<b>Recommendations</b>
<b>Bulk liquid</b> (delivered by truck or rail tanker) - continued		
	<b>Backflow prevention</b>	<ul style="list-style-type: none"> <li>• Install check valve on delivery lines.</li> <li>• Install backflow preventer on the water lines into facility prior to any process water connection lines.</li> </ul>
	<b>Security</b>	<ul style="list-style-type: none"> <li>• Install locking valves on delivery lines.</li> <li>• Proper lighting should be provided throughout the facility to ensure a secure, free movement of personnel and to carry out proper inspections.</li> </ul>
	<b>Overflow prevention</b>	<ul style="list-style-type: none"> <li>• Provide maximum visibility of the delivery system from the point of off-loading.</li> <li>• Use audible alarms to detect tank overflow during delivery.</li> </ul>
	<b>Emergency response</b>	<ul style="list-style-type: none"> <li>• Provide accessible storage for spill-response equipment, absorbent and personal protection equipment.</li> <li>• Provide appropriate measures for fire detection and suppression, as well as for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge.</li> <li>• Provide appropriate signalization of fire control equipment.</li> <li>• Install a telephone or other voice communication system and manual alarm switch near the off-loading area.</li> </ul>
<b>Containerized liquid</b> (drums)		
	<b>Objective:</b>	Provide an off-loading area that enhances spill prevention and containment.
	<b>National Fire Code of Canada 2010</b>	<ul style="list-style-type: none"> <li>• For flammable and combustible liquids, refers to acceptable solutions in Division B, Subsection 4.1.6 – Spill Control and Drainage Systems,</li> </ul>
	<b>Off-loading pad/shelter</b>	<ul style="list-style-type: none"> <li>• Provide an off-loading area near the storage area.</li> </ul>
	<b>Containment</b>	<ul style="list-style-type: none"> <li>• Ensure containment for a worst-event spill (e.g. 4 drums or 1 pallet load).</li> </ul>
	<b>Surfaces</b>	<ul style="list-style-type: none"> <li>• Provide a sealed surface; can be considered as a secondary containment for pad requirement.</li> <li>• Provide for containment with smooth surfaces for easy cleanup.</li> </ul>
	<b>Container handling</b>	<ul style="list-style-type: none"> <li>• Design for safe manipulation of containers.</li> </ul>
	<b>Access</b>	<ul style="list-style-type: none"> <li>• Locate off-loading area away from high yard traffic routes.</li> <li>• Restrict access to all unnecessary personnel during delivery.</li> </ul>
	<b>Emergency response</b>	<ul style="list-style-type: none"> <li>• Provide accessible storage for spill-response equipment, absorbent and personal protection equipment.</li> <li>• Provide appropriate measures for fire detection and suppression, as well as for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge.</li> <li>• Provide appropriate signalization of fire control equipment.</li> <li>• Install a telephone or other voice communication system and manual alarm switch near the off-loading area.</li> </ul>



**Table 10. Recommended Design Features for Chemical Delivery Areas (continued)**

Delivery format	Design feature	Recommendations
<b>Bulk Solid</b> (bags, containers for flakes or solid blocks)		<b>Objective:</b> Provide an off-loading area that promotes spill prevention and provides containment for and facilitates cleanup of spilled material
	<b>National Fire Code of Canada 2010</b>	<ul style="list-style-type: none"> <li>For flammable and combustible solid, refers to acceptable solutions in Division B, Subsection 4.1.6 – Spill Control and Drainage Systems,</li> </ul>
	<b>Off-loading area/shelter</b>	<ul style="list-style-type: none"> <li>Provide a dry, paved/concrete off-loading area with protection from the weather, preferably near the storage area.</li> </ul>
	<b>Containment</b>	<ul style="list-style-type: none"> <li>Provide for containment of a worst event spill of solids chemical (e.g. from dropped pallet load).</li> </ul>
	<b>Area cleanup</b>	<ul style="list-style-type: none"> <li>Provide a vacuum cleaner system (with proper filtered exhaust) for cleanup of solids spilled during unloading and transfer operations.</li> </ul>

**Table 11. Recommended Design Features for Chemical Storage Areas (All Preservatives)**

Storage format	Design feature	Recommendations
<b>Bulk liquids</b> <ul style="list-style-type: none"> <li>• Solvents</li> <li>• Concentrates</li> <li>• Working solutions</li> <li>• Contaminated surface runoff</li> <li>• Contaminated liquids</li> <li>• Drip return</li> <li>• Additives</li> </ul>		<b>Objectives:</b> <ul style="list-style-type: none"> <li>◊ Provide positive spill prevention features.</li> <li>◊ Provide spill containment capability</li> </ul>
	<b>National Fire Code of Canada 2010</b>	<ul style="list-style-type: none"> <li>• Refers to acceptable solutions for <ul style="list-style-type: none"> <li>◦ Indoor and Outdoor Storage: Division B, Part 3</li> <li>◦ Flammable and Combustible Liquids: Division B, Part 4</li> <li>◦ Install acceptable provisions for electric bonding to prevent static as per NFCC.</li> </ul> </li> </ul>
	<b>Tanks</b>	<ul style="list-style-type: none"> <li>• Engineer construction materials and dimensions in accordance with chemical suppliers and applicable codes and standards (potential standards*: ASME, CSA and API standards).</li> <li>• Provide tanks in sound physical condition, with no rust or serious physical damage. Tanks must be certified and deemed suitable for the intended use by an external accredited testing company or agency.</li> <li>• Mount tanks on containment pad surfaces.</li> <li>• Subsurface storage tanks should not be used</li> <li>• Mount tanks in stable positions and anchor securely.</li> <li>• Locate tanks within a dyked area.</li> <li>• Shelter from the weather (where appropriate) and protect from mechanical impact, vandalism.</li> <li>• Protect against freezing (as recommended for external tanks).</li> <li>• Provide means for detecting leaks in insulated tanks (e.g. identify inspection points, undertake regular leakage tests).</li> <li>• Evaluate and provide means of controlling contaminated surface waters (e.g. roofing of tanks, runoff water treatment).</li> <li>• Vent interior tanks to the exterior or into a dedicated overflow tank (<b>never</b> vent directly into the workplace): <ul style="list-style-type: none"> <li>– protect vents against release of entrained liquids or overflow (e.g. direct overflow piping to sumps or containment areas).</li> </ul> </li> </ul>
	<b>Location</b>	<ul style="list-style-type: none"> <li>• Provide safe, easy access to the mixing area (design to contain and facilitate cleanup of spills, dust/flakes lost during transit to the mixing area).</li> </ul>
	<b>Ventilation</b>	<ul style="list-style-type: none"> <li>• Provide adequate ventilation for routine operations and emergency situations.</li> <li>• Provide appropriate measures to control vapours in enclosed buildings (e.g. water spray and/or ventilation)</li> </ul>

**Table 11. Recommended Design Features for Chemical Storage Areas (continued)**

Storage format	Design feature	Recommendations
<b>Bulk liquids</b> (continued)	<b>Spill containment</b>	<ul style="list-style-type: none"> <li>• Install impervious, structurally sound floors.</li> <li>• Provide structurally sound dykes, seal all joints.</li> <li>• Provide a dyked containment volume capability of 110% of the volume for a single tank, and in multiple tank containment provide 100% of the largest tank plus 10% of the aggregate volume of the remaining tanks or 110% of the largest tank, whichever is greater (11).</li> <li>• Engineer containment for long-term integrity (leak-proof for infiltration and exfiltration).</li> <li>• Provide either an impermeable top coat to floors and dykes or a liner under the containment area.</li> <li>• Evaluate and provide means for detecting subsurface leakage from containment systems.</li> <li>• Provide for directing all spills, washes and infiltrating water to tanks (contaminated liquids must be treated to applicable limit before discharge).</li> <li>• Provide effective capability for transferring spilled liquids from containment areas.</li> <li>• Provide surface drainage to prevent pooling of minor spills and washdowns.</li> <li>• Design to minimize tracking of fluids from containment surfaces.</li> </ul>
	<b>Piping and valves</b>	<ul style="list-style-type: none"> <li>• Design according to applicable codes.</li> <li>• Waterlines must comply with all applicable local codes</li> <li>• Use rigid, permanent piping throughout.</li> <li>• Provide visible, accessible piping with a simple layout (to facilitate early leak detection and easy repair).</li> <li>• Maximize above-floor piping or open containment channels for subgrade piping. <b>Do not bury</b> piping!</li> <li>• Water supply lines are to be connected to the top of tanks above the high-level alarm sensor.</li> <li>• Piping systems for material and dimensions must be properly engineered.</li> <li>• Identify piping systems and valves (e.g. by labelling and/or colour coding).</li> <li>• Provide mechanical impact protection for vulnerable exposed piping.</li> <li>• Provide freezing protection for piping as required.</li> </ul>
	<b>Backflow prevention</b>	<ul style="list-style-type: none"> <li>• Design to protect against inadvertent transfers to/from interconnected tanks.</li> <li>• Install backflow preventers on all waterlines at plant entry.</li> <li>• Use top entry of waterlines to tanks (as secondary backflow prevention).</li> <li>• Waterlines must comply with all applicable local codes</li> </ul>
	<b>Drip containment</b>	<ul style="list-style-type: none"> <li>• Provide local collection/containment (isolated from large containment areas) at drip points (e.g. under pumps, valves, flanges).</li> <li>• Store in a paved/concrete, curbed or dyked area with no floor drains: <ul style="list-style-type: none"> <li>– provide containment capacity for the worst-event spill (no fewer than 4 drums)</li> <li>– provide for effective cleanup (including recovery of washdown water) in the event of a spill.</li> </ul> </li> </ul>
	<b>Surfaces</b>	<ul style="list-style-type: none"> <li>• Seal surfaces and joints to facilitate cleaning and surface impermeability.</li> <li>•</li> </ul>

**Table 11. Recommended Design Features for Chemical Storage Areas (continued)**

<b>Storage format</b>	<b>Design feature</b>	<b>Recommendations</b>
<b>Bulk liquids</b> (continued)	<b>Spill prevention/detection</b>	<ul style="list-style-type: none"> <li>• Install reliable, accurate level indicators on all tanks.</li> <li>• Provide mechanical impact protection on glass sight gauges (including provision for containing and stopping release from broken gauge tubes).</li> <li>• Install shut-off valves on all rupturable lines and tank gauges.</li> <li>• Install permanent overflow piping from tanks directly to a definitive contained area.</li> <li>• Install reliable, independent high-level alarms on tanks (visual and audible alarm).</li> <li>• Interlock high-level alarms to tank feed pump (auto shut-off).</li> <li>• Consider installation of 24-hour monitoring alarms (with remote) for immediate detection of major spills or immediate detection of tank or pipe rupture.</li> <li>• Install emergency manual alarm button at potential major spill points.</li> </ul>
	<b>Shelter</b>	<ul style="list-style-type: none"> <li>• The preferred location for tanks containing aqueous liquids (all solutions) is in an interior centralized process area.</li> <li>• The preferred location for oil-type liquids is in an exterior centralized tank farm area.</li> <li>• If possible, roof exterior tank farms to minimize the quantity of infiltrating precipitation.</li> <li>• Provide storage in an enclosed, secure area, segregated from other chemicals for drummed liquids</li> </ul>
	<b>Security</b>	<ul style="list-style-type: none"> <li>• Provide security precautions to prevent vandalism or access by unauthorized persons.</li> </ul>
	<b>Emergency response</b>	<ul style="list-style-type: none"> <li>• Provide accessible storage for spill response equipment, absorbents and personal protection equipment.</li> <li>• Provide appropriate measures for fire detection and suppression, as well as for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge.</li> <li>• Provide appropriate signalization of fire control equipment.</li> <li>• Install a telephone or other voice communication system and manual alarm switch near the off-loading area.</li> </ul>
<b>Drummed, Bagged solids</b>	<b>All features</b>	<ul style="list-style-type: none"> <li>• All feature recommendations from Bulk Liquids just above are applicable.</li> <li>• The following features are adapted for drummed solids.</li> </ul>
	<b>Shelter/containment</b>	<ul style="list-style-type: none"> <li>• Provide a contained, secured, enclosed paved/concrete area.</li> <li>• Store bags on pallets or in an area elevated from the floor.</li> </ul>
	<b>Containment/cleanup</b>	<ul style="list-style-type: none"> <li>• Provide a vacuum cleaner system (with filtered exhaust) for cleanup of solids spilled during unloading and transfer operations.</li> </ul>

\*Standards : ASME: American Society of Mechanical Engineers, API: American Petroleum Institute, CSA: Canadian Standards Associations

**Table 12. Recommended Design Features for Chemical Mixing Systems (All Preservatives)**

Design feature	Recommendations
<b>Objective:</b>	
<ul style="list-style-type: none"> <li>◇ Provide a mixing system with effective spill prevention features.</li> <li>◇ Provide a mixing system that minimizes worker contact with base ingredients, additives and concentrates.</li> </ul>	
<b>National Fire Code of Canada 2010</b>	<ul style="list-style-type: none"> <li>• Refers to acceptable solutions for               <ul style="list-style-type: none"> <li>○ Indoor and Outdoor Storage: Division B, Part 3</li> <li>○ Flammable and Combustible Liquids: Division B, Part 4</li> </ul> </li> </ul>
<b>Configuration</b>	<ul style="list-style-type: none"> <li>• Use permanent, closed systems (rigidly piped, tank to tank).</li> </ul>
<b>Location / shelter</b>	<ul style="list-style-type: none"> <li>• Locate in a contained area.</li> <li>• Provide protection against freezing (as applicable).</li> </ul>
<b>Spill prevention</b>	<ul style="list-style-type: none"> <li>• Install high-level alarms to prevent work tank overflow.</li> <li>• Interlock high-level alarms to tank feed pumps.</li> <li>• Consider installation of 24-hour monitoring alarms (with remote) for immediate detection of major spills (at containment).</li> </ul>
<b>Spill containment</b>	<ul style="list-style-type: none"> <li>• Provide all applicable features for spill containment of bulk liquids described in Table 11.</li> </ul>
<b>Drip containment</b>	<ul style="list-style-type: none"> <li>• Provide local drip collection at all potential drip points.</li> </ul>
<b>Splash protection</b>	<ul style="list-style-type: none"> <li>• No open transfer of treating solutions or additives is allowed.</li> </ul>
<b>Ventilation</b>	<ul style="list-style-type: none"> <li>• Provide adequate ventilation in the mixing area for routine operations and emergency situations</li> <li>• Work tank should be vented outside the workplace. Encourage to vent the work tank into a dedicated overflow tank, vented outside, to prevent releases of entrained liquids or overflow.</li> </ul>
<b>Tanks / Mixing vessels</b>	<ul style="list-style-type: none"> <li>• Encourage the use of mechanized transfer equipment to minimize worker exposure.</li> </ul>
<b>Emergency response</b>	<ul style="list-style-type: none"> <li>• Provide accessible storage for spill-response equipment, absorbent and personal protection equipment.</li> <li>• Provide appropriate measures for fire detection and suppression, as well as for rapid, effective fire control with containment of liquid firefighting residues and treatment to required limits before discharge.</li> <li>• Provide appropriate signalization of fire control equipment.</li> <li>• Install a telephone or other voice communication system and manual alarm switch</li> <li>• Provide features described in "Environmental Emergency Notification and Contingency Planning" Section 12.</li> </ul>

**Table 13. Recommended Design Features for Treatment Process Systems (All Preservatives)**

Design feature	Recommendations
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>◊ Minimize and contain all releases of preservative chemicals.</li> <li>◊ Recover and recycle releases that occur.</li> </ul>	
<b>Spill containment</b>	<ul style="list-style-type: none"> <li>• Provide spill containment capability of 110% of the volume for a single tank, and in multiple tank containment provide 100% of the largest tank plus 10% of the aggregate volume of the remaining tanks or 110% of the largest tank, whichever is greater.</li> <li>• Locate treatment cylinders and process tanks in an area with <ul style="list-style-type: none"> <li>– continuous, structurally sound concrete floors or with slabs or sections with sealed joints;</li> <li>– sealed surfaces for impermeability and ease of cleaning;</li> <li>– reinforced dyke walls and sealed joints;</li> <li>– graded surfaces for ready drainage of wetted surfaces; and</li> <li>– walkway grates (or alternative design) to minimize worker exposure and prevent tracking of chemicals from containment areas — keep surfaces clean.</li> </ul> </li> <li>• Provide either an impermeable top coat to floors and dykes or a liner under the containment area.</li> <li>• Engineer containment for long-term integrity (leak-proof for infiltration and exfiltration).</li> <li>• Provide permanent, isolated drainage/transfer systems to direct all spills, washes and infiltrating water to tanks. Treat contaminated liquids to applicable limits before discharge.</li> <li>• Isolate control and transfer equipment to avoid damage from spilled liquids in containment areas.</li> </ul>
<b>Process control area</b>	<ul style="list-style-type: none"> <li>• Segregate the operator control area from retort and tank spill containment areas.</li> <li>• Locate the process control area for maximum visibility of treatment systems.</li> <li>• Provide proper lighting in all operating areas.</li> </ul>
<b>Process emissions to air</b>	<ul style="list-style-type: none"> <li>• Provide control equipment for air emissions including tank emissions and any emissions subject to environmental controls: <ul style="list-style-type: none"> <li>– prevent worker exposure to vacuum pump exhausts;</li> <li>– install additional control equipment as required to comply with applicable air emissions limits;</li> <li>– provide traps on vents to remove entrained liquids or overflow;</li> <li>– assess levels of air contaminants in the workplace and provide ventilation in areas where excessive levels may occur; and</li> <li>– where applicable, condense emissions and return to storage.</li> </ul> </li> <li>• Pumps, tanks, cylinders and other exhausts should be vented to the exterior. Interior equipment may be vented to a dedicated overflow tank, which should have an exterior vent designed to prevent the release of entrained liquids or overflow.</li> <li>• Equipment should not vent directly into the workplace.</li> </ul>
<b>Fire control</b>	<ul style="list-style-type: none"> <li>• Refers to acceptable solutions in Division B, Part 5 of the <i>National Fire Code of Canada 2010</i>.</li> <li>• Provide appropriate site-specific rapid and effective fire control measures, in consultation with the local fire department, for fire detection and suppression.</li> <li>• Provide containment of liquid firefighting residues and treatment to required limits before discharge (e.g. blockage of storm drains, adjacent ditches).</li> <li>• Provide appropriate identification of fire control equipment.</li> </ul>

**Table 13. Recommended Design Features for Treatment Process Systems (continued)**

<b>Design feature</b>	<b>Recommendations</b>
<b>Objectives:</b> <ul style="list-style-type: none"><li>◇ Provide fail-safe operation of the treatment system.</li><li>◇ Minimize the potential for preservative spills.</li></ul>	
<b>Weather protection (winter operations)</b>	<ul style="list-style-type: none"><li>• Protect equipment from freezing temperatures, particularly where water is or may be present.</li><li>• Winterize process control area.</li></ul>
<b>Treatment cylinder</b>	<ul style="list-style-type: none"><li>• Treatment cylinder and pressurized components must meet all pressure vessel certifications stipulated by the provincial ministry responsible for such certification or by insurance requirements if there are no provincial requirements. If no requirements exist, then annual testing is required.</li><li>• Install an effective protection device to prevent doors opening when the cylinder is pressurized or filled with preservative:<ul style="list-style-type: none"><li>– provide independent backup protection.</li></ul></li><li>• Install independent indication and/or alarm/interlocks between the cylinder door and the control point.</li><li>• Design to facilitate drainage of excess preservative.</li></ul>
<b>Piping and recycle systems</b>	<ul style="list-style-type: none"><li>• Design an overall system that is effective at containing and recycling all chemicals with minimum potential for release and dispersal and minimum infiltration of water.</li><li>• Select and install piping as per Table 11.</li></ul>
<b>Sumps</b>	<ul style="list-style-type: none"><li>• Provide leak-proof design (e.g. impermeable surfaces, sealed joints).</li><li>• Provide a tertiary containment for sumps (e.g. steel lining or other suitable materials or devices) in addition to the concrete containment and impermeable liner or coating.</li><li>• Provide overflow protection if sump is not in containment area (e.g. install independent high-level alarms).</li></ul>
<b>Process controls</b>	<ul style="list-style-type: none"><li>• Design for simple, unambiguous operation (regardless of the degree of automation).</li><li>• Establish a clear relationship between process controls and process functions in order to minimize operator error.</li></ul>
<b>Ventilation</b>	<ul style="list-style-type: none"><li>• Provide adequate routine and emergency ventilation to control preservative component vapour levels in all work areas.</li></ul>

**Table 14. Recommended Design Features for Freshly Treated Wood Drip Areas**  
(All Preservatives)

Design feature	Recommendations
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>◊ Minimize losses of preservative chemicals from treated wood to the environment by <ul style="list-style-type: none"> <li>- providing adequate controls to ensure minimization of preservative drippage prior to removal to unprotected storage areas; and</li> <li>- controlling the generation and disposal of contaminated runoff waters.</li> </ul> </li> </ul> <p>(For accelerated stabilization or fixation process, please refer to Table 15)</p>	
<b>National Fire Code of Canada 2010</b>	<ul style="list-style-type: none"> <li>• Refers to acceptable solutions in Division B, Section 5.4.</li> </ul>
<b>General design</b>	<ul style="list-style-type: none"> <li>• Consider integrated design provisions for <ul style="list-style-type: none"> <li>- area that is sheltered from precipitation, dust, debris;</li> <li>- efficient drip and runoff collection and containment;</li> <li>- surface drainage and return of fluids to process with minimum dispersal from tracking by personnel and vehicles;</li> <li>- adequate air flow to maintain preservative constituent levels in the air below regulated limits; and</li> <li>- exhaust fans, ventilation fans, or water sprays to aid in air flow.</li> </ul> </li> </ul>
<b>Drip area and containment</b>	<ul style="list-style-type: none"> <li>• Provide a sufficiently sized and contained area to hold all freshly treated wood for the appropriate time for each preservative.</li> <li>• Provide a roofed drip pad for waterborne preservative</li> <li>• Provide impermeable and curbed charge unloading and drip areas, sloped to enable collection and storage of all runoff and infiltrating precipitation (for reuse or controlled discharge under terms of existing regulatory standards).</li> <li>• Provide drip areas with either an impermeable top coating on floors and dykes/berms or a liner underneath.</li> </ul>



**Table 15. Recommended Design Features for Kilns and Accelerated Fixation Areas**  
(All Preservatives)

<b>Design feature</b>	<b>Recommendations</b>
<b>Objectives:</b>	
<ul style="list-style-type: none"> <li>◇ Minimize losses of preservative chemicals from treated wood to the environment by <ul style="list-style-type: none"> <li>- providing adequate controls to ensure minimization of preservative drippage prior to removal to unprotected storage areas.</li> </ul> </li> <li>◇ Ensure fixation/stabilization of preservative prior to release to uncontained storage area.</li> <li>◇ Reduce the time required for fixation/stabilization from that required for ambient fixation/stabilization.</li> </ul>	
<b>General design</b>	<ul style="list-style-type: none"> <li>• Consider integrated design provisions for <ul style="list-style-type: none"> <li>- area that is sheltered from precipitation, dust, debris;</li> <li>- adequate air flow;</li> <li>- sufficient heat and humidity to achieve fixation or promote stabilization.</li> </ul> </li> </ul>
<b>Drip and containment</b>	<ul style="list-style-type: none"> <li>• Should have an impermeable floor and be designed so that any residues may easily be cleaned up.</li> <li>• Should be fully contained with sufficient grade and an efficient drainage system to direct any free liquid to a collection and recycling system.</li> <li>• Fluids should be returned to the treatment process with minimum dispersal from tracking by personnel and vehicles.</li> </ul>

**Table 16. Recommended Design Features for Treated Wood Storage Areas**

(All Preservatives)

Design feature	Recommendations
<b>Objective:</b>	Minimize and control releases of contaminated surface waters from treated wood storage areas.
<b>Storage areas</b>	<ul style="list-style-type: none"><li>• <i>Where applicable, fix or stabilise the preservative or dripping must be stopped prior to yard storage.</i></li><li>• Store treated wood under roof or wrap and provide impermeable flooring where leaching may cause excessive runoff or ground contamination.</li><li>• Elevate treated wood packages above the ground by placing them on supports (stringers) to avoid treated wood contact with runoff water. Stringers must be a minimum of 6 inches high for CEPA toxic preservatives. Lower stringers are possible if the storage ground is paved and well maintained (no excessive depressions and bumps, well plowed in winter) as this will minimize contact with runoff water.</li><li>• Maintain minimum inventories of treated wood.</li><li>• Segregate treated wood storage areas from untreated wood storage areas to minimize potential impacts to soil, groundwater or surface water.</li><li>• Locate unsurfaced ground storage areas away from surface water bodies.</li><li>• Routinely monitor contaminant levels in storage area runoff.</li><li>• Evaluate options for storage area surfaces on the basis of factors such as groundwater, usage, probability of bleeding/leaching and expected levels of precipitation (large paved areas will result in large quantities of runoff waters but may be necessary if groundwater is used for drinking water supply).</li><li>• Refers to acceptable solutions in Division B, Part 3 – Indoor and Outdoor Storage of the <i>National Fire Code of Canada 2010</i>.</li></ul>

Users should refer to their provincial authorities, as these authorities may have additional design requirements that apply to their facilities.

#### **7.4.1 Access and security design features**

In order to prevent unauthorized access to the facility site, a restriction system and an access procedure should be in place. This design features are safety measures to avoid potential exposures and to restrict their access. Valves and any sensitive equipment or area like the chemical storage that could cause the release of chemical, should also be secured (locked) to prevent unauthorised access or usage.

## 8 Operational Recommendations



### Workplace Hazardous Materials Information System (WHMIS)

In addition to the design objectives described in Section 7, a preservation facility should develop operating procedures to protect both workers and the environment from harmful exposure to preservative chemicals. The following protective measures recommended in this document **MUST** be used in conjunction with those provided on the pesticide label regulated by the PMRA under the *Pest Control Products Act*. All conditions on the pesticide label **MUST** be met.

The operating procedures are intended to:

- a) minimizes direct contact of personnel with wood-preserving chemicals;
- b) minimizes releases of chemicals to the environment; and
- c) facilitates clear and accurate plan and procedures in emergency situation.

Table 5 to 8 and table 17 to 26 provides the objectives and recommendations on the operational features of a wood preservation facility that use a typical process in handling and application of preservatives, as presented in [Figure 1](#). All new and existing wood preservation facilities should meet all the objectives and apply all the recommendations presented in these tables or apply alternative measures that meet the equivalent level of protection while taking into consideration certain site-specific considerations.

Detailed operating procedures for each process should be incorporated into an operations manual available to all personnel. Responsibility and accountability for how to implement these procedures should be clearly assigned to supervisors and on-site personnel. These recommendations should be included in the worker training program.

### 8.1 Operational Standards

The CSA O80 Series of Standards specifies requirements and recommendations related to some wood preservatives and are based solely on the treatment efficacy of the chemicals in question. Those standards should be followed and applied while respecting applicable laws and regulations.

The Workplace Hazardous Materials Information System (WHMIS) is Canada's hazard communication standard. The key elements of the system are cautionary labelling of containers of WHMIS "controlled products", the provision of material safety data sheets (MSDSs) and worker education programs.



Occupational health and safety is covered by provincial and territorial as well as federal governments which place an onus on employers to ensure that: all controlled products used, stored, handled or disposed of in the workplace are properly labelled; MSDSs are made available to workers; and workers receive education and training to ensure the safe storage, handling and use of controlled products in the workplace. (12)

WHMIS requirements are available at the Health Canada's website and user should refer to the Health Canada's website for more information on WHMIS: [http://www.hc-sc.gc.ca/ewh-sent/occup-travail/whmis-simdut/about-a\\_propos-eng.php](http://www.hc-sc.gc.ca/ewh-sent/occup-travail/whmis-simdut/about-a_propos-eng.php)

## 8.2 Facility Wide Recommendations

The following table 17 and 18 provides recommendations on the operational features of a wood preservation facility that are applicable to the facility level.

**Table 17. Recommended Operations Manual**

(All Preservatives)

Operation	Recommendations
<b>Operations Manual</b>	
<b>Objective:</b>	Provide written instructions to employees on all aspects of chemical use.
Operations Manual	<ul style="list-style-type: none"><li>• A current, site-specific manual should be available containing clear instructions for all aspects of chemical use, plant operation, equipment maintenance, housekeeping, accident prevention, first aid and emergency response procedures, and all applicable regulations.</li><li>• The manual should be readily available to all employees.</li><li>• Operations manual content should include<ul style="list-style-type: none"><li>○ Training programs that should be plant-specific and should at least include the following<ul style="list-style-type: none"><li>▪ training in all aspects of chemical use and plant operation</li><li>▪ chemical substances and their hazards, including personal hygiene</li><li>▪ safe operation and maintenance of equipment and processes</li><li>▪ spill and fire prevention procedures</li><li>▪ proper use of personal protective equipment</li><li>▪ proper use of all safety equipment for controlling spills and fires</li><li>▪ emergency response and first aid and rescue procedures</li><li>▪ handling, storage and disposal of waste material</li><li>▪ confined space protocol for tank entry (OSHA)</li><li>▪ annual updates, or when there has been a change in job responsibilities, procedures or equipment</li><li>▪ individual employee training records.</li><li>▪ employees' sign off on training received.</li></ul></li><li>○ Facility and plant description<ul style="list-style-type: none"><li>▪ up-to-date figures (blueprints) of the facility including emergency equipment location, access and circulation point and current specifications for all equipment.</li></ul></li><li>○ Personal protection equipment requirements</li><li>○ Chemical use procedure</li><li>○ Station operation procedure</li><li>○ Accident prevention program</li><li>○ First aid and emergency response procedures</li><li>○ Spill and fire contingency procedures</li><li>○ Monitoring program<ul style="list-style-type: none"><li>▪ chemical substance</li><li>▪ environmental</li><li>▪ workers' health</li></ul></li><li>○ Applicable regulations and reporting schedule</li><li>○ <b>Preventive maintenance program (PMP)</b><ul style="list-style-type: none"><li>▪ <i>Refer to the recommended detailed PMP in <a href="#">Appendix II</a></i></li></ul></li><li>○ Documentation and housekeeping procedures</li></ul></li></ul>

**Table 18. Recommended General Practices for Operating Wood Preservation Facilities**

(All Preservatives)

Operation	Recommendations
<b>Personnel</b>	<p><b>Objective:</b> Enhance worker protection by providing education and medical surveillance.</p> <ul style="list-style-type: none"> <li>• Train all forepersons, on-scene supervisors, operators and handlers in good work practices.</li> <li>• Provide periodic (at least annually or if there is a change in operations) review and update of education and training.</li> <li>• Provide pre-employment medical check-up and annual ongoing medical surveillance (see Sections 4 and 6). Surveillance frequency may be modified by the occupational physician.</li> <li>• Keep records of training sessions and individual employee training.</li> </ul>
<b>Procedures</b>	<p><b>Objective:</b> Ensure that worker responsibilities are well understood, and that site-specific procedures are available in hard copy for reference.</p> <ul style="list-style-type: none"> <li>• Prepare (and have readily available) explicit written instructions for all aspects of chemical use, facility operation, maintenance and emergency response.</li> <li>• Identify and communicate precautions for all other on-site handlers of treated wood (including quality control personnel, sorters and transporters).</li> </ul>
<b>Signing*</b>	<p><b>Objective:</b> Ensure clear and accurate signage at all wood preservation use areas.</p> <ul style="list-style-type: none"> <li>• Identify the contents of all tanks (e.g. CCA work tank, PCP oil storage tank).</li> <li>• Identify the function of each tank (e.g. concentrate tank, work tank).</li> <li>• Prominently display personnel safety precautions and first aid procedures.</li> <li>• Prominently display emergency response procedures.</li> <li>• Prominently display emergency telephone numbers for medical aid, facility management and local environmental control agencies.</li> <li>• Clearly identify emergency alarm switch to avoid confusion with process equipment control switch.</li> </ul>
<b>Personal hygiene and safety precautions</b>	<ul style="list-style-type: none"> <li>• Follow precautions outlined in Section 6.1 <a href="#">Table 6</a> and Section 6.3 <a href="#">Table 8</a>.</li> </ul>
<b>Housekeeping</b>	<p><b>Objective:</b> Maintain a clean, orderly site.</p> <ul style="list-style-type: none"> <li>• Define and practice regular housekeeping standards (suggest daily): <ul style="list-style-type: none"> <li>– contain all contaminated debris</li> <li>– minimize generation and accumulation of wastes, such as empty drums and containers (provide secure designated storage or dispose of in the appropriate manner).</li> <li>– minimize dust generation and accumulation. Avoid dust cloud formation with machinery circulation.</li> </ul> </li> <li>• Visually inspect for, record and report leaks routinely as defined in the facility's procedure manual (preferably daily).</li> <li>• Contain and repair leaks promptly.</li> </ul>

\* All signage is preferably done in accordance with Workplace Hazardous Materials Information System (WHMIS) requirements. (Note: At this time, wood preservation chemicals are not yet included under WHMIS legislation.)

**Table 18. Recommended General Practices for Operating Wood Preservation Facilities**  
(continued)

Operation	Recommendations
<b>Record keeping</b>	<p><b>Objectives:</b></p> <ul style="list-style-type: none"> <li>◇ Provide a secondary level of control for chemical losses.</li> <li>◇ Enable a rapid assessment of potential hazards, in the event of a catastrophic incident (e.g. tank rupture, fire).</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• Maintain accurate daily records for               <ul style="list-style-type: none"> <li>– chemical delivery, use and inventory; and</li> <li>– equipment condition and maintenance.</li> </ul> </li> <li>• Record and compare bulk tank volumes before and after facility shutdowns in excess of two days.               <ul style="list-style-type: none"> <li>– If changes in volume are apparent, check for tank leaks and/or irregular practices.</li> </ul> </li> <li>• Record alarm tests and ensure proper functioning.</li> </ul>
<b>Spill response</b>	<p><b>Objective:</b> Maintain a state of readiness to implement the plan in case of a chemical spill.</p> <hr/> <ul style="list-style-type: none"> <li>• Establish a spill contingency plan (see Section 12.2).</li> <li>• Carry out spill response drills.</li> </ul>
<b>Firefighting</b>	<p><b>Objective:</b> Maintain a state of readiness in case of fire emergency as per the <i>National Fire Code of Canada</i>.</p> <hr/> <ul style="list-style-type: none"> <li>• Refers to Division B, Section 2.8 – Emergency Planning, and any other applicable acceptable solutions for “fire safety plan” in Parts 3, 4 and 5 of the <i>National Fire Code of Canada 2010</i>.</li> <li>• Establish a fire contingency plan (Section 12.3) and maintain a state of readiness to implement the plan in case of fire emergency (including routine checks of the pressure and proper function of firefighting equipment; drills with all affected personnel in cooperation with the local fire department).</li> <li>• Communicate with the local fire department about chemicals in storage and use and emergency procedures.</li> <li>• When a fire alarm call is made, notify firefighters of chemical quantities in stock and verify the status quo of storage locations.</li> <li>• Only trained and properly equipped firefighting personnel should be allowed at the fire scene.</li> <li>• Make advance preparation to contain and properly dispose of contaminated fire residues to the greatest degree possible:               <ul style="list-style-type: none"> <li>– Runoff water, soot and ash from fire areas are presumed to be contaminated and provision should be made to contain these residues.</li> <li>– Analyze fire residues and involved ground soils (as applicable) to determine the need for and scope of special cleanup and disposal activities.</li> <li>– Dispose of contaminated firefighting waters as “contaminated runoff.”</li> <li>– Dispose of solid treated wood fire residues as “contaminated solid wastes.”</li> </ul> </li> </ul>

### 8.3 Process Area-specific Recommendations

**Table 19. Recommended Operating Practices for Chemical Handling and Storage**  
(All Preservatives)

Operation	Recommendations
<b>Unloading chemicals</b>	<p><b>Objective:</b> Ensure that unloading of treatment chemicals occurs in a safe manner.</p> <ul style="list-style-type: none"> <li>• Refers to Division B, Parts 3 and 4 of the <i>National Fire Code of Canada 2010 (NFCC)</i>.</li> <li>• Ensure that the delivery of preservation chemicals to the facility is undertaken by personnel who are trained in emergency response procedures as required by the <i>Transportation of Dangerous Goods Regulations (TDGR)</i>, Part 6.</li> <li>• Ensure that personnel with recognized first aid training are on-site at the facility during the unloading procedure (personnel can include the truck driver).</li> <li>• Ensure that ready access to emergency advice and aid is available during all chemical unloading periods. <ul style="list-style-type: none"> <li>– i.e. train employees in standard procedures for normal operations, as well as for emergencies, and post procedures in printed form for reference (NFCC and TDGR).</li> </ul> </li> <li>• Restrict access to the unloading area during chemical transfer operations. Prohibit nearby pedestrian or vehicle traffic.</li> <li>• Keep incompatible materials away from unloading and bag storage areas.</li> <li>• Retain package integrity and handle bags on a first-in, first-out basis.</li> <li>• Bags, wraps, drums, pallets, hooks, etc. should be cleaned, stored and disposed of in accordance with provincial regulatory requirements. <ul style="list-style-type: none"> <li>– Materials used in the shipment of preservatives or other chemicals should be returned to the supplier, wherever possible (see Section 9).</li> </ul> </li> <li>• Tank volumes should be verified and documented before chemical unloading commences to insure tank has sufficient volume to contain load.</li> </ul>
<b>Preparation of wood preservation solutions</b>	<p><b>Objective:</b> Ensure worker safety during handling of treatment chemicals.</p> <ul style="list-style-type: none"> <li>• Follow the personnel safety precautions for all procedures (Tables 6 and 8).</li> <li>• Use proper PPE for all additives and solvent as identified in the respective label/MSDS.</li> <li>• Avoid inhalation of, ingestion of, or skin or eye contact with all preservative chemicals.</li> <li>• Thoroughly empty and clean preservative containers (if applicable): <ul style="list-style-type: none"> <li>– recycle rinse water (for water-borne formulations)</li> <li>– return containers to suppliers or reuse sound containers for storage of wastes</li> <li>– dispose of unusable containers only in landfills specifically approved for such disposal (Section 9).</li> </ul> </li> </ul>



**Table 19. Recommended Operating Practices for Chemical Handling and Storage  
(continued)**

Operation	Recommendations
<b>Storage of wood preservation chemicals</b>	<p><b>Objective:</b> Ensure that all preservative chemicals are safely stored.</p> <hr/> <ul style="list-style-type: none"> <li>• Refers to Division B, Parts 3 and 4 of the <i>National Fire Code of Canada 2010</i>.</li> <li>• Assign responsibility for storage areas to trained personnel.</li> <li>• Label storage tanks, identifying contents by chemical name, type of solution and concentration: e.g. CCA concentrate (50%), CCA work solution (1% to 4%).</li> <li>• The current pesticide label must be on the concentrate tank.</li> <li>• Place chemical identity placards, fire or spill emergency response procedures, personnel safety precautions and first aid procedures at storage room entrances.</li> <li>• Check and maintain the integrity of storage tanks and storage containers: <ul style="list-style-type: none"> <li>– clean up all leaks or spills and implement remedial actions immediately.</li> <li>– Implement visual inspection routine (See Table 17. Recommended Operations Manual and the following Table 20)</li> </ul> </li> <li>• Provide secure storage areas; restrict access to authorized personnel only.</li> <li>• Prevent concentrate from contacting any flammable liquids (such as fuels, lubricants, paints, etc.) or from coming in contact with galvanized metal, aluminium, brass, zinc, sawdust and shavings.</li> </ul> <hr/>

**Table 20. Recommended Operating Practices for Process Systems (All Preservatives)**

Operation	Recommendation
<b>Routine checks</b>	<b>Objective:</b> Define procedural practices that will enhance environmental and worker safety.
Worker safety	<ul style="list-style-type: none"><li>Follow the personnel safety precautions for all procedures from <b>Tables 6</b> and <b>Table 8</b>.</li><li>Procedure for operating practices should be available to workers.</li></ul>
Work solutions	<ul style="list-style-type: none"><li>Regularly check and record quantities of treatment solution in storage.</li><li>Test and record solution strengths at regular intervals.</li><li>Take necessary measures to prevent solution contamination.</li></ul>
All process components	<ul style="list-style-type: none"><li>Condition wood adequately to minimize after-bleeding.</li><li>Visually check the complete system for leaks: take immediate action to stop leaks.</li><li>Check sludge levels in retorts: clean out as appropriate, in accordance with facility policy, observe personnel safety precautions.</li></ul>
Tank vents	<ul style="list-style-type: none"><li>Test tank vents to ensure they are not blocked (suggest once/year).</li></ul>
Charges	<ul style="list-style-type: none"><li>Secure loads to avoid uncontrolled floating and jamming.</li><li>Stack loads to allow good drainage of preservative from all wood surfaces after treatment.</li></ul>
Treating cylinder	<ul style="list-style-type: none"><li>Check door seals for damage and wear: replace door seals at regular intervals or as required if damaged or worn.</li><li>Check cylinder doors for proper seal after loading charges: ensure that all bolts on doors are securely fastened or that the hydraulic collar has moved to its regular endpoint.</li><li>Recommend that a final vacuum process be applied after completion of the pressure cycle.</li></ul>
Recycle systems	<ul style="list-style-type: none"><li>Check filters: clean or replace if necessary.</li></ul>
Trams	<ul style="list-style-type: none"><li>Clean soil and debris from trams to prevent contamination of the preservative.</li><li>Use tram design that will facilitate ready drippage during “drain” stage.</li><li>Thoroughly clean trams before alternative preservative treatments are used.</li></ul>

**Table 20. Recommended Operating Practices for Process Systems (Continued)**

Operation	Recommendation
<b>Checks during treatment</b>	Objective: Monitor the treatment system to quickly identify potential/actual problems.
System integrity	<ul style="list-style-type: none"> <li>• Process controls should be installed, maintained and calibrated in accordance with the proper standards and/or the supplier directions.</li> <li>• Closely monitor process systems for leaks during initial stages of treatment.</li> <li>• Check for leaks or abnormal conditions throughout pressurized system at least once per shift or once per charge (whichever is more frequent).</li> <li>• Frequently inspect and test all safety shutoff valves and other fire safety devices.</li> <li>• Compare recording instrument readings with indicating gauges and thermometers.</li> <li>• Note malfunctions of recording devices, thermometers, gauges (including level floats) and arrange for prompt repairs.</li> <li>• Carefully observe pressures during treatment to make certain that maximum limits are not exceeded (maintain records of treatment cycles, tank gauge readings and chemical consumption).</li> <li>• Define (in writing) operator actions for abnormal situations of concern (e.g. response to equipment breakdown).</li> </ul>
Treatment cylinder	<ul style="list-style-type: none"> <li>• Recommend that a final steaming/vacuum process be applied after completion of the pressure cycle to equilibrate internal wood pressure and to cool the wood.</li> <li>• Keep net retentions as close as possible to specified levels.</li> </ul>
<b>Post-treatment checks</b>	Objective: Prevent worker contact with treatment solution and with freshly discharged loads.
Retort opening	<ul style="list-style-type: none"> <li>• Ensure that retorts cannot be opened when liquid and/or pressure remains.</li> <li>• Avoid breathing preservative mists or vapours (see PPE in table 8).</li> </ul>
Charge removal	<ul style="list-style-type: none"> <li>• Pull charges only when the superficial excess preservative has sufficiently drained and the charges are essentially drip-free.</li> <li>• Consider accelerated fixation or stabilization methods to reduce potential for transfer of preservative solution to the environment.</li> </ul>
Load jams	<ul style="list-style-type: none"> <li>• Follow confined space protocol for tank entry following applicable provincial regulations (ACGIH – OSHA)* (<a href="http://www.acgih.org/">http://www.acgih.org/</a>)</li> <li>• Do not enter retorts until they are purged with fresh air (and cooled)</li> <li>• Ensure presence of and constant communication with a standby attendant.</li> <li>• Shower immediately after tank entry.</li> </ul>

\*ACGIH: American Conference of Governmental Industrial Hygienists

OSHA: Occupational Safety and Health Administration (OSHA), U.S. Department of Labor

[http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=9992](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9992)

[http://www.osha.gov/pls/oshaweb/owadisp.show\\_document?p\\_table=STANDARDS&p\\_id=9993](http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9993)

**Table 21. Recommended Operating Practices for Kiln, Accelerated Fixation Chamber and Dripping Area (All Preservatives)**

Operation	Recommendation
<b>Routine checks</b>	<b>Objective:</b> Define procedural practices that will enhance environmental and worker safety.
Worker safety	<ul style="list-style-type: none"> <li>Follow the personnel safety precautions for all procedures from <b>Tables 6</b> and <b>Table 8</b>.</li> <li>Procedure for operating practices should be available to workers.</li> </ul>
Vent	<ul style="list-style-type: none"> <li>Ensure that all vents are working properly prior to loading the charge.</li> </ul>
Charges	<ul style="list-style-type: none"> <li>Ensure that the charge is still stable (strapped).</li> </ul>
Recycle systems	<ul style="list-style-type: none"> <li>Ensure that drains or sumps are free of debris.</li> </ul>
<b>Drip free</b>	<b>Objective:</b> Monitor the charges to ensure all drippage has <b>stopped</b> (48hr may not be sufficient in certain conditions)
Condition control	<ul style="list-style-type: none"> <li>Check time.</li> <li>Minimum times have been established for some preservatives (ACQ, CA-B), while other times will be dependent on the preservative used, wood species and type of wood (posts, lumber, poles for example).</li> </ul>
Drip free	<ul style="list-style-type: none"> <li>Material can only be removed from contained area when all drippage has stopped.</li> </ul>
<b>Fixation/Stabilization</b>	<b>Objective:</b> Monitor the fixation/stabilization during and after accelerated fixation/stabilization in the chamber/kiln or drip pad.
Condition control	<ul style="list-style-type: none"> <li>Check humidity.</li> <li>Check temperature.</li> <li>Check time.</li> </ul>
Vent	<ul style="list-style-type: none"> <li>Ensure that all vents are working properly in the accelerated fixation room.</li> </ul>
Drip free	<ul style="list-style-type: none"> <li>Conduct a fixation test for CCA.</li> </ul>
Prior to yard storage	<ul style="list-style-type: none"> <li>Preservative should be fixed (for CCA) or drip free.</li> </ul>

**Table 22. Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems (All Preservatives)**

Operation	Recommendations
<b>Equipment maintenance</b>	<p><b>Objective:</b> Ensure that equipment is maintained in a manner that will minimize releases of preservative chemicals and minimize worker exposure to them and their by-products.</p> <ul style="list-style-type: none"> <li>• Maintain all equipment in good operating condition.</li> <li>• Cleaning equipment contaminated with preservative should be used only within the perimeter of the restricted/access control area of the facility.</li> <li>• Refers to applicable acceptable solution on maintenance in Division B, Parts 3 and 4 of the <i>National Fire Code of Canada</i>.</li> <li>• Should prepare explicit written maintenance procedures with assigned responsibility and accountability.</li> <li>• Follow all personnel safety precautions during maintenance procedures (Tables 6 and 8).</li> <li>• Drain and/or clean wood preservation chemicals from equipment prior to maintenance: <ul style="list-style-type: none"> <li>– Equipment should be flushed thoroughly with water, with reuse of the water for work solution preparation (where applicable).</li> </ul> </li> <li>• Use extreme caution if contaminated equipment must be welded (toxic fumes can be generated): <ul style="list-style-type: none"> <li>– Thoroughly clean surfaces to be welded.</li> <li>– Wear a NIOSH-approved respirator when welding equipment contaminated with preservatives or their components.</li> <li>– Provide good ventilation in the work area.</li> <li>– Contain all sparks and remove flammable materials from the repair area.</li> </ul> </li> </ul>
<b>Cleanout</b>	<p><b>Objectives:</b></p> <ul style="list-style-type: none"> <li>◊ Prevent accumulation of preservative solutions and sludge within the treatment system.</li> <li>◊ Ensure worker safety during cleanout operations.</li> </ul> <ul style="list-style-type: none"> <li>• Observe personnel safety precautions during all procedures (Tables 6 and 8).</li> <li>• Wash down and/or scrape drip pads at regular intervals to prevent accumulation of preservative residues. (The cleanup frequency should be determined by site-specific factors including the probability of worker exposure, vehicle traffic and washdown by rain.) <ul style="list-style-type: none"> <li>– Recover and reuse drainage from drip pads or provide appropriate treatment or disposal.</li> </ul> </li> <li>• Provide appropriate treatment for washwater (if applicable).</li> <li>• Routinely inspect sludge levels in all tanks and clean out if necessary. <ul style="list-style-type: none"> <li>– during cleanup, inspect gauge floats or similar equipment within tanks.</li> </ul> </li> <li>• Routinely inspect treatment cylinders for sludge accumulation and clean if necessary: <ul style="list-style-type: none"> <li>– Purge cylinders with fresh air sufficiently to permit entry.</li> <li>– If airborne concentrations are unknown, at, or above TLVs, the attendant should wear self-contained breathing apparatus, impermeable gloves, boots and coveralls.</li> <li>– A standby attendant should always be present and continuous communication should be provided.</li> <li>– Follow standard safety procedures for entry of confined spaces.</li> <li>– Prevent skin contact with sludge.</li> <li>– Collect, drain and store contaminated material in sealed drums pending disposal (Tables 11 and 23).</li> <li>– The attendant should shower immediately after cleaning retorts or tanks.</li> </ul> </li> </ul>
<b>Alarms and Safety Devices</b>	<ul style="list-style-type: none"> <li>• Test safety devices (e.g. interlocks, backflow preventers, monitoring equipment) at regular intervals (as specified by the manufacturer) ... and as specified in each preservative's chapters (table 22).</li> <li>• Test alarms as specified in each preservative's chapters (table 22).</li> <li>• Ensure all spill catchments materials and protective PPE are in sound condition and fully equipped accordingly to the specification of the emergency plan.</li> <li>• A spill kit accompanied with appropriate PPE should be stored in a centralized area that is within ready access to the unloading pad, tank farm, treating cylinder and waste storage area.</li> </ul>

**Table 22. Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems (Continued)**

Operation	Recommendations
<b>Long-term shutdown</b>	<p><b>Objective:</b> Ensure orderly shutdown prior to long-term closure.</p> <hr/> <ul style="list-style-type: none"> <li>• Thoroughly clean all equipment that has been in contact with preservatives.</li> <li>• Collect all solvents and washwaters generated by cleanup operations (Tables 11 and 23).</li> <li>• Hold solutions in closed tanks for prolonged shutdown: <ul style="list-style-type: none"> <li>– Drain all open tanks or sumps to closed storage tanks.</li> <li>– Ensure that temperatures in storage areas are above freezing levels or provide adequate freezing protection for all stored liquids.</li> </ul> </li> <li>• In case of permanent shutdown, arrange for reuse of solutions at another facility if possible or dispose as a hazardous waste.</li> </ul> <hr/>

## 9 Waste, Process Emissions and Disposal

The preservation of wood in treatment facilities generates liquid and solid wastes and may also produce emissions to the air. Wastes may include wood debris (treated or untreated), used filters, wraps, solution precipitates; and sludge removed from sumps, cylinders, tanks and containment areas. Other wastes include sludge from wastewater treatment processes (e.g. flocculated material) and contaminated soils. Waste minimization such as recovering and reusing preservatives should be practised to the utmost to reduce the amount of waste generated at the facility.



This section provides general recommendations on the techniques to minimize the amount of chemicals to be released from the wood preservation facility. There are numerous approaches available for control, treatment and disposal of process wastes and emissions. Due to the specific characteristics of the various preservatives, designs and operating procedures for pressure or thermal facilities, the issues are generally specific to individual facilities.

Post-use treated wood is not directly addressed in the TRD. A provisional code of practice for the management of post-use treated wood has been prepared by the Hazardous Waste Task Group of the Canadian Council of Ministers of the Environment (CCME) (11, 13).

### 9.1 *Control, Treatment and Disposal*

The facility pollution prevention plan should include practices to reduce the amount of solid and liquid wastes to be controlled, treated and/or disposed. Such practices can be developed with the help of a specialised process engineer or consultant since each facility has their own challenges.

For wastes that require control, treatment or disposal, the process used will generally be regulated by provincial jurisdiction and may vary from province to province. Potential practices for waste disposal may include incineration, recycling, transfer and final disposal in landfill at facilities that have an appropriate license.

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements for permits and application may also differ from province to province. Consult your provincial authority for more information.

## **9.2 Liquids Containing Preservative**

### *Contaminated Storm Runoff*

Contaminated storm runoff should be minimized. Various approaches can be used, including ensuring a proper final vacuum to remove any excess solution from treated wood; use of roofed areas for treated product storage; ensuring proper fixation methods and minimization of surface deposits (by keeping solutions clean) prior to storage in the open environment; and containment and reuse of storm runoff waters. In areas of high rainfall, complete containment may not be economically feasible and roofing might be preferred. Refer to Section 7 for the recommendations on design features that minimize storm runoff.

If the release of contaminated runoff is required, specific approvals must be obtained from the appropriate provincial or municipal environmental regulatory agency. Control specifications may depend on factors such as the volume and frequency of the discharge and the sensitivity of the receiving environment. The discharge of some contaminated runoff into waters inhabited by fish might be subject to the provisions of the federal *Fisheries Act* (14).

### *Liquid Process Wastes*

On-site reuse, transport to another facility for reuse and treatment of contaminated liquid are ways to avoid disposal of liquid solution such as drips and wash water.

If the contaminated liquid is to be treated on-site, the facility may be required to meet certain conditions set out by the municipal, provincial and/or federal requirements. Some treatment techniques that are available include the following:

- gravity separation
- plate separation
- activated carbon treatment
- flocculation
- evaporation/condensation

A regulatory discharge permit must be obtained for disposal of the treated aqueous wastes and the conditions governing the discharge must be met.

If off-site disposal is unavoidable, specific approval must be obtained from the appropriate regulatory agency. If no suitable means of disposal are readily available, the solutions should be sealed in leak-proof containers, labelled and stored in a secure area in accordance with WHMIS requirements as well as other conditions that are set out by the provincial and/or municipal jurisdiction.



### **9.3 Solids with High Preservative Concentrations**

For the purposes of this document, solids with “high preservative concentrations” include:

- recuperated spill material;
- sludge from sumps, tank and cylinders;
- sludge from wastewater treatment processes (e.g. flocculated material);
- cartridge filters used to filter recycled waters;
- “spent” activated carbon; and
- solid chemical dust from vacuum recuperation.

Recovery of the components (e.g. active chemicals) represents an ideal option but is rarely available for facilities. The current practices and requirements for the disposal for these solids with high preservative concentrated should be acquired from your local jurisdiction. In addition, refer to your provincial and municipal offices for more information. It is the responsibility of the waste generator to obtain and to comply with the conditions required by the appropriate jurisdiction(s).

Solids with high concentrations of preservative might need to be drained and stored in leak-proof, sealed and labelled containers while awaiting disposal. Contaminated solids should be stored in a specifically designated area that is curbed and lined with impermeable material. The area should be roofed to protect the wastes from precipitation. Refer to Table 11 for more details on design recommendation for storing area.

### **9.4 Miscellaneous Solid Wastes**

Miscellaneous solid wastes (e.g. empty concentrate drums, wrappings, stickers or cuttings/broken pieces from treated lumber, contaminated sawdust or debris and empty pallets) from wood preservative facilities may be disposed of at designated sanitary landfills as approved by the provincial regulatory agency.

Containers should be clean before final disposal unless otherwise specified by the recuperation company. Suggested procedure to clean containers of water-borne preservative before final disposal:

1. fill container about 10% full with water;
2. agitate container vigorously;
3. discard rinsate according to pesticide disposal instructions;
4. repeat this rinsing procedure two more times.

For oil-borne preservatives or additives, it may be required that containers be steam-cleaned prior to disposal.

Make empty non-reusable container unsuitable for further use.

Follow provincial regulatory requirements for any required additional cleaning and disposal of the container.

For additional information on disposal of unused, unwanted product, contact the manufacturer or the provincial regulatory agency.

## **9.5    *Air Emissions***

Air emissions from process operations at many facilities are localized; effects, if any, would mostly be restricted to workers at the facilities. Ventilation and/or use of specific PPE or protective measures should be in place for high-risk work stations (e.g. enclosed areas) and/or where frequent exposure may occur. An overall good air flow within the plant should be maintained. When possible, process controls (e.g. scrubbers, extraction fans) should be used to control releases from plant equipment.

Source of emissions may include:

- Vapours/mist from tank vent;
- Vapours/mist from opening of retort cylinder doors;
- Vapours/mist from freshly treated charges; and
- Vapours/mist from vacuum system outlets.

**Table 23. Recommended Practices for Handling Liquid & Solid Wastes and Sludge (All Preservatives)**

<b>Feature</b>	<b>Recommendations</b>
<b>Objective:</b> Minimize and safely process wastes.	
<b>PPE</b>	<ul style="list-style-type: none"> <li>Operators should wear the correct PPE when processing wastes and sludge.</li> <li>Preservative PPE requirements should be followed as determined by the concentration and the state (liquid, solid, sludge) of the material and in accordance with label instructions. (Table 8).</li> </ul>
<b>Minimization</b>	<ul style="list-style-type: none"> <li>Appropriately condition wood prior to treatment.</li> <li>Avoid the introduction of debris, soil, snow, ice and other foreign matter from wood and trams into the treatment vessel.</li> <li>Keep the treatment solution clean and ensure that solution concentrations and component balances are in accordance with acceptable standards (CAN/CSA O80).</li> <li>Minimize the frequency of switching from one preservative to another in a single treatment vessel: <ul style="list-style-type: none"> <li>Avoid mixing trams.</li> <li>Thoroughly clean vessels, ancillary piping, etc., and trams prior to a switch.</li> </ul> </li> <li>Do not exceed the stipulated limitations of process parameters (e.g. temperature).</li> <li>Thoroughly clean protective equipment after use.</li> <li>Thoroughly empty and clean preservative containers (if applicable): <ul style="list-style-type: none"> <li>Rinse drums thoroughly (triple rinsed) with water prior to disposal in designated sanitary landfills subject to approval by the regulatory agency.</li> <li>Steam cleaning for oil based pesticides.</li> <li>Follow provincial instructions for any additional cleaning requirements and for disposal.</li> </ul> </li> <li>Ensure proper stabilization or fixation methods prior to storage in the open environment</li> <li>Return containers to suppliers or reuse sound containers for storage of wastes or make the empty container unsuitable for further use and dispose in accordance with provincial requirements.</li> <li>If the discharge of contaminated runoff is required, specific approvals must be obtained from the appropriate provincial or municipal environmental regulatory agency.</li> <li>Reuse/ recycle all rinse waters for work solution preparation (for water-borne formulations)</li> </ul>
<b>Collection</b>	<ul style="list-style-type: none"> <li>To be carried out by personnel trained in potential chemical hazards and appropriate handling methods.</li> <li>All personal hygiene and general precautions as outlined in Section 6 should be followed (Tables 6 and 8).</li> <li>Prescribed practice for vessel entry should be observed (see Tables 20 and 22).</li> <li>Any runoff, recuperated spills or liquid wastes generated at the site must be contained and reused as much as possible.</li> <li>Collect, drain (where appropriate) and place wastes and sludge into sealed drums.</li> </ul>
<b>Storage</b>	<ul style="list-style-type: none"> <li>The contained area should be on a paved or concrete sealed surface.</li> <li>Appropriate signs identifying the storage area should be posted.</li> </ul>
<b>Records / reporting</b>	<ul style="list-style-type: none"> <li>Label all drums to indicate contents (type of waste).</li> <li>Maintain an up-to-date inventory of containers, including their volumes and contents.</li> <li>Undertake all labelling, reporting and disposal activities in accordance with WHMIS requirements and applicable regulations (municipalities, provinces, federal).</li> </ul>
<b>Transportation</b>	<ul style="list-style-type: none"> <li>All labelling, records and reporting should be in compliance with the TDGR requirements.</li> <li>Classify waste in accordance with the TDGR.</li> <li>Follow reporting obligations in case of a spill or emergency (Section 12).</li> <li>Follow all instructions as outlined in Section 11, Table 27.</li> </ul>
<b>Disposal</b>	<ul style="list-style-type: none"> <li>Always consult with the provincial regulatory agency to determine acceptable disposal</li> <li>Do not burn contaminated wastes (toxic gases may be formed).</li> <li>Do not use treated wood wastes as compost or mulch.</li> <li>Dispose of contaminated solid waste in sanitary landfills is subject to approval by the provincial regulatory agency.</li> <li>Contain and reuse contaminated firefighting water runoff as makeup for work solutions (to the greatest possible extent).</li> </ul>

## 10 Environmental and Workplace Monitoring

Site monitoring and workplace exposure assessment are strongly recommended at wood preservation facilities, in accordance with the design and operating objectives described in this manual, to verify that chemicals are being properly managed at the site and to achieve environmental and worker health protection.

The level of detail and scope of these monitoring activities depends on site characteristics, facility design and regulatory requirements. The minimal components of a site environmental, worker exposure monitoring and health monitoring program are contained in Tables 25 and 26.



### 10.1 Baseline Environmental Evaluation

It is important to determine the baseline background levels of any of the wood preservative's constituents and its breakdown products on site and in the surrounding environment prior to commencing operations. This will provide a basis for comparison in future assessments of pollution controls at the facility. Baseline data to be collected should include surface water, groundwater and soil, and as shown in the following template of Table 24.

**Table 24. Background of the Preservative Constituents in the Natural Environment**

Element	(Site-specific)		
	Concentration in non-polluted environments		
	Surface waters (mg/L)	Groundwater (mg/L)	Soils (mg/kg)
A			
B			
C			

Testing methods can vary depending on the environment and the chemical element to be tested. Private laboratories can provide the expertise to conduct these tests.

### 10.2 Environmental Monitoring

Environmental monitoring requirements (mainly for soil, groundwater and surface water; sometimes air) would normally be developed in consultation with the applicable provincial and federal regulatory agencies to ensure regulatory requirements are being addressed and along with environmental professional(s) (e.g. hydrogeologist or environmental engineer). Additional consultation with Environment Canada would be required if the facilities affect federally

managed resources (e.g. facilities located on or adjacent to Aboriginal lands, federal lands or adjacent to waters frequented by fish and/or migratory birds).

Areas to be monitored may include the following:

- areas where preservative chemicals are stored, processed and handled
- all treated wood storage areas
- areas located down gradient from the above
- drainage ditches and areas exposed to runoff
- adjacent water bodies
- storm water runoff

The quality of water is determined by its physical, chemical and biological characteristics. These characteristics are measured in either a laboratory setting or on site in the field in order to determine if known maximum allowable limits are exceeded.

By conducting regular, systematic measurements of the physical, chemical and biological conditions of water bodies, the facility is able to measure changes and conditions of waterbodies, identify emerging issues and track the results of remedial measures.

### **10.3 *Workplace Exposure Monitoring***

Baseline initial assessments of workplace exposures should be carried out in order to identify the potential sources of exposure including their airborne concentrations. These potential sources include cylinder doors, fixation/stabilization areas, fixation chamber, kiln, exhaust vents, enclosed preservative process areas and drip pad areas. The peak and 8-hour average levels of all preservative constituents at these areas should be assessed and determined. A long-term exposure monitoring program should be included as part of the worker health monitoring programs. These programs should be developed in consultation with provincial and/or local regulatory agencies, provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist. These programs should also be correlated with the biological monitoring discussed in Section 6.4. The programs should be re-assessed and updated if there are any changes in plant design and/or operating practices.

**Table 25. Recommended Routine Environmental Monitoring (All Preservatives)**

<b>Item</b>	<b>Recommendations</b>
<b>Authority/reporting</b>	<ul style="list-style-type: none"> <li>• Develop a site-specific monitoring plan.</li> <li>• Define reporting requirements.</li> <li>• Re-evaluate the plan if the facility expands or changes the design or operating practices.</li> </ul>
<b>Soils</b>	<ul style="list-style-type: none"> <li>• Consider implementing a soil monitoring program (with emphasis on unsurfaced ground) including <ul style="list-style-type: none"> <li>– all areas where preservative chemical is routinely stored, processed or handled;</li> <li>– all freshly treated wood storage areas;</li> <li>– all treated wood storage areas;</li> <li>– drainage ditches or areas exposed to surface runoff (including overflow from drip pads and paved/concrete areas).</li> </ul> </li> <li>• Define sampling frequency (e.g. annual), sample type (e.g. surface, core), and required analyses (e.g. constituents, detection levels, quality control) in consultation with the regulatory agency.</li> </ul>
<b>Surface waters</b>	<ul style="list-style-type: none"> <li>• Consider implementing a monitoring program for adjacent water bodies: <ul style="list-style-type: none"> <li>– Define monitoring frequencies and required analyses (e.g. constituents, detection levels, quality control) in consultation with the regulatory agency.</li> <li>– Define concentrations of concern.</li> </ul> </li> </ul>
<b>Groundwater</b>	<ul style="list-style-type: none"> <li>• Facilities should implement a groundwater monitoring program using permanent monitoring points down-gradient of process areas and treated wood storage areas: <ul style="list-style-type: none"> <li>– Define direction of flow of the aquifer</li> <li>– Define well construction.</li> <li>– Define sampling frequencies and required analyses (e.g. constituents, detection levels, quality control).</li> </ul> </li> <li>• Give special attention to on-site wells used for drinking water.</li> </ul>
<b>Air emissions</b>	<ul style="list-style-type: none"> <li>• Conduct a workplace exposure study once at the beginning of plant operations and update if there are any changes in plant design and/or operating practices.</li> <li>• Identify air emission sources using data provided in the workplace exposure study (see Table 26).</li> <li>• Monitor air emissions as required by provincial permits or as determined by industrial hygienist if no permits are required.</li> </ul>
<b>Liquid waste streams</b>	<ul style="list-style-type: none"> <li>• Identify liquid waste discharges (including stormwater runoff): <ul style="list-style-type: none"> <li>– Determine concentrations of preservative constituents.</li> <li>– Estimate total mass rates of emissions (suggested).</li> </ul> </li> <li>• Thereafter, monitor as required for all discharges governed by permits.</li> </ul>

**Table 26. Recommended Routine Workplace Monitoring (All Preservatives)**

Item	Recommendations
<b>Authority/reporting</b>	<ul style="list-style-type: none"><li>• Develop a facility-specific plan, preferably in consultation with the <u>provincial/regional</u> workers' compensation board or industrial hygienist/physician.</li><li>• Define reporting formats and requirements.</li></ul>
<b>Contact exposure</b>	<ul style="list-style-type: none"><li>• Identify existing and potential sources of skin exposure by periodic walk-through inspections.</li></ul>
<b>Air inhalation exposure</b>	<ul style="list-style-type: none"><li>• Define an initial indoor monitoring program (e.g. sampling techniques, frequency of sampling), preferably in consultation with the regulatory agency responsible for worker safety.</li><li>• For the purpose of defining worker health protection measures, provide an initial evaluation of peak and average levels of preservative constituents in air at significant points of worker exposure. Include areas such as<ul style="list-style-type: none"><li>– cylinder or kiln doors (openings);</li><li>– all enclosed preservative process areas; and</li><li>– areas adjacent to freshly treated wood storage.</li></ul></li><li>• Provide for subsequent monitoring,</li><li>• Make personal samplers available for spot monitoring (as required)</li></ul>
<b>Biological monitoring</b> (Section 6.4)	<ul style="list-style-type: none"><li>• Conduct initial screening medical exams to establish an initial baseline of the employee's health and then used to monitor their future health as it pertains to potential occupational exposures to hazardous agents.</li><li>• Define a schedule for<ul style="list-style-type: none"><li>– medical exams to confirm the absence of symptoms or signs of exposure to preservative constituents; and</li><li>– biological monitoring of workers for preservative constituents (e.g. arsenic concentration in urine).</li></ul></li><li>• Consult BEI from ACGIH</li></ul>

## 11 Transportation of Preservative Solids, Solutions and Wastes

The transportation and cross-border movements of preservative (pesticides) solids, solutions and the wastes generated by their use may be regulated under some or all of the following federal regulation:



- *Transportation of Dangerous Goods Regulations* (TDGR) (15):  
<http://www.tc.gc.ca/eng/tdg/safety-menu.htm>
- *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) : <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>
- *Interprovincial Movement of Hazardous Waste Regulations* (IMHWR) :  
<http://ec.gc.ca/lcpe-cepa/eng/regulations/detailReg.cfm?intReg=68>
- Treated wood exported to another country may be subject to the [Export Control List](#). This list contains substances whose export is controlled because their manufacture, import and/or use in Canada is prohibited or severely restricted, or because Canada has accepted, through an international agreement, to control their export.

Dangerous goods to be transported should be classified according to the TDGR and any additional requirements under provincial jurisdiction with authority. Requirements may vary from province to province. Facilities should contact their local Transport Canada office for classification requirements for preservative solids, solutions and the wastes generated by their use. Facilities need to ensure that the transportation of all preservatives and contaminated wastes need to conform with provisions of the TDGR. These Regulations cover, among other things, packaging, shipping documentation, interprovincial and Canada–U.S. shipments, labelling and placarding and the reporting of environmental emergencies.

The purpose of the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* is to ensure that hazardous waste and hazardous recyclables that are transported across international borders (to be exported, imported, or to transit through Canada) are managed appropriately to protect the environment and human health. The EIHWHRMR apply to anyone (individuals or businesses) who exports, imports or conveys in transit, for disposal or recycling purposes, waste or material that is considered to be hazardous under the EIHWHRMR. A permit issued by Environment Canada is required and carriers must have this permit with them during all stages of a movement, as well as a legal movement document (formerly known as a manifest).

The *Interprovincial Movement of Hazardous Waste Regulations* ensure that movements of hazardous waste and hazardous recyclables are properly classified and tracked. Shipments must be accompanied by a movement document. Consignor, consignee and all carriers must complete certain portions of movement document and once completed a copy of the document must be sent to the authorities of the province of origin and of the province of destination.

According to the [article 2.2 of the TGDR](#), the consignor is responsible for determining the classification of dangerous goods. This activity is normally done by, or in consultation with, a person who understands the nature of the dangerous goods such as a manufacturer, a person who



formulates, blends or otherwise prepares mixtures or solutions of goods or laboratory technologist or technician.

Table 27 provides recommendations on the transportation procedures for preservative chemicals. These procedures are based on good operating practices as well as conditions required under the TDGR.

**Table 27. Recommended Transportation Practices for Preservative-containing Solutions or Wastes (All Preservatives)**

<b>Feature</b>	<b>Recommendations</b>
<b>Container transportation &amp; specifications</b>	<ul style="list-style-type: none"> <li>• Ensure that the containers for transporting preservatives should be <ul style="list-style-type: none"> <li>– free from mechanical defects;</li> <li>– protected against physical abuse; and</li> <li>– filled and closed in the manner prescribed for wood preservatives by the <i>TDGR</i>, published by Transport Canada.</li> </ul> </li> <li>• Consult with your provincial and local authorities to know the applicable regulatory requirements for transportation as they may be specific.</li> </ul>
<b>Container labelling</b>	<ul style="list-style-type: none"> <li>• Comply with TDGR label requirements. <ul style="list-style-type: none"> <li>– Affix the proper labels to each container.</li> <li>– Label each container on at least two sides.</li> <li>– <i>See TDGR for complete list</i></li> </ul> </li> </ul>
<b>Loading procedures</b>	<ul style="list-style-type: none"> <li>• Ensure that personnel have the means and ability to transfer bulk materials safely.</li> <li>• Ensure that all procedures involving transfer flammable and combustible liquids are in accordance with Division B, Part 4 of the <i>National Fire Code of Canada 2010</i>.</li> <li>• Set vehicle handbrakes securely and place wheel blocks prior to unloading.</li> <li>• Ensure the presence of a person who knows the hazards of the preservative and who is trained and prepared to respond to spills and other emergencies.</li> <li>• If leakage or spillage occurs, decontaminate the vehicle prior to returning it to service.</li> <li>• Dispose of absorbents and spill cleanup materials as per Table 23 and the appropriate tables in Part II for preservative-specific systems.</li> </ul>
<b>Shipping documents</b>	<ul style="list-style-type: none"> <li>• The TDGR and EIHWHRMR* require shipping document (products or wastes).</li> <li>• Consult with your provincial and local authorities to know the applicable regulatory requirements.</li> </ul>
<b>Securing vehicle loads (e.g. drummed wastes)</b>	<ul style="list-style-type: none"> <li>• Replace drum spouts with leak-proof bungs prior to transit.</li> <li>• Strap drums or blocks vertically to pallets.</li> <li>• Strap drums or blocks horizontally to each other.</li> <li>• Brace or tie down loads to prevent shifting (do not rely on the vehicle floor or sides to prevent shifting).</li> <li>• Ensure a stable load consistent with the vehicle floor strength.</li> <li>• Secure other load items to prevent drum or wrap punctures and to prevent abuse to blocks.</li> </ul>
<b>Vehicle placarding</b>	<ul style="list-style-type: none"> <li>• Affix vehicle placards for the class and quantity of material shipped as designated by the TDGR. This is usually the responsibility of the waste transporter. Note: Vehicles carrying preservative-treated commodities need not be placarded.</li> </ul>
<b>Responsibilities of truck driver, ship captain or railroad crew</b>	<ul style="list-style-type: none"> <li>• Know the nature of the load.</li> <li>• Carry suitable emergency equipment and be trained in its proper use.</li> <li>• Know and follow correct procedures for the reporting of accidents or spills: <ul style="list-style-type: none"> <li>– Immediately telephone the 24-hour contact identified by provincial and federal competent authorities. <ul style="list-style-type: none"> <li>– Please refer to <a href="#">Appendix III</a>: Federal/Province/territory 24-hours authorities' numbers.</li> </ul> </li> <li>– Know and comply with any other requirements of the shipper/manufacture.</li> </ul> </li> <li>• Immediately replace lost or damaged placards or labels (carry spares). Notify the receiver of goods that preservative materials are in transit. (Note: Some provinces allow only licensed carriers to transport hazardous wastes.)</li> </ul>

## 12 Environmental Emergency Notification and Contingency Planning

Preparedness for emergencies is essential in any wood preservation facility. Hence, all wood preservation facilities should prepare and have readily available detailed contingency plans to ensure that response to spills and fires is quick, safe and effective.

It is recommended that all chemical discharge events be documented to improve future spill and fire contingency planning. Have the necessary documents including pesticide labels readily available (preferably in a firebox outside the facility entrance) for both facility workers and for emergency responders.



### 12.1 Environmental Emergency Notification

In the event of an environmental emergency or occurrence, such as an oil or chemical spill, federal and provincial/territorial authorities NEED to be notified.

Environmental Canada should be notified by calling the appropriate (local) 24-hour telephone number listed in [Appendix III](#). Additional information regarding notification requirements under the *Canadian Environmental Protection Act, 1999* and the *Fisheries Act* is available from the Environment Canada's website:

<http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=EED2E58C-1>

The Environmental Emergency Regulations and its requirements are applicable for pesticides containing substances listed in Schedule 1 of CEPA 1999.

### 12.2 Spill Contingency Planning

Facilities using any of the substances listed in Schedule 1 of the *Environmental Emergency Regulations* may be required to submit information to the Minister of the Environment as well as prepare, implement and test environmental emergency (E2) plans. E2 plans help to prevent releases or to react quickly in the event of an uncontrolled, unplanned or accidental release of a regulated substance in order to minimize the impact on human health and the environment.

For more information on environmental emergencies and the requirement of E2 planning, refer to the Environment Canada website:

<http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=8A6C8F31-1>

For more information on the substances listed in Schedule 1 of the *Environmental Emergency Regulations*, refer to the Environment Canada website:

<http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&xml=4ABEFFC8-5BEC-B57A-F4BF-11069545E434>

The *Implementation Guidelines for Part 8 of the Canadian Environmental Protection Act, 1999 – Environmental Emergency Plans* (update 2004) provide contextual information on Part 8 of CEPA 1999 and on the *Environmental Emergency Regulations*:

<http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=d6adad2d-1>

### **12.2.1 General Components**

Facilities that are required to submit information to the Minister of the Environment as well as prepare, implement and test environmental emergency (E2) plans should use the Implementation Guidelines mentioned above.

Facilities that are not required to prepare E2 plans under either section 200 or section 199, Part 8 of CEPA 1999, can use the following general components as a basis for a contingency plan. Although the details of a contingency plan are facility-specific, the following provisions are typical of most spill contingency plans. This can be adapted to individual facility conditions. It is recommended that the individual facility plan be filed with the authority and/or municipality that has jurisdiction over the facility.

A contingency plan should (but is not limited to)

- I. Have policy, purpose and organizational structure.
- II. Be geared to the most probable spill size.
- III. Address the following phases of spill response:
  - a. discovery and notification
  - b. evaluation and initiation of action
  - c. containment and countermeasures
  - d. cleanup, mitigation and disposal
  - e. documentation and cost accounting.
- IV. Clearly assign duties and roles to responsible personnel and organizations.
- V. Outline equipment (including PPE) requirements for spill control.
- VI. Include procedures for updating the plan on a scheduled basis.
- VII. Outline training needs for personnel in prevention and response.
- VIII. Coordinate with other chemical spill prevention plans and procedures if appropriate.
- IX. Be submitted to chemical suppliers and the cleanup consultant or contractor for review.
- X. Subsequently be submitted to appropriate government agencies including the local fire department for review.
- XI. Be tested through drills and exercises to identify gaps and opportunities for improvement to the contingency plan.
- XII. Address other site-specific aspects as necessary.

### **12.2.2 Implementation Capability**

A contingency plan should

- I. Describe the location, capability and limitations of cleanup and containment equipment.
- II. Pre-arrange for use of the best available cleanup and containment equipment.
- III. Identify detailed response options and strategies.
- IV. Provide for training programs and regular practice sessions.
- V. Identify communication requirements with police, fire departments and regulatory agencies.
- VI. Describe how communications will be maintained among all parties during response operations.
- VII. Describe steps to be taken as a routine precaution against spills.
- VIII. Address human safety issues.
- IX. Assign selected personnel to respond to public and media calls.
- X. Provide for sampling of and data collection about runoff waters.

It may be necessary to develop specific procedures for multi-preservative facilities. Procedures should be kept simple and direct to avoid confusion.

### **12.2.3 Environmental Protection and Other Liability Risks**

A contingency plan should

- I. Identify high-risk areas and operations.
- II. Discuss expected chemical and physical behaviour of spill materials.
- III. Identify and prioritize sensitive environments for protection.
- IV. Detail specific actions planned for minimizing damage to resources.
- V. Define explicit standards for the components and extent of effective cleanup.
- VI. Include provisions for responding to spills under all anticipated weather conditions.
- VII. Pre-arrange all response capability needed for the estimated worst-case spill.

### **12.2.4 Examples of Action Steps**

Safety of people is a prime concern. Before any action, you need to do a quick assessment of the situation to find the source of the spill and identify if there is an immediate danger to workers. Appropriate personal protective equipment should be put on immediately. A spill kit accompanied with appropriate PPE should be stored in a centralized area that is within ready access to the unloading pad, tank farm, treating cylinder and waste storage area. More than one spill kit may be required depending on the distance between these areas or other potential areas where spills could occur.

If a spill occurs, the following steps should be taken:

- I. Stop the flow of preservative solutions or any liquids containing preservative components:
  - a. Use common sense, always stay upwind of the spill.
  - b. Act quickly.
  - c. Shut off pumps, close valves, etc., if this can be done without risk.

- d. If applicable, shut down mechanical production systems first (e.g. lumber movement) to prevent injury.
- II. Warn people in the immediate vicinity:
  - a. Sound alarm.
  - b. Do not allow unauthorized personnel to enter the area and remove all unauthorized personnel from the scene of the spill.
  - c. Consult the pesticide label.
  - d. Provide proper protective equipment for on-site personnel.
  - e. Avoid any contact with skin, eyes, clothing or shoes.
- III. Contain the spill:
  - a. Act promptly.
  - b. Block off drains, culverts and ditches.
  - c. Surround spilled material with earth, peat, straw, sand, booms or commercial sorbents.
  - d. Use a liquid-recovery type vacuum cleaner (or empty cylinder and vacuum pump) for recovery of pools.
- IV. Obtain assistance as needed from
  - a. Company personnel (advise at earliest opportunity);
  - b. Chemical suppliers;
  - c. Fire/police/public works/highways department/contractors (depending on the situation).
- V. Notify applicable government agencies:
  - a. Prompt notification is especially important for spills that have entered or may enter receiving waters.
  - b. Spills to marine waters require contact with Environment Canada.
  - c. Spills to water bodies with fish or spills on or adjacent to First Nations lands require contact with Environment Canada and the provincial emergency program office.
  - d. For all other spills, contact the provincial emergency program office.
- VI. Commence recovery, cleanup and restoration action:
  - a. Recover pools using vacuum systems and contain recovered liquid for reuse.
  - b. Use an inert absorbent to complete cleanup.
  - c. Neutralize preservative solution spills, if appropriate, before recuperating them.
  - d. Ensure compatibility of materials before using tanks for salvage purposes.
  - e. Carry out cleanup and disposal in consultation with provincial and federal regulatory personnel.

## 12.3 Fire Contingency Planning

Precautions should be taken in the event that a fire occurs in the vicinity of preservative solutions. It is, therefore, important that wood preservation facilities devise an adequate contingency plan for fire protection. Proactive actions, like ensuring that preservatives are stored in fire-protected areas, is an example of a best practice to minimize fire impact.

Not all preservatives or their components are flammable, and they may behave differently in fires depending on their physical-chemical characteristics. All preservative substances can emit toxic fumes during fires. The contingency plan recommendations made here are of a general nature as outlined as acceptable solutions in the *National Fire Code of Canada* (always refer to last version available).



### 12.3.1 General Components

A fire contingency plan should

- I. Be prepared in consultation with local fire authorities and be in accordance with Division B, Section 2.8 of the *National Fire Code of Canada 2010* (NFCC) (8).
- II. Describe policy, purpose and organizational structure with up-to-date contact lists.
- III. Ensure that creosote, petroleum oil solutions (including PCP/oil solutions) and other flammable and combustible liquids are stored as per the applicable acceptable solutions outlined in the Division B, Part 4 of the NFCC (8).
- IV. Address medical and environmental aspects.
- V. Be geared to the most probably affected area.
- VI. Address the following phases of fire response:
  - a. discovery and notification
  - b. evaluation and initiation of action
  - c. cleanup, mitigation and disposal
  - d. documentation and cost accounting.
- VII. Ensure that proper fire extinguishing agents are available in adequate quantities.
- VIII. Clearly assign duties and roles to responsible personnel and organizations.
- IX. Include procedures for updating the plan on a scheduled basis.
- X. Coordinate with other fire prevention plans and programs as appropriate.
- XI. Be submitted to local fire department for review and resubmitted when the plan is updated.
- XII. Be accompanied by a training program and emergency drill.
- XIII. Be reviewed annually.
- XIV. Be stored in accessible locations, including a fire proof box outside the entrance to the facility.

The NFCC 2010 also provides additional acceptable solutions outlined in

- Division B, Sentence 3.1.2.6-1 for Dangerous Goods
- Division B, Article 3.2.2.5 for Indoor Storage
- Division B, Article 3.3.2.9 for Outdoor Storage

- Division B, Article 4.1.5.5 for Flammable and Combustible Liquid
- Division B, Subsection 5.1.5 for Hazardous Processes and Operations

### 12.3.2 Action Steps

Fire contingency plans and defined action steps will be site-specific. Nonetheless, an overall strategy should include provisions to ensure that

- I. Water can be used to cool fire-exposed containers.
- II. Appropriate firefighting media are available:
  - a. water blanket area
  - b. water spray to suppress toxic dust and gases and to keep temperatures of other oxidizable material below that for ignition
  - c. use of foam, dry chemical or carbon dioxide on oil fires
  - d. other fire protection agents.
- III. Firefighters are protected from dusts, gas and smoke emissions by the use of appropriate respirators approved by NIOSH and NFPA\*.
- IV. An evacuation plan is prepared for populations with potential exposure to the smoke plume.
- V. Contaminated runoff waters are contained.
- VI. The provincial emergency program office is notified if runoff waters could have entered receiving waters.
- VII. Clean-up has to be made in consultation with provincial and federal regulatory personnel. Note that ashes from treated wood should be considered a hazardous waste and disposed of as such.

\* [NIOSH = National Institute for Occupational Safety and Health.](#)  
[NFPA = National Fire Protection Association.](#)

A generic spill and fire contingency plan is available for Canadian treated wood manufacturer at Wood Preservation Canada Association (<http://www.woodpreservation.ca/index.php?lang=en>).



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# Part II

## Preservative-specific Information and Recommendations

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<a href="#"><u>Chapter C</u></a>	Ammoniacal Copper Zinc Arsenate (ACZA) Wood Preservation Facilities
<a href="#"><u>Chapter D</u></a>	Creosote (CREO) Wood Preservation Facilities
<a href="#"><u>Chapter E</u></a>	Pentachlorophenol Pressure (PCPP) Wood Preservation Facilities
<a href="#"><u>Chapter F</u></a>	Pentachlorophenol Thermal (PCPT) Wood Preservation Facilities
<a href="#"><u>Chapter G</u></a>	Alkaline Copper Quaternary (ACQ) Wood Preservation Facilities
<a href="#"><u>Chapter H</u></a>	Copper Azole (CA-B) Wood Preservation Facilities
<a href="#"><u>Chapter I</u></a>	Inorganic Boron (Borate) Wood Preservation Facilities

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## CHAPTER B

# Chromated Copper Arsenate (CCA) Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives.





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# 1 Production and Use

Chromated copper arsenate (CCA) is sold throughout the world as dry mixtures of crystalline powders, as pastes or as liquid concentrates. The registered CCA pesticides in Canada are all in liquid concentrate form. Hartford (1) describes the mixtures, which are prepared with a variety of different ratios of chromium, arsenic and copper. The only CCA formulation currently in use in Canada is known internationally as a Type C oxide formulation, which is prepared from copper oxide and chromic and arsenic acids.

The use of CCA-treated products over the last 40 years has increased significantly, particularly as a result of its acceptance in the residential markets until 2003. The ability to stain or paint CCA-treated wood, as well as the ease of handling treated products, resulted in widespread usage by homeowners for uses such as deck and patio construction, playground equipment, landscaping, foundation lumber and plywood, and fence posts (2). However, CCA was voluntarily withdrawn from use in residential applications; as of December 31, 2003, it can be used **only for industrial wood products** as per registration requirements. CCA uses for such industrial applications are summarized in Table 1(3).

The conditions of use specified on the pesticide label are mandatory by law. Electronic copies of the pesticide labels for all registered CCA products, which contain information on allowable uses, product handling precautions, minimum worker protective equipment and health hazard warnings, can be obtained from the Health Canada website:

<http://www.hc-sc.gc.ca/cps-spc/pest/registant-titulaire/tools-outils/index-eng.php> (7).

**Table 2. CCA Type C Use in Canada**

<b>Feature</b>	<b>Characteristics</b>
<b>Treated wood use limitations in Canada (3)</b>	<p>USE FOR INDUSTRIAL WOOD PRODUCTS ONLY</p> <ol style="list-style-type: none"> <li>1. Poles for highway and utility uses</li> <li>2. Fence posts and poles as defined in standard CSA O80.16-97 for use on farms and piles, and round, half-round and quarter round fence posts and rails; poles, round posts and posts sawn four sides used as structural members on farms; and plywood used on farms</li> <li>3. Round poles and posts used in building construction</li> <li>4. Sawn crossarms</li> <li>5. Wood for marine construction (salt and brackish water immersion) and structures above the water level (including cross bracing of 50 mm x 200 mm [2" x 8"] and/or 75 mm x 150 mm [3" x 6"] and larger nominal dimensions) subject to frequent salt water splash from wave action and degradation by marine organisms</li> <li>6. Land, fresh water, foundation and marine piles as defined in CSA O80.3-97.</li> <li>7. Lumber and plywood for permanent wood foundation as defined in standard CSA O80.15-97</li> <li>8. Sawn timbers 125 mm (5") and thicker used to support commercial structures or residential stilt home structures</li> <li>9. Structural glued-laminated members and laminations before gluing (mechanical fasteners may be used in combination with, or in lieu of, glue) limited to commercial/industrial uses</li> <li>10. Plywood</li> <li>11. Structural composite lumber</li> <li>12. Shakes and shingles</li> <li>13. Wood for highway construction as defined in standard CSA O80-14-97, including lumber for bridges and structural members; lumber for cribbing, culverts and bridge parts; piles used on land and in fresh and salt water structural lumber in salt water; posts (fence, guard rail, guide, sign and sight); lighting poles; bridge hand rails; guardrails; posts; and structural composite lumber</li> <li>14. Lumber, timbers and plywood for cooling towers</li> <li>15. Lumber for roller coaster construction</li> <li>16. Wood for construction of road salt storage buildings</li> </ol> <p>*Note: permitted uses and limitations of CCA-treated wood may change over time. Refer to pesticide label.</p>
<b>General process of application</b>	Pressure treatment (refer to the pesticide label)

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes CCA-treated products. (4)

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label.

## 2 Physical and Chemical Properties

The components of CCA (copper, chromium and arsenic) were selected for wood preservation use because of their biocidal properties and their ability to be retained within the wood for long-term protection. Fixation is a physical or chemical process whereby CCA is rendered leach-resistant in both water and soil applications in such a way that the active ingredient or ingredients maintain fungal/insecticidal efficacy (4). The fixation mechanism of CCA within wood is complex, and the reactions involved depend on the preservative formulation and concentration, wood species, temperature and humidity conditions (5). Reaction products include insoluble chromates and insoluble arsenates of copper and chromium (6).

General physical and chemical properties of CCA solution are summarized in Table 2. The data indicate that a wide variety of properties must be considered in order to safely manage CCA solutions. Detailed information can be obtained from manufacturers' material safety data sheets (MSDS) and the pesticide label. Electronic copies of the pesticide labels can be obtained at the Health Canada website:

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php> (7).

**Table 2. Physical and Chemical Properties of CCA Concentrate Solution**

Identification		
<b>Common synonyms:</b> ACC <b>United Nations (UN) Number:</b> 1556 <b>CAS Number:</b> <ul style="list-style-type: none"><li>chromic acid 7738-94-5;</li><li>copper (2) oxide or cupric oxide 1344-70-3;</li><li>arsenic pentoxide 1303-28-2</li></ul>	<b>Registrant in 2012:</b> Arch Wood Protection Canada Corp. (Mississauga, ON) <ul style="list-style-type: none"><li>•Wolmanac</li></ul> Timber Specialties Ltd. (Campbellville, ON) <ul style="list-style-type: none"><li>•C-60</li></ul> Chemical Specialties, Inc. (Charlotte, NC; Gilmar, TX; Augusta,GA) <ul style="list-style-type: none"><li>•CCA TYPE-C</li></ul>	
Transportation and storage information		
<b>Shipping state:</b> Liquid concentrate <b>Concentration:</b> 50% to 60% by weight <b>Classification:</b> Poisonous; corrosive oxidizer	<b>Storage temperature:</b> Ambient <b>Inert atmosphere:</b> No requirement <b>Venting:</b> No requirement <b>Containers/materials:</b> Bulk truck or train	<b>Placards:</b> Class 6.1 P.G II <i>Check with Transport Canada.</i> <b>Delivery format:</b> Bulk rail and truck
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1atm) <b>Solubility:</b> Freely soluble (water) <b>pH:</b> Strongly acidic (pH 1.6 to 3.0) <b>Vapour pressure:</b> Non-volatile <b>Active ingredients:</b> CrO <sub>3</sub> , CuO, As <sub>2</sub> O <sub>5</sub> <b>Concentration of work solutions:</b> 0.5% to 10% by weight	<b>Floatability:</b> Dissolves readily in water <b>Freezing point:</b> -30°C <b>Flash point:</b> Not flammable <b>Explosive limits:</b> Not explosive or flammable <b>Specific gravity:</b> 1.64 @ 50% concentrate	<b>Appearance:</b> Heavy liquid, dark brown <b>Colour:</b> Dark brown (concentrate) to yellow-green (dilute) <b>Odour:</b> Odourless <b>Typical preservative retention in treated wood:</b> 4.0 to 24 kg/m <sup>3</sup> (0.25 to 1.5 lb/ ft <sup>3</sup> )
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Not combustible; common extinguishing agents can be used with fires involving CCA solutions. <i>Fire behaviour:</i> On exposure to high temperatures CCA may emit arsenic fumes. Containers may rupture due to chromic acid reactivity. Chromic acid may reduce the combustibility of other materials. <i>Ignition temperature:</i> Not combustible <i>Burning rate:</i> Not combustible	<b>Reactivity</b> <i>With water:</i> No reaction <i>With common materials:</i> Contact with reducing agents (such as aluminium or zinc) may liberate arsine gas (AsH <sub>3</sub> – colourless, highly toxic) and/or may cause violent explosions due to chromic acid reactions. Contact with combustible materials (such as acetic acid, acetone, ammonia, alcohol, glycerol, hydrocarbons, hydrogen sulphide, naphthalene, sulphur and turpentine) may result in violent reactions and subsequent fire and/or explosions. <i>Stability:</i> Stable	

## 3 Environmental Effects

### 3.1 *Aquatic Toxicity*

In considering the aquatic toxicity of CCA, the following points should be borne in mind:

- Ratios of copper, chromium and arsenic in soil and runoff water from CCA facilities are not necessarily consistent with their ratios in the original CCA working solutions. Depending on various factors, it is possible that only one element may be predominant. As a result, the toxicity of each element, in addition to the toxicity of the CCA mixture, should be reviewed.
- Valence changes of arsenic, chromium or copper may occur within the environment, and those changes may reduce or enhance the toxicities of the elements. There have been no studies reported in the literature on valence interconversion of copper, chromium or arsenic in soil or groundwater at—or in surface runoff water from—CCA facilities. Chromium is released into water and soil as trivalent chromium, but the concentration of trivalent chromium is the lowest of the three metals, partly attributed to the fixation process in the wood structure. Arsenic is leached into soil and water as pentavalent arsenic (8). A limited study was carried out for the purposes of this document to assess arsenic speciation. The study indicated that samples of soil and water in the vicinity of CCA facilities contained at least 97% of the original pentavalent form of arsenic (9).

Canadian limits for arsenic, chromium and copper in aquatic environments are listed in Table 3, and these limits are subject to change from time to time. Recurrent review of these limits is recommended.

All of the guidelines and limits in Table 3 are based on total concentrations of arsenic, chromium or copper and reflect the recommended approach of many scientific reviews. These reviews indicate that the current state of knowledge does not enable water quality limits to be based on either valence state or dissolved fractions in water (10, 11, 12, 13).

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for Arsenic, Chromium and Copper in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Arsenic	Maximum: 0.05 mg/L	Protection of human health	International Joint Commission <sup>(a)</sup>
	Maximum: 0.01 mg/L	Protection of human health Objective: < 0.005 mg/L	Health Canada <sup>(b,c)</sup>
	Fresh water: 0.005 mg/L Marine: 0.0125 mg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>
Chromium	Maximum: 0.05 mg/L	Protection of human health	International Joint Commission <sup>(a)</sup>
	Maximum: 0.05 mg/L (under review)	Protection of human health Objective: < 0.0002 mg/L	Health Canada <sup>(b,c)</sup>
	Fresh water: 0.001 mg/L Marine: 0.0015 mg/L	Protection of aquatic life	CCME <sup>(d)</sup>
Copper	Maximum: 0.005 mg/L	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
		Protection of human health Aesthetic objectives: < 1.0 mg/L	Health Canada <sup>(b,c)</sup>
	Varies with hardness 0.002 mg/L (hardness = 0-60 mg/L CaCO <sub>3</sub> ) 0.003 mg/L (hardness = 60-120 mg/L CaCO <sub>3</sub> ) 0.004 mg/L (hardness = 120-180 mg/L CaCO <sub>3</sub> ) 0.006 mg/L (hardness > 180 mg/L CaCO <sub>3</sub> )	Protection of aquatic life	CCME <sup>(d)</sup>

- (a) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).
- o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)
  - o <http://www.ijc.org/rel/agree/quality.html>
- (b) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.
- o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- (c) "Maximum acceptable" was defined by Health and Welfare Canada as: "Drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable." "Objective" is defined by Health and Welfare Canada as: "This level is interpreted as the ultimate quality goal for both health and aesthetic purposes."
- (d) Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life. <http://st-ts.ccme.ca/>



## 4 Human Health Concerns

Chromium, copper and arsenic are elements that occur naturally in food, water and air. Although these elements are a natural part of our environment, and some are necessary micronutrients (chromium, copper), chromium and arsenic are carcinogens. Exposure to CCA or the individual constituents should be minimized to the maximum practical extent possible in the workplace.

One safety objective for the industrial use of any chemical (in this case, chromium, copper and arsenic formulations) is to minimize worker exposure. If safeguards are not provided or implemented, a variety of human health effects may occur depending on the duration and manner of exposure, concentration of chemicals, chemical forms (valence), and varying metabolic sensitivities of individual workers.

The PMRA's *Re-evaluation decision for the registration of the heavy duty wood preservatives creosote, pentachlorophenol, chromated copper arsenate and ammoniacal copper zinc arsenate*, has granted continued registration of these products for sale and use in Canada. Potential risks from inhalation and dermal exposure were identified for some occupational tasks within wood-treatment facilities. The addition of new risk-reduction measures and the development of a Risk Management Plan for heavy duty wood preservatives will continue to lower the potential for occupational exposure for treatment facility workers (14).

Table 4 outlines the possible human health effects that may result from exposure to CCA solutions and its components. The following possible human health effects are estimated from risk from chromium as Cr+6 and arsenic as As+5. Extensive reviews of the potential health effects of individual elements are provided in documents from Health Canada (13), the World Health Organization (15), the International Labor Organization (16) and the United States Environmental Protection Agency (17).

**Table 4. Potential Health Effects of Exposure to CCA Solutions**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) with limited to no health effect <sup>(a)</sup>			
• Arsenic (found in foods, especially seafood) ( <i>organic arsenic</i> )	0.042 mg/day		
• Copper (an essential element)	2.47 mg/day		
• Chromium (in trace quantities in all foods)	0.06 mg/day		
Eye contact <sup>(b,c,d,e,f)</sup>	Direct contact	<ul style="list-style-type: none"><li>• CCA is corrosive</li><li>• Inflammation</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• Potential carcinogenic action</li></ul>
Skin contact <sup>(b,c,d,e,f)</sup>	Significant skin contact with work solutions or concentrates	<ul style="list-style-type: none"><li>• Skin irritation</li><li>• Inflammation</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• Potential carcinogenic action</li></ul>
Exposure to airborne contaminant or dust Inhalation <sup>(b,c,d,e,f)</sup>	Inhalation of mists, droplets or dust of work solutions or concentrates	<ul style="list-style-type: none"><li>• Severe irritation of nose and throat</li><li>• Irritation of eyes</li></ul>	<ul style="list-style-type: none"><li>• Arsenic and chromium are potential carcinogens</li><li>• Ulceration and perforation of nasal septum</li></ul>
ACGIH threshold limit value-time weighted averages (TWAs) <sup>(g,h)</sup>	Arsenic* and soluble compounds: 0.01 mg As/m <sup>3</sup> air  Copper (dusts and mists): 1.0 mg Cu/m <sup>3</sup> air Cr+6 compounds water soluble: 0.05 mg Cr/m <sup>3</sup> air Insoluble : 0.01 mg Cr/m <sup>3</sup> air * U.S. OSHA-PEL		
Ingestion <sup>(b,c,d,e,f)</sup>	Ingestion of work solutions or concentrates through manipulation of contaminated goods (dishes, gum, candy, food, tobacco, liquids)	<ul style="list-style-type: none"><li>• Nausea, abdominal pain, vomiting, shock, coma</li><li>• Death<sup>5</sup> reported after ingestion of quantity from 0.1 to 1 g arsenic and 0.7 g Cr+6</li></ul>	<ul style="list-style-type: none"><li>• Possible liver and kidney damage, jaundice, reduced white blood cell count upon long-term exposure to 0.15 to 0.6 mg arsenic per day</li><li>• Potential carcinogenic action</li></ul>

<sup>5</sup> These reported fatalities did not take place in CCA plants

**Table 4. Potential Health Effects of Exposure to CCA Solutions** (continued)

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Chronic symptoms (b,c,d,e,f)	Repeated over-exposures	<ul style="list-style-type: none"> <li>• Ulceration of the skin or mucous membrane (breaks in the skin, disintegration of tissue, pus formation)</li> <li>• Abdominal pains and other persistent symptoms of illness</li> <li>• Possible effect on skin (hyperkeratosis), cardiovascular system, peripheral nervous system, bone marrow (hematopoietic changes) liver and lungs</li> <li>• Carcinogenic to humans</li> </ul>	

- a) Health Canada / Water Quality - Reports and Publications / Chemical/Physical Parameters:
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/arsenic/index-eng.php>
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/copper-cuivre/index-eng.php>
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/chromium-chrome/index-eng.php>
- b) Pest Management Regulatory Agency, Re-evaluation Decision RVD2011-06, Heavy Duty Wood Preservatives: Creosote, Pentachlorophenol, Chromated Copper Arsenate (CCA) and Ammoniacal Copper Zinc Arsenate (ACZA)
  - <http://www.hc-sc.gc.ca/cps-spc/pubs/pest/decisions/rvd2011-06/index-eng.php>
- c) International Labour Organization ICSC Card database, .
  - <http://www.ilo.org/dyn/icsc/showcard.home>
- d) World Health Organization, International Programme on Chemical Safety  
<http://www.who.int/ipcs/en/>
  - [http://www.who.int/ipcs/assessment/public\\_health/arsenic/en/index.html](http://www.who.int/ipcs/assessment/public_health/arsenic/en/index.html)
- e) United States Environmental Protection Agency (USEPA).  
 Reregistration Eligibility Decision (RED) for Chromated Arsenicals (Case 0132), September 25, 2008
  - [http://www.epa.gov/oppsrrd1/reregistration/REDs/cca\\_red.pdf](http://www.epa.gov/oppsrrd1/reregistration/REDs/cca_red.pdf)
- f) Agency for Toxic Substances and Disease Registry (ATSDR)
  - <http://www.atsdr.cdc.gov/substances/index.asp>
- g) American Conference of Governmental Industrial Hygienists (ACGIH):
  - <http://www.acgih.org/tlv/>
- h) Occupational Safety & Health Administration (OSHA) Permissible Exposure Limits (PELs):
  - <https://www.osha.gov/dsg/topics/pel/>

## **5 Description of Preservative Application and Potential Chemical Discharges at CCA Wood Preservation Facilities**

### **5.1 Description of Process**

In 2012, 31 facilities used CCA and only 13 used it as their sole preservative (18). The impregnation of CCA into wood is carried out in pressure treatment plants ([refer to Part 1 – General Background Information, Section 2.2.3 Figure 3](#)).

Suppliers of CCA generally offer a high level of support services, including facility design and routine safety and consulting expertise on operations, maintenance and emergency response procedures. This approach provides a relatively high level of control over preservative use at most facilities (19). Design and operational guidance from the suppliers provides a national level of general consistency to CCA facilities.

CCA is normally purchased as a premixed concentrate (50% or 60%) shipped by bulk truck and rail tanker. The concentrate is stored in tanks and diluted with water to a 1.5–5.0% strength working solution. This dilution is accomplished by pumping transfers and by recirculation between bulk tanks. The working solution is then applied to the wood in a pressure cylinder, which may be up to 45 m long and 2 m in diameter.

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label. The CAN/CSA O80 (4) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

### **5.2 Potential Chemical Discharges**

CCA wood preservation plant designs and operational practices do differ, and within each plant there are various potential emission sources that may affect the adjacent environment and/or worker health. The potential sources and types of releases are illustrated in Figure 1.

#### *Liquid Discharges*

The CCA process uses water as a solvent. Therefore, drippage collected on the pad or rainwater collected in the process areas can be reused within the process. Economics and the toxicity of the process chemicals have led the CCA wood preservation industry to use closed treatment systems that contain, collect and reuse the chemical mixture to the greatest possible extent. Primary elements that may be used for CCA containment and recycling at well-operated facilities are illustrated in [Part 1 – General Background Information, Section 2.2.3 Figure 3](#).

Under normal operating practices, liquid discharges from a CCA treatment facility are confined to stormwater runoff from unpaved and unroofed areas where treated products are stored. The

quantity of copper, chromium or arsenic in such waters depends on many factors, such as quantity of precipitation, the degree of chemical fixation in the treated wood as determined by fixation time and temperature prior to the precipitation event, and soil characteristics of the storage yard. Uncontained liquid releases other than stormwater are generally confined to yard soils.

#### *Solid Wastes*

Refer to [Part 1, Chapter A, Section 5.2](#) for details on potential solid waste discharges.

#### *Air Emissions*

Several monitoring studies in the vicinity of CCA air emission sources (e.g. cylinder doors, tank storage areas) have been reported in the literature, and concentrations of copper, chromium and arsenic below existing occupational health limits were reported (19, 20, 21).

Refer to [Part 1, Chapter A, Section 5.2](#) for more details on potential chemical discharges.

### **5.3 Potential Effects of Chemical Discharges**

The actual impact to the environment of any liquid discharge, solid waste or air emission depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the released amount, the frequency of releases and contingency measures in place at the facility.

Environmental assessments of CCA facilities (19, 21) do exist. Environmental or worker health effects are commonly not caused by “normal” CCA usage at wood preservation facilities. However, available information indicates that improperly designed and/or operated facilities do have the potential to contaminate site soils and groundwater to levels that would prevent the use of such groundwater for drinking purposes (19). Also, surface runoff waters that exceed various regulatory limits have been reported (9). Nevertheless, accidental events in well-designed and maintained facilities can occur and are of equal concern.

**CCA  
Liquid Concentrate (Bulk)**

**Potential  
Chemical Releases**

```

graph TD
    A[Chemical Delivery  
(Bulk Tankers)] --> B[Chemical Storage  
(Tanks)]
    B --> C[Chemical Mixing  
(Closed System)]
    C --> D[Solution Storage  
(Tanks)]
    D --> E[Pressure Treatment  
(Retort cylinder)]
    E --> F[Freshly Treated Wood Storage  
Roofed Drip Pads]
    F --> G[Fixation Chamber]
    G --> H[Dry Treated Wood Storage (Ground)]
    
    A -.-> S1[Sumps]
    B -.-> S2[Sumps]
    C -.-> CS[Contaminated Solution]
    CS -.-> S3[Sumps]
    CS -.-> F1[Filter]
    F1 --> D
    E -.-> S4[Sumps]
    F -.-> S5[Sumps]
    G -.-> S6[Sumps]
    
    A --- AR[•DRIPS, SPILLS to floor, to sumps]
    B --- BR[•AEROSOLS to vents (outside vents)  
•DRIPS, SPILLS to floor, to sumps]
    C --- CR[•AEROSOLS to vents (outside vents)  
•DRIPS, SPLATTERS to surfaces (Access points)]
    D --- DR[•AEROSOLS to vents (outside vents)  
•DRIPS, SPILLS to floor, to sumps]
    E --- ER[•AEROSOLS to air (retort opening), to vents (outside vacuum exhaust)  
•DRIPS to floor, to sumps (retort opening)]
    F --- FR[•DRIPS, SPILLS to floor, to sumps  
•PAD Overflow to floor  
•DUST to air]
    G --- GR[•DRIPS to floor, to sumps  
•Condensates to air  
•DUST to air]
    H --- HR[•RAINWASH to ground  
•DUST to air]
  
```

**Process Flow and Potential Releases:**

- Chemical Delivery (Bulk Tankers)**
  - DRIPS, SPILLS to floor, to sumps
- Chemical Storage (Tanks)**
  - AEROSOLS to vents (outside vents)
  - DRIPS, SPILLS to floor, to sumps
- Chemical Mixing (Closed System)**
  - AEROSOLS to vents (outside vents)
  - DRIPS, SPLATTERS to surfaces (Access points)
- Solution Storage (Tanks)**
  - AEROSOLS to vents (outside vents)
  - DRIPS, SPILLS to floor, to sumps
- Pressure Treatment (Retort cylinder)**
  - AEROSOLS to air (retort opening), to vents (outside vacuum exhaust)
  - DRIPS to floor, to sumps (retort opening)
- Freshly Treated Wood Storage (Roofed Drip Pads)**
  - DRIPS, SPILLS to floor, to sumps
  - PAD Overflow to floor
  - DUST to air
- Fixation Chamber**
  - DRIPS to floor, to sumps
  - Condensates to air
  - DUST to air
- Dry Treated Wood Storage (Ground)**
  - RAINWASH to ground
  - DUST to air

**SUMPS & FILTERS:**

- SLUDGES to ground, to landfill

## 6 Protection of Personnel

Electronic copies of the pesticide labels for all registered CCA products, which contain information on product handling precautions, minimum worker protective equipment and health hazard warnings, can be obtained at the Health Canada website: <http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php> (7). The conditions of use specified on the pesticide label are mandatory by law. Ensure that the information on the most current product label is followed.

### 6.1 *First Aid, Precautions and Hygiene for CCA Exposure*

The general rule for dealing with exposure is as follows: **the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs.** If there is any doubt as to the concentration, the response should be the same as for the most concentrated form.

Facility staff should have access to pesticide labels and appropriate training to apply first aid. First aid personnel should periodically verify up-to-date response measures with chemical suppliers and/or industrial physicians.

Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with CCA solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

Table 5 details the first aid measures for different type of exposure to CCA. First and second actions are described to provide hierarchic step by step actions.

**Table 5. First Aid Measures for Exposure to CCA**

Exposure	First action	Second action
<ul style="list-style-type: none"> <li>Eye contact</li> </ul>	<ul style="list-style-type: none"> <li>Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids.</li> <li>Flush eyes for at least 15 minutes.</li> <li>If exposed person wears contact lenses, remove them 5 minutes after rinsing and then continue rinsing for at least 10 min.</li> </ul> <p><i>Workers should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>Use boric acid solution and cortisone ophthalmic drops.*</li> <li>Call an industrial physician or poison control centre immediately for subsequent advice (have product label at hand).</li> <li>Get medical attention.</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>Flush contaminated area immediately with flowing water.</li> <li>Subsequently remove contaminated clothing.</li> <li>Continue to flush contaminated skin for at least 15 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre immediately for subsequent advice (have product label at hand).</li> <li>Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>Immediately remove the exposed person to fresh air.</li> <li>If breathing has stopped: <ul style="list-style-type: none"> <li>Call emergency services (ex. 911)</li> <li>Apply artificial respiration with barrier device</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Keep the affected person warm and quiet.</li> <li>Get immediate medical attention (have product label at hand).</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>Promptly have the exposed person drink a large quantity of milk, egg whites, gelatin solution or water if the aforementioned are unavailable.</li> <li>Never give liquids to an unconscious person.</li> </ul>	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre immediately for subsequent advice (Stomach pumping by medical personnel is desirable) (have product label at hand).</li> <li>Do not induce vomiting.</li> </ul>
Chronic symptoms <ul style="list-style-type: none"> <li>– nervous system</li> <li>– ulceration of the skin or mucous membrane</li> <li>– abdominal pains</li> <li>– other persistent symptoms of illness</li> </ul>		<ul style="list-style-type: none"> <li>Get medical attention</li> </ul>

\* Emergency first aid kits should be equipped with boric acid solution and cortisone ophthalmic drops.

For all medical attention, always take the pesticide label to show to the health personnel.

Personnel should follow the recommendations from [Table 6 of Chapter A](#) outlining general precautions and personal hygiene measures.



## 6.2 Regulatory Controls

The labels for pesticide products contain information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the facility.

**Specific limits for worker protection are generally prescribed by provincial regulations.** Consult your local authorities for specific applicable regulations.

Most of the criteria are based on the TLVs and BEIs recommended by the [American Conference of Governmental Industrial Hygienists \(ACGIH\)](#). The ACGIH limits of exposure in the workplace are specified in Table 4.

### *Skin and Eye Contact*

Chromated copper arsenate, as such, is not discussed by the ACGIH. With reference to skin and eye contact, the ACGIH provides the following conclusions in its support rationale (22) for TLV levels for individual components of CCA:

- Copper salts act as irritants that may produce itchy eczema on skin and conjunctivitis or ulceration of the eye. However, the TLV for copper salts is based on inhalation.
- Hexavalent chromium may cause contact dermatitis and skin ulcers, and may be absorbed through skin to cause kidney damage.

Nonetheless, ACGIH-recommended limits for copper, chromium and arsenic are based only on “inhalation” TLVs. These limits may not adequately take into account routes of exposure other than inhalation. The ACGIH has suggested that in such cases, “biological exposure indices may be useful as a guide to safe exposure” (22)

### *Inhalation*

The ACGIH has defined TLVs for many substances based on exposure by inhalation and/or by skin exposure. The ACGIH limits for copper, chromium and arsenic are based solely on exposure by inhalation. The TLVs stipulated by the ACGIH are those “airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects.” The TLVs for copper, chromium and arsenic (22) are defined in Table 4 with the following provisos of the ACGIH:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentration.”

- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

Since CCA wood preservation facilities exclusively use CCA water solutions, the limits as defined by the ACGIH would apply primarily to suspended aerosols, dusts or gases generated during welding or at the cylinder door when pulling charges. Generally, airborne contaminants are not generated in CCA facilities at quantities that would cause worker health problems. Incidents of aerosol exposure would be more probable at improperly maintained facilities (i.e. from leaking seals) or at inadequately designed or maintained facilities (e.g. from vacuum pump discharges to the work area). Nevertheless, incidental exposure in well-designed and maintained facilities can occur and are of equal concern. Dust generation is most probable from forklifts and trucks moving on the drip pad and the yard and is also expected from cleaning operations. Frequent washdowns of pads and collection of the sump contents should minimize airborne contaminants caused by pad traffic. The International Labor Organization strongly suggests the use of wet or vacuum methods for cleaning up chromium solution spills, to prevent dispersion as airborne dust.

### *Ingestion*

Oral intake of CCA must be avoided. Ingestion of CCA-containing liquids is unlikely if workers follow the precautions outlined in Table 8. Acceptable limits of ingestion are not prescribed by regulation, since it is generally expected that no such intake will occur. Reported fatal single dose levels for components of CCA, include

- 0.7 g chromium as Cr+6 assuming a 70-kg body weight (13); and
- 14 g copper as Cu+2 (23).

Oral toxicity values of arsenic As+5 to humans are not defined. Reported fatal doses for “arsenic” and “As+3” have ranged from 20 to 300 mg (13, 24). The Registry of Toxic Effects (20) suggests that As+5 is more acutely toxic to rats than As+3; however, it is known that laboratory animals react to arsenic differently than do humans. An absolute lethal dose to a person of As+5 as used in CCA, therefore, cannot be derived from animal data and remains unknown. However, because As+5 is partially metabolized into As+3, its potential toxicity should be assumed to be as high as that of As+3.

### 6.3 Safety Precautions

Workers need to familiarize themselves with the following safety precautions in addition to those mentioned in [Chapter A, Section 6.3](#). Sensitive individuals should take special care to avoid exposure.

**Table 8. Additional Safety Precautions for Personnel Working with CCA**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 8.)

Activity	Recommendations
<b>Objective:</b> Ensure safe workplace practices for each activity during the treatment process	
Cleaning cylinders, fixation chambers or storage tanks	<ul style="list-style-type: none"><li>• <b>Personal protective equipment:</b> Select NIOSH-approved respirators with combination of acid gas/high-efficiency filter cartridges (or breathing apparatus if working in an enclosed environment) approved for inorganic arsenic.</li></ul>
Removing load jams	
Removing treated charges from cylinders	
And other process as required if preservative concentrations are above regulatory values or concentrations are unknown.	

### 6.4 Biological Monitoring of Exposed Workers

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to [Chapter A, Section 6.4](#).

## 7 Design Recommendations

The following tables present good design features specifically applicable to CCA wood preservation facilities. The additional recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 7 and their corresponding tables. All tables of general content from Chapter A, [Section 7](#) must be taken into consideration.

**Table 12. Additional Recommended Design Features for Chemical Mixing Systems**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 12.)

Chemical format	Design feature	Recommendations
CCA bulk concentrate	Location/shelter	<ul style="list-style-type: none"><li>• Locate in a contained, enclosed, heated area, particularly if sub-freezing temperatures are encountered during operation.</li></ul>

**Table 14. Additional Recommended Design Features for Freshly Treated Wood Drip Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 14.)

Design feature	Recommendations
<b>Objective</b>	Minimize losses of preservative chemicals from treated wood by <ul style="list-style-type: none"><li>• providing proper conditions for preservative fixation in freshly treated wood; and</li><li>• controlling the generation and disposal of contaminated runoff waters.</li></ul>
<b>Drip area</b>	<ul style="list-style-type: none"><li>• Provide for sufficient contained, impermeable floor and <u>roofed</u> storage or transfer area for freshly treated wood prior to application of the fixation process (accelerated or under ambient conditions).</li></ul>
<b>Storage area for fixation under ambient conditions</b>	<ul style="list-style-type: none"><li>• The storage area for fixation under ambient conditions should be contained and roofed, with provisions for recovery of drips and any infiltrating precipitation.</li><li>• Provide the fixation storage area with a drip collection system and an impermeable floor for collection of drips.</li></ul>

**Table 15. Recommended Design Features for Accelerated Fixation Areas**

<b>Design feature</b>	<b>Recommendations</b>
<b>Objectives:</b>	<ul style="list-style-type: none"><li>◊ Minimize losses of preservative chemicals from treated wood to the environment by providing adequate controls to ensure minimization of preservative drippage prior to removal to unprotected storage areas</li><li>◊ Ensure fixation of preservative prior to release to uncontained storage area</li><li>◊ Reduce the time required for fixation from that required for ambient fixation</li></ul>
<b>General design</b>	<ul style="list-style-type: none"><li>• Consider integrated design provisions for<ul style="list-style-type: none"><li>– area that is sheltered from precipitation, dust, debris;</li><li>– adequate air flow; and</li><li>– sufficient heat and humidity to achieve fixation.</li></ul></li></ul>
<b>Drip and containment</b>	<ul style="list-style-type: none"><li>• Area should have an impermeable floor and designed so that any residues may easily be cleaned up.</li><li>• Area should be fully contained with sufficient grade and an efficient drainage system to direct any free liquid to a collection and recycling system.</li><li>• Provide for return of fluids to treatment process with minimum dispersal from tracking by personnel and vehicles.</li></ul>

## 8 Operational Recommendations

The following tables present good operating practices specifically applicable to CCA wood preservation facilities. The recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8 and their corresponding tables. All tables of general content from Chapter A, [Section 8](#) must be taken into consideration.

### 8.1 Operational Standards

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including CCA. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2-08 Clause 4.1 (referenced to AWWA M3). The calibration can be conducted by facility staff if they have the appropriate training.

As per the pesticide labels, a fixation process shall be used after CCA treatment to ensure the chemical reduction of soluble hexavalent chromium and substantially immobilize CCA components in the wood before removal from protected storage. The reduction of chromium is a temperature-dependent process that needs from several hours under typical fixation chamber conditions to several weeks at near freezing temperatures. Treated wood shall be held at the treating facility in protected storage until chromium reduction has been completed and hexavalent chromium is not detectable using Method 11 of AWWA A3 and the supplementary requirements to Method 11 specified in Clause 6.5.2 (4).

### 8.2 Facility Wide Recommendations

In order to develop a successful facility-specific worker safety and environmental protection protocol, it is important to have an operations manual that provides written instructions to employees for all aspects of chemical use.

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### 8.3 Area specific Recommendations

Table 21 provides additional recommended operating practices for the accelerated fixation chamber and for the dripping area. Table 22 provides additional recommended operating practices for maintenance, cleanout and shutdown of CCA treatment systems. User should refer also with Part I, Chapter A – [Table 21](#) and [Table 22](#) since these tables should be used in conjunction.

**Table 21. Additional Recommended Operating Practices for Accelerated Fixation Chamber and Dripping Area**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 21.)

Design feature	Recommendations
Objective	Ensure that ground contamination due to preservative drippage or leaching is minimized
Treatment process	Apply an effective final vacuum after completion of the pressure cycle.
Fixation	<p>Fixation is a temperature- and humidity-sensitive process that may take from several hours at 60 to 70°C to more than 4 or 5 months at 5°C.</p> <p>Accelerated fixation at elevated temperatures (e.g. 70°C) requires the presence of high humidity conditions to ensure optimum fixation results. Accelerated fixation is preferred to fixation under ambient conditions. It can be achieved by application of elevated temperatures, while maintaining high humidity conditions. Conditions promoting drying do not result in optimum fixation levels.</p> <p>Where interim storage is necessary, freshly treated wood should be held in a protected, contained area until moved into the accelerated fixation unit or to the protected area used for fixation under ambient conditions.</p> <p>The treated wood should be released from the protected fixation area only after CCA fixation has been verified by an acceptable test method (e.g. CAN/CSA O80 and AWWA-A3/11).</p> <p>See also Tables 14 and 15, Drip and Fixation Areas.</p>

**Table 22. Additional Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems (CCA Preservatives)**

(Use in conjunction with Part I, Chapter A - General Recommendations for All Wood Preservatives, Table 22.)

Operation	Recommendations
<b>Equipment maintenance</b>	<p><b>Objective:</b> Ensure that equipment is maintained in a manner that will minimize releases of preservative chemicals and minimize worker exposure to them and their by-products</p>
<b>Alarms and Safety Devices</b>	<p><b>Equipment:</b></p> <ul style="list-style-type: none"> <li>• <b>Valves</b> must be tested every 6 months and replaced as required.</li> <li>• Test <b>tank vents</b> at least once a year to ensure they are not blocked.</li> </ul> <p><b>Alarms:</b></p> <ul style="list-style-type: none"> <li>• <b>Off-loading area:</b> Test the manual alarm on a weekly basis and prior to the delivery of concentrate.</li> <li>• <b>Chemical storage area:</b> <ul style="list-style-type: none"> <li>○ The circuitry of the tank's high-level alarm and the 24-hour monitoring alarm should be tested weekly and probes should be checked every 12 months.</li> <li>○ The function of all manual emergency alarms should be tested weekly.</li> <li>○ The containment high-level alarm should be tested weekly.</li> </ul> </li> <li>• <b>Chemical mixing systems:</b> <ul style="list-style-type: none"> <li>○ The circuitry of the high-level alarm should be tested weekly and probes should be checked every 12 months.</li> </ul> </li> <li>• <b>Treatment process systems:</b> <ul style="list-style-type: none"> <li>○ The high-level alarms of the sumps should be tested weekly.</li> </ul> </li> </ul> <p><b>All test details should be recorded (documented).</b></p>



## 9 Waste, Process Emissions and Disposal

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 9.1 Control, Treatment and Disposal

Potential process emission sources from CCA wood preservation facilities are described in Figure 1 and Section 5.2. The main categories of process wastes or emissions that may be encountered at CCA facilities, along with their recommended disposal methods, are presented in Table 23.

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information.

### 9.2 Liquids Containing CCA

#### *Liquid Process Wastes*

Liquid process wastes are not normally discharged from CCA plants. Liquid solutions containing CCA, such as drips and washwaters, are routinely collected and reused in preparing new treatment solutions. If unusual circumstances (such as prolonged plant shutdown) prevent on-site reuse, transport to another CCA facility (for reuse) should be arranged. Disposal should be considered only as a last alternative.

### 9.3 Solids with High CCA Concentrations

Consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 9.4 Miscellaneous Solid Wastes

CCA concentrate drums should be rinsed thoroughly (triple rinsed – see Chapter A [Section 9.4](#)) with water prior to disposal, and the rinse water should be used for the preparation of working solutions.

- Do not use CCA treated wood as a compost or mulch.
- Incineration of CCA-contaminated materials is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products.

### 9.5 Air Emissions

Air emissions at CCA facilities are normally localized; effects, if any, would be restricted to workers at the facilities. Air emissions from CCA facilities include the following:

- exhaust from tank vents
- mists from vacuum pump discharge

- mists from opening of retort cylinder doors
- mists from accelerated fixation facilities

Monitoring of mists (20, 21) in the vicinity of several CCA retort cylinder door openings has shown that, at the studied sites, arsenic, chromium and copper concentrations were below published ACGIH TLVs (22). Emissions from vacuum pump discharges have not been evaluated. However, evidence of CCA releases from such discharges was reported in an Environment Canada study (19). Some facilities discharge vacuum pumps through simple traps to condense and collect emissions (19). This practice is highly recommended. A study on air emissions from kilns treating CCA-impregnated wood indicated that releases of chromium, copper and arsenic were frequently below detection limits (25).

**Table 23. Recommended Disposal Practices for Wastes Contaminated with CCA**

Waste category	Examples	Recommendations
(Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, <a href="#">Table 23.</a> )		

## 10 Environmental and Workplace Monitoring

### 10.1 Baseline Environmental Evaluation

Copper, chromium and arsenic, the components of CCA, are natural elements that at normal background concentrations (generally in Canada) do not have discernible adverse effects on biota. Table 24 presents a typical concentration of CCA constituents in a Canadian non-polluted environment (7, 13).

**Table 24. Typical Background of CCA Constituents  
(copper, chromium, arsenic)**

Element	Typical concentration in non-polluted environments	
	Surface waters (mg/L)	Soils (mg/kg)
Copper (Cu)	< 0.001 to 0.04	2 to 100
Chromium (Cr)	0.003 to 0.04	5 to 1000 (50 mg/kg is normal)
Arsenic As)	< 0.001 to 0.01	1 to 50 (up to 500 mg/kg found in sulphide deposits)

Considerable variability in natural concentrations of copper, chromium and arsenic occurs in soils and waters. Therefore, it is important to determine background levels of the site immediately prior to operating a facility, to enable meaningful future assessments of pollution control at the facility. Older facilities may not have this information available. A comparative site from a nearby property can be used as a reference. The facility may use the template provided in Part 1, Section 10, [Table 24](#) from Chapter A.

### 10.2 Environment Monitoring

There have been few studies of CCA releases from wood preservation facilities to the adjacent environment. Data compiled for regulatory purposes (19) indicate that when proper precautions are not taken, groundwater in the immediate vicinity of CCA facilities may be contaminated to levels that render it unsafe for human use. To a limited extent, stormwater runoff from CCA facilities has also been analyzed, and the results indicate that this water may contain at least one of the elements copper, chromium or arsenic at levels in excess of existing water quality limits (9). The studies also indicate that ratios of copper/chromium/arsenic are not consistent within runoff waters. The inconsistency may be due to differences in the ability of the components to bind to the yard soils or due to different sources within the yards (i.e. stored lumber washoff versus dripped material from freshly treated loads). Arsenic is persistent in the environment and close monitoring studies (such as surface water discharges, groundwater and contaminated soil) are recommended to properly assess the degree of such releases. Arsenic, copper and chromium are the minimum components that should be monitored for CCA facilities.

### 10.3 Workplace Exposure Monitoring

Workplace monitoring generally falls under provincial jurisdiction. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a

provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist.

Studies of air quality at several CCA facilities have been reported (19, 20, 21); concentrations of arsenic, copper and chromium at those facilities were found to be below regulatory workplace standard action levels. The treatment process requires no external heat sources (except for kiln drying and in facilities applying accelerated fixation processes) and no vapours should be created. Air releases, if any, would be in the form of localized mists. The effect of a normal CCA facility on air quality of the surrounding environment is expected to be non-detectable.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## 11 Transportation of CCA and its Wastes

The transportation of CCA concentration, solution and the wastes generated by their use is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details, please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/menu.htm>

<http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of CCA and its wastes.

## **12 Environmental Emergency Notification and Contingency Planning**

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using CCA should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective.

### **12.1 Environmental Emergency Notification**

The Environmental Emergency Regulations and its requirements are applicable for CCA since it contains arsenic and chromium VI, listed in Schedule 1 of CEPA 1999.

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.2 Spill Contingency Planning**

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.3 Fire Contingency Planning**

Components of CCA and CCA solutions are not flammable. Tests comparing the toxicity of combustion products from CCA-treated wood versus untreated wood showed no differences in acute toxicity (23).

However, precautions should be taken in the event that a fire occurs in the vicinity of CCA solutions. One of the components, chromic acid, is a strong oxidizer and may increase the fire threat upon dispersal on wood floors, pallets, cotton packaging or cartons. Arsenic acid may be converted to more toxic reduced forms of arsenic upon exposure to high temperatures. It is, therefore, important that CCA wood preservation facilities devise an adequate contingency plan for fire protection, including storing a copy of all necessary documents in a fire proof box outside the entrance to the facility.

Please refer to the *National Fire Code of Canada (always refer to last version available)* (26) and to [Section 12.2](#) of Part I, Chapter A - General Recommendations for All Wood Preservatives.

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## CHAPTER C

# Ammoniacal Copper Zinc Arsenate (ACZA) Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives

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# 1 Production and Use

Ammoniacal copper zinc arsenate (ACZA) is a water-borne formulation that can be purchased in a premixed solution only. It use to be prepared on-site at wood preservation facilities by mixing and oxidizing arsenic acid, copper oxide, zinc oxide, ammonium hydroxide, ammonium bicarbonate and water.

ACZA is bought as a concentrate; 9.92% total oxide as CuO, ZnO and As<sub>2</sub>O<sub>5</sub> at an approximated ratio of 2:1:1. For the preparation of work solutions (0.5% to 10% active ingredients) the concentrate is diluted with requisite amounts of water. Totes rinsate and effluent water can be used for this purpose. The use of Ammonium Hydroxide concentrate can sometime be use to top up the ACZA concentrate if the ammonia levels gets low.

ACZA is particularly suited for treatment of refractory wood species such as Douglas Fir. Major products are construction timbers (e.g. highway timbers), fence posts and marine structures. Although ACZA was developed in Canada and has been used in the United States for about twenty years, it was not introduced commercially into Canada only until 1999.

ACZA treated wood was produced in Canada until 2006 (1). In 2012, no facility in Canada used ACZA preservative. However one facility is scheduled to begin treating operations with ACZA in 2013. (2).

**Table 1. ACZA Use in Canada**

<b>Feature</b>	<b>Characteristics</b>
<b>Treated wood use limitations in Canada</b>	Not for residential uses Not for infrastructure that may be in contact with drinking water, food or animal feeds (storage, production, transport...) *Note: permitted uses and limitations of ACZA-treated wood may change over time. Refer to pesticide label for up-to-date uses.
<b>General process of application</b>	Pressure treatment (refer to the pesticide label for details) with closed mixing and transfer system only.

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes ACZA-treated products (3).

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label.

## 2 Physical and Chemical Properties

Copper, zinc and arsenic are used because of their biocidal properties and their ability to be retained by wood for long-term protection. Ammonium bicarbonate facilitates the dissolution of the metals. Ammonium hydroxide is used as a solvent carrier for copper zinc arsenate; once the ammonia evaporates from the wood, the copper and zinc arsenate precipitate in the wood cells in forms that remain highly resistant to leaching. The use of ammonia also prevents copper from corroding iron components in the treating equipment.

The physical and chemical properties of ACZA and its constituents are outlined in Tables 2.0 and 2.1. General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and the product labels for pesticidal products (pesticide label). Electronic copies of the pesticide label can be obtained from the Health Canada website: <http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php> (4).

**Table 2.0. Physical and Chemical Properties of ACZA Solution**

Identification		
<b>Common synonyms:</b> Chemonite, ACZA (Ammoniacal copper zinc arsenate)	<b>Registrant in 2012:</b> Lonza - Arch Wood Protection Canada Corp. (Mississauga, ON): <ul style="list-style-type: none"><li>Chemonite Wood Preservative Solution</li></ul>	
Transportation and storage information		
<b>Shipping state:</b> Liquid concentrate; <b>Concentration:</b> (by weight, as oxides) Concentrates, 22% including <ul style="list-style-type: none"><li>copper or cupric oxide;</li><li>zinc oxide;</li><li>arsenic acid;</li><li>ammonia.</li></ul>	<b>Storage temperature:</b> Ambient <b>Hoses:</b> Use PVC, rubber, polyethylene steel or stainless steel fittings only. <b>Venting:</b> No requirement  <b>Containers/materials:</b> Plastic, steel or steel polylined	<b>Classification:</b> Poisonous, corrosive liquid  <b>Placards: Class 6.1 P.G II</b> <i>Check with Transport Canada.</i>  <b>Delivery format:</b> Bulk tank for concentrate
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1 atm) <b>Vapour pressure (27°C):</b> 8% solution, 72 mm Hg <b>Solubility:</b> Freely soluble (water) <b>Concentration of work solutions:</b> Work solutions 0.5% to 10%	<b>Floatability:</b> Mixes with water <b>Freezing point:</b> -3°C to -5°C <b>Flash point:</b> Not applicable (see ammonia) <b>Explosive limits:</b> Mixtures of ammonia in air (16–25% by volume) in an enclosed space can ignite or explode if sparked or exposed to temperatures exceeding 650°C (1200°F)	<b>Colour:</b> Light blue <b>Odour:</b> Sharp, characteristic odour (50 ppm threshold) <b>pH:</b> 2% solution, 10.2 8% solution, 12.0 <b>Typical preservative retention in treated wood:</b> 4.0 to 30 kg/m <sup>3</sup> treated wood
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Liquid is non-flammable. Most extinguishing agents can be used on fires involving ammonium hydroxide and arsenic acid. <i>Fire behaviour:</i> Liquid not flammable. Mixtures of ammonia and air can ignite or explode (see above). When exposed to fire, the liquid solution releases ammonia gas as well as copper, zinc and arsenic fumes. <i>Ignition temperature:</i> Not flammable as liquid; ammonia is flammable at 649°C. <i>Burning rate:</i> Not applicable		<b>Reactivity</b> <i>With water:</i> No reaction, soluble. <i>With common materials:</i> Copper, tin and zinc alloys are readily corroded. Reacts with acrolein, acrylic acid, chlorosulphonic acid, dimethyl sulphate, halogens, hydrochloric acid, hydrofluoric acid, nitric acid, sulphuric acid, oleum, propylene oxide and silver nitrate. Avoid contact with aluminium or zinc. Strong reducing conditions may produce arsine gas. <i>Stability:</i> Stable



**Table 2.1. Physical and Chemical Properties of Ammonium Hydroxide (5)**

Identification		
<b>Common synonyms:</b> Aqua ammonia, NH <sub>4</sub> OH Anhydrous Ammonia Ammonium hydrate Ammonium solution Ammonia water		<b>Manufacturers:</b> CFIndustries Inc., Courtright, Ontario Canadian Fertilizers Ltd., Medicine Hat, Alberta Simplot Chemical Ltd., Brandon, Manitoba
<b>United Nations (UN) number:</b> 2672		
Transportation and storage information		
<b>Shipping state:</b> Liquid <b>Concentrations:</b> Grade A: 29.4%      USP: 27–29% B: 25%              CP: 28% C: 15% <b>Classification:</b> Poisonous, corrosive	<b>Storage temperatures:</b> Ambient <b>Hoses:</b> Use PVC, rubber, polyethylene steel or stainless steel fittings only. <b>Venting:</b> Provide scrubbing to meet air discharge regulatory limits.	<b>Containers/materials:</b> Totes, tank trucks, tank cars (steel or steel polylined). Use all iron or stainless steel pumps (no copper alloys, brass or bronze). 29% aqua ammonia liquid (bulk) <b>Placards:</b> Check with Transport Canada.
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1 atm.) <b>Vapour pressure:</b> Ammonia      (0°C)      (27°C) 10%          31 mm Hg      159 mm Hg 20%          88 mm Hg      310 mm Hg 30%          238 mm Hg      786 mm Hg <b>Solubility:</b> Freely soluble (water)	<b>Floatability:</b> Floats and mixes with water <b>Flash point:</b> Flammable as ammonia <b>Explosive limits:</b> Mixtures of ammonia in air (16–25% by volume) in an enclosed space can ignite or explode if sparked or exposed to temperatures exceeding 650°C (1200°F).	<b>Colour:</b> Colourless <b>Odour:</b> Sharp, characteristic odour (50 ppm threshold) <b>Vapour density:</b> 0.6 <b>Specific gravity:</b> 0.90 (15.5°C)
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Liquid is non-flammable. Most extinguishing agents can be used on fires involving ammonium hydroxide and arsenic acid. <i>Fire behaviour:</i> Liquid not flammable. Mixtures of ammonia and air can ignite or explode (see above). When exposed to fire, the liquid solution releases ammonia gas. <i>Ignition temperature:</i> Not flammable as liquid; ammonia is flammable at 649°C. <i>Burning rate:</i> Not applicable		<b>Reactivity</b> <i>With water:</i> No reaction, soluble <i>With common materials:</i> Copper, tin and zinc alloys are readily corroded. Reacts with acrolein, acrylic acid, chlorosulphonic acid, dimethyl sulphate, halogens, hydrochloric acid, hydrofluoric acid, nitric acid, sulphuric acid, oleum, propylene oxide and silver nitrate. Avoid contact with aluminium or zinc. <i>Stability:</i> Stable

### 3 Environmental Effects

Ammonia, copper, zinc and arsenic are found naturally in the environment. Considerable variation occurs in natural concentrations of copper, zinc and arsenic in soils and waters (5).

#### 3.1 *Aquatic Toxicity*

In considering the aquatic toxicity of ACZA, the following points should be borne in mind:

- The valence of arsenic, copper and zinc may change in the environment, and these changes may reduce or enhance the toxicities of the elements. No studies have been reported in the literature on valence inter-conversion of copper, zinc or arsenic in soils, groundwater or surface runoff water at or from ACZA facilities. Nonetheless, it is known that reduced forms of copper rarely occur in aqueous environments (6). A limited study to assess arsenic speciation in samples of soil and water in the vicinity of chromate copper arsenate (CCA) facilities showed that the samples contained at least 97% of the original pentavalent form of arsenic (7). A similar predominance of the pentavalent form is assumed at ACZA facilities.

The guidelines and limits for copper, zinc and arsenic noted in Table 3 are based on total concentrations. They reflect the recommendations of many scientific reviews that indicate that the current state of knowledge does not enable water quality limits to be based on either valence state or dissolved fractions in water (8).

Canadian limits for ammonia, arsenic, copper and zinc in aquatic environments are listed in Table 3, and these limits are subject to change from time to time. Recurrent review of these limits is recommended.

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for Arsenic, Ammonia, Copper and Zinc in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Arsenic	Maximum: 0.05 mg/L	Protection of human health	International Joint Commission <sup>(a)</sup>
	Maximum: 0.01 mg/L	Objective: < 0.005 mg/L	Health Canada <sup>(b,c)</sup>
	Fresh water: 0.005 mg/L Marine: 0.0125 mg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>
Ammonia	Maximum: 0.5 mg/L Maximum: 0.02 mg/L	Protection of human health Protection of aquatic life	International Joint Commission <sup>(a)</sup>
	No numerical guidelines (under review)		Health Canada <sup>(b,c)</sup>
	Fresh water: 0.019 mg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>
Copper	Maximum: 0.005 mg/L	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
		Aesthetic objectives: < 1.0 mg/L	Health Canada <sup>(b,c)</sup>
	Fresh water: • 0.002 mg/L Hardness 0-60 mg/L as CaCO <sub>3</sub> • 0.003 mg/L Hardness 60-120 mg/L as CaCO <sub>3</sub> • 0.004 mg/L Hardness 120–180 mg/L as CaCO <sub>3</sub> • 0.006 mg/L Hardness > 180 mg/L as CaCO <sub>3</sub>	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>
Zinc	Maximum: 0.03 mg/L	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
		Aesthetic objectives: < 5.0 mg/L	Health Canada <sup>(b,c)</sup>
	Freshwater: 0.03 mg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>

(a) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).

o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)

o <http://www.ijc.org/rel/agree/quality.html>

(c) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.

o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>

(c) “Maximum acceptable” was defined by Health and Welfare Canada as: “Drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable.” “Objective” is defined by Health and Welfare Canada as: “This level is interpreted as the ultimate quality goal for both health and aesthetic purposes.”

(d) Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life. <http://st-ts.ccme.ca/>

## 4 Human Health Concerns

Ammonia, copper, zinc and arsenic are found naturally in food, water and air. Table 4.0 provides estimated daily intakes of these elements by the general population (5, 9, 10, 11). Figure 1 in Section 5.2 – Potential Chemical Discharges indicates where each component can be encountered in the process.

One safety objective for the industrial use of any chemical (in this case, ammonia, copper, zinc or arsenic) is to minimize worker exposure to the chemical, ideally so as not to exceed acceptable intake levels. If safeguards are not provided or implemented, a variety of human health effects may occur depending on the duration and manner of exposure, concentration of chemicals, chemical forms (valence), and varying metabolic sensitivities of individual workers.

The PMRA's re-evaluation decision for the registration of the heavy duty wood preservatives creosote, pentachlorophenol, chromated copper arsenate and ammoniacal copper zinc arsenate, has granted continued registration of these products for sale and use in Canada. Potential risks from inhalation and dermal exposure were identified for some occupational tasks within wood-treatment facilities. The addition of new risk-reduction measures and the development of a Risk Management Plan for heavy duty wood preservatives will continue to lower the potential for occupational risks to treatment facility workers (12).

Workers need to familiarize themselves with all current material safety data sheets.

Table 4, which is based on information from existing literature, outlines the spectrum of human health effects that could result from various degrees of exposure to ACZA and ammonium hydroxide concentrate.

**Table 4.0. Potential Health Effects of Exposure to ACZA**

Exposure Category (Route of Entry)	Type of exposure	Possible health effects <sup>(a,b,c,d,e)</sup>	
		Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) with limited to no health effect <sup>(a)</sup>			
Arsenic (found in foods, especially seafood) ( <i>organic arsenic</i> )	0.042 mg/day		
Copper (an essential element)	2.47 mg/day		
Ammonia (mostly through food)	18.6 mg/day		
Zinc (mostly through food)	13.0–16.1 mg/day		
Eye contact <sup>(b)</sup>	Eye contact with work solutions or concentrates	<ul style="list-style-type: none"><li>• Eye damage</li><li>• Irritation,</li><li>• Ulceration</li></ul>	<ul style="list-style-type: none"><li>• Not applicable</li></ul>
Skin contact	Skin contact with work solutions or concentrates	<ul style="list-style-type: none"><li>• Skin irritation, burns</li><li>• Inflammation</li><li>• Peripheral neuropathy</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• Potential carcinogenic action</li></ul>
Exposure to contaminated aerosols or dusts <sup>(b)</sup>	Inhalation of mists, droplets or aerosols of work solutions or concentrates (see table 4.1)	<ul style="list-style-type: none"><li>• Severe irritation of nose and throat</li></ul>	<ul style="list-style-type: none"><li>• Potential carcinogenic action</li></ul>
Ammonium Hydroxide	TLV <sup>(e)</sup> -time weighted averages (TWA): 1.0 mg/m <sup>3</sup> air		
Copper Oxide	TLV <sup>(e)</sup> -time weighted averages (TWA)*: 0.01 mg As/m <sup>3</sup> air TWA for arsine: 0.2 mg/m <sup>3</sup> of air (0.05 ppm)		
Arsenic Acid	TLV <sup>(e)</sup> -time weighted averages (TWA)*: 0.01 mg As/m <sup>3</sup> air TWA for arsine: 0.2 mg/m <sup>3</sup> of air (0.05 ppm)		
Zinc	TLV <sup>(e)</sup> -time weighted averages (TWA): zinc oxide (dust): 10 mg/m <sup>3</sup>		
Ingestion	Ingestion of work solutions or concentrates	<ul style="list-style-type: none"><li>• Nausea, abdominal pain, vomiting, shock, coma</li><li>• Death may occur if the absorbed amount of solution contains more than 130 mg arsenic or ammonia</li></ul>	<ul style="list-style-type: none"><li>• Possible liver and kidney damage, jaundice, reduced white blood cell count upon long-term exposure to 0.15-0.6 mg arsenic per day</li><li>• Potential carcinogenic action</li></ul>

**Table 4.1. Potential Health Effects of Exposure to Ammonium Hydroxide**

Exposure category	Type of exposure	Possible health effects <sup>(a,b,c,d,e)</sup>	
		Short-term exposure	Longer-term exposure
Eye contact <sup>(b)</sup>	Eye contact is very dangerous with 28% solutions	<ul style="list-style-type: none"> <li>• Cornea can be perforated</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>• Single contact</li> <li>• Contact of several minutes with 28% solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Skin irritation</li> <li>• Can cause corrosive damage</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>
Exposure to vapour, to airborne contaminant or dust	Inhalation of vapours	<ul style="list-style-type: none"> <li>• Severe irritation of nose and throat at 400 ppm Irritation of eyes at 700 ppm</li> <li>• At high concentration: laryngeal oedema, inflammation of the respiratory tract and pneumonia<sup>(b)</sup></li> </ul>	Minimal Risk Levels (MRLs) (as NH <sub>3</sub> ) <sup>(d)</sup> <ul style="list-style-type: none"> <li>• No MRL was derived for intermediate duration (15–364 days).</li> <li>• An MRL of 0.2 ppm has been derived for chronic-duration inhalation exposure (≥1 year).</li> </ul>
N.B. Evaporation of the substance at 20°C	TLV <sup>(e)</sup> -time weighted averages (TWA): 18 mg/m <sup>3</sup> air (25 ppm)	TLV <sup>(e,f)</sup> -short-term exposure limit (STEL): 24 mg/m <sup>3</sup> (35 ppm)	
		Minimal Risk Levels (MRLs) (as NH <sub>3</sub> ) <sup>(d)</sup> <ul style="list-style-type: none"> <li>• An MRL of 1.7 ppm has been derived for acute-duration inhalation exposure (≤14 days).</li> </ul>	
		<ul style="list-style-type: none"> <li>• Convulsive coughing at 1720 ppm May be fatal after 0.5-hour exposure</li> <li>• Respiratory spasm and asphyxia at 5000 to 10 000 ppm Rapidly fatal for exposure causing these symptoms</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> <li>• Not applicable</li> </ul>
Ingestion	Ingestion of work solutions or concentrates	<ul style="list-style-type: none"> <li>• Nausea, abdominal pain, vomiting, shock, coma</li> <li>• Death may occur from ingestion of more than 30 mL (1 oz.) of 25% solution</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>

a) Health Canada / Water Quality - Reports and Publications / Chemical/Physical Parameters:

- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/arsenic/index-eng.php>
- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/copper-cuivre/index-eng.php>
- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/ammonia-ammoni/index-eng.php>
- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/zinc/index-eng.php>

b) Pest Management Regulatory Agency, Re-evaluation Decision RVD2011-06, Heavy Duty Wood Preservatives: Creosote, Pentachlorophenol, Chromated Copper Arsenate (CCA) and Ammoniacal Copper Zinc Arsenate (ACZA)

- <http://www.hc-sc.gc.ca/cps-spc/pubs/pest/decisions/rvd2011-06/index-eng.php>

- c) International Labour Organization ICSC Card database:
  - <http://www.ilo.org/dyn/icsc/showcard.home>
- d) World Health Organization, International Programme on Chemical Safety  
<http://www.who.int/ipcs/en/>
  - [http://www.who.int/ipcs/assessment/public\\_health/arsenic/en/index.html](http://www.who.int/ipcs/assessment/public_health/arsenic/en/index.html)
- e) Threshold limit values. Agency for Toxic Substances and Disease Registry (ATSDR)
  - <http://www.atsdr.cdc.gov/substances/index.asp>
- f) American Conference of Governmental Industrial Hygienists (ACGIH):
  - <http://www.acgih.org/tlv/>

## **5 Description of Preservative Application and Potential Chemical Discharges at ACZA Wood Preservation Facilities**

### **5.1 Description of Process**

The impregnation of ACZA into wood is carried out in pressure treatment plants using a process similar to that used for chromate copper arsenate (CCA) (refer to Part 1– General Background Information, Section 2.2.3 [Figure 3](#)).

The specific treatment times and pressures are dictated by the species of wood, the wood product and the moisture content of the wood. Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label. The CAN/CSA O80 (3) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

Good practice, after the impregnation cycle, includes applying heat and a prolonged vacuum to remove ammonia. Ammonia loss causes precipitation of the active ingredients in the wood. Quality control tests are carried out to ensure that treated products meet a minimum quality standard.

### **5.2 Potential Chemical Discharges**

Based on the plant design and operational practices, various potential emission sources exist that may affect worker health and/or the environment. The potential sources and releases are illustrated in Figure 1.

#### *Liquid Discharges*

The ACZA process uses water-borne ingredients and is operated as a “closed” system. Dripped solution or contaminated storm runoff water can be reused in the process. Primary facility design features that should be used for ACZA containment and recycling include the following:

- sealed containment surfaces and dyking of major process components including the cylinder and ACZA tanks
- containment surfaces for chemical drips from treated wood on the cylinder discharging track and in the storage area for freshly treated wood
- a collection sump to receive residual preservative from the cylinder (following the treatment cycle) and the accumulated contaminated runoff from other containment surfaces. This material can then be reused in the treatment process following filtration to remove dust and debris.

The greatest potential sources of contaminated liquid discharges from ACZA facilities are stormwater runoff waters from unsealed and unroofed areas where treated products are stored or transferred. The quantities of ammonia, copper, zinc or arsenic in these waters depend on many factors, including quantity of precipitation, elapsed stabilisation time and temperature prior to a



precipitation event, and soil characteristics of the storage yard. Uncontained liquid releases other than stormwater are generally confined to yard soils, particularly those locations near drip pads in charging/unloading areas and when freshly treated wood is not stored on containment surfaces. These contaminated yard soils have the potential to cause groundwater contamination.

### *Solid Wastes*

Refer to Part 1, Chapter A, [Section 5.2](#) for details on potential solid waste discharges.

### *Air Emissions*

Due to its volatility, the use of aqueous ammonia implies a significant potential for ammonia emissions at the ACZA facility, if proper controls are not in place. Potential sources of ammonia releases include storage tank vents, ACZA mixing tank hatches and vents, vacuum pump exhausts, vapours released when retort cylinder doors are opened, and from freshly removed wood charges. Scrubbers should be used to control ammonia releases from plant equipment (vent tank). Potential sources of copper, zinc and arsenic emissions include mists from vacuum pump exhaust, cylinder doors and tank vents. Air emissions are generally intermittent and restricted to localized areas.

Air monitoring at one ACZA plant revealed that levels of ammonia were below 10ppm, 8 hour TWA and all levels of other component were below occupational health limits; however, ammonia emissions in the vicinity of retort cylinder doors during openings and near freshly treated wood could still be uncomfortable for the operator. Nevertheless, it is possible that the concentration of emissions can exceed existing occupational health limits depending on the plant design and its operational procedures.

Refer to Part 1, Chapter A, [Section 5.2](#) for more details on potential chemical discharges.

### **5.3 *Potential Effects of Chemical Discharges***

The actual impact to the environment of any liquid discharge, solid waste or air emission depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the released amount, the frequency of releases and contingency measures in place at the facility.

There have been no documented environmental or worker health effects as a result of “normal” ACZA use at wood preservation facilities. It can be assumed that improperly designed and/or operated facilities do have the potential to contaminate site soils and groundwater to levels that would prevent the use of such groundwater for drinking. Nevertheless, accidental events in well-designed and maintained facilities can occur and are of equal concern.



## 6 Protection of Personnel

### 6.1 *First Aid, Precautions and Hygiene for ACZA Exposure*

Human health effects could occur as a result of improper controls during manual preparation of ACZA, exposure to minor spills and residues in working areas, and improper handling of treated products. When exposure to a chemical occurs, the severity and speed of damage to human health depends on the concentration. The general rule is as follows: the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs. Immediate response is required if a worker is exposed to aqua ammonia, arsenic acid or ACZA concentrate or work solutions. Table 5 outlines first aid measures for exposure to ACZA and its constituents.

Facility staff should have access to product labels and appropriate training to apply first aid. First aid personnel should periodically verify up-to-date response measures with chemical suppliers and/or industrial physicians.

Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with ACZA solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

For all medical attention, always take the pesticide label to show to the health personnel.

**Table 5. First Aid Measures for Exposure to ACZA Solution/Concentrate and Ammonium Hydroxide Concentrate.**

Exposure	First action	Second action
Eye contact	<ul style="list-style-type: none"> <li>Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids.</li> <li>Flush eyes for at least 30 minutes.</li> <li>If exposed person wears contact lenses, remove them 5 minutes after rinsing and then continue rinsing for at least 30 minutes</li> </ul> <p><i>Workers Should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre immediately for subsequent advice.</li> <li>Get medical attention (have product label at hand).</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>Flush contaminated area immediately with flowing water, while removing soaked clothing or articles in contact with the skin.</li> <li>Continue to flush contaminated skin for at least 15 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre immediately for subsequent advice.</li> <li>Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain) (have product label at hand).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>Immediately remove the exposed person to fresh air (coughing and sneezing occur almost immediately after excessive inhalation of ammonia fumes).</li> </ul>	<ul style="list-style-type: none"> <li>If breathing has stopped: <ul style="list-style-type: none"> <li>call 911 or an ambulance</li> <li>apply artificial respiration with barrier device.</li> </ul> </li> <li>Keep the affected person warm and quiet.</li> <li>Get immediate medical attention (have product label at hand).</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>Give conscious victim a large quantity of water or milk. Never give liquids to an unconscious person.</li> <li>Do not induce vomiting.</li> </ul>	<ul style="list-style-type: none"> <li>Call an industrial physician or the poison control centre immediately for subsequent advice. (have product label at hand) (Stomach pumping by medical personnel is desirable.)</li> </ul>

Personnel should follow the recommendations from [Table 6 of Chapter A](#), outlining general precautions and personal hygiene measures.

## 6.2 Regulatory Controls

The labels for pesticide products contain information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

**Specific limits for worker protection are generally prescribed by provincial regulations.** Consult your local authorities for specific applicable regulations.

Most of the criteria are based on the TLVs and BEIs recommended by the [American Conference of Governmental Industrial Hygienists \(ACGIH\)](#). The ACGIH limits of exposure in the workplace are specified in Tables 4.0 and 4.1 above.

### *Skin and Eye Contact*

For skin and eye contact with individual components of ACZA, the ACGIH provides the following comments (11):

- A TLV of 25 ppm ammonia has been selected to protect against irritation to eyes and the respiratory tract and to minimize discomfort among unaccustomed workers.
- Copper salts act as irritants and can produce itchy eczema on skin, and conjunctivitis or ulceration on the eye. However, the TLV for copper salts is based on inhalation.
- Adequate skin and eye protection is required during the handling of all acids, including arsenic acid. ACGIH-recommended limits for arsenic acid are based on the “inhalation” TLV.

In cases where ACGIH-recommended limits (e.g. for copper and arsenic) are based only on “inhalation” as the route of exposure, these limits may not adequately take into account other routes of exposure. The ACGIH has suggested that in such cases, “biological exposure indices may be useful as a guide to safe exposure” (11).

### *Inhalation*

The ACGIH has defined TLVs for many substances based on exposure by inhalation and/or by skin exposure. The ACGIH limits for copper and arsenic are based solely on exposure by inhalation. The TLVs are stipulated by the ACGIH as those “airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects.” The short-term limit is defined as “a 15-minute TWA [time-weighted average] exposure, which should not be exceeded at any time during the work day.” The TLVs for ammonia, copper, zinc and arsenic (11) are defined in Table 4.0 and 4.1 with the following provisos of the ACGIH:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e.

- proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentration.”
  - “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
  - “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

### *Ingestion*

Oral intake of ACZA must be avoided. Ingestion of ACZA-containing liquids is unlikely if workers follow the safety precautions outlined in Table 8. Upper limits of ingestion are not prescribed by regulation, since it is generally expected that no such intake will occur.

Oral toxicity values of As+5, to humans are not defined. Reported fatal doses for “arsenic” and “As+3” have ranged from 20 to 300 mg (11, 13). Reported fatal single dose levels for components of ACZA, include 30 mL of 25% ammonia solution (11); and 1.5 to 3.5 g of Cu as Cu+1 (11). The Registry of Toxic Effects suggests that As+5 is more toxic to rats than As+3; however, it is known that laboratory animals react differently to arsenic than do humans. The lethal toxicity to humans of As+5 as used in ACZA, therefore, cannot be derived from animal data and remains unknown. However, because As+5 is partially metabolized into As+3, its potential toxicity should be assumed to be as high as that of As+3.

## 6.3 Safety Precautions

Workers need to familiarize themselves with the following safety precautions in addition to those recommended in Chapter A, [Section 6.3](#). Sensitive individuals should take special care to avoid exposure.

**Table 8. Additional Safety Precautions for Personnel Working with ACZA**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 8.)

Activity	Recommendations
<b>Objective:</b> Ensure safe workplace practices for each activity during the treatment process	
Cleaning cylinders or storage tanks	<ul style="list-style-type: none"><li>• <b>Personal protective equipment:</b> Select NIOSH-approved respirators with combination of acid gas/ammonia high-efficiency filter cartridges with a P100 prefilter (or breathing apparatus if working in an enclosed environment) approved for inorganic arsenic.</li></ul>
Removing treated charges from cylinders.	<p>Retort opening</p> <ul style="list-style-type: none"><li>• <b>PPE:</b> Wear appropriate NIOSH-approved respirator with combination of acid gas/ammonia high-efficiency filter cartridges with a P100 prefilter and approved for inorganic arsenic if ACZA concentrations are above regulatory values or concentrations are unknown.</li></ul>

## 6.4 Biological Monitoring of Exposed Workers

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#)



## 7 Design Recommendations

The following tables present good design features specifically applicable to ACZA wood preservation facilities. The additional recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 7 and their corresponding tables. All tables of general content from Chapter A, [Section 7](#) must be taken into consideration.

It should be noted that ammonia is highly corrosive to copper and zinc alloys; therefore, pipes, valves, etc. should be made of non-corrosive materials.

**Table 10. Additional Recommended Design Features for Chemical Delivery Area**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 10.)

Delivery format	Design feature	Recommendations
<b>Bulk liquid</b> (Bulk tank for premixed solution) (Aqua ammonia delivered by truck or rail tanker)	Emergency response	<ul style="list-style-type: none"><li>• Provide emergency ventilation for ammonia vapour control (in enclosed spaces).</li></ul>

**Table 11. Additional Recommended Design Features for Chemical Storage Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 11.)

Storage format	Design feature	Recommendations
<b>Bulk ACZA liquids</b> <ul style="list-style-type: none"><li>• Aqua ammonia</li><li>• Working solutions</li><li>• Contaminated surface runoff</li></ul>	Spill containment	<ul style="list-style-type: none"><li>• Provide water sprays and/or ventilation to control ammonia vapours.</li></ul>
	Drip containment	<ul style="list-style-type: none"><li>• Provide adequate ventilation to control ammonia vapours.</li></ul>
	Vapour control	<ul style="list-style-type: none"><li>• Install control equipment (scrubbers) as required to comply with applicable air emission limits for ammonia vapours.</li><li>• If wet scrubbers are used, they should be designed for recycle and reuse of scrubber fluid.</li></ul>

**Table 12. Additional Recommended Design Features for Chemical Mixing Systems**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 12.)

Chemical form	Design feature	Recommendations
<ul style="list-style-type: none"> <li>• Aqua ammonia</li> <li>• Working solutions</li> <li>• Drip return</li> <li>• Contaminated surface runoff</li> </ul>	Location/shelter	<ul style="list-style-type: none"> <li>• Locate mixing and working solution tanks in an enclosed, heated area, particularly if sub-freezing temperatures are encountered during operation.</li> </ul>
	Ventilation	<ul style="list-style-type: none"> <li>• Provide an efficient scrubbing system for the mix tank to minimize emissions.</li> <li>• If wet scrubbers are used, they should be designed for recycle and reuse of scrubber fluid</li> </ul>
	Unloading totes	<ul style="list-style-type: none"> <li>• Provide adequate equipment for safe, controlled handling of the containers.</li> </ul>

**Table 13. Additional Recommended Design Features for Treatment Process Systems**  
(Use in conjunction with Part I, Chapter A - General Recommendations for All Wood Preservatives, Table 13.)

Design feature	Recommendations
Ventilation	<ul style="list-style-type: none"> <li>• Provide adequate routine and emergency ventilation to control ammonia vapour levels in all work areas.</li> </ul>

**Table 14. Additional Recommended Design Features for Freshly Treated Wood Drip Areas**  
(Use in conjunction with Part I, Chapter A - General Recommendations for All Wood Preservatives, Table 14.)

Design feature	Recommendations
Drip area	<ul style="list-style-type: none"> <li>• Provide for sufficient contained, impermeable floor and roofed storage or transfer area for freshly treated wood prior to application of the stabilization process (accelerated or under ambient conditions).</li> </ul>
Storage area for stabilization under ambient conditions	<ul style="list-style-type: none"> <li>• The storage area for stabilization under ambient conditions should be contained and roofed, with provisions for recovery of drips and any infiltrating precipitation.</li> <li>• Provide the stabilization storage area with a drip collection system and an impermeable floor for collection of drips.</li> </ul>

## 8 Operational Recommendations

The recommendations for good operating practices listed in the following tables must be used in conjunction with those in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8](#).

### 8.1 Operational Standards

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements including ACZA. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2-08 Clause 4.1 (referenced to AWWA M3). The calibration can be conducted by facility staff if they have the appropriate training.

All tables of general content from Chapter A, [Section 8](#) must be taken into consideration.

### 8.2 Facility Wide Recommendations

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### 8.3 Area specific Recommendations

**Table 20. Additional Recommended Operating Practices for Process Systems**  
(Use in conjunction with Part I, Chapter A – General Recommendations for all Wood Preservatives, [Table 20](#).)

Operation	Recommendations
Treatment process	<ul style="list-style-type: none"><li>After pressure treating, apply a final vacuum of maximum 25 kPa for at least 2 hours. The retort should be heated to between 80 and 100°C during the vacuum process.</li><li>After removal from the retort, keep the materials on the drip pad/holding area until all dripping has ceased.</li></ul>

**Table 21. Additional Recommended Practices for Operating Practices for Kiln, Accelerated Stabilisation Chamber and Dripping Area**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, [Table 21](#).)

Operation	Recommendations
Post-treatment process	<ul style="list-style-type: none"><li>Post-treatment procedures may vary from plant to plant in order to ensure stabilisation. Contact your pesticide provider for detailed procedure.</li></ul>

In order to develop a successful facility-specific worker safety and environmental protection protocol, it is important to have an operations manual that provides written instructions to employees for all aspects of chemical use. Please refer to [Table 17](#) in Chapter A – General Recommendations for All Wood Preservatives and also refer to Table 22 – Additional Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems.

**Table 22. Additional Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems (ACZA Preservatives)**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 22.)

Operation	Recommendations
<b>Equipment maintenance, alarms and Safety Devices</b>	<p><b>Objective:</b> Ensure that equipment is maintained in a manner that will minimize releases of preservative chemicals and minimize worker exposure to them and their by-products</p> <hr/> <p><b>Equipment:</b></p> <ul style="list-style-type: none"> <li>• <b>Valves</b> must be tested every 6 months and replaced as required.</li> <li>• Test <b>tank vents</b> at least once a year to ensure they are not blocked.</li> </ul> <p><b>Alarms:</b></p> <ul style="list-style-type: none"> <li>• <b>Off-loading area:</b> Test the manual alarm on a weekly basis and prior to the delivery of concentrate.</li> <li>• <b>Chemical storage area:</b> <ul style="list-style-type: none"> <li>○ The circuitry of the tank's high-level alarm and the 24-hour monitoring alarm should be tested weekly and probes should be checked every 12 months.</li> <li>○ The function of all manual emergency alarms should be tested weekly.</li> <li>○ The containment high-level alarm should be tested every 6 months or within 6 months of a routine alarm sounding.</li> </ul> </li> <li>• <b>Chemical mixing systems:</b> <ul style="list-style-type: none"> <li>○ The circuitry of the high-level alarm should be tested weekly and probes should be checked every 12 months.</li> </ul> </li> <li>• <b>Treatment process systems:</b> <ul style="list-style-type: none"> <li>○ The high-level alarms of the sumps should be tested weekly.</li> </ul> </li> </ul> <p style="text-align: center;"><b>All test details should be recorded (documented).</b></p> <p><b>Prior to cleanout:</b></p> <ul style="list-style-type: none"> <li>• Thoroughly purge all ammonia vapours and provide effective ventilation.</li> </ul>

## **9 Waste, Process Emissions and Disposal**

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.1 Control, Treatment and Disposal**

Potential process emission sources at ACZA wood preservation facilities were described in Section 5.2 Figure 1. The main categories of process wastes or emissions that may be encountered at ACZA facilities, along with their recommended disposal methods, are presented in Chapter A [Table 23](#).

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information.

### **9.2 Liquids Containing ACZA**

Liquid solutions containing ACZA, such as drips and washwaters, should be routinely collected and reused as makeup in preparing new treatment solutions. If unusual circumstances (such as prolonged plant shutdown) prevent on-site reuse, transport to another ACZA facility (for reuse) should be arranged. The chemical supplier may be able to suggest another facility that uses ACZA. Disposal should be considered only as a last alternative.

### **9.3 Solids with High ACZA Concentrations**

Consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.4 Miscellaneous Solid Wastes**

Miscellaneous solid wastes (e.g. cuttings from ACZA-treated lumber) from ACZA wood preservation plants may be disposed of at designated sanitary landfills as approved by the provincial regulatory agency.

Containers should be rinsed thoroughly (triple rinsed – see [Section 9.4](#) of Chapter A) with water prior to disposal, and the rinse water should be used for the preparation of work solutions.

Do not use ACZA treated wood as a compost or mulch.

Incineration of ACZA-contaminated materials is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products.

## **9.5 Air Emissions**

Air emissions at ACZA facilities are normally localized; effects, if any, would be confined within the boundaries of the facilities. Air emissions from ACZA facilities may include the following:

- vapours from ammonia storage tank vents
- vapours from ACZA mixing and storage tank vents
- vapours from vacuum pump discharge
- vapours from opening of retort cylinder doors
- vapours from freshly treated charges
- vapours from kiln-drying operations

Vapours from ammonia storage tanks, ACZA working solution tanks and vacuum pump discharge, should be captured and redirected to a common vent line prior to passing through a scrubber and exiting the building.

Recent air monitoring at one ACZA plant equipped with a scrubber revealed that levels of ammonia were very low and barely detectable by smell. Scrubber or any similar air pollutant control device is a necessity to ACZA plants since measured airborne ammonia concentrations up to 250 ppm were detected in the past at one ACA facility (9).

## 10 Environmental and Workplace Monitoring

### 10.1 Baseline Environmental Evaluation

Ammonia, copper, zinc and arsenic are found naturally in the environment. Typical background levels of ACZA constituents are listed in Table 24. Considerable variation occurs in natural concentrations of copper, zinc and arsenic in soils and waters (5). Because ammonia concentrations may vary both in time and space (14), it is important to determine background levels immediately prior to operating a facility, to enable meaningful future assessments of pollution control. Older mills may not have this information available. A comparative site from a nearby property can be used as a reference. The facility may use the template provided in [Table 24](#) from Chapter A.

**Table 24. Typical Background Levels of ACZA Constituents**

Element	Typical concentration in non-polluted environments	
	Surface waters (mg/L)	Soils (mg/kg)
Copper (Cu)	< 0.001 to 0.04	2 to 100
Arsenic (As)	< 0.001 to 0.01	1 to 50 (up to 500 mg/kg found in sulphide deposits)
Ammonia (NH <sub>3</sub> )	< 0.1	1 to 5 ppm (as NH <sub>4</sub> <sup>+</sup> )
Zinc (Zn)	< 0.05	60

### 10.2 Environmental Monitoring

There have been few studies of ACZA releases from wood preservation facilities to the adjacent environment. Environmental risk of release from ACZA facilities and CCA facilities can be very similar. On this indication, ACZA facilities have the potential to contaminate groundwater in the immediate vicinity of the facilities to levels that render it unsafe for human use. Stormwater runoff may contain at least one of the elements copper, zinc, ammonia or arsenic at levels in excess of existing water quality limits (7). The ratios of copper/zinc/arsenic/ammonia are not consistent within runoff waters and that may be due to differences in the ability of the components to bind to the yard soils or due to different sources within the yards (i.e. stored lumber washoff versus dripped material from freshly treated loads). Ammonia concentration can vary in time due to its vaporisation and biological decomposition/adsorption.

Arsenic is persistent in the environment and close monitoring studies (such as surface water discharges, groundwater and soil contamination) are recommended to properly assess the degree of such releases. Arsenic, copper, zinc and ammonia are the minimum components that should be monitored for ACZA facilities.

### 10.3 Workplace Exposure Monitoring

Workplace monitoring generally falls under provincial jurisdiction. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist. It is important to complete baseline air monitoring immediately

prior to operating a facility, to enable meaningful exposure assessments and determine appropriate controls.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.



## 11 Transportation of ACZA Components, Solutions and Wastes

The transportation of ACZA solutions and ACZA wastes is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details, please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/menu.htm>

<http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of ACZA, its components and its wastes.

## 12 Environmental Emergency Notification and Contingency Planning

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using ACZA should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective.

### 12.1 Environmental Emergency Notification

The Environmental Emergency Regulations and its requirements are applicable for ACZA since it contains arsenic, listed in Schedule 1 of CEPA 1999.

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 12.2 Spill Contingency Planning

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

The following additional recommendations apply to ACZA facilities if a spill of ammonium hydroxide, ACZA solution or arsenic acid occurs:

- Immediately put on appropriate NIOSH-approved respirators, full-face mask / breathing apparatus, (NIOSH-approved respirators and full-face mask should be equipped with high-efficiency filter cartridges in combination for acid gas and ammonia with a P100 prefilter, e.g., TC23-C, TC14-G).
- Always stay upwind to avoid potential exposure to ammonia fumes.
- For ammonia spills, use water spray to knock down vapours.
- If tanks other than normal work tanks are used for salvage purposes, ensure compatibility of materials, i.e., do not use galvanized or aluminium tanks because of the corrosiveness of ammonia.

### 12.3 Fire Contingency Planning

Although the ingredients of ACZA and ACZA solutions are not flammable, precautions should be taken in the event that a fire occurs in the vicinity of ACZA solutions, arsenic acid or ammonia. Ammonia gas could be released if ACZA or aqua ammonia are heated. Mixtures of ammonia and air in an enclosed space with an ignition source could be explosive. In addition, heating of ACZA could result in the formation of toxic arsenic vapours. Using water blanket areas, water spray to suppress toxic dust and gases and keeping temperatures of oxidizable materials below that for ignition, are additional recommendation that can be considered.

It is, therefore, important that ACZA wood preservation facilities devise an adequate contingency plan for fire protection, including storing a copy of all necessary documents in a fire proof box outside the entrance to the facility.

Please refer to the *National Fire Code of Canada (always refer to last version available)* and to [Section 12.3](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

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## CHAPTER D

# Creosote Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives.



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# 1 Production and Use

Wood Preservation Canada (WPC) describes creosote as the oldest and one of the most effective industrial preservatives for protecting wood from deterioration and decay caused by fungi, insects and marine organisms.

Creosote has been known for its preservative properties since 1706. In 1838, the Bethell (full cell) process using creosote was patented. Creosote has been applied to a large variety of wood products for more than 150 years. It is used primarily for railway ties (where it is often blended with heavy petroleum oil), utility poles, marine piling and timbers, and highway construction (1). Creosote has been described as one of the most effective substances known for the protection of wood against all forms of wood-destroying organisms. It has a marked toxicity to a wide spectrum of wood-destroying fungi, marine borers and insects.



Creosote's attributes, aside from its broad-spectrum efficacy, are that it gives the treated wood water repellency, improved dimensional stability and mechanical wear, corrosion resistance, reduced electrical conductivity, and increased resistance to corrosive chemicals.

Creosote, as defined by the American Wood Protection Association (AWPA), is a distillate derived from coal tar, derived by the high-temperature carbonization of bituminous coal. Creosote consists primarily of liquid, solid polycyclic aromatic hydrocarbons (PAHs), other heteronuclear aromatic substances, and some tar acids and bases (2).

This carbonization process takes place during the making of coke by the steel industry. The coal tar is then distilled to produce creosote and other products.

Many factors affect the character and composition of creosote, including the characteristics of the coal that is used, the method of coal tar distillation and the temperature range in which the creosote fractions are collected. Creosote has approximately 200 to 250 chemical compounds. Therefore, relative concentrations of creosote components can vary from batch to batch.

During the distillation of coal tar, the first fractions contain the light oils (or low molecular weight oils), with pitch being the main product. The higher boiling point liquid fraction recovered between the light oils and pitch is designated creosote. It is heavier than water, and has a continuous boiling range beginning at about 200°C (3)

Because creosote is oily, the treated wood is somewhat water repellant. This improves the wood's dimensional stability and reduces checking and splitting. Creosote-treated wood is also

more resistant to mechanical wear, which is of vital importance for such applications as railway ties and bridge decking.

Creosote for wood preservation uses is currently produced in Canada and imported from the United States. Table 1 provides an overview of creosote use in Canadian pressure treatment facilities (4).

**Table 1. Overview of Creosote Use in Canada**

<b>Feature</b>	<b>Characteristics</b>
<b>Treated wood use limitations in Canada</b>	USE FOR INDUSTRIAL WOOD PRODUCTS ONLY <ul style="list-style-type: none"><li>• Railway ties</li><li>• Marine pilings and timber</li><li>• Construction timbers</li></ul> <p>*Note: permitted uses and limitations of Creosote-treated wood may change over time. Refer to pesticide label for up-to-date uses</p>
<b>General process of application</b>	Pressure treatment (refer to the pesticide label for details)

The CSA O80 Series of Standards specifies requirements related to the preservation through chemical treatment (pressure), which includes creosote treated products. (5)

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label

## 2 Physical and Chemical Properties

Creosote is a complex and variable mixture produced from coal that is made up of more than 250 compounds.

There are five major classes of compounds in creosote (3):

- *Aromatic Hydrocarbons* including PAHs, alkylated PAHs, benzene, toluene, and xylene (PAHs can constitute up to 90% of creosote);
- *Phenolics* including phenols, cresols, xylenols, and naphthols (1 to 3% of creosote);
- *Nitrogen-containing Heterocycles* including pyridines, quinolines, acridines, indolines, carbazoles (1 to 3% of creosote);
- *Sulphur-containing Heterocycles* including benzothiophenes (1 to 3% of creosote); and
- *Oxygen-containing Heterocycles* including dibenzofurans (5 to 7.5% of creosote) (U.S. EPA, 1987).

Polycyclic aromatic hydrocarbons (PAHs) are the main constituents of creosote, with the most toxic being anthracene, fluoranthene, acenaphthene, fluorene, naphthalene, chrysene, pyrene and phenanthrene) (6). Other components can include phenols, cresols, cresylic acid, pyridines, quinolines and acridines. All components may vary in proportion (3).

Creosote oil is the common name used to describe different fractions of creosote.

### Creosote

P1/P13: Creosote preservative – 50% coal tar creosote, 50% petroleum oil

P2: Creosote solution

P3: Creosote & petroleum oil solution

P 13: Petroleum oil for blending with creosote

### Creosote Additives and/or Extenders

Naphthalene oil - naphthalene is a coal tar derived product

Coal tar distillate blend

There are two major types of creosote: P1/P13 fraction (creosote preservative being 50% coal tar creosote and 50% petroleum oil), which is used in the treatment of poles and pilings; and the P2 fraction (creosote solution) which is used in the treatment of railroad ties.

These two fractions of creosote are derived by carbonizing coal through high-temperature distillation and collecting the coal tar fractions that are composed of light oil, middle oil and heavy (oil) anthracene. The middle oil fraction is further distilled, creating additional fractions. P1/P13 and P2 fractions are collected when the middle oil temperature is between 210°C and 355°C (6).

The many components in creosote complement each other with respect to wood preservation. The lighter molecular weight PAHs in creosote are generally more toxic to decay organisms. The heavier molecular weight components of creosote help “retain” the more toxic lighter components within the wood by minimizing leaching or volatilization. The heavier residues of

creosote, when impregnated into wood, also act as water repellents, limiting moisture changes (2). This improves the wood's dimensional stability and reduces checking and splitting (1).

Because of the many components of creosote and their varying concentrations, the physical and chemical properties of creosote per se can only be generalized. Table 2 summarizes properties that have been compiled in various documents.

Properties that warrant special consideration for the safe handling of creosote include the following:

- combustibility
- moderate vapour pressure
- solubility of minimal fractions in water
- density, which is greater than water, implying that creosote will sink to the bottom of fresh and marine waters

The physical and chemical properties of creosote are outlined in Table 2. General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and the labels for pesticide products (pesticide label). Electronic copies of the pesticide label can be obtained from the Health Canada website (4):

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>.

**Table 2. Physical and Chemical Properties of Creosote**

Identification		
<b>Common synonyms:</b> Creosote oil Creosote Coal tar creosote	<b>Registrant in 2012:</b> Ruetgers Canada Inc. [formerly VFT Canada Inc] (Hamilton, ON) <ul style="list-style-type: none"><li>• Coal tar creosote (P1/P13)</li><li>• Coal tar creosote (P2)</li></ul>	
<b>CAS Registry Number:</b> Coal Tar Creosote CAS 8001-58-9	Coopers Creek Chemical Corporation (West Conshohocken, PA) <ul style="list-style-type: none"><li>• C-4 Brand Coopersote creosote oil</li></ul>	
Transportation and storage information		
<b>Shipping state:</b> Liquid <b>Delivery format:</b> Bulk rail ship and truck <b>Chemical family:</b> Coal tar distillate <b>Classification:</b> Combustible, Poison, Corrosive <b>Storage temperature:</b> Ambient	<b>Inert atmosphere:</b> No requirement <b>Venting: required</b> Open (flame arrestor), or to filter systems <b>Containers/materials</b> Tankers, tank cars, tank trucks (steel)	<b>Placards: Class 9 P.G III</b> <i>Check with Transport Canada</i>
Physical and chemical properties		
<b>Physical state:</b> Liquid/solid mixture at ambient temperatures <b>Solubility</b> Practically insoluble in water. Soluble in alcohol, benzene and toluene <b>Major components:</b> Polycyclic aromatic hydrocarbons <b>Concentration of work solutions:</b> Either 100% creosote or 50:50 mixture of creosote and petroleum oil	<b>Specific gravity</b> 1.05–1.09 at 15°C <b>Vapour pressure:</b> Variable <b>Boiling point:</b> 200–450°C <b>Odour:</b> Acrid, tarry aromatic <b>Vapour density:</b> Variable (typically 3 to 5) <b>Typical preservative retention in treated wood:</b> 96–400 kg creosote/m <sup>3</sup> treated wood (6-25 lb/ft <sup>3</sup> ); typically 128 kg/m <sup>3</sup> of wood	<b>Floatability:</b> Sinks in fresh and marine waters <b>Appearance:</b> Yellow to black, oily liquid with sharp, aromatic or tarry odour <b>Melting point:</b> Varies (-60 to -20°C) <b>Flash point</b> >74°C (combustible liquid) <b>Explosive limits:</b> Variable, 1% to 7%
Hazard data		
<b>Fire:</b> <i>Extinguishing data:</i> Use dry chemical, foam or carbon dioxide. Use water to cool fire-exposed containers <i>Fire behaviour:</i> Forms irritating heavy black smoke <i>Ignition temperature:</i> Variable, typically 400°C <i>Burning rate:</i> 4 mm/min	<b>Reactivity:</b> <i>With water:</i> No reaction; insoluble <i>With common materials :</i> May react with oxidizing agents or strong acids <i>Stability:</i> Stable	
(4, 6, 7, 8, 9)		

(4, 6, 7, 8, 9)

### 3 Environmental Effects

Creosote is a mixture of 200–250 identifiable substances; of these, 85% are PAHs (6). Therefore, the following environmental effects are based on the potential effects of PAHs on the environment. In general, PAHs become increasingly less soluble in water with an increasing number of benzenoid or other rings, and with increasing molecular weight. PAHs from creosote mixture have little solubility in water.

PAHs have a low degree of volatility and photo-oxidation appears to be an important dissipation pathway for PAHs in the environment. However, the photo-oxidized products are persistent in air, water and soils and are bioaccumulative (6).

PAHs are a group of complex hydrocarbons composed of two or more fused aromatic (benzenoid) rings. Differences in the structure and size of individual PAHs result in substantial variability in the physical and chemical properties of these substances (10).

#### 3.1 Aquatic Toxicity

Aquatic organisms may be adversely affected by exposure to elevated levels of PAHs in sediments, freshwater or marine environment.

The fate and behavior of PAHs in aquatic systems is influenced by a number of physical, chemical and biological processes. While some of these processes, such as photo-oxidation, hydrolysis, biotransformation, biodegradation and mineralization, result in the transformation of PAHs into other substances, other physical processes, such as adsorption, desorption, solubilization, volatilization, resuspension and bioaccumulation, are responsible for the cycling of these substances throughout the aquatic environment (10).

Although there are no water quality objectives or standards specifically for creosote, water quality criteria do exist for some component compounds or indicators of creosote (10, 11, 12, 13, 14, 15). These criteria are summarized in Table 4. The Canadian Council of Ministers of the Environment (CCME)' *Canadian Water Quality Guidelines for the Protection of Aquatic Life* has guidelines for 19 specific polycyclic aromatic hydrocarbons (PAHs), but there is insufficient information on PAHs in the marine environment at this time (12).

The PAHs listed in Section 2 are highly to very highly toxic to freshwater and saltwater fish and invertebrates, with anthracene and fluoranthene being the most toxic PAHs in the water column (6).

Canadian limits for PAHs in aquatic environments are accessible on the CCME website under the Canadian Environmental Quality Guidelines Summary Table, available from the following website: <http://st-ts.ccme.ca/>

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for Creosote Components in Natural Water Bodies**

Element	Limit value	Basis (objectives)	Agency
Oil and petrochemicals	For the protection of aquatic life, <b>should not</b> be present in concentrations that exceed 5% of the median lethal concentration in a 96-hour test for any sensitive local species	Oil and petrochemicals <b>should not</b> be present in concentrations that: <ul style="list-style-type: none"> <li>• can be detected as a visible film, sheen or discoloration on the surface;</li> <li>• can be detected by odour;</li> <li>• can cause tainting of edible aquatic organisms; or</li> <li>• can form deposits on shorelines and bottom sediments that are detectable by sight or odour, or are deleterious to resident aquatic organisms.</li> </ul>	International Joint Commission <sup>(a)</sup>
Benzo(a)pyrene in water	Maximum concentration 0.01 µg/L	Protection of drinking water (aesthetic considerations)	Health Canada <sup>(b)</sup>
Polycyclic aromatic hydrocarbons (PAH)	Please refer to the CCME summary table	Protection of aquatic life	CCME <sup>(c)</sup>

(a) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).

○ [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)

○ <http://www.ijc.org/rel/agree/quality.html>

(d) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.

○ <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>

“Maximum acceptable” was defined by Health Canada as: “Drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable.” “Objective” is defined by Health and Welfare Canada as: “This level is interpreted as the ultimate quality goal for both health and aesthetic purposes.”

(c) Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life. <http://st-ts.ccme.ca/>

## 3.2 Air Pollution

Air pollution from wood preservation is usually specific to some process within the plant and rarely is an issue outside the facility. Creosote can emit vapours of PAHs once applied to wood products. A few PAHs like acenaphthene, fluorene, phenanthrene, anthracene and fluoranthene show a degree of volatility from wood surfaces. More volatility has been observed at higher temperatures (30°C) and less at lower temperatures (4°C). As much as 85% of PAHs still remain on the wood surface at lower temperatures. Half-lives for volatility of these components are between 6 months and one year. Volatilization also does not appear to be a dissipation pathway for PAHs in the environment. (6)

Air pollution from wood preservative facilities can be generated as vapour/gas, aerosols and/or contaminated dust, especially where the creosote is heated and is open to ambient air. Section 4 addresses the potential health effects of exposure to air pollution from wood



preservatives. Air pollution should be considered when evaluations of potential chemical discharges are made in Section 5.

### **3.3 Soil Contamination**

PAHs are found in environmental samples almost always as complex mixtures. Any possible approach for dealing with environmental risks of mixtures involves a number of trade-offs in terms of the ability of the approach to account for compositional variability across sites; toxicological variability across different taxa and soil types; and the possibility of non-additive effects (synergistic or antagonistic interactions, for example) of individual constituents in the mixture (16).

A study from Debruyne et al. (2007), suggests that *Mycobacteria* could be capable of degrading high molecular weight PAHs. This may be an eventual avenue to attenuate the effects of PAHs on contaminated sites (17).

The CCME has developed the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*. Developing soil quality guidelines for PAHs is particularly challenging because there is likely to be more than one toxicological mode of action in an exposed organism. There is no single final soil quality guideline (SQG<sub>f</sub>) for any of the PAHs that will protect both human and environmental health. The reader is encouraged to read the detailed scientific rationale for the development of these PAH soil quality guidelines to better understand the inherent assumptions and limitations (16).

Alkyl-substituted PAHs, in particular, are common constituents of petrogenic (petroleum-derived) PAH mixtures. Too little is currently known about the environmental fate and toxicity (either for humans or various other living organisms) to enable development of Canadian soil quality guidelines for alkyl-PAHs (16).

Soil contamination can be an issue at wood preservation facilities if no effective measures are in place. Contaminated soil can be spread by vehicles and wind, but it will mostly migrate into runoff water and can potentially contaminate drinking water or surface water. The design and operational recommendations presented in Sections 7 and 8 contain measures to minimize soil contamination.

Certain information can be found in various CCME publications:  
Canadian Soil Quality Guidelines

- <http://ceqg-rcqe.ccme.ca/>

Additional general information on PAH are available at:

- [http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/hydrocarb\\_aromat\\_polycycl/index-eng.php](http://www.hc-sc.gc.ca/ewh-semt/pubs/contaminants/psl1-lsp1/hydrocarb_aromat_polycycl/index-eng.php)

## 4 Human Health Concerns

A safety objective for the industrial use of any chemical, including creosote, is to minimize worker exposure. If safeguards are not provided or not implemented, a variety of human health effects can occur, depending on the duration and manner of exposure, concentration of the chemical to which exposure has occurred, and the varying metabolic sensitivities of individual workers. On the basis of information from existing literature, Table 4 outlines the spectrum of human health effects that could result from various degrees of exposure to creosote.

The PMRA's re-evaluation decision for the registration of the heavy duty wood preservatives creosote, pentachlorophenol, chromated copper arsenate and ammoniacal copper zinc arsenate, has granted continued registration of these products for sale and use in Canada. Potential risks from inhalation and dermal exposure were identified for some occupational tasks within wood-treatment facilities. The addition of new risk-reduction measures and the development of a Risk Management Plan for heavy duty wood preservatives will continue to lower the potential for occupational exposure for treatment facility workers (8).

Table 4 outlines the possible human health effects that may result from exposure to creosote solutions and its components. Extensive reviews of the potential health effects of individual elements are provided in documents from Health Canada Publications (8), the World Health Organization (13), the International Labor Organization (18), the United States Environmental Protection Agency (6), the U.S. Department of Health and Human Services (15), the National Institute for Occupational Safety and Health (19), the American Conference of Governmental and Industrial Hygienists (20) and the Occupational Safety & Health Administration (21).

**Table 4. Potential Health Effects of Exposure to Creosote**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food – ex. BBQ meat) <sup>(a)</sup>			
• Polycyclic aromatic hydrocarbons (PAHs)	<i>Varies largely, depending on the different sources of petroleum hydrocarbon or coal-derived products and their uses.</i>		
	<i>The highest concentrations of PAHs in ambient air in Canada were measured at stations located about 1 km from aluminum smelters using the Horizontal Stud Söderberg process in Jonquière and Shawinigan, Quebec. The median concentrations of total PAHs (the sum of 26 compounds) were 693 ng/m<sup>3</sup> (mean of 1687 ng/m<sup>3</sup>) at Jonquière and 435 ng/m<sup>3</sup> (mean of 1519 ng/m<sup>3</sup>) at Shawinigan, with maxima of 10400 and 16 390 ng/m<sup>3</sup>, respectively (Ringuette et al., 1993).</i>		
Eye contact <sup>(a,b,c,d)</sup>	Direct contact Mist, vapour or splashes	<ul style="list-style-type: none"><li>• Redness</li><li>• Irritation of eyes</li><li>• Pain</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• Potential carcinogenic action</li><li>• Severe burn</li></ul>
Skin contact <sup>(a,b,c,d)</sup>	Occasional direct contact with liquid, vapours or mists  Significant skin contact with creosote (i.e. total immersion of worker in tank, improper protective measures inside storage tank or retort)	<ul style="list-style-type: none"><li>• Reddening and itching (contact dermatitis)</li><li>• Effects enhanced by exposure to sunlight</li><li>• Burning may result if creosote is not removed from skin</li><li>• Absorption of creosote through skin causes discoloration of skin, sweating, thirst, vomiting, diarrhea and stomach pains</li><li>• May cause dermatitis and hyperpigmentation of skin</li><li>• Potential carcinogenic action (skin cancer) has been reported</li></ul>	
Exposure to airborne contaminant or dust Inhalation <sup>(a,b,c,d)</sup>  ACGIH threshold limit value (TLV) time weighted averages (TWA) <sup>(e,f)</sup>	Inhalation of vapours in excess of TLV  Benzene-soluble coal tar pitch volatiles: 0.2 mg/m <sup>3</sup> air (Potential contributions to overall exposure can occur through the cutaneous route, including mucous membranes and eye, either by airborne or, more particularly, by direct contact with the substance.)	<ul style="list-style-type: none"><li>• Irritation of nose and throat</li><li>• Sweating, thirst, nausea, vomiting, stomach pain, with subsequent convulsions or coma</li></ul>	

**Table 4. Potential Health Effects of Exposure to Creosote (continued)**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Ingestion <sup>(a,b,c,d)</sup>	Ingestion of creosote through manipulation of contaminated goods (dishes, gum, candy, food, tobacco, liquids)	<ul style="list-style-type: none"> <li>Burns mouth, throat and stomach</li> <li>Subsequent salivation, vomiting, respiratory difficulties, thready pulse, vertigo, headache, loss of pupillary reflexes, hypothermia, cyanosis and convulsions</li> <li>Fatal dose: 7–10 g Death would be due to circulatory collapse and respiratory failure</li> </ul>	
Chronic symptoms <sup>(a,b,c,d)</sup>	Repeated exposures		<ul style="list-style-type: none"> <li>Carcinogenic to humans</li> <li>Skin irritation, sensitivity</li> <li>Skin lesions</li> </ul>

- a) United States Environmental Protection Agency (USEPA)  
Reregistration Eligibility Decision (RED) for Creosote (Case 0139), September 25, 2008  
  - [http://www.epa.gov/oppsrrd1/REDs/creosote\\_red.pdf](http://www.epa.gov/oppsrrd1/REDs/creosote_red.pdf)
- b) International Labour Organization ICSC Card database,  
  - <http://www.ilo.org/dyn/icsc/showcard.home>
- c) World Health Organization, International Programme on Chemical Safety  
  - <http://www.who.int/ipcs/en/>
  - [http://www.who.int/ipcs/assessment/public\\_health/arsenic/en/index.html](http://www.who.int/ipcs/assessment/public_health/arsenic/en/index.html)
- d) Agency for Toxic Substances and Disease Registry (ATSDR)  
  - <http://www.atsdr.cdc.gov/substances/index.asp>
- e) American Conference of Governmental Industrial Hygienists (ACGIH):  
  - <http://www.acgih.org/tlv/>
- f) Occupational Safety & Health Administration (OSHA) Permissible Exposure Limits (PELs):  
  - <https://www.osha.gov/dsg/topics/pel/>

## 5 Description of Preservative Application and Potential Chemical Discharges at Creosote Wood Preservation Facilities

In 2012, there were five active pressure wood preservation creosote facilities in Canada, and only one used it as their sole preservative (1). The impregnation of creosote into wood is carried out in pressure treatment plants and is for industrial and commercial purposes only. Refer to Part 1, General Background Information, Section 2.2.3 [Figure 4](#), for an overview of the process.

A highly individualized approach exists to design and operating practices, which is emphasized by the fact that the technical support services at those facilities depend upon internal resources. Most of the plants have been in operation for 50 years or more. These older plants, although state of the art at the time of construction, did not have the benefit of today's knowledge of environmental protection. However, the plants have used the recommendations contained in the previous technical recommendations documents to upgrade designs and operating practices (22).

### 5.1 Description of Process

Creosote is used either in a mixture of 50:50 creosote/petroleum oil or alone—full strength. Creosote and petroleum oil are delivered to wood preservation facilities by bulk truck or rail tanker and are stored in a bulk storage tank.

The Western Wood Preservers Institute, Wood Preservation Canada, the Southern Pressure Treaters' Association and the Southern Forest Products Association have developed U.S. and Canadian recommended guidelines for the production and use of treated wood products in aquatic and other sensitive environments. The industry associations' best management practice (BMP) is to place enough preservative into a product to provide the needed level of protection while also minimizing use of the preservative above the required minimum industry standard to reduce the amount potentially available for movement in the environment (23).

After delivery of the creosote and petroleum oil, the following process steps occur (Refer to Part 1 – General Background Information, Section 2.2.3, [Figure 4](#)).

#### *Chemical Mixing*

In Canada, creosote/petroleum oil mixtures are blended by pumping transfers and by recirculation between bulk tanks. The benefits of blending creosote with oil are lower cost and improved penetration (lower viscosity) in applications such as railway ties, where conditions of use allow for less protection than that usually provided by 100% creosote. The physical properties of wood treated with a mix are quite similar to those of material treated with 100% creosote; better dimensional stability (compared with untreated or water-borne treated wood), improved mechanical wear, corrosion inhibition, resistance to chemicals, water repellency and improved resistance to electrical conductivity. Full strength creosote is used where maximum biocidal protection is desired, such as for timbers exposed to marine borers.

### *Wood Conditioning*

In order to enhance penetration of the water-immiscible creosote into the wood, the moisture content of the wood is reduced by a conditioning process. Conditioning may be achieved by air seasoning, kiln drying or by processes carried out in the treatment cylinder—for example, application of steam and subsequent vacuum, or boiling under a vacuum in the presence of the treating solution (Boultonizing). For certain wood products, conditioning procedures are stipulated by the Canadian Standards Association (5).

### *Preservative Application*

If Boultonizing or steam-vacuum processes have been used for conditioning, creosote is applied in the following steps, either by the full-cell treatment process or the empty-cell treatment process. It should be noted that in contrast to treatments with water-borne preservatives, creosote solutions are applied at an elevated temperature (70–90°C).

Depending on the species of wood, the wood product and the moisture content of the wood, the operator of the facility determines the appropriate treatment process (full cell or empty cell), and the pressure, temperature and times for various process sequences.

An expansion bath and final vacuum are usually added after the pressure cycle so as to render product surfaces relatively dry and to minimize long-term “bleeding” of preservative and to improve the surface cleanliness of the material. The expansion bath can be applied before removal of the preservative from the cylinder, by quickly re-heating the oil surrounding the material to the maximum temperature permitted by the CSA Standard for a specific species, either at atmospheric pressure or under vacuum. The steam shall be turned off as soon as the maximum temperature is reached. The cylinder shall then be quickly emptied of preservative. A vacuum equal to or stronger than –75 kPa (562.5 mmHg) shall be created promptly and maintained until the material can be removed free of dripping preservative. (5) Condensate from steam should be recuperated to be treated in a proper manner, see section 9.

The treated wood is withdrawn from the treating cylinder and stored on a drip pad until drippage has essentially stopped. From there the wood is either taken for storage in the yard or shipped by truck or rail car. Best management practices (BMPs) are promoted by the industry associations to minimize preservative drippage and bleeding during storage and service (23).

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label. The CAN/CSA O80 (5) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

## **5.2 Potential Chemical Discharges**

Creosote wood preservation facility design and operational practices vary (22, 24), and each facility has potential sources of emissions that could affect worker health and/or the environment. The potential sources and releases are illustrated in Figure 1.

### *Liquid Discharges*

Leaks and drips of oil solutions can be contained and reused in the oil-borne treatment process. Liquids that cannot be recycled and reused may include the following:

- condensates removed from wood during the conditioning and during the initial application of the vacuum process
- water released by the wood during the treating cycle and subsequently separated from the unabsorbed treatment oil prior to recycling of the oil
- washwaters

Washwaters commonly consist of high pressure steam cleaning since low pressure washing systems are generally not sufficient for the cleaning of creosote stained surfaces or equipment.

These liquids can contain creosote and must be treated before discharge as a waste stream.

Other liquids that may be released from oil-borne creosote facilities include the following:

- steam condensates from indirect heat transfer in cooling and heating coils, which are generally checked for contamination prior to discharge
- condenser cooling water, which is not normally contaminated and is discharged without treatment
- surface runoff from treated wood storage areas contaminated by preservative

The creosote content in runoff waters depends on many factors, including vacuum and drip time in the last step of the pressure process; viscosity of the wood preservative; wood species; moisture content of the wood prior to application of preservative; specific treatment process (i.e. full cell versus empty cell); and exposure to the weather. The need for control of runoff waters would depend upon analytical and/or bioassay evaluations and regulatory requirements.

### *Solid Wastes*

Solid wastes from creosote treatment facilities include the following:

- sludge from tanks, sumps and pressure cylinders
- sludges from wastewater treatment processes (e.g. flocculated material)
- contaminated soils

### *Air Emissions*

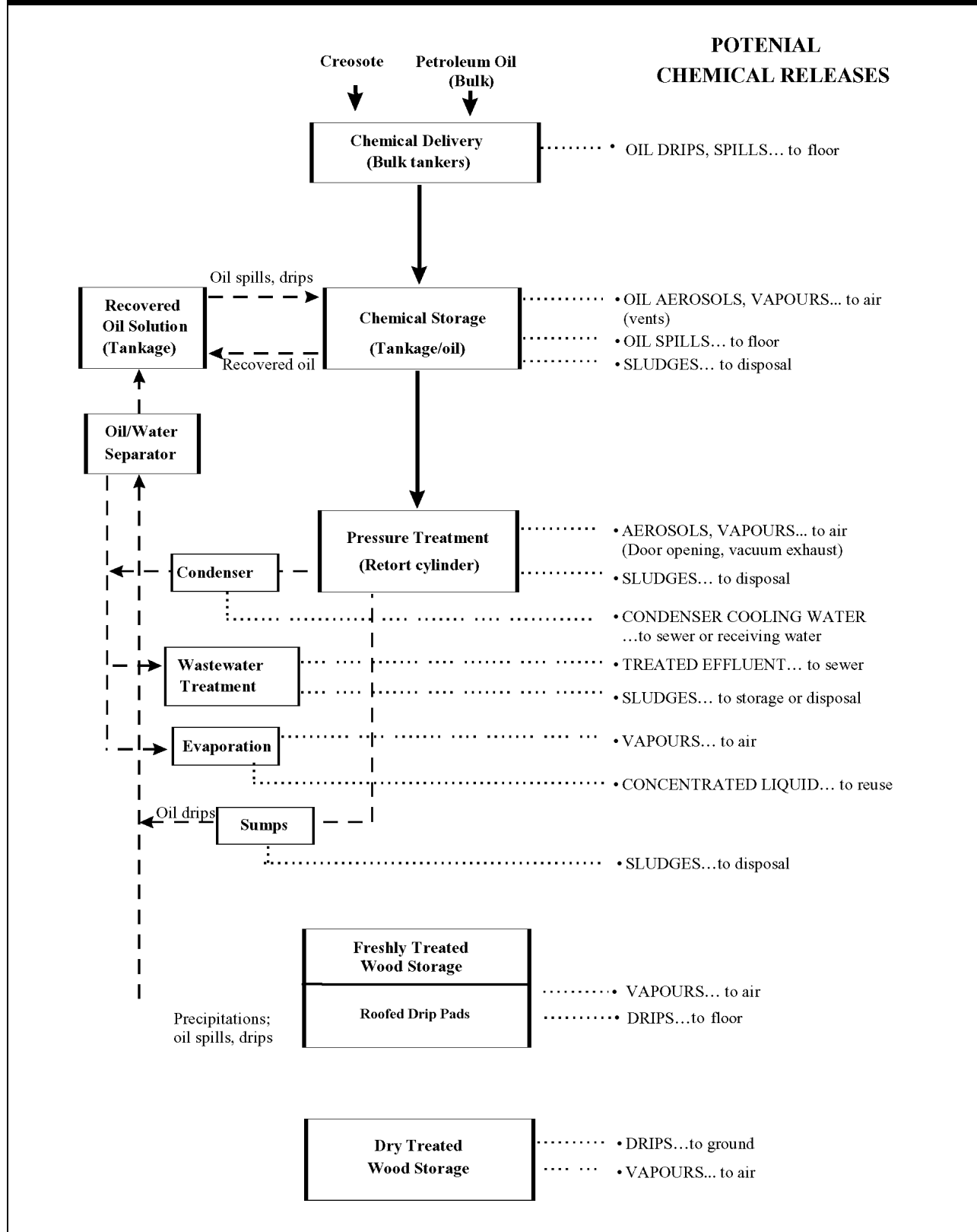
Air emissions from creosote treatment facilities are generally localized and may include the following:

- emissions during application of vacuum for wood conditioning, for the full-cell process or during the final vacuum step
- vapours from tank vents
- vapours from treating cylinders
- vapours from opening of cylinder doors;
- vapours from freshly treated charges

Refer to Part 1, Chapter A, [Section 5.2](#) for more details on potential chemical discharges.



**Figure 1 Potential Chemical Releases From Creosote Pressure Treating Plants**



### **5.3 *Potential Effects of Chemical Discharges***

The actual impact to the environment of any liquid discharge, solid waste or air emission depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the species of aquatic biota in adjacent surface waters, and the amount of preservative released. Variables that can influence effects on worker health include ambient concentrations, frequency of exposure and protective measures during the time(s) of exposure.

All facilities that use creosote could affect the environment, as could any industrial facility that uses chemical, if proper control measures are not in place. Historically, documented releases of creosote from wood preservation facilities have been due either to poor design or to poor operating practices. The effects of these releases appear to be localized at the plant site (i.e. soil and groundwater contamination) or in the immediate environment adjacent to the plant site (25).

Human health could be affected if appropriate precautions are not taken during spills of creosote and residues, operation of the treatment system (e.g. cylinder door opening) and handling of treated products. Skin burns and allergic reactions were reported in a survey of the accident history of 50 pressure treatment plants (26). A review of the literature by Todd and Timbie (27) concluded that “there is neither positive nor negative human experience data in the wood treating industry to indicate that additional or less restrictive exposure control is appropriate.”

## 6 Protection of Personnel

### 6.1 First Aid, Precautions and Hygiene for Creosote Exposure

The general rule applies: for work with creosote, creosote/oil mixtures and/or sludge, **the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs.**

Facility staff should have access to product labels and appropriate training to apply first aid.

Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with Creosote solution, making the first aider the next victim if direct mouth-to-mouth contact is made. First aid personnel should periodically verify up-to-date response measures with chemical suppliers and/or industrial physicians

Table 5 contains the recommended actions in case of creosote exposure. Potential exposure to creosote in pressure treatment facilities includes exposure to creosote, creosote treating solutions and sludge, contaminated aqueous solutions and treated wood. Inhalation exposure can occur from vapours or aerosols.

**Table 5. First Aid Measures for Exposure to Creosote**

Exposure	First action	Second action
Eye contact	<ul style="list-style-type: none"> <li>Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids.</li> <li>Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li> <li>Flush eyes for at least an additional 15 minutes.</li> </ul> <p><i>Workers should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>Get medical attention or call a poison control centre for treatment advice (have product label at hand).</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>Immediately remove soaked clothing or articles in contact with the skin.</li> <li>Immediately wash contaminated skin thoroughly with soap or mild detergent and water for 15-20 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>Call a poison control centre or doctor for treatment advice (have product label at hand).</li> <li>Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>Immediately move the affected person to fresh air.</li> <li>If no pulse, apply CPR.</li> <li>If breathing has stopped: <ul style="list-style-type: none"> <li>Call emergency services (ex. 911)</li> <li>Apply artificial respiration with barrier device</li> </ul> </li> <li>Shake and shout</li> </ul>	<ul style="list-style-type: none"> <li>Keep affected person warm and quiet..</li> <li>Get medical attention (have product label at hand).</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>Get medical attention or call a poison control centre immediately for treatment advice.</li> <li>Do not induce vomiting unless told to do so by a poison control centre or doctor.</li> <li>Give conscious victim water or milk to drink.</li> </ul>	<ul style="list-style-type: none"> <li>Then give 30–60 mL of Fleet's Phospho-Soda diluted 1:4 in water.</li> </ul>
Chronic symptoms requiring medical referral		<ul style="list-style-type: none"> <li>Medical referral <ul style="list-style-type: none"> <li>○ Skin irritation, sensitivity</li> <li>○ Skin lesions</li> </ul> </li> </ul>

For all medical attention, always take the pesticide label to show to the health personnel.

Personnel should follow the recommendations from [Table 6 of Chapter A](#) outlining general precautions and personal hygiene measures.

## **6.2 Regulatory Controls**

The labels for pesticide products contain information on the minimum necessary protective equipment and practices necessary for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

Most regulatory criteria established by worker protection agencies are based on TLVs and BEIs, as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH). Creosote per se is not addressed by the ACGIH. The ACGIH suggests the use of benzene soluble fractions of coal tar pitch volatiles as a measure of exposure (20).

The ACGIH TLV-TWAs for chemicals are defined with the following provisos:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentration.”
- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

Recently, the ACGIH has suggested augmenting TLV workplace evaluations by using “biological exposure indices (which) may be useful as a guide to safe exposure” (20).

### *Skin and Eye Contact*

A wide range of dermal exposures to creosote can potentially be encountered in the workplace, from exposure to “pure” creosote, to creosote/oil mixtures or to waters containing a few parts per million of creosote. A minimal level of protection and hygiene—for example, impermeable gloves and regular clothing changes—should be maintained by all facility workers who could have dermal exposure to creosote, creosote/oil and aqueous solutions of creosote or freshly treated wood. The level of protection should increase with increasing potential for exposure.

### *Inhalation*

The ACGIH recommended threshold limit value - time weighted average (TLV-TWA) for creosote represents a TWA concentration “for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.” The recommended TLV-TWA value for benzene-soluble fractions of coal tar pitch volatiles is 0.2 mg/m<sup>3</sup>.

The ACGIH TLV-TWA values for coal tar pitch volatiles are applicable as maximum allowable values for inhalation. Adequate design and operational procedures (e.g. adequate local ventilation and use of appropriate respiratory equipment, where necessary) will minimize worker exposure to vapours. Other potential sources of inhaled coal tar pitch volatiles include vapours in the vicinity of charge removal areas and in the vicinity of freshly treated wood, and aerosols at improperly maintained facilities (e.g. from leaking seals) or at inadequately designed facilities (e.g. from vacuum pump discharges to work area).

### *Ingestion*

Oral intake of creosote must be avoided. Ingestion of creosote or creosote-containing liquids is unlikely if workers follow elementary rules of good hygiene. Acceptable limits of ingestion are not prescribed by regulation since there is no valid reason for any such intake to occur. The single dose level of creosote suggested to be fatal is in the order of 0.1 g creosote per 1 kg of body weight (18).

## **6.3 Safety Precautions**

Workers need to familiarize themselves with the following safety precautions in addition to those mentioned in Chapter A, [Section 6.3](#). Sensitive individuals should take special care to avoid exposure.

**Table 8. Additional Safety Precautions for Personnel Working with Creosote**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 8.)

<b>Objective:</b> Ensure safe workplace practices for each activity during the treatment process	
<b>Activity</b>	<b>Recommendations</b>
General	<ul style="list-style-type: none"> <li>Impermeable resistance rating of materials for creosote:               <ul style="list-style-type: none"> <li>excellent — viton, neoprene, butyl rubber</li> <li>good — nitrile, polyvinyl chloride (PVC)</li> <li>fair — polyvinyl alcohol, polyethylene</li> </ul> </li> <li>Respirators must be in accordance with NIOSH guidelines (PAH and organic vapours cartridges)</li> <li>First aid kits must contain <i>Fleet Phospho-Soda</i></li> </ul>
Unloading or handling creosote	<ul style="list-style-type: none"> <li>Should wear a respirators and must be in accordance with NIOSH guidelines (PAH and organic vapours cartridges)</li> <li>Provide adequate equipment for safe, controlled transfer of creosote as outlined in the <i>National Fire Code of Canada</i> and as appropriate for the specific facility.</li> </ul>
Sampling procedures	<ul style="list-style-type: none"> <li>Wear eye protection and gauntlets impermeable to creosote when sampling creosote solutions, e.g., from a pipe tap.</li> <li>Should wear a respirators and must be in accordance with NIOSH guidelines (polynuclear aromatic hydrocarbons and organic vapours cartridges) when sampling creosote solutions or treated wood (if at temperatures above ambient).</li> <li>Other non-routine sampling efforts such as through cover ports may necessitate more stringent precautions.</li> </ul>
Cleaning cylinders or storage tanks	<ul style="list-style-type: none"> <li>Follow appropriate confined space program and procedures.</li> <li>Provide self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode.</li> <li>Provide combination respirator that includes Type C-supplied air respirator and full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode.</li> </ul>
Handling treated lumber	<ul style="list-style-type: none"> <li>Wear a breathing apparatus if treated wood is handled in <b>enclosed</b> areas (e.g. boxcars).</li> <li>Change coveralls daily.</li> </ul>
Handling and maintaining contaminated equipment	<ul style="list-style-type: none"> <li>Thoroughly steam-clean or flush contaminated equipment with solvent (e.g. Varsol or equivalent) prior to handling. (Contain all solvent washings.)</li> <li>Change coveralls daily.</li> </ul>
Welding	<ul style="list-style-type: none"> <li>Prevent distribution of sparks to other contaminated areas or to areas where volatiles of creosote may be deposited.</li> </ul>

\* An initial workplace monitoring program will have determined the need for respirator use. The results of the program are assumed to be indicative of conditions in subsequent facility operations, unless procedural or design changes have occurred.

Note: Observe also the general precautions and personal hygiene measures outlined in Part I, Chapter A – General Recommendations for All Wood Preservatives.

## 6.4 Biological Monitoring of Exposed Workers

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#).

## 7 Design Recommendations

The following tables present good design features specifically applicable to creosote wood preservation facilities. The additional recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 7](#) and their corresponding tables. All tables of general content from Chapter A, Section 7 must be taken into consideration.

**Table 10. Additional Recommended Design Features for Chemical Delivery Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 10.)

Delivery format	Design feature	Recommendations
<b>Bulk liquid</b> <ul style="list-style-type: none"> <li>• Creosote</li> <li>• Petroleum oil</li> </ul> (delivered by truck, or rail tanker)	<b>Objective:</b> Provide an off-loading area that enhances spill prevention and containment	
	<b>National Fire Code of Canada 2010 (NFCC)</b>	<ul style="list-style-type: none"> <li>• Special attention to the equipment and design requirement from the NFCC for flammable and combustible liquids</li> <li>• Division B, Part 4.</li> </ul>
	Static protection	<ul style="list-style-type: none"> <li>• Install acceptable provisions for electric bonding as per the NFCC.</li> </ul>

**Table 11. Additional Recommended Design for Chemical Storage Area**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 11.)

Storage format	Design feature	Recommendations
<b>Bulk liquids</b> <ul style="list-style-type: none"> <li>• Creosote</li> <li>• Petroleum oil</li> <li>• Working solutions</li> <li>• Contaminated surface runoff</li> <li>• Drip return</li> </ul>	<b>Objectives:</b>	
	<ul style="list-style-type: none"> <li>• Provide positive spill prevention features</li> <li>• Provide spill containment capability</li> </ul>	
	<b>National Fire Code of Canada 2010 (NFCC)</b>	<ul style="list-style-type: none"> <li>• Special attention to the equipment and design requirement from the NFCC for flammable and combustible liquids (see Division B, Part 4).</li> <li>• Location of tanks</li> <li>• Equipment grounding</li> <li>• Design</li> <li>•</li> </ul>
	Tanks	<ul style="list-style-type: none"> <li>• Subsurface tanks and piping must not be used.</li> <li>• The preferred location for oil tankage (all solutions) is in an exterior centralized tank farm area.</li> </ul>
	Security	<ul style="list-style-type: none"> <li>• Provide security precautions to prevent vandalism or access to tanks by unauthorized persons.</li> </ul>

**Table 14. Additional Recommended Design Features for Freshly Treated Wood Drip Areas**  
 (Use in conjunction with Part I, Chapter A [General Recommendations for All Wood Preservatives, Table 14.](#))

Design feature	Recommendations
<b>Objective</b>	Minimize losses of preservative chemicals from treated wood by <ul style="list-style-type: none"> <li>• providing proper conditions for freshly treated wood; and</li> <li>• controlling the generation and disposal of contaminated runoff waters.</li> </ul>
<b>Drip area</b>	<ul style="list-style-type: none"> <li>• Provide for sufficient contained, impermeable floor and <u>roofed</u> storage or transfer area for freshly treated lumber.</li> <li>• Roofing, as an alternative to collection and treatment of contaminated waters, might be necessary for pole treating in areas of high precipitation</li> </ul>



## 8 Operational Recommendations

The additional recommendations for good operating practice listed in the following tables must be used in conjunction with those in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8](#). All tables of general content from Chapter A, Section 8 must be taken into consideration.

### 8.1 Operational Standards

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including creosote (5). Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2-08 Clause 4.1 (referenced to AWWA M3). The calibration can be conducted by facility staff if they have the appropriate training.

Special attention is required on the part of creosote plant operators to ensure that operational activities are in accordance with the *National Fire Code of Canada* (NFCC) for flammable and combustible liquids (28).

### 8.2 Facility Wide Recommendations

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### 8.3 Process Area-specific Recommendations

**Table 19. Additional Recommended Operating Practices for Chemical Handling and Storage**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 19.)

Operation	Recommendations
<b>Storage of wood preservation chemicals</b>	<b>Objective:</b> Ensure that all creosote solutions are safely stored
<ul style="list-style-type: none"><li>• Creosote</li><li>• Petroleum oil</li></ul>	<ul style="list-style-type: none"><li>• Implement visual inspection routine at least once each shift for prompt detection of abnormal conditions.</li><li>• Frequently inspect and test all safety shutoff valves and other fire safety devices (as per the NFCC).</li></ul>

NFCC = National Fire Code of Canada

**Table 20. Additional Recommended Operating Practices for Process Systems**  
 (Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 20.)

Operation	Recommendations
Treatment	<ul style="list-style-type: none"> <li>• Condition wood adequately to minimize after-bleeding.               <ul style="list-style-type: none"> <li>○ Keep net retention as close as possible to specified levels.</li> <li>○ Apply as a minimum after the impregnation cycle an effective final vacuum to equilibrate internal wood pressure and to cool the wood.</li> <li>○ To minimize bleeding, apply an effective expansion bath or final steam/vacuum cycle.</li> </ul> </li> </ul>

## 9 Waste, Process Emissions and Disposal

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 9.1 Control, Treatment and Disposal

Potential sources of chemical releases from creosote pressure treatment facilities were described in Section 5.2 and Figure 1. Table 23 at the end of this section identifies the main categories of process wastes or emissions that can be generated at creosote facilities, and summarizes recommended control, treatment and/or disposal methods.

**The processes used for waste disposal fall under provincial jurisdiction and may vary from province to province.**

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information.

### 9.2 Liquids Containing Creosote

#### *Contaminated Storm Runoff*

Because creosote wood preservation facility sites are generally large, considerable volumes of storm runoff occur from these sites. Precautions should be taken to avoid contamination of storm runoff water, particularly in the vicinity of creosote treatment areas, treated wood discharging areas and storage sites. It is good practice to roof the process areas, including the pressure cylinder and associated equipment, since this practice reduces contaminated storm runoff. Discharging areas should be paved and bermed, with provisions for collection of surface runoff. The likelihood of creosote-contaminated runoff from treated wood storage areas must be acknowledged, and surface runoff from the storage areas should be monitored for creosote and oil. If contamination occurs please refer to Section 12 – Environmental Emergency Notification and Contingency Planning for more direction.

#### *Liquid Process Wastes*

Leaks and drips of oil solutions are contained and reused in the treatment process. Liquids such as condensates, washwaters and infiltrating waters, which cannot be reused, must be treated to remove creosote and petroleum oil prior to discharge (29, 30, 31). The treatment techniques may include one or a combination of the following:

- oil/water API separation, or plate separation
- gravity separation in settling tanks
- activated sludge treatment
- activated carbon treatment

- physical-chemical treatment (e.g. flocculation)
- evaporation/condensation

A regulatory discharge permit must be obtained for disposal of the treated wastewaters.

### **9.3 Solids with High Creosote Concentrations**

Activated carbon contaminated with creosote can be regenerated, in which case it should not be considered as waste.

It should be noted that several provinces limit the volumes of creosote wastes that can be stored.

The wood preservation industry in Canada has the following options for handling and disposal of creosote-contaminated solids:

- on-site storage until hazardous waste disposal facilities have been constructed and are operating in Canada
- shipment to the United States for high-temperature incineration
- incineration of the wastes following approval by the appropriate provincial regulatory agency
- disposal at hazardous waste landfill sites

### **9.4 Miscellaneous Solid Wastes**

For non-bulk containers, follow recommendation from Chapter A, [section 9.4](#). Additional recommendation for empty container:

- Make the empty container unsuitable for further use

Do not use creosote- treated wood as a compost or mulch.

Incineration of creosote -contaminated materials is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products

### **9.5 Air Emissions**

Air emissions at creosote pressure treatment facilities are generally localized; effects, if any, would be restricted to workers at the facilities. Analyses of air emissions from creosote facilities indicate that the components are mostly low molecular weight organic compounds (27).

**Table 23. Additional Recommended Disposal Practices for Creosote Contaminated Wastes**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 23.)

Waste category	Examples	Recommendations
<b>Liquid creosote or creosote/oil solutions</b>	<ul style="list-style-type: none"> <li>Preservative work solutions</li> <li>Material skimmed from oil separators</li> <li>Drips from freshly treated lumber</li> </ul>	<ul style="list-style-type: none"> <li>Collect and reuse (standard practice at creosote/oil plants).</li> <li>Recover and reuse (successfully demonstrated at some oil-borne plants).</li> </ul>
<b>Liquid creosote/water solutions</b>	<ul style="list-style-type: none"> <li>Condensates</li> <li>Washwaters</li> <li>Infiltrating waters</li> </ul>	<ul style="list-style-type: none"> <li>Treat to remove oil and creosote to within regulatory limits.</li> <li>Reuse retrieved oil and creosote, e.g., from gravity separation.</li> <li>Dispose of treated waters as per regulatory requirements.</li> </ul>
<b>Contaminated solid wastes</b>	<ul style="list-style-type: none"> <li>Debris and bottom sludge from storage tanks, sumps and pressure cylinders</li> <li>Soils contaminated by spills</li> <li>Cleanup absorbents</li> </ul>	<ul style="list-style-type: none"> <li>Drain and/or drum, store and dispose of in accordance with provincial regulatory requirements (high-temperature thermal destruction is considered a feasible disposal option).</li> </ul>
<b>Miscellaneous solid wastes</b>	<ul style="list-style-type: none"> <li>Scraps, cuttings and shavings from creosote-treated lumber</li> </ul>	<ul style="list-style-type: none"> <li>Dispose of in sanitary landfills (subject to approval by the municipal and/or provincial regulatory agency).</li> </ul>
<b>Contaminated storm runoff</b>	<ul style="list-style-type: none"> <li>Any storm runoff or contaminated liquid discharge that is determined to be toxic to fish at the point of discharge (toxicity is determined by bioassay tests of specific discharges)</li> </ul>	<ul style="list-style-type: none"> <li>Prevent or minimize contamination of storm runoff to the greatest possible extent.</li> <li>Monitor surface water discharges (in consultation with the provincial regulatory agency) to assess contaminant concentrations and to determine the need for control.</li> </ul>
<b>Firefighting water runoff</b>	<ul style="list-style-type: none"> <li>As above (contaminated storm runoff)</li> </ul>	<ul style="list-style-type: none"> <li>Consider containment provisions in areas where creosote and creosote/oil solutions are present.</li> <li>Consult the provincial regulatory agency to determine acceptable disposal practices.</li> </ul>
Note: Consult the provincial and/or local regulatory agency for any specific requirements.		

## 10 Environmental and Workplace Monitoring

### 10.1 Baseline Environmental Evaluation

A comprehensive perspective on the sources and distribution of PAHs in the Great Lakes is provided in the 1983 report of the International Joint Commission's Aquatic Ecosystem Objectives Committee (11). The report indicates that the major anthropogenic sources of PAHs in the environment are fuel combustion (coal, oil and wood burning), refuse combustion and coke production. Fossil fuels such as crude or bunker oil contain PAHs, and accidental spills from boating and shipping activities contribute considerably to PAH contamination in coastal waters. Levels of PAHs in waters, air and sediments in the vicinity of populated and industrial areas are frequently significantly higher than in non-populated areas. To illustrate PAH levels in the environment, the following lists concentrations found in sediments, water and biota of the Great Lakes.

Benzo(a)pyrene in water is found in the Great Lakes water system at a concentration of 0.012 µg/L and Phenanthrene is found at a concentration of 0.024 µg/L (mean basis).

The sediment data show the influence of anthropogenic sources on PAH levels in the environment (e.g. for Benzo(a)pyrene Lake Superior 0.028 µg/kg versus Lake Erie 0.255 ± 0.152 µg/kg).

The Fish data also show the influence of anthropogenic sources on PAH levels in the environment (e.g. for Benzo(a)pyrene Lake Erie 0.046 ± 0.041 µg/kg and Lake Ontario 0.069 ± 0.044 µg/kg)

Since PAHs are also produced during forest fires and volcanic eruptions (11), they can be considered natural compounds. It has been estimated that forest fires contributed 10% of total PAH emissions in the United States during the mid-1970s (32).

Releases from creosote wood preservation facilities have been reported and are primarily ascribed to historical events resulting from poor operating practices. Contamination of several Canadian preservation plant sites has been reported (33). The available evidence, which is limited and not very conclusive, indicates that the quantities of PAHs entering the environment from treated wood in service are small (34).

The facility should have in hand the background levels of the preservative constituents in the natural environment prior to plant operation. Older mills may not have this information available. A comparative site from a nearby property can be used as a reference. The facility may use the template provided in [Table 24](#) from Chapter A.

### 10.2 Environmental Monitoring

A possibility of creosote-contaminated ground and runoff from treated wood storage areas must be acknowledged. PAH are persistent and bioaccumulative in the environment and close monitoring studies (such as surface water discharges, groundwater and soil contamination) are recommended to detect and properly assess the degree of such potential toxic releases.

### **10.3    *Workplace Exposure Monitoring***

Workplace monitoring generally falls under provincial jurisdiction. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## 11 Transportation of Creosote and its Wastes

The transportation of creosote, oils for blending and the wastes generated by their use is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details, please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of creosote and its wastes.



## **12 Environmental Emergency Notification and Contingency Planning**

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using creosote or creosote/oil solutions should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective.

### **12.1 Environmental Emergency Notification**

The Environmental Emergency Regulations and its requirements are applicable for Creosote since creosote-impregnated waste materials and polycyclic aromatic hydrocarbons are listed in Schedule 1 of CEPA 1999.

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.2 Spill Contingency Planning**

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.3 Fire Contingency Planning**

Creosote is a combustible liquid. An irritating heavy, black smoke forms with a creosote fire. Although water is ineffective as an extinguishing medium and should not be used directly on the fire, it should be used to cool fire-exposed containers. It is, therefore, important that creosote wood preservation facilities devise an adequate contingency plan for fire protection, including storing a copy of all necessary documents in a fire proof box outside the entrance to the facility.

Please refer to the *National Fire Code of Canada (always refer to last version available)* (28) for proper fire extinguishing agents and other requirements for contingency planning, and refer to [Section 12.3](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

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## CHAPTER E

# Pentachlorophenol Pressure (PCPP) Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives.



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# 1 Production and Use

Pentachlorophenol\* (PCP) was first used as a wood preservative in 1936 (1). The biological properties of PCP have resulted in its use as an antimicrobial agent in industrial cooling systems and papermaking, and as a fungicide in protein-based latex paints (2). Agriculture Canada restrictions in 1981 limited the use of PCP for preservation of outdoor wood products. PCP is currently used for pressure treatment of wood products (PCPP) such as telephone and electrical utility poles, cross-arms, posts and construction timbers (3). Over 90% of all PCPP is used for utility pole preservation. PCP use by the wood preservation industry depends primarily on the size of the pole and cross-arm markets: chromated copper arsenate (CCA) has partially replaced PCP in the utility pole market, and the PCP railway tie market has been converted to creosote/oil treatments, leading to a decline in use since 1981 (4). Table 1 provides an overview of PCP use at Canadian pressure treatment facilities.

PCP is prepared by reacting chlorine with phenol in the presence of a catalyst at high temperatures. PCP was last manufactured in Canada in 1983. It is now obtained from only one U.S. manufacturer who supplies it in the form of solid blocks (900 kg/2000 lbs) or liquid bulk. The petroleum oils used as carriers for PCP are purchased generally from Canadian sources.

The pressure-impregnated PCP/oil mixture is retained by the wood, and its bio-effectiveness protects the wood against fungi and insects. In addition to functioning as a carrier of PCP, the oil also provides extra protection against moisture content changes, leading to greater wood stability and resistance to splitting. For utility pole use it has the additional advantage of providing resistance to electrical currents and facilitating the climbing of poles by line personnel.

**Table 1. Overview of PCPP Use in Canada**

Feature	Characteristics
<b>Treated wood use limitations in Canada</b>	USE FOR INDUSTRIAL WOOD PRODUCTS ONLY <ul style="list-style-type: none"><li>• Utility poles</li><li>• Cross-arms</li><li>• Posts</li><li>• Pilings</li><li>• Construction timbers</li><li>• Railway ties</li></ul> Note: permitted uses and limitations of PCP-treated wood may change over time. Refer to pesticide label for up-to-date uses
<b>General process of application</b>	Pressure treatment (refer to the pesticide label for details)

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes PCP-treated products. (5) Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label

\* The technical product referred to as "PCP" in this document is not pure PCP. It contains 86% PCP and 10% "other chlorophenols and related products." Related products include trace amounts of some polychlorinated dibenzo-p-dioxins, polychlorinated dibenzofurans and hexachlorobenzene. Use of the term "PCP" in this document is consistent with industry nomenclature and refers to the technical-grade product. "PCPP" refers to pentachlorophenols applied with the pressurized process, which is the only process referred to in this chapter.

## 2 Physical and Chemical Properties

PCP is a solid at room temperature. It can be characterized as a stable organic compound that is sparingly soluble in water and highly soluble in organic solvents. It adsorbs strongly to organic solids such as cellulose in wood.

PCP is chemically and biologically persistent at high concentrations (i.e. the 5–9% concentrations used for treatment of wood). Its persistence in treated wood and its toxicity to wood decay organisms are two major reasons for the use of PCP as a wood preservative. However, it is photodegradable and at low concentrations is also biodegradable.

The physical and chemical properties listed below must be given special consideration during handling and contingency planning:

- the ability of PCP to dissolve in water; dissolution increases as pH and temperature increase
- the high solubility of PCP in oils, including skin oils, which enhances its ability to penetrate skin following dermal contact
- the potential to form toxic fumes upon exposure to fires and high temperatures (i.e. over 350°C)
- a vapour pressure (although low at room temperature) that will result in a small degree of sublimation of PCP

The physical and chemical properties of PCP are outlined in Table 2 (6, 7). General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and from labels for pesticide products. Electronic copies of the pesticide label can be obtained from the Health Canada website (8):

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>.

**Table 2. Physical and Chemical Properties of PCP Solids**

Identification		
<b>Common synonyms:</b> (past and present) Penta PCP		<b>Registrant in 2012:</b> KMG-Bernuth Inc. (Houston, TX) <ul style="list-style-type: none"> <li>• <a href="#">DURA TREAT 40</a></li> <li>• <a href="#">KMG PENTA BLOCKS</a></li> </ul>
<b>Chemical Abstracts Service Registry Number (CAS RN):</b> 87-86-5		
Transportation and storage information		
<b>Shipping state:</b> KMG: Solid blocks – 900 kg (2000 lbs.) DURA: Liquid solution <b>Concentration:</b> 96% by weight total (technical grade) chlorophenols (86% PCP 10% other chlorophenols and related compounds and 4% inerts)	<b>Storage temperature:</b> Ambient <b>Inert atmosphere:</b> No requirement <b>Venting:</b> Required <b>Containers/materials:</b> Solid blocks: polyethylene wrap Liquid solution : Totes	<b>Classification:</b> Poisonous <b>Placards:</b> PENTA: Class 3 UN 1306 KMG: Class 6.1 PG II UN 3155 <i>Check with Transport Canada</i>
Physical and chemical properties		
<b>Physical state:</b> Solid <b>Solubility:</b> Freely soluble (oil and alcohol) Slightly soluble (water) 5 ppm by weight (0°C) 14 ppm (20°C) 35 ppm (50°C) <b>Melting point:</b> 191°C (anhydrous) 184°C (1*H <sub>2</sub> O) <b>Boiling point:</b> 293.08°C Decomposes at 310°C <b>Flash point:</b> Not flammable	<b>Explosive limits:</b> Not flammable <b>Floatability:</b> Sinks in water <b>Specific gravity:</b> 1.978 (22°C) <b>Vapour pressure:</b> 0.00019 mm Hg (15°C) 40 mm Hg (211°C) <b>Vapour density:</b> 9.2 <b>Odour:</b> Strong pungent odour when heated	<b>Appearance:</b> White to light brown solid <b>Concentration of work solutions:</b> 5% to 8% in petroleum oil <b>Typical preservative retention in treated wood:</b> 3.4–16 kg PCP/m <sup>3</sup> of treated wood (0.21-1.0 lbs./cu. ft.)
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Use water spray, dry chemical, foam or carbon dioxide. (Note: fire residues may contain chlorinated furans or dioxins and must be treated as contaminated.) Use water to cool fire-exposed containers. Consult your fire department for proper equipment at your facility. <i>Fire behaviour:</i> When heated to decomposition, toxic fumes of hydrogen chloride are formed. Chlorinated dioxins may be generated. <i>Ignition temperature:</i> Not combustible <i>Burning rate:</i> Not combustible		<b>Reactivity</b> <i>With water:</i> No reaction <i>With common materials:</i> Can cause deterioration of rubber when dissolved in oil. <b>Stability</b> Stable

### 3 Environmental Effects

PCP is an anthropogenic chemical that is ubiquitous in the Canadian environment as a result of extensive historical use in the wood preservation industry.

Impurities in technical-grade PCP, which may include tetrachlorophenol, trichlorophenols, hexachlorobenzene, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and chlorinated phenoxyphenols, are contributors to the compound's toxicity. Chronic toxicity studies indicate that technical-grade PCP can be up to 10 times more potent than purified PCP due to the presence of these impurities (9).

Results from previous studies demonstrate that PCP has low bioaccumulation tendency in terrestrial invertebrates. PCP is metabolized rapidly in plants, so that while PCP products may be detected in plants, little intact PCP is found in plant tissues (9).

#### 3.1 Aquatic Toxicity

On an acute basis, PCP is very highly toxic to aquatic invertebrates and highly toxic to fish. Acute LC<sub>50</sub> values for fish ranged from 20 µg/L to 600 µg/L.

Pentachlorophenol is hydrolytically stable in water at pH 4 to pH 9, precluding hydrolysis as a major degradation process in the environment. Chemical degradation of PCP in water will occur mainly through photodegradation. In surface water, PCP will rapidly photodegrade when exposed to direct sunlight, with more rapid degradation occurring with increased pH (when the compound is dissociated) (10).

The exposure of aquatic organisms to PCP could result in both short-term (acute) and long-term (chronic) toxic effects. At low concentrations, PCP is not considered a persistent contaminant in the environment because of documented photochemical degradation and microbial breakdown in surface waters, soil media and sewage effluents (11). However, PCP is widespread at low concentrations in the environment (11). The environmental effects are dependent upon a complex array of parameters including concentration, pH, adsorption to suspended solids, temperature, biodegradation rate and photodecomposition rate.

Based on extensive reviews of the literature and unpublished information, regulatory agencies have derived upper limits for PCP in the environment. As of July 1987, upper limits for Canadian waters have been defined under the auspices of the following regulatory agencies or commissions: the International Joint Commission (IJC), for Great Lakes waters (11); Health Canada, for maximum acceptable concentrations in drinking water (12); and the Canadian Council of Ministers of the Environment (CCME), for protection of aquatic life (13). The upper limits are summarized in Table 3.

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for PCP in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Pentachlorophenol	Maximum acceptable <sup>(a)</sup> concentration (MAC) = 0.06 mg/L (60 µg/L)  Aesthetic objective (AO) ≤ 0.03 mg/L (30 µg/L)	Protection of human health (drinking water)  The odour threshold (AO), is more sensitive than the toxic threshold for humans (MAC)	Health Canada <sup>(a)</sup>
	Guidelines 0.5 µg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(b)</sup>
	<b>Should not</b> be present in concentrations that exceed 5% of the median lethal concentration (LC <sub>50</sub> ) in a 96-hour test for any sensitive local species	Protection of aquatic life (PCP falls under the category of <i>unspecified non-persistent toxic substances and complex effluents of municipal, industrial or other origin</i> )	International Joint Commission <sup>(c)</sup>
	Short-term maximum contaminant level (MCL) = 1 mg/L (1 ppb) for 1 day or 0.3 mg/L for 10 days.  0.022 mg/L is the long-term maximum contaminant level	Protection of human health (drinking water)	U.S. Environmental Protection Agency <sup>(d)</sup>
	Criteria: Examples <sup>(e)</sup> 5.5 µg/L at pH 6.5 20 µg/L at pH 7.8 68 µg/L at pH 9.0 Examples <sup>(f)</sup> 3.5 µg/L at pH 6.5 13 µg/L at pH 7.8 43 µg/L at pH 9.0  7.9 g/L  13 µg/L	Protection of freshwater biota <ul style="list-style-type: none"> <li>1-hour average concentration not to exceed the criterion more than once every 3 years on the average</li> <li>4-day average concentration not to exceed the criterion more than once every 3 years on the average</li> </ul> Protection of saltwater biota <ul style="list-style-type: none"> <li>4-day average concentration not to exceed the criterion more than once every 3 years on the average</li> <li>1-hour average concentration not to exceed the criterion more than once every 3 years on the average</li> </ul>	U.S. Environmental Protection Agency <sup>(e, f)</sup>

**Table 3. Regulatory Limits for PCP in Natural Water Bodies** (continued)

Element	Limit value (mg/L)	Basis (objectives)	Agency
Oil and Petrochemicals	To protect aquatic life, <b>should not</b> be present in concentrations that exceed 5% of the median lethal concentration (LC <sub>50</sub> ) in a 96-hour test for any sensitive local species	Oil and petrochemicals <b>should not</b> be present in concentrations that <ul style="list-style-type: none"> <li>• can be detected as visible film, sheen or discoloration on the surface;</li> <li>• can be detected by odour;</li> <li>• can cause tainting of edible aquatic organisms; and</li> <li>• can form deposits—on shorelines and bottom sediments—that are detectable by sight or odour, or are deleterious to resident aquatic organisms.</li> </ul>	International Joint Commission <sup>(c)</sup>
Polycyclic aromatic hydrocarbons (PAHs)	Please refer to the CCME summary table	Protection of aquatic life	CCME <sup>(b)</sup>

- (a) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.
- o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- “Maximum acceptable” was defined by Health Canada as “drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable.” “Objective” is defined by Health and Welfare Canada as “this level is interpreted as the ultimate quality goal for both health and aesthetic purposes.”
- (b) Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life. <http://st-ts.ccme.ca/>
- (c) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).
- o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)
  - o <http://www.ijc.org/rel/agree/quality.html>
- (d) United States Environmental Protection Agency (USEPA), Basic Information about Pentachlorophenol in Drinking Water
- o <http://water.epa.gov/drink/contaminants/basicinformation/pentachlorophenol.cfm>
- (e) United States Environmental Protection Agency (USEPA), 1986. Ambient Water Quality Criteria for Pentachlorophenol - 1986. Federal Register:4400586009.
- Expressed as an exponential function:  $PCP \text{ limit (mg/L)} = \exp^{[1,005(pH)-4,830]}$ .
- (f) United States Environmental Protection Agency (USEPA), 1986. Ambient Water Quality Criteria for Pentachlorophenol - 1986. Federal Register:4400586009.
- Expressed as an exponential function:  $PCP \text{ limit (mg/L)} = \exp^{[1,005(pH)-5,290]}$ .

### 3.2 Air Pollution

Pentachlorophenol is a relatively volatile compound, while its sodium salt is non-volatile. In the atmosphere, volatilized PCP may undergo photolytic degradation or may react with photochemically produced hydroxyl radicals. Atmospheric PCP that is associated with particulate matter or moisture will be lost from the atmosphere through wet deposition. Based on PCP's low Henry's Law constant, volatilization from aqueous systems will not be a significant mode of transport in the environment (10).

Pentachlorophenol contains chlorinated dibenzodioxins and chlorinated dibenzofurans (CDDs and CDFs) as contaminants formed during the manufacturing process. The CDDs and CDFs in

the product may be released into the environment via volatilization and leaching. In addition, CDDs and CDFs may enter the environment during the pressure-treatment of the utility poles, as well as when the utility poles are removed from service and are disposed of in landfills. These compounds are inherently toxic, as well as environmentally persistent, and their presence may increase the ecological risk associated with the use of PCP (10). According to the Proposed Re-evaluation Decision, PRVD2010-03 Heavy Duty Wood Preservatives, “The wood preservation industry continues to be a source of dioxins and furans into the Canadian environment, however, a reduction in the amount of pentachlorophenol used in wood preservation due to the availability of alternatives for some uses and the measures taken by the technical grade active ingredient registrant to reduce levels of Track 1 contaminants in its technical product.” (6)

Section 4 addresses the potential health effects of exposure to air pollution from wood preservatives. Air pollution should be considered when evaluations of potential chemical discharges are made in Section 5.

### **3.3 Soil Contamination**

Soil contamination can be an issue at wood preservation facilities if no effective measures are in place. PCP may be photodegraded, making degradation products available for being mobile in water. Contaminated soil can be spread by vehicles and wind, but it will mostly migrate into runoff water and can potentially contaminate drinking water. The design and operational recommendations presented in Sections 7 and 8 contain measures to minimize soil contamination.

Adsorption of PCP to soil is influenced by soil pH and organic carbon content (14). In general, adsorption was found to increase as soil pH decreased. As adsorption increases, PCP is less bioavailable and the rate of biodegradation tends to be reduced (15).

Leaching of PCP tends to increase with high PCP input, high soil moisture, alkaline soil conditions and low organic matter content in the soil (16). Over a range of environmentally significant temperatures and pH, the solubility of PCP was found to vary from 5 to 8000 mg/L.

Biodegradation is an important process, particularly under aerobic conditions. Biodegradation processes reported include reduction, dechlorination, methylation, demethylation, acetylation and hydroxylation. By-products include lower chlorinated phenols, methyl ethers and pentachloroanisole. The rate of biodegradation in soil is affected by temperature, pH, moisture, adsorption and cation exchange capacity. Microbial species known to biodegrade PCP include *Pseudomonas*, *Flavobacterium* and *Arthrobacter* species. Several species of fungi are also known to be capable of PCP degradation (9).

The CCME has developed the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*. Limit concentrations for industrial sites are set as follows:

- $SQG_{HH}$  = soil quality guideline for human health      7.6 mg/kg dry weight
- $SQG_E$  = soil quality guideline for environmental health 28 mg/kg dry weight



The CCME recommends the application of various check mechanisms, when relevant, in order to provide a broader scope of protection. This additional information on check values can be found in the CCME Canadian Soil Quality Guidelines, available at <http://ceqg-rcqe.ccme.ca/>.

## 4 Human Health Concerns

Human health effects from low PCP environmental concentration are unknown. Acute, high-dose exposure to PCP can induce a hypermetabolic state and excessive heat production. Effects—including hyperthermia, hypertension and metabolic acidosis—were observed in adults and children severely exposed to PCP through ingestion, inhalation or skin absorption. Death can result from seizures and cardiovascular collapse. In animals, chronically administered high doses of PCP were hepatotoxic and carcinogenic, and they adversely affected thyroid function. PCP is not mutagenic or teratogenic (17).

The International Agency on Research for Cancer has determined that PCP is classified in Group III, “possibly carcinogenic to humans” (18). PCP is absorbed rapidly via the lungs, gastrointestinal tract and skin (9). After absorption, PCP is distributed to most tissues and is not extensively metabolized (17).

After a single dose, PCP is eliminated over a few days; with repeated or chronic exposure, the elimination half-life may be a week or more. Most of the PCP taken into the body does not break down, but instead is eliminated via the urine. Much smaller amounts are eliminated in feces. Only a small amount is exhaled. Some of the PCP taken into the body is joined with other natural chemicals that render it less harmful. The combined product can then leave the body more easily (18). Finding a measurable amount of PCP in urine does not mean that the level of PCP causes an adverse health effect (17).

Considering previous studies on the effects of PCP effects and the limitations of these studies, it can reasonably be argued that exposure to PCP is associated with increased risks of a number of diseases, namely chloracne, soft tissue sarcoma, non-Hodgkin’s lymphoma and possibly abnormal births (10).

One safety objective of the industrial use of any chemical is to minimize worker exposure. If safeguards are not provided or are not implemented, a variety of human health effects can occur depending on the duration and manner of exposure, the concentration of the chemical to which exposure has occurred, the form of the chemical (e.g. ionic vs. non-ionic) and the varying metabolic sensitivities of individual workers.

The PMRA’s re-evaluation decision for the registration of the heavy duty wood preservatives creosote, pentachlorophenol, chromated copper arsenate and ammoniacal copper zinc arsenate, has granted continued registration of these products for sale and use in Canada. Potential risks from inhalation and dermal exposure were identified for some occupational tasks within wood-treatment facilities. The addition of new risk-reduction measures and the development of a Risk Management Plan for heavy duty wood preservatives will continue to lower the potential for occupational exposure for treatment facility workers (6).

Table 4, which is based on information from existing literature, outlines the spectrum of human health effects that could result from various degrees of exposure to PCP (as purified PCP).

**Table 4. Potential Health Effects of Exposure to PCP**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) <sup>(a,b)</sup> • Pentachlorophenol (PCP) Range* from 0.039 µg/kg to 0.16 µg/kg  (Large variation can be explained by the various contaminated environments.)			
Eye contact <sup>(b,c,d,e)</sup>	Direct contact Mist, vapour or splashes	<ul style="list-style-type: none"><li>• Redness</li><li>• Irritation of eyes</li></ul>	<ul style="list-style-type: none"><li>• Potential carcinogenic action</li><li>• Ulceration</li><li>• Severe burn</li><li>• Possible increased metabolism</li></ul>
Skin contact <sup>(b,c,d,e)</sup>	Occasional direct contact with dust, liquid, vapours or mists	<ul style="list-style-type: none"><li>• Irritation of skin, possible increased metabolism</li></ul>	<ul style="list-style-type: none"><li>• Burning may result if PCP is not removed from skin</li></ul>
	Worker with significant exposure, e.g., frequent skin contact, exposure to high dust levels, liquid, vapours or mists	<ul style="list-style-type: none"><li>• Profuse sweating, headaches, nausea, weakness, fever, intense thirst</li><li>• Increased body temperature</li></ul>	<ul style="list-style-type: none"><li>• Potential carcinogenic action</li><li>• Damage to immune system</li><li>• Dermatitis; chloracne; suspected damage to kidney, liver, nervous system; weight loss</li></ul>
Exposure to airborne contaminant or dust Inhalation <sup>(b,c,d,e)</sup>	Inhalation of vapours in excess of threshold limit values (TLV)	<ul style="list-style-type: none"><li>• Irritation of nose and throat</li></ul>	<ul style="list-style-type: none"><li>• Potential carcinogenic action</li></ul>
ACGIH threshold limit value-time weighted averages (TWA) and biological exposure indices (BEI) <sup>(g,h)</sup>	TWA: 0.5 mg/m <sup>3</sup> air  BEI in urine prior to last shift of workweek at the end of shift = 2 mg/g creatinine  BEI in plasma prior to last shift of workweek at the end of shift = 5 mg/L)		<i>(Potential contributions to overall exposure can occur through the cutaneous route including mucous membranes and eye either by airborne particles, or, more particularly, by direct contact with the substance.)</i>

**Table 4. Potential Health Effects of Exposure to PCP (continued)**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Ingestion <sup>(b,c,d,e)</sup>	Ingestion of PCP through manipulation of contaminated goods (dishes, gum, candy, food, tobacco, liquids)	<ul style="list-style-type: none"> <li>Increased body temperature</li> <li>Damage to immune system, reproductive effects and developmental effects</li> <li>Suspected damage to kidney, liver, nervous system and gastrointestinal tract; weight loss</li> <li>The reported lethal dose of PCP for adults ranges from 1 to 3 g</li> </ul> <p>Death from heart failure</p>	<ul style="list-style-type: none"> <li>Potential carcinogenic action</li> <li>The effects are more intense with longer exposure or more concentrated exposure</li> </ul>
Chronic symptoms <sup>(b,c,d,e,f)</sup>	Repeated exposures	<ul style="list-style-type: none"> <li>Possibly carcinogenic to humans</li> <li>In drinking water: could experience liver or kidney problems</li> <li>Increased risks of a number of diseases: chloracne, soft tissue sarcoma, non-Hodgkin's lymphoma and possibly abnormal births</li> </ul>	

- a) Canadian Council of Ministers of the Environment (CCME) - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - PENTACHLOROPHENOL 1997
- [http://www.ccme.ca/assets/pdf/pn\\_1272\\_e.pdf](http://www.ccme.ca/assets/pdf/pn_1272_e.pdf)
- b) Center for Disease Control and Prevention (CDC)
- <http://www.cdc.gov/>
- c) United States Environmental Protection Agency (USEPA)  
Reregistration Eligibility Decision (RED) for Pentachlorophenol (List B Case 2505), September 25, 2008
- [http://www.epa.gov/oppsrrd1/REDs/pentachlorophenol\\_red.pdf](http://www.epa.gov/oppsrrd1/REDs/pentachlorophenol_red.pdf)
- d) International Labour Organization - ICSC Card database
- <http://www.ilo.org/dyn/icsc/showcard.home>
- e) World Health Organization, International Programme on Chemical Safety
- <http://www.who.int/ipcs/en/>
  - [http://www.who.int/ipcs/assessment/public\\_health/arsenic/en/index.html](http://www.who.int/ipcs/assessment/public_health/arsenic/en/index.html)
- f) Agency for Toxic Substances and Disease Registry (ATSDR)
- <http://www.atsdr.cdc.gov/substances/index.asp>
- g) American Conference of Governmental Industrial Hygienists (ACGIH)
- <http://www.acgih.org/tlv/>
- h) Occupational Safety & Health Administration (OSHA) Permissible Exposure Limits (PELs)
- <https://www.osha.gov/dsg/topics/pel/>

## 5 Description of Preservative Application and Potential Chemical Discharges

In 2012, there were eight pressure impregnation facilities applying PCP/oil in Canada (19).

### 5.1 Description of Process

PCP is generally purchased as solid blocks, usually weighing 907 kg (2000 lbs). Petroleum oils used as carriers for PCP are delivered by bulk truck or rail tanker and are stored in exterior tanks. After delivery of PCP and the carrier oils, the chemicals are mixed and the wood is treated as outlined below. (Refer also to Part 1 – General Background Information, Section 2.2.3 [Figure 4](#)).

#### *Chemical Mixing*

##### *PCP solid blocks*

The PCP blocks are dissolved by placing them in the treatment cylinder or into a mix tank and recirculating heated oil between the cylinder or mix tank and the bulk storage tanks. A concentrated solution may first be prepared. The concentrate is then diluted to working concentration (5–9% PCP (5)) by recirculation between the cylinder or mix tank and the bulk storage tank.

##### *PCP liquid solution (minor use in Canada)*

The concentrate is then diluted to working concentration (5–9% PCP (5)) by recirculation between the cylinder or mix tank and the bulk storage tank.

#### *Wood Conditioning*

Prior to application of the PCP/carrier oil mixture, the moisture content of the wood is reduced by one of several conditioning processes. Conditioning of the wood may be achieved by air seasoning, kiln drying or by processes carried out in the treatment cylinder—for example, the application of steam and subsequent vacuum, or boiling under a vacuum in the presence of the treating solution (Boultonizing). In Canada, air seasoning is the most common means of conditioning poles, which make up 90% of the total PCP-treated material (19). Dry kilns or steaming is sometimes used if air seasoning has not been sufficient prior to treatment.

#### *Preservative Application*

The preservative is applied in a pressure cylinder, which may be up to 45 m long and 2 m in diameter. Specific treatment parameters (e.g. temperature, pressure and duration) are dictated by the species of wood, the wood product and the initial moisture content of the wood. Many of the operating parameters, preservative standards and product quality characteristics (e.g. penetration and preservative retention) are defined by the Canadian Standards Association (5).

After conditioning, an empty-cell treatment process is generally used to apply the oil-borne PCP preservative. Following the drain cycle at the end of the impregnation process, a vacuum is

applied to encourage the removal of excess preservative and pressurized air from the wood cells. This process minimizes preservative “bleeding” from the treated product.

Alternatively, an expansion bath or final steam cycle, followed by a vacuum, may be used to minimize surface exudations and long-term bleeding and to improve the surface cleanliness of the material. This expansion bath can be applied before removal of the preservative from the cylinder, by quickly reheating the oil surrounding the material to the maximum temperature permitted by the CSA Standard for a specific species, either at atmospheric pressure or under vacuum. The steam is turned off as soon as the maximum temperature is reached. The cylinder is then quickly emptied of preservative. A vacuum equal to, or stronger than -75 kPa (-22 in. Hg) is created promptly and maintained until the material can be removed free of dripping preservative (5).

The treated wood is withdrawn from the treating cylinder and stored on a drip pad until drippage has essentially stopped. From there the wood is either taken for storage in the yard or shipped by truck or rail car. Best management practices (BMPs) are promoted by the industry associations to minimize preservative drippage and bleeding during storage and service (20).

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label. The CAN/CSA O80 (5) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

#### *Storage of Treated Product*

The treated wood is withdrawn from the treating cylinder and put on a drip pad. The time on the drip pad may vary depending on the facility design, ambient conditions, wood species and application process. The charge must only be removed from the drip pad once drippage has stopped. The treated wood is removed from the drip pad by forklift and stored in a designated area until it is transported to the customer.

## **5.2 Potential Chemical Discharges**

PCP wood preservation facility design and operational practices can vary (21), and each facility has potential sources of emissions that could affect worker health and/or the environment. The potential sources and releases are illustrated in Figure 1.

#### *Liquid Discharges*

Leaks and drips of oil solutions can be contained and reused in the oil-borne treatment process. Liquids that cannot be recycled and reused include the following:

- condensates removed from the wood during conditioning and during the initial application of the vacuum process

- water released by the wood during the treating cycle and subsequently separated from the unabsorbed treatment oil prior to recycling of the oil
- washwaters

These liquids can contain PCP and must be treated before discharge as a waste stream. Other liquids that may be released from facilities that use oil-borne PCP may include the following:

- steam condensates from indirect heat transfer in cooling and heating coils, which are generally checked for contamination prior to discharge
- condenser cooling waters, which are not normally contaminated and are discharged without treatment
- surface runoff from treated wood storage areas, which can contain preservative
- washwaters

The PCP content in runoff waters depends on many factors, including drip and vacuum time in the last step of the pressure process; viscosity of the wood preservative; wood species; moisture content of the wood prior to application of preservative (i.e. adequacy of conditioning step); specific treatment process (i.e. Rueping or Lowry); effectiveness of the post-pressure-cycle processes applied (expansion bath, final steaming, final vacuum); and exposure to the weather. The method for controlling runoff waters depends on analytical and/or bioassay evaluations and regulatory requirements. Section 10 – Emission and Site Monitoring provides information on this matter.

### *Solid Wastes*

Solid wastes from pressure treatment facilities that use oil-borne PCP may include the following:

- sludge from tanks, sumps and pressure cylinders
- sludge from wastewater treatment processes (e.g. flocculated material)
- containers or wrappings and pallets from bulk PCP
- contaminated soils

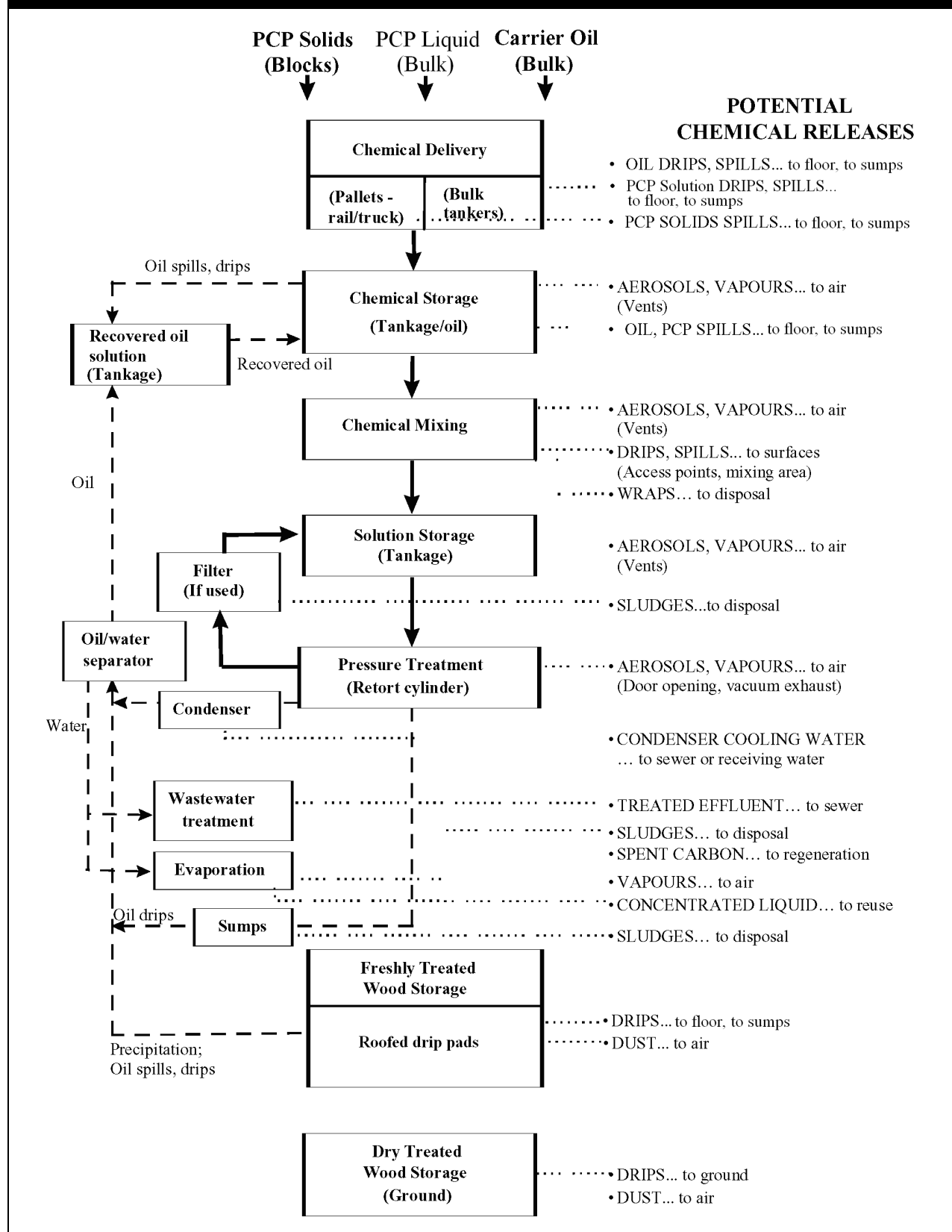
### *Air Emissions*

Air emissions from pressure treatment facilities that use oil-borne PCP are generally localized and may include the following:

- vapours from block storage
- emissions during wood conditioning and the final vacuum step
- vapours from tank vents
- vapours from venting cylinders
- vapours from the opening of cylinder doors
- vapours from freshly treated charges

Refer to Part 1 – Chapter A, [Section 5.2](#) for more details on potential chemical discharges.

**Figure 1 Potential Chemical Releases From PCP Pressure Treating Plants**





### **5.3 *Potential Effects of Chemical Discharges***

The actual impact on the environment of any liquid discharge, solid waste or air emission depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the species of aquatic biota in adjacent surface waters, and the amount of preservative released. Variables that can influence effects on worker health include ambient concentrations, frequency of exposure and protective measures during the time(s) of exposure.

All PCP pressure treatment facilities could potentially affect the environment, as could any other industrial facility that uses chemicals, if proper control measures are not in place. Documented PCP releases from wood preservation facilities have been due to either poor design or poor operating practices. The effects of these releases appeared to be either localized within the plant site (i.e. soil and groundwater contamination) or in the environment immediately adjacent to the plant site.

Fires at Canadian wood preservation facilities have also been documented (22, 23, 24). These incidents illustrate the need for proper contingency planning for fire control and for containment of oil solutions and fire runoff waters.

Human health could be affected if appropriate precautions are not taken during manual preparation of PCP solutions, minor spills in working areas and handling of treated products.

## 6 Protection of Personnel

With the use of PCP, it is important to provide protection against all potential types of exposure: eye contact, skin contact and inhalation. Many work situations require protection against more than one type of exposure—for example, when chlorophenol dusts, aerosols or vapours are produced. In these situations, the use of nose-mouth respirators that do not cover the eyes or the skin around the eyes may lead to a false sense of security. PCP is absorbed rapidly via the skin (13). **Full face shields or full-face cartridge respirators should be used.**

### 6.1 *First Aid, Precautions and Hygiene for PCP Exposure*

Table 5 contains the recommended actions in case of PCP exposure. **The higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs.**

Facility staff should have access to product labels and appropriate training to apply first aid.

First aid personnel should periodically verify up-to-date response measures with chemical suppliers and/or industrial physicians.

Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with PCP solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

For all medical attention, always have the Pest Control Products label and the MSDS at your disposal so that you can properly inform health personnel.

**Table 5. First Aid Measures for Exposure to PCP**

Exposure	First action	Second action
Eye contact	<ul style="list-style-type: none"> <li>Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids.</li> <li>Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li> <li>Flush eyes for at least 15 minutes.</li> </ul> <p><i>Workers should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>Use boric acid solution and cortisone ophthalmic drops*.</li> <li>Get medical attention or call a poison control centre immediately for treatment advice (have product label at hand).</li> </ul>
Skin contact (Even small exposure)	<ul style="list-style-type: none"> <li>Immediately remove soaked clothing or articles in contact with the skin.</li> <li>Immediately wash contaminated skin thoroughly with soap or mild detergent and water.</li> </ul>	<ul style="list-style-type: none"> <li>Call a poison control centre immediately or doctor for treatment advice (have product label at hand).</li> <li>Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>Immediately remove the exposed person to fresh air (coughing and sneezing occur almost immediately after excessive inhalation of chlorophenols).</li> <li>If person is not breathing, call 911 or an ambulance, then apply artificial respiration using a barrier device.</li> </ul>	<ul style="list-style-type: none"> <li>Keep the affected person comfortable and quiet.</li> <li>PCP can cause excessive body temperature.</li> <li>Get medical attention or call a poison control centre or doctor immediately for treatment advice (have product label at hand).</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>For PCP solids: Get medical attention or call a poison control centre immediately for treatment advice. If the victim is conscious, have that person immediately drink large quantities of water. Do not induce vomiting unless told to do so by a poison control centre or doctor.</li> <li>For PCP in oil: Get medical attention or call a poison control centre immediately for treatment advice. Do not induce vomiting.</li> </ul>	<ul style="list-style-type: none"> <li>Call a poison control centre or an industrial physician immediately for subsequent advice (have product label at hand).</li> </ul>
Chronic symptoms requiring medical referral	<ul style="list-style-type: none"> <li>Dermatitis, headaches, nausea</li> <li>Hyperthermia, fever, sweating, weight loss</li> <li>Chloracne</li> </ul>	

\* Emergency first aid kits should be equipped with boric acid solution and cortisone ophthalmic drops.

Personnel should follow the recommendations from [Table 6 of Chapter A](#) outlining general precautions and personal hygiene measures.

## 6.2 Regulatory Controls

The labels for pesticide products contain information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

Most regulatory criteria established by worker protection agencies are based on TLVs and BEIs, as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) (25). The ACGIH threshold limit value-time weighted averages (TLV-TWAs) for chemicals are defined with the following provisos:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentrations.”
- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

Recently, the ACGIH has suggested augmenting TLV workplace evaluations by using “biological exposure indices (BEI) which may be useful as a guide to safe exposure” (25). See section 6.4 for more details.

### *Skin and Eye Contact*

The ACGIH-recommended TLV-TWA for PCP represents a time-weighted average (TWA) concentration “for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.” The recommended TLV-TWA value for PCP is  $0.5 \text{ mg/m}^3$ , and is followed by the designation “skin,” which refers to “the potential contribution to the overall exposure by the cutaneous route including mucous membranes and eyes, either by airborne, or more particularly, by direct contact with the substance” (25).

In practice, a wide range of dermal exposure to PCP can be encountered in the wood treatment workplace (i.e. from pure PCP solids to waters containing a few parts per million PCP). Dermal penetration is a significant route of PCP intake, and this penetration is enhanced if exposure to PCP/oil solution occurs (26).

### *Inhalation*

The ACGIH TLV-TWA considered that the PCP values for skin and eye contact would also be applicable to the maximum allowable values for inhalation. In its rationale for using TLV-TWAs, the ACGIH makes the following statement about PCP: “Dusts are particularly irritating to the eyes and nose in concentrations greater than  $1 \text{ mg/m}^3$ . Some irritation may occur at  $0.3 \text{ mg/m}^3$ . Seasoned workers can tolerate up to  $2.4 \text{ mg/m}^3$ ” (25)

A review of the literature indicates that many of the documented industrial health incidents involving PCP have occurred as a result of dumping bagged PCP flakes (formerly used) in poorly ventilated areas (26, 27, 28). Other exposures to dusts may occur during activities such as cleanup of spilled PCP solids. Facility operators must ensure that adequate designs and operational procedures are in place in order to minimize worker exposure to PCP dusts (i.e. adequate local ventilation, use of appropriate respiratory equipment, and use of wet or vacuum methods for cleaning of spilled PCP solids). Other potential sources of inhaled PCP include vapours in the vicinity of charge removal areas and in the vicinity of freshly treated wood, and aerosols at improperly maintained facilities (e.g. from leaking seals) or at inadequately designed facilities (e.g. from vacuum pump discharges to work areas).

### *Ingestion*

Oral intake of PCP must be avoided. Ingestion of PCP or liquids that contain PCP is unlikely if workers follow elementary rules of good hygiene. Acceptable limits of ingestion are not prescribed by regulation, since there is no valid reason for any such intake to occur. The single dose level of PCP known to result in fatality is in the order of 1 to 3 g (29, 30).

## **6.3 Safety Precautions**

All facility workers who have any potential for dermal exposure to PCP, oil solutions of PCP, or freshly treated wood should be required to adhere to minimum levels of protection and hygiene. The level of protection should increase with increasing potential for exposure to PCP.

**Table 8. Additional Safety Precautions for Personnel Working with PCP Solutions**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 8.)

<b>Objective:</b> To ensure safe workplace practices for each activity during the treatment process	
<b>Activity</b>	<b>Recommendations</b>
For all activities	<ul style="list-style-type: none"> <li>• <b>PPE (personal protective equipment):</b> material impermeable to organic solvents, with a resistance rating for PCP:  excellent – viton, neoprene, butyl rubber  good – nitrile, polyvinyl chloride (PVC)  fair – polyvinyl alcohol, polyethylene</li> <li>• <b>PPE:</b> Respirator cartridges must be NIOSH-rated for protection from organic vapours and acid gases, in combination with a dust mist and fume filter</li> </ul>
Unloading PCP solids	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Approved respirators should be readily available. Wear full face protection respirators whenever exposure* to dust can occur.</li> <li>• Do not wear contact lenses.</li> <li>• Provide adequate equipment for safe, controlled handling of blocks as appropriate for the specific facility</li> <li>• Do not drop PCP blocks.</li> <li>• Immediately vacuum PCP chips or spilled solids (vacuums should have effectively filtered exhausts).</li> </ul>
Unloading PCP solution	<ul style="list-style-type: none"> <li>• Wear an approved full facepiece respirator whenever dust conditions occur. Respirator cartridges must be NIOSH-rated for protection from pesticides and organic vapours and dusts.</li> </ul>
Preparing PCP work solutions	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear an approved full facepiece respirator whenever dust conditions occur.</li> <li>• Thoroughly vacuum PCP dust and solids from the work area following solution preparation.</li> <li>• Dispose of empty PCP wraps and PCP-contaminated debris according to Table 23.</li> </ul>
Sampling procedures	<ul style="list-style-type: none"> <li>• Wear eye protection and gauntlets resistance rating for PCP when sampling PCP solutions, e.g., from a pipe tap.</li> <li>• Should wear respirators and must be in accordance with NIOSH guidelines (pesticide, polynuclear aromatic hydrocarbons and organic vapours cartridges, and dust) when sampling PCP solutions or treated wood (if at temperatures above ambient).</li> <li>• Other non-routine sampling efforts such as through cover ports may necessitate more stringent precautions.</li> </ul>
Cleaning cylinders or storage tanks	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear NIOSH-approved breathing apparatus, organic-solvent-impermeable gauntlets, outer clothing and boots during all vessel entries.</li> </ul>
Handling treated lumber	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Change coveralls daily. Wash separately from other laundry.</li> </ul>
Handling and maintaining contaminated equipment	<ul style="list-style-type: none"> <li>• Thoroughly steam-clean or flush contaminated equipment with hydrocarbon solvent (e.g. Varsol or equivalent) prior to handling. Contain all solvent washings.</li> <li>• <b>PPE:</b> Change coveralls daily.</li> </ul>

NIOSH = National Institute for Occupational Safety and Health.

\* An initial workplace monitoring program as suggested in Chapter A, Section 10.2, [Table 26](#) will have determined the need for respirator use. The results of the program are assumed to be indicative of conditions in subsequent facility operations, unless procedural or design changes have occurred.

## **6.4 Biological Monitoring of Exposed Workers**

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#)

Blood PCP exposures are good indicators of acute short-term exposures because blood PCP values reach maximum 4 hours after exposure. It is useful for monitoring PCP exposures via skin contact, inhalation and ingestion. The BEI in blood is measured in plasma, at the end of shift, prior to the last shift of the workweek, and is set at 5 mg/L. Chronic exposures can best be monitored by measuring PCP in urine. BEI for total PCP in urine = 2 mg/g creatinine sampled prior to last shift of workweek at the end of shift (25).

## 7 Design Recommendations

The following tables present good design features specifically applicable to PCP pressure wood preservation facilities. The additional recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 7 and their corresponding tables. All tables of general content from Chapter A, [Section 7](#) must be taken into consideration.

**Table 11. Additional Recommended Design Features for Chemical Storage Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 11.)

Storage format	Design feature	Recommendations
<b>Bulk liquids</b> <ul style="list-style-type: none"> <li>Petroleum oil (CSA O80.201)</li> <li>PCP/oil working solutions</li> <li>Drip return</li> </ul>	<b>Objectives:</b>	
	<ul style="list-style-type: none"> <li>To provide positive spill prevention features</li> <li>To conform to the <i>National Fire Code of Canada</i> (NFCC), where applicable</li> </ul>	
	Location	The preferred location for oil tankage (all solutions) is in an exterior centralized tank farm area that is arranged in accordance with the NFCC.
<b>PCP</b> Solid blocks	<b>Objective:</b> To provide sheltered, secure, fire-protected storage of PCP solids	
	All features	<ul style="list-style-type: none"> <li>All feature recommendations for bulk liquids from Chapter A are applicable.</li> </ul>
	Location	<ul style="list-style-type: none"> <li>Provide safe, easy access to the mixing area (design so as to contain and facilitate cleanup of PCP dust/chips lost during transit to the mixing area).</li> </ul>
	Shelter	<ul style="list-style-type: none"> <li>Provide storage in an enclosed, secure area, segregated from other chemicals (design so as to prevent infiltrating precipitation).</li> <li>Design so as to prevent fire in PCP storage areas (use of non-combustible construction materials is preferred).</li> </ul>
<b>Bulk sludges</b>	All features	<ul style="list-style-type: none"> <li>All feature recommendations for bulk liquids from Chapter A are applicable.</li> </ul>
	Handling	<ul style="list-style-type: none"> <li>Provide transfer equipment for clean, safe sludge handling with minimum worker exposure.</li> </ul>



**Table 12. Additional Recommended Design Features for Chemical Mixing Systems**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 12.)

Design feature	Recommendations
<b>PCP</b>	<b>Objectives:</b>
<ul style="list-style-type: none"> <li>• PCP blocks</li> <li>• Petroleum oil</li> </ul>	<ul style="list-style-type: none"> <li>◊ To provide a mixing system with effective spill prevention features</li> <li>◊ To provide a mixing system that minimizes worker contact with PCP</li> </ul>
<b>Configuration</b>	<ul style="list-style-type: none"> <li>• Mixing by block placement in a closed tank is the preferred method.</li> <li>• Use permanent, closed mixing systems (rigidly piped, tank to tank).</li> </ul>
<b>Location/shelter (mixing tanks)</b>	<ul style="list-style-type: none"> <li>• Locate in a contained, dry sheltered area (giving attention to worker comfort).</li> <li>• Provide protection against freezing (as applicable).</li> </ul>
<b>Solids handling</b>	<ul style="list-style-type: none"> <li>• Provide appropriate equipment for safe, controlled lifting and handling of PCP blocks.</li> <li>• Provide a dry, concrete / paved area for plastic wrap removal from blocks.</li> <li>• Ventilate to control air levels of PCP during routine operation and during worst event spills.</li> <li>• Provide a vacuum cleaner system (filtered exhaust) for effective cleanup of PCP dust and granules from handling/transfer operations.</li> <li>• Provide local exhaust system and closed solids handling systems (e.g. flexible covers on hoppers) to eliminate direct worker exposure to PCP dust and granules during unwrapping.</li> </ul>

**Table 14. Additional Recommended Design Features for Freshly Treated Wood Drip Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 14.)

Design feature	Recommendations
<b>Objective</b>	Minimize losses of preservative chemicals from treated wood by <ul style="list-style-type: none"> <li>• providing proper conditions for freshly treated wood; and</li> <li>• controlling the generation and disposal of contaminated runoff waters.</li> </ul>
<b>Drip area</b>	<ul style="list-style-type: none"> <li>• Provide for sufficient contained, impermeable floor and <u>roofed</u> storage or transfer area for freshly treated lumber.</li> <li>• Roofing, as an alternative to collection and treatment of contaminated waters, might be necessary for pole treating in areas of high precipitation.</li> </ul>

## 8 Operational Recommendations

The additional recommendations for good operating practices listed in the following tables must be used in conjunction with those in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8](#). All tables of general content from Chapter A, Section 8 must be taken into consideration. They are meant to protect both workers and the environment from harmful exposure to PCP and its solutions.

### 8.1 Operational Standards

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including PCP. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2-08 Clause 4.1 (referenced to AWPA M3). The calibration can be conducted by facility staff if they have the appropriate training.

Special attention is required on the part of PCP plant operators to ensure that operational activities are in accordance with the *National Fire Code of Canada* (NFCC) for flammable and combustible liquids (31).

### 8.2 Facility Wide Recommendations

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### 8.3 Process Area-specific Recommendations

**Table 19. Additional Recommended Operating Practices for Chemical Handling and Storage**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, [Table 19](#).)

Operation	Recommendations
Unloading chemicals <ul style="list-style-type: none"><li>PCP solids</li></ul>	<b>Objective:</b> To ensure that the unloading of treatment chemicals occurs in a safe manner
Handling of wood preservative <ul style="list-style-type: none"><li>PCP blocks</li></ul>	<ul style="list-style-type: none"><li>Contain all spilled PCP solids (dust, granules) and reuse or dispose of as contaminated solid waste.</li><li>Store empty PCP wrappings and dispose of as contaminated wastes in accordance with Section 9.</li></ul>

**Table 20. Additional Recommended Operating Practices for Process Systems**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 20.)

Operation	Recommendations
<b>Objectives:</b>	<ul style="list-style-type: none"><li>◇ To define procedural practices to enhance environmental protection and worker safety.</li><li>◇ To operate the facility in compliance with the <i>National Fire Code of Canada</i></li></ul>
Post-treating checks	<ul style="list-style-type: none"><li>• Maximize the use of mechanical equipment for charge removal in order to minimize the need for worker handling of freshly treated wood.</li><li>• Remove charges to drip pads only when the superficial excess preservative has drained.</li></ul>
Charge removal	

## 9 Waste, Process Emissions and Disposal

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 9.1 Control, Treatment and Disposal

The PCP oil-borne pressure treatment process generates liquid and solid wastes and emissions to air. Numerous approaches are used or can be used by the industry to control, treat and/or dispose of the process wastes and emissions. Potential sources of chemical releases from PCP pressure treatment facilities are described in Section 5.2 and in Figure 1. Table 23 at the end of this section identifies the main categories of process wastes or emissions that can be generated at PCPP facilities, and summarizes recommended control, treatment and/or disposal methods.

**The processes used for waste disposal fall under provincial jurisdiction and may vary from province to province.**

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information.

#### *Control Requirements*

Control specifications will depend on factors such as the volume and frequency of the discharge, and the sensitivity of the receiving environment. The discharge of chlorophenol-contaminated effluent into waters inhabited by fish is subject to the federal *Fisheries Act*. Refer to Table 3 for CCME water quality guidelines.

### 9.2 Waste Liquids Containing PCP

#### *Liquid Process Wastes*

Leaks and drips of oil solutions are contained and reused in the treatment process. Liquids such as condensates, washwaters and infiltrating waters, which cannot be reused, should be treated to remove oil and PCP prior to discharge (32, 23, 24). The treatment techniques include one or a combination of the following:

- gravity separation
- oil/water API separation, plate separation
- activated sludge treatment
- activated carbon treatment
- physical-chemical treatment (i.e. flocculation)
- evaporation/condensation

A regulatory discharge permit must be obtained for disposal of the treated aqueous wastes.

### *Contaminated Storm Runoff*

Because PCP wood preservation facility sites are generally large, considerable volumes of storm runoff waters originate from these sites. Every precaution should be taken to avoid contamination of storm runoff water. See Section 7 for more details on design and equipment recommendations.

If contamination occurs, refer to Section 12 – Environmental Emergency Notification and Contingency Planning for more direction.

### **9.3 Solids with Potentially High PCP Concentrations**

For the purposes of this document, solids with potentially high levels of PCP are defined as:

- sludges from sumps, concentrate and work solution tanks, and pressure cylinders
- sludges from wastewater treatment processes (e.g. flocculated materials)
- unwashed containers or wrappings for PCP blocks
- filters from cleaning vacuum

#### *Guidelines for the Disposal of Solid Wastes*

While awaiting disposal, the contaminated solids should be in leakproof containers in a specially designed area that is curbed with a paved or concrete sealed surface. The area should be roofed to protect the wastes from precipitation. Any seepage or leachate generated at the site should be contained. Refer to Chapter A, Section 9, [Table 23](#) – Recommended Practices for Handling Liquid & Solid Wastes and Sludge for complete details.

The most feasible disposal option for chlorophenol wastes appears to be high-temperature thermal destruction by an approved facility. Refer to your local and provincial authorities for the best potential disposal options.

### **9.4 Disposal of Miscellaneous Solid Wastes**

Refer to Chapter A, [Section 9.4](#) – Miscellaneous Solid Wastes for complete details.

- Make the empty container unsuitable for further use
- Do not use PCP-treated wood as a compost or mulch.
- Incineration of PCP-contaminated materials is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products

### **9.5 Air Emissions**

Air emissions at oil-borne PCP pressure treatment facilities are generally localized; effects, if any, would be restricted to workers at the facilities. Such emissions may include the following:

- dust and vapours from manual unwrapping of PCP blocks

- vapours from tank vents
- vapours from opening of retort cylinder doors
- vapours from freshly treated charges
- vapours from vacuum system outlets

**Table 23. Recommended Disposal Practices for PCP-Contaminated Wastes**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 23.)

Waste category	Examples	Recommendations
Liquid PCP/oil solutions	<ul style="list-style-type: none"> <li>• Spilled PCP/oil concentrates</li> <li>• PCP work solutions</li> <li>• Drips from freshly treated lumber</li> <li>• Material skimmed from oil separators</li> </ul>	<ul style="list-style-type: none"> <li>• Collect and reuse.</li> </ul>
Liquid PCP/water solutions	<ul style="list-style-type: none"> <li>• Condensates</li> <li>• Washwaters</li> <li>• Infiltrating waters</li> </ul>	<ul style="list-style-type: none"> <li>• Treat to remove oil and PCP to within regulatory limits.</li> <li>• Dispose of treated waters as per regulatory requirements.</li> </ul>
Contaminated solid wastes	<ul style="list-style-type: none"> <li>• Debris and bottom sludge from storage tanks, sumps and pressure cylinders</li> <li>• Soils contaminated by spills</li> <li>• Cleanup absorbents</li> <li>• Filter from cleaning vacuum</li> <li>• Sludges from wastewater treatment processes</li> <li>• Solid fire residues from PCP or PCP/oil storage areas</li> <li>• Wrapping used for PCP blocks</li> <li>• Scraps, cuttings and shavings from PCP-treated lumber</li> </ul>	<ul style="list-style-type: none"> <li>• Drain and/or drum, store and dispose of in accordance with provincial regulatory requirements (high-temperature thermal destruction at authorized facilities appears to be the most feasible disposal option).</li> </ul>
Miscellaneous solid wastes	<ul style="list-style-type: none"> <li>• Empty containers and wrapping rinsed with alkaline water</li> </ul>	<ul style="list-style-type: none"> <li>• Dispose of in authorized sanitary landfills (subject to approval by the provincial regulatory agency).</li> <li>• Recuperated by authorized facilities.</li> </ul>
Contaminated storm runoff	<ul style="list-style-type: none"> <li>• Storm runoff or contaminated liquid discharges containing PCP requires consultation with regulatory agency.</li> </ul>	<ul style="list-style-type: none"> <li>• Prevent or minimize contamination of storm runoff to greatest possible extent.</li> <li>• Monitor surface water discharges (in consultation with the provincial regulatory agency) to assess contaminant concentrations and determine the need for control.</li> <li>• Provide mean for collection of contaminated storm runoff.</li> </ul>
Firefighting water runoff	<ul style="list-style-type: none"> <li>• As above (contaminated storm runoff)</li> </ul>	<ul style="list-style-type: none"> <li>• Consider provisions for containment where PCP and PCP/oil solutions are present.</li> <li>• Consult with provincial regulatory agency to determine acceptable disposal practices.</li> </ul>

## **10 Environmental and Workplace Monitoring**

### **10.1 Baseline Environmental Evaluation**

PCP has been detected in snowpack, water, landfill leachates, sewage effluents, sediments, and aquatic and terrestrial organisms (2, 11). There are many suspected sources of PCP releases. These include disposal areas for various commercial formulations used historically as slimicides and fungicides; storage areas for PCP-treated products (including the former process of lumber dipping or spraying with aqueous solutions of chlorophenates for sapstain control); accidental or uncontrolled process releases from wood preservation facilities; and chlorinated wastewaters, especially those from pulp and paper mills and municipal sewage treatment plants (11).

PCP is not a natural compound, and its environmental background level should be “zero.” However, anthropogenic sources have resulted in trace concentrations even in remote areas. For example, levels of 0.003 mg/L to 23 mg/L have been detected in many tributaries and bays of each of the Great Lakes. Supposedly remote areas have frequently shown levels of 0.01 mg/L. A survey of the Fraser River showed PCP concentrations ranging from 0.002 to 0.0037 mg/L in waters sampled upstream of industrial areas (10). The reported trace concentrations illustrate the high degree of detection capability, i.e., to a fraction of one-billionth of a gram of PCP in a litre of water. These concentrations are much lower than concentrations that have been found to affect aquatic biota or human health (11). Restrictions on PCP use implemented during the early 1980s, as well as the cessation of chlorophenate uses for antisapstain treatments, may have had a positive impact on the current levels of PCP in the Canadian environment.

### **10.2 Environmental Monitoring**

A possibility of PCP-contaminated ground and runoff from treated wood storage areas must be acknowledged. Even if PCP has low bioaccumulation tendency and persistence in the environment, its effect on the environment can have great consequence. Close monitoring studies (such as surface water discharges, groundwater and soil contamination) are recommended to detect and properly assess the degree of such potential toxic releases.

### **10.3 Workplace Exposure Monitoring**

Workplace monitoring generally falls under provincial jurisdiction. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers’ compensation board and/or department of labour and/or industrial physician/industrial hygienist.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## 11 Transportation of PCP, Oil Solvents and PCP Wastes

The transportation of PCP blocks, flakes, oil solvents and PCP wastes is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of PCP and its wastes.



## **12 Environmental Emergency Notification and Contingency Planning**

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using PCP/oil should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective.

### **12.1 Environmental Emergency Notification**

The Environmental Emergency Regulations and its requirements are applicable for PCP since it contains polychlorinated dibenzodioxins (Dioxins), polychlorinated dibenzofurans (Furans) and hexachlorobenzene, listed in Schedule 1 of CEPA 1999.

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.2 Spill Contingency Planning**

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.3 Fire Contingency Planning**

Although PCP is not flammable, work solutions of PCP and carrier oils are flammable. Extreme caution is to be exercised at fires involving PCP. If solid PCP is exposed to fire, or if combustion of PCP/oil mixtures occurs, the PCP will decompose, creating fumes containing hydrochloric acid, and likely dioxins as well. All fire residues must be considered contaminated and must be contained for analysis and disposal as appropriate (see Table 23).

Please refer to the *National Fire Code of Canada (always refer to last version available)* (31) for proper fire extinguishing agents and other requirements for contingency plans, and refer to [Section 12.3](#) of Part I, Chapter A – *General Recommendations for All Wood Preservatives*. A copy of the fire contingency plan and all necessary documents should be stored in a fire proof box outside the entrance to the facility.

## 13 References

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## CHAPTER F

# Pentachlorophenol Thermal (PCPT) Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives.



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# 1 Production and Use

Pentachlorophenol (PCP) was first used as a wood preservative in 1936 (1). The biological properties of PCP have resulted in its use as an antimicrobial agent in industrial cooling systems and papermaking, and as a fungicide in protein-based latex paints (2). Agriculture Canada restrictions in 1981 limited the use of PCP for preservation of outdoor wood products. PCP use by the thermal process (PCPT) depends primarily on the size of the utility pole and cross-arm markets: chromated copper arsenate (CCA) has partially replaced PCP in the utility pole market, and the PCP tie market has been converted to creosote/oil treatments, leading to a decline in use since 1981 (3). PCP pressure treatments and CCA have partially replaced thermal PCP in the utility pole market. In 1993, three thermal treatment plants operated in Canada. In 2012 there are still only three PCP facilities with thermal process in Canada (4). The design and operational practices for control of PCP at thermal facilities varies. Newer facility designs reflect an increased awareness of the need for chemical control. Older facilities may compensate for design limitations through operational controls. Detailed design and operating practices are highly individualized. Table 1 provides an overview of PCP use at Canadian thermal treatment facilities.

PCP is prepared by reacting chlorine with phenol in the presence of a catalyst at high temperatures. PCP was last manufactured in Canada in 1983. It is now obtained from only one of two U.S. manufacturers, who supply it in the form of solid blocks (907 kg/2000 lbs) or liquid solution. The petroleum oils used as carriers for PCP are purchased from Canadian sources.

PCP/oil mixtures are used for the thermal treatment of wood products such as telephone and electrical utility poles, as well as cross-arms. Thermal treatments for poles may be either full length or butt treatments only with just butt treatment currently being conducted in Canada. The impregnated PCP is retained by the wood, and its bio-effectiveness protects the wood against fungi and insects. In addition to functioning as a carrier of PCP, the oil also provides extra protection against moisture content changes, providing more wood stability and resistance to splitting. For utility pole use, it has the additional advantage of providing resistance to electrical currents and facilitating the climbing of poles by line personnel.

**Table 3. Overview of PCPT Use in Canada**

Feature	Characteristics
Treated wood use limitations in Canada	USE FOR INDUSTRIAL WOOD PRODUCTS ONLY <ul style="list-style-type: none"><li>• Utility poles</li><li>• Cross-arms</li><li>• Posts</li><li>• Pilings</li><li>• Construction timbers</li><li>• Railway ties (not manufactured in Canada at this time)</li></ul> Note: permitted uses and limitations of PCP-treated wood may change over time. Refer to pesticide label for up-to-date uses
General process of application	Thermal application

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes PCP-treated products.  
(5) Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label

## 2 Physical and Chemical Properties

PCP is a solid at room temperature. It can be characterized as a stable organic compound that is sparingly soluble in water and highly soluble in organic solvents. It adsorbs strongly to organic solids such as cellulose in wood.

PCP is chemically and biologically persistent at high concentrations (i.e. the 5–9% concentrations used for treatment of wood). Its persistence in treated wood and its toxicity to wood decay organisms are two major reasons for the use of PCP as a wood preservative. However, it is photodegradable and at low concentrations is also biodegradable.

The physical and chemical properties listed below must be given special consideration during handling and contingency planning:

- the ability of PCP to dissolve in water; dissolution increases as pH and temperature increase
- the high solubility of PCP in oils, including skin oils, which enhances its ability to penetrate skin following dermal contact
- the potential to form toxic fumes upon exposure to fires and high temperatures (i.e. over 350°C)
- a vapour pressure (although low at room temperature) that will result in a small degree of sublimation of PCP

The physical and chemical properties of PCP are outlined in Table 2 (6, 7). General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and from labels for pesticide products. Electronic copies of the pesticide label can be obtained from the Health Canada website (8):

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>

**Table 2. Physical and Chemical Properties of PCP solids**

Identification		
<b>Common synonyms:</b> (past and present) Penta PCP	<b>Registrant in 2012:</b> KMG-Bernuth Inc. (Houston, TX) <ul style="list-style-type: none"><li>• <a href="#">DURA TREAT 40</a></li><li>• <a href="#">KMG PENTA BLOCKS</a></li></ul>	
<b>Chemical Abstracts Service Registry Number (CAS RN):</b> 87-86-5		
Transportation and storage information		
<b>Shipping state:</b> KMG: Solid blocks – 900 kg (2000 lbs.) DURA: Liquid solution <b>Concentration:</b> 96% by weight total (technical grade) chlorophenols (86% PCP, 10% other chlorophenols and related compounds and 4% inert)	<b>Storage temperature:</b> Ambient <b>Inert atmosphere:</b> No requirement <b>Venting:</b> Open <b>Containers/materials:</b> Solid blocks: polyethylene wrap Liquid solution : Totes	<b>Classification:</b> Poisonous <b>Placards:</b> PENTA: Class 3 UN 1306 KMG: Class 6.1 PGII UN 3155 <i>Check with Transport Canada</i>
Physical and chemical properties		
<b>Physical state:</b> Solid (blocks, flakes) <b>Solubility:</b> Freely soluble (oil and alcohol) Slightly soluble in water 5 ppm by weight (0°C) 14 ppm by weight (20°C) 35 ppm by weight (50°C) <b>Melting point:</b> 191°C (anhydrous) 184°C(1*H <sub>2</sub> O) <b>Boiling point:</b> 293.08°C Decomposes at 310°C <b>Flash point:</b> Not flammable	<b>Explosive limits:</b> Not flammable <b>Floatability:</b> Sinks in water <b>Specific gravity:</b> 1.978 (22°C) <b>Vapour pressure:</b> 0.00019 mm Hg (15°C) 40 mm Hg (211°C) <b>Vapour density:</b> 9.2 <b>Odour:</b> Strong pungent odour when heated	<b>Appearance:</b> White to light brown solid <b>Concentration of work solutions:</b> 5% to 8% in petroleum oil <b>Typical preservative retention in treated wood</b> 3.4–16 kg PCP/m <sup>3</sup> of treated wood (0.21–1.0 lbs./cu. ft.)
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Use water spray, dry chemical, foam or carbon dioxide. (Note: fire residues may contain chlorinated furans or dioxins and must be treated as contaminated.) Use water to cool fire-exposed containers. Consult your fire department for proper equipment at your facility. <i>Fire behaviour:</i> When heated to decomposition, toxic fumes of hydrogen chloride are formed. Chlorinated dioxins may be generated. <i>Ignition temperature:</i> Not combustible <i>Burning rate:</i> Not combustible		<b>Reactivity</b> <i>With water :</i> No reaction <i>With common materials:</i> Can cause deterioration of rubber when dissolved in oil. <b>Stability</b> Stable

### 3 Environmental Effects

PCP is an anthropogenic chemical that is ubiquitous in the Canadian environment as a result of extensive historical use in the wood preservation industry.

Impurities in technical-grade PCP, which may include tetrachlorophenol, trichlorophenols, hexachlorobenzene, polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and chlorinated phenoxyphenols, are contributors to the compound's toxicity. Chronic toxicity studies indicate that technical-grade PCP can be up to 10 times more potent than purified PCP due to the presence of these impurities (9).

Results from previous studies demonstrate that PCP has low bioaccumulation tendency in terrestrial invertebrates. PCP is metabolized rapidly in plants, so that while PCP products may be detected in plants, little intact PCP is found in plant tissues (9).

#### 3.1 Aquatic Toxicity

On an acute basis, PCP is very highly toxic to aquatic invertebrates and highly toxic to fish. Acute LC<sub>50</sub> values for fish ranged from 20 µg/L to 600 µg/L.

Pentachlorophenol is hydrolytically stable in water at pH 4 to pH 9, precluding hydrolysis as a major degradation process in the environment. Chemical degradation of PCP in water will occur mainly through photodegradation. In surface water, PCP will rapidly photodegrade when exposed to direct sunlight, with more rapid degradation occurring with increased pH (when the compound is dissociated) (10).

The exposure of aquatic organisms to PCP could result in both short-term (acute) and long-term (chronic) toxic effects. At low concentrations, PCP is not considered a persistent contaminant in the environment because of documented photochemical degradation and microbial breakdown in surface waters, soil media and sewage effluents (11). However, PCP is widespread at low concentrations in the environment (11). The environmental effects are dependent upon a complex array of parameters including concentration, pH, adsorption to suspended solids, temperature, biodegradation rate and photodecomposition rate.

Based on extensive reviews of the literature and unpublished information, regulatory agencies have derived upper limits for PCP in the environment. As of July 1987, upper limits for Canadian waters have been defined under the auspices of the following regulatory agencies or commissions: the International Joint Commission (IJC), for Great Lakes waters (11); Health Canada, for maximum acceptable concentrations in drinking water (12); and the Canadian Council of Ministers of the Environment (CCME), for protection of aquatic life (13). The upper limits are summarized in Table 3.

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for PCP in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Pentachlorophenol	Maximum acceptable <sup>(a)</sup> concentration (MAC) = 0.06 mg/L (60 µg/L)  Aesthetic objective (AO) ≤ 0.03 mg/L (30 µg/L)	Protection of human health (drinking water)  The odour threshold (AO), is more sensitive than the toxic threshold for humans (MAC)	Health Canada <sup>(a)</sup>
	Guidelines 0.5 µg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(b)</sup>
	<b>Should not</b> be present in concentrations that exceed 5% of the median lethal concentration (LC <sub>50</sub> ) in a 96-hour test for any sensitive local species	Protection of aquatic life (PCP falls under <i>the category of unspecified non-persistent toxic substances and complex effluents of municipal, industrial or other origin</i> )	International Joint Commission <sup>(c)</sup>
	Short-term maximum contaminant level (MCL) = 1 mg/L (1 ppb) for 1 day or 0.3 mg/L for 10 days.	Protection of human health (drinking water)	U.S. Environmental Protection Agency <sup>(d)</sup>
	0.022 mg/L is the long-term maximum contaminant level		
	Criteria: Examples <sup>(e)</sup> 5.5 µg/L at pH 6.5 20 µg/L at pH 7.8 68 µg/L at pH 9.0 Examples <sup>(f)</sup> 3.5 µg/L at pH 6.5 13 µg/L at pH 7.8 43 µg/L at pH 9.0	Protection of freshwater biota • 1-hour average concentration not to exceed the criterion more than once every 3 years on the average  • 4-day average concentration not to exceed the criterion more than once every 3 years on the average	U.S. Environmental Protection Agency <sup>(e, f)</sup>
	7.9 g/L	Protection of saltwater biota • 4-day average concentration not to exceed the criterion more than once every 3 years on the average	
	13 µg/L	• 1-hour average concentration not to exceed the criterion more than once every 3 years on the average	

**Table 3. Regulatory Limits for PCP in Natural Water Bodies** (continued)

Element	Limit value (mg/L)	Basis (objectives)	Agency
Oil and Petrochemicals	To protect aquatic life, <b>should not</b> be present in concentrations that exceed 5% of the median lethal concentration (LC <sub>50</sub> ) in a 96-hour test for any sensitive local species.	Oil and petrochemicals <b>should not</b> be present in concentrations that <ul style="list-style-type: none"> <li>• can be detected as visible film, sheen or discoloration on the surface;</li> <li>• can be detected by odour;</li> <li>• can cause tainting of edible aquatic organisms; and</li> <li>• can form deposits—on shorelines and bottom sediments—that are detectable by sight or odour, or are deleterious to resident aquatic organisms.</li> </ul>	International Joint Commission <sup>(c)</sup>
Polycyclic aromatic hydrocarbons (PAHs)	Please refer to the CCME summary table	Protection of aquatic life	CCME <sup>(b)</sup>

- (a) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.
- o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>  
“Maximum acceptable” was defined by Health Canada as “drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable.” “Objective” is defined by Health and Welfare Canada as “this level is interpreted as the ultimate quality goal for both health and aesthetic purposes.”
- (b) Canadian Council of Ministers of the Environment (CCME), Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life. <http://st-ts.ccme.ca/>
- (c) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).
- o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)
  - o <http://www.ijc.org/rel/agree/quality.html>
- (d) United States Environmental Protection Agency, (USEPA), Basic Information about Pentachlorophenol in Drinking Water
- o <http://water.epa.gov/drink/contaminants/basicinformation/pentachlorophenol.cfm>
- (e) United States Environmental Protection Agency (USEPA), 1986. Ambient Water Quality Criteria for Pentachlorophenol - 1986. Federal Register:4400586009.
- Expressed as an exponential function:  $PCP \text{ limit (mg/L)} = \exp^{[1.005(pH)-4.830]}$ ..
- (f) United States Environmental Protection Agency (USEPA), 1986. Ambient Water Quality Criteria for Pentachlorophenol - 1986. Federal Register:4400586009.
- Expressed as an exponential function:  $PCP \text{ limit (mg/L)} = \exp^{[1.005(pH)-5.290]}$ .

## 3.2 Air Pollution

Pentachlorophenol is a relatively volatile compound, while its sodium salt is non-volatile. In the atmosphere, volatilized PCP may undergo photolytic degradation or may react with photochemically produced hydroxyl radicals. Atmospheric PCP that is associated with particulate matter or moisture will be lost from the atmosphere through wet deposition. Based on PCP’s low Henry’s Law constant, volatilization from aqueous systems will not be a significant mode of transport in the environment (10).



Pentachlorophenol contains chlorinated dibenzodioxins and chlorinated dibenzofurans (CDDs and CDFs) as contaminants formed during the manufacturing process. The CDDs and CDFs in the product (utility poles) may be released into the environment via volatilization and leaching. In addition, CDDs and CDFs may enter the environment during the thermal treatment of the utility poles, as well as when the utility poles are removed from service and are disposed of in landfills. These compounds are inherently toxic, as well as environmentally persistent, and their presence may increase the ecological risk associated with the use of PCP (10).

According to the Proposed Re-evaluation Decision, PRVD2010-03 Heavy Duty Wood Preservatives, “The wood preservation industry continues to be a source of dioxins and furans into the Canadian environment, however, a reduction in the amount of pentachlorophenol used in wood preservation due to the availability of alternatives for some uses and the measures taken by the technical grade active ingredient registrant to reduce levels of Track 1 contaminants in its technical product.” (6)

Section 4 addresses the potential health effects of exposure to air pollution from wood preservatives. Air pollution should be considered when evaluations of potential chemical discharges are made in Section 5.

### **3.3 Soil Contamination**

Soil contamination can be an issue at wood preservative facilities if no effective measures are in place. PCP may be photodegraded, making degradation products available for being mobile in water. Contaminated soil can be spread by vehicles and wind, but it will mostly migrate into runoff water and can potentially contaminate drinking water. The design and operational recommendations presented in Sections 7 and 8 contain measures to minimize soil contamination.

Adsorption of PCP to soil is influenced by soil pH and organic carbon content (14). In general, adsorption was found to increase as soil pH decreased. As adsorption increases, PCP is less bioavailable and the rate of biodegradation tends to be reduced (15).

Leaching of PCP tends to increase with high PCP input, high soil moisture, alkaline soil conditions and low organic matter content in the soil (16). Over a range of environmentally significant temperatures and pH, the solubility of PCP was found to vary from 5 to 8000 mg/L.

Biodegradation is an important process particularly under aerobic conditions. Biodegradation processes reported include reduction, dechlorination, methylation, demethylation, acetylation and hydroxylation. By-products include lower chlorinated phenols, methyl ethers and pentachloroanisole. The rate of biodegradation in soil is affected by temperature, pH, moisture, adsorption and cation exchange capacity. Microbial species known to biodegrade PCP include *Pseudomonas*, *Flavobacterium* and *Arthrobacter* species. Several species of fungi are also known to be capable of PCP degradation (9).

The CCME has developed the *Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health*. Limit concentrations for industrial sites are set as follows:

- $SQG_{HH}$  = soil quality guideline for human health 7.6 mg/kg dry weight
- $SQG_E$  = soil quality guideline for environmental health 28 mg/kg dry weight

The CCME recommends the application of various check mechanisms, when relevant, in order to provide a broader scope of protection. This additional information on check values can be found in the CCME Canadian Soil Quality Guidelines, available at <http://ceqg-rcqe.ccme.ca/>.

## 4 Human Health Concerns

Human health effects from low PCP environmental concentration are unknown. Acute, high-dose exposure to PCP can induce a hypermetabolic state and excessive heat production. Effects—including hyperthermia, hypertension and metabolic acidosis—were observed in adults and children severely exposed to PCP through ingestion, inhalation or skin absorption. Death can result from seizures and cardiovascular collapse. In animals, chronically administered high doses of PCP were hepatotoxic and carcinogenic, and they adversely affected thyroid function. PCP is not mutagenic or teratogenic (17).

The International Agency on Research for Cancer has determined that PCP is classified in Group III, “possibly carcinogenic to humans” (18). PCP is absorbed rapidly via the lungs, gastrointestinal tract and skin (9). After absorption, PCP is distributed to most tissues and is not extensively metabolized (17).

After a single dose, PCP is eliminated over a few days; with repeated or chronic exposure, the elimination half-life may be a week or more. Most of the PCP taken into the body does not break down, but instead is eliminated via the urine. Much smaller amounts are eliminated in feces. Only a small amount is exhaled. Some of the PCP taken into the body is joined with other natural chemicals that render it less harmful. The combined product can then leave the body more easily (18). Finding a measurable amount of PCP in urine does not mean that the level of PCP causes an adverse health effect (17).

Considering previous studies on the effects of PCP and the limitations of these studies, it can reasonably be argued that exposure to PCP is associated with increased risks of a number of diseases, namely chloracne, soft tissue sarcoma, non-Hodgkin’s lymphoma and possibly abnormal births (10).

One safety objective of the industrial use of any chemical is to minimize worker exposure. If safeguards are not provided or are not implemented, a variety of human health effects can occur depending on the duration and manner of exposure, the concentration of the chemical to which exposure has occurred, the form of the chemical (e.g. ionic vs. non-ionic) and the varying metabolic sensitivities of individual workers.

The PMRA’s re-evaluation decision for the registration of the heavy duty wood preservatives creosote, pentachlorophenol, chromated copper arsenate and ammoniacal copper zinc arsenate, has granted continued registration of these products for sale and use in Canada. Potential risks from inhalation and dermal exposure were identified for some occupational tasks within wood-treatment facilities. The addition of new risk-reduction measures and the development of a Risk Management Plan for heavy duty wood preservatives will continue to lower the potential for occupational exposure for treatment facility workers (6).

Table 4, which is based on information from existing literature, outlines the spectrum of human health effects that could result from various degrees of exposure to PCP (as purified PCP).

**Table 4. Potential Health Effects of Exposure to PCP**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) <sup>(a,b)</sup> • Pentachlorophenol (PCP) Range* from 0.039 µg/kg to 0.16 µg/kg  (Large variation can be explained by the various contaminated environments.)			
Eye contact <sup>(b,c,d,e)</sup>	Direct contact Mist, vapour or splashes	<ul style="list-style-type: none"><li>• Redness</li><li>• Irritation of eyes</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• Potential carcinogenic action</li><li>• Severe burn</li><li>• Possible increased metabolism</li></ul>
Skin contact <sup>(b,c,d,e)</sup>	Occasional direct contact with dust, liquid, vapours or mists	<ul style="list-style-type: none"><li>• Irritation of skin; possible increased metabolism</li></ul>	<ul style="list-style-type: none"><li>• Burning may result if PCP is not removed from skin</li></ul>
	Worker with significant overexposure, e.g. frequent skin contact, exposure to high dust levels, liquid, vapours, or mists	<ul style="list-style-type: none"><li>• Profuse sweating, headaches, nausea, weakness, fever, intense thirst</li><li>• Increased body temperature</li></ul>	<ul style="list-style-type: none"><li>• Potential carcinogenic action</li><li>• Damage to immune system</li><li>• Dermatitis; chloracne; suspected damage to kidney, liver, nervous system; weight loss</li></ul>
Exposure to airborne contaminant or dust Inhalation <sup>(b,c,d,e)</sup>	Inhalation of vapours in excess of threshold limit values (TLV)	<ul style="list-style-type: none"><li>• Irritation of nose and throat</li></ul>	<ul style="list-style-type: none"><li>• Potential carcinogenic action</li></ul>
ACGIH threshold limit value-time weighted averages (TWA) and biological exposure indices (BEI) <sup>(g,h)</sup>	TWA: 0.5 mg/m <sup>3</sup> air  BEI for total PCP in urine: 2 mg/g creatinine sampled prior to last shift of workweek  BEI for free PCP in plasma: 5 mg /L sampled at the end of work shift		<i>(Potential contributions to overall exposure can occur through the cutaneous route including mucous membranes and eye either by airborne particles, or, more particularly, by direct contact with the substance.)</i>

**Table 4. Potential Health Effects of Exposure to PCP (Continued)**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Ingestion <sup>(b,c,d,e)</sup>	Ingestion of PCP through manipulation of contaminated goods (dishes, gum, candy, food, tobacco, liquids)	<ul style="list-style-type: none"> <li>• Increased body temperature</li> <li>• Damage to immune system, reproductive effects and developmental effects</li> <li>• Suspected damage to kidney, liver, nervous system and gastrointestinal tract; weight loss</li> <li>• The reported lethal dose of PCP for adults ranges from 1 to 3 g. Death from heart failure</li> </ul>	<ul style="list-style-type: none"> <li>• The effects are more intense with longer exposure or more concentrated exposure</li> </ul>
Chronic symptoms <sup>(b,c,d,e)</sup>	Repeated over-exposures	<ul style="list-style-type: none"> <li>• Possibly carcinogenic to humans.</li> <li>• In drinking water: could experience liver or kidney problems.</li> <li>• increased risks of a number of diseases: chloracne, soft tissue sarcoma, non-Hodgkin's lymphoma and possibly abnormal births</li> </ul>	

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- a) Canadian Council of Ministers of the Environment (CCME) - Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health - PENTACHLOROPHENOL 1997
- [http://www.ccme.ca/assets/pdf/pn\\_1272\\_e.pdf](http://www.ccme.ca/assets/pdf/pn_1272_e.pdf)
- b) Center for Disease Control and Prevention (CDC)
- <http://www.cdc.gov/>
- c) United States Environmental Protection Agency (USEPA)  
Reregistration Eligibility Decision (RED) for Pentachlorophenol (List B Case 2505), September 25, 2008
- [http://www.epa.gov/oppsrrd1/REDs/pentachlorophenol\\_red.pdf](http://www.epa.gov/oppsrrd1/REDs/pentachlorophenol_red.pdf)
- d) International Labour Organization – ICSC Card database
- <http://www.ilo.org/dyn/icsc/showcard.home>
- e) World Health Organization, International Programme on Chemical Safety
- <http://www.who.int/ipcs/en/>
  - [http://www.who.int/ipcs/assessment/public\\_health/arsenic/en/index.html](http://www.who.int/ipcs/assessment/public_health/arsenic/en/index.html)
- f) Agency for Toxic Substances and Disease Registry (ATSDR)
- <http://www.atsdr.cdc.gov/substances/index.asp>
- g) American Conference of Governmental Industrial Hygienists (ACGIH)
- <http://www.acgih.org/tlv/>
- h) Occupational Safety & Health Administration (OSHA) Permissible Exposure Limits (PELs)
- <https://www.osha.gov/dsg/topics/pel/>
-

## 5 Description of Preservative Application and Potential Chemical Discharges

In 2012, there were three thermal impregnation facilities applying PCP/oil in Canada. Design and operating practices are highly individualized at these plants (4).

### 5.1 Description of Process

PCP dissolved in oil is the only wood preservation chemical used at thermal treatment facilities in Canada. Discussions and recommendations in this document are therefore limited to the use of PCP in thermal operations (PCPT), although the objectives would be applicable to any alternative wood preservative chemical that may be used in the thermal process.

Thermal treatment is used to achieve penetration and subsequent stabilization of the chemical agent within wood. The process can be used to treat entire lengths of timbers (e.g. poles) or only the ends of poles (butt treatment). The latter type of treatment would be used for the protection of only the portion of the utility pole that normally is placed below ground level.

PCP is generally purchased in solid blocks (usually weighing 907 kg/2000 lbs.). Petroleum oils used as carriers for PCP are delivered by bulk truck or rail tanker and stored in tanks. Following delivery of PCP and the carrier oils, the chemicals are mixed and the wood is treated as outlined below. (Refer also to Part 1 – General Background Information, Section 2.2.3 [Figure 5](#)).

#### *Chemical Mixing*

##### *PCP solid blocks*

The PCP blocks are lowered into a thermal treatment tank. Hot petroleum oil is circulated between the tank and a PCP/oil storage tank until a dissolved solution is attained. The prepared solution is then transferred to an insulated storage tank. Solution concentrations may range from 5% to 9% PCP.

##### *PCP liquid solution (minor use in Canada)*

The concentrate is then diluted to working concentration (5–8% PCP (8)) by recirculation between the cylinder or mix tank and the bulk storage tank.

#### *Wood Conditioning*

Air seasoning is used to reduce moisture in wood in preparation for thermal treatments. Dry kilns or steaming is sometimes used if air seasoning has not been sufficient prior to treatment. Prior to treatment, the wood products may be incised and shaped to end-user specifications. Poles are the most common thermally treated product, although cross-arms may also be treated by this process (19). The poles are loaded into horizontal, rectangular tanks for full-length treatment, or into tanks for upright butt treatment of pole ends, using cranes or custom forklift equipment. Poles placed in the horizontal full-length tanks are held in place by steel cross-beams. Full-length tanks are normally covered with plywood or steel lids prior to application of the preservative. Typical dimensions of such tanks are 4 m x 4 m x 30.5 m.

### *Preservative Application*

Thermal treatment is analogous to the full-cell pressure treatment process. The treatment cycle basically consists of a hot and cold bath as described in Section 2.2.2 (Preservation Processes) of Part I – General Background Information. After the impregnation cycle is completed, the poles are left in the treatment tanks to cool and to allow any excess preservative to drip off. They are then inspected and sampled for quality control purposes.

For butt treatments, the wood is held vertically with only a portion of the pole submerged in oil. The impregnation cycles are similar to the full-length thermal cycles. Butt dip tanks are difficult to cover during treatment. However, the exposed oil surface area is limited. Hollow polypropylene balls are sometimes used to float on the oil surface to help reduce steam and heat loss while also reducing potential foaming. The tanks should be covered when not in use to prevent precipitation entering the tank.

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label. The CAN/CSA O80 (5) also has retention and process standards to ensure effective treatments for specific uses without damage to the wood. The pesticide label is the legal document and should be considered as such in the event of discrepancy between the standards.

### *Storage of Treated Product*

The cooled treated wood is moved from the treatment tank to a drip pad and then to a storage area. It is common for poles to remain in the treating tank until essentially drip free. The time on the drip pad may vary depending on the facility design, ambient conditions, wood species and application process. The charge must only be removed from the drip pad once drippage has stopped. The treated wood is removed from the drip pad by forklift or crane and stored in a designated area until transport to the customer.

## **5.2 Potential Chemical Discharges**

Thermal wood preservation facility design and operational practices vary (20), and each facility has potential sources of emissions that may affect worker health and/or the environment. The potential sources and releases are illustrated in Figure 1.

### *Liquid Discharges*

Although no liquid process wastes are produced during thermal treatment, the following situations could create liquid releases:

- spills or overflows of liquid from open treatment tanks
- infiltration of groundwater into tank containment systems
- leaks from treatment tanks that have no containment provisions
- surface runoff from the treated wood storage areas

- washwaters

The method for controlling runoff waters depends on analytical and/or bioassay evaluations and on regulatory requirements. Section 10 – Emission and Site Monitoring provides information on this matter.

### *Solid Wastes*

Solid wastes from thermal treatment facilities that use oil-borne PCP may include the following:

- sludge from treatment and storage tanks, in particular the “cold” PCP/oil storage tank
- sludge from wastewater treatment processes (e.g. flocculated material)
- pallets and wrappings from bulk PCP

### *Air Emissions*

Air emissions from thermal treatment facilities are localized and intermittent, and may include the following:

- vapours that escape from the treatment tanks during the treatment cycle
- vapours from tank vents
- vapours from PCP block storage
- vapours from freshly treated charges

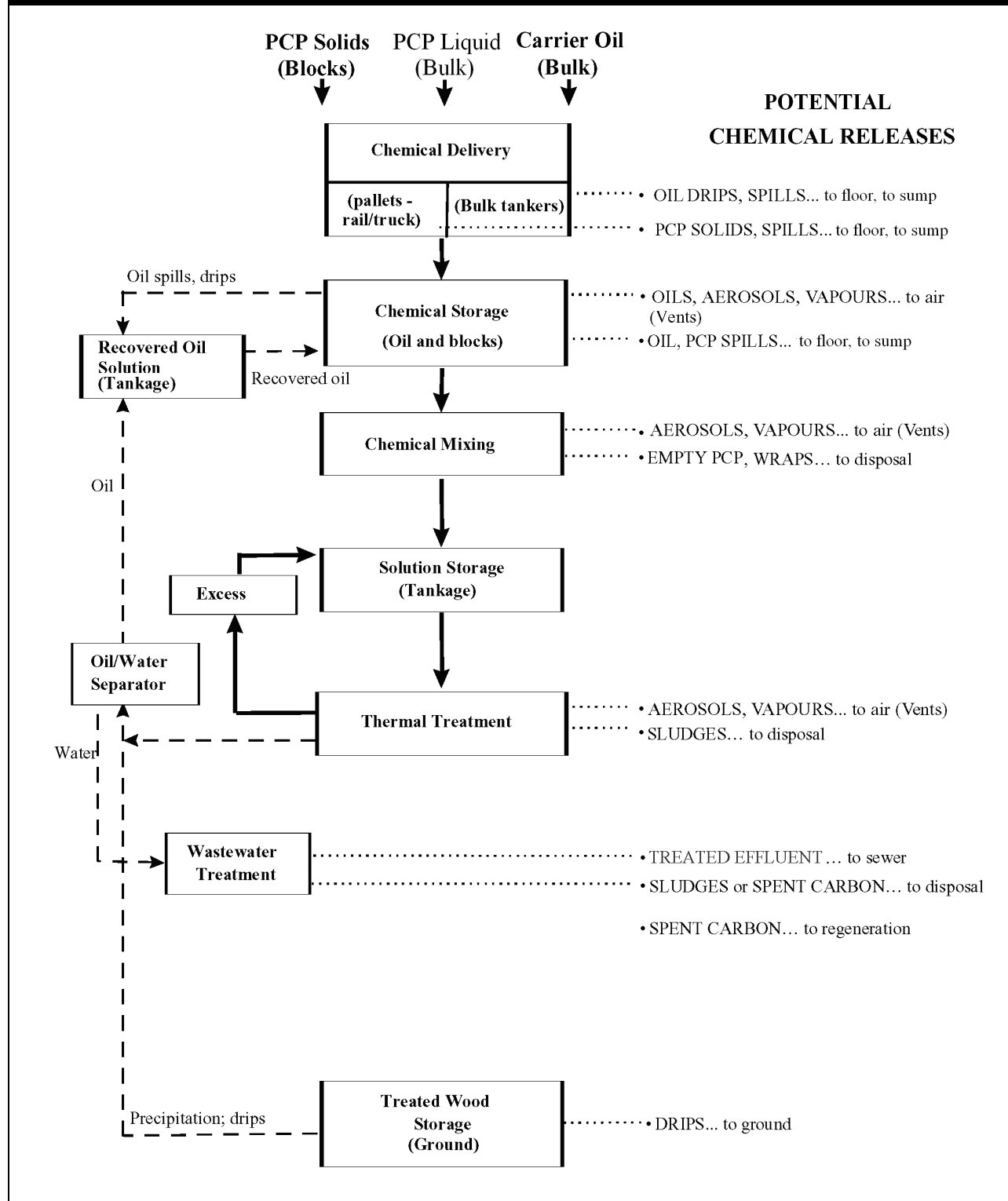
Emissions that could disperse beyond facility boundaries include the following:

- vapours from uncovered treatment tanks during the treatment cycle

Refer to Part 1 – Chapter A, [Section 5.2](#) for more details on potential chemical discharges. .



**Figure 1 Potential Chemical Releases From PCP Thermal Treating Plants**



### **5.3    *Potential Effects of Chemical Discharges***

The actual impact on the environment of any liquid discharge, solid waste or air emission depends upon many factors, including the location of the wood preservation facility relative to ground or surface waters, the species of aquatic biota in adjacent surface waters, and the amount of preservative released. Variables that can influence effects on worker health include ambient concentrations, frequency of exposure and protective measures during the time(s) of exposure.

All thermal facilities could potentially affect the environment, as could any other industrial facility that uses chemicals, if proper control measures are not in place. Documented PCP releases from wood preservation facilities have been due to either poor design or poor operating practices. The effects of these releases appear to be either localized within the plant site (i.e. soil and groundwater contamination) or in the environment immediately adjacent to the plant site.

Fires that have occurred at Canadian PCP thermal facilities illustrate the need for proper contingency planning for fire control and for containment of oil solutions and fire runoff waters.

Human health could be affected if proper precautions are not taken during handling of PCP, exposure to minor spills and residues in working areas, exposure to vapours, or handling of treated products.

## 6 Protection of Personnel

With the use of PCP, it is important to provide protection against all potential types of exposure: eye contact, skin contact and inhalation. Many work situations require protection against more than one type of exposure—for example, when chlorophenol dusts, aerosols or vapours are produced. In these situations, the use of nose-mouth respirators that do not cover the eyes or the skin around the eyes may lead to a false sense of security. PCP is absorbed rapidly via the skin (13). **Full face shields or full-face cartridge respirators should be used.**

### 6.1 *First Aid, Precautions and Hygiene for PCP Exposure*

Table 5 contains the recommended actions in case of PCP exposure. **The higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs.**

Facility staff should have access to product labels and appropriate training to apply first aid. Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with PCP solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

For all medical attention, always have the Pest Control Products label and the MSDS at your disposal so that you can properly inform health personnel.

Personnel should follow the recommendations from [Table 6 of Chapter A](#) outlining general precautions and personal hygiene measures.

**Table 5. First Aid Measures for Exposure to PCP**

Exposure	First action	Second action
Eye contact	<ul style="list-style-type: none"> <li>Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids.</li> <li>Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li> <li>Flush eyes for at least 15 minutes.</li> </ul> <p><i>Workers should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>Use boric acid solution and cortisone ophthalmic drops*.</li> <li>Get medical attention or call a poison control centre immediately for treatment advice (have product label at hand).</li> </ul>
Skin contact (Even small exposure)	<ul style="list-style-type: none"> <li>Immediately remove soaked clothing or articles in contact with the skin.</li> <li>Immediately wash contaminated skin thoroughly with soap or mild detergent and water.</li> </ul>	<ul style="list-style-type: none"> <li>Call a poison control centre or doctor immediately for treatment advice (have product label at hand).</li> <li>Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>Immediately remove the exposed person to fresh air (coughing and sneezing occur almost immediately after excessive inhalation of chlorophenols).</li> <li>If person is not breathing, call 911 or an ambulance then apply artificial respiration using a barrier device.</li> </ul>	<ul style="list-style-type: none"> <li>Keep the affected person comfortable and quiet.</li> <li>PCP can cause excessive body temperature.</li> <li>Get medical attention or call a poison control centre immediately or doctor for treatment advice (have product label at hand).</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>For PCP solids: Get medical attention or call a poison control centre immediately for treatment advice. If the victim is conscious, have that person immediately drink large quantities of water. Do not induce vomiting unless told to do so by a poison control centre or doctor.</li> <li>For PCP in oil: Get medical attention or call a poison control centre immediately for treatment advice. Do not induce vomiting.</li> </ul>	<ul style="list-style-type: none"> <li>Call a poison control centre or an industrial physician immediately for subsequent advice (have product label at hand).</li> </ul>
Chronic symptoms requiring medical referral	<ul style="list-style-type: none"> <li>Dermatitis, headaches, nausea</li> <li>Hyperthermia, fever, sweating, weight loss, chloracne</li> </ul>	

\* Emergency first aid kits should be equipped with boric acid solution and cortisone ophthalmic drops.

For all medical attention, always have the Pest Control Products label and the MSDS at your disposal so that you can properly inform health personnel.

## 6.2 Regulatory Controls

The labels for pesticide products contain information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

Most regulatory criteria established by worker protection agencies are based on TLVs and BEIs, as recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) (21). The ACGIH threshold limit value-time weighted averages (TLV-TWAs) for chemicals are defined with the following provisos:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentrations.”
- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

Recently, the ACGIH has suggested augmenting TLV workplace evaluations by using “biological exposure indices (BEI) which may be useful as a guide to safe exposure” (21). See section 6.4 for more details.

### *Skin and Eye Contact*

The ACGIH-recommended TLV-TWA for PCP represents a time-weighted average (TWA) concentration “for a normal 8-hour workday and a 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.” The recommended TLV-TWA value for PCP is  $0.5 \text{ mg/m}^3$ , and is followed by the designation “skin,” which refers to “the potential contribution to the overall exposure by the cutaneous route including mucous membranes and eyes, either by airborne, or more particularly, by direct contact with the substance” (21).

In practice, a wide range of dermal exposure to PCP can be encountered in the wood treatment workplace (i.e. from pure PCP solids to waters containing a few parts per million PCP). Dermal penetration is a significant route of PCP intake, and this penetration is enhanced if exposure to PCP/oil solution occurs (22).

### *Inhalation*

The ACGIH TLV-TWA considered that the PCP values for skin and eye contact would also be applicable to the maximum allowable values for inhalation. In its rationale for using TLV-TWAs, the ACGIH states that PCP “dusts are particularly irritating to the eyes and nose in concentrations greater than 1 mg/m<sup>3</sup>. Some irritation may occur at 0.3 mg/m<sup>3</sup>. Seasoned workers can tolerate up to 2.4 mg/m<sup>3</sup>” (21).

A review of the literature indicates that many of the documented industrial health incidents involving PCP have occurred as a result of dumping bagged PCP flakes (formerly used) in poorly ventilated areas (22, 23, 24). Other exposures to dusts may occur during activities such as cleanup of spilled PCP solids. Facility operators must ensure that adequate designs and operational procedures are in place in order to minimize worker exposure to PCP dusts (i.e. adequate local ventilation, use of appropriate respiratory equipment, and use of wet or vacuum methods for cleaning of spilled PCP solids). Other potential sources of inhaled PCP include vapours in the vicinity of charge removal areas and in the vicinity of freshly treated wood, and aerosols at improperly maintained facilities (e.g. from leaking seals) or at inadequately designed facilities (e.g. from vacuum pump discharges to work areas).

### *Ingestion*

Oral intake of PCP must be avoided. Ingestion of PCP or liquids that contain PCP is unlikely if workers follow elementary rules of good hygiene. Acceptable limits of ingestion are not prescribed by regulation, since there is no valid reason for any such intake to occur. The single dose level of PCP known to result in fatality is in the order of 1 to 3 g (25, 26).

## **6.3 Safety Precautions**

All facility workers who have any potential for dermal exposure to PCP, oil solutions of PCP, or freshly treated wood should be required to adhere to minimum levels of protection and hygiene. The level of protection should increase with increasing potential for exposure to PCP.

**Table 8. Additional Safety Precautions for Personnel Working with PCP Solutions**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 8.)

<b>Objective:</b> To ensure safe workplace practices for each activity during the treatment process.	
<b>Activity</b>	<b>Recommendations</b>
For all activities	<ul style="list-style-type: none"> <li>• <b>PPE (personal protective equipment):</b> material impermeable to organic solvents, with a resistance rating for PCP: <ul style="list-style-type: none"> <li>excellent – viton, neoprene, butyl rubber</li> <li>good – nitrile, polyvinyl chloride (PVC)</li> <li>fair – polyvinyl alcohol, polyethylene</li> </ul> </li> <li>• <b>PPE:</b> Respirator cartridges must be NIOSH-rated for protection from organic vapours and acid gases, in combination with a dust mist and fume filter</li> </ul>
Unloading PCP solids	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Approved respirators should be readily available. Wear full face protection respirators whenever exposure* to dust can occur.</li> <li>• Do not wear contact lenses.</li> <li>• Provide adequate equipment for safe, controlled handling of blocks as appropriate for the specific facility</li> <li>• Do not drop PCP blocks.</li> <li>• Immediately vacuum PCP chips or spilled solids (vacuums should have effectively filtered exhausts).</li> </ul>
Unloading PCP solution	<ul style="list-style-type: none"> <li>• Wear an approved full facepiece respirator whenever dust conditions occur. Respirator cartridges must be NIOSH-rated for protection from pesticides and organic vapours and dusts.</li> </ul>
Preparing PCP work solutions	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear an approved full facepiece respirator whenever dust conditions occur.</li> <li>• Thoroughly vacuum PCP dust and solids from the work area following solution preparation.</li> <li>• Dispose of empty PCP wraps and PCP-contaminated debris according to Table 23.</li> </ul>
Cleaning treatment or storage tanks	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Wear NIOSH-approved breathing apparatus, organic-solvent-impermeable gauntlets, outer clothing and boots during all tank entries.</li> <li>• Follow procedure for confined spaces.</li> </ul>
Removing treated charges from tanks	<ul style="list-style-type: none"> <li>• Wear eye protection (butt treatment) or full faceshield (full length treatment) and organic-solvent-impermeable gauntlets and coveralls or apron when manually handling slings for charge removal.</li> <li>• Avoid breathing preservative mists. Wear an approved respirator if airborne concentrations are unknown or are at or above TLVs.*</li> </ul>
Sampling procedures	<ul style="list-style-type: none"> <li>• Wear eye protection and gauntlets resistance rating for PCP when sampling PCP solutions, e.g., from a pipe tap.</li> <li>• Should wear respirators and must be in accordance with NIOSH guidelines (pesticide, polynuclear aromatic hydrocarbons and organic vapours cartridges, and dust) when sampling PCP solutions or treated wood (if at temperatures above ambient).</li> <li>• Other non-routine sampling efforts such as through cover ports may necessitate more stringent precautions.</li> </ul>
Handling treated lumber	<ul style="list-style-type: none"> <li>• <b>PPE:</b> Change coveralls daily. Wash separately from other laundry.</li> </ul>
Handling and maintaining contaminated equipment	<ul style="list-style-type: none"> <li>• Thoroughly steam-clean or flush contaminated equipment with hydrocarbon solvent (e.g. Varsol or equivalent) prior to handling. Contain all solvent washings.</li> <li>• <b>PPE:</b> Change coveralls daily.</li> </ul>

NIOSH = National Institute for Occupational Safety and Health.

\* An initial workplace monitoring program as suggested in Chapter A, Section 10.2, [Table 26](#) will have determined the need for respirator use. The results of the program are assumed to be indicative of conditions in subsequent facility operations, unless procedural or design changes have occurred.

## **6.4 *Biological Monitoring of Exposed Workers***

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#)

Blood PCP exposures are good indicators of acute short-term exposures because blood PCP values reach maximum 4 hours after exposure. It is useful for monitoring PCP exposures via skin contact, inhalation and ingestion. The BEI in blood is measured in plasma, at the end of shift, prior to the last shift of the workweek, and is set at 5 mg/L. Chronic exposures can best be monitored by measuring PCP in urine. BEI for total PCP in urine: 2 mg/g creatinine sampled prior to last shift of workweek (21).



## 7 Design Recommendations

The following tables present good design features specifically applicable to PCP thermal wood preservation facilities. The additional recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 7 and their corresponding tables. All tables of general content from Chapter A, [Section 7](#) must be taken into consideration.

**Table 11. Additional Recommended Design Features for Chemical Storage Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 11.)

Storage format	Design feature	Recommendations
<b>Bulk liquids</b> <ul style="list-style-type: none"> <li>Petroleum oil (CSA O80.201)</li> <li>PCP/oil working solutions</li> <li>Drip return</li> </ul>	<b>Objectives:</b> <ul style="list-style-type: none"> <li>◇ To provide positive spill prevention features</li> <li>◇ To conform to the <i>National Fire Code of Canada</i> (NFCC), where applicable</li> </ul>	
	Location	The preferred location for oil tankage (all solutions) is in an exterior centralized tank farm area that is arranged in accordance with the NFCC.
<b>PCP</b> Solid blocks	<b>Objective:</b> To provide sheltered, secure, fire-protected storage of PCP solids	
	All features	<ul style="list-style-type: none"> <li>All feature recommendations for bulk liquids from Chapter A are applicable.</li> </ul>
	Location	<ul style="list-style-type: none"> <li>Provide safe, easy access to the mixing area (design so as to contain and facilitate cleanup of PCP dust lost during transit to the mixing area).</li> </ul>
	Shelter	<ul style="list-style-type: none"> <li>Provide storage in an enclosed, secure area, segregated from other chemicals (design so as to prevent infiltrating precipitation).</li> <li>Design so as to prevent fire in PCP storage areas (use of non-combustible construction materials is preferred).</li> </ul>
<b>Bulk sludge</b>	All features	<ul style="list-style-type: none"> <li>All feature recommendations for bulk liquids from Chapter A are applicable.</li> </ul>
	Handling	<ul style="list-style-type: none"> <li>Provide transfer equipment for clean, safe sludge handling with minimum worker exposure.</li> </ul>

**Table 12. Additional Recommended Design Features for Chemical Mixing Systems**  
 (Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 12.)

Design feature	Recommendations
<b>PCP</b>	<b>Objectives:</b>
• PCP blocks	◊ To provide a mixing system with effective spill prevention features
• Petroleum oil	◊ To provide a mixing system that minimizes worker contact with PCP
<b>Configuration</b>	<ul style="list-style-type: none"> <li>• Mixing by block placement in a closed tank is the preferred method.</li> <li>• Use permanent, closed mixing systems (rigidly piped, tank to tank).</li> </ul>
<b>Location/shelter (mixing tanks)</b>	<ul style="list-style-type: none"> <li>• Locate in a contained, dry sheltered area (giving attention to worker comfort).</li> <li>• Provide protection against freezing (as applicable).</li> </ul>
<b>Solids handling</b>	<ul style="list-style-type: none"> <li>• Provide appropriate equipment for safe, controlled lifting and handling of PCP blocks.</li> <li>• Provide a dry, concrete / paved area for plastic wrap removal from blocks.</li> <li>• Ventilate to control air levels of PCP during routine operation and during worst event spills.</li> <li>• Provide a vacuum cleaner system (filtered exhaust) for effective cleanup of PCP dust and granules from handling/transfer operations.</li> <li>• Provide local exhaust system and closed solids handling systems (e.g. flexible covers on hoppers) to eliminate direct worker exposure to PCP dust and granules during unwrapping</li> </ul>
<b>Splash protection</b>	<ul style="list-style-type: none"> <li>• Not Applicable.</li> </ul>

**Table 13. Additional Recommended Design Features for PCPT Treatment Process Systems**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 13.)

Design feature	Recommendations
<b>Objectives:</b> <ul style="list-style-type: none"> <li>◇ To minimize and contain all releases of PCP</li> <li>◇ To recover and recycle releases that occur</li> <li>◇ To provide fail-safe operation of the treatment system</li> <li>◇ To minimize the potential for PCP spills</li> <li>◇ To conform with the NFCC</li> </ul>	
Shelter, configuration	<ul style="list-style-type: none"> <li>• Use exterior treatment tank.</li> <li>• Locate other process equipment and systems in a centralized area.</li> <li>• Provide heated (where necessary) enclosure for process controls, with any air emissions vented externally.</li> </ul>
Tanks, piping and valves	<ul style="list-style-type: none"> <li>• Provide effective access and containment for all subsurface tanks and piping.</li> </ul>
Process emissions to air	<ul style="list-style-type: none"> <li>• Locate treatment tanks so as to minimize downwind effects either to yard workers or to adjacent properties actively used for residential/commercial purposes.</li> <li>• Install any control equipment as necessary to comply with applicable emission limits.</li> <li>• Provide vapour traps for hot liquid tank vents and vacuum exhaust.</li> <li>• Vent tank vapours (cold storage) to outside.</li> </ul>
Treating tanks	<ul style="list-style-type: none"> <li>• Engineer treatment tanks for long-term integrity.</li> <li>• Ensure that tanks are secured to prevent uplifting.</li> <li>• Provide secondary containment vessel or other impermeable containment around treatment tanks.</li> <li>• Install an effective protection device to prevent overfilling of treatment tanks with preservative: <ul style="list-style-type: none"> <li>– Install independent overflow indication/alarm/pump interlocks between the treating tanks and the control point (where the tank is not visible from the control point).</li> <li>– Provide containment for collection and direct return of tank overflow.</li> <li>– Construct overflow connection as per the NFCC.</li> </ul> </li> <li>• Provide corrosion protection of subsurface steel tanks as per the NFCC.</li> <li>• Provide for tank lids or roofing to reduce vapour emissions and to reduce or prevent rain and snow falling into tanks. Construct lids as per the NFCC.</li> <li>• Provide walkway grates (or alternative design) to prevent worker contact or tracking of chemicals.</li> <li>• Provide guard rails and other safety measures as required by provincial authorities for operations near open tanks.</li> <li>• Provide means to contain frothing and/or overflows.</li> </ul>
Piping and recycle systems	<ul style="list-style-type: none"> <li>• Design an overall system that is effective at containing and recycling all chemicals, with minimum potential for release and dispersal and minimum infiltration of water.</li> <li>• Select and install piping as per <a href="#">Table 11</a> of Chapter A.</li> </ul>
Process controls	<ul style="list-style-type: none"> <li>• Design for simple, unambiguous operation (regardless of the degree of automation).</li> <li>• Establish a clear relationship between process controls and process functions in order to minimize operator error (e.g. provide flow diagrams for process).</li> </ul>

## 8 Operational Recommendations

The additional recommendations for good operating practices listed in the following tables must be used in conjunction with those in Part I, Chapter A – General Recommendations for all Wood Preservatives, [Section 8](#). All tables of general content from Chapter A, Section 8 must be taken into consideration. They are meant to protect both workers and the environment from harmful exposure to PCP and its solutions.

### 8.1 Operational Standards

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including PCP. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2-08 Clause 4.1 (referenced to AWPA M3). The calibration can be conducted by facility staff if they have the appropriate training.

Special attention is required on the part of PCP plant operators to ensure that operational activities are in accordance with the *National Fire Code of Canada* (NFCC) for flammable and combustible liquids (27).

### 8.2 Facility Wide Recommendations

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### 8.3 Process Area specific Recommendations

**Table 19. Additional Recommended Operating Practices for Chemical Handling and Storage**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 19.)

Operation	Recommendations
Unloading chemicals <ul style="list-style-type: none"> <li>• PCP solids</li> </ul>	<b>Objective:</b> To ensure that the unloading of treatment chemicals occurs in a safe manner
Handling of wood preservative <ul style="list-style-type: none"> <li>• PCP blocks</li> </ul>	<ul style="list-style-type: none"> <li>• Contain all spilled PCP solids (dust, granules) and reuse or dispose of as contaminated solid waste.</li> <li>• Store empty PCP wrappings and dispose of as contaminated wastes in accordance with Section 9.</li> </ul>

**Table 20. Additional Recommended Operating Practices for Process Systems**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 20.)

Operation	Recommendations
<b>Objectives:</b>	<ul style="list-style-type: none"> <li>◇ To define procedural practices to enhance environmental protection and worker safety</li> <li>◇ To prevent worker contact with treatment solution and with freshly treated loads</li> <li>◇ To operate the facility in compliance with the <i>National Fire Code of Canada</i></li> </ul>
Routine checks	<ul style="list-style-type: none"> <li>• Implement visual inspection routine at least once each shift for prompt detection of abnormal conditions (as per the NFCC).</li> <li>• Frequently inspect and test all safety shutoff valves and other fire safety devices (as per the NFCC).</li> </ul>
Charges	<ul style="list-style-type: none"> <li>• Secure loads to avoid uncontrolled floating.</li> <li>• Stack loads to allow good drainage of preservative from all surfaces after treatment.</li> </ul>
Treating tank lids	<ul style="list-style-type: none"> <li>• Ensure that lids fit tightly on tanks to minimize the release of vapours when tanks are not used.</li> </ul>
Charge removal	<ul style="list-style-type: none"> <li>• Allow ventilation of the charge before unloading by exposing the open tank to air.</li> <li>• Minimize exposure to vapours by working upwind of the charge and/or wearing an approved respirator.</li> <li>• Maximize use of mechanical equipment for charge removal to minimize the need for worker handling of freshly treated wood.</li> <li>• Remove charges from tank to drip pads only when preservative drippage has stopped.</li> </ul>

**Table 22. Additional Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 22.)

Operation	Recommendations
Equipment maintenance	<ul style="list-style-type: none"> <li>• Check integrity of subsurface thermal tanks at least once every five years (cracks will be visible in cleaned tanks).</li> </ul>
Cleanout	<p><b>Objectives:</b></p> <ul style="list-style-type: none"> <li>◇ To prevent accumulation of PCP solutions and sludge within the treatment systems</li> <li>◇ To ensure worker safety during cleanout operations</li> </ul> <hr/> <ul style="list-style-type: none"> <li>• Observe personnel safety precautions during all procedures (Tables 6 and 8 from this chapter and from chapter A).</li> <li>• Routinely inspect sludge levels in storage tanks, mix tanks and treating tanks and clean out if necessary. Determine and specify sludge levels that require removal, in consultation with qualified technical personnel. <ul style="list-style-type: none"> <li>– During cleanup, inspect gauge floats.</li> </ul> </li> <li>• Prior to entering tanks:: <ul style="list-style-type: none"> <li>– Follow all standard precautions and safety procedures for vessel entry (as per provincial health and safety regulations).</li> <li>– Thoroughly cool tanks. Do not enter treating tanks until they have cooled.</li> <li>– If airborne concentrations are unknown, or are at or above TLVs, attendant must wear self-contained breathing apparatus, impermeable gloves, boots and disposable coveralls.</li> <li>– If airborne concentrations are below TLVs, attendant must wear approved full face respirators, impermeable gloves, boots and disposable coveralls.</li> <li>– Remove sludge with equipment used only for facility-related purposes.</li> <li>– Thoroughly clean treatment tank interiors (as required) and test for structural integrity every 5 years</li> </ul> </li> </ul>

TLV = Threshold limit value

## 9 Waste, Process Emissions and Disposal

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 9.1 Control, Treatment and Disposal

The PCP oil-borne thermal treatment process generates solid wastes and emissions to air. Little liquid process wastewater may be generated from incidental infiltration. Numerous approaches are used or can be used by the industry to control, treat and/or dispose of the process wastes and emissions. Potential sources of chemical releases from PCP thermal treatment facilities are described in Section 5.2 and in Figure 1. Table 23 at the end of this section identifies the main categories of process wastes or emissions that can be generated at PCPT facilities, and summarizes recommended control, treatment and/or disposal methods.

**The processes used for waste disposal fall under provincial jurisdiction and may vary from province to province.**

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information.

#### *Control Requirements*

Control specifications will depend on factors such as the volume and frequency of the discharge and the sensitivity of the receiving environment. The discharge of chlorophenol-contaminated effluent into waters inhabited by fish is subject to the federal *Fisheries Act*. Refer to Table 3 for CCME water quality guidelines.

### 9.2 Waste Liquids Containing PCP

#### *Liquid Process Wastes*

Leaks and drips of oil solutions generally do not occur during the thermal treatment of wood. Frothing and/or overflow from the treatment tank can occur, however. The thermal tank should be designed to accommodate containment of such overflow. Structural defects in the treatment tank can also result in releases of oil solutions to groundwater. Containment shells are required in order to prevent groundwater contamination. Contaminated water solutions may be generated; these include washwaters and waters that infiltrate subgrade containment shells. Oil and PCP must be removed from these wastewaters prior to discharge (19, 28, 29). The techniques may include one or a combination of the following:

- gravity separation
- oil/water API separation, plate separation
- activated sludge treatment

- activated carbon treatment
- physical-chemical treatment (i.e. flocculation)
- evaporation/condensation

A regulatory discharge permit must be obtained for disposal of the treated aqueous wastes.

### *Contaminated Storm Runoff*

Because thermal treatment facility sites are generally large, considerable volumes of storm runoff waters occur from these sites. Every precaution should be taken to avoid contamination of storm runoff water, particularly in the vicinity of PCP storage sites and treatment areas. Facility operators must acknowledge that there is a possibility of PCP-contaminated runoff from treated wood storage areas; surface runoff from the storage areas should therefore be monitored for chlorophenols and oil. See Section 7 for more details on design and equipment recommendations.

If contamination occurs, refer to Section 12 – Environmental Emergency Notification and Contingency Planning for more direction.

## **9.3 Solids with Potentially High PCP Concentrations**

For the purposes of this document, solids with potentially high levels of PCP are defined as:

- sludge from work solution tanks and treatment tanks
- sludge from wastewater treatment processes (e.g. flocculated materials)
- unwashed containers or wrappings for PCP
- filters from cleaning vacuum

Sludge from thermal tanks constitute most of the solid wastes at thermal facilities. Operating and design modifications can be used to significantly reduce the volume of sludge. For example, open exposure of the tanks to precipitation leads to the generation of higher volumes of sludge. Roofing could eliminate this source of contamination.

### *Guidelines for the Disposal of Solid Wastes*

While awaiting disposal, the contaminated solids should be in leakproof containers in a specially designed area that is curbed with a paved or concrete sealed surface. The area should be roofed to protect the wastes from precipitation. Any seepage or leachate generated at the site should be contained. Refer to Chapter A, Section 9, [Table 23](#) – Recommended Practices for Handling Liquid & Solid Wastes and Sludge for complete details.

The most feasible disposal option for chlorophenol wastes appears to be high-temperature thermal destruction by an approved facility. Refer to your local and provincial authorities for the best potential disposal options.



## **9.4 Disposal of Miscellaneous Solid Wastes**

Refer to Chapter A, [Section 9.4](#) – Miscellaneous Solid Wastes for complete details.

- Make the empty container unsuitable for further use
- Do not use PCP-treated wood as a compost or mulch.
- Incineration of PCP-contaminated materials is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products

## **9.5 Air Emissions**

Air emissions at thermal treatment facilities are generally localized; effects, if any, would be restricted to workers at the facilities. Such emissions may include the following:

- vapour from thermal tanks during the hot oil treatment process
- dust from manual unwrapping
- vapours from tank vents
- vapours from freshly treated charges

Ensure that lids from thermal treating tanks fit tightly in order to minimize the release of vapours.

Design and procedural recommendations for control of these localized emissions are suggested in Sections 7 and 8.

**Table 23. Recommended Disposal Practices for PCP-Contaminated Wastes***(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 23.)*

<b>Waste category</b>	<b>Examples</b>	<b>Recommendations</b>
Liquid PCP/oil solutions	<ul style="list-style-type: none"> <li>• Spilled PCP/oil concentrates</li> <li>• PCP work solutions</li> <li>• Drips from freshly treated lumber</li> <li>• Material skimmed from oil separators</li> </ul>	<ul style="list-style-type: none"> <li>• Collect and reuse.</li> </ul>
Liquid PCP/water solutions	<ul style="list-style-type: none"> <li>• Washwaters</li> <li>• Infiltrating waters</li> </ul>	<ul style="list-style-type: none"> <li>• Treat to remove oil and PCP to within regulatory limits.</li> <li>• Dispose of treated waters as per regulatory requirements.</li> </ul>
Contaminated solid wastes	<ul style="list-style-type: none"> <li>• Debris and bottom sludge from storage tanks, sumps and thermal tanks</li> <li>• Soils contaminated by spills</li> <li>• Cleanup absorbents</li> <li>• Filter from cleaning vacuum</li> <li>• Sludge from wastewater treatment processes</li> <li>• Solid fire residues from PCP or PCP/oil storage areas</li> <li>• Wrapping used for PCP blocks</li> <li>• Scraps, cuttings and shavings from PCP-treated lumber</li> </ul>	<ul style="list-style-type: none"> <li>• Drain and/or drum, store and dispose of in accordance with provincial regulations (high-temperature thermal destruction at authorized facilities appears to be the most feasible disposal option).</li> </ul>
Miscellaneous solid wastes	<ul style="list-style-type: none"> <li>• Empty containers and wrapping rinsed with alkaline water</li> </ul>	<ul style="list-style-type: none"> <li>• Dispose of in authorized sanitary landfills (subject to approval by the provincial regulatory agency).</li> <li>• Recuperated by authorized facilities.</li> </ul>
Contaminated storm runoff	<ul style="list-style-type: none"> <li>• Storm runoff or contaminated liquid discharge containing PCP requires consultation with regulatory agency.</li> </ul>	<ul style="list-style-type: none"> <li>• Prevent or minimize contamination of storm runoff to greatest possible extent.</li> <li>• Monitor surface water discharges (in consultation with the provincial regulatory agency) to assess contaminant concentrations and determine the need for control.</li> <li>• Provide mean for collection of contaminated storm runoff.</li> </ul>
Firefighting water runoff	<ul style="list-style-type: none"> <li>• As above (contaminated storm runoff)</li> </ul>	<ul style="list-style-type: none"> <li>• Consider provisions for containment where PCP and PCP/oil solutions are present.</li> <li>• Consult with provincial regulatory agency to determine acceptable disposal practices.</li> </ul>

## **10 Environmental and Workplace Monitoring**

### **10.1 Baseline Environmental Evaluation**

PCP has been detected in snowpack, water, landfill leachates, sewage effluents, sediments, and aquatic and terrestrial organisms (2, 11). There are many suspected sources of PCP releases. These include disposal areas for various commercial formulations used historically as slimicides and fungicides; storage areas for PCP-treated products (including the former process of lumber dipping or spraying with aqueous solutions of chlorophenates for sapstain control); accidental or uncontrolled process releases from wood preservation facilities; and chlorinated wastewaters, especially those from pulp and paper mills and municipal sewage treatment plants (11).

PCP is not a natural compound, and its environmental background level should be “zero.” However, anthropogenic sources have resulted in trace concentrations even in remote areas. For example, levels of 0.003 mg/L to 23 mg/L have been detected in many tributaries and bays of each of the Great Lakes. Supposedly remote areas have frequently shown levels of 0.01 mg/L. A survey of the Fraser River showed PCP concentrations ranging from 0.002 to 0.0037 mg/L in waters sampled upstream of industrial areas (10). The reported trace concentrations illustrate the high degree of detection capability, i.e., to a fraction of one-billionth of a gram of PCP in a litre of water. These concentrations are much lower than concentrations that have been found to affect aquatic biota or human health (11). Restrictions on PCP use implemented during the early 1980s, as well as the cessation of chlorophenate uses for antisapstain treatments, may have had a positive impact on the current levels of PCP in the Canadian environment.

### **10.2 Environmental Monitoring**

A possibility of PCP-contaminated ground and runoff from treated wood storage areas must be acknowledged. Even if PCP has low bioaccumulation tendency and persistence in the environment, its effect on the environment can have great consequence. Close monitoring studies (such as surface water discharges, groundwater and soil contamination) are recommended to detect and properly assess the degree of such potential toxic releases.

### **10.3 Workplace Exposure Monitoring**

Workplace monitoring generally falls under provincial jurisdiction. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers’ compensation board and/or department of labour and/or industrial physician/industrial hygienist.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## 11 Transportation of PCP, Oil Solvents and PCP Wastes

The transportation of PCP blocks, flakes, oil solvents and PCP wastes is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of PCP and its wastes.

## **12 Environmental Emergency Notification and Contingency Planning**

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using PCP/oil should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective.

### **12.1 Environmental Emergency Notification**

The Environmental Emergency Regulations and its requirements are applicable for PCP since it contains polychlorinated dibenzodioxins (Dioxins), polychlorinated dibenzofurans (Furans) and hexachlorobenzene, listed in Schedule 1 of CEPA 1999.

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.2 Spill Contingency Planning**

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.3 Fire Contingency Planning**

Although PCP is not flammable, work solutions of PCP and carrier oils are flammable. Extreme caution is to be exercised at fires involving PCP. If solid PCP is exposed to fire, or if combustion of PCP/oil mixtures occurs, the PCP will decompose, creating fumes containing hydrochloric acid, and possibly dioxins as well. All fire residues must be considered contaminated and must be contained for analysis and disposal as appropriate (see Table 23).

Please refer to the *National Fire Code of Canada (always refer to last version available)* (27) for proper fire extinguishing agents and other requirements for contingency plans, and refer to [Section 12.3](#) of Part I, Chapter A – *General Recommendations for All Wood Preservatives*. A copy of the fire contingency plan and all necessary documents should be stored in a fire proof box outside the entrance to the facility.

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## CHAPTER G

# Alkaline Copper Quaternary (ACQ) Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives.

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# 1 Production and Use

There are four formulations of alkaline copper quaternary (ACQ) preservative: Type A, Type B, Type C and Type D. Type A, Type C and Type D are currently registered for use in Canada. The different formulations allow flexibility in achieving compatibility with different wood species and end use applications. All ACQ types contain two active ingredients, which may vary within the following limits: copper ethanolamine complex or basic copper carbonate, which is the primary fungicide and insecticide; and a quaternary ammonium compound (quat), which provides additional fungicide and insect resistance properties. All ACQ types contain copper and quat at either 2:1 or 1:1 ratio CuO to quat. (1).

- ACQ-A: ACQ type A is copper dissolved in ethanolamine with didecyl dimethyl ammonium chloride (DDAC) as the quat. ACQ-A contains 50% copper oxide and 50% quat.
- ACQ-B: Not currently registered for use in Canada. Was primarily used for the treatment of western wood species such as Douglas Fir because its ammonia carrier solution allows the ACQ to penetrate into these difficult-to-treat species. This formulation contains 66.7% copper oxide and 33.3% DDAC as the quat. Wood treated with ACQ-B has a dark greenish brown colour that fades to a lighter brown and may have a slight ammonia odour until dry. ACQ-B is no longer use in Canada and is excluded from the CSA O80 Series of Standards.
- ACQ-C: It contains 66.7% copper oxide and 33.3% quat as alkyldimethylbenzyl-ammonium chloride (ADBAC). Ammonia and/or ethanolamine can be used as the carrying solution in this formulation. Wood treated with ACQ-C varies in colour that ranges between that of type B and type D. Most wood-preservation facilities in Canada use the ACQ-C formulation.
- ACQ-D: ACQ-D contains 66.7% copper oxide and 33.3% quat as didecyl dimethyl ammonium chloride (DDAC) or carbonate/bicarbonate (DDACB). Type D differs from type B in that it uses an ethanolamine carrier solution rather than ammonia. Type D differs from type A in the proportion of quat and copper oxide. Wood treated with ACQ-D has a lighter greenish brown colour with little odour (2).

The term “alkaline” is used generally to describe either ammonia or ethanolamine formulations. With either carrier, the formulation is completed by the addition of copper oxide and quaternary ammonium compound to water. ACQ is a technology that was developed in Canada and further advanced in the U.S. It has been in commercial production in Europe, Japan and the U.S. since the late 1980s. Wood products treated with ACQ preservative were commercially produced in Canada for the first time in 2004. ACQ replaced chromated copper arsenate (CCA) at many plants due to restrictions on residential uses of CCA-treated wood. In 2012, 22 Canadian facilities were using ACQ, and 8 were using it as the sole preservative (3).

The ACQ-C preservative is shipped in tanker trucks to wood preservation facilities as a premixed concentrated solution of 14.14% active ingredients (as CuO) that is then made into a ready-to-use working-strength solution by adding a known quantity of water in a mix tank.

The ACQ-C preservative is shipped in tanker trucks to wood preservation facilities as a premixed concentrated solution that is then made into a ready-to-use working-strength solution by adding a known quantity of water in a mix tank.

ACQ-D and ACQ-A preservative are shipped as two premixed solutions that are then mixed together at the facility. The preservative is prepared by adding a known quantity of amine copper to a measured amount of water in a mix tank. Quat is then added to achieve a copper-to-quat ratio of 2:1 by weight for ACQ-D and 1:1 by weight for ACQ-A, in the working solution. The quaternary (quat) component is shipped in totes at concentrations of about 43% to 50% and the copper ethanamine complex as an 11.25% CuO concentrate. The copper ethanamine concentrate can also be used for make-up to balance the solution.

The use of Ammonium Hydroxide concentrate can sometime be use to top up the ACQ solution or concentrate if the ammonia levels get low.

ACQ is suited for treatment of all commercially used tree species and can be applied to those species that are refractory and difficult to impregnate. ACQ is suitable for above-ground and ground contact in the categories described in Table 1. It is often used where environmental sensitivities exist for the intended use of the treated wood product (4).

**Table 1. Overview of ACQ Use in Canada**

Feature	Characteristics
<b>Treated wood use limitations in Canada</b>	<p>Not used to treat wood that will be used in water.</p> <p>Not used to treat wood used in critical infrastructures such as utility poles, pilings, railway ties or foundations.</p> <p>Industrial and non-industrial use for above-ground and ground contact in the following categories:</p> <ul style="list-style-type: none"> <li>• Residential construction such as decks, patios, fencing, lattice panels, deck accessories, play structures, siding, plywood, sill plates</li> <li>• Recreational applications such as walkways, board walks, landscaping, docks, gazebos</li> <li>• General construction and commercial applications such as dimensional lumber, structural timbers, posts, decking</li> <li>• Agriculture and horticulture applications such as fencing, framing and building poles</li> <li>• Highway construction applications such as lumber and timbers for bridges, bridge decking, hand rails, guard rails, spacer blocks, posts</li> </ul> <p>Not for infrastructure that may be in contact with drinking water, food or animal feeds (storage, production, transport...)</p> <p>*Note: permitted uses and limitations of ACQ-treated wood may change over time. Refer to pesticide label for up-to-date uses.</p>
<b>General process of application</b>	Pressurized application (and sometimes spray application for ACQ-C; refer to the pesticide label)

Single-cylinder preservation plants sometimes use more than one preservative. This is not recommended with ACQ as an ongoing practice, but can be done if appropriate precautions are taken and strictly followed. ACQ solutions are basic in pH, while others, such as CCA, are acidic. This situation dictates complete flushing of one preservative from the cylinder, piping, and all sumps and collection areas before introduction of the other preservative. One of ACQ's

advantages is that it is free of ingredients such as arsenic and chromium. This environmental and operational advantage may be lost if ACQ is mixed with the components of other preservatives.

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes ACQ-treated products. (5)

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label

## **2 Physical and Chemical Properties**

Copper and quat, the two active components of ACQ, are used because of their biocidal and insecticidal properties and their ability to be retained by wood for long-term protection. Ammonia or amine are used as solvent carriers along with water and are deposited in the wood cells. The physical and chemical properties of ACQ-C and ACQ-D and its constituents are outlined in Tables 2.0, 2.1 and 2.2. (4, 6, 7, 8, 9, 10)

General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and from labels for pesticide products. Electronic copies of the pesticide label can be obtained from the Health Canada website:

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php> (4).

**Table 2.0. Physical and Chemical Properties of ACQ Solution TYPE C**

Identification		
<b>Common synonyms:</b> ACQ-C <b>Chemical Abstracts Service Registry Number (CAS RN):</b> <ul style="list-style-type: none"> <li>Copper ethanolamine complex – 14215-52-2</li> <li>n-Alkyl (67% C<sub>12</sub>, 25% C<sub>14</sub>, 7% C<sub>16</sub>, 1% C<sub>18</sub>) Dimethyl benzyl ammonium chloride (ADBAC)  CAS: 68391-01-5</li> </ul>	<b>Registrant in 2012:</b> Viance LLC (Charlotte, NC) <ul style="list-style-type: none"> <li>ACQ 2102 Wood Preservative Concentrate</li> </ul> Timber Specialties Co.(Buffalo, NY) <ul style="list-style-type: none"> <li>NW 100 Wood Preservative Concentrate</li> </ul>	
Transportation and storage information		
<b>Shipping state:</b> Liquid concentrate <b>Concentration:</b> 12–26% by weight <b>Classification:</b> Poisonous; corrosive oxidizer <b>Storage temperature:</b> Ambient and dry <b>Inert atmosphere:</b> No requirement <b>Venting:</b> Need good ventilation	<b>Containers/materials:</b> Plastic, polylined or stainless steel Mild steel for solutions <b>Hoses/materials:</b> Use PVC, rubber, polyethylene or stainless steel fittings only	<b>Placards:</b> <i>Check with Transport Canada</i>  <b>Delivery format:</b> tank truck or totes
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1atm) <b>Solubility:</b> Freely soluble (water) <b>pH:</b> 9.9 (15°C) <b>Vapour pressure:</b> Non-volatile <b>Active ingredients:</b> Copper ethanolamine, ADBAC Boric Acid may be present at various concentration – <i>Corrosion control, not as active ingredient</i>	<b>Concentration of work solutions:</b> 0.5–3.4% by weight in water <b>Floatability:</b> Dissolves readily in water <b>Freezing point:</b> -5°C <b>Flash point:</b> Not flammable <b>Explosive limits:</b> Not explosive or flammable	<b>Specific gravity:</b> 1.2 (15°C) <b>Colour:</b> Dark blue <b>Odour:</b> Sharp, characteristic ammonia or amine smell <b>Typical preservative retention in treated wood:</b> ACQ-C: 4–6.4 kg/m <sup>3</sup>
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Not combustible; common extinguishing agents (water, foam, halon, carbon dioxide and dry chemical extinguishing materials) can be used with fires involving ACQ solutions. <i>Fire behaviour:</i> This product is an irritant, is potentially corrosive, and presents a contact hazard to firefighters. May decompose in a fire to produce copper compounds, ammonia and nitrogen oxides. <i>Ignition temperature:</i> Not combustible <i>Burning rate:</i> Not applicable	<b>Reactivity</b> <i>With water:</i> No reaction, soluble <i>With common materials:</i> Copper, tin, aluminium and zinc alloys are readily corroded. Avoid contact with strong acids.  <b>Stability</b> Stable	



**Table 2.1. Physical and Chemical Properties of ACQ Solution TYPE A & D**  
**Part 1 – Copper Ethanolamine Complex**

Identification		
<b>Common synonyms:</b> Copper ethanolamine complex, CuO, Copper (II) 2-aminoethanolate Copper bis.	<b>Registrant in 2012:</b> Viance LLC (Charlotte, NC) <ul style="list-style-type: none"><li>ACQ-C2 EU Component for Wood Preservative ACQ</li></ul> Timber Specialties Co. (Buffalo, NY) <ul style="list-style-type: none"><li>NW 100-C Wood Preservative Concentrate</li></ul>	
<b>Chemical Abstracts Service Registry Number (CAS RN):</b> <ul style="list-style-type: none"><li>10465-36</li></ul>		
Transportation and storage information		
<b>Shipping state:</b> Liquid concentrate <b>Concentration:</b> Copper as mixed copper ethanolamine complexes = 9-28% by weight <b>Classification:</b> Poisonous; corrosive <b>Storage temperature:</b> Ambient and dry. Do not store concentrate near heat or open flame.	<b>Inert atmosphere:</b> No requirement <b>Venting:</b> Need good ventilation <b>Containers/materials:</b> Plastic, poly-lined or stainless steel Mild steel for solutions <b>Hoses/materials:</b> Use PVC, rubber, polyethylene or stainless steel fittings only	<b>Placards:</b> <i>Check with Transport Canada</i>  <b>Delivery format:</b> , tank truck or totes
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1atm) <b>Solubility:</b> Freely soluble (water) <b>Vapour pressure:</b> NA <b>Active ingredients:</b> CuO Other ingredients: Ethanolamine, Boric Acid may be present at various concentration – <i>Corrosion control, not as active ingredient</i>	<b>Concentration of work solutions:</b> 0.5–3.4% by weight in water at a ratio of 2 CuO : 1 quat <b>Floatability:</b> Dissolves readily in water <b>Melting point:</b> NA <b>Flash point:</b> NA <b>Explosive limits:</b> Not explosive <b>Vapour density:</b> > 1	<b>Specific gravity:</b> approx 1.22 (25°C) <b>Colour:</b> light blue <b>Odour:</b> Faint ammonia-like odour <b>Typical preservative retention in treated wood:</b> ACQ-D: 4–6.4 kg/m <sup>3</sup>
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Flammable (not a fire hazard); common extinguishing agents (water, foam, halon, carbon dioxide and dry chemical extinguishing materials) can be used with fires involving ethanolamine solutions. <i>Fire behaviour:</i> May decompose and produce irritating vapours and toxic gases.	<b>Reactivity</b> <i>With water:</i> No reaction, soluble, hygroscopic <i>With common materials:</i> Reacts with strong oxidizing agents, strong acids and alkalies. Incompatible with water-reactive materials. Liquid ethanolamine will attack some forms of plastic, rubber and coatings. <b>Stability</b> Stable	

**Table 2.2. Physical and Chemical Properties of ACQ Solution TYPE A & D**  
**Part 2 – Didecyl dimethyl ammonium chloride/carbonate/bicarbonate**

Identification		
<b>Common synonyms:</b> Quaternary ammonium; Didecyl dimethyl ammonium carbonate and Didecyl dimethyl ammonium bicarbonate (DDACB) Didecyl dimethyl ammonium chloride (DDAC)		<b>Registrant in 2012:</b> Viance LLC (Charlotte, NC) <ul style="list-style-type: none"> <li>Q50-C Heavy-duty Wood Preservative Concentrate</li> </ul> Lonza Inc. (Allendale, NJ, USA) <ul style="list-style-type: none"> <li>CARBOQUAT WP-50 Wood Preservative Concentrate</li> </ul> Timber Specialties <ul style="list-style-type: none"> <li>DAC-QM Wood Preservative Concentrate</li> </ul>
<b>Chemical Abstracts Service Registry Number (CAS RN):</b> DDA carbonate: 148788-55-0 [C <sub>22</sub> H <sub>48</sub> N] <sub>2</sub> CO <sub>3</sub> DDA bicarbonate: 148812-65-1 [C <sub>22</sub> H <sub>48</sub> N] <sub>1</sub> HCO <sub>3</sub> DDA Chloride: 7173-51-5 [C <sub>22</sub> H <sub>48</sub> ClN]		
Transportation and storage information		
<b>Shipping state:</b> Liquid concentrate, 20 L bulk <b>Concentration:</b> Didecyl dimethyl ammonium carbonate and bicarbonate salts = 43% - 50% by weight <b>Classification:</b> Poisonous; corrosive <b>Storage temperature:</b> Ambient and dry	<b>Inert atmosphere:</b> No requirement <b>Venting:</b> Need good ventilation <b>Containers/materials:</b> Plastic, poly-lined or stainless steel Mild steel for solutions <b>Hoses/materials:</b> Use PVC, rubber, polyethylene or stainless steel fittings only	<b>Placards:</b> <i>Check with Transport Canada</i> <b>Delivery format:</b> tank truck or totes
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1atm) <b>Solubility:</b> Freely soluble (water) <b>pH:</b> 10.46–10.80 at 10% active in water at 25°C <b>Active ingredients:</b> DDACB <b>Concentration of work solutions:</b> 0.5–3.4% by weight in water at a ratio of 2 CuO:1 quat	<b>Floatability:</b> Dissolves readily in water <b>Freezing point:</b> Near 0°C <b>Flash point:</b> NA <b>Explosive limits:</b> Not explosive <b>Specific gravity:</b> 0.962 @25°C	<b>Colour:</b> Clear yellow liquid to colourless <b>Odour:</b> Faint alcoholic amine <b>Typical preservative retention in treated wood:</b> ACQ-D: 4–6.4 kg/m <sup>3</sup>
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> Not flammable; common extinguishing agents (water, foam, halon, carbon dioxide and dry chemical extinguishing materials) can be used with fires involving ACQ solutions. <i>Fire behaviour:</i> May decompose and produce irritating vapours and toxic gases.		<b>Reactivity</b> <i>With water:</i> No reaction, soluble, hygroscopic <i>With common materials:</i> Reacts with strong oxidizing agents, strong acids and materials that are incompatible with water. <b>Stability:</b> Stable

## 3 Environmental Effects

### 3.1 Aquatic Toxicity

In considering the aquatic toxicity of ACQ, the following points should be borne in mind:

- The toxicity of the concentrates and working solutions should be considered since they are all handled at ACQ facilities.
- The valence of copper may change in the environment, and these changes may reduce or enhance copper's toxicity. No studies have been reported in the literature on valence inter-conversion of copper in soils, groundwater or surface runoff waters at or from wood preserving facilities. Nonetheless, it is known that reduced forms of copper rarely occur in aqueous environments (11).

#### *Copper:*

There is no acute aquatic ecotoxicity data available for this Copper Ethanolamine Complex but Copper is the component of this substance that imparts the pesticidal activity and is, therefore, the component of interest for a review of environmental fate and toxicity.

Several processes influence the fate of copper in the aqueous environment. These include complex formation, sorption to hydrous metal oxides, clays and organic materials, and bioaccumulation. Information on the physicochemical forms of copper (speciation) is more informative than total copper concentrations. Much of the copper discharged to water is in particulate form and tends to settle out, precipitate out or be adsorbed by organic matter, hydrous iron, manganese oxides and clay in the sediment or water column. In the aquatic environment the concentration of copper and its bioavailability depend on factors such as water hardness and alkalinity, ionic strength, pH and redox potential, complexing ligands, suspended particulate matter and carbon, and the interaction between sediments and water (12).

*ADBAC: (n-Alkyl (67% C<sub>12</sub>, 25% C<sub>14</sub>, 7% C<sub>16</sub>, 1% C<sub>18</sub>) dimethyl benzyl ammonium chloride)*

USEPA Reregistration Eligibility Decision categorized ADBAC as highly toxic to fish (LC<sub>50</sub> = 280 µg ai/L) and very highly toxic to aquatic invertebrates (LC<sub>50</sub> = 5.9 µg ai/L) on an acute exposure basis. Chronic effects were seen in fish at a concentration of 32.2 µg ai/L and a no observable adverse effect concentration of 4.15 µg ai/L was established for aquatic invertebrates.

The ADBAC component of ACQ-C is hydrolytically stable under abiotic and buffered conditions over the pH 5–9 range. However, based on a biodegradation study, the U.S. Environmental Protection Agency (USEPA) concluded that ADBAC readily degrades into 60% carbon dioxide in 13 days. The soil mobility study indicated that ADBAC is immobile in soil. ADBAC was not expected to pose a concern for bioconcentration in aquatic organisms (10)

*DDACB/DDAC: (didecyl dimethyl ammonium chloride / carbonate / bicarbonate)*

Didecyl dimethyl ammonium chloride (DDAC) is the representative of the group of quaternary ammonium compounds, and hazard data generated for DDAC are considered to be representative of the hazards associated with all chemicals assigned to this class of quaternary ammonium chemicals (7).

DDAC-based pesticides are persistent in soil and water/sediment systems. It is stable to hydrolysis, phototransformation and biotransformation and does not form any major transformation products in the environment. It strongly binds to soils; therefore, it has a low potential to leach into groundwater and contaminate it.

As DDACB-based pesticides partition into sediment, bind strongly and are persistent, they have a high potential to pose a risk to sediment-dwelling organisms. If surface runoff water from stacked treated wood in open lumber yards and effluents from treatment plants enter into aquatic systems, they will pose a risk to aquatic organisms (13).

Because DDAC is immobile in soil and is not subject to runoff contamination of water bodies, bioaccumulation of DDAC in freshwater fish or aquatic organisms is not likely to occur. Information on the aqueous availability of DDAC from wood indicates that the use of DDAC as a preservative may result in minimal releases to the environment (6).

In British Columbia, where DDAC is used in antisapstain formulations, provincial regulations state that the concentration of DDAC in effluent shall not exceed 700 µg/L (14).

#### *Boron:*

Boric Acid may be present at various concentrations in ACQ solution. The boric acid is added as a corrosion inhibitor and not as an active ingredient which is why it is generally present in low concentration.

Boron's effects on aquatic plants are highly species-specific (15). Borate, like silicate, is an essential micronutrient for the growth of aquatic plants. Boron, under conditions of excess, alleviates nutrient deficiency in some phytoplankters and may cause temporal variations of phytoplankton composition in coastal waters (15). Phytoplankton can tolerate up to 10 mg inorganic B/L in the absence of stress from pH adversity and nutrient deficiency, although higher borate concentrations up to 100 mg/L are expected to cause species redistribution by favoring the growth of some species and suppressing that of others (16). Boron has been shown to accumulate in aquatic plants, which may be evidence for its importance in plant nutrition. Despite a tendency to accumulate in plants and algae, boron does not appear to biomagnify through the food chain (17).

Juvenile Pacific oysters (*Crassostrea gigas*) accumulated boron in relation to availability, but showed no prolonged retention following cessation of exposure. At current industrial discharge levels of about 1.0 mg B/L, no hazard is clear to oysters and aquatic vertebrates (18).

The most sensitive aquatic vertebrates tested for which data are available were coho salmon (*Oncorhynchus kisutch*), with a median lethal concentration (LC<sub>50</sub>) value of 12 mg B/L in seawater (16-day exposure), and sockeye salmon (*O. nerka*), showing elevated tissue residues after exposure for 3 weeks in seawater containing 10 mg B/L.

Boron concentrations between 0.001 and 0.1 mg/L had little effect on survival of rainbow trout embryos after exposure for 28 days. These low levels may represent a reduction in reproductive potential of rainbow trout, and > 0.2 mg B/L may impair survival of other fish species, according to Birge and Black (19); however, additional data are needed to verify these speculations. Birge and Black reported that concentrations of 100–300 mg B/L killed all species of aquatic vertebrates tested; that embryonic mortality and teratogenesis were greater in hard water than in soft water, but that larval mortality of fish and amphibians was higher in soft water than in hard water; and that boron compounds were more toxic to embryos and larvae than to adults (20).

Canadian guidelines on maximum concentrations for ACQ solution and ethanolamine in aquatic environments have not been established, but guidelines do exist for DDACB, ammonia and copper as listed in Table 3. However, as these limits are subject to change from time to time, periodic reviews of the limits and guidelines are recommended.

The guidelines and limitations for copper noted in Table 3 are based on total concentrations, reflecting the recommendations of many scientific reviews that indicate that the current state of knowledge does not enable water quality limitations to be based on either valence state or dissolved fractions in water (21).

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for Ammonia, Copper and Quat in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Ammonia	Maximum: 0.5 mg/L	Protection of human health	International Joint Commission <sup>(a)</sup>
	Maximum: 0.02 mg/L	Protection of aquatic life	Health Canada <sup>(b, c)</sup>
	No numerical guidelines (under review)		
	Fresh water: 0.019 mg/L	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>
DDACB	Fresh water: 0.0015 mg/L Marine: <i>Insufficient data</i>	Protection of aquatic life	CCME <sup>(d)</sup>
Copper	Maximum: 0.005 mg/L	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
	Aesthetic objectives: < 1.0 mg/L	Protection of human health	Health Canada <sup>(b, c)</sup>
	<ul style="list-style-type: none"> <li>0.002 mg/L Hardness 0-60 mg/L as CaCO<sub>3</sub></li> <li>0.003 mg/L Hardness 60-120 mg/L as CaCO<sub>3</sub></li> <li>0.004 mg/L Hardness 120-180 mg/L as CaCO<sub>3</sub></li> <li>0.006 mg/L Hardness &gt; 180 mg/L as CaCO<sub>3</sub></li> </ul>	Protection of aquatic life	CCME <sup>(d)</sup>
Boron	Not determined	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
	Interim maximum acceptable concentrations: 5 mg/L	Protection of human health: Guidelines for Canadian Drinking Water Quality	Health Canada <sup>(b, c)</sup>
	Maximum: 2.4 mg/L	Protection of human health: Drinking water quality guidelines	World Health Organization (WHO) <sup>(e)</sup>
	Freshwater <ul style="list-style-type: none"> <li>Short term 29 mg/L</li> <li>Long term 1.5 mg/L</li> </ul>	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>
	Marine <ul style="list-style-type: none"> <li>No recommended guideline</li> </ul>		
	Irrigation <ul style="list-style-type: none"> <li>Variable upon crops</li> </ul>	Protection of agriculture	CCME <sup>(d)</sup>
	Livestock <ul style="list-style-type: none"> <li>5 mg/L</li> </ul>		

(a) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).

o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)

o <http://www.ijc.org/rel/agree/quality.html>

(b) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.

o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>

(c) "Maximum acceptable" was defined by Health and Welfare Canada as "drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable." "Objective" is defined by Health and Welfare Canada as: "this level is interpreted as the ultimate quality goal for both health and aesthetic purposes."

(d) Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life.

- <http://st-ts.ccme.ca/>
- (e) Guidelines for Drinking-water Quality, Fourth Edition, © World Health Organization 2011. ISBN 978 92 4 154815 1. Table 8.8, Guideline values for naturally occurring chemicals that are of health significance in drinking water, p. 178.
  - [http://www.who.int/water\\_sanitation\\_health/dwq/guidelines/en/](http://www.who.int/water_sanitation_health/dwq/guidelines/en/)

### **3.2 Air Pollution**

Airborne pollution from ACQ facilities can have significant levels of ammonia and/or ethanolamine emissions. Air emission levels should be monitored, and appropriate control devices such as scrubbers can be employed where necessary to meet air emission regulatory limits.

### **3.3 Soil Contamination**

In the terrestrial environment a number of factors influence the fate of copper in soil, including: the nature of the soil itself, pH, presence of oxides, redox potential, charged surfaces, organic matter and cation exchange. Most copper deposited in soil is strongly adsorbed. Bioaccumulation of copper from the environment occurs if the copper is biologically available. Accumulation factors vary greatly between different organisms, but tend to be higher at lower exposure concentrations. Accumulation may lead to exceptionally high body burdens in certain animals (such as bivalves) and terrestrial plants (such as those growing on contaminated soils). However, many organisms are capable of regulating their body copper concentration (12).

Copper is an essential element required for good health and proper functioning of biological processes in plants and animals. Copper overexposure and deficiency can both have serious adverse effects (22).

## 4 Human Health Concerns

Ammonia and copper are found naturally in food, water and air. Table 4.0 provides estimated daily intakes of these elements by the general population (23).

One safety objective of the industrial use of any chemical (in this case ammoniacal copper, amine copper or quat) is to minimize worker exposure, ideally so that natural intake levels are not exceeded. If safeguards are not provided or are not implemented, a variety of human health effects can occur depending on the duration and manner of exposure, the concentration of the chemical, the form of the chemical (valence), and the varying metabolic sensitivities of individual workers.

The data in Tables 4.0–4.3 outline the possible human health effects that may result from exposure to ACQ and its components.

The American Conference of Governmental Industrial Hygienists (ACGIH) does not provide a recommended limit for ACQ, as such. For skin and eye contact with individual components of ACQ, the ACGIH provides the following comments (24):

- A threshold limit value (TLV) of  $18 \text{ mg/m}^3$  (25 ppm) ammonia has been selected to protect against irritation to eyes and the respiratory tract and to minimize discomfort in unaccustomed workers. A short-term exposure limit of  $24 \text{ mg/m}^3$  (35 ppm) is suggested.
- A TLV of  $7.5 \text{ mg/m}^3$  (3 ppm) ethanolamine has been selected to protect against irritation to eyes and the respiratory tract. A short-term exposure limit of  $15 \text{ mg/m}^3$  (6 ppm) is suggested.
- A TLV of  $1 \text{ mg/m}^3$  (inhalable particulates) for copper has been established, and is based on inhalation.
- Adequate skin, inhalation and eye protection is required during handling of quat. A TLV for quat has not been established.

Table 4, which is based on information from existing literature, outlines the spectrum of human health effects that could result from various degrees of exposure to ACQ, to amine copper concentrate, to quaternary ammonium concentrate and to ammonium hydroxide concentrate.



**Table 4.0. Potential Health Effects of Exposure to ACQ-C or ACQ-D Solutions**

Exposure category (Route of Entry)	Type of exposure	Possible health effect	
		Short-term exposure	Longer-term exposure
Estimated daily intake from various sources (air, water, food) with limited to no health effect <sup>(a)</sup>			
Ammonia (mostly through food)	18.6 mg/day		
Copper oxide (an essential element)	2.47 mg/day		
Boron (food being the principal source)	1 to 4 mg/day		
Eye contact <sup>(b,c,d,e,f, g,h,i)</sup>	Direct contact	<ul style="list-style-type: none"><li>• Irritation</li><li>• Reddening</li><li>• Pain</li><li>• Blurred vision</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• May cause blindness</li></ul>
Skin contact <sup>(b,c,d,e,f, g,h,i)</sup>	Skin contact with work solutions or concentrates	<ul style="list-style-type: none"><li>• Skin irritation</li><li>• Reddening</li></ul>	<ul style="list-style-type: none"><li>• Ulceration</li><li>• Chemical burns, dermatitis</li></ul>
Exposure to airborne contaminant or dust Inhalation <sup>(b,c,d,e,f, g,h,i)</sup>	Inhalation of vapours	<ul style="list-style-type: none"><li>• Corrosive irritation or burns to nose, throat and lungs; coughing; difficulty breathing; central nervous system effects</li></ul>	<ul style="list-style-type: none"><li>• Chemical pneumonitis, pulmonary edema, liver and kidney disorders, death</li></ul>
ACGIH threshold limit value-time weighted averages (TWAs) <sup>(c,d)</sup>	Ammonia: <ul style="list-style-type: none"><li>• 18 mg/m<sup>3</sup> (25 ppm) air</li><li>• TLV<sup>(c)</sup>-short-term exposure limit (STEL: 24mg/m3 (35 ppm)</li></ul> Copper: 1 mg/m <sup>3</sup> air  Ethanolamine 7.5 mg/m <sup>3</sup> air (3 ppm)  Quat: Not established  Boron: PEL is 15 mg/m <sup>3</sup> respirable dust. <ul style="list-style-type: none"><li>• Borate compounds, inorganic: TLV TWA 2 mg/m3 (l) = inhalable fraction</li><li>• Boron oxide: TLV TWA 10 mg/m3</li></ul>		
Ingestion <sup>(b,c,d,e,f, g,h,i)</sup>	Ingestion of work solution or concentrates	Irritation and burns of the mouth, throat, esophagus, and digestive system; gastric distress; vomiting	May be fatal

**Table 4.1. Potential Health Effects of Exposure to Amine Copper Concentrate (Part 1)**

Exposure category	Type of exposure	Possible health effect	
		Short-term exposure	Longer-term exposure
Eye contact <sup>(b,c,d,e,f, g,h,i)</sup>	Direct contact	<ul style="list-style-type: none"> <li>• Irritation</li> <li>• Reddening</li> <li>• Pain</li> <li>• Blurred vision</li> </ul>	<ul style="list-style-type: none"> <li>• Ulceration</li> <li>• May cause blindness</li> </ul>
Skin contact <sup>(b,c,d,e,f, g)</sup>	Skin contact with work solutions or concentrates	<ul style="list-style-type: none"> <li>• Skin irritation</li> <li>• Reddening</li> </ul>	<ul style="list-style-type: none"> <li>• Ulceration, chemical burns, dermatitis</li> </ul>
Exposure to airborne contaminant or dust  Inhalation exposure to contaminated aerosols <sup>(b,c,d,e,f, gi)</sup>	Inhalation of vapours	Corrosive irritation or burns to nose, throat and lung;,, wheezing; difficulty breathing; visual disturbances	Liver and kidney disorders, adverse lung effects, pulmonary edema, death
Ingestion <sup>(b,c,d,e,f, g)</sup>	Ingestion of work solution or concentrates	Irritation and burns of the mouth, throat, esophagus and digestive system	May be fatal

**Table 4.2. Potential Health Effects of Exposure to Quaternary Ammonium Concentrate (Part 2)**

Exposure category	Type of exposure	Possible health effect	
		Short-term exposure	Longer-term exposure
Eye contact <sup>(b,c,d,e,f, g)</sup>	Direct contact	<ul style="list-style-type: none"> <li>• Irritation</li> <li>• Reddening</li> <li>• Watering</li> <li>• Blurred vision</li> </ul>	<ul style="list-style-type: none"> <li>• Ulceration</li> <li>• May cause blindness</li> </ul>
Skin contact <sup>(b,c,d,e,f, g)</sup>	Skin contact with work solutions or concentrates	<ul style="list-style-type: none"> <li>• Skin irritation</li> <li>• Redness</li> <li>• Itching</li> </ul>	<ul style="list-style-type: none"> <li>• Ulceration, chemical burns, dermatitis</li> </ul>
Exposure to airborne contaminant or dust  Inhalation <sup>(b,c,d,e,f, g)</sup>	Inhalation of vapours	Respiratory irritation, dizziness, central nervous system effects	Potentially fatal lung damage, chemical pneumonitis
Ingestion <sup>(b,c,d,e,f, g)</sup>	Ingestion of work solution or concentrates	Gastric distress, nausea, vomiting, diarrhea	Ingestion exposure may be fatal

**Table 4.3. Potential Health Effects of Exposure to Ammonium Hydroxide**

Exposure category	Type of exposure	Possible health effects <sup>(a,b,c,d,e)</sup>	
		Short-term exposure	Longer-term exposure
Eye contact <sup>(b)</sup>	Eye contact is very dangerous with 28% solutions	<ul style="list-style-type: none"> <li>• Cornea can be perforated</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>• Single contact</li> <li>• Contact of several minutes with 28% solutions</li> </ul>	<ul style="list-style-type: none"> <li>• Skin irritation</li> <li>• Can cause corrosive damage</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>
Exposure to vapour, to airborne contaminant or dust  N.B. Evaporation of the substance at 20°C	Inhalation of vapours TLV <sup>(c)</sup> -time weighted averages (TWA): 18 mg/m <sup>3</sup> air (25 ppm) TLV <sup>(c)</sup> -short-term exposure limit (STEL): 24 mg/m <sup>3</sup> (35 ppm)	<ul style="list-style-type: none"> <li>• Severe irritation of nose and throat at 400 ppm Irritation of eyes at 700 ppm</li> <li>• At high concentration: laryngeal oedema, inflammation of the respiratory tract and pneumonia<sup>(b)</sup></li> <li>• An MRL of 1.7 ppm has been derived for acute-duration inhalation exposure (≤14 days).</li> <li>• No MRL was derived for intermediate duration (15–364 days).</li> </ul> <p><i>Coughing and sneezing occur almost immediately after excessive inhalation of ammonia fumes.</i></p>	<p>Minimal Risk Levels (MRLs) (as NH<sub>3</sub>)<sup>(d)</sup></p> <ul style="list-style-type: none"> <li>• An MRL of 0.2 ppm has been derived for chronic-duration inhalation exposure (≥1 year).</li> </ul>
		<ul style="list-style-type: none"> <li>• Convulsive coughing at 1720 ppm May be fatal after 0.5-hour exposure</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>
		<ul style="list-style-type: none"> <li>• Respiratory spasm and asphyxia at 5000 to 10 000 ppm Rapidly fatal for exposure causing these symptoms</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>
Ingestion	Ingestion of work solutions or concentrates	<ul style="list-style-type: none"> <li>• Nausea, abdominal pain, vomiting, shock, coma</li> <li>• Death may occur from ingestion of more than 30 mL (1 oz.) of 25% solution</li> </ul>	<ul style="list-style-type: none"> <li>• Not applicable</li> </ul>

a) Health Canada / Water Quality - Reports and Publications / Chemical/Physical Parameters

- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/copper-cuivre/index-eng.php>

b) Agency for Toxic Substances and Disease Registry (ATSDR)

- <http://www.atsdr.cdc.gov/substances/index.asp>

- c) American Conference of Governmental Industrial Hygienists (ACGIH):
  - <http://www.acgih.org/tlv/>
- d) Occupational Safety & Health Administration (OSHA) Permissible Exposure Limits (PELs)
  - <http://www.osha.gov/dsg/topics/pel/index.html>
- e) Health Canada, Pest Management Regulatory Agency, Re-evaluation Decision RVD2009-07, Didecyl dimethyl ammonium chloride cluster (DDAC), 26 March 2009, ISBN: 978-1-100-12110-9 (978-1-100-12111-6)
  - <http://www.hc-sc.gc.ca/cps-spc/pubs/pest/decisions/rvd2009-07/index-eng.php>
- f) U.S. Environmental Protection Agency (USEPA), Didecyl dimethyl ammonium carbonate and Didecyl dimethyl ammonium bicarbonate (DDACB), Summary Document: Registration Review: Initial Docket EPA-HQ-OPP-2012-0651, September 2012
- g) U.S. Environmental Protection Agency (USEPA), MEMORANDUM, Product Chemistry, Environmental Fate, and Ecological Effects Scoping Document in Support of Registration Review of Didecyl dimethyl ammonium carbonate (DDA Carbonate) and Didecyl dimethyl ammonium bicarbonate (DDA Bicarbonate), September 13, 2012
- h) U.S. Environmental Protection Agency (USEPA), Reregistration Eligibility Decision for Alkyl dimethyl benzyl ammonium chloride (ADBAC), EPA739-R-06-009, August 2006
- i) Health Canada, Pest Management Regulatory Agency, Proposed Re-evaluation Decision: Alkyl dimethyl benzyl ammonium chloride cluster (ADBAC), 26 June 2008, ISBN: 978-1-100-10055-5 (978-1-100-10056-2)
  - <http://www.hc-sc.gc.ca/cps-spc/pest/part/consultations/prvd2008-23/index-eng.php#enviroconsid>

## **5 Description of Preservative Application and Potential Chemical Discharges**

### **5.1 Description of Process**

ACQ preservatives, whether amine or ammonia versions, are water-based products that are applied by pressure treatment in essentially the same manner as chromated copper arsenate (CCA) (refer to Part 1 – General Background Information, Section 2.2.3 [Figure 3](#)).

ACQ-A (amine version) is prepared on-site at wood preservation facilities from concentrates and water to form a working strength solution of 0.5–3.4% actives (copper plus quat). The main differences between ACQ-A and the other ACQ types is that the quat is DDA-chloride, and is present in a 1:1 copper:quat ratio within the treatment solution.

ACQ-C (ammonia version) is prepared on-site at wood preservation facilities from concentrates and water to form a working strength solution of 0.5–3.4% actives (copper plus quat).

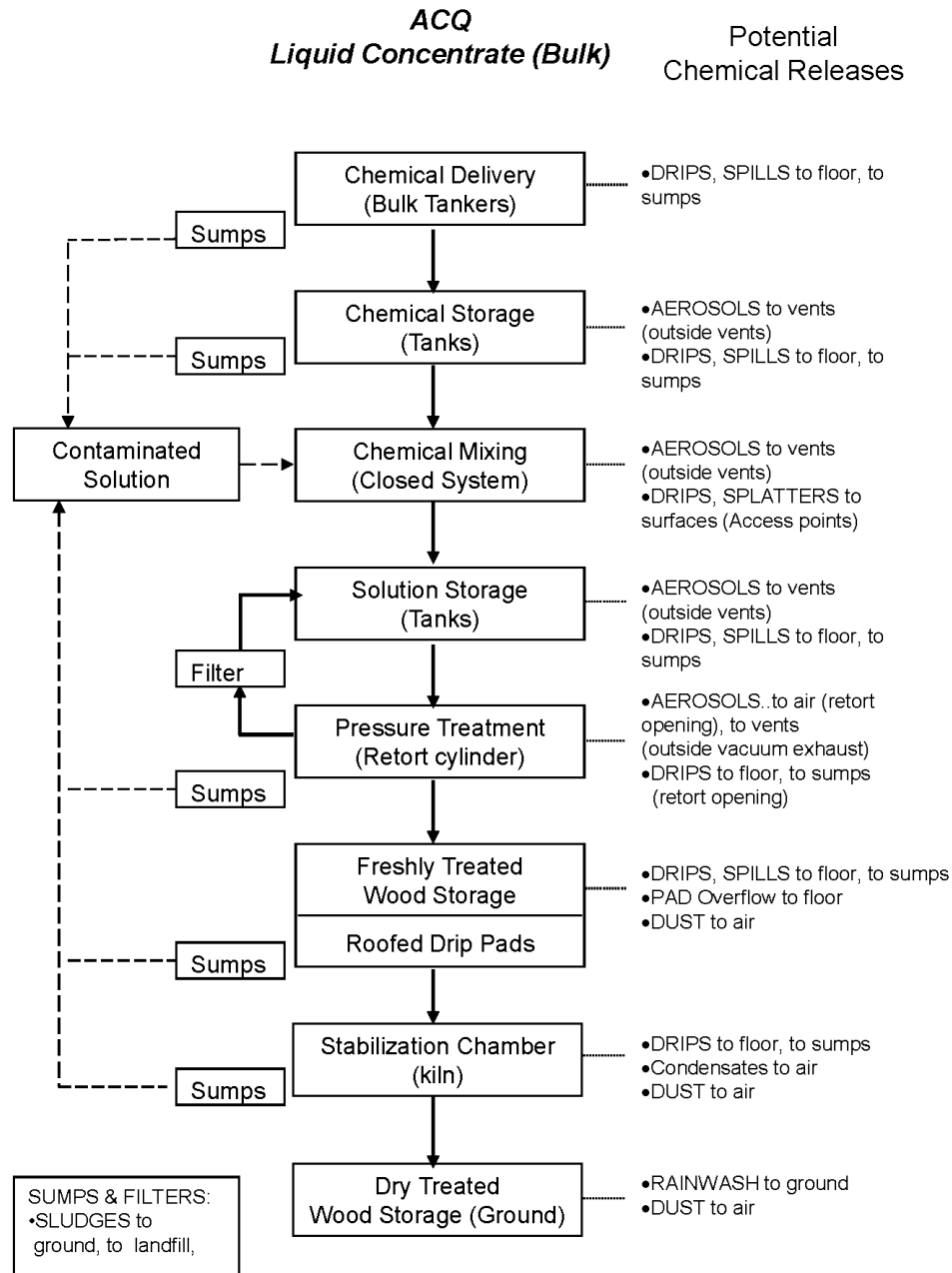
ACQ-D (amine version) is shipped as two premixed solutions that are then mixed together at the facility. It is prepared by adding a known quantity of amine copper to a measured amount of water in a mix tank to form a working strength solution of 0.5 to 5.0% actives (copper plus quat). The strength of the working solution is determined by the amount of preservative to be retained in the wood. When using recuperated water in the working solution, ethanolamine can be used for makeup to adjust mixture concentration. The working solution is applied to wood that has been loaded into pressure cylinders varying in size depending on the wood products being treated.

The specific treatment times and pressures are dictated by the species of wood, the wood product and the moisture content of the wood. A predetermined range of process parameters is defined by the applicable treatment standards of the CSA-O80 Series of Standards (5). Good practice, after the impregnation cycle, includes a prolonged vacuum to remove ammonia. Ammonia loss causes precipitation of the active ingredients in the wood.

### **5.2 Potential Chemical Releases**

The potential sources and releases from plants using ACQ are illustrated in Figure 1. Based on the plant design and operational practices, various potential emission sources exist that may affect the environment and/or worker health.

**Figure 1 Potential Releases from ACQ Pressure Treating Plants**



### *Liquid Discharges*

The ACQ process uses water-borne ingredients and can be operated as a “closed system.” Once dripping has ceased and a minimum of 48 hours has passed, freshly treated lumber should be wrapped prior to storage in the yard or under sheds. If incidental drippage occurs, the lumber must be returned immediately to the drip pad area until all dripping has been confirmed to have stopped. Immediate cleanup of the drippage should be initiated to prevent any potential for causing stormwater contamination or tracking. Dripped solution or contaminated storm runoff water can be reused in the process. Primary facility design features that should be used for ACQ containment and recycling include the following:

- concrete containment surfaces and diking with a second barrier for major process areas, including the cylinder and tanks
- containment surfaces for chemical drips from treated wood on the cylinder discharging track and in the freshly treated drip pad
- a collection sump to receive residual preservative from the cylinder (following the treatment cycle) and the accumulated contaminated runoff from other containment surfaces. This material can then be reused in the treatment process following filtration to remove dust and debris.

Under normal operating practices in a properly designed facility there should be few contaminated liquid discharges. The most common potential sources of contaminated liquid discharges in an ACQ facility are stormwater runoff waters from unpaved and unroofed treated product storage areas. The quantities of preservative in these waters depend on many factors, including quantity of precipitation, stabilization method, elapsed stabilization time, temperature prior to a precipitation event, and soil characteristics of the storage yard. Uncontained liquid releases other than stormwater are generally confined to yard soils, particularly those locations near drip pads in charging/unloading areas and where containment surfaces are used for freshly treated wood. These contaminated yard soils, at high concentration, have potential for causing groundwater contamination.

### *Solid Wastes*

During normal operating conditions, solid waste generation at ACQ facilities should be small. See Chapter A, [Section 5.2](#) for more details.

### *Air Emissions*

The use of the ammonia formulation implies a significant potential for ammonia emissions at the ACQ facility if proper controls are not in place, and likewise with ethanolamine emissions when the amine formulation is used. Potential sources of release for either of these components include storage and mix tank vents, vacuum pump exhausts, vapours released when cylinder doors are opened, and freshly removed wood charges. Air emission levels should be monitored and appropriate controls such as exhaust extractors employed where necessary. Air emissions are generally intermittent and restricted to localized areas.

Concentrations of ACQ active components have generally been measured to be below occupational health limits. However, as was the case with ammoniacal copper arsenate (ACA) facilities, emissions of ammonia have the potential to be higher; dictating the use of a combination of process controls and personal protective equipment, specifically on mixing and in the immediate vicinity of cylinder doors during openings and vacuum exhausts (25). Refer to Part 1 – Chapter A, [Section 5.2](#) for more details on potential chemical discharges.

### **5.3 *Potential Effects of Chemical Discharges***

The actual impact on the environment of any chemical release depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the amount and concentration of preservative released, the frequency of releases, and contingency measures in place at the facility.

Improperly designed and/or operated facilities would have the potential to contaminate site soils and groundwater to levels that would prevent the use of such groundwater for drinking.



## 6 Protection of Personnel

### 6.1 *First Aid Precautions and Hygiene for ACQ Exposure*

Human health effects could occur as a result of improper controls during preparation of ACQ; exposure to minor spills and residues in working areas; and improper handling of, in particular, freshly treated products. When exposure to a chemical occurs, the severity and speed of damage to human health depends on the concentration. The general rule is as follows: **the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs.**

Facility staff should have access to product labels and appropriate training to apply first aid. Immediate response is required if a worker is exposed to ammonia copper, amine copper, quat or ACQ work solutions.

Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with ACQ solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

Table 5 outlines first aid measures for exposure to ACQ and its constituents.

**Table 5. First Aid Measures for Exposure to Ethanolamine and ACQ Solutions**

Exposure	First action	Second action
Eye contact	<ul style="list-style-type: none"> <li>• Hold eye open and rinse slowly and gently with water for 15–20 minutes.</li> <li>• Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.</li> </ul> <p><i>Workers should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>• Call a poison control centre or doctor immediately for treatment advice (have product label at hand).</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>• Take off contaminated clothing.</li> <li>• Rinse skin immediately with plenty of water for 15-20 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>• Call a poison control centre or doctor immediately for treatment advice (have product label at hand).</li> <li>• Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>• Immediately remove the exposed person to fresh air.</li> <li>• If breathing has stopped: <ul style="list-style-type: none"> <li>• Call emergency services (ex. 911)</li> <li>• Apply artificial respiration with barrier device</li> </ul> </li> </ul> <p><i>Coughing and sneezing occur almost immediately after excessive inhalation of ammonia fumes.</i></p>	<ul style="list-style-type: none"> <li>• Call a poison control centre or doctor immediately for treatment advice.</li> <li>• Keep the affected person warm and quiet.</li> <li>• Get immediate medical attention.</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>• Call a poison control centre or doctor immediately for treatment advice (have product label at hand).</li> </ul>	<ul style="list-style-type: none"> <li>• Have person sip a glass of water if able to swallow.</li> <li>• Do not induce vomiting unless told to do so by a poison control centre or doctor.</li> </ul> <p>Do not give anything by mouth to an unconscious person.</p>

\* First aid personnel should periodically verify up-to-date response measures with chemical suppliers and/or industrial physicians. Take the pesticide label or product name and Pest Control Product Registration Number with you when seeking medical attention.

A summary of the first aid measures listed in Table 5 should be available on-site, preferably in the same location as the first aid material.

For all medical attention, always have the Pest Control Products label and the MSDS at your disposal so that you can properly inform health personnel.

Personnel should follow the recommendations from [Table 6 of Chapter A](#) outlining general precautions and personal hygiene measures.

## 6.2 Regulatory Controls

The label for pesticide products contains information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

**Specific limits for worker protection are generally prescribed by provincial regulations.** Consult your local authorities for specific applicable regulations.

Most regulatory criteria established by worker protection agencies are based on TLVs and BEIs recommended by the [American Conference of Governmental Industrial Hygienists \(ACGIH\)](#). The ACGIH does not provide a recommended limit for ACQ, as such. The ACGIH-recommended limits for individual components (ammonia, copper and ethanolamine) are summarized in Table 4.0 above.

### *Skin and Eye Contact*

In cases where ACGIH-recommended limits are based only upon “inhalation” as the route of exposure, these limits may not adequately take into account other routes of exposure.

### *Inhalation*

The ACGIH has defined TLVs for many substances based on exposure by inhalation and/or skin exposure. The ACGIH limits for copper, amine and ammonia are based solely on exposure by inhalation. The TLVs are stipulated by the ACGIH as those “airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects.” The TLVs for copper, ethanolamine and ammonia (24) are defined in Table 4.0, with the following provisos of the ACGIH:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentrations.”
- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

## Ingestion

Oral intake of ACQ must be avoided. Ingestion of liquids containing ACQ is unlikely if workers follow the safety precautions outlined in Table 8. Upper limits of ingestion are not prescribed by regulation, because it is generally expected that no such intake will occur. Reported fatal single dose levels for some components of ACQ include 30 ml of 25% ammonia solution (26); and 1.5-3.5 g of copper as copper<sup>+1</sup> (27).

### 6.3 Safety Precautions

Workers need to familiarize themselves with the following safety precautions in addition to those recommended in Chapter A, [Section 6.3](#). Sensitive individuals should take special care to avoid exposure.

**Table 8. Additional Safety Precautions for Personnel Working with ACQ**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 8.)

<b>Objective:</b> To ensure safe workplace practices for each activity during the treatment process	
<b>Activity</b>	<b>Recommendations</b>
<i>Facilities mixing their own solution:</i> Unloading drums	<ul style="list-style-type: none"><li>• Provide NIOSH-approved respirators with combination of acid gas/ammonia high-efficiency filter cartridges with a P100 prefilter (or breathing apparatus if working in an enclosed environment) for spill response.</li><li>• Provide adequate equipment for safe, controlled drum and bag handling.</li><li>• Do not drop drums or bags.</li></ul>
<i>Facilities mixing their own solution:</i> Preparing ACQ work solutions	<ul style="list-style-type: none"><li>• Wear NIOSH-approved respirators equipped with high-efficiency filter cartridges in combination for acid gas and ammonia with a P100 prefilter if air monitoring indicates potential exposure to fumes. e.g., TC23-C, TC14-G.</li></ul>
Cleaning cylinders or storage tanks	<ul style="list-style-type: none"><li>• <b>Personal protective equipment:</b> Wear NIOSH-approved respirators with combination of acid gas/ammonia high-efficiency filter cartridges with a P100 prefilter (or breathing apparatus if working in an enclosed environment).</li></ul>

### 6.4 Biological Monitoring of Exposed Workers

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#)

## 7 Design Recommendations

This section suggests approaches for the design of ACQ wood preservation facilities for protection of workers and the environment from harmful effects. The following additional recommendations based on “best practices” must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 7](#) and their corresponding tables. All tables of general content from Chapter A, Section 7 must be taken into consideration.

It should be noted that ammonia is highly corrosive to copper and zinc alloys; therefore, pipes, valves, etc. should be made of non-corrosive materials.

**Table 10. Additional Recommended Design Features for Chemical Delivery Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 10.)

Delivery format	Design feature	Recommendations
<b>Bulk liquids</b> (Bulk tank for premixed solution) (Aqua ammonia delivered by truck or rail tanker)	Emergency response	<ul style="list-style-type: none"><li>• Provide emergency ventilation for ammonia and/or amine vapour control (in enclosed spaces).</li></ul>

**Table 11. Additional Recommended Design Features for Chemical Storage Areas**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 11.)

Storage format	Design feature	Recommendations
<b>Bulk liquids</b> <ul style="list-style-type: none"><li>• Aqua ammonia</li><li>• Working solutions</li><li>• Contaminated surface runoff</li></ul>	Spill containment	<ul style="list-style-type: none"><li>• Provide water sprays and/or ventilation to control ammonia and/or amine vapours.</li></ul>
	Drip containment	<ul style="list-style-type: none"><li>• Provide adequate ventilation to control ammonia and/or amine vapours.</li></ul>
	Vapour control	<ul style="list-style-type: none"><li>• Install control equipment as required to comply with applicable air emission limits for ammonia and amine vapours.</li><li>• If wet scrubbers are used, they should be designed for recycling and reuse of scrubber fluid.</li></ul>

**Table 12. Additional Recommended Design Features for Chemical Mixing Systems**  
 (Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 12.)

Chemical form	Design feature	Recommendations
<ul style="list-style-type: none"> <li>• Aqua ammonia</li> <li>• Working solutions</li> <li>• Drip return</li> <li>• Contaminated surface runoff</li> </ul>	Location/shelter	<ul style="list-style-type: none"> <li>• Locate mixing and working solution tanks in an enclosed, heated area, particularly if sub-freezing temperatures are encountered during operation.</li> </ul>
	Spill prevention	<ul style="list-style-type: none"> <li>• Provide equipment to enable safe, controlled manipulation of ingredient drums and bags.</li> <li>• Provide equipment for transferring drum and bag contents with minimum worker contact and minimum spill potential.</li> </ul>
	Ventilation	<ul style="list-style-type: none"> <li>• Provide an efficient scrubbing system for the mix tank to minimize emissions.</li> <li>• If wet scrubbers are used, they should be designed for recycling and reuse of scrubber fluid.</li> </ul>
	Unloading drums or totes	<ul style="list-style-type: none"> <li>• Provide adequate equipment for safe, controlled handling of the containers.</li> </ul>

**Table 13. Additional Recommended Design Features for Treatment Process Systems**  
 (Use in conjunction with Part I, Chapter A - General Recommendations for All Wood Preservatives, Table 13.)

Design feature	Recommendations
Ventilation	<ul style="list-style-type: none"> <li>• Provide adequate routine and emergency ventilation to control ammonia and/or amine vapour levels in all work areas.</li> </ul>

## **8 Operational Recommendations**

The recommendations for good operating practice listed in this section must be used in conjunction with those in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8](#). The objectives are meant to protect both workers and the environment from harmful exposure to ACQ components and solutions.

### **8.1 Operational Standards**

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including ACQ-C and ACQ-D. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2-08 Clause 4.1 (referenced to AWWA M3). The calibration can be conducted by facility staff if they have the appropriate training.

All tables of general content from Chapter A, Section 8 must be taken into consideration.

### **8.2 Facility Wide Recommendations**

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### **8.3 Process Area -specific Recommendations**

Currently, knowledge of preservative stabilization and leachability of ACQ is based on operational observation and monitoring. Plants must take all necessary precautions to minimize charge drippage (e.g. charge tilting, extended vacuums, hot air purging of cylinder) and allow for at least 48 hours of storage at a minimum of 20°C on a roofed drip pad that allows stabilization of ACQ and recovery of all drip liquid. Only the use of an accelerated stabilization process at controlled humidity and temperature can shorten the 48-hour storage time. Treated wood should be wrapped prior to moving to any outside storage area.

**Table 22. Additional Recommended Operating Practices for Maintenance, Cleanout and Shutdown of Treatment Systems (ACQ Preservatives)**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 22.)

Operation	Recommendations
Equipment maintenance	<p><b>Objective:</b> To ensure that equipment is maintained in a manner that will minimize releases of preservative chemicals and minimize worker exposure to them and their by-products</p>
Alarms and safety devices	<p><b>Equipment:</b></p> <ul style="list-style-type: none"> <li>• <b>Valves</b> must be tested every 6 months and replaced as required.</li> <li>• Test <b>tank vents</b> at least once a year to ensure they are not blocked.</li> </ul> <p><b>Alarms:</b></p> <ul style="list-style-type: none"> <li>• <b>Off-loading area:</b> Test the manual alarm on a weekly basis and prior to the delivery of concentrate.</li> <li>• <b>Chemical storage area:</b> <ul style="list-style-type: none"> <li>○ The circuitry of the tank's high-level alarm and the 24-hour monitoring alarm should be tested weekly, and probes should be checked every 12 months.</li> <li>○ The function of all manual emergency alarms should be tested weekly.</li> <li>○ The containment high-level alarm should be tested every 6 months or within 6 months of a routine alarm sounding.</li> </ul> </li> <li>• <b>Chemical mixing systems:</b> <ul style="list-style-type: none"> <li>○ The circuitry of the high-level alarm should be tested weekly, and probes should be checked every 12 months.</li> </ul> </li> <li>• <b>Treatment process systems:</b> <ul style="list-style-type: none"> <li>○ The high-level alarms of the sumps should be tested weekly.</li> </ul> </li> </ul> <p><b>All test details should be recorded (documented).</b></p> <p><b>Prior to cleanout:</b></p> <ul style="list-style-type: none"> <li>• Thoroughly purge all ammonia vapours and provide effective ventilation.</li> </ul>



## **9 Waste, Process Emissions and Disposal**

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.1 Control, Treatment and Disposal**

Potential process emission sources at ACQ wood preservation facilities were described in Section 5.2, Figure 1. The main categories of process wastes and emissions that may be encountered at ACQ facilities, along with their recommended disposal methods, are presented in Chapter A, [Table 23](#).

### **9.2 Liquids Containing ACQ**

Liquid solutions containing ACQ, such as drips and washwaters, should be routinely collected and reused as makeup waters in preparing new treatment solutions. If unusual circumstances (such as prolonged plant shutdown) prevent on-site reuse, transport such solutions to another facility that uses ACQ. Disposal should be considered only as a last alternative.

### **9.3 Solids with High ACQ Concentrations**

For the purpose of this document, solids with high ACQ concentrations include sludge from sumps and cylinders, and disposable cartridge filters used to filter recycled waters. Recovery of the components (copper and quat) would be ideal, but this option is not commercially feasible in Canada at this time. The preferred means of disposal depends on the local or provincial jurisdiction that applies. It is the responsibility of the waste generator to obtain and comply with approvals required by the jurisdiction in which the facility is located.

Consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.4 Miscellaneous Solid Wastes**

Miscellaneous solid wastes (e.g. empty copper concentrate and quat drums, cuttings from ACQ-treated lumber) from ACQ wood preservation plants may be disposed of at designated sanitary landfills as approved by the provincial regulatory agency. The ingredient drums should be rinsed thoroughly (triple-rinsed) with water prior to disposal, and the rinse water should be used for the preparation of work solutions.

Do not use ACQ-treated wood as a compost or mulch.

Incineration of materials contaminated with ACQ is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products.

## **9.5 Air Emissions**

Air emissions at ACQ facilities are normally localized; effects, if any, would be confined within the boundaries of the facilities. Air emissions from ACQ facilities include vapours from the following:

- ammonia/copper or amine/copper storage tank vents
- ACQ mixing and storage tank vents
- vacuum pump discharges
- opening of retort cylinder doors
- freshly treated charges
- vapours from kiln-drying operations

Although information is not yet available for ACQ facilities, there have been studies on the preservative ammoniacal copper arsenate (ACA). Monitoring of mists (28) in the vicinity of several ACA retorts during cylinder door openings has shown arsenic and copper concentrations below published ACGIH threshold limit values (24). Ammonia emissions in the vicinity of ACA retort cylinder door openings and in the vicinity of freshly treated wood have been reported at concentrations above occupational health limits. For example, Todd and Timbie (25) measured airborne ammonia concentrations of up to 250 ppm within localized areas of one ACA facility. These concentrations were much higher than occupational health limits of 35 ppm for a 15-minute exposure and 25 ppm for an 8-hour exposure. Concern about ammonia releases and control measures at an ACA facility also has been expressed in an Environment Canada report (28).

## 10 Environmental and Workplace Monitoring

### 10.1 Baseline Environmental Evaluation

Ammonia and copper are found naturally in the environment. Amines are derived from ammonia and are not naturally occurring. Quaternary ammonium compounds (Quats) are synthetically produced and are not naturally occurring; all Quats found in the environment are therefore assumed to be from human-made sources. Typical background levels of naturally occurring ACQ constituents are listed in Table 24.

Considerable variation occurs in natural concentrations of copper and ammonia in soils and waters (22). Because ammonia concentrations may vary both spatially and temporally, it is important to determine background levels immediately prior to the operation of a facility, to enable meaningful future assessments of pollution control. Older mills may not have this information available. A comparative site from a nearby property can be used as a reference. The facility may use the template provided in [Table 24](#) from Chapter A.

**Table 24. Typical Background Levels of ACQ Constituents**

Component	Typical background levels in environment	
	Surface waters (mg/L)	Soils (mg/kg)
Copper (Cu)	< 0.001 to 0.04	2–100
Ammonia (NH <sub>3</sub> )	< 0.01	1–5 ppm (as NH <sub>4</sub> <sup>+</sup> )
Boron (B)	0.0001–2.58	2–100
	Typical boron concentrations are less than 0.1 mg/L	

### 10.2 Environmental Monitoring

Environmental monitoring requirements for an ACQ facility would normally be developed for soil, groundwater and surface water.

ACQ facilities have the potential to contaminate groundwater in the immediate vicinity of the facilities to levels that could potentially pose a risk to aquatic organisms. Stormwater runoff may contain at least one of the elements copper, DDAC, ADBAC or Boron at levels in excess of existing water quality limits. Additional monitoring studies (such as surface water discharges, groundwater and contaminated soil) are recommended to properly assess the degree of such releases.

### 10.3 Workplace Exposure Monitoring

Workplace monitoring generally falls under provincial jurisdiction. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## **11 Transportation of ACQ Components, Solutions and Wastes**

The transportation of ethanolamine, ACQ solutions and ACQ wastes is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details, please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of ACQ, its components and its wastes.

## 12 Environmental Emergency Notification and Contingency Planning

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using ACQ should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective. It is recommended that the individual facility plans be filed with the authorities that have jurisdiction over the facility.

### 12.1 Environmental Emergency Notification

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### 12.2 Spill Contingency Planning

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

The following recommendations apply to ACQ facilities if a spill of a solvent, liquid ingredient or ACQ solution occurs:

- Immediately put on appropriate NIOSH-approved respirators, (NIOSH-approved respirators should be equipped with high-efficiency filter cartridges in combination for acid gas and ammonia with a P100 prefilter).
- Always stay upwind to avoid potential exposure to fumes.
- For ammonia spills use water spray to knock down vapours.
- If tanks other than normal work tanks are used for salvage purposes, ensure compatibility of materials, i.e., do not use galvanized or aluminium tanks because of the corrosiveness of ammonia.

### 12.3 Fire Contingency Planning

Although the components and solutions of ACQ are not flammable, precautions should be taken in the event that a fire occurs. Gases could be released from the preservative materials if heated, and mixtures of ammonia and air in enclosed spaces with an ignition source could be explosive. The use of water blankets and water spray to suppress toxic gases and to keep oxidizable materials at temperatures below that for ignition are additional recommendations that could be considered.

Please refer to the *National Fire Code of Canada (always refer to last version available)* (29) and to [Section 12.3](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives. A copy of the fire contingency plan and all necessary documents should be stored in a fire proof box outside the entrance to the facility.

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## CHAPTER H

# Copper Azole (CA-B) Wood Preservation Facilities

### Preservative-specific Information and Recommendations

This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives

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# 1 Production and Use

Copper azole (CA-B) is a water-borne formulation that is delivered in concentrate form to wood preservation facilities. Copper azole was originally formulated in the mid 1980s in Europe to meet the demand of consumers requesting an alternative wood preservative. Variants of this formulation have been in commercial production in more than 20 countries worldwide. The CA-B used in North America is CA-B type B (1)

The CA-B preservative is shipped to wood preservation facilities as a premixed concentrated solution that is diluted to working strength by adding a known quantity of water in a mix tank. The preservative is shipped to wood preservation facilities as a concentrate by tanker truck or totes.

CA-B is suited for treatment of refractory wood species and for all commercially used species. Water-based preservatives like CA-B leave wood with a clean, paintable surface after they dry (2). Copper azole is for use in the pressure treatment of wood products for residential and commercial use. It is not currently registered for use in saltwater marine immersion applications.

CA-B and other preservatives such as chromated copper arsenate (CCA) are incompatible and could cause chemical problems if used in a single treatment system. It is therefore not recommended that CA-B be used in the same cylinder as other preservative systems, such as CCA, as an ongoing practice. CA-B solutions are basic in pH whereas CCA, for example, is acidic. If a switch from one preservative to another is unavoidable, the situation would dictate complete flushing of one preservative from the cylinder, piping and pumps, and all sumps and collection areas before introduction of the other preservative.

**Table 1. Overview of CA-B Use in Canada**

Feature	Characteristics
<b>Treated wood use limitations in Canada (3)</b>	<p>For industrial and non-industrial wood products for above-ground, ground, or freshwater contact, or for treatable wood products out of water but subject to saltwater splash in the following categories:</p> <p><b>Residential construction</b> such as decks, patios, fencing, play structures, siding, plywood and sill plates, as well as recreational applications such as walkways, boardwalks, landscaping, docks, gazebos and picnic tables</p> <p><b>General construction and commercial applications</b> such as dimensional lumber, structural timbers, posts and decking</p> <p><b>Agriculture and horticulture applications</b> such as fencing, framing and building poles</p> <p>Also used in highway construction and as lumber and timbers for bridges, bridge decking, hand rails, spacer blocks and posts</p> <p><b>Do not use to treat utility poles and pilings.</b></p> <p>*Note: permitted uses and limitations of CA-B-treated wood may change over time. Refer to pesticide label for up-to-date uses.</p>
<b>General process of application</b>	Pressure treatment (refer to the pesticide label for details)

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes CA-B treated products. (4)

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label

## 2 Physical and Chemical Properties

Copper as Cu and azole as tebuconazole, the two active components of CA-B, are used because of their fungicidal and termiticidal properties and their ability to offer long-term protection in the wood. Copper monoethanolamine complexes allow the copper to be transported and deposited in the wood cells.

General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and from labels for pesticide product. Electronic copies of the pesticide label can be obtained from the Health Canada website (3):

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>

The physical and chemical properties of CA-B and its constituents are outlined in Tables 2 (3, 5).

**Table 2. Physical and Chemical Properties of CA-B Solution**

Identification		
<b>Common synonyms:</b> Copper azole	<b>Registrant in 2012:</b> Arch Wood Protection Inc. <ul style="list-style-type: none"><li>• Wolman® NB</li></ul>	
Transportation and storage information		
<b>Shipping state:</b> Liquid concentrate	<b>Storage temperature:</b> Ambient	<b>Containers/materials:</b> Carbon or stainless steel No copper-based alloys
<b>Concentration:</b> 9.62% by weight Wolman® NB Cu as Copper monoethanolamine complex 9.25% Tebuconazole 0.37%	<b>Inert atmosphere:</b> No requirement <b>Venting:</b> No requirement <b>Delivery format:</b> Tanker trucks or totes as concentrate	<b>Placards:</b> <i>Check with Transport Canada</i>
Physical and chemical properties		
<b>Physical state:</b> Liquid (20°C, 1 atm.) <b>Solubility:</b> Freely soluble in water <b>pH:</b> 9.3–11.0(15°C) <b>Vapour pressure:</b> Not Established <b>Floatability:</b> Soluble in water <b>Freezing point:</b> <-30°C <b>Flash point:</b> >93°C (200°F) <b>Specific gravity:</b> 1.18–1.22 (22°C)	<b>Active ingredients:</b> Wolman® NB Tebuconazole: CAS 107534-96-3 Copper Monoethalonamine complex  <b>Classification:</b> Corrosive n.o.s.	<b>Concentration of work solutions:</b> 0.3–3% as total actives <b>Typical preservative retention in treated wood:</b> 1.7–5 kg/m <sup>3</sup> treated wood <b>Colour:</b> Wolman® NB Blue <b>Odour:</b> Mild amonia-like
Hazard data		
<b>Fire</b> <i>Extinguishing data:</i> common extinguishing agents can be used with fires involving CA-B solutions. <i>Fire and explosion hazard:</i> Moderate fire and explosion hazard when exposed to heat or flame. <i>Combustible liquid:</i> May burn. Does not ignite unless there is an ignition source. Flammable, poisonous gases may accumulate in enclosed areas. Avoid contact with or storage with any of the incompatible substances listed in the “Reactivity” section of this table.	<b>Reactivity</b> <i>Conditions contributing to instability:</i> Stable under normal conditions <i>Incompatibilities:</i> Oxidizers, strong acids, cellulose nitrates, sodium hypobromite, acetylene, hydrazine, nitromethane, aluminium and zinc <i>Hazardous reactions/decomposition/ combustion products:</i> Toxic or hazardous oxides of carbon and/or nitrogen <i>Hazardous polymerization:</i> Not known to occur	

## 3 Environmental Effects

### 3.1 Aquatic Toxicity

Canadian limits for tebuconazole and monoethanolamine have not been established, but limits for copper in aquatic environments are listed in Table 3. However, as these limits are subject to change from time to time, periodic reviews of these limits is recommended.

The guidelines and limitations noted in Table 3 are based on total concentrations, reflecting the recommendations of many scientific reviews that indicate that the current state of knowledge does not enable water quality limitations to be based on either valence state or dissolved fractions in water (6).

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for Copper in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Copper	Maximum: 0.005 mg/L	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
		Protection of human health Aesthetic objectives: < 1.0 mg/L	Health Canada <sup>(b,c)</sup>
	<ul style="list-style-type: none"> <li>• 0.002 mg/L Hardness 0-60 mg/L as CaCO<sub>3</sub></li> <li>• 0.003 mg/L Hardness 60-120 mg/L as CaCO<sub>3</sub></li> <li>• 0.004 mg/L Hardness 120-180 mg/L as CaCO<sub>3</sub></li> <li>• 0.006 mg/L Hardness &gt; 180 mg/L as CaCO<sub>3</sub></li> </ul>	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(d)</sup>

- (a) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).

o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)

o <http://www.ijc.org/rel/agree/quality.html>

- (f) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.

o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>

- (c) "Maximum acceptable" was defined by Health and Welfare Canada as "drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable." "Objective" is defined by Health and Welfare Canada as "this level is interpreted as the ultimate quality goal for both health and aesthetic purposes."

- (d) Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life.

o <http://st-ts.ccme.ca/>



### *Tebuconazole*

While tebuconazole is slightly persistent in the environment, it has been shown not to be mobile. In addition, light dramatically enhances the degradation process. In the Organization for Economic Co-operation and Development's (OECD) Test Guideline 301C, tebuconazole degrades approximately 20% in water. Its half-life in soil is around 100 days. Tebuconazole is considered moderately toxic to aquatic organisms and has a slight potential to bioconcentrate, but it is rapidly eliminated from fish.

### *Copper*

Toxicity depends on bioavailability, but copper is generally reported as toxic to aquatic organisms. Copper is considered not to be bioaccumulative.

Copper-containing pesticides are formulated using various forms of copper, which ultimately dissociate into cupric ion complexes and compounds, including the cupric ion ( $\text{Cu}^{2+}$ ), which is the active component.(7)

The active component of toxicological concern with the majority of copper-containing pesticides is elemental copper (the cupric ion), and most copper compounds can be considered similar in terms of their toxicity.

Copper is expected to pose a risk to aquatic organisms and terrestrial vascular plants. As such, mitigative measures must be taken to minimize adverse effects on plant populations and aquatic organisms. (7) Copper is an element that occurs naturally in the environment and does not break down any further via hydrolysis, metabolism or any other degradation processes. The free cupric ion has a high sorption affinity for soil, sediments and organic matter, and copper applied to the soil surface is not expected to move readily into groundwater. The copper ion is highly reactive, especially in aquatic environments. The form in which copper is found depends on the pH of the medium and the nature and concentration of other forms of copper present.

### *Copper Monoethanolamines*

The amine use in the Wolman<sup>®</sup> NB product is a copper ethanolamine complex that carries the copper into the wood. The following overall ecotoxicity statement for ethanolamine, as a pure formula, can be used as a reference to understand the potential impact of such substance:

2-Aminoethanol or monoethanolamine (often abbreviated as ETA or MEA) is an organic chemical compound that is both a primary amine and a primary alcohol (due to a hydroxyl group). MEA is not expected to bioaccumulate in aquatic organisms. MEA has demonstrated a relatively low degree of toxicity to aquatic organisms (8).

A series of pan studies was conducted under various environmental conditions to examine the biodegradability of MEA in soil recovered from a gas plant site. Experimental results indicate that MEA was successfully biodegraded or transformed into other compounds under both aerobic and anaerobic conditions even at concentrations greater than 1500 mg/kg. Ammonium, acetate,

and nitrogen gas were the dominant by-products in these experiments. The generation of nitrogen gas suggests that simultaneous nitrification and denitrification occurred because of the existence of anoxic zones resulting from diffusion that limited oxygen transport into the soils. Cold temperatures (5°C) reduced biodegradation rates significantly compared to rates at room temperature (9).

MEA is expected to be mobile in soil and is not expected to be adsorb to suspended solids or sediment in water. It readily undergoes biodegradation and is not expected to persist in the environment.

## 4 Human Health Concerns

Tables 4 outline the possible human health effects that may result from exposure to CA-B solutions and their components. The possible human health effects are estimated from risk studies on copper azole solution and its components, copper amine solution (ethanolamine) and tebuconazole. Extensive reviews of the potential health effects of individual elements are provided in documents from Health Canada (10), the material safety data sheet (MSDS), the World Health Organization (11), the International Labour Organization (12), the United States Environmental Protection Agency (13), the American Conference of Governmental Industrial Hygienists (ACGIH) (14) and the Occupational Safety and Health Administration (15).

In the Wolman® NB concentrate, the tebuconazole concentration is 0.37%. The manufacturer's data supplied are based upon a pure tebuconazole product. Workers will generally only come into contact with the working solution, which is diluted to 0.3% to 3% total active ingredient, meaning only 0.011% to 0.11% of tebuconazole.

**Table 4.0. Potential Health Effects of Exposure to Copper Azole Solutions**

<i>(Wolman® NB)</i>		Possible health effects	
Exposure category (Route of Entry)	Type of exposure	Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) with limited to no health effect <sup>(a)</sup>			
• Copper (an essential element)	2.47 mg/day		
Eye contact <sup>(a,b)</sup>	Direct contact	<ul style="list-style-type: none"> <li>• CA-B concentrate is corrosive</li> <li>• Will cause irritation, pain and reddening</li> </ul>	<ul style="list-style-type: none"> <li>• Ulceration, may cause irreversible damage</li> </ul>
Skin contact <sup>(a,b)</sup>	Significant skin contact with concentrates	Short term (up to 1 hour) <ul style="list-style-type: none"> <li>• Mild to moderate skin irritation, inflammation, reddening</li> </ul>	Long term <ul style="list-style-type: none"> <li>• Severe irritation, ulceration, chemical burns</li> </ul>
ACGIH threshold limit value-time weighted averages (TWAs) <sup>(c)</sup>	Ethanolamine: 8 mg/m <sup>3</sup> air 3 ppm		
Exposure to airborne contaminant or dust Inhalation <sup>(a,b)</sup>	Inhalation of mists, droplets or dust of concentrates	<ul style="list-style-type: none"> <li>• May cause upper respiratory tract irritation</li> <li>• Moderate irritation of nose, throat and lungs</li> <li>• Irritation of eyes</li> </ul>	<ul style="list-style-type: none"> <li>• Moderate to severe irritation of mucous membrane, nose, throat and lungs</li> <li>• Irritation of eyes</li> </ul>
ACGIH threshold limit value-time weighted averages (TWAs) <sup>(c)</sup>	Copper (dusts and mists): 1.0 mg Cu/m <sup>3</sup> air		
Ingestion <sup>(a,b)</sup>	Ingestion of work solutions or concentrates through manipulation of contaminated goods (dishes, gum, candy, food, tobacco, liquids)	<ul style="list-style-type: none"> <li>• Irritation of the gastrointestinal tract</li> <li>• Gastrointestinal discomfort with potential nausea, abdominal pain, vomiting, diarrhea</li> </ul>	<ul style="list-style-type: none"> <li>• Large quantity may result in liver and kidney damage</li> </ul>
Chronic symptoms <sup>(a,b)</sup>	Repeated overexposures	<ul style="list-style-type: none"> <li>• Prolonged or repeated inhalation will cause severe irritation and lung damage and may result in liver and kidney damage</li> <li>• Severe skin irritation, ulceration, chemical burns</li> <li>• Abdominal pains and other persistent symptoms of illness</li> <li>• Not known as carcinogenic to humans</li> </ul>	

- a) Health Canada / Water Quality - Reports and Publications / Chemical/Physical Parameters
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
  - <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/copper-cuivre/index-eng.php>
  - <http://publications.gc.ca/site/archivee-archived.html?url=http://publications.gc.ca/collections/Collection/H113-7-2006-11E.pdf>
- b) Arch Treatment Technologies, Inc. Material Safety Data Sheet, *Wolman*® NB, Revision date 09/16/2009
- c) American Conference of Governmental Industrial Hygienists (ACGIH)
  - <http://www.acgih.org>

## 5 Description of Preservative Application and Potential Chemical Discharges

### 5.1 Description of Process

CA-B preservative is a water-based product which is applied by pressure treatment in essentially the same manner as chromated copper arsenate (CCA) using the Full Cell (Bethell) pressure treatment process (refer to Part 1 – General Background Information, Section 2.2.3 [Figure 3](#)).

CA-B working solution is prepared at wood preservation facilities by diluting the preservative concentrate, or the two CA-B components concentrates, with water to form a working-strength solution of 0.3–3.4% actives. The working-solution strength is determined by the desired treatment level to be retained in the wood. Vacuum and pressure cycles vary depending on the wood species and size of the wood product being treated, such that they meet the desired standard (4) or specification.

The specific treatment times and pressures are dictated by the species of the wood, the wood product, and the moisture content of the wood. A predetermined range of process parameters is defined by the applicable treatment standards of the CSA-O80 Series of Standards (4). Quality control tests are carried out to ensure that a minimum treated product quality is maintained. The treated wood is stored on site until ready for shipment.

### 5.2 Potential Chemical Discharges

CA-B wood preservation facilities vary in design and operating practices, which may cause differences in the nature of potential releases from any particular plant. The potential sources and types of releases are illustrated in Figure 1.

#### *Liquid Discharges*

The CA-B process uses water-borne ingredients and can be operated as a “closed system.” Once dripping has ceased, and a minimum of 48 hours has passed, freshly treated lumber should be wrapped prior to storage in the yard or under sheds. If incidental drippage occurs, the lumber must be returned immediately to the drip pad area until all dripping has been confirmed to have stopped. Immediate cleanup of the drippage should be initiated to prevent any potential for causing stormwater contamination or tracking. Dripped solution or contaminated storm runoff water can be reused in the process. Primary facility design features that should be used for CA-B containment and recycling include the following:

- concrete containment surfaces and diking with a second barrier for major process areas, including the cylinder and tanks
- containment surfaces for chemical drips from treated wood on the cylinder discharging track and in the freshly treated drip pad
- a collection sump to receive residual preservative from the cylinder (following the treatment cycle) and the accumulated contaminated runoff from other containment surfaces. This material can then be reused in the treatment process following filtration to remove dust and debris.

Under normal operating practices in a properly designed facility there should be few contaminated liquid discharges. The most common potential sources of contaminated liquid discharges in a CA-B facility are stormwater runoff waters from unpaved and unroofed treated product storage areas. The quantities of preservative in these waters depend on many factors, including quantity of precipitation, stabilization method, elapsed stabilization time, temperature prior to a precipitation event, and soil characteristics of the storage yard. Uncontained liquid releases other than stormwater are generally confined to yard soils, particularly those locations near drip pads in charging/unloading areas and where containment surfaces are used for freshly treated wood. These contaminated yard soils, at high concentration, have potential for causing groundwater contamination.

#### *Solid Wastes*

Solid waste generation at CA-B facilities should be relatively small. During normal operating conditions, solid waste sources are limited to filters, and to dirt and debris that are periodically scooped from the sump, cylinder and tanks. Treated wood debris and contaminated articles are another source.

#### *Air Emissions*

Using an amine formulation at ambient temperature will produce minimal tank emissions under normal operating conditions. Typically no controls are necessary for ambient temperature solutions with the CA-B product. There should be no in-plant emissions from storage tank vents or vacuum pump exhausts, as these must be vented to the plant exterior with liquid-release protection.

The use of heated solutions may imply some potential for amine emissions at the CA-B facility if proper controls are not in place.

Refer to Part 1 – Chapter A, [Section 5.2](#) for more details on potential chemical discharges.

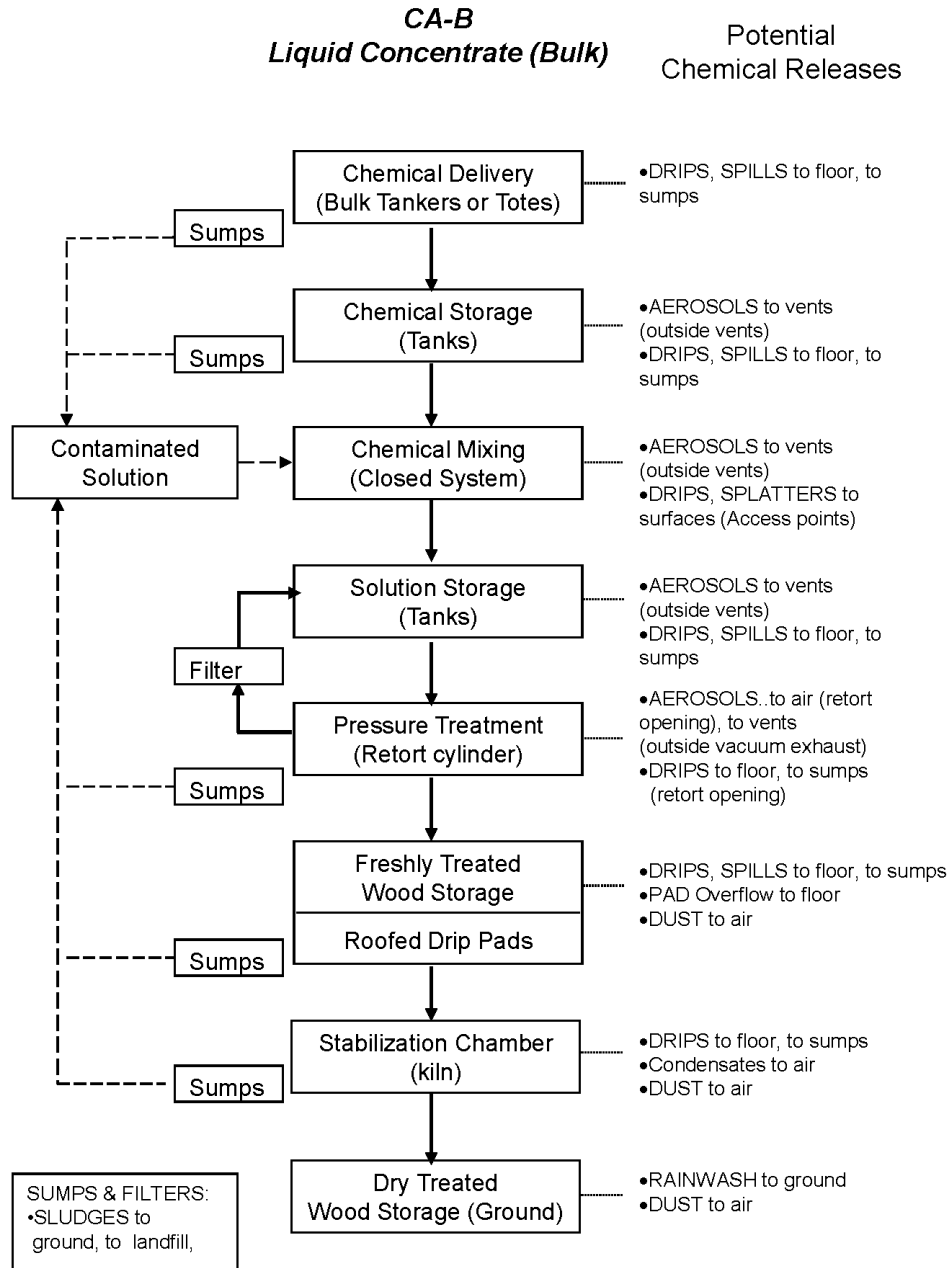
### **5.3 Potential Effects of Chemical Discharges**

The actual impact on the environment of any chemical release depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the amount and concentration of preservative releases, the frequency of releases, and contingency measures in place at the facility.

Improperly operated facilities have the potential to contaminate surrounding site soils and groundwater to levels that exceed drinking water standards.

Human health effects for workers are minimized by the use of closed systems for concentrates and working solutions. The main source of potential contact with CA-B would be from improper handling of the product.

**Figure 1 Potential Releases from CA-B Pressure Treating Plants**





## 6 Protection of Personnel

Electronic copies of the pesticide labels for all registered CA-B products, which contain information on product handling precautions, minimum worker protective equipment and health hazard warnings, can be obtained on the Health Canada website: <http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php> (3). The conditions of use specified on the pesticide label are mandatory by law. Ensure that the information on the most current product label is followed.

### 6.1 First Aid Precautions and Hygiene for CA-B Exposure

A summary of the first aid measures listed in Table 5 should be available on-site, preferably in the same location as the first aid material. For all medical attention, always take the pesticide label to show to the health personnel.

Table 5 outlines first aid measures for exposure to CA-B and its constituents.

**Table 5. First Aid Measures for Exposure to CA-B**

Exposure	First action	Second action
Eye contact	<ul style="list-style-type: none"> <li>Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids (no rubbing).</li> <li>If exposed person wears contact lenses, remove those 5 minutes after rinsing and then continue rinsing for at least 10 minutes.</li> <li><i>Workers should not wear contact lenses</i></li> <li>Flush eyes for at least 15 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre immediately for subsequent advice (have product label at hand).</li> <li>Get medical attention.</li> </ul>
Skin contact	<ul style="list-style-type: none"> <li>Flush contaminated area immediately with flowing water.</li> <li>Subsequently remove contaminated clothing.</li> <li>Continue to flush contaminated skin for at least 15-20 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre immediately for subsequent advice (have product label at hand).</li> <li>Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
Inhalation	<ul style="list-style-type: none"> <li>Immediately remove the exposed person to fresh air.</li> <li>If breathing has stopped: <ul style="list-style-type: none"> <li>call emergency services (ex. 911);</li> <li>apply artificial respiration with barrier device.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Keep the affected person warm and quiet.</li> <li>Get immediate medical attention (have product label at hand).</li> </ul>
Ingestion	<ul style="list-style-type: none"> <li>Call an industrial physician or poison control centre <b>immediately</b> for treatment advice.</li> <li>Review MSDS/PMRA label to determine if water can be promptly given to the exposed person if able to swallow.</li> </ul>	<ul style="list-style-type: none"> <li>Never give liquids to an unconscious person.</li> <li>Do not induce vomiting.</li> </ul>
Chronic symptoms requiring medical attention	<ul style="list-style-type: none"> <li>Skin, eyes, liver or kidney symptoms</li> <li>Ulceration of the skin or mucous membrane</li> <li>Abdominal pains</li> <li>Other persistent symptoms of illness</li> </ul>	

When exposure to a chemical occurs, the severity and speed of damage to human health depends on the concentration. The general rule for dealing with exposure is as follows: **the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs.** If there is any doubt as to the concentration, the response should be the same as for the most concentrated form. Immediate response is required if a worker is exposed to CA-B concentrate solutions.

Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with CA-B solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

Facility staff should have access to product labels and appropriate training to apply first aid.

Personnel should follow the recommendations from [Table 6 of Chapter A](#) outlining general precautions and personal hygiene measures.

## **6.2 Regulatory Controls**

The label for pesticide product contains information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

**Specific limits for worker protection are generally prescribed by provincial regulations.** Consult your local authorities for specific applicable regulations.

Most of the criteria established by worker protection agencies are based on the TLVs and BEIs recommended by the [American Conference of Governmental Industrial Hygienists \(ACGIH\)](#). The ACGIH limits of exposure in the workplace are specified in Table 4 for copper and ethanolamine only; no limits are provided for tebuconazole.

### *Skin and Eye Contact*

Copper azole, as such, is not discussed by the ACGIH. With reference to skin and eye contact, the ACGIH provides the following conclusion in its support rationale (14) for TLV levels only for copper and ethanolamine: copper salts act as irritants that may produce itchy eczema on skin and conjunctivitis or ulceration of the eye. However, the TLV for copper salts is based on inhalation. These limits may not adequately take into account routes of exposure other than inhalation. The ACGIH has suggested that in such cases, “biological exposure indices may be useful as a guide to safe exposure” (14).

### *Inhalation*

The TLVs stipulated by the ACGIH are those “airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse

effects.” The TLVs for copper (14) are defined in Table 4, with the following provisos of the ACGIH:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentrations.”
- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

The limits as defined by the ACGIH would apply primarily to suspended aerosols, dusts or gases generated during welding. Generally, airborne contaminants are not generated in CA-B facilities at quantities that would cause significant worker exposure, since CA-B wood preservation facilities use exclusively CA-B water solutions. Though incidental exposures are possible at all facilities, incidents of aerosol exposure would be more probable at improperly maintained facilities (i.e. from leaking seals) or at inadequately designed facilities (e.g. from vacuum pump discharges to the work area). Dust generation is most probable from forklifts and trucks moving on the drip pad and the yard, and is also expected from cleaning operations. Frequent washdowns of pads and collection of the sump contents should minimize airborne contaminants caused by pad traffic.

### *Ingestion*

Oral intake of CA-B must be avoided. Ingestion of liquids containing CA-B liquids is unlikely if workers follow the precautions and personal hygiene measures outlined in Chapter A, Section 6, [Table 6](#). Acceptable limits of ingestion are not prescribed by regulation, since it is generally expected that no such intake will occur.

## **6.3 Safety Precautions**

Workers need to familiarize themselves with the safety precautions mentioned in Chapter A, Section 6.3, [Table 8](#).

Sensitive individuals should take special care to avoid exposure.

## **6.4 Biological Monitoring of Exposed Workers**

Biological monitoring is a useful tool for evaluating the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#)

## **7 Design Recommendations**

The following recommendations must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 7](#) and their corresponding tables. All tables of general content from Chapter A, Section 7 must be taken into consideration.

For the accelerated stabilization process, please refer to Chapter A, [Table 15](#).

## **8 Operational Recommendations**

The recommendations for good operating practice listed in this section must be used in conjunction with those in Part I, Chapter A– General Recommendations for All Wood Preservatives, [Section 8](#). The objectives are to protect both workers and the environment from harmful exposure to CA-B solutions.

### **8.1 Operational Standards**

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including CA-B. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2 08 Clause 4.1 (referenced to AWWPA M3). The calibration can be conducted by facility staff if they have the appropriate training.

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8.1](#).

### **8.2 Facility Wide Recommendations**

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### **8.3 Process Area-specific Recommendations**

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.3 and consult [Table 19](#) to [Table 22](#).

## **9 Waste, Process Emissions and Disposal**

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.1 Control, Treatment and Disposal**

Potential process emission sources at CA-B wood preservation facilities were described in Section 5.2 and in Figure 1. The main categories of process wastes and emissions that may be encountered at CA-B facilities, along with their recommended disposal methods, are presented in [Table 23](#) and in Chapter A.

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information.

### **9.2 Liquids Containing CA-B**

#### *Liquid Process Wastes*

Liquid process wastes should not be discharged from CA-B plants. Liquid solutions (such as drips and washwaters) containing CA-B are routinely collected and reused as makeup waters in preparing new treatment solutions. If unusual circumstances (such as prolonged plant shutdown) prevent on-site reuse, transportation to another CA-B facility should be arranged. Disposal of process liquids should be considered only as a last alternative.

### **9.3 Solids with High CA-B Concentrations**

Consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.4 Miscellaneous Solid Wastes**

CA-B concentrate drums should be rinsed thoroughly (triple-rinsed) with water prior to disposal, and the rinse water should be used for the preparation of working solutions.

Do not use wood treated with CA-B as a compost or mulch.

Incineration of materials contaminated with CA-B is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products.

The additive drums (moldicide and defoamer) should be thoroughly triple-rinsed with water prior to disposal, and the rinse water should be used for the preparation of work solutions. These drums should either be returned to supplier if appropriate or disposed of by the appropriate disposal company.

## **9.5 Air Emissions**

The use of an amine formulation at ambient temperature will produce minimal tank emissions from normal operation. Typically no controls are necessary for ambient-temperature solutions of the CA-B product. There should be no in-plant emissions from storage tank vents or vacuum pump exhausts, as these must be vented to the plant exterior with liquid release protection.

The use of heated solutions may imply some potential for amine emissions at the CA-B facility if proper controls are not in place. Consult the chemical supplier.

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 9, [Table 23](#) Recommended Practices for Handling Liquid & Solid Wastes and Sludge.

## 10 Environmental and Workplace Monitoring

### 10.1 Baseline Environmental Evaluation

Copper is found naturally in the environment. Typical background levels of naturally occurring copper are listed in Table 24. As with all metals, there is a wide range of naturally occurring concentrations of copper found in soil, and it is recommended that baseline levels be determined prior to operating a facility that uses copper azole in order to enable meaningful future assessments of pollution control at the facility. Older mills may not have this information available. A comparative site from a nearby property can be used as a reference. The facility may use the template provided in [Table 24](#) from Chapter A.

Ethanolamine and tebuconazole are synthetically produced and are not naturally occurring; therefore, all ethanolamine (MEA) and tebuconazole that may be found in the environment is expected to be from human-made sources.

**Table 24. Typical Background Levels for Copper**

Component	Typical background levels in environment (16)	
	Surface waters (mg/L)	Soils (mg/L)
Copper (Cu) CAS RN 7440-50-8	< 0.001 to 0.04	2–100

### 10.2 Environmental Monitoring

Environmental monitoring requirements for a CA-B facility would normally be developed for soil, groundwater and surface water. CA-B facilities have the potential to contaminate groundwater in the immediate vicinity of the facilities to levels that can pose a risk to aquatic organisms. Stormwater runoff may contain at least one of the elements copper or tebuconazole at levels in excess of existing water quality limits. Additional monitoring studies (such as surface water discharges, groundwater and contaminated soil) are recommended to properly assess the degree of such releases.

### 10.3 Workplace Exposure Monitoring

A monitoring program must be designed to ensure that there are adequate monitoring sites and that the frequency of monitoring and the detection limits of the preservative constituents are defined. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist.

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## 11 Transportation of CA-B and its Wastes

The transportation of CA-B concentrates, solutions and the wastes generated by their use is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details, please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of CA-B and its wastes.



## **12 Environmental Emergency Notification and Contingency Planning**

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using CA-B should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective. It is recommended that the individual facility plans be filed with the authorities that have jurisdiction over the facility.

### **12.1 Environmental Emergency Notification**

Please refer to [Section 12.1](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.2 Spill Contingency Planning**

Please refer to [Section 12.2](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **12.3 Fire Contingency Planning**

CA-B is not flammable, but precautions should be taken in the event that a fire occurs. Toxic gases could be released from the preservative materials if these are excessively heated.

Use an extinguishing agent appropriate for the type of fire encountered. Plant operators should consult their local fire department and refer to the *National Fire Code of Canada (always refer to last version available)* (17) and to [Section 12.3](#) of Part I, Chapter A - General Recommendations for All Wood Preservatives. A copy of the fire contingency plan and all necessary documents including the pesticide label should be stored in a fire proof box outside the entrance to the facility.

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## CHAPTER I

### Inorganic Boron (Borate) Wood Preservation Facilities

Preservative-specific Information and Recommendations

**This chapter must be used in conjunction with Part I – Chapter A  
General Recommendations for All Wood Preservatives.**

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# 1 Production and Use

Inorganic boron (borate) wood preservation chemicals are generally sold as disodium octaborate tetrahydrate, which is supplied as a water-soluble inorganic borate salt (powder) with insecticidal, termiticidal and fungicidal properties. Treating solutions are stored in mild steel (carbon steel) tanks and are applied to wood under pressure until a predetermined amount has been absorbed by the wood in accordance with applicable standards (1). On removal of the wood from the pressure vessel, treated wood is stored in a roofed area or under wrap. It remains wrapped at all times until final use. It should be noted that borates are water soluble, and treated wood is suitable only for applications where the wood is not in contact with the ground and is continuously protected from free water.

Although borates have been used for over 50 years by diffusion processes for interior applications, it is now mostly applied pressure treatment in North America for lumber and timber for interior construction. Currently there are two impregnation plants operating in Canada that use borates (2). Table 1 presents basic information on use of borates in Canada.

**Table 1. Overview of Borate Use in Canada**

Feature	Characteristics
Treated wood use limitations in Canada	<b>For interior construction in residential and institutional/industrial buildings, and for exterior wood that will be protected from excessive rain and not in direct contact with soil.</b> <b>Types of wood include, but are not limited to, all types of lumber, logs, timber, siding and plywood.</b>  <b>*Note: permitted uses and limitations of boron-treated wood may change over time. Refer to pesticide label for up-to-date uses.</b>
General process of application	Pressure treatment (refer to the pesticide label for details).

The CSA O80 Series of Standards specifies requirements related to the preservation and fire retardance of wood through chemical treatment (pressure), which includes Boron-treated products. (1)

Treatment conditions must be calibrated to yield the target retention levels described on the pesticide label

# 2 Physical and Chemical Properties

The chemical composition of the borates used for wood treatments was chosen to enable the appropriate impregnation of wood with an active ingredient that is effective in protecting wood against fungi, termites and other wood-boring insects.

The boron preservatives registered have disodium octaborate tetrahydrate as the active ingredient.

The physical and chemical properties of borate are outlined in Table 2. General physical and chemical properties can be obtained from manufacturers' material safety data sheets (MSDS) and from label for pesticide products. Electronic copies of the pesticide label can be obtained from the Health Canada website:

<http://www.hc-sc.gc.ca/cps-spc/pest/registrant-titulaire/tools-outils/index-eng.php>

**Table 2. Physical and Chemical Properties of Borate Wood Preservatives**

Identification		
Common synonyms: Boron, borate, disodium octaborate tetrahydrate	Registrants in 2012: U.S. BORAX <ul style="list-style-type: none"><li>20 mule team tim-bor® industrial wood preservative</li></ul> SOCIETA' CHIMICA LARDERELLO S.P.A. <ul style="list-style-type: none"><li>Borowood</li></ul>	
Transportation and storage information		
Shipping state: Powder (inorganic borate salt)	Storage temperature: Ambient	Containers: Multi-wall paper bags with a polyethylene moisture-resistant barrier for powder Mild steel for solutions
Concentration: As disodium octaborate tetrahydrate TIM-BOR: 98% w/w Borowood: 20.9% w/w	Venting: no requirement	
Classification: Eye irritant	Special sensitivity: Moisture (caking)	Delivery format: Bags of 5-25 kg net weight
Placards: Check with Transport Canada		
Physical and chemical properties		
Physical state: Solid	Appearance: White powder	
Chemical formula: Na2B8O13.4H2O	Odour: Odourless	
Chemical Abstracts Service Registration Number (CAS RN): 12280-03-4	Melting point: 815°C	
Chemical composition:	Vapour pressure: Negligible @ 20°C	
Sodium oxide (Na2O) 14.7%	Molecular weight: 412.52	
Boric oxide (B2O3) 67.1%	Concentration of work solutions: 1–5%	
Water of crystallization (H2O) 18.2%	Typical preservative retention in treated wood:	
Equivalent boron (B) 20.5%	2.7 kg/m³ (as B2O3)	
Solubility: 9.7% (20°C) 34.4% (50°C)		
pH @ 20°C: 8.3 (3.0% solution) 7.6 (10.0% solution)		
Hazard data		
Fire	Reactivity	
Fire behaviour: No general hazard; not flammable, combustible or explosive Product is a fire retardant.	Reacts with strong reducing agents such as metal hydrides or alkali metals; will generate hydrogen gas, which could create an explosive hazard	
Extinguishing data:	Stability: Stable	
Compatible with all extinguishing media.	Hazardous decomposition:None	

### 3 Environmental Effects

Boron is ubiquitous in the environment; it is widespread in nature at relatively low concentrations (3) and is occurring naturally in over 80 minerals. The boron content of soils ranges from 0.002 to 0.1 mg/g dry weight (4); it is highly mobile in this medium and is easily leached. Factors influencing boron adsorption to soil include soil pH, texture, organic matter, cation exchange capacity, moisture and temperature (5). The concentration of boron in Canadian coastal waters is reported to range between 3.7 and 4.3 mg/L, and estuarine waters are generally rich in boron (6).

Boron is an essential trace element for the growth of terrestrial crop plants and some algae, fungi and bacteria, but can be toxic in excess. Toxicity to aquatic organisms, including vertebrates, invertebrates and plants, can vary depending on the organism's life stage and environment. Early life-cycle stages are more sensitive to boron than later ones, and the use of reconstituted water shows higher toxicity in lower boron concentrations than natural waters. In mammals, excessive consumption can adversely affect growth, reproduction or survival (7).

Although boron is present naturally in Canada, industrial potential releases can be found in much greater concentrations that can potentially become harmful to the environment and human health.

The data indicate that a wide variety of properties must be considered in order to safely manage borate.

#### 3.1 *Aquatic Toxicity*

The toxicity of boron compounds is generally expressed in terms of boron itself. The predominant form of boron in water is boric acid. Conversion may be necessary to reflect the element concentration.

Because boric acid is a weak acid with an acid dissociation constant (pKa) of 9.2, it exists primarily as the undissociated acid  $\text{H}_3\text{BO}_3$  in aqueous solution at physiological pH, as do the borate salts (3). Therefore, the toxicity associated with these compounds is expected to be similar based on boron equivalents. Boron oxide will also produce similar effects because it is an anhydride that reacts exothermically with water in the body to form boric acid (8).

**Provincial guidelines are applicable and should be consulted. Provincial guidelines may differ from or be more specific than national guidelines. Provincial regulations may require additional measures that may enhance, but not reduce, protection.**

**Table 3. Regulatory Limits for Boron in Natural Water Bodies**

Element	Limit value (mg/L)	Basis (objectives)	Agency
Boron	Not determined	Protection of aquatic life	International Joint Commission <sup>(a)</sup>
	Interim maximum acceptable concentrations: 5 mg/L	Protection of human health: Guidelines for Canadian Drinking Water Quality	Health Canada <sup>(b,c)</sup>
	Maximum: 2.4 mg/L	Protection of human health: Drinking water quality guidelines	World Health Organization (WHO) <sup>(d)</sup>
	Freshwater <ul style="list-style-type: none"> <li>• Short term 29 mg/L</li> <li>• Long term 1.5 mg/L</li> </ul>	Protection of aquatic life	Canadian Council of Ministers of the Environment (CCME) <sup>(e)</sup>
	Marine <ul style="list-style-type: none"> <li>• No recommended guideline</li> </ul>		
	Irrigation <ul style="list-style-type: none"> <li>• Variable upon crops</li> </ul>	Protection of agriculture	CCME <sup>(e)</sup>
	Livestock <ul style="list-style-type: none"> <li>• 5 mg/L</li> </ul>		

- (a) Recommendations of the International Joint Commission (IJC) to the governments of Canada and the United States, Great Lakes Water Quality Agreement, 1978 (Review 2007).  
 o [http://binational.net/glwqa\\_2007\\_e.html](http://binational.net/glwqa_2007_e.html)  
 o <http://www.ijc.org/rel/agree/quality.html>
- (b) Health Canada, Guidelines for Canadian Drinking Water Quality, 2010.  
 o <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>  
 o <http://hc-sc.gc.ca/ewh-semt/pubs/water-eau/boron-bore/index-eng.php>
- (c) "Maximum acceptable" was defined by Health and Welfare Canada as "drinking water that contains substances in concentrations greater than these limits is either capable of producing deleterious health effects or is aesthetically objectionable." "Objective" is defined by Health and Welfare Canada as "this level is interpreted as the ultimate quality goal for both health and aesthetic purposes."  
 Available practicable treatment technology is inadequate to reduce boron concentrations in Canadian drinking water supplies to less than 5 mg/L; on this basis, an interim maximum acceptable concentration (IMAC) of 5 mg/L has been established. This IMAC will be reviewed periodically in light of new data.
- (d) Guidelines for Drinking-water Quality, Fourth Edition, © World Health Organization 2011. ISBN 978 92 4 154815 1. Table 8.8, Guideline values for naturally occurring chemicals that are of health significance in drinking water, p. 178.  
 o [http://www.who.int/water\\_sanitation\\_health/dwq/guidelines/en/](http://www.who.int/water_sanitation_health/dwq/guidelines/en/)
- (e) Canadian Council of Ministers of the Environment (CCME) Canadian Environmental Quality Guidelines, Water Quality Guidelines for the Protection of Aquatic Life.  
 • <http://st-ts.ccme.ca/>

Boron's effects on aquatic plants are highly species-specific (9). Borate, like silicate, is an essential micronutrient for the growth of aquatic plants. Boron, under conditions of excess, alleviates nutrient deficiency in some phytoplankton and may cause temporal variations of phytoplankton composition in coastal waters (9). Phytoplankton can tolerate up to 10 mg inorganic B/L in the absence of stress from pH adversity and nutrient deficiency, although higher borate concentrations up to 100 mg/L are expected to cause species redistribution by favoring the growth of some species and suppressing that of others (10). Boron has been shown to accumulate in aquatic plants, which may be evidence for its importance in plant nutrition. Despite a tendency to accumulate in plants and algae, boron does not appear to biomagnify through the food chain (11).

Data are limited for aquatic invertebrates and boron. Juvenile Pacific oysters (*Crassostrea gigas*) accumulated boron in relation to availability, but showed no prolonged retention following cessation of exposure. At current industrial discharge levels of about 1.0 mg B/L, no hazard is clear to oysters and aquatic vertebrates (12).

The most sensitive aquatic vertebrates tested for which data are available were coho salmon (*Oncorhynchus kisutch*), with a median lethal concentration (LC<sub>50</sub>) value of 12 mg B/L in seawater (16-day exposure), and sockeye salmon (*O. nerka*), showing elevated tissue residues after exposure for 3 weeks in seawater containing 10 mg B/L.

Boron concentrations between 0.001 and 0.1 mg/L had little effect on survival of rainbow trout embryos after exposure for 28 days. These low levels may represent a reduction in reproductive potential of rainbow trout, and > 0.2 mg B/L may impair survival of other fish species, according to Birge and Black (13); however, additional data are needed to verify these speculations. Birge and Black reported that concentrations of 100–300 mg B/L killed all species of aquatic vertebrates tested; that embryonic mortality and teratogenesis were greater in hard water than in soft water, but that larval mortality of fish and amphibians was higher in soft water than in hard water; and that boron compounds were more toxic to embryos and larvae than to adults (14).

## 4 Human Health Concerns

Boron is a naturally ubiquitous element to which humans are commonly exposed (15). However, in industrial settings, appropriate safeguards (see section 6) need to be implemented to avoid overexposure.

Table 4 presents the estimated daily intake of boron by Canadians. Even at the maximum levels measured in marine air, intake of boron through inhalation is likely to be negligible compared with that ingested in food and water. In the past, boron was considered to be non-essential for animals. However, one study indicating a narrow range of levels in human blood, as well as deprivation studies in rats, suggests that boron might indeed be an essential element (6). Boron has been classified in Group IVC—probably not carcinogenic to humans.

Boron does not accumulate in normal tissues but may concentrate in malignant brain tumors. Boron is eliminated from the body mainly by the kidney (urine), with minor amounts being excreted in feces, sweat and saliva. About half of the boron absorbed by humans is excreted during the first 24 hours after intravenous administration of 562 to 611 mg of boric acid; more than 92% elimination has been reported to occur within 96 hours of ingestion of 750 mg of boric acid in water or up to 50 mg in a water-emulsifying ointment by human volunteers (6).

A number of acute poisonings in humans from boric acid or borax have been reported following ingestion; parenteral injection; scrubbing of serous cavities; enemas; and application of dressings, powders or ointments to large areas of burned or abraded skin. Symptoms of acute boron poisoning include nausea, vomiting, diarrhea, headache, skin rashes, desquamation and evidence of central nervous system stimulation followed by depression. In severe cases, death usually results in five days as a result of circulatory collapse and shock. The acute lethal dose of boric acid has been estimated to be 15 to 20 g for adults, 5 to 6 g for infants and 1 to 3 g for newborns. Children, the elderly and individuals with kidney problems are most susceptible to the acute toxic effects of boron (6).

Researchers at the University of California in Los Angeles conducted a NIOSH-funded study of over 1000 boron-exposed workers in China. Preliminary results indicate that 9.6% of boron-exposed workers reported a history of infertility, compared with 4.8% of unexposed workers. No significant correlations were found between blood or urine boron and adverse semen parameters. Exposures did not reach those causing adverse male reproductive effects, as published in animal toxicology work, but exceeded those previously published for boron occupational groups. Laboratory measurements of semen quality, blood hormones and boron levels revealed that high exposure levels changed the ratio of Y- to X-bearing sperm, potentially influencing the gender of the workers' offspring—and suggesting a need for further study (16).

**Table 4. Potential Health Effects of Exposure to Boron**

Exposure category (Route of Entry)	Type of exposure	Possible health effects	
		Short-term exposure	Long-term exposure
Estimated daily intake from various sources (air, water, food) with limited to no health effect <sup>(a)</sup>			
• Boron (food being the principal source)	1 to 4 mg/day		
Eye contact <sup>(b,c,d,e,f,g)</sup>	Direct contact	<ul style="list-style-type: none"><li>• Moderate irritation</li><li>• Redness, pain</li></ul>	<ul style="list-style-type: none"><li>• Irritation</li><li>• Inflammation</li></ul>
Skin contact <sup>(b,c,d,e,f,g)</sup>	Significant skin contact with work solutions or concentrates	<ul style="list-style-type: none"><li>• Can be absorbed through skin in presence of lesion</li><li>• Irritation, redness</li></ul>	<ul style="list-style-type: none"><li>• Irritation</li><li>• Inflammation</li></ul>
Exposure to airborne contaminant or dust Inhalation <sup>(b,c,d,e,f,g)</sup>	Inhalation of mists, droplets or dust of work solutions or concentrates	<ul style="list-style-type: none"><li>• Moderate irritation</li><li>• Can be absorbed through mucous membranes and by ingestion of mucociliary activity</li></ul>	<ul style="list-style-type: none"><li>• Irritation</li><li>• Inflammation</li></ul>
ACGIH threshold limit value-time weighted averages (TWAs) <sup>(e,f)</sup> ACGIH refers to disodium octaborate tetrahydrate as a “particulate not otherwise classified” or “nuisance dust.”	Borate compounds, inorganic: TLV TWA 2 mg/m3 (I) = inhalable fraction  Boron oxide: TLV TWA 10 mg/m3  The OSHA/PEL (permissible exposure level) is 15 mg/m <sup>3</sup> respirable dust.		
Ingestion <sup>(b,c,d,e,f,g)</sup>	Ingestion of work solutions or concentrates through manipulation of contaminated goods (dishes, gum, candy, food, tobacco, liquids)	<ul style="list-style-type: none"><li>• Boron is well absorbed from gastrointestinal tract</li><li>• Vomiting, abdominal pain, nausea, pain and diarrhea</li><li>• Potential male fertility issues</li></ul>	<ul style="list-style-type: none"><li>• Lethargy, headache, lightheadedness and rash</li></ul>
Chronic symptoms <sup>(b,c,d,e,f,g)</sup>	Repeated exposures	<ul style="list-style-type: none"><li>• Potential male fertility issues</li></ul>	

a) Health Canada / Water Quality - Reports and Publications / Chemical/Physical Parameters

- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/index-eng.php>
- <http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/boron-bore/index-eng.php>

b) International Labour Organization ICSC Card database

- <http://www.ilo.org/dyn/icsc/showcard.home>

c) World Health Organization, International Programme on Chemical Safety

- <http://www.who.int/ipcs/en/>
- [http://www.who.int/water\\_sanitation\\_health/dwg/chemicals/boron/en/](http://www.who.int/water_sanitation_health/dwg/chemicals/boron/en/)

- d) Agency for Toxic Substances and Disease Registry (ATSDR)
  - <http://www.atsdr.cdc.gov/substances/index.asp>
  - <http://www.atsdr.cdc.gov/toxfaqs/TF.asp?id=452&tid=80>
- e) American Conference of Governmental Industrial Hygienists (ACGIH)
  - <http://www.acgih.org/tlv/>
- f) Occupational Safety & Health Administration (OSHA) Permissible Exposure Limits (PELs):
  - <http://www.osha.gov/dsg/topics/pel/index.html>
  - [https://www.osha.gov/dts/chemicalsampling/data/CH\\_221500.html](https://www.osha.gov/dts/chemicalsampling/data/CH_221500.html)
- g) United States Environmental Protection Agency (USEPA). Washington, DC. TOXICOLOGICAL REVIEW OF BORON AND COMPOUNDS (CAS No. 7440-42-8). In Support of Summary Information on the Integrated Risk Information System (IRIS), June 2004, EPA 635/04/052
  - <http://www.epa.gov/iris/toxreviews/0410tr.pdf>



## **5 Description of Preservative Application and Potential Chemical Discharges**

### **5.1 Description of Process**

The impregnation of borates into wood is carried out in pressure-treatment plants with generally a standard full-cell impregnation process in a conventional mild steel vessel (pressure cylinder). The standard full-cell impregnation process is described in Part 1 – General Background Information, [Section 2.2.2](#) and the pressure treatment plant design is described in Part 1 – General Background Information, Section 2.2.3, [Figure 3](#). Borate plants are similar to chromated copper arsenate (CCA) plants with the exception of having dried chemical storage.

Process conditions and treatment results are described in the CSA-O80 Series of Standards (1).

The treating chemical is purchased as a powder in 5–25 kg bags. Indoor dry storage is recommended to prevent caking. Usually, a treatment solution is prepared by direct mixing with water in a suitable mild steel tank. Once the treated wood has been removed from the impregnation vessel, it has to be kept under a roof or a wrap until it is used in an interior location. Exposure to precipitation or running water can deplete the treatment chemical from the wood. Diffusion of the chemical into the wood carries on in the presence of adequate wood moisture after the pressure process has been terminated.

### **5.2 Potential Chemical Discharges**

Borate wood preservation plant designs and operational practices vary, and within each plant there are various potential emission sources that may affect the adjacent environment and/or worker health. The potential sources and types of releases are illustrated in Figure 1.

#### *Liquid Discharges*

The borate process uses water as a solvent. Therefore, drippage collected on the pad or rainwater collected in the process areas can be reused within the process. The process technology and economics have led the borate wood preservation industry to use closed treatment systems that contain, collect and reuse the chemical mixture to the greatest possible extent. Primary elements that may be used for borate containment and recycling are essentially the same those used in pressure treatment facilities applying other water-borne preservatives.

Under normal operating practices, liquid discharges from a borate treatment facility are confined to liquids that are not contained and reused within the process. For example, stormwater runoff from unpaved and unroofed treated-product storage areas might be the most common liquid from a borate treatment facility. The quantity of borate in such waters depends on many factors, such as quantity of precipitation, the degree of wrapping prior to the precipitation event, and soil characteristics of the storage yard. Uncontained liquid releases other than stormwater are generally confined to yard soils. Potential for groundwater contamination exists in locations where drip pads are not used in discharging areas or where the pad areas are inadequate to hold the treated wood until wrapping is accomplished.

### *Solid Wastes*

Solid waste generation at borate facilities should be minimal. During normal operating conditions, solid waste is limited to cartridge filters that are used for dust and debris removal from recycled water and to the debris and sludge that are periodically removed from the sump, cylinder and tanks. Treated wood, such as stickers, cut-offs or broken products are another source of solid wastes.

### *Air Emissions*

Potential sources of air emissions include mists from vacuum pump exhausts, cylinder doors and tank vents. At this time, no air emissions monitoring data are available from borate treatment plants.

Refer to Part 1 – Chapter A, [Section 5.2](#) for more details on potential chemical discharges.

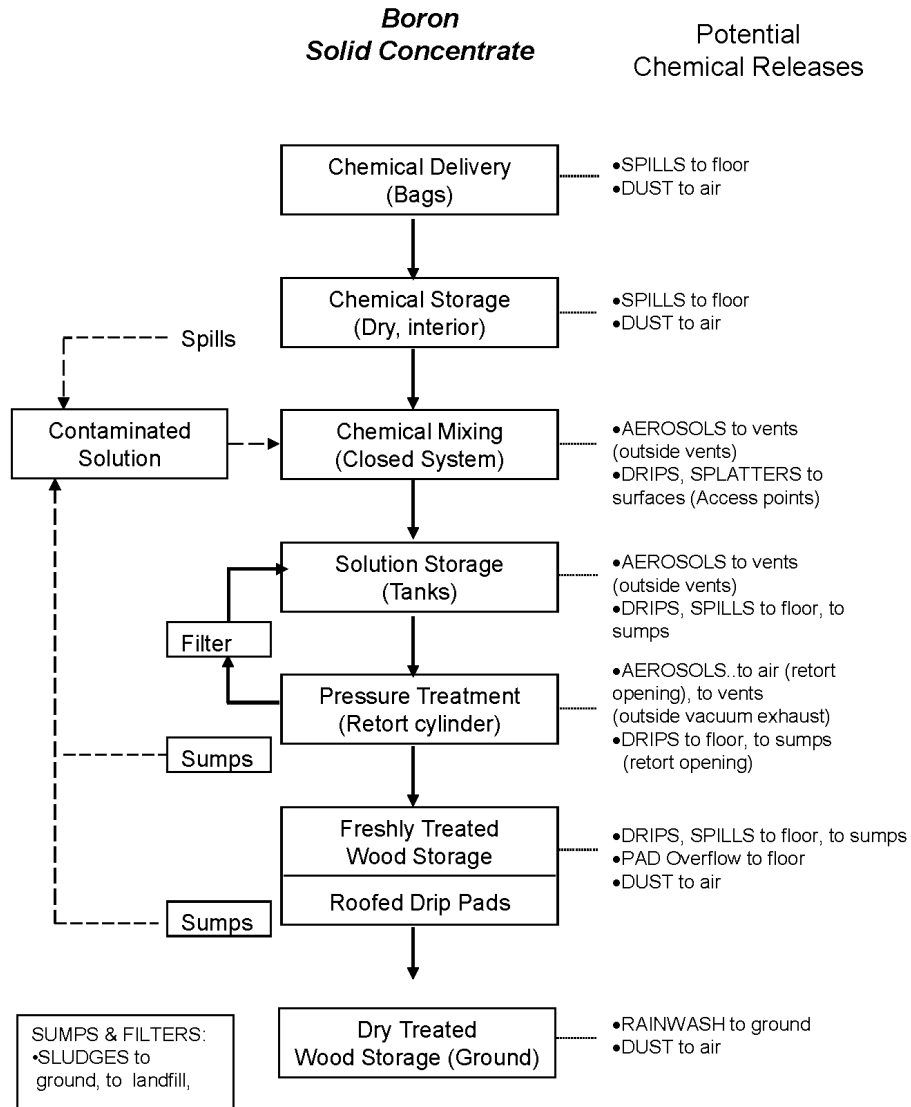
## **5.3 Potential Effects of Chemical Discharges**

The actual impact on the environment of any chemical release depends on many factors, including the location of the wood preservation facility relative to ground and surface waters, the amount associated with the releases, and contingency measures in place at the facility.

Borates have only been recently introduced into Canada and no environmental assessments from plants are available as of January 2004. It is not expected that there would be environmental and worker health effects in facilities that respect normal operating practices. Although borates have relatively low fish toxicity, contamination of water bodies must be prevented. Boron is an essential micronutrient for plants, but it can be harmful in large quantities via absorption through plant roots.

Borates also have a low vapour pressure. Treatments under ambient temperature would not represent substantial air quality issues. With elevated process conditions, vapour generation would be increased. However, any air releases would likely be in the form of localized mists, and the effect of a facility on the surrounding environment is expected to be of little consequence.

**Figure 1 Potential Releases from Borate Pressure Treating Plants**



## 6 Protection of Personnel

For general comments, and for recommendations on precautions and personal hygiene measures on personnel exposure and protection, refer to Part I – Chapter A, [Section 6](#). All comments and recommendations in that section are applicable to borate wood preservation facilities.

### 6.1 *First Aid Precautions and Hygiene for Borate Exposure*

The general rule for dealing with exposure is as follows: the higher the concentration of a preservative to which a worker is exposed, the greater the need for protective measures and immediate response if contact occurs. If there is any doubt as to the concentration, the response should be the same as for the most concentrated form.

Facility staff should have access to product labels and appropriate training to apply first aid. Artificial respiration should not be performed without the use of a barrier device, as the injured person may be contaminated (on skin) with boron solution, making the first aider the next victim if direct mouth-to-mouth contact is made.

Disodium octaborate tetrahydrate is not considered an acute poison. See Section 4 – Human Health Concerns.

For all medical attention, always take the pesticide label to show to the health personnel.

**Table 5. First Aid Measures for Exposure to Borate**

Exposure (17)	First action	Second action
<b>Eye contact</b>	<ul style="list-style-type: none"> <li>• Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids (no rubbing).</li> <li>• If exposed person wears contact lenses, remove those 5 minutes after rinsing and then continue for at least 10 minutes.</li> <li>• Flush eyes for at least 15 minutes.</li> </ul> <p><i>Workers should not wear contact lenses</i></p>	<ul style="list-style-type: none"> <li>• Call an industrial physician or poison control centre immediately for subsequent advice (have product label at hand).</li> <li>• Get medical attention.</li> </ul>
<b>Skin contact</b>	<ul style="list-style-type: none"> <li>• Flush contaminated area immediately with flowing water.</li> <li>• Subsequently remove contaminated clothing.</li> <li>• Continue to flush contaminated skin for at least 15–20 minutes.</li> </ul>	<ul style="list-style-type: none"> <li>• Call an industrial physician or poison control centre immediately for subsequent advice (have product label at hand).</li> <li>• Get prompt medical attention if the skin becomes inflamed (redness, itchiness or pain).</li> </ul>
<b>Inhalation</b>	<ul style="list-style-type: none"> <li>• Immediately remove the exposed person to fresh air.</li> <li>• If breathing has stopped: <ul style="list-style-type: none"> <li>▪ call emergency services (ex. 911)</li> <li>▪ apply artificial respiration with barrier device</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Keep the affected person warm and quiet.</li> <li>• Get immediate medical attention (have product label at hand).</li> </ul>
<b>Ingestion</b>	<ul style="list-style-type: none"> <li>• Call an industrial physician or poison control centre immediately for treatment advice (have product label at hand).</li> <li>• Promptly have the exposed person sip water if able to swallow.</li> </ul>	<ul style="list-style-type: none"> <li>• Never give liquids to an unconscious person.</li> <li>• Do not induce vomiting.</li> </ul>
<b>Chronic symptoms requiring medical attention</b>	<ul style="list-style-type: none"> <li>• <b>There is no information on any adverse chronic effects of industrial use of borates.</b></li> </ul>	

## 6.2 Regulatory Controls

The label for pesticide products contains information on the minimum necessary protective equipment and practices for using the product. The worker protection measures on the pesticide label are mandatory. Provincial or municipal regulations may require additional measures that may enhance, but not reduce, protection. [Table 7](#) in Chapter A can be used to summarize the local regulatory threshold limit values (TLVs) and/or biological exposure indices (BEIs) applicable to the plant.

Specific limits for worker protection are generally prescribed by provincial regulations. Consult your local authorities for specific applicable regulations.

#### *Skin and Eye Contact*

There is no suggested “biological exposure indices” (BEI) that are developed for boron by the American Conference of Governmental Industrial Hygienists (ACGIH).

#### *Inhalation*

Most regulatory criteria established by worker protection agencies are based on TLVs and BEIs recommended by the ACGIH (18)

The ACGIH has defined TLVs for many substances based on exposure by inhalation and/or skin exposure. The ACGIH limits for Boron are based solely on exposure by inhalation. The TLVs are stipulated by the ACGIH as those “airborne concentrations of substances to which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects.” The ACGIH-recommended limits for Inorganic Borate compounds and Boron oxide. ACGIH refers to disodium octaborate tetrahydrate (DOT) as a “particulate not otherwise classified” or “nuisance dust” and are summarized in Table 4.0 above with the following provisos of the ACGIH:

- “The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use” (i.e. proof or disproof of the cause of an existing disease or physical condition).
- “The limits are not fine lines between safe and dangerous concentrations.”
- “In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical.”
- “When two or more hazardous substances, which act upon the same organ system, are present, their combined effect, rather than that of either individually, should be given primary consideration.”

#### *Ingestion*

Oral intake of Boron must be avoided. Ingestion of liquids containing Boron is unlikely if workers follow the safety precautions outlined in Chapter A, [Table 8](#). Upper limits of ingestion are not prescribed by regulation, because it is generally expected that no such intake will occur.

### **6.3 Safety Precautions**

Workers need to familiarize themselves with the safety precautions mentioned in Chapter A, [Section 6.3](#). Sensitive individuals should take special care to avoid exposure.

Boron compounds are currently under re-evaluation at the PMRA. The safety precautions outlined on the pesticide labels must be followed.

## 6.4 Biological Monitoring of Exposed Workers

Although boron is not acutely toxic, workers can have different sensitivity tolerance to it. Biological monitoring can be a useful tool for evaluating the health of workers and the long-term effectiveness of the protective measures applied. Routine biological monitoring of exposed workers (primarily those who handle preservatives and treated wood, e.g., plant operators and quality control personnel) is recommended. Refer to Chapter A, [Section 6.4](#)

## 7 Design Recommendations

The following tables present additional good design features specifically applicable to borate wood preservation facilities. The additional recommendations made here must be used in conjunction with the basic design criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 7](#) and their corresponding tables. All tables of general content from Chapter A, Section 7 must be taken into consideration.

**Table 10. Additional Recommended Design Features for Chemical Delivery Areas**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 10.)

Objective: To provide an off-loading area that enhances spill prevention and containment		
Delivery format	Design feature	Recommendations
Borate (bags)	Area cleanup	<ul style="list-style-type: none"><li>• Provide a vacuum cleaner with a filter capable of filtering particles 1 micrometer in diameter or smaller for cleanup of solids spilled during unloading and transfer operations.</li></ul>

**Table 11. Additional Recommended Design Features for Chemical Storage Areas**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 11.)

Storage format	Design feature	Recommendations
Borates (bags)	Objective: To provide sheltered, secure, fire-protected storage of borate solids	
	Shelter	<ul style="list-style-type: none"><li>• Provide storage in an enclosed, secure area, segregated from other chemicals (design to prevent infiltrating precipitation). Note: moisture leads to caking of borate.</li><li>• Design to prevent fire in storage areas (use of non-combustible construction materials is preferred).</li></ul>
	Containment / clean-up	<ul style="list-style-type: none"><li>• Provide a vacuum cleaner with a filter capable of filtering particles 1 micrometer in diameter or smaller for cleanup of solids spilled during unloading and transfer operations.</li></ul>

**Table 12. Additional Recommended Design Features for Chemical Mixing Systems**

(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 12)

Design feature	Recommendations
Solids handling	<ul style="list-style-type: none"><li>• Provide a dry, paved area for bag opening.</li></ul>
	<ul style="list-style-type: none"><li>• Provide a vacuum cleaner for effective cleanup of dusts.</li></ul>

**Table 14. Additional Recommended Design Features for Freshly Treated Wood Drip Areas**

([Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 14](#))

Design feature	Recommendations
Drip area	<ul style="list-style-type: none"><li>• Provide a sheltered, contained area to wrap treated wood prior to releasing it to an unprotected area (i.e. exposed to precipitation and uncontained ground).</li></ul>

**Table 16. Additional Recommended Design Features for Treated Wood Storage Areas**

([Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 16](#))

Treated wood that is not protected from precipitation and running water will leach; - ensure that all treated wood is wrapped prior to release into open storage.
--



## 8 Operational Recommendations

The recommendations made here must be used in conjunction with the basic operational criteria listed in Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8](#) and their corresponding tables. All tables of general content from Chapter A, Section 8 must be taken into consideration.

### 8.1 Operational Standards

The registered pesticide labels are legal documents that must be followed when treating wood with wood preservatives. The labels state the required PPE, the acceptable treatment solution concentrations and the target retention rates within the wood. While not a legal requirement, the CSA O80 Series of Standards specifies a number of additional requirements and recommendations related to wood preservatives, including Boron. Those standards should be followed and applied in respect of applicable laws and regulations. Process controls should be installed, maintained and calibrated in accordance with CSA O80.2 08 Clause 4.1 (referenced to AWWPA M3). The calibration can be conducted by facility staff if they have the appropriate training.

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, [Section 8.1](#).

### 8.2 Facility Wide Recommendations

Refer to Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 8.2 and consult [Table 17](#) and [Table 18](#).

### 8.3 Process Area-specific Recommendations

**Table 20. Additional Recommended Operating Practices for Borate Process Systems**  
(Use in conjunction with Part I, Chapter A – General Recommendations for All Wood Preservatives, Table 20)

Operation	Recommendation
<b>Routine checks</b>	Objective: To define procedural practices that will enhance environmental and worker safety.
Treatment	• It is recommended that no or only a slight final vacuum be applied.
cylinder	• Keep net retentions as close as possible to specified levels.

All treated wood must be protected from precipitation (wrapped) until final installation.

## **9 Waste, Process Emissions and Disposal**

For general information on process emissions and disposal, consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.1 Control, Treatment and Disposal**

Potential process emission sources from borate wood preservation facilities are described in Figure 1 and in Section 5.2. Recommended practices for handling liquid and solid wastes and sludge are presented in Chapter A, [Table 23](#).

Federal and provincial regimes address hazardous waste and hazardous recyclable material in different manners. Provincial requirements may also differ from province to province. Consult your provincial authority for more information. Borates are generally considered nonhazardous waste when spilled or disposed of. When borate is spilled into water, advise local water authorities that none of the affected water should be used for irrigation or for potable water until natural dilution returns to its normal environmental background level.

### **9.2 Liquids Containing Boron**

#### *Liquid Process Wastes*

Liquid process wastes are not normally discharged from borate plants. Liquid solutions containing boron, such as drips and washwaters, are routinely collected and reused in preparing new treatment solutions. If unusual circumstances (such as prolonged plant shutdown) prevent on-site reuse, transport to another borate facility (for reuse) should be arranged. Disposal should be considered only as a last alternative.

### **9.3 Solids with High Boron Concentrations**

Consult [Section 9](#) of Part I, Chapter A – General Recommendations for All Wood Preservatives.

### **9.4 Miscellaneous Solid Wastes**

Miscellaneous solid wastes (e.g. plastic wrappers, chemical bags, cuttings from boron-treated lumber) from borate wood preservation plants may be disposed of at designated sanitary landfills as approved by the provincial regulatory agency.

- Do not use boron-treated wood as a compost or mulch.
- Incineration of materials contaminated with boron is not permitted except in facilities authorized for disposal of such products because of the formation of toxic combustion by-products.

## **9.5    *Air Emissions***

Air emissions at borate facilities are normally localized; effects, if any, would be restricted to workers at the facilities. Air emissions from borate facilities include the following:

- exhaust from tank vents
- mists from vacuum pump discharge
- mists from opening of retort cylinder doors

## 10 Environmental and Workplace Monitoring

### 10.1 Baseline Environmental Evaluation

Boron [B] is the element in disodium octaborate tetrahydrate that is used by convention to report ecological effects of borate products. It occurs naturally in rock, soils, and fresh and salt water (19). Table 24 presents natural background levels (6).

**Table 24. Typical Background Levels of Boron**

Element	Typical concentration in non-polluted environments	
	Surface waters (mg/L) (11)	Soils (19)
Boron (B)	0.0001–2.58 Typical boron concentrations are less than 0.1 mg/L	2–100 <b>mg/kg</b>

Considerable variability in natural concentrations of boron occurs in soils and waters. Therefore, it is important to determine background levels of the site immediately prior to operating a facility, to enable meaningful future assessments of pollution control at the facility. Older mills may not have this information available. A comparative site from a nearby property can be used as a reference.

### 10.2 Environmental Monitoring

Disodium octaborate tetrahydrate (boron) is measured in its oxidized form as boric acid in water. Boron facilities have the potential to contaminate groundwater in the immediate vicinity of the facilities to levels that can pose a risk to aquatic organisms. Additional monitoring studies (such as surface water discharges, groundwater and contaminated soil) are recommended to properly assess the degree of such releases.

### 10.3 Workplace Exposure Monitoring

A monitoring program must be designed to ensure that there are adequate monitoring sites and that the frequency of monitoring and the detection limits of the preservation constituents, detection levels and quality control are defined. Worker health programs should be developed with provincial and/or local regulatory agencies in consultation with a provincial workers' compensation board and/or department of labour and/or industrial physician/industrial hygienist. The NIOSH suggested measurement method for ambient air concentration is [NIOSH 0500](#).

The appropriate components of a site and worker exposure monitoring program are contained in Section 10.2 of Part I, Chapter A – General Recommendations for All Wood Preservatives: [Table 25](#) – Recommended Routine Environmental Monitoring and [Table 26](#) – Recommended Routine Workplace Monitoring.

## 11 Transportation of Preservative Solids, Solutions and Wastes

The transportation of Boron concentrates, solutions and the wastes generated by their use is regulated under the federal *Transportation of Dangerous Goods Regulations* (TDGR) and the *Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations* (EIHWHRMR) under the *Canadian Environmental Protection Act, 1999* (CEPA 1999).

For more details, please refer to the following links:

For TDGR: <http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

For EIHWHRMR: <http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

The recommended transportation procedures are abstracted in Part I, Chapter A – General Recommendations for All Wood Preservatives, Section 11, [Table 27](#).

It is recommended that wood preservation facility operators consult their provincial and/or local regulatory agency regarding any specific requirements for transportation of Boron and its wastes.

## 12 Environmental Emergency Notification and Contingency Planning

Preparedness for emergencies is essential in any wood preservation facility. Hence, facilities using borates should prepare detailed contingency plans and have them readily available to ensure that response to spills and fires is quick, safe and effective. It is recommended that the individual facility plans be filed with the authorities that have jurisdiction over the facility.

Regular drills will enhance a plant's preparedness.

No special requirements exist for borates; the basic spill and fire planning components are listed in Part I, Chapter A, [Section 12](#). A copy of the fire contingency plan and all necessary documents should be stored in a fire proof box outside the entrance to the facility.

## 13 References

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2. Wood Preservation Canada / Préservation du bois Canada. 2011. Personal communication between Henry Walthert, CAE Executive Director and Alain Gingras, Environment Canada.
3. Woods, W.G. 1994. An introduction to boron: history, sources, uses, and chemistry. *Environ Health Perspect* 102(Suppl 7):5–11.
4. Bradford, G.R. 1966. Boron. In H.D. Chapman, editor, *Diagnostic criteria for plants and soils*. Division of Agricultural Science, University of California. p. 33.
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8. United States Environmental Protection Agency (USEPA). 2004. TOXICOLOGICAL REVIEW OF BORON AND COMPOUNDS, (CAS No. 7440-42-8), In Support of Summary Information on the Integrated Risk Information System (IRIS). June 2004, EPA 635/04/052. Washington (DC): U.S> Environmental Protection Agency. Available from: <http://www.epa.gov/iris/toxreviews/0410tr.pdf>
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12. Thompson, J.A.J., J.C. Davis and R.E. Drew. 1976. Toxicity, uptake and survey studies of boron in the marine environment. *Water Res* 10:869–875.
13. Birge, W.J. and J.A. Black. 1977. Sensitivity of vertebrate embryos to boron compounds. U.S. Environ. Prot. Agency Rep. 560/1-76-008. 66 pp.
14. Eisler, R. 1990. Biological Report 85(1.20) Contaminant Hazard Reviews, April 1990. Report 20, Boron Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review, by U.S. Fish and Wildlife Service. Laurel (MD): Patuxent Wildlife Research Center.

15. United States Environmental Protection Agency (USEPA). 2008. Drinking Water Health Advisory For Boron, Prepared by: Health and Ecological Criteria Division, Office of Science and Technology, Office of Water. May, 2008. Document Number: 822-R-08-013. Available from : <http://www.epa.gov/waterscience/>
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19. Woods, G.W. 1992. An Introduction to Boron – History, Sources, Uses and Chemistry. Presentation to International Symposium on the Health Effects of Boron and its Components, University California, September 1992.







# Part III

## Appendices

<a href="#"><u>Appendix I</u></a>	Useful Links and Guidance Documents
<a href="#"><u>Appendix II</u></a>	Preventative Maintenance Programs Sample Checklists
<a href="#"><u>Appendix III</u></a>	24/7 Emergency Contact Numbers
<a href="#"><u>Appendix IV</u></a>	Pesticides Labels
<a href="#"><u>Appendix V</u></a>	Additional Documents

**Appendix I**

**Useful Links**

**and**

**Guidance Documents**

# **Federal Government**

## **Federal Departments and Agencies**

Environment Canada:

[http://www.ec.gc.ca/CEPA Environmental Registry](http://www.ec.gc.ca/CEPA/Environmental%20Registry)  
[Environmental Emergencies](#)  
[Environmental Enforcement](#)  
[Pollution and Waste](#)  
[Hazardous Waste and Recyclable Material](#)

Fisheries and Oceans Canada: Canadian Coast Guard

<http://www.ccg-gcc.gc.ca/eng/CCG/Home>

Health Canada:

<http://www.hc-sc.gc.ca/index-eng.php>  
Pest Management Regulatory Agency (PMRA)  
<http://www.hc-sc.gc.ca/pmra-arla/english/pubs/pubs-e.html>

Transport Canada:

<http://www.tc.gc.ca/eng/menu.htm>  
[CANUTEC](#)

Publication Canada

<http://publications.gc.ca/site/eng/home.html>

## **Federal Acts and Regulations**

*Canadian Environmental Protection Act, 1999* (S.C. 1999, c. 33)

<http://laws-lois.justice.gc.ca/eng/acts/C-15.31/index.html>  
<http://www.ec.gc.ca/pollution/default.asp?lang=En&n=A24743CC-1>

*Export and Import of Hazardous Waste and Hazardous Recyclable Material Regulations*

<http://www.laws-lois.justice.gc.ca/eng/regulations/SOR-2005-149/>  
<http://www.ec.gc.ca/gdd-mw/default.asp?lang=En&n=8BBB8B31-1>

*Environmental Emergency Regulations*

<http://www.laws-lois.justice.gc.ca/eng/regulations/SOR-2003-307/>  
<http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=8A6C8F31-1>

*Fisheries Act* (R.S.C., 1985, c. F-14)

<http://laws-lois.justice.gc.ca/eng/acts/F-14/index.html>  
<http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14151-eng.htm>

*Hazardous Products Act* (R.S.C., 1985, c. H-3)

<http://laws-lois.justice.gc.ca/eng/acts/H-3/index.html>

*Pest Control Products Act* (S.C. 2002, c. 28) and Regulations

<http://laws-lois.justice.gc.ca/eng/acts/P-9.01/index.html>

<http://laws-lois.justice.gc.ca/eng/regulations/SOR-2006-124/>

*Transportation of Dangerous Goods Act* (S.C. 1992, c. 34)

<http://www.tc.gc.ca/eng/tdg/safety-menu.htm>

<http://laws-lois.justice.gc.ca/eng/acts/T-19.01/index.html>

<http://laws-lois.justice.gc.ca/eng/regulations/SOR-2001-286/index.html>

Regulations amending the *Transportation of Dangerous Goods Regulations* (SOR/2011-239), November 9, 2011, *Canada Gazette*, Part II, Vol. 145, No. 23. Amendment 8.

<http://www.gazette.gc.ca/rp-pr/p2/2011/2011-11-09/html/sor-dors239-eng.html>

<http://www.tc.gc.ca/eng/tdg/clear-tofc-211.htm>

*Interprovincial Movement of Hazardous Waste Regulations* (SOR/2002-301)

<http://laws-lois.justice.gc.ca/eng/regulations/SOR-2002-301/index.html>

## **Agreements / Protocols**

Great Lakes Binational Toxics Strategy

<http://www.epa.gov/greatlakes/p2/bns.html#Appendix%20I>

Canada–Ontario Agreement Respecting the Great Lakes Basin Ecosystem

<http://www.ec.gc.ca/grandslacs-greatlakes/default.asp?lang=En&n=B903EE0D-1>

St-Laurence Action Plan 2011-2026

<http://planstlaurent.qc.ca/en.html>

## **Technical Guidance Documents**

Recommendations for the Design and Operation of Wood Preservation Facilities, 2004

<http://publications.gc.ca/site/eng/455003/publication.html>

Technical Guidelines for the Design and Operation of Wood Preservation Facilities, 2004

<http://publications.gc.ca/site/eng/454999/publication.html>

Industrial Treated Wood Users Guidance Document

<http://publications.gc.ca/site/eng/455006/publication.html>

National Guidelines for Decommissioning Industrial Sites

[http://www.ccme.ca/assets/pdf/pn\\_1074\\_e.pdf](http://www.ccme.ca/assets/pdf/pn_1074_e.pdf)

CEPA Guidelines / Codes of practice

<http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=E9DBBC31-1>

Canadian Environmental Quality Guidelines

<http://ceqg-rcqe.ccme.ca/>

These guidelines were developed by the Canadian Council of Ministers of the Environment (CCME) representing federal, provincial and territorial governments.

Federal Environmental Quality Guidelines (FEQGs)

<http://www.chemicalsubstanceschimiques.gc.ca/fact-fait/feqg-recommand-eng.php>

FEQGs support federal environmental quality monitoring and risk assessment and risk management activities on substances not yet covered by the Canadian Environmental Quality Guidelines developed by the Canadian Council of Ministers of the Environment (CCME).

Canadian Soil Quality Guidelines for Copper: Environmental and Human Health

<http://ceqg-rcqe.ccme.ca/download/en/263/>

Canadian Soil Quality Guidelines for Pentachlorophenol: Environmental and Human Health

<http://ceqg-rcqe.ccme.ca/download/en/276/>

Canadian Soil Quality Guidelines

<http://ceqg-rcqe.ccme.ca/download/en/342/>

Provisional Code of Practice for the Management of Post-Use Treated Wood

[http://www.ccme.ca/assets/pdf/pn\\_1227\\_e.pdf](http://www.ccme.ca/assets/pdf/pn_1227_e.pdf)

Canada-wide standards for Dioxins and Furans

[http://www.ccme.ca/assets/pdf/d\\_and\\_f\\_standard\\_e.pdf](http://www.ccme.ca/assets/pdf/d_and_f_standard_e.pdf)

NIOSH Pocket Guide to Chemical Hazards

<http://www.cdc.gov/niosh/npg/>

The NIOSH Pocket Guide (NPG) to Chemical Hazards is intended as a source of general industrial hygiene information on several hundred chemicals/classes for workers, employers, and occupational health professionals.

## **Provinces**

### **Provincial Acts and Regulations**

#### **Alberta**

*Water Act*

*Environmental Protection and Enhancement Act*

#### **British Columbia**

*Waste Management Act*

*Environmental Management Act*

*Integrated Pest Management Act (Pesticides Control Act)*

*Workers Compensation Act*

#### **Manitoba**

*Dangerous Goods Handling and Transportation Act*

*Environment Act*

#### **New Brunswick**

*Clean Environment Act*

#### **Newfoundland and Labrador**

*Department of Environment Act*

#### **Nova Scotia**

*Environmental Protection Act, SNS, 1973*

*Dangerous Goods and Hazardous Wastes Management Act, SNS, 1986*

#### **Ontario**

*Dangerous Goods Transportation Act*

*Environmental Protection Act*

*Health Protection and Promotion Act*

*Lakes and Rivers Improvement Act*

*Ontario Water Resources Act*

*Pesticides Act*

*Occupational Health and Safety Act*

#### **Prince Edward Island**

*Environmental Protection Act*

#### **Quebec**

*Loi sur la qualité de l'environnement (Environmental Quality Act)*

*Loi sur la santé et la sécurité du travail (An Act respecting Occupational Health and Safety)*

*Code de la sécurité routière (Highway Safety Code)*



**Saskatchewan**

*Environmental Management and Protection Act, 2010*  
*Clean Air Act*

**Newfoundland and Labrador**

*The Department of the Environment Act*

**Standards****Canadian Standards Association (CSA)**

CAN/CSA-O80 SERIES-08 (R2012) CONSOLIDATED

<http://shop.csa.ca/en/canada/wood/canca-o80-series-08/inv/27005992008/&bklist=icat,5,shop,publications,construction,wood>

**Western Wood Preservers Institute**

Best Management Practices (wetlands and aquatic environments)

<http://www.wwpinstitute.org/aquatics.html>

Recommended American and Canadian guidelines for the production and use of treated wood products in aquatic and other sensitive environments.

## **Appendix II**

### **Preventative Maintenance Programs**

#### **Sample Checklists**

## **Preventative Maintenance Program**

The objective of a preventative maintenance program (PMP) is to conduct and document regular inspections of all equipment to ensure that everything is in good working order and that any equipment problems are addressed immediately.

To conduct a PMP a facility should have:

- plant-specific written instructions for all equipment.
- routine inspections (frequency could differ between preservatives and plants).
- documentation, compilation and revision of the information
- identify the need for special attention to persistent problems.
- checklists as method for implementation of the PMP

Items for consideration on the checklists include:

### **Daily Checklist**

- Visual inspection of process equipment during operation (per shift or daily) including tanks, pumps, sumps, cylinder and piping.
- Drip trays for valves. Any free liquid should be removed.
- Drip trays for pumps. Any free liquid should be removed.
- Sumps should not have free standing liquid since it will not allow for inspection.
- Records for chemical delivery and use including transfers to and from the concentrate tank as they occur and transfers to and from the work tanks as they occur.
- Floor surfaces (unloading area, tank farm, drip pad) for damage or cracks. Clean as required but surfaces should be kept clean enough to allow for inspection.
- Air compressor – check for leaks and oil levels. (Could be weekly for some plants).
- General cleaning as required.

### **Weekly checklist**

- Tank, containment, sump and emergency alarms circuitry.
- Spill response equipment
- Sludge level in cylinders
- Treating solution component balance
- Filters: check and replace as required (could be more frequent for some plants).
- Grease cylinder door wedges and door ring.
- Inspect/grease (if required) trams or rollers.
- Inspect fixation chamber floor and sump and clean as required.
- General cleaning: perform as required.

### **Monthly checklist**

- Inventory of concentrate and working solution volumes.
- Fire alarms, fire extinguishers and emergency lighting.
- First aid and eye wash stations.

- Cylinder door autolock.
- General cleaning: perform as required.

### **Semi-annual checklist**

- Check and document that all valves not used regularly within the 6 month period are working.
- Obtain print out of containment alarm (minimum) records from alarm company.

### **Annual \* checklist**

- Calibrate level indicators, process control equipment and recording and indicator instruments.
- Test alarm probe.
- Check for vent blockage.
- Check tank sludge levels and clean if required.
- Check tank exterior for corrosion.
- Obtain cylinder inspection certificates (or equivalent).
- Check backflow preventer or as per manufacturer's instructions.
- Conduct indoor air testing.
- Conduct underground tank testing, if present, but this type of tank is not recommended.
- Conduct environmental monitoring.
- Conduct biological monitoring.
- Review training requirements.
- Conduct spill enactment drill.
- Conduct fire response drill.

\* All chemical storage tanks should be tested every 5 years and deemed suitable for the intended use by an external accredited testing company or agency.

All items on these checklists should be documented, including indicating the completion date and person conducting the inspection or work.

## **Appendix III**

### **24/7 Emergency Contact Numbers**

## Emergencies involving the transport of dangerous goods

### 24/7 contact numbers for CANUTEC:

Emergency: 613-996-6666 (accepts collect calls)

Cellular: \* 666 (in Canada only)

<http://www.tc.gc.ca/eng/canutec/menu.htm>

**CANUTEC, the federal Canadian Transport Emergency Centre**, is operated by Transport Canada's Transportation of Dangerous Goods Directorate.

## Province / Territory emergencies 24/7 contact numbers

<p><b>Alberta</b> Alberta Environment and Sustainable Resource Development Telephone: 780-422-4505 or 1-800-222-6514</p> <p><b>British Columbia</b> Emergency Management BC Ministry of Public Safety and Solicitor General Telephone: 1-800-663-3456</p> <p><b>Manitoba</b> Department of Conservation Telephone: 204-944-4888 (collect calls accepted within province)</p> <p><b>New Brunswick</b> Maritimes Regional Office Canadian Coast Guard Fisheries and Oceans Canada Telephone: 902-426-6030 or 1-800-565-1633</p> <p><b>Newfoundland and Labrador</b> Newfoundland and Labrador Regional Office Canadian Coast Guard Fisheries and Oceans Canada Telephone: 709-772-2083 or 1-800-563-9089</p> <p><b>Northwest Territories</b> Department of Environment and Natural Resources Government of the Northwest Territories Telephone: 867-920-8130</p> <p><b>Nova Scotia</b> Maritimes Regional Office Canadian Coast Guard Fisheries and Oceans Canada Telephone: 902-426-6030 or 1-800-565-1633</p>	<p><b>Nunavut (uses NWT emergency contact)</b> Department of Environment and Natural Resources Government of the Northwest Territories Telephone: 867-920-8130</p> <p><b>Ontario</b> Spills Action Centre Ministry of the Environment Telephone: 416-325-3000 or 1-800-268-6060</p> <p><b>Prince Edward Island</b> Maritimes Regional Office Canadian Coast Guard Fisheries and Oceans Canada Telephone: 902-426-6030 or 1-800-565-1633</p> <p><b>Quebec</b> Important: You <b>must</b> contact both the provincial and the federal numbers in Quebec</p> <p>Environmental Protection Operations Directorate, Quebec Environment Canada Telephone: 514-283-2333 or 1-866-283-2333 and Urgence-Environnement Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs 1-866-694-5454</p> <p><b>Saskatchewan</b> Ministry of Environment Telephone: 1-800-667-7525</p> <p><b>Yukon</b> Environment Yukon Telephone: 867-667-7244</p>
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This list is also available at the following Environment Canada website:

<http://www.ec.gc.ca/ee-ue/default.asp?lang=En&n=EED2E58C-1>

Last updated: June 26, 2013

## **Appendix IV**

# **Pesticides Labels**

Please insert copies of the most recent pest control product labels of  
the registered pesticides used within your facility

## **Appendix V**

# **Additional Documents**