Environment and
Climate Change Canada

Environnement et
Changement climatique Canada

Guidance for Wood Preservation Facilities to the National Pollutant Release Inventory

Cat. No.: En84-265/2021E-PDF
ISBN: 978-0-660-39048-2
EC8357

Report last reviewed and updated in 2017

Environment and Climate Change Canada
Public Inquiries Centre
12th Floor, Fontaine Building
200 Sacré-Coeur Boulevard
Gatineau QC K1A 0H3
Telephone: 819-938-3860
Toll Free: 1-800-668-6767 (in Canada only)
Email: enviroinfo@ec.gc.ca

Aussi disponible en français

Acknowledgements

Prepared by: Manufacturers/ Treaters Steering Committee – National Pollutant Release Inventory (NPRI) Reporting Working Group

In collaboration with:

Paul A. Cooper & Associates, Toronto, Ontario

H. M. Rollins Company, Inc., Gulfport, MS, USA

NPRI National and Regional Offices

With contributions by:

Terry Mah, Environment Canada
Andrea Moore, Environment Canada

Table of Contents

List of Tables

List of Figures

Preface

Environment Canada and Health Canada developed a process for managing environmental contaminants under the *Canadian Environmental Protection Act* (CEPA). This process involved establishing a Priority Substances List, performing an assessment of toxicity, and developing a risk-management strategy through a Strategic Options Process (SOP). As part of the Strategic Options Process for the Wood Preservation Sector, recommendations for the most effective options for reducing exposure to the following CEPA-toxic substances were developed by stakeholders:

- chromium VI
- inorganic arsenic compounds
- polycyclic aromatic hydrocarbons (PAHs)
- creosote-impregnated waste materials
- polychlorinated dibenzodioxins (dioxins)
- polychlorinated dibenzofurans (furans), and
- hexachlorobenzene (HCB).

The Wood Preservation Sector SOP developed recommendations for those industry-related activities that cause the release of these CEPA-toxic substances. The final report from the Issue Table, *Strategic Options for the Management of CEPA-Toxic Substances from the Wood Preservation Sector – Final Report from the Issue Table*, was made publicly available in July 1999.[1] This publication is referred to as the Strategic Options Report (SOR).

For wood preservative manufacturers and treatment plants, Environment Canada's National Pollutant Release Inventory (NPRI) was identified in the SOR as the mechanism that will be used to track releases and transfers of the above-noted CEPA-toxic substances on an annual basis. As identified in Recommendation B3 of the SOR, **all** wood preservative manufacturing and treatment facilities in Canada **must examine the criteria and determine if they are required** to report all releases and transfers of the applicable CEPA-toxic substances each year.

The number of substances listed on the NPRI is subject to change as substances can be added, removed or regrouped. Refer to the *Canada Gazette Part I* Notice for the year being reported for the relevant list of reportable substances to the NPRI.

---

[1] The final report from the Issue Table can be downloaded electronically from the following Environment Canada Web site: http://www.ec.gc.ca/sop/wood-bois/pubs/sor_e.htm.

It is important to note the following:
The Wood Preservation Sector SOP only addresses CEPA-toxic substances that are manufactured, processed or used by the wood preservation sector. If facilities meet the reporting criteria for other NPRI-listed substances, such as ammonia – total, copper (and its compounds), zinc (and its compounds), mercury, naphthalene, and anthracene, criteria air contaminants, or other NPRI listed substances they are legally obligated to file an NPRI report to Environment Canada by the deadline date.

This guide only addresses wood preservatives that contain the CEPA-toxic substances listed above and one formulation of ammoniacal copper quaternary (ACQ). Facilities should consult the guidance material and *Canada Gazette Part I* Notice for the year being reported to determine the reporting requirements for other wood preservatives and their components including ACQ and Copper Azole.

Disclaimer

The *Guidance for Wood Preservation Facilities Reporting to the National Pollutant Release Inventory* (referred to as the Guide) is intended **only** to assist owners and operators of wood preservative manufacturing and treatment facilities in reporting releases and transfers to the NPRI. This Guide **does not replace or substitute in any manner** the official guidance documents listed below that are published and provided by the NPRI for reporters. All wood preservation manufacturing and treatment facilities should refer specifically to the following NPRI documents for the year being reported:

- *Guide for Reporting to the National Pollutant Release Inventory*
- *Supplementary Guide for Reporting to the National Pollutant Release Inventory – Alternate Thresholds*
- *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)*

Furthermore, should any inconsistencies be found between this Guide, the official NPRI guidance documents identified above, and the official *Canada Gazette Part I* Notice, the *Canada Gazette Part I* Notice for the year being reported will prevail.

I Introduction

Environment Canada and Health Canada developed a process for managing environmental contaminants under the *Canadian Environmental Protection Act* (CEPA) that consisted of the following stages:

- identification of potentially toxic chemicals;
- assessment of the risk to the Canadian environment and population; and
- identification and review of the options available to reduce environmental and/or public health risk posed by toxic chemicals.

This process involved establishing a Priority Substances List, performing an assessment of toxicity, and developing a risk-management strategy through a Strategic Options Process (SOP). In the SOP, recommendations for the most effective options for reducing exposure to toxic substances were developed by stakeholders.

An Issue Table was established in December 1994 to address issues of concern from the wood preservation sector. The Issue Table, with representation from the federal government, provincial governments, wood preservative manufacturers, wood preservative treatment facilities, industrial users of treated wood products, and environmental non-government organizations (ENGOs), met as a whole and in various working groups over a four-year period to determine:

- chemical release data, and
- criteria to determine priority areas for investigation prior to making recommendations for the most effective options for reducing exposure to toxic substances.

The wood preservation sector covers a wide range of areas related to the manufacture and use of the heavy-duty wood preservatives chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), creosote, and pentachlorophenol (PCP). Activities included under the sector definition are wood preservative manufacture, application of preservative to the wood, the use of treated wood products, the management of used treated wood, the transportation of both preservative chemicals and treated products, and the contamination of sites. It was determined that the CEPA-toxic substances may be released to the environment from the above areas of activity, as shown in the table following.

CEPA-Toxic Substance	Wood Preservative
Chromium VI, Inorganic arsenic compounds	Chromated Copper Arsenate (CCA)
Inorganic arsenic compounds	Ammoniacal Copper Zinc Arsenate (ACZA)
Polycyclic Aromatic Hydrocarbons (PAHs)	Creosote
Creosote-impregnated waste materials	Creosote
Polychlorinated dibenzodioxins (Dioxins) **Polychlorinated dibenzofurans (Furans)** **Hexachlorobenzene (HCB)**	Pentachlorophenol (PCP)[2]

The Wood Preservation Sector SOP developed recommendations for those activities that may cause the release of these CEPA-toxic substances. The final report from the Issue Table, *Strategic Options for the Management of CEPA-Toxic Substances from the Wood Preservation Sector – Final Report from the Issue Table*, was made publicly available in July 1999.[3] This publication is referred to as the Strategic Options Report (SOR).

The recommendations identified by the Issue Table were categorized into the following four sections:

A. General Recommendations;
B. Manufacturers and Treaters recommendations;
C. Consumer Treated Wood Product Recommendations; and
D. Industrial Treated Wood User Recommendations.

The SOR summarized the recommendations for the wood preservative manufacturers and treating facilities as follows:

1. **Mandatory reporting of CEPA-toxic releases** through the National Pollutant Release Inventory (NPRI).

2. Voluntary implementation of “best management practices” or the recommendations found in *Recommendations for the Design and Operation of Wood Preservation Facilities* (March 1999). This is referred to as the Technical Recommendations Document (TRD). It was acknowledged that wood preservative manufacturing plants already have adequate management systems in place.

---

[2] Polychlorinated dibenzodioxins, polychlorinated dibenzofurans, and hexachlorobenzene are found as micro-contaminants in pentachlorophenol.

[3] The final report from the Issue Table can be downloaded electronically from the following Environment Canada Web site: http://www.ec.gc.ca/sop/wood-bois/pubs/sor_e.htm.

3. Program implementation will be overseen by a multi-stakeholder steering committee that will recommend mandatory implementation of the TRD should the voluntary approach be unsuccessful.

4. Evaluation of the success of the program will be conducted by the steering committee twice within the five years following the program's commencement.

5. The TRD implementation program will continue beyond the five-year evaluation program.

More specifically regarding the **mandatory reporting of CEPA-toxic releases** through the NPRI, Recommendation B3 (page 51 of the SOR) states the following:

Annual Reporting for All Plants

B3. It is recommended that all wood preservation treatment facilities and wood preservative chemical manufacturers report their emissions of CEPA-toxic substances as listed below to the National Pollutant Release Inventory (NPRI) beginning in 2001 (this will cover the year 2000 releases). The NPRI list will be expanded for the wood preservation sector to include dioxins, furans, PAHs (a list specific to the wood preservation sector), and hexachlorobenzene. The industry will also report on chromium (and its compounds), arsenic (and its compounds), naphthalene and anthracene, which are already listed on NPRI. The reporting requirements will be developed to ensure duplicative and inconsistent reporting will not occur. Moreover, release data generated above and beyond the normal NPRI requirements by the sector are to be compiled separately from other NPRI data and not aggregated with data from other industries. This reporting program implementation is contingent upon the outcome of the current Environment Canada review of NPRI.

The Issue Table agreed that reporting CEPA-toxic substances to the NPRI will provide a benchmark as well as a mechanism for tracking anticipated reductions in releases and transfers on a yearly basis that result from upgrades of treating facilities and practices.

For more information on the progress of the implementation of the above-noted recommendation, refer to Environment Canada's website at http://www.ec.gc.ca/sop/wood-bois/.

What is the National Pollutant Release Inventory?

The NPRI is at the centre of the Government of Canada's efforts to track toxic substances. It is the only nation-wide, publicly accessible program in Canada that provides information on pollutants being released to the environment and transferred for disposal. Since its inception in 1992, the role of the NPRI has expanded to include the gathering of information on the recycling of NPRI substances as well as on pollution-prevention activities being undertaken by facilities.

How has the NPRI been modified to accommodate the requirements of the Wood Preservation Sector SOP?

As identified in the SOR recommendations, reporting requirements specific to the wood preservation sector were incorporated into the *Canada Gazette Part I* Notice for NPRI and published on December 25, 1999. As such, most, if not all wood treatment facilities should meet the reporting requirements for the CEPA toxic substances covered by this guide. Reporting requirements for all NPRI-listed substances are subject to change and so the *Canada Gazette Part I* notice for the year being reported should be consulted for the relevant reporting criteria.

This Guide, together with the guidance documents published by NPRI for the year being reported, should be consulted by owners and operators of wood preservative manufacturing and wood preservation treating facilities in reporting to the NPRI.

More information on the NPRI is available on Environment Canada’s Web site at www.ec.gc.ca/pdb/npri.

II Reporting to the National Pollutant Release Inventory

Overview of this Guide

This Guide is broken into two specific categories: wood preservative manufacturers and wood preservation treatment facilities. More specifically, this Guide provides information on the following:

- reporting requirements for NPRI-listed substances used in wood preservation.
- methodologies to estimate on-site releases and off-site transfers of NPRI-listed substances applicable for wood preservative manufacturing and wood preservation treatment facilities; and
- examples of how to estimate on-site releases and off-site transfers of substances for the purposes of reporting to the NPRI.

For a full listing of NPRI substances, please refer to the *Canada Gazette Part I* Notice or the *Guide for Reporting to the National Pollutant Release Inventory* for the year being reported.

NPRI Reporting Requirements

Report Due Dates

Reporting deadlines for the NPRI are subject to change and should be verified in the *Canada Gazette Part I* Notice for the year being reported.

PAST EXAMPLE:

Canada Gazette Part I **Notice**	**Reporting Year**	**Due Date**
December 25, 1999	**2000** calendar year	**June 1, 2001**

NPRI Definitions

All definitions are subject to modification. For the most relevant definitions, please consult the *Canada Gazette Part I* Notice and the *Guide for Reporting to the NPRI* for the year being reported. Other NPRI definitions can also be found in the above two documents.

Wood Preservation

"Wood preservation" means the use of a preservative for the preservation of wood by means of heat or pressure treatment, or both, and includes the manufacture, blending, or reformulation of wood preservatives for that purpose.

By-products

"By-product" means an NPRI substance which is incidentally manufactured, processed or otherwise used at the facility at any concentration, and released on site to the environment, released to surface waters or transferred off site for disposal.

By-products are included in the calculation of the mass-reporting threshold for some NPRI substances in order to capture large-volume, low-concentration releases and transfers. Verify in the *Canada Gazette Part I* Notice for the year being reported which substances require the inclusion of by-products in mass calculations.

Contiguous Facility

"Contiguous facility" means all buildings, equipment, structures and stationary items that are located on a single site or on contiguous or adjacent sites and that are owned or operated by the same person and that function as a single integrated site and includes wastewater collection systems that discharge treated or untreated wastewater into surface waters.

Disposal

“Disposal” means the final disposal of the material (e.g., landfill), or treatment (e.g., stabilization) prior to final disposal.

Facility

"Facility" means a contiguous facility and a pipeline installation.

Manufacture

"Manufacture" means to produce, prepare or compound an NPRI substance and includes the coincidental production of an NPRI substance as a by-product (see definition) as a result of the manufacturing, processing or other use of other substances.

Other Use

The terms "other use" and "otherwise used" encompass any use of an NPRI substance at a facility that does not fall under the definitions of "manufacture" or "process". This includes the use of the substance as a chemical processing aid, manufacturing aid or some other ancillary use. *Other use* does not include routine janitorial or facility grounds maintenance.

"Other use" includes any use of a substance, listed in Schedule 1 of the *Canada Gazette Part I* Notice, relevant to the purpose of the facility which is not included under the definitions of "manufacture" or "process".

On-Site Release

An "on-site release" is an on-site discharge of a pollutant to the environment. This includes emissions to air, discharges to surface waters, on-site releases to land and deep-well underground injection, within the boundaries of the facility.

Off-Site Transfer

An "off-site transfer" is a shipment of an NPRI substance to an off-site location for disposal or recycling.

Pollution Prevention (P2)

"Pollution prevention" means the use of processes, practices, materials, products, substances or energy that avoid or minimize the creation of pollutants and waste, and reduce the overall risk to the environment or human health."

P2 seeks to eliminate the causes of pollution rather than managing it after it has been created. It encourages the kinds of changes that are likely to lead to lower production costs, increased efficiencies and more effective protection of the environment. Pollution prevention does not include on-site treatment activities (pollution control) or off-site recycling and disposal activities.

Process

"Process" means the preparation of an NPRI substance, after its manufacture, for commercial distribution. Processing includes the preparation of a substance with or without changes in physical state or chemical form. The term also applies to the processing of a mixture or formulation that contains an NPRI substance as one component, as well as the processing of “articles”.

Production Ratio and *Activity Index*

A “production ratio” is the ratio of “reporting-year production” to “prior-year production” that will permit year-to-year comparisons of changes in the total on-site releases plus off-site transfers. An “activity index” is based on a variable, other than production, that is the primary influence on the total, and that will in turn permit comparison of changes from year to year.

Recycling

“Recycling” refers to activities that keep a material or a component of the material from becoming a waste destined for disposal. Recyclable materials may be cleaned, regenerated or reprocessed to their original specifications and reused for their original purpose. They may also be used for an entirely different purpose without any pretreatment or modification. Components may be recovered or reclaimed from the recyclable material or the material may be used as a fuel for energy recovery. The recyclable material may be used in the manufacture of another product. For the purposes of the NPRI, recycling also includes substances sent back to the manufacturer or supplier for reprocessing, repackaging, resale or for credit or payment.

Toxic Equivalency (TEQ)

"TEQ" is the relative toxicity of a particular congener of dioxins/furans to the toxicity of 2,3,7,8-TCDD, the most toxic congener. The relative toxicity is computed by the use of toxic equivalent factors (TEFs), relating the toxicity of specific congeners to that of 2,3,7,8-TCDD, which is assigned a TEF of 1. The *Guide for Reporting to the National Pollutant Release Inventory* should be consulted to obtain these weighting factors for the year being reported.

Completing the NPRI Reporting Forms and Submitting Information to Environment Canada's NPRI Offices

For more information regarding the completion of the NPRI report using the NPRI reporting software, all **wood preservative manufacturing facilities** and **wood preservation facilities** should refer to the *Guide for Reporting to the National Pollutant Release Inventory* for the year being reported. The NPRI report and a signed Statement of Certification **must** be submitted to your regional Environment Canada office no later than the date specified in the *Canada Gazette Part I* Notice of that reporting year.

III–A Wood Preservative Manufacturing Activities

NPRI-listed Substances Related to Wood Preservative Manufacturing Activities

The following substances may have to be reported to NPRI by companies in the wood preservative manufacturing sector:

- anthracene
- ammonia (total)
- arsenic (and its compounds)
- biphenyl
- chromium (and its compounds)
- copper (and its compounds)
- cresol (all isomers, including *m*-,*o*- and *p*-)(and its salts)
- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))
- dimethyl phenol
- hexavalent chromium compounds
- mercury (and its compounds)
- naphthalene
- PAHs
- quinoline (and its salts)
- zinc (and its compounds)

The NPRI-listed substances shown above provide a summary of the substances that may be applicable for wood preservative manufacturers.

It is important to note the following:
If facilities meet the reporting criteria for other NPRI-listed substances not shown above, they are legally obligated to file an NPRI report on those substances to Environment Canada by the date specified in the *Canada Gazette Part I* Notice for the year being reported.

In what concentrations can some of the above-listed substances be found in certain wood preservatives?

- **Chromated Copper Arsenate (CCA):** CCA-C on a solids basis contains approximately 24.7% wt chromium, 22.7% wt arsenic and 14.8% wt copper.

- **Ammoniacal Copper Zinc Arsenate (ACZA):** ACZA on a solids basis typically contains about 39.9% wt copper, 20.1% wt zinc, and 16.3% wt arsenic. Ammonium hydroxide solutions are typically at 1.95% wt.

Reportable Substances Specific to Individual Preservative Manufacturers

CCA and ACZA Manufacturers:

The following list comprises **examples** of substances that should be considered for reporting. Refer to the *Canada Gazette Part I* Notice for the year being reported for the specific reporting criteria for these substances in determining if reporting is necessary.

- ammonia (total)
- arsenic (and its compounds)
- chromium (and its compounds)
- copper (and its compounds)
- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))
- hexavalent chromium compounds
- mercury (and its compounds)
- zinc (and its compounds)

Creosote Manufacturers:

The following list comprises **examples** of substances that should be considered for reporting. Refer to the *Canada Gazette Part I* Notice for the year being reported for the specific reporting criteria for these substances in determining if reporting is necessary.

- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))
- mercury (and its compounds)
- PAHs

This Guide, together with the guidance documents published by NPRI for the year being reported, should be consulted by owners and operators of wood preservative manufacturing facilities in reporting to the NPRI.

III–B Information Required by Wood Preservative Manufacturing Facilities Reporting to the NPRI

In order to make an accurate determination of the quantity of releases each year, a wood preservative manufacturing facility must gather as much information as possible about its processes, waste shipments, and releases to the environment. This requires a detailed investigation of the sources of releases to each medium (air, water and land), identification of the components that contribute to those releases or transfers, and the establishment of the proper engineering approaches needed to quantify those releases or transfers. The facility must use all relevant monitoring data and emissions measurements collected to meet other regulatory requirements, or as part of routine plant operations, or to the extent a facility has such data.

No monitoring data or emissions measurements need to be collected specifically for NPRI reporting. In the absence of data, reasonable estimates must be made using published emission factors, mass balance calculations, or engineering calculations. However, the rationale for the Wood Preservation Sector SOP recommendation that all applicable CEPA-toxic substances be reported to the NPRI for all wood preservative manufacturers was to determine whether the adoption of the SOP recommendations would result in a reduction of those specific substances to the environment. It is therefore important that an accurate and quantitative estimate of releases and transfers be made such that any improvements by the sector can be demonstrated and documented.

III–C Chromated Copper Arsenate Manufacture (CCA type C)

Process Description

(Carrol-Hatch 1998, El Rayes 1998)

The production process of CCA-C is described in Figure 3.1. Liquid chromic acid (CrO_3 in water solution at 60% concentration), arsenic acid (As_2O_5 in water solution at 75%) and solid copper (oxide) are mixed for approximately two hours to form a 50% concentrate. The concentrate is stored in a settling tank, then filtered and transferred to a storage tank. The liquid components are hard piped from their storage tanks to the reactor to minimize air emissions. Reactor vents are equipped with a wet scrubber to remove most airborne emissions. Storage tank areas are protected by secondary containment (paved and dyked) to collect drips or spills and avoid discharge to surface water or groundwater. Paved areas are coated with an impervious chemical resistant membrane. Storage tank vents are equipped with wet scrubbers.

The process is a closed cycle and the facilities are enclosed so that the risk of storm water contamination is minimized. Process water and wastewater are recycled for makeup of the CCA concentrate. Solid wastes and sludges containing copper, chromium (mainly hexavalent), and arsenic generated in the process from chemical impurities are washed to remove any soluble components. The wash water is used as makeup water for the concentrate. Any residual solids are then disposed of in a hazardous landfill. Arsenic in air emissions is monitored for personnel exposure and the scrubber is tested for efficiency every two to three years.

Potential Sources of Emissions

(Figure 3.2)

- **Material Unloading Area:** drippage at raw materials unloading area (liquid discharge of arsenic and chromium—recovered and recycled), airborne dust (copper), aerosol (arsenic and chromium), potential for catastrophic spills.

- **Raw Materials and Finished Product Storage Areas:** spills, leaks (recovered and recycled).

- **Mixing Reactor:** aerosol at vents (copper, chromium and arsenic).

- **Finished Product (CCA concentrate) Loading Area:** drips (recovered and recycled), aerosol (all components), potential for catastrophic spills.

Table 3.1: Probable Reportable Compounds with CAS Numbers — CCA Manufacturing Facilities

Compound	CAS* Registry Number
Arsenic pentoxide (arsenic acid)	1303-28-2
Chromium trioxide (chromic acid)	12018-01-8
Copper oxide	1317-38-0
Criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))	Refer to the *Canada Gazette Part I* Notice for the year being reported.

* CAS denotes Chemical Abstracts Service.

Figure 3.1. CCA Concentrate Manufacturing Plant Layout

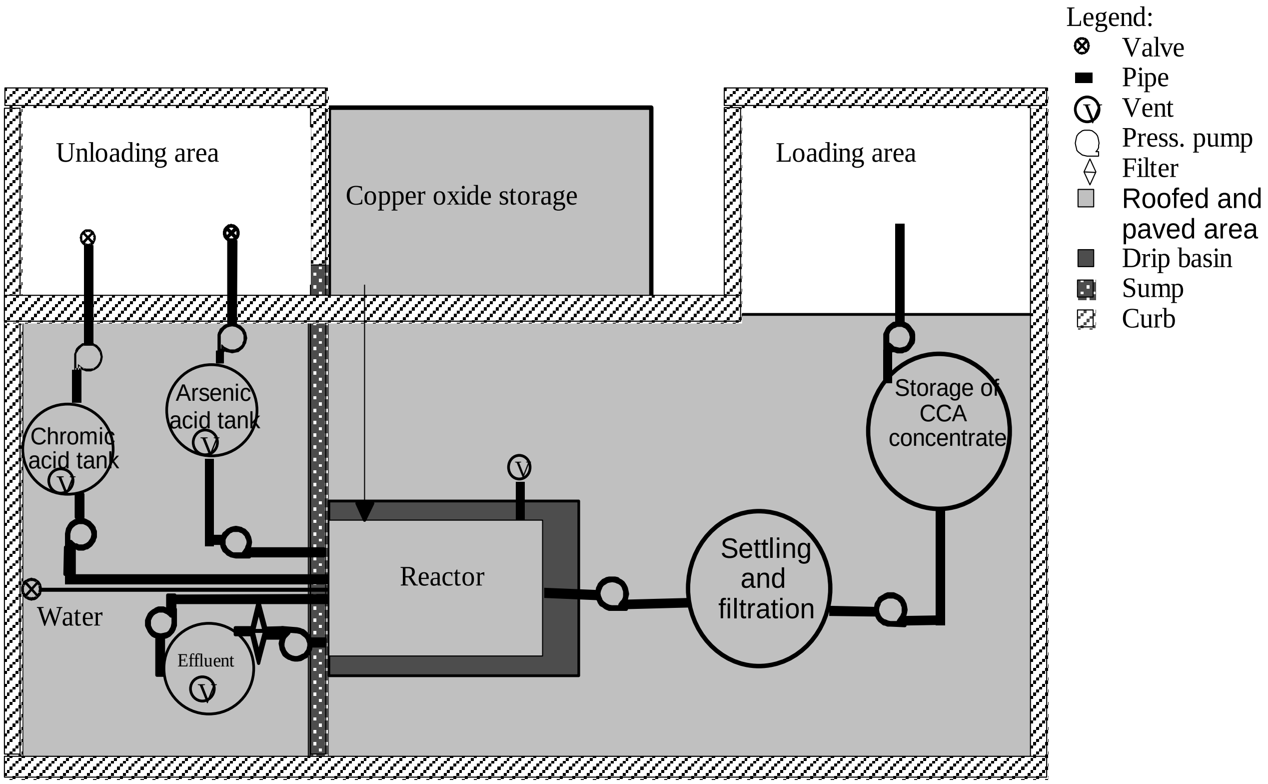
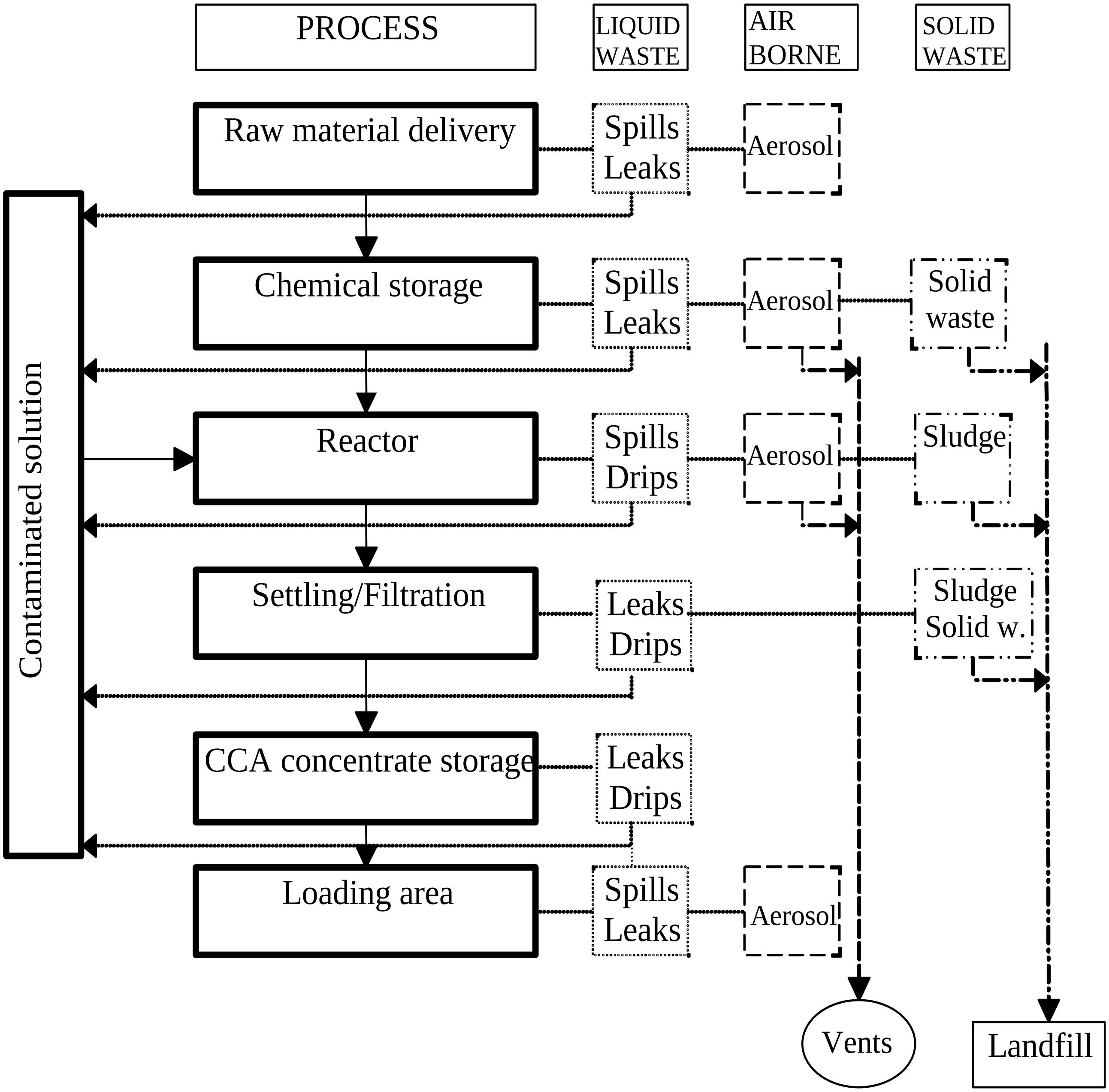


Figure 3.2. CCA Concentrate Manufacturing Plant Potential Emissions



Estimation Methodologies to Determine Releases and Transfers—CCA Manufacturing Facilities

Estimates of emissions can generally be made by one of the following procedures:

- sampling or direct measurement
- mass balance
- engineering calculations, or
- emission factors

However, as noted above, one of the primary objectives of using the NPRI is to monitor annual releases and transfers of applicable CEPA-toxic substances from the wood preservation sector. Annual release and transfer information obtained from the NPRI will demonstrate if the measures adopted and implemented by the wood preservative manufacturing and treating sector, in response to the Wood Preservation Sector SOP, are successful in reducing releases of CEPA-toxic substances.

Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

In consideration of this fact, it is very important that any estimation methodologies used provide an accurate and quantitative measurement such that an evaluation of year-to-year improvements can be monitored and determined. For example, emission factors based on general average process estimates of releases per unit of chemical manufactured, will not provide this quantitative comparison—unless emission factors can be modified based on control measures that are put in place.

Airborne Emissions

Aerosol emissions are possible at the raw materials unloading and final product loading areas, storage tank vents and reactor vents. These are generally fugitive uncontrolled losses, except where emission-control technologies are employed, such as wet scrubbers on the storage and reactor vents. Airborne concentrations should be monitored periodically by plants at different locations for occupational health control. If monitoring is performed, this can provide an estimate of the average concentration of emitted substances in the manufacturing facility; however, without information on airflow or air-exchange rates of the building(s), emission rates cannot be determined.

Estimation by Direct Measurement

The airborne concentrations of NPRI substances are measured directly at various locations in a plant several times per year, representing the entire building volume, at times when different activities are ongoing. The average concentrations (C in mg/m^3 air) weighted with the fraction of time that the activity is ongoing (F) is determined; the volume of the facility is V m^3; the average air exchange rate is determined for the facility (R in building volume per day); the relevant number of days per year is determined (D).

The estimated emission is **(C x V x R x D x 10^{-3} mg/g) g per year**.

Example

The air quality is measured four times per year during the mixing process, when the plant is idle, and at different locations in the plant. The overall average airborne concentrations are based on the average; mixing accounts for 40% of plant time (F = 0.4) and no mixing activity accounts for 60% of the time (F = 0.6):

Cu: 3.0 x 10^{-3} mg/m^3 when mixing and 0.8 x 10^{-3} mg/m^3 when idle
As: 2.2 x 10^{-3} mg/m^3 when mixing and 0.5 x 10^{-3} mg/m^3 when idle
Cr: 2.2 x 10^{-3} mg/m^3 when mixing and 0.5 x 10^{-3} mg/m^3 when idle

The volume of the facility, V, is 15,000 m^3; the building air exchange rate is 0.6 times per hour (14.4 times per day = R); the emissions are mainly from the storage tanks and are assumed to be similar 365 days per year (D).

Then the estimated emissions are:

Cu: (0.4 x 3.0 x 10^{-3} + 0.6 x 0.8 x 10^{-3}) x 15,000 x 14.4 x 365
= 132,450 mg or 132 g or **0.13 kg per year**

Cr: (0.4 x 2.2 x 10^{-3} + 0.6 x 0.5 x 10^{-3}) x 15,000 x 14.4 x 365
= 93,030 mg or 93 g or **0.09 kg per year**

As: (0.4 x 2.2 x 10^{-3} + 0.6 x 0.5 x 10^{-3}) x 15,000 x 14.4 x 365
= 93,030 mg or 93 g or **0.09 kg per year**

Estimation by emission factor

Typical process emission factors have been generated by the U.S. EPA (MRI 1999) and the Australian Timber Preservers' Association (NPI 1999) for the CCA treating process, but none have been developed for the CCA manufacturing process. Since these emission factors are based on the volume of wood treated, involve releases at the treating retort and associated vacuum pumps, and are developed for facilities with generally fewer emission-control technologies installed compared to manufacturing facilities, they are not appropriate for estimating releases by CCA manufacturing facilities; however they may be used to assist manufacturers in developing their own emission factors.

Estimation by Mass Balances and Engineering Calculations

Since aerosol releases are very low, mass-balance estimates cannot accurately determine airborne releases. Also, since engineering calculations are dependent on properties like vapour pressure of components (considered negligible for inorganic compounds), this approach is not appropriate for estimating airborne emissions.

Liquid Emissions to Soil or Water

As it is expected that all plant process water is recovered and recycled, and incidental leaks are contained and recovered, the main potential source of liquid emissions to soil or ground/surface water is catastrophic spills at the liquid loading or unloading sites. These estimates are determined by measuring the amount spilled, minus amounts recovered, multiplied by the concentration of NPRI substance in the spilled liquid.

Example

At a plant, 75% liquid arsenic acid (H_3AsO_4), which consists of 39.6% elemental arsenic, is received by tanker at the raw materials unloading site. A hose breaks and 54 kg of arsenic acid sprays beyond the containment; 29.6 kg of this acidic solution is immediately recovered by wiping up the spill. The release to soil is as follows:

(54 - 29.6) or 24.4 kg lost at 39.6% As or **9.66 kg As**

The recovered amount (29.6 kg x 39.6% = **11.72 kg As**) if not re-solubilized and recycled will be transferred off site for disposal and must be reported as such.

Solid Wastes

Production sludge, used filters, and other solid wastes are collected for several months before being transferred off site for disposal. Prior to shipment, this solid waste should be sampled and analyzed for elemental copper, chromium and arsenic using an appropriate analytical technique. If the elements were analyzed as ppm (mg/kg), the emissions are calculated as follows:

ppm Cu x mass of solid waste (kg) x $\mathbf{10^{-6}}$ mg/kg
ppm Cr x mass of solid waste (kg) x $\mathbf{10^{-6}}$ mg/kg
ppm As x mass of solid waste (kg) x $\mathbf{10^{-6}}$ mg/kg
(determined on an annual basis)

Example

A plant transfers 650 kg solid waste off site on June 30, 2002 (analyzed at the following concentrations: 11,500 ppm Cu, 20,600 ppm Cr and 12,200 ppm As). A second shipment of 760 kg solid waste is sent off site on December 31 (analyzed at: 13,050 ppm Cu, 21,430 ppm Cr and 18,200 ppm As). The reportable amounts are:

Cu: ((11,500 x 650 x 10^{-6}) + ((13,050 x 760 x 10^{-6})) = **17.4 kg**

Cr: ((20,600 x 650 x 10^{-6}) + ((21,430 x 760 x 10^{-6})) = **29.7 kg**

As: $((12{,}200 \times 650 \times 10^{-6}) + ((18{,}200 \times 760 \times 10^{-6})) =$ **21.8 kg**

Summary of NPRI Reporting Steps—CCA Manufacturing Facilities

1. Gather information on sources of releases to air, soil, groundwater, storm water, and off-site releases.

2. Determine reporting thresholds for NPRI reportable substances from *Canada Gazette Part I* Notice for the year being reported.

3. Estimate quantities released on site or transferred off site, based on monitoring data, engineering calculations or emission factors.

Sample Release Summary Form

Substance	Type of Release	Release	Kg Released
Arsenic	Process	Stack emissions to air	
	Process	Fugitive aerosol and vapour	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Hazardous waste	Solid waste transferred to hazardous-waste site	

III–D Creosote Manufacture

Process Description

(Carrol-Hatch 1998, El Rayes 1998)

The production process of creosote is described in Figure 3.3. Coal tar from steel mill coke ovens arrives by rail car and is distilled to separate different fractions, including coal tar creosote used for wood preservation. The creosote is condensed from the distillation tower into storage tanks. Creosote is pumped from the storage tanks into rail tankers for shipment to the treating plants.

Potential Sources of Emissions of Creosote and PAH Constituents

(Figure 3.4)

Water Discharges to Sewer

Process and wastewater are collected and treated (API oil/ water separation) prior to discharging to a municipal sewer system. Storm water run-off from the site is discharged to the sewers.

Air Discharges from Vents and Fugitive Losses

- **Loading and unloading areas:** spills to the ground and drips.
  These areas should be paved and any wastes collected from leaks and spills should be recycled on site as stock feed for the distillation unit. Vapours generated during loading are recovered using an oil scrubber system.

- **Storage tanks:** spills and leaks.
  Air emissions should be controlled by a scrubber system allowing recovery of most volatile components from tank vents.

- **Distillation plant:** leaks and spills to ground.
  The process and handling areas should be paved and contained; air emissions should be collected and recycled or destroyed by an appropriate technology, such as incineration.

- **Solid wastes generated:**
  Most solid waste materials are recycled back into the process or transferred to a steel mill as fuel; the remainder is disposed of at an off-site hazardous-waste landfill.

Figure 3.3. Creosote Manufacturing Plant Layout

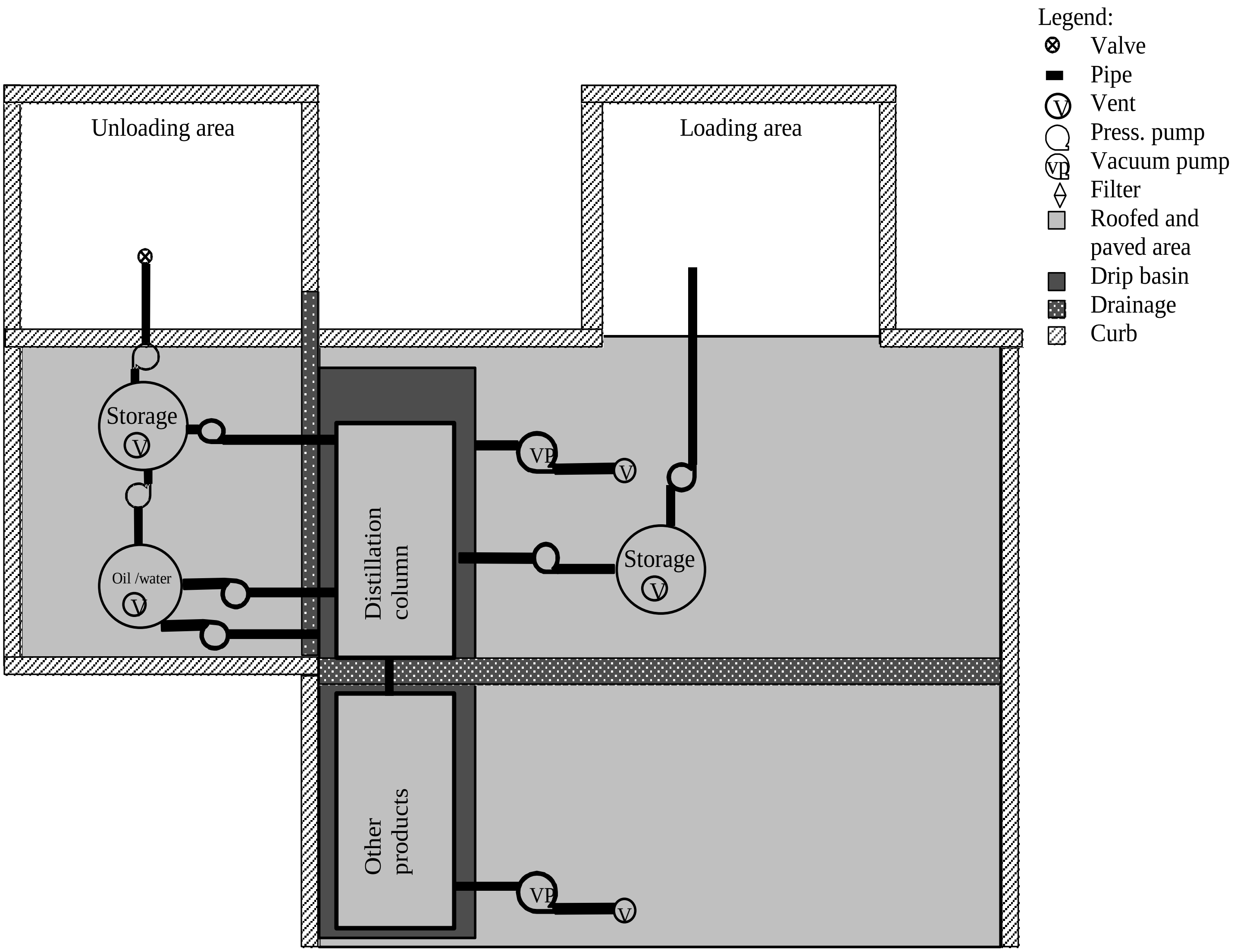


Figure 3.4: Creosote Manufacturing Plant — Source of Potential Emissions

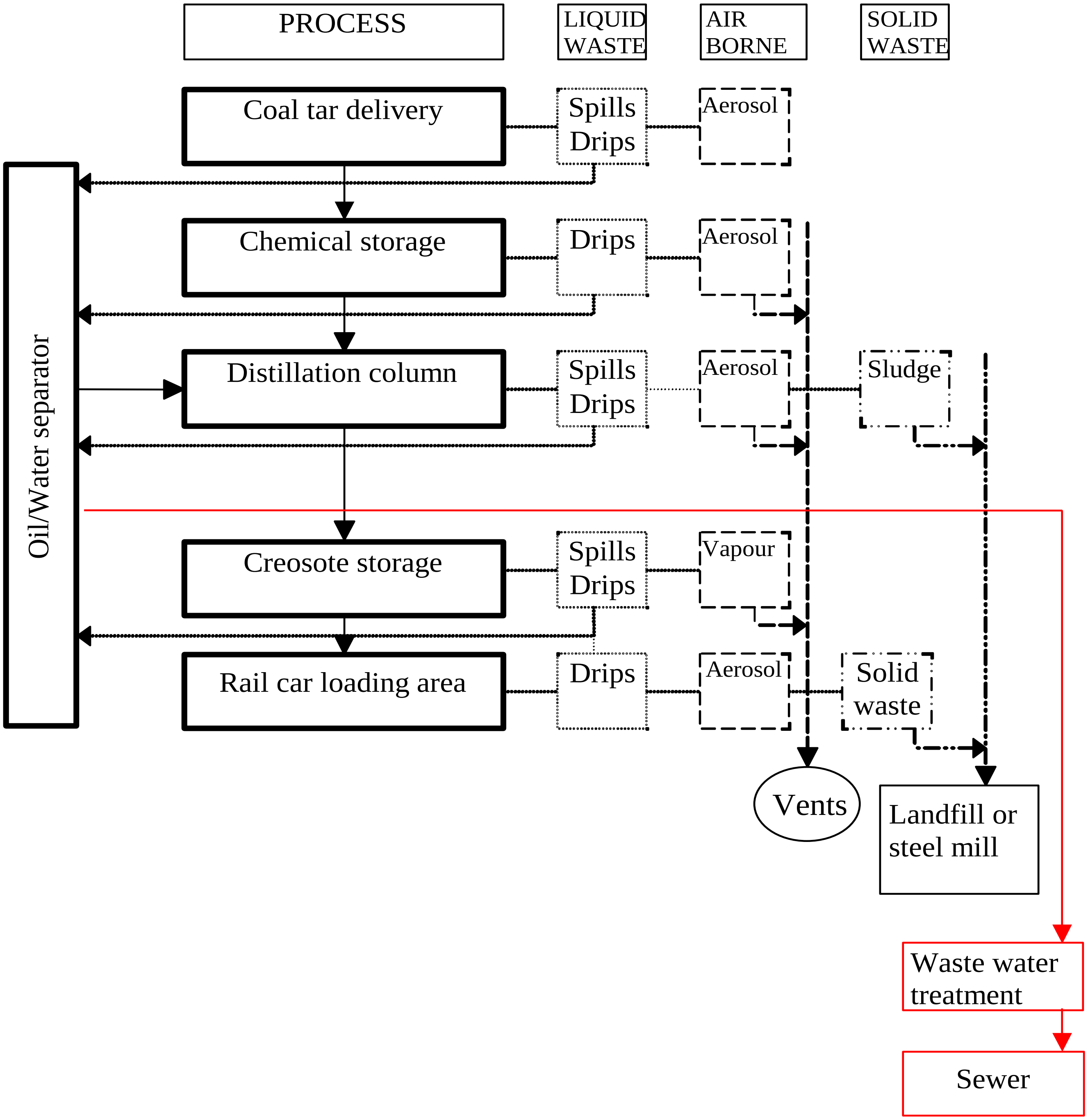


Table 3.2: Probable Reportable Compounds with CAS Numbers — Creosote Manufacturing Facilities

Compound	CAS Registry Number*	VFT Typical Analysis**	Typical Analysis AWPA P1 creosote[†]
		%	%
Anthracene	120-12-7	2.43	1.7
Biphenyl	92-52-4	1.57	1.3
Naphthalene	91-20-3	9.53	12.9
Aniline	62-53-3	-	0.21
o*-Cresol**	108-39-4	-	0.10
m*-Cresol**	95-48-7	-	0.12
p*-Cresol**	106-44-5	-	0.12
Dimethyl phenol	1300-71-6	-	0.41
Quinoline (and its salts)	91-22-5	0.97	0.59
Benzo(a)anthracene	56-55-3	0.89	0.50
Benzo(a)phenanthrene	218-01-9	-	0.10
Benzo(a)pyrene	50-32-8	0.17	0.20
Benzo(b)fluoranthene	205-99-2	-	-
Benzo(e)pyrene	192-97-2	-	0.20
Benzo(g,h,I)perylene	191-24-2	0.04	0.10
Benzo(j)fluoranthene	205-82-3	-	0.12
Benzo(k)fluoranthene	207-08-9	-	0.22
Dibenz(a,j)acridine	224-42-0	-	-
Dibenzo(a,h)anthracene	53-70-3	<0.01	-
Dibenzo(a,I)pyrene	189-55-9	-	-
7H-Dibenzo(c,g)carbazole	194-59-2	-	-
Fluoranthene	206-44-0	5.76	4.6
Indeno(1,2,3-c,d)pyrene	193-39-5	0.04	-
Perylene	198-55-0	-	0.10
Phenanthrene	85-01-8	14.26	11.2
Pyrene	129-00-0	3.44	3.7

Criteria air contaminants (including oxides of nitrogen (expressed as NO$_x$), sulphur dioxide (SO$_2$), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns (PM$_{2.5}$), and particulate matter with a diameter □ 10 microns (PM$_{10}$))	Refer to the *Canada Gazette Part I* Notice for the year being reported.	NA****	NA****

* CAS denotes Chemical Abstracts Service
** Environment Canada (2000a)
*** Listed together on the NPRI as cresol (and its isomers)(and its salts)
**** Not applicable
[†] Betts (1990)

Estimation Methodologies to Determine Releases and Transfers—Creosote Manufacturing Facilities

Airborne Releases

Estimates of fugitive PAH releases, as aerosols or vapour, can be made based on monitoring results for occupational health if the air-exchange rate of the facility is known (see example for CCA manufacturing facility above). Alternatively, emission factors can be developed and used by the manufacturer; at this time such emission factors have not been developed. Stack or vent emissions should be estimated from the average stack outlet concentration and average airflow rates.

Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

Example:
Calculating Air Releases of PAHs Using Stack Monitoring Data

Stack testing has determined that PAHs are detected in a facility's stack gases at concentrations (g per dry standard cubic metre of gas) as follows:

The moisture content in the stack is estimated to be 10%.
The stack gas velocity was determined to be 1.8 m/s.

The diameter of the stack is 0.3 m.

To calculate the annual air release of the PAHs from the stack:

1. Calculate volumetric flow of stack gas stream:

   Volumetric flow = (gas velocity) x *Pi* x (internal stack diameter)^2 / 4]
   = (1.8 m/s) x [3.142 x (0.3m)^2 / 4]
   = **0.13 m^3/s**

2. Correct volumetric flow for moisture content in stack gas stream:

   Stack gases may contain large amounts of water vapour. The concentration of the substance in the exhaust is often presented on a 'dry gas' basis. For an accurate emission rate, correct the stack or vent gas-flow rate in Step 1 for the moisture content in the facility's stack gas. This can be done as follows:

   Corrected dry gas volumetric flow = (volumetric flow) x (1 - fraction of water vapour)
   = (*0.13 m^3/s*) x (*1 - 0.10*)
   = **0.11 m^3/s**

3. Estimate annual stack emissions to air:
   Multiply the dry gas volumetric flow rate by the concentration of PAHs measured in the stack gases, as follows:

   $R_{air} = C \times V \times CF \times H$

   Where:

   R $_{air}$ = Annual release of PAHs to air (g/year)
   C = Stack gas concentration of PAHs (g/dry standard m^3)
   V = Hourly volumetric flow rate of combustion stack gas (m^3/hour)

   CF = Capacity factor, fraction of time that the facility operates on an annual basis (e.g., 0.85)

   H = Total hours in a year (8,760 hours/year)

Example:
Calculations Based on Direct Measurements
(emission factors not available)

Substance	Concentration (g/m^3), C	Air flow (m^3/h), V	Hours/y active (CF x H)	Emissions (g/year), R

Naphthalene	0.06	412	3,842	95,000
Anthracene	0.02	412	3,842	31,700
Benzo (a)anthracene	3 x 10^{-5}	412	3,842	47.5
Benzo (b)fluoranthene	6 x 10^{-5}	412	3,842	95.0
Benzo (k)fluoranthene	4 x 10^{-6}	412	3,842	6.3
Benzo(a)pyrene	2 x 10^{-6}	412	3,842	3.2

Releases to Surface Water

Example:
Estimating Water Releases of PAHs to Surface Water

A facility discharges 4,550 litres per day of treated wastewater into surface water. The average measured emissions for the facility are 1.2 mg naphthalene and 0.02 mg benzo(a)pyrene per litre of wastewater discharged. The emission values reflect the level of PAH control that is occurring at the facility. This facility operates 365 days each year. Estimate the annual release of PAHs to surface water.

Calculate the annual release of PAHs to water:

- Naphthalene release (kg) =
  4,550 L/ day x 365 days x 1.2 mg naphthalene *x* 10^{-6} kg/ mg
  = **1.99 kg naphthalene**

- Benzo(a)pyrene release (kg) =
  4,550 L/ day x 365 days x 0.02 mg benzo(a)pyrene *x* 10^{-6} kg/ mg
  = **0.033 kg benzo(a)pyrene**

Solid Waste Releases

Under NPRI reporting requirements, the disposal of NPRI-listed substances to a landfill on site is considered a release to land. The disposal of NPRI-listed substances to a landfill off site is considered to be an off-site transfer.

Example:
Estimating Releases On Site to Land in the Disposal of Sludge

A facility generates approximately 1 kg of dry sludge per 4,000 litres of wastewater treated at the facility’s on-site industrial wastewater treatment plant. The facility operations produce approximately 100,000 litres of wastewater per day. The facility operates 350 days per year. Monitoring results indicate that the sludge, on average, contains approximately 140 mg naphthalene and 1.8 mg benzo(a)pyrene per kg dry sludge produced. All of the sludge from the facility is placed in an on-site landfill. To calculate the annual amount of PAHs released to land from this facility, as a function of land disposal of the sludge contaminated with PAHs:

1. Determine the amount of sludge produced per day from the wastewater treatment process.

   Total sludge = (1 kg/4,000 L) x 100,000 L/day
   = **25 kg/day**

2. Determine the amount of PAHs contained in the sludge produced each day.

   Total amount of PAHs in sludge
   = (total sludge generated) × (average PAH concentration in sludge)

   = (25 kg sludge/day) x (140 mg naphthalene/kg sludge) x 350 days x 10^{-6} kg/mg
   = **1.225 kg naphthalene/year**

   and

   = (25 kg sludge/day) x (1.8 mg benzo(a)pyrene/kg sludge) x 350 days x 10^{-6} kg/mg
   = **0.016 kg benzo(a)pyrene/year**

Summary of NPRI Reporting Steps—Creosote Manufacturing Facilities

1. Gather information on sources of releases to air, soil, groundwater, storm water, and off-site releases.

2. Determine reporting thresholds for NPRI reportable substances from the *Canada Gazette Part I* Notice for the year being reported.

3. Estimate quantities released on site or transferred off site, based on monitoring data, engineering calculations or emission factors.

Sample Release Summary Form

Substance	Type of Release	Release	Kg Released
Pyrene	Process	Stack emissions to air	
	Process	Fugitive aerosol and vapour	

	Process	Fugitive losses to soil	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Hazardous waste	Solid waste transferred to hazardous-waste site	

IV–A Wood Preservation Treatment Activities

NPRI-listed Substances Related to Wood Preservation Activities

The following substances may have to be reported to NPRI by companies in the wood preserving sector:

- anthracene
- ammonia (total)
- arsenic (and its compounds)
- biphenyl
- chromium (and its compounds)
- copper (and its compounds)
- cresol (and its isomers, including *m*-, *o*- and *p*-) (and its salts)
- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))
- dimethyl phenol
- dioxins
- furans
- hexachlorobenzene
- hexavalent chromium compounds
- mercury (and its compounds)
- naphthalene
- PAHs
- quinoline (and its salts)
- zinc (and its compounds)

The NPRI-listed substances shown above provide a summary of substances that may be applicable for wood preservation facilities.

It is important to note the following:
If facilities meet the reporting criteria for other NPRI-listed substances not shown above, they are legally obligated to file an NPRI report on those substances to Environment Canada by the date specified in the *Canada Gazette Part I* Notice for the year being reported.

In what concentrations can some of the above-listed substances be found in certain wood preservatives?

- **Chromated Copper Arsenate (CCA):** CCA-C on a solids basis contains approximately 24.7% wt chromium, 22.7% wt arsenic and 14.8% wt copper.

- **Ammoniacal Copper Zinc Arsenate (ACZA):** ACZA on a solids basis typically contains about 39.9% wt copper, 20.1% wt zinc, and 16.3% wt arsenic. Ammonium hydroxide solutions are typically at 1.95% wt.

- **Ammoniacal Copper Quaternary (ACQ):** ACQ-B contains approx. 53.3% wt copper on a dry solids basis. ACQ-B solutions are typically found in concentrations 1.9% wt or greater. Treating solutions contain a mass of ammonia equal to or greater than the mass of CuO, therefore, ACQ solutions higher than 1.5% as well as concentrated ammonia solutions will meet or exceed 1% wt total ammonia.

Reportable Substances Specific to Individual Wood Preservation Facilities

CCA and ACZA Wood Preservation Facilities:

The following list comprises **examples** of substances that should be considered for reporting at CCA and ACZA wood preservation facilities. Refer to the *Canada Gazette Part I* Notice for the year being reported for the specific reporting criteria for these substances in determining if reporting is necessary.

- ammonia (total)
- arsenic (and its compounds)
- chromium (and its compounds)
- copper (and its compounds)
- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))
- hexavalent chromium compounds
- mercury (and its compounds)
- zinc (and its compounds)

Creosote Wood Preservation Facilities:

The following list comprises **examples** of substances that should be considered for reporting at creosote wood preservation facilities. Refer to the *Canada Gazette Part I* Notice for the year being reported for the specific reporting criteria for these substances in determining if reporting is necessary.

- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))mercury (and its compounds)
- PAHs

Pentachlorophenol Wood Preservation Facilities:
The following list comprises **examples** of substances that should be considered for reporting at pentachlorophenol wood preservation facilities. Refer to the *Canada Gazette Part I* Notice for the year being reported for the specific reporting criteria for these substances in determining if reporting is necessary.

- criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))
- Dioxins and furans
- hexachlorobenzene

This Guide, together with the guidance documents published by NPRI for the year being reported, should be consulted by owners and operators of wood preservation treating facilities in reporting to the NPRI.

IV–B Information Required by Wood Preservation Facilities Reporting to the NPRI

In order to make an accurate determination of the quantity of releases each year, a wood preservation facility must gather as much information as possible about its processes, waste shipments, and releases to the environment. This requires a detailed investigation of the sources of releases to each medium (air, water and land), identification of the components that contribute to those releases or transfers, and the establishment of the proper engineering approaches needed to quantify those releases or transfers. The facility must use all relevant monitoring data and emissions measurements collected to meet other regulatory requirements, or as part of routine plant operations, or to the extent a facility has such data.

No monitoring data or emissions measurements need to be collected specifically for NPRI reporting. In the absence of data, reasonable estimates must be made using published emission factors, mass balance calculations, or engineering calculations. However, the rationale for the Wood Preservation Sector SOP recommendation that all applicable CEPA-toxic substances be reported to the NPRI for all wood preservation treaters was to determine whether the adoption of the SOP recommendations would result in a reduction of those specific substances to the environment. It is therefore important that an accurate and quantitative estimate of releases and transfers be made such that any improvements by the sector can be demonstrated and documented.

IV–C CCA Wood Preservation Facilities

Overview

CCA concentrate and working solutions contain oxides of copper, hexavalent chromium and arsenic. Typical solution strengths employed are 1 to 8% depending on products treated. Approximately 65% of the total production is utilized for residential construction with retentions of 4 to 6.4 kg/m^3. Commercial products, such as poles, with retentions 6.4 to 9.6 kg/m^3, and marine products, with retentions 24 to 40 kg/m^3, are treated in lesser quantities.

The CCA treating process is a closed system with process and other contaminated water collected, filtered and recycled as mix water. To minimize generation of solid sludge wastes, CSA specifications require treating solutions to be maintained at near ambient temperatures and treatment by the full cell process, requiring initial and final vacuum steps as part of the process. Treating chemicals are provided to the treating plants by one of three suppliers as liquid concentrates (50% solids) which are diluted for use. Copper, chromium and arsenic constituents are NPRI reportable substances, and arsenic (and its compounds) and hexavalent chromium compounds are identified as CEPA-toxic substances.

Process Description

(Figure 4.1)

Wood impregnation with CCA is done by the full-cell or Bethell process. “Full cell” implies the full saturation of wood cells by CCA solution. Wood is loaded on trams and sealed in the pressure retort. The impregnation process starts with applying a vacuum for 30 to 60 minutes to remove air from the pressure retort and from the accessible wood cells. Treating solution, at ambient temperature is drawn into the cylinder with the vacuum. Liquid pressure up to 1,040 kPa is applied which forces the solution into the wood until the designated preservative retention is achieved. This can take up to several hours depending on wood species used. Pressure is then released and excessive preservative is pumped into the working solution storage tank. A final vacuum is applied to remove excess preservative from the wood surfaces.

The treated wood is then allowed to stand in a protected area (drip pad) until no more solution drips from the wood. The preservative chemicals must react with the wood substrate chemically in a “fixation” process, which renders them highly insoluble. This fixation process is time and temperature dependent. The fixation phase should take place either in a protected storage area, letting the wood and preservative react under ambient conditions, or in specially designed fixation chambers under high temperature and humidity conditions.

Potential Sources of Emissions of CCA Components

Generally the preservation system is closed, meaning that preservative losses due to leaks, spills and drips are contained and recovered as much as possible and returned back to the process. Unloading, chemical storage and treating areas, all with potential for spills and leaks are curbed and paved, and connected to a drain system so spills and leaks can be captured. The main potential for releases is from catastrophic releases, such as when a hose breaks during unloading. Treated wood can continue to drip CCA components and leach significant amounts if it is not confined to protected storage until the fixation reactions are complete.

After fixation, some leaching will occur from wood placed in storage and exposed to precipitation. The airborne emissions of CCA components may be fugitive or may be drawn into a central exhaust. Process sludges, classified as hazardous wastes, result from the reaction of CCA components with wood extractives and wood particles in the working tank. Other solid wastes result from dust, dirt and debris on the drip pad, fixation chamber floor and treating retort sump, as well as from used clothing and filters. Non-hazardous wastes such as broken pieces of treated wood may also be transferred off site for disposal.

Table 4.1: Probable Reportable Compounds with CAS Numbers— CCA Manufacturing Facilities

Compound	CAS* Registry Number
Arsenic pentoxide	1303-28-2
Chromium trioxide	12018-01-8
Copper oxide	1317-38-0
Criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter $\leq$ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter $\leq$ 10 microns (PM_{10}))	Refer to the *Canada Gazette Part I* Notice for the year being reported.

* CAS denotes Chemical Abstracts Service.

Figure 4.1: CCA Preservation Plant Layout

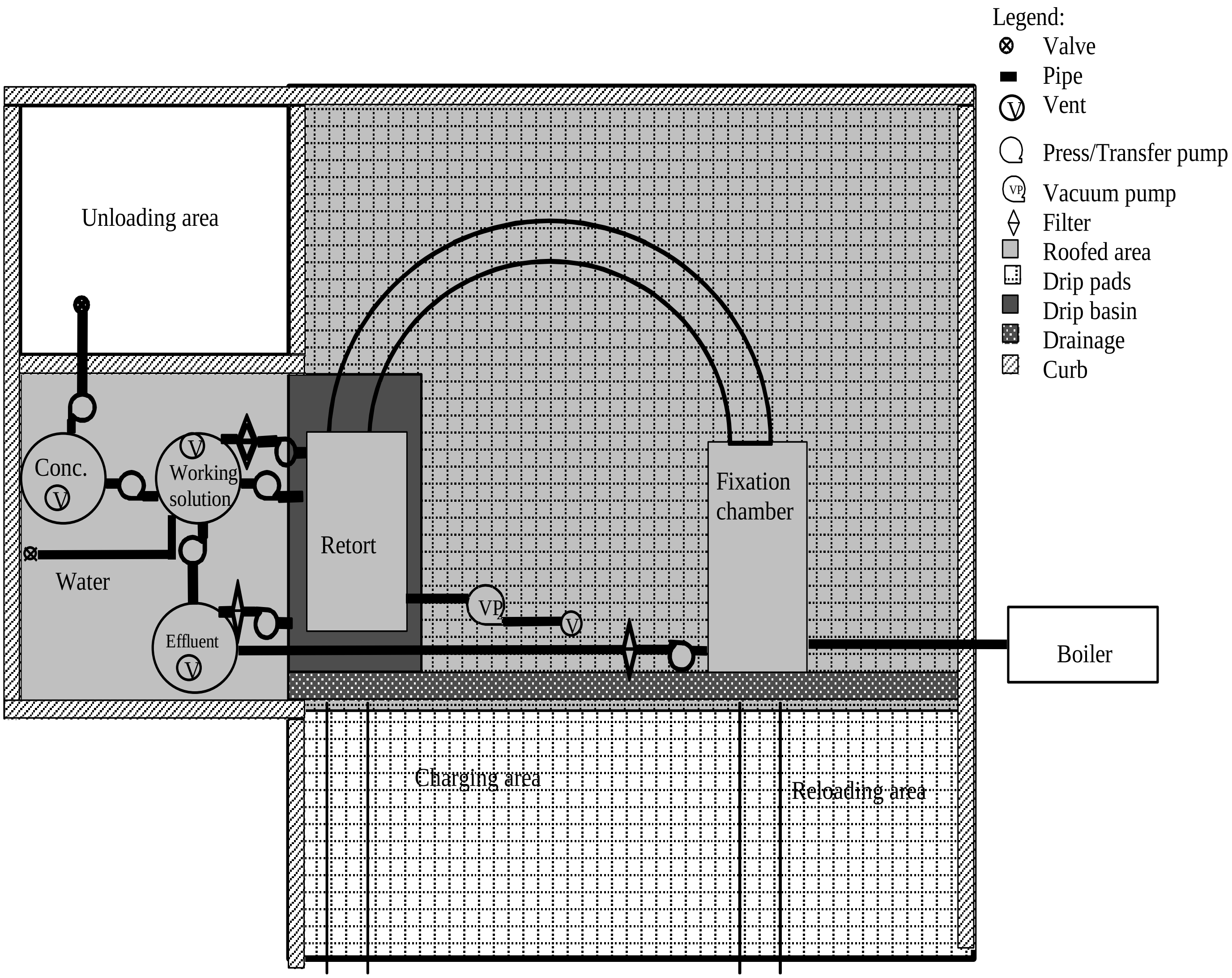
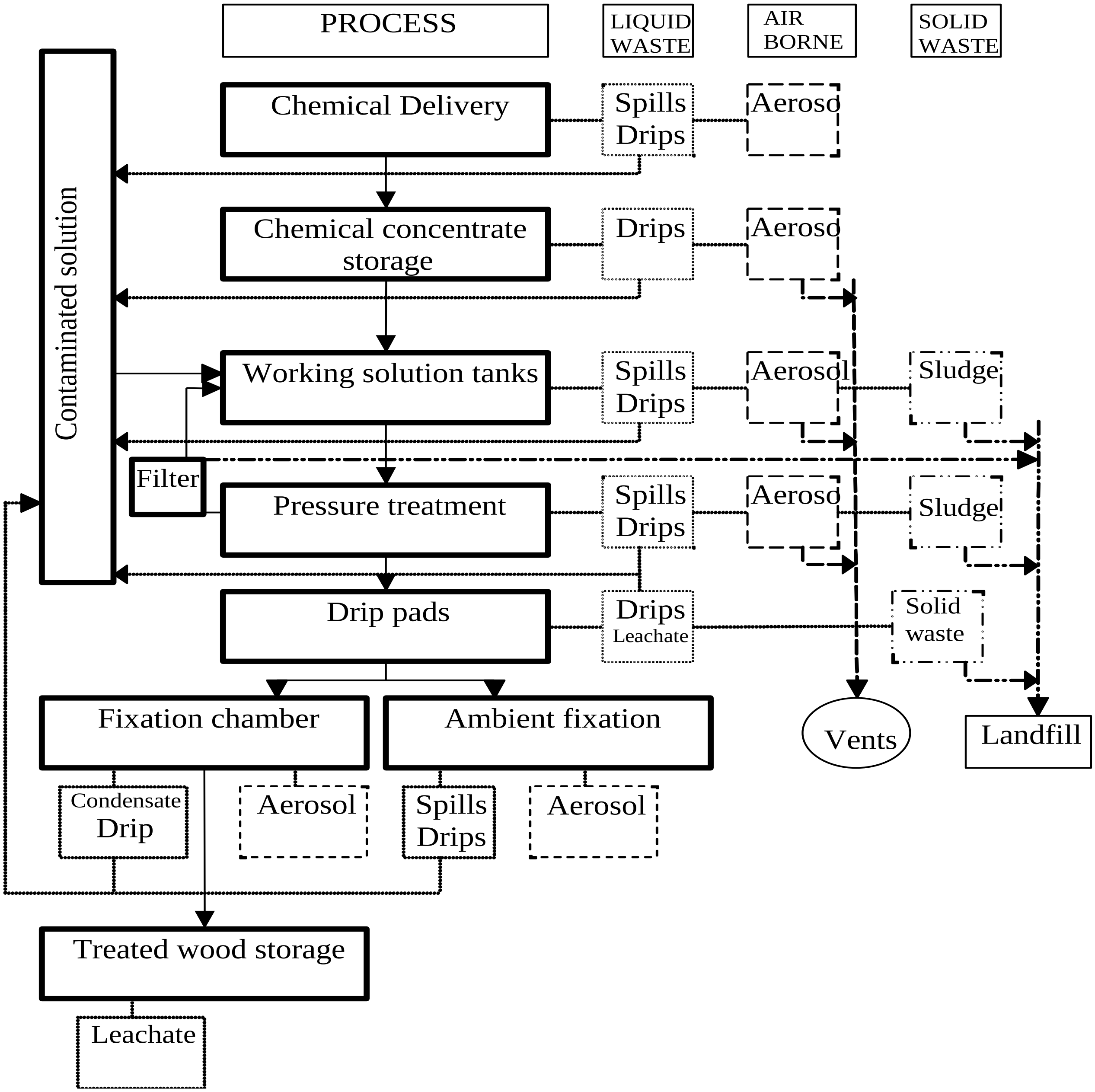


Figure 4.2: Potential Sources of Emissions — CCA Wood Preservation Facilities



Estimation Methodologies to Determine Releases and Transfers—CCA Wood Preservation Facilities

Potential types of releases and other waste-management activities from the sources described above include fugitive and stack air emissions, direct and indirect wastewater discharges, and on-site and off-site management of solid wastes.

Air Emissions

Air emissions from the retort door opening, from valves, flanges, and pumps, and from the treated wood while on the drip pad and in storage, are typically considered fugitive emissions because they are often released into the ambient air and not from a specific point or stack. Air emissions from the vacuum system may be fugitive emissions if emitted direct to the ambient air, or stack emissions if channeled through a pollution-control device, and should be reported appropriately.

Air emissions from CCA waterborne wood preserving plants are very low. The vapour pressure (measure of tendency to evaporate) of CCA inorganic metals is very low under the low ambient temperature treating conditions (15 to 30^{o}C), and fixing and drying of treated wood (up to 90^{o}C) used for this preservative. For example, the concentration of arsenic oxide in a saturated environment is about 1.1 mg/m^3 at 100^{o}C and the extrapolated value at 20^{o}C is about 0.08 *u*g/m^3.

Release of CCA solution as an aerosol, however, can occur at vacuum pump exhausts, work tank vents, retort door openings, and fixation chamber vents (although studies performed in 1984 showed no significant releases), as well as from fixation kiln vents (Bridges 1984).

Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

Direct Measurement

If exhausts from the above sources are collected in a vented hood, the amounts released can be estimated from the time-weighted concentrations of NPRI substances measured in the exhaust and from the flow rate through the exhaust. This will allow the determination of positive effects of introducing emission-control technologies such as wet scrubbers to the exhaust. It is important that measurements reflect the effects of different process steps since there will be higher releases at certain points, such as when the retort is opened or the vacuum pumps are operating.

Example 1

Aerosols from the retort door opening, vacuum pumps and storage tanks are all vented through one exhaust vent. The exhaust vent is determined to have a flow rate (F) of 100 m^3 per hour. Air concentrations of Cu, Cr and As are measured (Ci in mg/m^3) at the vent outlet on several occasions:

- when the retort door is opened and the charge removed,
- when the initial and final vacuum pumps are operating,
- during the rest of the impregnation process (fill retort, pressure treat, empty solution), and
- when the treating system is not in operation.

The number of days that wood was treated per year (Dt) and the number of days it was inactive (Dnt) are known, as well as the number of hours each day that the different process steps are active (ti).

The estimated emission during a given process step (such as retort opening and unloading) is derived using the following formula:

$$\text{Emission (kg)} = F\ (m^3/h) \times ti\ (h/day) \times Dt\ (days) \times Ci\ (mg/m^3) \times 10^{-6}\ kg/mg$$

An example of estimates for annual releases is shown in the table below.

Process	**Hours per day**	**Operating days**	**Hours per year**	**Exhaust vent rate** (m^3/h)	**As conc. in exhaust** (mg/m^3)	**Annual As emission** (mg)
Door opening, unload	3	300	900	100	2×10^{-3}	180
Vacuum	2	300	600	100	1.1×10^{-3}	66
Fill, pressure, empty	5	300	1500	100	3×10^{-4}	45
Retort idle	14	300	4200	100	1.2×10^{-4}	50
	24	65	1560	100	1.2×10^{-4}	19
					Total	360 (0.36g)

Use of Emission Factors

Emission factors for copper and chromium (U.S. EPA) and for arsenic (Australian Timber Preservers' Association) have been developed based on measurements made at representative CCA treating plants. They are, however, based on volumes of wood treated and are therefore not useful for determining reductions in releases as process improvements are implemented, although they can be used to estimate airborne releases (Table 4.2). Please note that emission factors are updated on a periodic basis – the *Guide for Reporting to the National Pollutant Release Inventory* for the year being reported and other reference documents should be consulted to ensure that you are using the most current emission factors.

Table 4.2: Emission Factors from CCA Treatment (MRI 1999, NPI 1999)

Substance	Type of release	Emission Factor	
		(kg/m^3)	(pounds/ft.^{3})
Arsenic	Fugitive air emissions during process	2.2×10^{-8}	1.4×10^{-9}
Chromium	Fugitive air emissions during process	2.2×10^{-8}	1.4×10^{-9}
Copper	Fugitive air emissions during process	3.0×10^{-8}	1.9×10^{-9}
Arsenic	Leaching loss in storage	ND*	ND*
Chromium	Leaching loss in storage	ND*	ND*
Copper	Leaching loss in storage	ND*	ND*

Not determined

Example 2

A CCA treating plant treats 600,000 cubic feet of product annually. The estimated airborne emissions of arsenic and chromium, using the above emission factors is 600,000 x 1.4 x 10^{-9} or about 0.0008 pounds (0.38 grams) and the emissions of copper are 600,000 x 1.9 x 10^{-9} or 0.0011 pounds or 0.52 grams.

Wastewater Discharges

Wastewater discharges may result from the wash down of process equipment, and from storm water run-off. They can also be generated from the drip pad and wastewater from the vacuum discharge condensate.

Note: Most wood preserving facilities using waterborne preservative solutions, such as CCA Type C recycle 100% of the CCA solution. The following calculation is included to assist any facility that may not conduct 100% recycling of the CCA solution.

Direct Measurement

Example 1

A facility discharges its wastewater to municipal sewers. Provincial regulations require you to record the total flow and monitor for chromium, copper, and arsenic. The average monthly flow was 525,000 imperial gallons; the chromium concentration averaged 0.5 mg/L; the copper concentration averaged 2.0 mg/L; and the arsenic concentration, 0.05 mg/L.

The amount of chromium discharged is:

= (525,000 gal./month, total flow) x 12 months/year x (0.5 mg/L, Cr concentration) x (10^{-6} kg/mg) x (4.54 L/gal.)

= 14.3 kg per year

The amount of copper discharged is:

= (525,000 gal./month, total flow) x 12 months/year x (2.0 mg/L, Cu concentration) x (10^{-6} kg/mg) x (4.54 L/gal.)

= 57.1 kg per year

The amount of arsenic discharged is:

= (525,000 gal./month, total flow) x 12 months/year x (0.05 mg/L, As concentration) x (10^{-6} kg/mg) x (4.54 L/gal.)

= 1.44 kg per year

Example 2:
Storm Water Release Estimates
(if flow rates are not known)

Quantification of storm water releases is required if a facility has data on the concentration of NPRI-listed substances in its discharges. Determination of the amount of CCA components released in storm water run-off involves calculating the total amount of volumetric run-off from the site and applying the measured or estimated concentration of CCA to that volume.

To determine the total volume of run-off, the facility must determine the total area drained by each outfall and the weighted average run-off coefficient for that area that is dependent on that area's soil structure, topography, usage and development. The run-off coefficient represents the amount of rainfall that does not soak into the ground but runs off as storm water. Typical values are 0.80 for impervious areas and 0.20 for pervious areas (unimproved). Once the volumetric flows are determined, the facility must apply the correct concentration (found through sampling during the event) at each outfall to each outfall's flow.

I. Calculate total drainage area of each outfall:

L x W = sq. ft.

Outfall#1	Outfall#2
575,200 sq. ft.	568,100 sq. ft.

II. Calculate square footage of **pervious** and **impervious** land areas in each outfall drainage:

A. Pervious – land area that water will soak into (i.e., lawns, gravel yards, unimproved areas, etc.)
B. Impervious – land area that water runs off of (i.e., roofs, streets, etc.)

Outfall # 1	Outfall #3
92,200 sq. ft. – pervious	510,500 sq. ft. – pervious
483,000 sq. ft. – impervious	57,600 sq. ft. – impervious

III. Determine run-off coefficient for land area.

IV. Determine number of gallons of storm water traveling into each outfall and off site:

A. Calculate average rainfall for area:

inches of yearly rainfall ÷ 12 = # ft. of rain/year
i.e., average rainfall is 50 in./year

50 in. of yearly rainfall ÷ 12 = 4.16 ft. of rain/year

B. Calculate run-off from impervious and pervious areas:

ft. of rain/year x sq. ft. of **impervious area** (step 2b) x 7.48 (# gal. per cu. ft. of rain) x 0.8 (run-off coefficient).

Outfall #1: 4.16 ft. x 483,000 x 7.48 x 0.8 = 12,023,531 gal.

Outfall #2: 4.16 ft. x 57,600 x 7.48 x 0.8 = 1,433,862 gal.

ft. of rain/year x sq. ft. of **pervious area** (step 2b) x 7.48 (# gal. per cu. ft. of rain) x 0.2 (run-off coefficient).

Outfall #1: 4.16 ft. x 92,200 x 7.48 x 0.2 = 573,793 gal.

Outfall #2: 4.16 ft. x 510,500 x 7.48 x 0.2 = 3,177,025 gal.

C. Add gallons together for pervious and impervious areas to obtain total gallons for each outfall:

Outfall #1	Outfall #3
12,023,531	1,433,862
+ 573,793	+3,177,025
= 12,597,324 gal.	= 4,610,887 gal.

D. Convert gallons to litres:

gal. (step 4c) x 4.54 L/gal.

Outfall #1	Outfall #2
12,597,324 gal.	4,610,887 gal.
x 4.54	x 4.54
57,191,851 L	20,933,427 L

V. Determine kg of copper (Cu), chromium (Cr), and arsenic (As) released for each outfall:

Use composite results from your storm water sample data for your calculations. (Note: mg/L = ppm)

Outfall #1	Outfall #2
Cr = 0.03 mg/L	Cr = 0.20 mg/L
	As = 0.02 mg/L

Litres of rainwater traveling off site x mg/L Cr x 10^{-6} kg/mg = kg Cr/year

(Note: Do same calculation for copper, chromium and arsenic for each outfall)

Outfall #1:
57,191,851 litres x 0.03 mg/L Cr x 10^{-6} kg/mg = 1.72 kg Cr/year

Outfall #2:
20,933,427 litres x 0.20 mg/L Cr x 10^{-6} kg/mg = 4.18 kg Cr/year

20,933,427 litres x 0.02 mg/L As x 10^{-6} kg/mg = 0.42 kg As/year

VI. Determine total release volumes:

Add kilograms of copper, chromium, and arsenic separately from each outfall to calculate the total kilograms of copper, chromium and arsenic released:

Chromium Arsenic

Outfall #1: 1.72 kg Cr/year and 0 kg As/year
Outfall #3: 4.18 kg Cr/year and 0.42 kg As/year

Total Release: 6.00 kg Cr/year and 0.42 kg As/year

Water Discharges to Soil

One source of emissions to soil is leaching from treated wood during rain events while it is being stored. Leaching rates from freshly treated wood are highly variable, depending on the time of year, type of treated product (species, shape, retention), weather conditions during storage, configuration of stored material (e.g., height of stacks), season and length of storage.

Direct Measurement

Water drippage from representative stored treated product can be collected and measured for volume (V in L) and average concentration (C in mg/L) of CCA components during rain events over the average storage time (t in weeks) for the product. Using the amount of wood represented by the tested material (At in any units) and the average amount of similar material in the yard at any time (A in same units), the leaching emissions to soil can be estimated:

$$\text{Emissions (kg)} = [C\ (\text{mg/L}) \times 10^{-6}\ \text{kg/mg}] \times [V\ (\text{L}) \times A/At \times 52\ \text{weeks/year}]/\ t\ (\text{weeks})$$

Example 1

Drip water was collected from a stack of treated lumber containing 800 cubic feet (At). At any given time, the amount of wood in the yard (A) is 50,000 cubic feet. Over the average storage time of six weeks (t), there were seven rain events and a total volume of 1,350 litres (V) of drip water was collected with an average arsenic content of 1.4 mg/L (C).

Please note that this is only an example—no general emission factors have been developed for wood leaching.

Then the estimated arsenic emissions for the year are:

[1.4 mg/L x 10^{-6} kg/mg] x [1,350 L x 50,000/800 x 52 weeks/year]/6 weeks
= **1.02 kg As/year**

Emission factors

Emission factors have been published for freshly treated wood, but these are variable and depend on estimating the surface area of exposed wood in the yard.

Examples of measured emission factors (Taylor et al. 2000) are:

Cr: 13 mg/m^2/rain event,
Cu: 44 mg/m^2/rain event, and
As: 33 mg/m^2/rain event.

Example 2

Lumber is piled in rectangular stacks 6.5-metres high, 1.4-metres wide and 5.1-metres long. It is assumed that the area exposed to rain at any time is that of the top and four sides with a total area of 91.6 m^2. At any given time there are an average of 36 such stacks in the yard and it is determined from meteorological records that there were 47 rain events during the year.

The estimated emissions of the CCA components are:

Cr: 13 mg/m^2/rain event x 10^{-6} kg/mg x 47 rain events x 91.6 m^2 per stack x 36 stacks = **2.01 kg Cr/year**

Cu: 44 mg/m^2/rain event x 10^{-6} kg/mg x 47 rain events x 91.6 m^2 per stack x 36 stacks = **6.80 kg Cu/year**

As: 33 mg/m^2/rain event x 10^{-6} kg/mg x 47 rain events x 91.6 m^2 per stack x 36 stacks = **5.10 kg As/year**

Releases Caused by Remedial Action

Remedial action can include a number of activities: disposal of contaminated soils, recovery and treatment of contaminated groundwater, or other one-time, non-routine clean-ups.

If groundwater near the plant has been contaminated, it is usually pumped out of the ground and into the treating plant for use as make-up water for the process. In situations where groundwater is treated and released, the amount of release is a function of concentration and volume of water discharge meeting provincial and federal limits.

Example

Groundwater in the amount of 250,000 gallons was recovered, treated, and discharged with concentrations of copper, chromium and arsenic to septic drains at 0.15 ppm, 0.10 ppm and 0.2 ppm, respectively. This results in releases of 0.375, 0.25, and 0.50 pounds per year of Cu, Cr and As, respectively.

Releases to soil were determined by applying the results from soil sample analysis of the chromium, copper and arsenic in the soil samples to the total amount of soil involved. In this example, 20,000 pounds of soil were removed as a result of remedial activities containing calculated Cu, Cr, and As concentrations slightly above current CCME guidelines for industrial sites. The actual concentrations of copper, chromium and arsenic by weight were multiplied by 20,000 pounds as follows:

20,000 lb. x 20 ppm (Cu) x 10^{-6} = 0.4 lb.
20,000 lb. x 50 ppm (Cr) x 10^{-6} = 1.0 lb.
20,000 lb. x 100 ppm (As) x 10^{-6} = 2.0 lb.

Release Due to Catastrophic Events

These involve spills or accidental releases outside the containment areas and in all cases require reporting to the environmental authorities. The amount of the release is a function of CCA concentration and volume released.

Example

CCA 50% concentrate in an amount of 200 gallons is spilled outside the containment area due to a ruptured hose during the unloading process. The release is promptly cleaned up and neutralized with spill neutralizer, and subsequently stored in drums as hazardous waste for shipment to a secure landfill. The appropriate authorities are promptly notified. The total amount of the spill can be calculated as follows:

1. Calculate the total mass of the spill:

200 gal. x 1.638 lb./gal. x 10 lb./gal. = 3,276 lb.

CuO = 3,276 lb. x 9.25% = 303.0 lb.

CrO_3 = 3,276 lb. x 23.75% = 778.0 lb.

As_2O_5 = 3,276 lb. x 17.00% = 557.0 lb.

2. Determine actual elemental Cu, Cr, and As:

Element	Atomic Mass	
Cu	64	(CuO) = 64/(64+16) = 0.8
Cr	52	(CrO_3) = 52/(52 = 3(16)) = 0.52
As	75	(As_2O_5) = 2(75)/(2(75) + 5(16)) = 0.65

3. Multiply the elemental ratio in step 2 by the determined total oxide mass from step 1:

Cu = 303.0 lb. x 0.8 = 242.4 lb.
Cr = 778.0 lb. x 0.52 = 404.56 lb.
As = 557.0 lb. x 0.65 = 362.05 lb.

Releases of Solid Hazardous Waste

For solid hazardous waste, a determination of the total quantity of waste as well as the concentration of the copper, chromium and arsenic must be made. Hazardous waste manifests are used to determine the amount of hazardous waste that was shipped off site. In addition, a waste analysis should be performed to determine the concentration of Cu, Cr and As in the waste. This analysis should then be used to determine the actual release to landfill.

Example

The facility sent six 45-gallon drums of hazardous waste to a secure landfill. The total quantity of waste disposed was 2,104 kg containing copper, chromium and arsenic in the following proportions 1.966%, 2.262% and 4.219%, respectively. None of the results contained hexavalent chromium.

Therefore actual quantity in the waste is:

2,104 kg x 1.966% = 41.36 kg Cu
2,104 kg x 2.262% = 47.59 kg Cr
2,104 kg x 4.219% = 88.77 kg As

The facility had additional manifests for the soils disposed of during remedial action. However these releases have already been accounted for in that section.

Summary of NPRI Reporting Steps—CCA Wood Preservation Facilities

1. Gather information on sources of releases to air, soil, groundwater, storm water, and off-site releases.

2. Determine reporting thresholds for NPRI reportable substances from the *Canada Gazette Part I* Notice for the year being reported.

3. Estimate quantities released on site or transferred off site based on monitoring data, engineering calculations or emission factors.

Sample Release Summary Form

Substance	Type of Release	Release	Kg Released

Cr/ Cu/ As	Process	Fugitive aerosol and vapour	
	Storage	Leaching losses to soil	
	Remedial action	Contaminated soil, etc.	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Non-hazardous wastes	Solid wood, etc., to landfill	
	Hazardous waste	Solid waste transferred to a hazardous-waste site	

IV–D Ammoniacal Copper Zinc Arsenate (ACZA) Wood Preservation Facilities

Overview

The treating process is similar to that of CCA in that a full-cell treating process is used to achieve preservative retentions similar to those required for CCA. The treating process is a closed system, and process water and liquid releases are collected and reused. The active preservative constituents are kept in solution at high pH with ammonia. Copper, zinc, arsenic and ammonia constituents are all NPRI reportable substances—arsenic is a CEPA-toxic substance.

Process Description

(Figure 4.3)

ACZA preservative is made on site by mixing arsenic acid, copper oxide, zinc oxide, ammonium hydroxide, ammonium bicarbonate and water. Zinc oxide, copper oxide and ammonium bicarbonate are manually added into a mixing tank containing water. After mixing and slurry formation, ammonium hydroxide is added followed by arsenic acid, and mixing continues until the copper is dissolved, which takes 10 to 72 hours. This initial concentrate of 8 to 13% total oxides with the ratio of the $ZnO:CuO:As_2O_5$ of 1:2:1, is then diluted to a working solution concentration of 2 to 7% total oxides.

The preservation process is similar to that of CCA. Wood impregnation is obtained using the full-cell or Bethell process. Wood is loaded on trams and sealed in the pressure retort. The impregnation process starts with applying vacuum for 30 to 60 minutes to remove air from the pressure retort and from the accessible wood cells. Treating solution, at ambient temperature, is drawn into the cylinder with the vacuum. Liquid pressure up to 1,040 kPa is applied.

The pressure is held until the designated amount of preservative enters the wood, which can take up to several hours depending on the wood species used. Pressure is then released and excessive preservative is pumped out to a storage tank. A final vacuum is usually applied to remove excess preservative from the wood surfaces. The treated wood is then allowed to stand in a protected area (drip pad) until no more solution drips from the wood. ACZA fixation is achieved by the loss of ammonia from the treated wood, ideally under ambient temperature conditions.

Please refer to Figure 4.4 for an illustration of potential sources of emissions of ACZA components.

Arsenic, copper, zinc and ammonia are the compounds that have to be monitored during the above processes for NPRI reporting. Processing steps that can result in emissions to air, soil, and groundwater or for off-site disposal are shown in Figure 4.4. Airborne emissions of all components as aerosols are possible at the retort door (especially when opened after a treatment charge), at vacuum pump exhausts and tank vents. In addition, fugitive emissions of ammonia will occur wherever treating solution and freshly treated wood is exposed to the environment. Liquid emissions to the soil, groundwater and surface water can occur wherever uncontained drips, leaks and spills occur. Unprotected, treated wood in storage will leach small amounts of all components when subjected to rain.

Solid contaminated wastes result from used filters, contaminated dirt, dust and sawdust and from process sludges that build up in the solution storage tanks.

Table 4.3: Probable Reportable Compounds with CAS Numbers—ACZA Preservation Facilities

Compound	CAS* Registry Number
Ammonia	7664-41-7
Ammonium bicarbonate	
Ammonium hydroxide	1336-21-6
Arsenic pentoxide	1303-28-2
Copper oxide	1317-38-0
Criteria air contaminants (including oxides of nitrogen (expressed as NO$_x$), sulphur dioxide (SO$_2$), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns (PM$_{2.5}$), and particulate matter with a diameter □ 10 microns (PM$_{10}$))	Refer to the *Canada Gazette Part I* Notice for the year being reported.
Zinc oxide	1314-13-2

* CAS denotes Chemical Abstracts Service.

Figure 4.3: ACZA Preservation Plant Layout

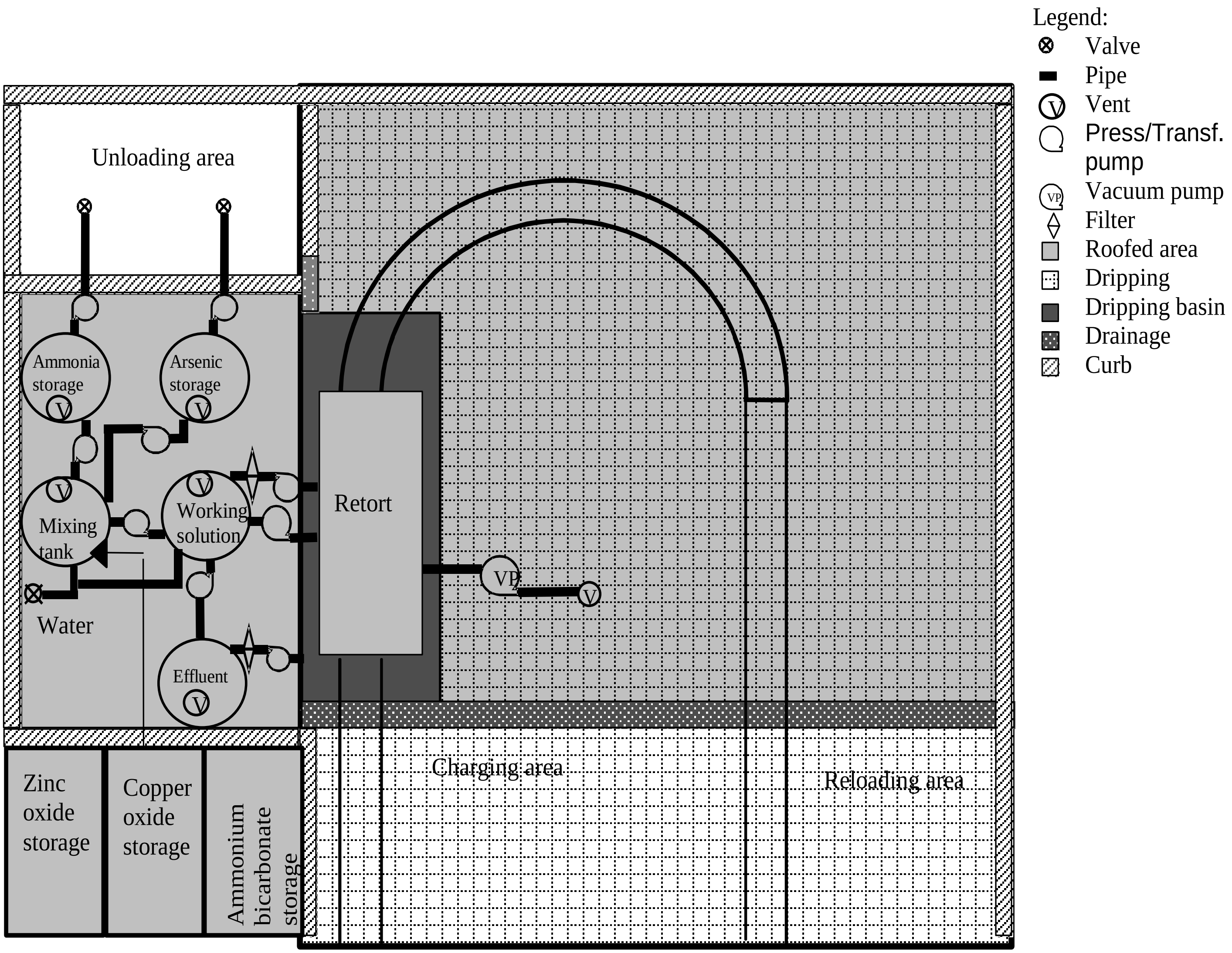
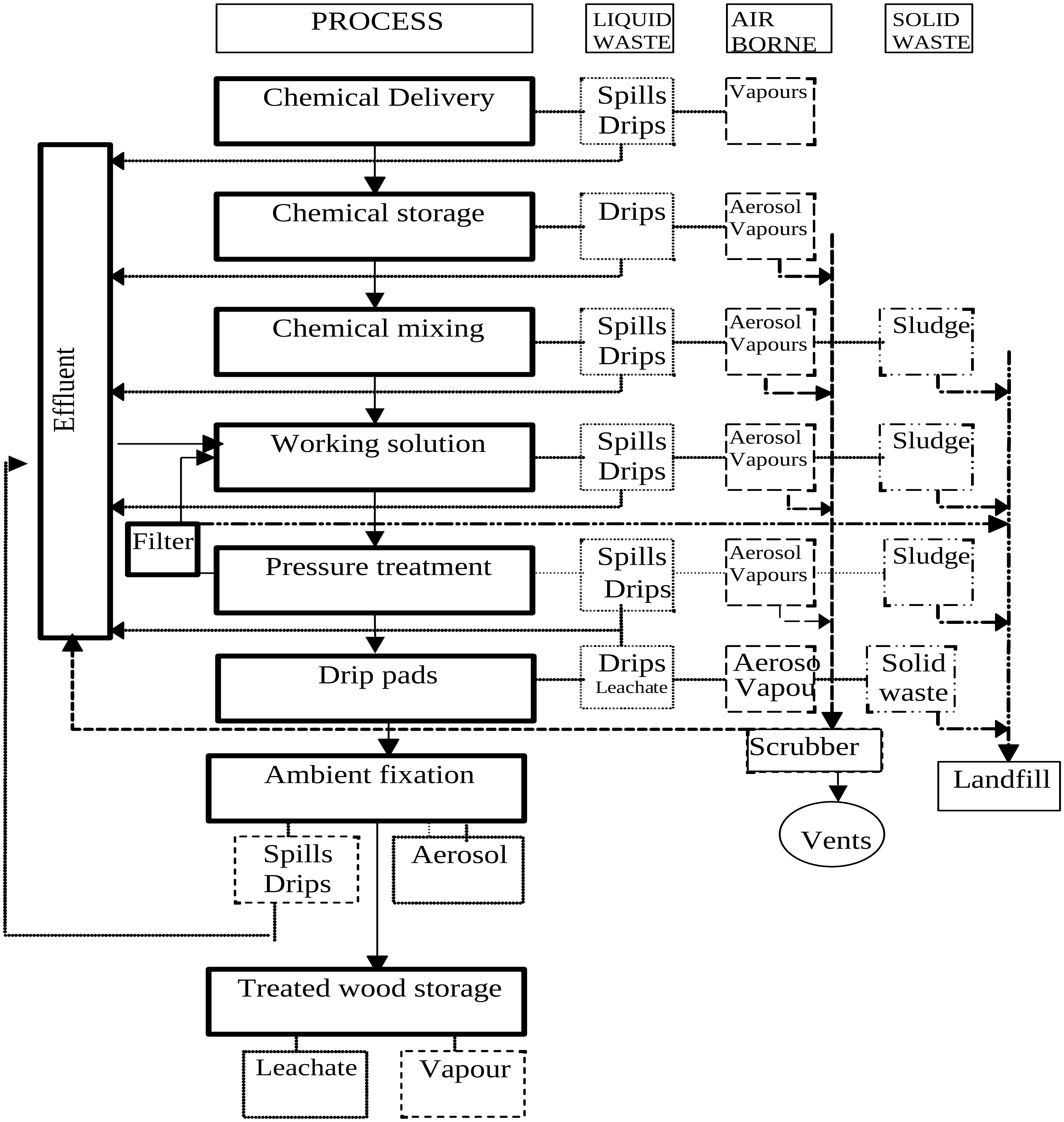


Figure 4.4: Potential Sources of Releases from an ACZA Wood Preservation Plant



Estimation Methodologies to Determine Releases and Transfers—ACZA Wood Preservation Facilities

Estimation methodologies for emissions are similar to those for CCA wood preservation facilities, with two exceptions:

- Emission factors have not been developed for ACZA airborne emissions.
- There will be a release of ammonia during the process and from freshly treated wood.

Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

For the determination of releases to water, soil and off-site transfers of solid wastes, refer to the section on estimating releases for CCA wood preservation facilities.

Airborne Emissions of Ammonia

Ammonia releases can be estimated by direct measurements for occupational exposure monitoring for those process steps where information on flow rates or air-exchange rates are known. Treaters can also develop their own emission factors. It may also be feasible to use a mass-balance approach.

Direct Measurement: Vented or Stack Releases

Example 1

The ammonia concentration is measured at different times during the treating process at the outlet of the wet scrubber installed in the exhaust vent (see table below). Aerosols and vapours from the retort door opening, vacuum pumps and storage tanks are all vented through the one exhaust. The vent is determined to have a flow rate (F) of 1,000 m^3 per hour. Air concentrations of ammonia are measured (Ci in mg/m^3) at the vent outlet on several occasions when the retort door is opened and the charge removed, when the initial and final vacuum pumps are operating, during the rest of the impregnation process (fill retort, pressure treat, empty solution) and when the treating system is not in operation. The number of days that wood was treated per year (Dt) and the number of days it was inactive (Dnt) are known, as well as the number of hours each day that the different process steps are active (ti).

The estimated emission during a given process step (such as retort opening and unloading) is given by:

$$\text{Emission (kg)} = F\ (m^3/h) \times ti\ (h/day) \times Dt\ (days) \times Ci\ (mg/m^3) \times 10^{-6}\ kg/mg$$

Examples of estimated releases based on direct measurements (emission factors not developed):

Process	**Hours per day**	**Operating days**	**Hours per year**	**Exhaust vent rate (m^3/h)**	**NH_3 Conc. in exhaust (mg/m^3)**	**Annual NH_3 emission (kg)**
Door opening, unload	3	300	900	1000	150	135
Vacuum	2	300	600	1000	87	52.2
Fill, pressure, empty	5	300	1500	1000	56	84.0
Retort idle	14	300	4200	1000	21	88.2
	24	65	1560	1000	21	32.8
					Total	392.2 (0.39 tonnes)

Example 2:
Mass Balance

It is known that much of the ammonia used in the process will be released to the environment as a result of process losses and evaporation of ammonia from the treated wood to fix the preservative chemicals. However, it is also known that some ammonia is retained in the final treated product as a reaction product between the wood components and the other preservative components, and process ammonia is recovered by vacuum and other post-treatment processes in the retort. If it is assumed that 50% of the ammonia is retained in the treated wood and the remainder is released, mainly as vapour.

- A treater uses 120,000 kg dry mass basis of ACZA containing 39.9% copper (47,880 kg). They formulate the solution with ammonia at 1.8 x the weight of copper (1.8 x 47,880 = 86,184 kg ammonia).

- Assuming 50% is released during and after treatment, the total release is 86,184/2 or 43,092 kg (43.1 tonnes).

Note that this example ignores ammonia recovered by post-treatment conditioning and through scrubbers in vents and will be an overestimate.

Summary of NPRI Reporting Steps—ACZA Wood Preservation Facilities

1. Gather information on sources of releases to air, soil, groundwater, storm water, and off-site releases.

2. Determine reporting thresholds for NPRI reportable substances from the *Canada Gazette Part I* Notice for the year being reported.

3. Estimate quantities released on site or transferred off site, based on monitoring data, engineering calculations or emission factors.

Sample Release Summary Form

Substance	Type of release	Release	Kg Released
Ammonia	Process	Fugitive aerosol and vapour	
	Storage	Leaching losses to soil	
	Storage	Fugitive vapour loss	
	Remedial action	Contaminated groundwater, etc.	
	Storm water	Release to sewer	
	Catastrophic releases	Release to air and groundwater	
Arsenic	Process	Fugitive aerosol and vapour	
	Storage	Leaching losses to soil	
	Remedial action	Contaminated soil, etc.	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Non-hazardous wastes	Solid wood, etc. to landfill	
	Hazardous waste	Solid waste transferred to hazardous-waste site	

IV–E Ammoniacal Copper Quaternary (ACQ) Wood Preservation Facilities

Overview

Ammoniacal copper quaternary (Type B) wood preservative is formulated with copper oxide (66.7%) and the quaternary ammonium compound, didecyldimethylammoniumchloride – DDAC (33.3The treating process and sources of emissions are similar to ACZA.

Process Description

(Figure 4.5)

As with the other water-based treatments, the process should be a closed system so liquid releases are collected for reuse. ACQ is diluted to similar working solution concentrations as for CCA and ACZA. Wood is treated using a full-cell process involving initial and final vacuums and a pressure process of variable duration, depending on the species and target preservative loading. Chemical fixation of the active components is relatively rapid and, as with ACZA, involves the evaporation of ammonia under ambient conditions.

Chemical Discharges

(Figure 4.6)

Copper, ammonia, and the criteria air contaminants are compounds that should be monitored during the processes for NPRI reporting. Processing steps that can result in emissions to air, soil, and groundwater or for off-site disposal are shown in Figure 4.6. Airborne emissions of all components as aerosols are possible at the retort door (especially when opened after a treatment charge), at vacuum pump exhausts, and tank vents. In addition, fugitive emissions of ammonia will occur wherever treating solution and freshly treated wood is exposed to the environment. Liquid emissions to the soil, groundwater and surface water can occur wherever uncontained drips, leaks and spills can occur. Unprotected treated wood in storage will leach small amounts of components when subjected to rain. Solid contaminated wastes result from used filters, contaminated dirt, dust and sawdust, and from process sludges that build up in the solution storage tanks.

Figure 4.5: ACQ Wood Preservation Plant Layout

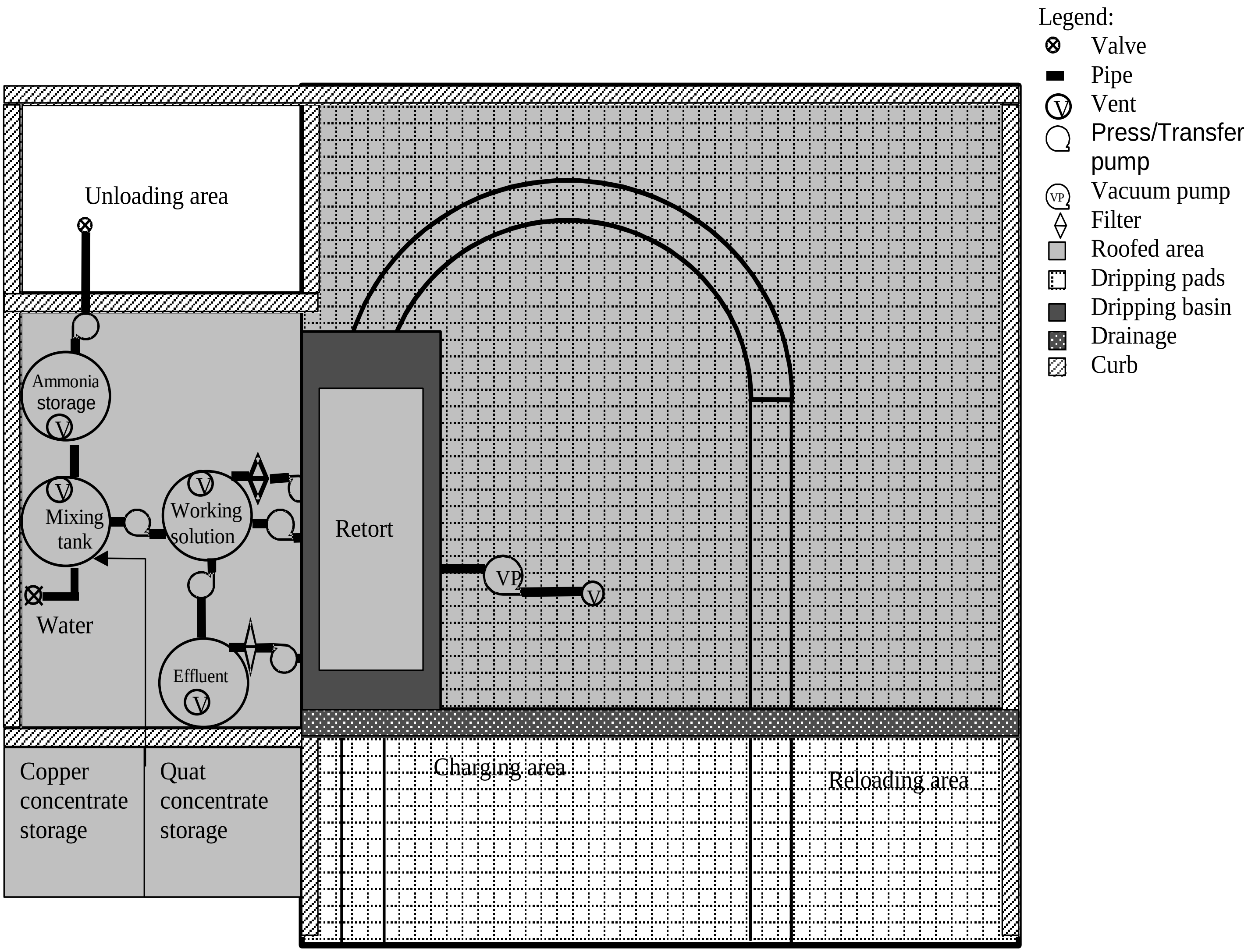


Figure 4.6: Potential Sources of Releases from an ACQ Wood Preservation Plant

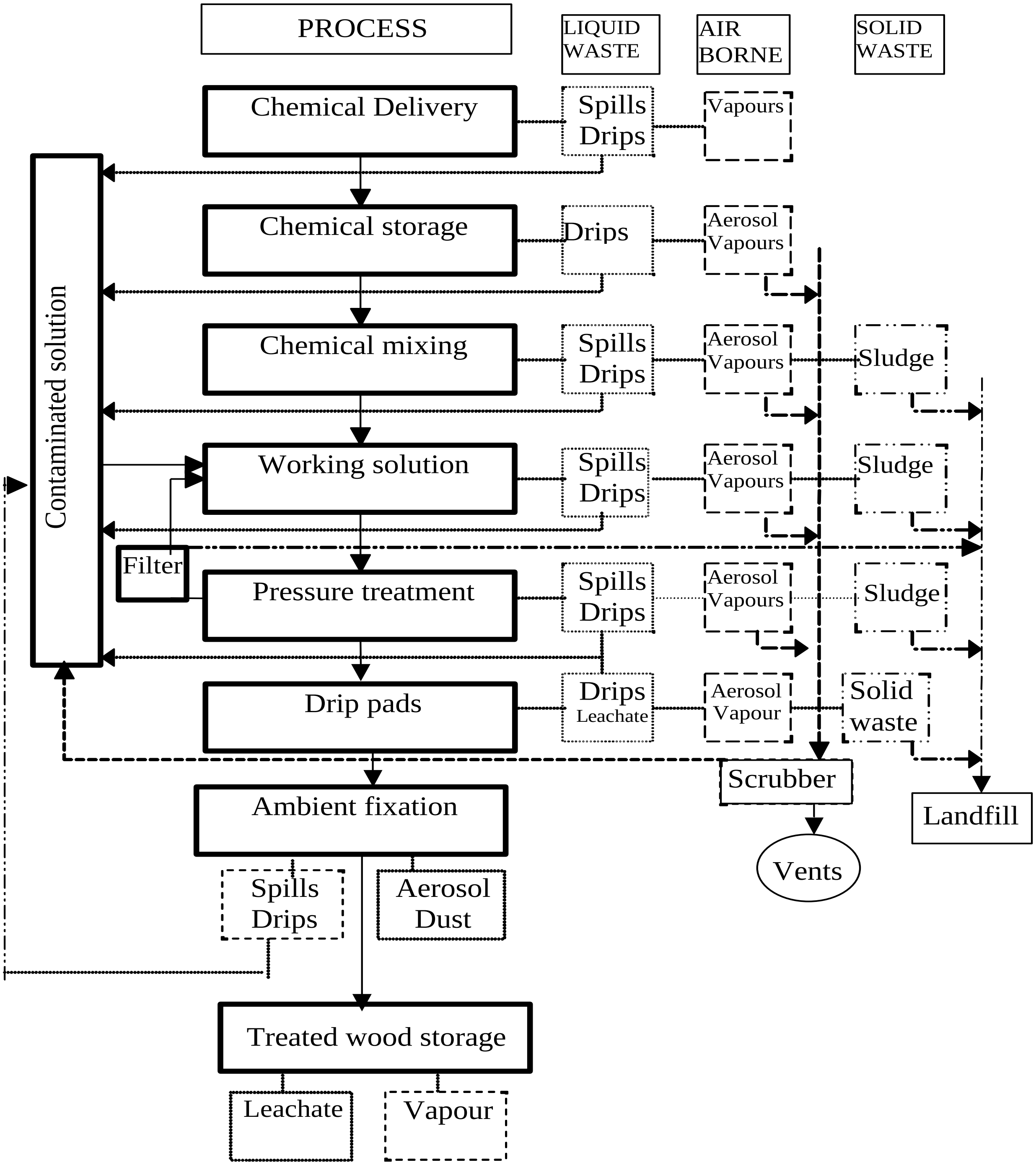


Table 4.4: Probable Reportable Substances with CAS Numbers—ACQ Preservation Facilities

Compound	CAS* Registry Number
Ammonia	7664-41-7
Ammonium bicarbonate	1066-33-7
Ammonium hydroxide	1336-21-6
Copper oxide	1317-38-0
Criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter $\leq$ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter $\leq$ 10 microns (PM_{10}))	Refer to the *Canada Gazette Part I* Notice for the year being reported.

* CAS denotes Chemical Abstracts Service.

Estimation Methodologies to Determine Releases and Transfers for ACQ Wood Preservation Facilities

Estimation procedures for emissions are similar to those for CCA wood preservation facilities, with two exceptions:

- Emission factors have not been developed for ACQ airborne emissions.
- There will be a release of ammonia during the process and from freshly treated wood.

Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

For the determination of releases to water, soil and off-site transfers of solid wastes, refer to the section on estimating releases for CCA wood preservation facilities.
For an estimation of ammonia releases, refer to the section on ACZA wood preservation facilities.

Summary of NPRI Reporting Steps—ACQ Wood Preservation Facilities

1. Gather information on sources of releases to air, soil, groundwater, storm water, and off-site releases

2. Determine reporting thresholds for NPRI reportable substances from the *Canada Gazette Part I* Notice for the year being reported.

3. Estimate quantities released on site or transferred off site, based on monitoring data, engineering calculations or emission factors.

Sample Release Summary Form

Substance	Type of Release	Release	Kg Released
Ammonia	Process	Fugitive aerosol and vapour	
	Storage	Leaching losses to soil	
	Storage	Fugitive vapour loss	
	Remedial action	Contaminated groundwater, etc.	
	Storm water	Release to sewer	
	Catastrophic releases	Release to air and groundwater	
Copper	Process	Fugitive aerosol	
	Storage	Leaching losses to soil	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Non-hazardous wastes	Solid wood, etc. to landfill	

IV–F Creosote Wood Preservation Facilities

Overview

Creosote contains a large number of compounds, many of which are polycyclic aromatic hydrocarbons (PAHs). Creosote solutions contain a number of NPRI reportable substances including naphthalene, anthracene, biphenyl, and certain individual PAHs.

Process Description

(Figure 4.7)

Where high creosote retentions are required the full-cell or Bethel process is used. Creosote is heated to 70 to 90°C to reduce its viscosity and promote better penetration. Wood is loaded on trams and sealed in the pressure retort, and a vacuum is applied to remove air from the retort and accessible wood cells. The heated solution is drawn or pumped in and pressure is applied until the target retentions are achieved. After the impregnation stage, treated wood is subjected to an expansion bath before the preservative is drained and a final vacuum is applied in order to remove excess preservative from the surface. In some cases, the treated wood is subjected to a post-steaming treatment to improve the wood’s surface cleanliness.

Where lower retentions are required, empty-cell processes can be performed, either by the Rueping or the Lowry process. These processes result in preservative coating the inner cell walls rather than saturating the cell voids. Empty-cell processes differ from the full-cell process in the initial impregnation stage. In the Rueping process, treating commences by applying air pressure of 200 to 500 kPa for a short time, so that the air inside the wood is compressed. Creosote is pumped under pressure into the treating retort and pressure is increased to about 1,040 kPa and held for sufficient time for the predetermined amount of solution to enter the wood. After pressure release, the compressed air in the wood expands pushing the excess preservative out, which is facilitated by a final vacuum.

In the Lowry process no air pressures are applied at the initial impregnation stage. The preservative is pumped into the retort at atmospheric pressure (no initial vacuum). When pressure is applied, the air in the wood is compressed as the preservative penetrates. When the pressure is released, the air inside the wood expands resulting in the “kick out” of treating solution, although to a lesser extent than the Reuping process. The application of an expansion bath, final vacuum and post-treatment steaming are also common with empty-cell treatments.

It is also possible to season and condition wood in the retort prior to pressure treatment. These processes result in contaminated water condensates. For example, unseasoned pilings can be seasoned in the retort by the Boultonizing or boiling under a vacuum process. Piles are sealed in the retort and hot creosote is then added. A vacuum is applied, resulting in rapid evaporation of water from the wood under the reduced pressure and high-temperature conditions. It is possible to dry large timbers to a low enough moisture content to permit treatment in 24 hours or less. The evaporated water containing the low-boiling-point components of the creosote is condensed out for treatment and disposal.

It is also common practice to condition poles and other timbers by steam/vacuum cycles in the retort. This results in condensate in the retort, which is contaminated by creosote components from the retort walls. This condensate must also be collected and treated.

The thermal treatment process is rarely used for the treatment of cedar, lodge poles or pine poles. The poles are placed in rectangular treatment tanks and hot creosote (88 to 113°C) is pumped in until the poles are immersed. This causes the air in the wood to expand out of the wood. After a minimum of six hours the hot preservative is quickly replaced by preservative at ambient temperature. This causes contraction of the air remaining in the wood cells drawing the preservative oil into the wood. After a few hours, the cold oil is pumped out. Full sapwood penetration may be achieved by this process. It is possible to impregnate only the butt portion of cedar poles by the thermal process.

In this practice, instead of the rectangular and horizontal tanks, cylindrical and vertical tanks are used. Poles are loaded so that preservative reaches only to a certain height of their lengths. Method, temperature, and time are otherwise the same as in the regular thermal treatment.

Chemical Discharges

(Figure 4.8)

Creosote components have measurable vapour pressures at ambient temperatures and, since solutions are heated for treatment and storage, there may be significant airborne emissions at all stages of the process, but especially at the retort door, vacuum pump vents, storage tank vents, and from freshly treated wood. Contaminated process-water results from conditioning treatments such as Boultonizing or steaming pretreatments. Contaminated storm water run-off can result from leached preservative or uncontained drips, leaks and spills. Oil-based preservatives are not chemically fixed in the wood and they may be prone to liquid bleeding of preservative from stored treated wood. Sludges can result from creosote/water emulsions produced by treating inadequately seasoned wood. Other solid wastes result from contaminated dirt and sawdust as well as used filters.

Table 4.5: Probable Reportable Compounds with CAS Numbers—Creosote Wood Preservation Facilities

Compound	CAS* Registry Number	VFT Typical Analysis**	Typical Analysis AWPA P1 creosote†
		%	%
Anthracene	120-12-7	2.43	1.7
Biphenyl	92-52-4	1.57	1.3
Naphthalene	91-20-3	9.53	12.9
Benzo(a)anthracene	56-55-3	0.89	0.50
Benzo(a)phenanthrene	218-01-9	-	0.10
Benzo(a)pyrene	50-32-8	0.17	0.20
Benzo(b)fluoranthene	205-99-2	-	-
Benzo(e)pyrene	192-97-2	-	0.20
Benzo(g,h,i)perylene	191-24-2	0.04	0.10
Benzo(j)fluoranthene	205-82-3	-	0.12
Benzo(k)fluoranthene	207-08-9	-	0.22
Dibenz(a,j)acridine	224-42-0	-	-
Dibenzo(a,h)anthracene	53-70-3	<0.01	-
Dibenzo(a,i)pyrene	189-55-9	-	-
7H-Dibenzo(c,g)carbazole	194-59-2	-	-
Fluoranthene	206-44-0	5.76	4.6
Indeno(1,2,3-c,d)pyrene	193-39-5	0.04	-
Perylene	198-55-0	-	0.10
Phenanthrene	85-01-8	14.26	11.2
Pyrene	129-00-0	3.44	3.7
Criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))	Refer to the *Canada Gazette Part I* Notice for the year being reported.	NA***	NA***

* CAS denotes Chemical Abstracts Service.

** Environment Canada 2000a

*** Not applicable

† Betts (1990)

Figure 4.7: Creosote Treating Plant Layout

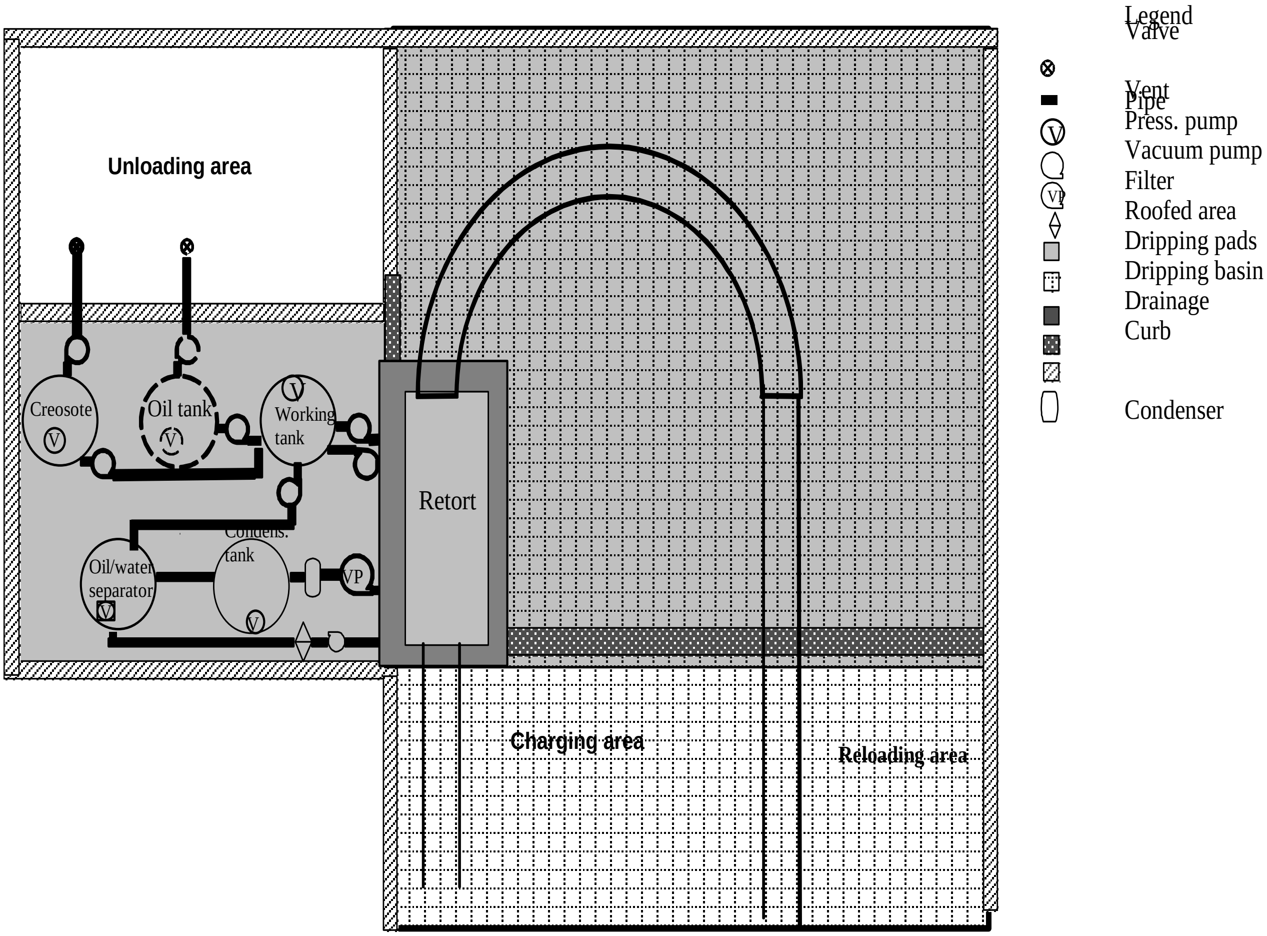
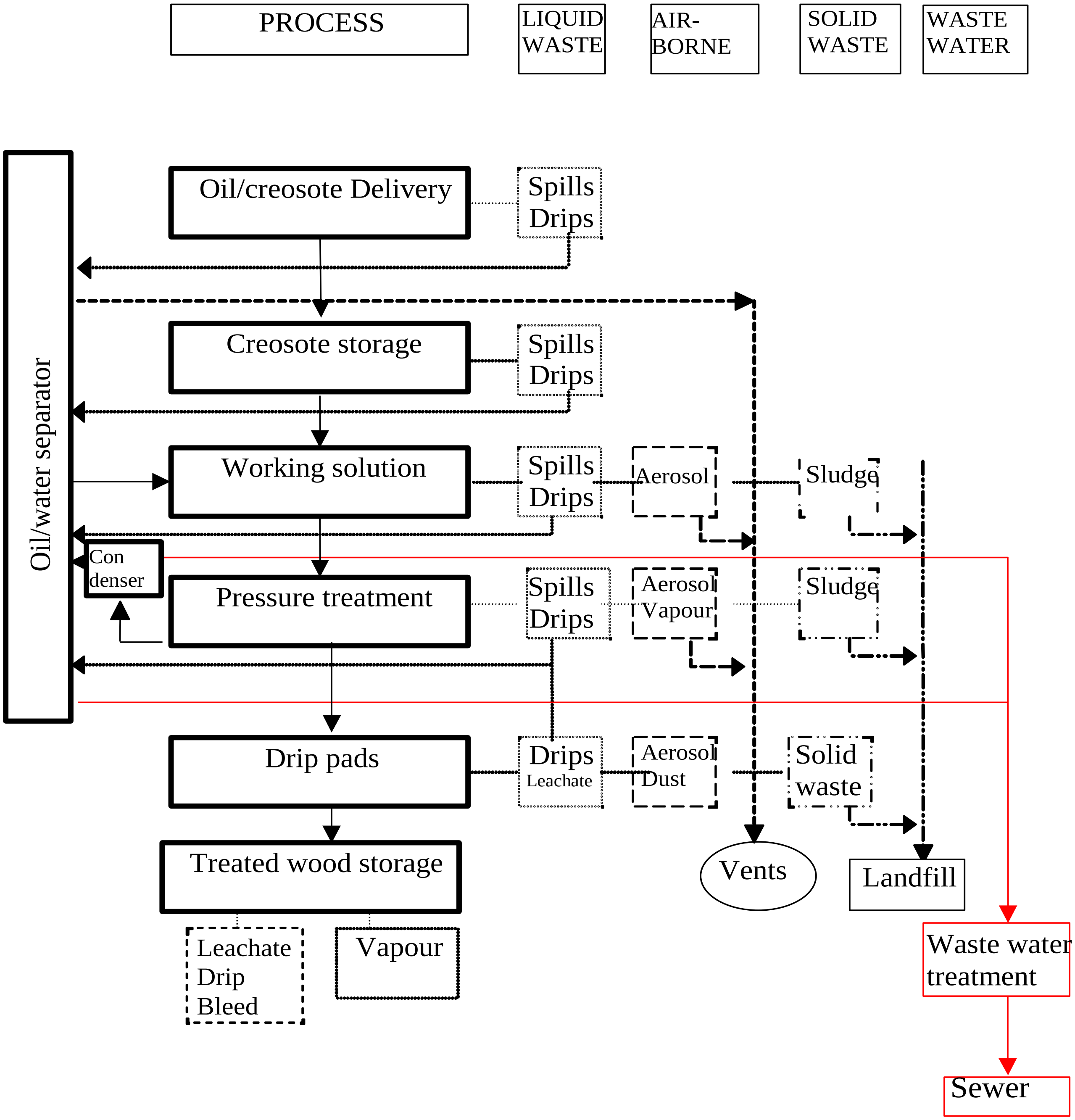

Unloading area
Creosote
V
Oil tank
V
V
Working tank
Condens. tank
V
Oil/water separator
V
VP
Retort
Charging area
Reloading area
Legend
Valve
Vent
Pipe
Press. pump
Vacuum pump
Filter
Roofed area
Dripping pads
Dripping basin
Drainage
Curb
Condenser

Figure 4.8: Sources of Releases from Creosote Wood Preservation Plants



Estimation Methodologies to Determine Releases and Transfers for Creosote Wood Preservation Plants

For a creosote treating facility, information requirements can be grouped into the following categories:

- Process
- Storm water
- Remedial action
- Catastrophic events
- Non-hazardous solid waste
- Hazardous wastes

Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

Potential types of releases and other waste management activities from the sources described above include fugitive and stack air emissions, direct and indirect wastewater discharges, and on-site and off-site management of solid wastes.

Process Air Emissions

Air emissions from the retort door opening, from valves, flanges, and pumps, and from the treated wood while on the drip pad and in storage are typically considered fugitive emissions because they are often released into the ambient air and not from a specific point or stack. Air releases from storage and working tanks are considered stack emissions released through a controlled exhaust or channeled through a pollution control device. Air emissions from the vacuum system may be fugitive emissions if they are emitted direct to the ambient air, or stack emissions if they are channeled through an air-pollution control.

Direct Measurement

PAH emissions can be estimated directly, based on air-monitoring results. Stack emissions are the most easily and reliably estimated since representative concentrations can be determined as well as stack flow rates.

Example 1:

Calculating Air Releases of PAHs Using Stack Monitoring Data

Stack testing has determined that PAHs are detected in the stack gases at a facility at concentrations (g per dry standard cubic metre of gas) as tabulated below. The moisture content in the stack is typically 10%. The stack gas velocity is typically 1.8 m/sec. The diameter of the stack is 0.3 metres. The annual air release of the PAHs from the stack of the facility may be estimated as follows.

1. Calculate the volumetric flow of stack gas stream:

   Volumetric flow = (gas velocity) x [*Pi* x (internal stack diameter)^2 / 4]
   = (1.8 m/s) x [3.142 x (0.3m)^2 / 4]
   = 0.13 m^3/s

2. Correct the volumetric flow for moisture content in stack gas stream:

   Stack gases may contain large amounts of water vapour. The concentration of the chemical in the exhaust is often presented on a 'dry gas' basis. For an accurate release rate, correct the stack or vent gas flow rate in step 1 for the moisture content of the facility's stack gas. This is done as follows:

   Corrected dry gas volumetric flow = (volumetric flow) x (1 - fraction of water vapour)
   = (0.13 m3/s) x (1 - 0.10)
   = 0.11 m3/s

3. Estimate annual stack emissions to air:

   Multiply the dry gas volumetric flow rate by the concentration of PAHs measured in the stack gases:

   $R_{air} = C \times V \times CF \times H$

   Where:

   R_{air} = Annual release of PAHs to air (g/year)
   C = Stack gas concentration of PAHs (g/dry standard m^3)
   V = Hourly volumetric flow rate of combustion stack gas (m^3/hour)
   CF = Capacity factor, fraction of time that the facility operates on an annual basis (e.g. 0.85)
   H = Total hours in a year (8,760 hours/year)

Substance	**Concentration (g/m^3), C**	**Air flow (m^3/h), V**	**Hours / year active (CF x H)**	**Emissions (grams/year), R**
	6 x 10^{-4}	412	3,842	950

Anthracene	2 x 10^{-4}	412	3,842	317
Benzo(a)anthracene	3 x 10^{-6}	412	3,842	4.75
Benzo(b)fluoranthene	6 x 10^{-6}	412	3,842	9.50
Benzo(k)fluoranthene	4 x 10^{-7}	412	3,842	0.63
Benzo(a)pyrene	2 x 10^{-7}	412	3,842	0.32

Example 2:
Emission Factors

The U.S. EPA has developed emission factors for several PAHs for different creosote treating scenarios and for losses from freshly treated wood (Table 4.6).

A creosote treating plant that treats 130,000 cubic feet of Boultonized and full-cell treated marine pilings per year and 900,000 cubic metres of empty-cell treated railway ties per year. The estimated emissions are:

- Relevant volume x emission factor

Benzo(a)pyrene: Pilings: 130,000 x 6.5 x 10^{-8} = 0.00845 lb. or 3.8 g
Ties: 900,000 x 8.2 x 10^{-9} = 0.00738 lb. or 3.3 g

Total process 7.1 g or 0.0071 kg

Naphthalene: Pilings: 130,000 x 7.9 x 10^{-5} = 10.27 lb. or 4.67 kg
Ties: 900,000 x 4.6 x 10^{-6} = 4.14 lb. or 1.88 kg

Total process 6.55 kg

The same methodology may be used to calculate estimated emissions of other substances for which emission factors are available.

Table 4.6: Emission Factors for Wood Treated with Creosote

Emission factors in kg emitted per cubic metre (pounds per cubic foot in brackets) of wood treated with creosote with and without Boultonizing conditioning and surface emissions to air during storage (g/m^2) (MRI 1999)

	Emission Factors		
Substance	**Total treatment with Boultonizing kg/m^3 (lb./ft.^{3})**	**Total treatment without Boultonizing kg/m^3 (lb./ft.^{3})**	**Emissions from freshly treated wood g/m^2 (lb./1000 ft.^{2})**
Anthracene	2.1 x 10^{-6} (1.3 x 10^{-7})	2.6 x 10^{-7} (1.6 x 10^{-8})	0.488 (0.10)
Naphthalene	1.3 x 10^{-3} (7.9 x 10^{-5})	7.3 x 10^{-5} (4.6 x 10^{-6})	30.7 (6.3)
Total VOC**	0.093 (5.8 x 10^{-3})	0.012 (7.4 x 10^{-4})	ND*
Benzo(a)anthracene	2.1 x 10^{-6} (1.3 x 10^{-7})	2.6 x 10^{-7} (1.6 x 10^{-8})	ND*
Benzo(b)fluoranthene	2.1 x 10^{-6} (1.3 x 10^{-7})	2.6 x 10^{-7} (1.6 x 10^{-8})	ND*
Benzo(k)fluoranthene	7.7 x 10^{-7} (4.8 x 10^{-8})	9.6 x 10^{-8} (6.0 x 10^{-9})	ND*
Benzo(a)pyrene	1.0 x 10^{-7} (6.5 x 10^{-8})	1.3 x 10^{-7} (8.2 x 10^{-9})	ND*
Fluoranthene	1.1 x 10^{-5} (6.8 x 10^{-7})	1.4 x 10^{-6} (8.6 x 10^{-8})	0.488 (0.10)
Fluorene	6.2 x 10^{-5} (3.9 x 10^{-6})	1.2 x 10^{-6} (7.8 x 10^{-8})	8.30 (1.7)
Phenanthrene	3.0 x 10^{-5} (1.9 x 10^{-6})	4.5 x 10^{-6} (2.8 x 10^{-7})	10.74 (2.2)
Pyrene	9.3 x 10^{-6} (5.8 x 10^{-7})	1.2 x 10^{-6} (7.3 x 10^{-8})	0.100 (0.02)
Chrysene	1.1 x 10^{-6} (6.7 x 10^{-8})	1.3 x 10^{-7} (8.4 x 10^{-9})	ND*
All **PAHs**; fugitive leaching losses in storage: No emission factors available.			

* Not Determined

** Refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimates emissions of the other CACs to air.

Example 3

Estimate the PAH emissions from stored railway ties in 90 stacks, 8.5-feet wide, 30-feet long and 20-feet high. Assume emissions are from the outer stack surface area only (MRI 2000).

The total exposed area is from the top (8.5 ft. x 30 ft. or 255 ft.^{2}), two ends: (2 x 8.5 ft. x 20 ft. or 340 ft.^{2}) and two sides: (2 x 20 ft. x 30 ft. or 1,200 ft.$^{2)}$ for a total surface area per stack of 1,795 ft.^{2} or a total surface area of 90 x 1,795 or 161,550 ft.^{2}.

The estimated emissions to air are as follows:

Naphthalene: 161,550 ft.^{2} x 6.3/1000 psf = 1,018 lb. or 463 kg

Anthracene: 161,550 ft.^{2} x 0.488/1000 psf = 78.8 lb. or 35.8 kg

Fluoranthene: 161,550 ft.^{2} x 0.10/1000 psf = 16.15 lb. or 7.34 kg

Phenanthrene: 161,550 ft.^{2} x 2.2/1000 psf = 355 lb. or 161.5 kg

The same methodology may be used to calculate estimated emissions of other substances where emission factors for freshly treated wood are available.

Wastewater Discharges

Example 1

A facility discharges its wastewater via storm sewers to a local sewage-treatment plant. The reportable PAHs are sampled and analyzed. The total flow for the year was 5,520 m^3 and the naphthalene concentration averaged 0.5 mg/L, the anthracene concentration 0.14 mg/L, and the benzo(a)pyrene concentration 0.02 mg/L.

The amount of naphthalene discharged is:

= (5,520 m^3/year, total flow) x (10^3 L/m^3) x (0.5 mg/L concentration) x (10^{-6} kg/mg)
= **2.76 kg**

The amount of anthracene discharged is:

= (5,520 m^3/year, total flow) x (10^3 L/m^3) x (0.14 mg/L concentration) x (10^{-6} kg/mg)
= **0.77 kg**

The amount of benzo(a)pyrene discharged is:

= (5,520 m^3/year, total flow) x (10^3 L/m^3) x (0.02 mg/L concentration) x (10^{-6} kg/mg)
= **0.110 kg or 110 g**

Releases Caused by Remedial Action

Remedial action can include a number of activities including disposal of contaminated soils, recovery and treatment of contaminated groundwater, or other one-time, non-routine clean-ups.

If groundwater near the plant has been contaminated, it is usually pumped out of the ground, treated and released where the amount released is a function of the concentration and volume of water discharge meeting provincial and federal limits. Remediation of contaminated soil may result in the off-site transfer of contaminated soil. Releases are determined by applying the results from soil sample analysis of the relevant PAHs in the samples to the total amount of soil involved.

Example 1

Groundwater in the amount of 250,000 imperial gallons was recovered, treated, and discharged with concentrations of naphthalene, pyrene and benzo(a)pyrene of 0.15 mg/L, 0.10 mg/L and 0.03 mg/L, respectively. The amount released is calculated as:

250,000 gallons x 4.54 L/gal. x concentration mg/L x 10^{-6} kg/mg

This results in releases of **0.170, 0.113 and 0.034 kg (170, 113 and 34 g) per year** of naphthalene, pyrene and benzo(a)pyrene, respectively.

Example 2

Twenty thousand pounds (9,090 kg) of contaminated soil were removed as a result of remedial activities on soil containing PAH concentrations above current CCME guidelines for industrial sites. The actual concentrations of PAHs in the soil are as shown in the table below.

The releases in kilograms can be calculated as follows:

Weight of soil (kg) x concentration (mg/kg) x 10^{-6} (kg/mg)

Substance	Soil Concentration mg/kg	Releases kg (g)
Naphthalene	50.0	0.45 (450)

Benzo(a)anthracene	1.5	0.014 (14)
Benzo(b)fluoranthene	0.85	0.0077 (7.7)
Benzo(k)fluoranthene	0.40	0.0036 (3.6)
Benzo(a)pyrene	0.55	0.0050 (5.0)
Fluoranthene	2.5	0.023 (23)
Phenanthrene	4.5	0.041 (41)

Release Due to Catastrophic Events

These involve spills or accidental releases outside the containment areas and in all cases require reporting to the environmental authorities. The amount of the release is the amount released minus that recovered.

Example 1

Creosote in the amount of 200 imperial gallons (1.08 kg/L) is spilled outside the containment area due to a ruptured hose during the unloading process. The release is promptly cleaned up and stored in drums as waste for shipment to a secure landfill. The appropriate regulatory authorities are notified promptly. The total release of NPRI-listed substances depends on the concentration found in the solution.

1. Calculate the total mass of the spill (kg) as follows:

   200 gal. X 4.54 L/gal. x 1.08 kg/L = **980.6 kg**

2. Determine concentration (C) of components in the creosote (from manufacturer).

3. Multiply the percentage concentration of substance by the determined total mass of the spill, as shown in the table below.

Substance	Content in Creosote (%)	Release
Anthracene	2.0	19.6 kg
Naphthalene	3.0	29.4 kg

Biphenyl	0.8	7.84 kg
Benzo(a)anthracene	0.9	8.82 kg
Benzo(g,h,i)perylene	0.04	0.392 kg
Benzo(a)pyrene	0.17	1.67 kg
Fluoranthene	10	98.1 kg
Phenanthrene	21	205.9 kg
Pyrene	8.5	83.4 kg
Chrysene	3.0	29.4 kg

Transfers in Solid Hazardous Waste

For solid hazardous waste, a determination of the total quantity of waste and the concentration of the PAH components must be made. Hazardous waste manifests are used to determine the amount of hazardous waste that was shipped off site. In addition, a waste analysis should be performed to determine the concentration of PAHs in the waste. This analysis should then be used to determine the actual transfer to landfill.

Example:

A facility sent 10 45-gallon drums of waste to a secure landfill. The total quantity of waste disposed was 3,520 kg, containing naphthalene (300 mg/kg), anthracene (130 mg/kg), biphenyl (98 mg/kg), phenanthrene (450 mg/kg), benzo(a)fluoranthene (2 mg/kg), pyrene (34 mg/kg), and benzo(a)pyrene (3.5 mg/kg). Therefore, the actual quantities in the waste are as follows:

3,520 kg x 300 mg/kg x 10^{-6} kg/mg = 1.06 kg naphthalene
3,520 kg x 130 mg/kg x 10^{-6} kg/mg = 0.46 kg anthracene
3,520 kg x 98 mg/kg x 10^{-6} kg/mg = 0.344 kg biphenyl
3,520 kg x 450 mg/kg x 10^{-6} kg/mg = 1.58 kg phenanthrene
3,520 kg x 2 mg/kg x 10^{-6} kg/mg = 0.007 kg benzo(a)fluorene
3,520 kg x 34 mg/kg x 10^{-6} kg/mg = 0.120 kg pyrene
3,520 kg x 3.5 mg/kg x 10^{-6} kg/mg = 0.012 kg benzo(a)pyrene

The facility had additional manifests for the soils disposed of during remedial action. However, these releases have already been accounted for in that section.

Summary of NPRI Reporting Steps — Creosote Wood Preservation Facilities

1. Gather information on sources of releases to air, soil, groundwater, storm water, and off-site releases.

2. Determine reporting thresholds for NPRI reportable substances from *Canada Gazette Part I* Notice for the year being reported..

3. Estimate quantities released on site or transferred off-site, based on monitoring data, engineering calculations or emission factors.

Sample Release Summary Form

Substance	Type of Release	Release	Kg Released
Naphthalene	Process	Fugitive aerosol and vapour	
	Process	Fugitive losses to groundwater	
	Process	Fugitive losses to soil	
	Storage	Fugitive vapour and leachate	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Hazardous waste	Solid waste transferred to hazardous waste site	
Benzo(a)pyrene	Process	Stack emissions to air	
	Process	Fugitive aerosol and vapour	
	Process	Fugitive losses to soil	
	Storage	Fugitive vapour and leachate	
	Storm water	Release to sewer	
	Catastrophic releases	Release to soil/groundwater	
	Hazardous waste	Solid waste transferred to hazardous waste site	

IV-G: Pentachlorophenol Wood Preservation Facilities

Process Description

Wood preserving using PCP employs either a pressure process or a thermal process to impregnate the wood with the preservative chemical. In the first instance, hydraulic pressure is used to force the preservative into the wood. In the second instance, the effects of heating and cooling are used to induce preservative movement into the wood.

However, before the wood can be preserved, it must be seasoned or dried to ensure that preservative penetration requirements can be met. Seasoning or drying may be done by air seasoning or kiln drying, and, at pressure treatment plants, by either Boulton drying or steam conditioning. In these two processes a combination of heat and vacuum is used to remove moisture from the wood in the pressure retort.

PCP can be purchased in liquid solution, dry flake or block form. The PCP solution used for wood preservation is typically dissolved in a petroleum solvent and contains between 5 and 10% technical-grade PCP by weight.

The pressure-treatment process is carried out in horizontal pressure retorts or cylinders. Properly seasoned wood is placed in the retort and then the retort door is sealed. If the Rueping process is used, the retort is first pressurized with air. The retort is then filled with the preservative chemical while maintaining the initial air pressure in the retort by bleeding air through a vent line into the preservative tank. If the Lowery process is used, the retort is filled with oil while atmospheric pressure is maintained in the vessel.

When the retort is full of preservative the pressure is increased until the desired injection has been achieved. The maximum allowable pressure is 200 psi (1,380 kPa). The pressure is then reduced and, if desired, the temperature of the oil can be quickly raised to create an expansion bath. The preservative is then returned to the preservative tank. A vacuum is then applied to the retort to recover excess preservative from the cells of the wood.

After the recovered preservative is pumped from the retort a final steam bath may be applied. After the retort has been drained the door is opened and the treated wood is removed from the retort. Quality control testing is then completed and the material is either shipped or moved to storage to await shipment.

The thermal-treating process is carried out in open tanks. In some cases the full length of the wood member is immersed in the preservative, while in other cases only the butt end of the material is treated.

The seasoned wood is placed in the thermal-treating chamber and the tanks are filled with hot preservative. After completion of the hot-bath period, the hot preservative is either replaced by cold preservative (cold bath) or the preservative in the tank is allowed to cool (cooling bath). This cycle may be repeated if required. A final expansion bath with hot preservative may be applied. The oil is then removed from the tanks and the treated wood is taken out. Quality control testing is then completed and the material is either shipped or moved to storage to await shipment.

At a facility used for wood preservation using PCP, the probable NPRI reportable substances are shown in Table 4.7.

Table 4.7 Probable Reportable Substances with CAS Numbers—Preservation Facilities Using Pentachlorophenol

Compound	**CAS Registry Number**[1]
Criteria air contaminants (including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}))	Refer to the *Canada Gazette Part I* Notice for the year being reported.
Hexachlorobenzene[2]	118-74-1
Polychlorinated dibenzo-p-dioxins and Polychlorinated dibenzofurans[2]	*

[1] CAS Registry Number denotes the Chemical Abstracts Service Registry Number, as appropriate

[2] This class of substances is restricted to certain congeners. Consult the *Canada Gazette Part I* Notice for the year being reported for the relevant list of congeners.

* No single CAS number applies to their NPRI listing.

Figure 4.9: NPRI Flow Diagram — Wood Preservation Using Pentachlorophenol Pressure Process

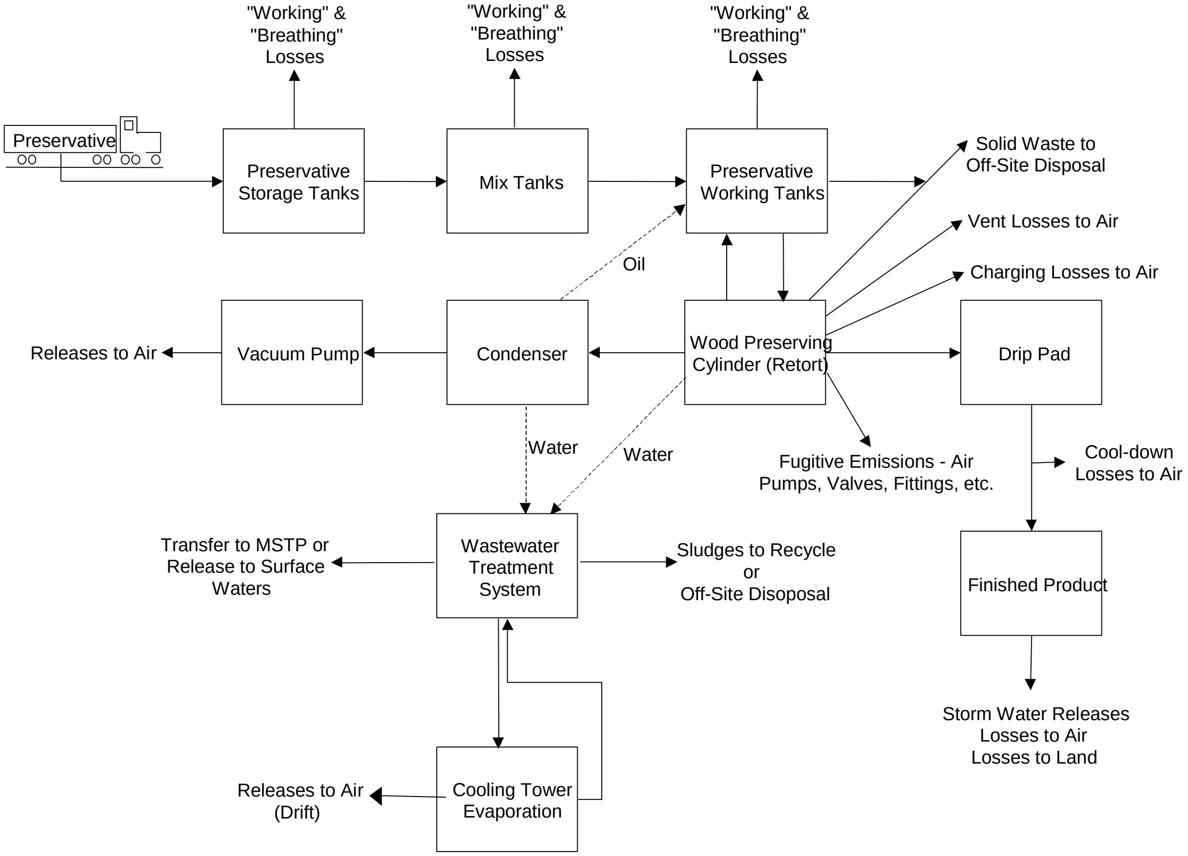
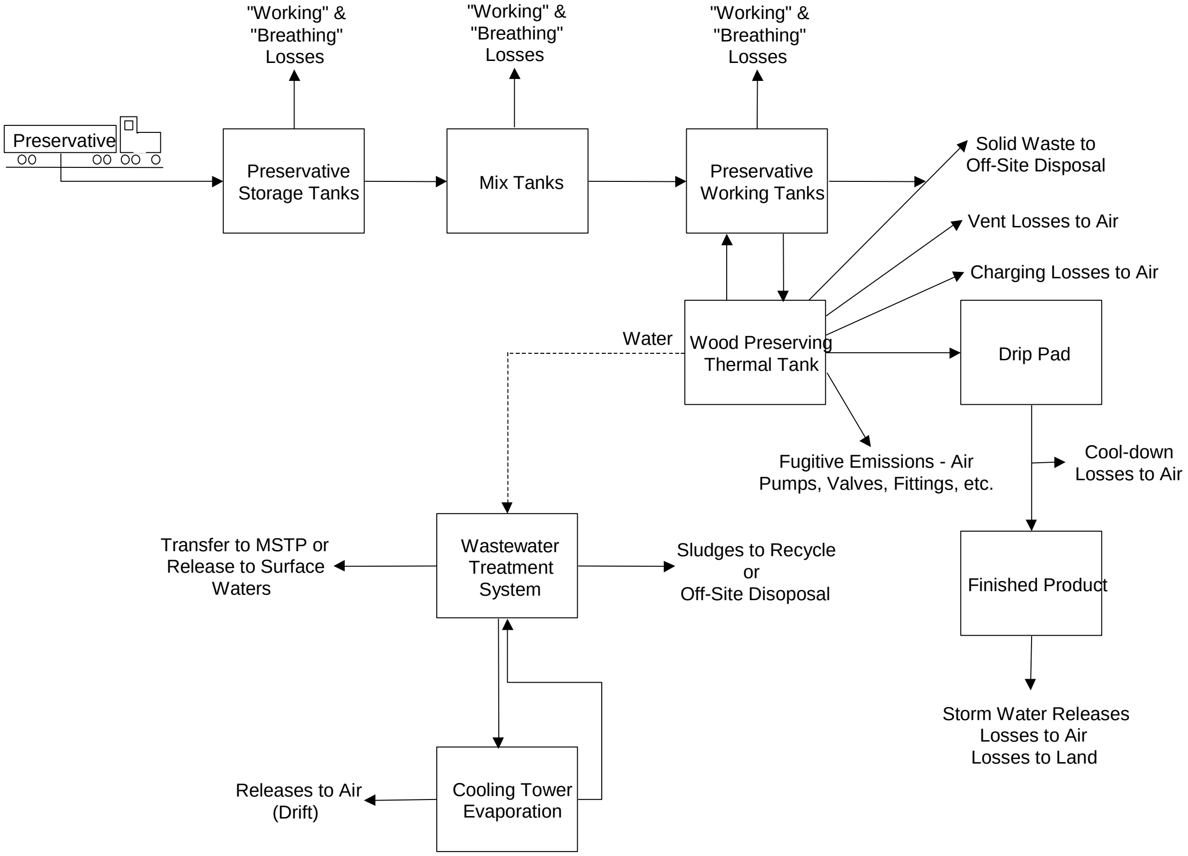


Figure 4.10: NPRI Flow Diagram — Wood Preservation Using Pentachlorophenol Thermal Process



Sources of Releases and Transfers of NPRI-Listed Substances

A facility using PCP must account for all releases and transfers of an NPRI-listed substance. Releases and transfers of NPRI-listed substances can occur from numerous sources and activities at a wood preserving plant, as shown in Figures 4.9 and 4.10. Additionally, facilities should also consider any releases to air of criteria air contaminants from their plant processes and operations – including oxides of nitrogen (expressed as NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOCs), total particulate matter (TPM), particulate matter with a diameter □ 2.5 microns ($PM_{2.5}$), and particulate matter with a diameter □ 10 microns (PM_{10}).

Two types of activities lead to releases to the air from tanks and vessels containing the wood preserving chemicals. The first activity is the receipt and storage of oils in tanks and the mixing of chemicals or oils to be used for wood preserving. The second activity is the transfer of oils, air, steam, and wood to and from the wood preserving tanks and vessels.

Emissions of NPRI-listed substances from the tanks used to store or mix the solutions used in wood-treating operations may be broken into working losses and breathing losses. As tanks are filled or refilled, a volume of air equal to the volume of the incoming liquid may be expelled to the atmosphere. This is a working loss. Breathing losses occur in an unheated tank as a result of changing ambient temperatures that cause the volume of the air in the void space of the tank to change, thereby causing a release. Breathing losses are essentially independent of the volume of the liquid throughput. Please note that as based on the experience of PCP representatives in the U.S. and the results of subsidiary calculations in the release estimates computed by the spreadsheets, a conservative factor of 1.5 is applied to the working losses. In addition, working losses are calculated from the receipt, storage, and mixing of chemicals in unheated tanks, to account for breathing losses from these tanks.

Additional air emissions from the wood-preserving process systems are related to the working losses caused by the displacement of air from the tanks and vessels by the movement of oils and wood, the use of initial air pressure, the use of steam, and the use of vacuum cycles. As wood-preserving cylinders or thermal tanks are filled, the oil displaces the air in the vessel. At a thermal tank, this is considered a release. At a pressure cylinder, the air is vented back into the oil tank. If initial air pressure is used, an expansion of the compressed air in the tank vapour space may cause an emission. When the preservative is pumped from the treating cylinder back to the tank, another emission may occur from the oil tank.

The application of steam to treating cylinders may also result in an emission of air from the treating cylinder because air is initially bled from the cylinder as steam is introduced. At the end of the steaming cycle, there may be another emission as the steam is blown out into the atmosphere.

If a vacuum is pulled on the treating cylinder, the non-condensable air in the cylinder will be emitted from the vacuum device (i.e. pump or jet). When a treating cylinder is opened to remove treated material and to insert untreated material, emissions may be released from the open cylinder. If freshly treated wood is at an elevated temperature when it is removed from the treating cylinder or thermal tank, emissions will result when the wood cools to ambient temperature. There may be minor emissions of NPRI-listed substances during the storage of the finished product prior to shipment.

The U.S. EPA has indicated in its guidance document, *Estimating Chemical Releases from Wood Preserving Operations*, EPA 560/4-88-004P (February 1988), that no significant emissions of PCP are expected to occur from routine wastewater management and evaporation at a wood preserving facility. Since the vapour pressures of HCB, dioxins and furans are lower than the vapour pressure of PCP, it is expected that their water concentrations will be lower by many orders of magnitude. This also suggests that any potential air emissions of these substances from the management of routine wastewater are not expected to be significant. However, if water containing NPRI-listed substances is used in cooling towers, releases from cooling tower drift could be significant. Computations for potential releases from cooling tower drift are included in the release estimating spreadsheets.

There may also be fugitive air emissions from miscellaneous sources such as flanges, valves, pumps, and sampling taps. These emissions are expected to be very small because of the low vapour pressure of the NPRI-listed substances at PCP wood preserving facilities; however, the spreadsheets include an estimation of these emissions.

Several other sources of releases may exist at a wood treating plant. Releases may occur as a result of remedial or waste-treatment activities at the site. Releases to surface water can occur in storm water run-off and from discharges of process wastewater into streams or water bodies. Releases to land could occur from a spill that was not removed from the site, from on-site disposal of wastes containing an NPRI substance, or from contaminated storm water that percolates into the ground. Transfers of an NPRI substance to other locations will occur in the shipment of waste products to off-site locations for treatment, recycling, or disposal. These transfers can be in the form of wastewater discharged to a municipal sewage-treatment plant, or solid and/or hazardous wastes shipped to recycling/disposal facilities.

Methods Used for Release and Transfer Estimations

After the identification of release and transfer points, the facility must develop a means to quantify those releases and transfers. Currently NPRI does not require a facility to obtain analytical data if that data is not already available. However, the spreadsheets accompanying this Guide allow for the use of actual release and transfer data, if available.

The methods used to estimate the quantity of the releases of NPRI-listed substances in this document are based on the guidance documents that are listed as references. All of these release-estimation or release-calculation methodologies require an estimate of the total volume or mass of a release or transfer as well as the concentration of the NPRI-listed substance in that volume or mass. The following sections will explain the methodologies used to calculate the releases and transfers and will also describe the procedures used to estimate the required data if measured data is unavailable. The methodologies include engineering calculations based on the chemical and physical properties of the NPRI-listed substances, and PCP product chemistry data. Additional documentation and details of the estimation methods are found in the appendices to this section of the Guide.

The releases of HCB, dioxins and furans to the air in vapour form will be calculated using standard engineering estimating techniques. These techniques are based on the concentration of the substances in technical grade PCP and the molecular weights and vapour pressures of the substances. Table 4.8 presents the average dioxin, furan and HCB concentrations in technical PCP as reported by PCP manufacturers. This table also includes information on the chemical and physical properties of these substances. Not all of the dioxins and furans in PCP are of the 2,3,7,8-substituted compound category listed by the NPRI. The percent of 2,3,7,8-substituted compounds in each congener group was reported by Environment Canada (EC, 1999).

The PCP data provided by the manufacturers did not indicate the presence of tetra- or penta-substituted dioxins and furans. The total hexa- and hepta-substituted dioxin/furan concentrations were adjusted by the factors published in the Environment Canada reference noted above. Each of the 2,3,7,8-substituted congeners has a toxic equivalency factor (TEF) that relates its estimated toxicity to that of 2,3,7,8-TCDD. The mass, in grams, of a specific congener multiplied by its TEF produces a Toxic Equivalent (TEQ) value. *The Guide for Reporting to the National Pollutant Release Inventory* should be consulted to obtain these weighting factors for the year being reported.

Releases to other environmental media will be estimated as based on PCP product chemistry data. Facilities that meet the NPRI reporting criteria for CACs should refer to the *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI)* and other reference documents to estimate emissions of CACs to air.

Table 4.8: Information Used to Calculate Releases or Transfers from Pentachlorophenol Wood Preserving Facilities

Chemical or Congener Group	MW	VP@25°C mm Hg	Average Total Reported Concentration in Technical PCP (ppm)	Fraction 2,3,7,8-Substituted	2,3,7,8-Substituted Congener Concentration in Technical PCP (ppm)	Toxic Equivalent Factor (TEF)**
PCP*	266.00	1.90E-04	9.99E+05	N/A	N/A	N/A
4CDD	321.98	1.50E-09	0.00E+00		0.00E+00	1
5CDD	356.42	4.40E-10	0.00E+00		0.00E+00	0.5
6CDD	390.87	4.10E-11	1.412E+00	0.59	8.33E-01	0.1
7CDD	425.31	5.60E-12	2.68E+01	0.76	2.04E+01	0.01
8CDD	460.76	8.25E-13	7.33E+02	1.0	7.33E+02	0.001
4CDF	305.98	1.50E-08	0.00E+00		0.00E+00	0.1
5CDF	340.42	2.15E-09	0.00E+00		0.00E+00	0.5
6CDF	374.87	2.35E-10	6.633E+00	0.13	8.62E-01	0.1
7CDF	409.31	7.10E-11	5.6549E+01	0.27	1.53E+01	0.01
8CDF	444.76	3.75E-12	2.11E+02	1.0	2.11E+02	0.001
HCB	284.80	1.09E-05	5.00E+01	N/A	N/A	N/A

* Technical PCP may contain low levels of other chlorinated phenols.

** TEF values should be obtained from the *Guide for Reporting to the National Pollutant Release Inventory* for the year being reported.

Releases to the Air from Closed Tanks and Vessels

The movement of a liquid or air into a tank or vessel containing NPRI-listed substances will result in an air emission from that tank. The volume of air emitted will be equal to the volume of the material that is added to the tank. The concentration of the NPRI-listed substance emitted is dependent on the following:

1. The concentration of the NPRI substance in the liquid in the tank;

2. Physical characteristics (vapour pressure and molecular weight) of the NPRI-listed substance;

3. The concentration and physical characteristics of other chemicals in the tank liquid; and

4. The length of time that the air has been in the tank.

Air emissions associated with the transfer of chemicals into tanks are called "working losses". Because of the time required to reach equilibrium between the liquid and vapour phases in a tank, the concentrations found in the vapour emissions are not the same in all instances. The equation for calculating working losses from a tank is found in several of the reference guidance documents, including the document entitled *Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Form* (U.S. EPA 1987). The application of the equation to wood preserving facilities is presented in Appendix 1 and also found in the printed output files from the NPRI calculation workbook.

Releases from unheated tanks also occur as a result of diurnal heating and cooling cycles that cause the air in the vapour space to alternately contract and expand. Air is drawn into the tank during the cooling cycle and then expelled from the tank during the heating cycle. This loss is referred to as the "breathing loss". It is generally accepted that there are no significant "breathing losses" from heated tanks. Breathing losses are independent of the volume of liquid throughput and as explained in Appendix 1, the working-loss estimates are conservative to account for breathing losses.

Releases to the Air from Open-Topped Tanks

A "spill" evaporation model is presented in a U.S. EPA guidance document (U.S. EPA 1988). As stated in that document, this evaporation model can be used to estimate the evaporation rate from open-topped tanks. The derivation of specific forms of the equations in the evaporation model for application to wood preserving facilities is presented in Appendix 2 and is also found in the printed output files from the NPRI calculation workbook.

Releases to the Air from Piping, Valves, Flanges and Associated Equipment

Any minor releases from process piping and associated equipment due to gasket leakage or similar conditions will typically occur as drips of preservative solution. Although these releases are typically cleaned up on a frequent basis, some estimate of potential fugitive air emissions from this source should be included in the release calculations. A conservative estimate will be based on the assumption that this minor process drippage results in a liquid wetted surface area of 100 square feet on a continuous basis. The estimating methodology employed for open tanks will be used to estimate releases from this area.

Releases to the Air from Treated Wood During Cool-Down and Storage

A study of the volatilization of PCP from treated wood is presented in the *Proceedings, American Wood Preservers Association* (AWPA 1981). The study provides a methodology that can be used to estimate PCP releases to the air from freshly treated wood at various temperatures. That method is used in conjunction with treating plant operating data to estimate PCP releases into the air during the cool-down period immediately following the treatment cycle and during subsequent storage prior to shipment. Specific details regarding this method are described in Appendix 3 and are also found in the printed output from the NPRI calculation workbook.

Releases to Air from the Management of Water Containing Pentachlorophenol

In *Estimating Chemical Releases from Wood Preserving Operations* (U.S. EPA 1988), the U.S. EPA states that significant evaporative losses of PCP are not expected to occur as a result of routine wastewater evaporation. Based on this U.S. EPA guidance, it is assumed that no significant materials will be evaporated from water effluent containing PCP. This is supported by the fact that the vapour pressures of dioxins, furans and HCB are all less than the vapour pressure of PCP and thus aqueous concentrations would be many orders of magnitude lower.

If wastewater containing the NPRI-listed substances is used in a cooling tower, releases of these substances will occur as drift losses from the cooling tower. The calculation of potential releases from use in a cooling tower is found in Appendix 4. Significant releases to the air are not expected from other routine wastewater-management activities.

Releases to Surface Water from Point-Source Discharges and Storm Water Run-off

Releases to surface waters from point-source discharges occur when wastewater, storm water, or recovered groundwater containing NPRI-listed substances are discharged to surface water. If facilities do not possess analytical data available for dioxins, furans or HCB, the concentrations of these substances can be estimated based on the analytical results of other parameters.

The methodology used to calculate releases to surface water is shown in Appendix 5 and is also found in the printed output files from the NPRI calculation workbook.

On-Site Releases to Land

On-site releases to land can occur as a result of a spill that is not removed from the site or as a result of the on-site disposal of wastes containing an NPRI substance at the facility. Releases to land are estimated based on the quantity of release and the concentration of the NPRI-listed substance in the release. In addition, some releases to land may occur as a result of the infiltration of contaminated storm water. The storm water calculations in the worksheet determine releases to surface water from a run-off coefficient and any available analytical data. Releases to land are estimated based on the quantity of rainfall and the fraction that does not exit the site as run-off. Details of the storm water computations are found in Appendix 5.

Transfers of NPRI-Listed Substances

The amount of NPRI-listed substances transferred to off-site locations must be determined for reporting to the NPRI. The calculation for off-site transfers requires a measurement of the amount of material transferred and the concentration of the NPRI-listed substance in the waste. These transfers may occur in solid or hazardous wastes shipped off site or in wastewater discharged to a municipal sewage-treatment plant (MSTP) for treatment. The methods used to calculate transfers to off-site locations are shown in Appendix 6 and are also provided in the printed output files from the NPRI calculation workbook.

Automated Release and Transfer Calculations for the NPRI Reports

The CD-ROM provided by the NPRI contains an interactive spreadsheet in Microsoft® Excel97 format that will request data to be inputted before performing calculations for estimating releases and transfers of dioxins, furans and HCB from wood preserving facilities for reporting to the NPRI. The instructions for completing the estimating spreadsheets and entering the necessary data into the NPRI reporting software are found in Appendix 8.

References

American Wood Preservers Association (AWPA). 1981. *The Relative Amount of Pentachlorophenol Volatilization from Treated Wood*, by L. L. Ingram, Jr., G. D. McGinnis, and L. R. Gjovik. Bethesda, MD (now Granbury, TX).

Betts, W.D. 1990. Information about coal-tar creosote for wood preservation. International Tar Conference. Tar Industries Service, Mill Lane, Wingerworth, Chesterfield, UK.

Canada Gazette Part I (CG). *Notice with Respect to Substances in the National Pollutant Release Inventory for 2000, 2001, and 2002*. Department of the Environment.

Chemical Engineers Handbook (CEH). 1973. Fifth Edition, under editorial direction of Robert H. Perry and Cecil H. Chilton. New York, NY: McGraw-Hill Book Company.

Carroll-Hatch. 1994. *Value Assessment of the Canadian Pressure Treated Wood Industry*. Canadian Forest Service, SSC Contract 4Y002-0187/01-SQ.

Environment Canada (EC). 2003. *Criteria Air Contaminants (CACs) Technical Source Guide for Reporting to the National Pollutant Release Inventory (NPRI) – 2002*.

Environment Canada (EC). 2001. *Guide for Reporting to the National Pollutant Release Inventory – 2000*.

Environment Canada (EC). 2002. *Guide for Reporting to the National Pollutant Release Inventory – 2001*.

Environment Canada (EC). 2003. *Guide for Reporting to the National Pollutant Release Inventory – 2002*.

Environment Canada. 2000b. *Recommendations for the Design and Operation of Wood Preservation Facilities*. Jointly prepared by Environment Canada and the Canadian Institute of Treated Wood (CITW). <www.ec.gc.ca/sop/english/wp.htm>

Environment Canada (EC). 2003. *Supplementary Guide for Reporting Criteria Air Contaminants (CACs) to the National Pollutant Release Inventory (NPRI) – 2002*.

Environment Canada (EC). 2000a. *Supplementary Guide for Reporting to the National Pollutant Release Inventory – Alternate Thresholds – 2000*.

Environment Canada. 2000a. *Strategic Options for the Management of CEPA-Toxic Substances for the Wood Preservation Sector*, Volume I, II, and III, Hull, QC www.ec.gc.ca/sop/english/wp.htm

Environmental Protection Agency (EPA). 1987. *Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Form*. EPA560/4-88-002. Washington, D.C.: Office of Pesticides and Toxic Substances.

Environmental Protection Agency (EPA). 1988. *Title III Section 313 Release Reporting Guidance: Estimating Chemical Releases from Wood Preserving Operations*. EPA560/4-88-004p. Washington, D.C.: Office of Pesticides and Toxic Substances.

Environmental Protection Agency (EPA). 1994. *Air Emission Models for Water and Wastewater*. Appendix C. EPA-453/C-94-080A. Research Triangle Park, NC: Office of Air Quality Planning and Standards.

Environmental Protection Agency (EPA). 1995. *Compilation of Air Pollutant Emission Factors*. Volume 1, Fifth Edition with supplements. Research Triangle Park, NC: Office of Air Quality Planning and Standards.

Environmental Protection Agency (EPA). 2000a. “Draft Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds” in *Draft Dioxin Reassessment*. Washington, D.C.: National Center for Environmental Assessment.

Environmental Protection Agency (EPA). 2000b. *Emergency Planning and Community Right-to-Know Act – Section 313: Guidance for Reporting Toxic Chemicals Within the Dioxin and Dioxin-like Compounds Category*. Draft. EPA-745-B-00-00X. Washington, D.C.: Office of Information Analysis and Access.

Environmental Protection Agency (EPA). 2000c. *Toxic Chemical Release Inventory Reporting Forms and Instructions, Revised 1999 Version*. EPA745-B-00-001. Washington, D.C.: Office of Information Analysis and Access.

Midwest Research Institute (MRI). 1999. *Emission factor documentation for AP-42, Section 10.8 Wood Preserving*. Midwest Research Institute Project No. 4945 for the U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Emission Factor and Inventory Group.

National Pollutant Inventory (NPI) – Australia. 1999. *Emission estimation technique manual for timber and wood product manufacturing*. Australia.

North Atlantic Treaty Organization/Committee on the Challenges of Modern Society (NATO/CCMS). 1998. “Pilot Study on Internal Information Exchange on Dioxins and Related Compounds”. International Toxicity Equivalency Factor (I-TEF). Method of Risk Assessment for Complex Mixtures of Dioxins and Related Compounds. Report No. 176. 26 pp.

The Marley Cooling Tower Company. 1983. *Cooling Tower Fundamentals*. Edited by John C. Hensley. Mission, KS.

Verschueren, Karel. 1983. *Handbook of Environmental Data on Organic Chemicals*. New York, NY: Van/Vostrand Reinhold Company.

World Health Organization (WHO). 1998. *Executive Summary, Assessment of the Health Risk of Dioxins: Re-evaluation of the Tolerable Daily Intake (TDI).* Geneva, Switzerland: World Health Organization – European Centre for Environment and Health.

Appendices

Appendix 1: Pentachlorophenol Wood Preservation Facilities – Calculation of Working and Breathing Losses from Fixed Roof Tanks at Wood Preserving Facilities Using Pentachlorophenol

Appendix 2: Pentachlorophenol Wood Preservation Facilities – Calculation of the Emissions from Open-topped Tanks at Wood Preserving Facilities Using Pentachlorophenol

Appendix 3: Pentachlorophenol Wood Preservation Facilities – Estimation of Emissions from Wood Treated with Pentachlorophenol

Appendix 4: Pentachlorophenol Wood Preservation Facilities – Calculation of Air Releases from the Management of Water Containing Pentachlorophenol

Appendix 5: Pentachlorophenol Wood Preservation Facilities – Wastewater, Groundwater and Storm Water Releases

Appendix 6: Pentachlorophenol Wood Preservation Facilities – Calculation of Transfers to Off-Site Locations

Appendix 7: Pentachlorophenol Wood Preservation Facilities – Estimated Vapour Pressures

Appendix 8: User's Guide for the Calculation of Releases for Pentachlorophenol Wood Preservation Facilities Reporting to the NPRI

  Exhibit 1: Data Input Sheets for Pentachlorophenol Wood Preservation Facilities

  Exhibit 2: Calculation of Dioxin/Furan Combined TEQ Concentrations for Pentachlorophenol Wood Preservation Facilities

APPENDIX 1

Pentachlorophenol Wood Preservation Facilities

Calculation of Working and Breathing Losses from Fixed Roof Tanks at Wood Preserving Facilities Using Pentachlorophenol

There are two types of activities that cause emissions from tanks and vessels at wood preserving facilities. The first activity is the receipt, storage, and mixing of oils and chemicals in tanks to be used for wood preserving. The second activity is the transfer of oils, air, steam, and wood to and from the wood preserving tanks and vessels during the wood preserving process.

Emissions of NPRI substances from the tanks used to store or mix the solutions used in wood treating operations may be broken into working losses and breathing losses. As tanks are filled or refilled, a volume of air equal to the volume of the incoming liquid is expelled to the atmosphere. This is referred to as a working loss. Breathing losses occur in an unheated tank as a result of diurnal temperature changes that cause the volume of the air in the void space of the tank to change, thereby causing a release. Breathing losses are generally independent of the volume of the liquid throughput.

The release estimating methodology employed in this Guide accounts for breathing losses by inflating the calculated working losses by a conservative factor of 1.5, which was derived from subsidiary calculations based on historic results of breathing versus working losses from a variety of wood preserving operations. The releases (working and breathing) of the NPRI substances due to the receipt, storage, and mixing of the oils are calculated on the worksheet “Tanks” in the NPRI calculation workbook, using the equations developed below.

The movement of oils and wood, the use of compressed air and steam, and the use of vacuum cycles during the wood treating process, relate additional air emissions from the wood preserving systems to the working losses caused by the displacement of air from the tanks and vessels. As wood preserving cylinders are filled, the oil displaces air, which is then vented back into the oil tank. If initial air pressure is used, the expansion of the compressed air in the tank vapour space results in an emission. When the preservative is pumped from the treating cylinder back to the tank, another emission occurs. All of these emissions occur from the treating tanks.

The use of steam in the treating cylinder will also result in an emission, because air is bled from the treating cylinder as steam is introduced. At the end of the steaming cycle, there will be another emission as the steam is blown into the atmosphere.

If a vacuum is pulled on the treating cylinder, the non-condensable air in the cylinder and vacuum receiver will be emitted from the vacuum device (i.e., pump or jet). When a treating cylinder is emptied and filled with wood, an emission may occur from the open cylinder. If the freshly treated wood is at an elevated temperature when it is removed from the treating process, there will be some emissions generated as the wood cools to ambient temperature. In addition, there may also be some additional fugitive emissions generated from the pumps, valves, pipes, and fittings.

The air emissions resulting from the wood preserving process operations are calculated on the Pressure Treatment or Thermal Treatment worksheets using the equations developed below.

The quantity of any substance released may be calculated by multiplying the volume or mass of the emission by the concentration of the chemical in that emission. The volume or mass of emissions can be calculated by using standard engineering equations relating volume and mass. The concentration of NPRI-listed substances in an air emission is dependent upon the amount of time that the air and liquid are in contact, the liquid temperature, the concentration of each chemical in the liquid, and the molecular weight and vapour pressure of each substance.

The working losses of one component of a mixture or solution from a fixed roof tank or vessel may be calculated by the following equation (U.S. EPA 1987, pages 3-15, 3-16, and 3-17):

$$\mathbf{WL_A = 2.40E\text{-}5 * MW_A * PP_A * V * N * K_n * K_c}$$

Where:

WL_A = working loss of compound A, in pounds

2.40E-5 = a factor derived from 1/14.7 psia, 1/359 ft.^3/lb-mole, (460+32)°R/(460+60)°R, and 1/7.48 ft.^3/gal.

MW_A = molecular weight, compound A

PP_A = partial pressure of compound A, which is the vapour pressure of compound A times the mole fraction of compound A in the liquid. The mole fraction of compound A in the liquid is defined as the weight percent of A divided by the molecular weight of A over the sum of the weight percents of each of the individual constituents divided by the molecular weights of each of the constituents. See the reference cited above, pg. 3-10.

V = the volume of the tank in gallons

N = the number of “turnovers” in the tank (throughput ÷ tank volume, V). V*N is equal to the throughput, and is equal to the volume of emissions caused by refilling the tank, or returning liquid or air to the tank.

Kn = the “turnover factor” taken from the formula found on page 18 of AP-42 Section 7.1 (EPA 1995), where Kn = (180+N)/6N if N>36, or Kn = 1 if N<36

Kc = a “product factor”, and it is given as one (1) for all organic liquids except crude oil

The working-loss equation may be re-written to allow the calculation of emissions from any compound at varying temperatures, with volume in cubic feet, as:

$$\mathbf{WL_A = 0.09323 * MW_A * VP_A * MFL_A * VOL * K_n / (460 + T)}$$

Where:

ML_A = working loss of compound A, pounds
MW_A = molecular weight, compound A
VP_A = vapour pressure, compound A at temperature T
MFL_A = mole fraction of compound A in the liquid
VOL = volume of air emissions, cubic feet
K_n = turnover factor
T = temperature, °F

In this form, the emissions of any compound from any tank may be calculated if the information listed above is available or can be estimated.

Molecular Weight

The molecular weight of the NPRI-listed substances can be found in standard chemical handbooks and other readily available sources.

Vapour Pressure

The vapour pressure of most NPRI-listed substances is available at one temperature in standard chemical references. An exception to this is the dioxins/furans, for many of which there are little or no actual vapour pressure measurements available in the literature. Vulcan Chemicals, a manufacturer of PCP, provides the vapour pressure of PCP at five temperatures. The vapour pressures of dioxins and furans are reported at 25°C in an U.S. EPA document (EPA 2000a). The known PCP vapour pressures may be fitted to Antoine’s Equation (CEH 1973) using linear regression, with the following results:

Pentachlorophenol: **log (10) VP = 8.50555 - (7486.43/T)**,

Where VP is in psia, and T = °R = °F + 460, or
VP, psia = 10^(8.50555-(7486.43/T))

Please note that there is no readily available data on the variations in vapour pressure with temperature for most of the dioxins, furans or for hexachlorobenzene. For these substances, it has been assumed that the relative rate of change of vapour pressures with temperature will be similar to that of PCP. The molecular weights and the melting and boiling points of these materials suggest this is a reasonable approach, given the lack of actual data. The resulting equations for estimating the vapour pressure of the dioxins, furans and HCB are given in the table following.

Vapour Pressure Equations	
Hexachlorodibenzodioxin (6CDD):	VP, psia = 10^(1.84038-(7486.43/T))
Heptachlorodibenzodioxin (7CDD):	VP, psia = 10^(0.97578-(7486.43/T))
Octachlorodibenzodioxin (8CDD):	VP, psia = 10^(0.14405-(7486.43/T))
Hexachlorodibenzofuran (6CDF):	VP, psia = 10^(2.59866-(7486.43/T))
Heptachlorodibenzofuran (7CDF):	VP, psia = 10^(2.07885-(7486.43/T))
Octachlorodibenzofuran (8CDF):	VP, psia = 10^(0.80162-(7486.43/T))
Hexachlorobenzene (HCB):	VP, psia = 10^(7.26462-(7486.43/T))

Graphs for these vapour pressure equations are found in Appendix 7.

Mole Fraction in the Liquid

As discussed above, the mole fraction in the liquid (MFL) of a chemical is required to calculate the losses using the working loss equation. The method of calculating the MFL is described in *Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Form* (U.S. EPA 1988) and is illustrated below.

The mole fraction in the liquid of Compound A in a mixture containing compounds A, B, C, and D through N, is defined as:

MFL = mole fraction, liquid, A
MW_A = molecular weight, compound A

$$MFL_A = \frac{\frac{Wt.\%A}{MW_A}}{\frac{Wt.\ \%A}{MW_A} + \frac{Wt.\ \%B}{MW_B} + \frac{Wt.\ \%C}{MW_C} + \frac{Wt.\ \%D}{MW_D} + \ldots \frac{Wt.\ \%N}{MW_N}}$$

The MFLs for dioxins, furans and HCB are calculated by the spreadsheet using these methods and based on the concentration of PCP reported in the concentrate and the treating solution, and the concentrations of dioxins/furans and HCB in PCP as shown in Table 4.9. An estimated molecular weight of 130 is used for the remaining petroleum oil. These values are used in the calculations of releases of dioxins, furans and HCB to the air.

Volume of Air Emissions

The volume of air released is calculated using data on the number of charges treated, the treating process used, and the amount of preservatives used. These volumes are calculated and shown in the output sheets “Tanks”, “Pressure” and “Thermal”.

Turnover Factor

Turnover factors are calculated based on the total liquid volume passed through the tanks divided by the volume of the tanks. These factors are shown on the output sheets “Tanks”, “Pressure” and “Thermal”.

Temperature

The temperature of the various air emissions are based on input temperature data and on assumptions explained in the output sheets “Pressure” and “Thermal”.

APPENDIX 2

Pentachlorophenol Wood Preservation Facilities

Calculation of the Emissions from Open-Topped Tanks at Wood Preserving Facilities Using Pentachlorophenol

A “spill” evaporation model is found in Section 6.2.3, Vapourization Model, Estimating Releases and Waste Treatment Efficiencies for the Toxic Chemical Release Inventory Form (U.S. EPA 560/4-88-002, December 1987, pp. 6-4). This evaporation model can be used to estimate the evaporation rate from open-topped tanks, and it has the form of:

$$\mathbf{W = M*K*A*P_0/R*T1}$$

Where W = vapour generation rate, lb./second
M = molecular weight of the chemical
A = area of the spill
P_0 = vapour pressure of the chemical at the spill temperature, T1
T1 = temperature of the spill, °R (°F +460)
R = universal gas constant, 10.73 psia-ft.^{3}/°R-lb mole
K = gas-phase mass transfer coefficient, ft./second

For vapourization of the constituents of a mixture, the partial pressure (Pp) is used in place of the vapour pressure. See the discussion in the working-loss equation section for an explanation of the derivation of the partial pressure.

An equation is presented for determining the gas-phase mass transfer coefficient. The value for K is dependent on the gas diffusion coefficient, D (ft.^2/sec.), and the wind speed, U (miles/hour). The values for the gas diffusion coefficients for the chemicals and compounds of concern were found in the computer program, CHEM8.exe, Compound Properties Estimation and Data (U.S. EPA, RTP, NC), and are reported below, along with the resulting equations for K for each of the chemicals/congeners.

Chemical/ Congener	D cm^2/sec.	D ft.^2/sec.	Gas-phase mass transfer coefficient (K) equations
6CDD	1.15E-02	1.24E-05	K_{6CDD} = 5.12E-04 x U^0.78
7CDD	1.11E-02	1.19E-05	K_{7CDD} = 5.00E-04 x U^0.78
8CDD	1.06E-02	1.14E-05	K_{8CDD} = 4.85E-04 x U^0.78
6CDF	1.62E-02	1.74E-05	K_{6CDF} = 6.43E-04 x U^0.78
7CDF	1.55E-02	1.67E-05	K_{7CDF} = 6.24E-04 x U^0.78
8CDF	1.48E-02	1.59E-05	K_{8CDF} = 6.05E-04 x U^0.78
HCB	1.41E-02	1.52E-05	K_{HCB} = 5.86E-04 x U^0.78

These values of K are used in the vaporization model to calculate the emissions from open-topped tanks.

Further manipulation of the vaporization model for the compounds of concern in the wood preserving solution lead to the following forms of the equation which are used to calculate the emissions from open-topped tanks (with 453.6 grams/lb, and t in °F):

6CDD:

W, lb./hour = 390.87 x (5.12E-4 x U^0.78) x A x P_0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or

W_{6CDD}, grams/hour = 30456.4 x U^0.78 x A x P_0 x MFL / (t +460)

7CDD:

W, lb./hour = 425.31 x (5.00E-4 x U^0.78) x A x P0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or

W_{7CDD}, grams/hour = 32363.2 x U^0.78 x A x P_0 x MFL / (t +460)

8CDD:

W, lb./hour = 460.76 x (4.85E-4 x U^0.78) x A x P_0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or

W_{8CDD}, grams/hour = 34008.9 x U^0.78 x A x P_0 x MFL / (t +460)

6CDF:

W, lb./hour = 374.87 x (6.43E-4 x U^0.78) x A x P_0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or

W_{6CDF}, grams/hour = 36683.2 x U^0.78 x A x P_0 x MFL / (t +460)

7CDF:

W, lb./hour = 409.31 x (6.24E-4 x U^0.78) x A x P_0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or

W_{7CDF}, grams/hour = 38869.8 x U^0.78 x A x P_0 x MFL / (t +460)

8CDF:

W, lb./hour = 444.76 x (6.05E-4 x U^0.78) x A x P_0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or
W_{8CDF}, grams/hour = 40950.3 x U^0.78 x A x P_0 x MFL / (t +460)

HCB:

W, lb./hour = 284.8 x 5.86E-4 x U^0.78 x A x P_0 x MFL x 60 sec./min. x 60 min./hour / (10.73 x T), or

W_{HCB}, grams/hour = 25398.8 x U^0.78 x A x P_0 x MFL / (t + 460)

Annual open-surface evaporation releases are estimated by multiplying the calculated emission factors by the hours/year that the tanks were open with an oil layer in the tank.

This same estimating methodology will be used to estimate potential releases from minor process drippage. A continuously exposed surface area of 100 square feet of preservative solution at ambient temperature will be used for this estimate.

APPENDIX 3

Pentachlorophenol Wood Preservation Facilities

Estimation of Emissions from Wood Treated with Pentachlorophenol

Freshly treated wood will have fugitive air emissions of minor amounts of NPRI-listed substances. The spreadsheets calculate potential emissions during two separate time intervals. For wood preserving processes conducted at elevated temperatures, the spreadsheets calculate emissions during the "cool-down" period during which the material returns to ambient temperature. The "Pressure" and "Thermal" spreadsheets perform these calculations. Ambient temperature emissions that may occur during extended storage prior to shipment are calculated on the "Tanks" spreadsheet. The methodology for both emission computations is similar.

A study of the volatilization of pentachlorophenol (PCP) from treated wood is presented in the *Proceedings*, *American Wood Preservers Association* (AWPA 1981). The study presents an equation for the concentration of PCP in air versus temperature, from an airflow rate of one litre per minute over a board with 90 square inches of surface area that had been treated with PCP dissolved in a heavy oil meeting AWPA P-9, Type A Standards. That equation is:

$$\mathbf{\ln C = -9{,}277 \times (1/T) + 34.35} \qquad \text{(Equation 1)} \qquad \text{with } T = \text{temperature in °K}$$

The concentration, C, found in Equation 1 above has units of $\mu g/m^3$, and is based on a test flow of one litre per minute over a 90-square-inch surface area. This can be rewritten to solve for an emission rate (ER), in units of lb./ft.^{2}-hour, by multiplying the concentration ($\mu g/m^3$/board) x (1 g/1,000,000µg) x (1 m^3/1,000 litres) x flow rate (l litre per minute) x (1 board/90 in.^{2}) x (144 in^2/1 ft.^{2}) x (60 min./hour) x (1lb./454 g). This yields the following equation:

$$\mathbf{ER = 2.11E\text{-}10 \times C} \qquad \text{(Equation 2)} \qquad \begin{array}{l}\text{with ER} = \text{lb./ft.}^2\text{-hour} \\ \text{and C} = \mu g/m^3\end{array}$$

Dioxin, furan and HCB releases during cool-down are estimated by applying the ratio of vapour pressures and molecular weights of the D/Fs and HCB to PCP at each temperature to determine a relative C for use in Equation 1, as shown below:

$$\mathbf{C_{D/F} = C_{PCP} \times (VP_{D/F}\ @T/VP_{PCP}\ @T) \times (MW_{D/F}/MW_{PCP}) \times (MFL_{D/F}/MFL_{PCP})}$$

$$\mathbf{C_{HCB} = C_{PCP} \times (VP_{HCB}\ @T/VP_{PCP}\ @T) \times (MW_{HCB}/MW_{PCP}) \times (MFL_{HCB}/MFL_{PCP})}$$

The amount of dioxin, furan and HCB released are calculated by multiplying the Emission Rate times the total surface area of the wood times the length of time that the wood is at a temperature above ambient temperature. It is assumed that the wood will take approximately six hours to cool from the temperature it is at the end of treatment to the average ambient temperature. The temperature during that period will be assumed to drop evenly with time from the initial temperature, such that the hourly drop is equal to the difference between the final temperature and the ambient temperature divided by six. Average temperatures during each of the cool-down-period hours are calculated based upon this drop rate, and PCP concentrations are calculated based upon those average hourly temperatures using Equation 1. From this, an average concentration over the six-hour cool-down period can be calculated, and an emission rate can be determined using Equation 2. For the purposes of these calculations, it is assumed that the initial temperature will equal the “charge changing” temperature, as determined using the assumptions listed in the Changing Charges section of the applicable worksheet.

In the absence of actual data concerning the surface area of the wood treated, an estimate will be made based on an average diameter of nine inches. This diameter approximates the mid-point diameter of the average sized utility pole treated in Canada. This size estimate results in a surface area of 2.36 ft.^{2}/lf., or a specific surface area of 5.36 ft.^{2}/ft.^{3}. This value will be applied to the total cubic feet of wood treated during the year.

The actual emission of dioxins, furans and HCB is then calculated by multiplying the emission rate times the square footage of surface area treated and the hours of exposure, as shown below:

$$\text{Release} = \text{ER} \times (5.36 \times \text{Annual Production, ft.}^3) \times 6 \text{ hours}$$

The long-term storage emissions are calculated based on the average treated wood inventory present during the year, and the computations are based on the emission rate at ambient temperature times the computed wood surface area times 8,760 hours per year.

APPENDIX 4

Pentachlorophenol Wood Preservation Facilities

Calculation of Air Releases from the Management of Water Containing Pentachlorophenol

If contaminated water is used in cooling tower systems, consideration must be given to air releases of NPRI substances due to this activity. These releases are considered to be fugitive air releases, and will be added to the other fugitive air releases calculated in other sections. For wastewater evaporation, *Estimating Chemical Releases From Wood Preserving Operations* (U.S. EPA 1988) states that 0% pentachlorophenol (PCP) is evaporated. Given this, and the extremely low vapour pressures of dioxins/furans and hexachlorobenzene (HCB), no significant evaporation of these materials is expected.

U.S. EPA guidance at Section 13.4, AP-42 (U.S. EPA 1995), on emissions from wet cooling towers, addresses the emissions from the "drift" losses from these towers. Drift losses are estimated to be 0.02% of the cooling water flow. Using equations from *Cooling Tower Fundamentals* (Marley 1983), the releases to the air in the drift losses may be calculated. In the following equations, E is the total amount of water evaporated (gallons/year); R is the cooling range, in °F (assumed to be 15°); C is the concentration factor (assumed to be 5, based on a mid-range blow down rate); and Q is the total amount of water circulated through the system (gallons per year).

From the Marley reference:

> The evaporation rate, E, in gallons per year (gpy), may be estimated as:
>
> $$E = Q \times R \times 0.0008.$$
>
> Given the amount of water evaporated and the cooling range, the total recirculated volume, Q, in gallons per year, may be calculated as:
>
> $$Q = E \div (0.0008 \times R).$$
>
> The drift loss, D, gpy, may be estimated as: $D = Q \times 0.0002$.

With a concentration factor of five (5) and no evaporative chemical losses, the concentration of pollutants in the cooling water will be five times the concentration in the make-up water.

Using available analytical data, or estimates if data is not available, estimates of the emissions of the NPRI-listed substances in the drift losses from the cooling tower can be made. The estimated emissions of dioxins, furans and HCB from this source will be based upon their respective concentrations in technical grade PCP.

APPENDIX 5

Pentachlorophenol Wood Preservation Facilities

Wastewater, Groundwater and Storm Water Releases

Releases to surface waters are calculated as storm water releases and point-source releases on three worksheets in the program.

Storm Water Releases

For PCP wood treating facilities, the NPRI-listed substances typically found in technical grade pentachlorophenol (PCP) are dioxins, furans and hexachlorobenzene (HBC). Please note that if facilities possess actual monitoring data for these substances, the spreadsheets will calculate emissions accordingly as based on other parameters such as PCP or Oil & Grease. In addition, dioxin, furan and HCB release estimates will be based on that data using default assumptions.

Outfall Data and Run-off Coefficients

To determine the amount of run-off generated by a facility, the size of the area drained by each of the outfalls and a run-off coefficient must be determined. Run-off coefficients listed below are the average of the ranges presented in a U.S. EPA guidance document (EPA 2000c). The weighted average run-off coefficient for a drainage area is calculated as the sum of the percentage of the area employed for each type of use times the run-off coefficient for that type of use.

Type of Use	Run-off Coefficient
% Heavy Industrial Use	(RC = 0.75)
% Light Industrial Use	(RC = 0.65)
% Paved and/or Roofed	(RC = 0.90)
% Railroad Yard Areas	(RC = 0.30)
% Unimproved Areas	(RC = 0.20)

Estimation of Chemical Releases in Storm Water

Available analytical results for dioxin, furans and hexachlorobenzene should be used by facilities, if available. If data on these substances are not available, release estimates will be based on the results for PCP or Oil & Grease, if available. If PCP data is available, it will then be used to estimate dioxin, furan and HCB concentrations as based on PCP product chemistry. Furthermore, if PCP is not monitored one-tenth of the value of the Oil & Grease result will be used as the PCP concentration, with an assumption that the other nine-tenths are associated with the petroleum solvent used for PCP. Typically, oils used for PCP solutions will have a maximum solubility for PCP of about 10%. The concentration of dioxins, furans and HCB will be estimated using PCP product chemistry data as applied to the PCP concentration estimate. Releases are then calculated by multiplying the concentrations in each discharge by the mass flow of that discharge.

Please note that the quantity of rainfall that does not leave the facility as run-off must infiltrate into the ground. An estimate of on-site releases will then be based on the concentrations calculated above, multiplied by the mass of rainfall that does not leave the site as run-off.

Point-Source Releases

Releases of NPRI-listed substances in point-source discharges are calculated by multiplying the concentration of the chemical by the mass flow of the discharge. Efforts will be made to estimate their concentrations if dioxins, furans and HCB analytical data is not available.

In addition, if analytical data is not available for process wastewater, conservatively high default values will be used for PCP concentrations, as based on industry experience. For raw wastewater (after oil/water gravity separation), the assigned Oil & Grease default value will be 2,500 ppm. The Oil & Grease is assumed to be 10% PCP and 90% P9 oil. If the water is chemically flocculated the Oil & Grease can be assumed to be reduced to 250 ppm. This 250-ppm is then assumed to contain 25 ppm PCP. If the water has been biologically treated, the PCP content is assumed to be 5 ppm. If the water is treated by filtration through activated carbon, the PCP content is estimated as 1.25 ppm.

Dioxins, furans and HCB concentrations will be estimated from the PCP concentrations using product chemistry data. The process wastewater release will be calculated using these concentrations times the total mass of the annual wastewater discharge.

APPENDIX 6

Pentachlorophenol Wood Preservation Facilities

Calculation of Transfers to Off-Site Locations

Transfers of NPRI-listed substances to off-site locations are calculated by multiplying the weight of waste material transferred off site by the concentration of the NPRI-listed substance estimated or measured in the waste. These calculations are straightforward and are shown in the worksheets covering these activities. If concentration data on dioxin, furan and hexachlorobenzene are not available, estimates will be determined as based on the concentration of technical grade pentachlorophenol (PCP), using the PCP product chemistry data found in Table 4.8.

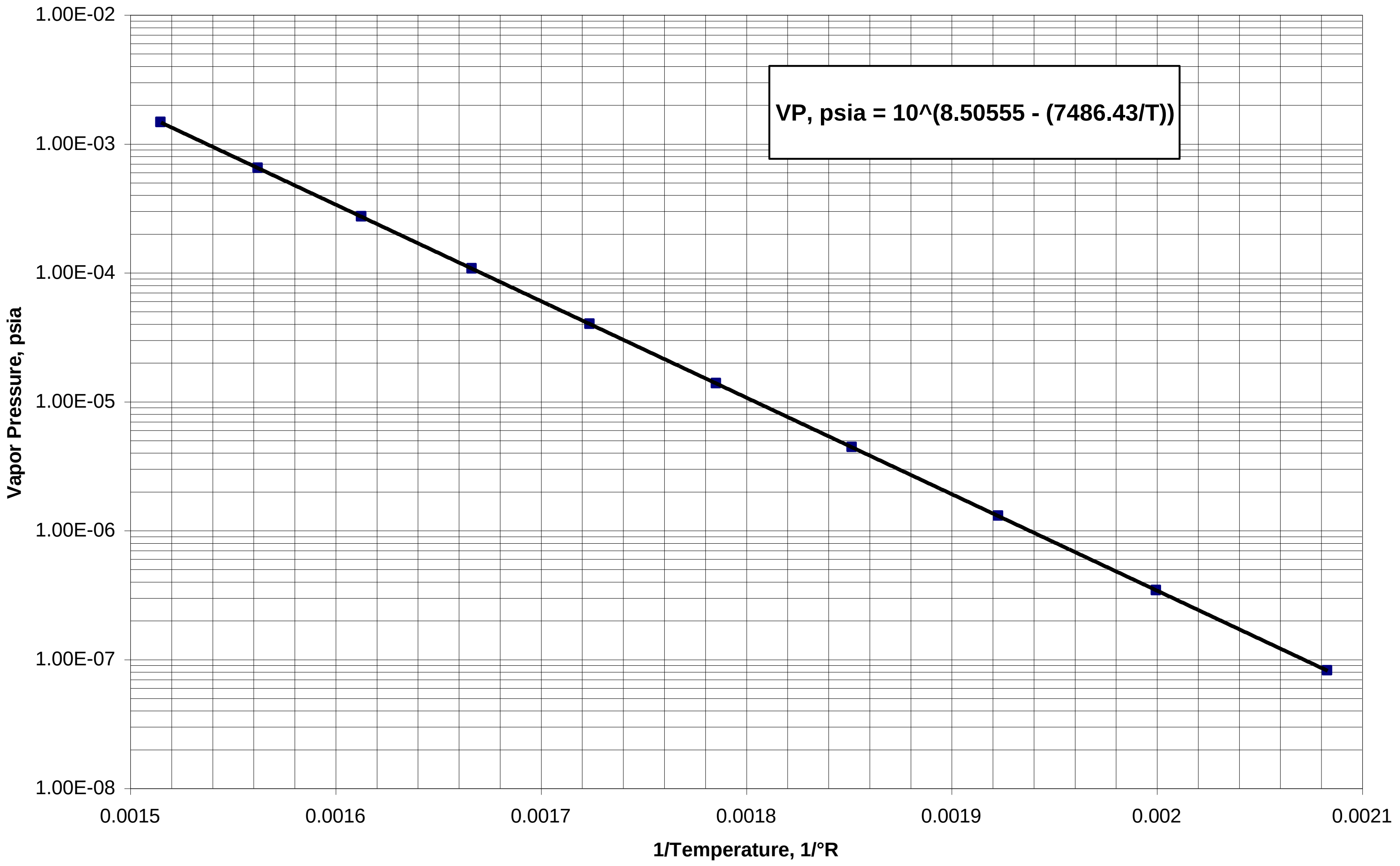
APPENDIX 7

Pentachlorophenol Wood Preservation Facilities

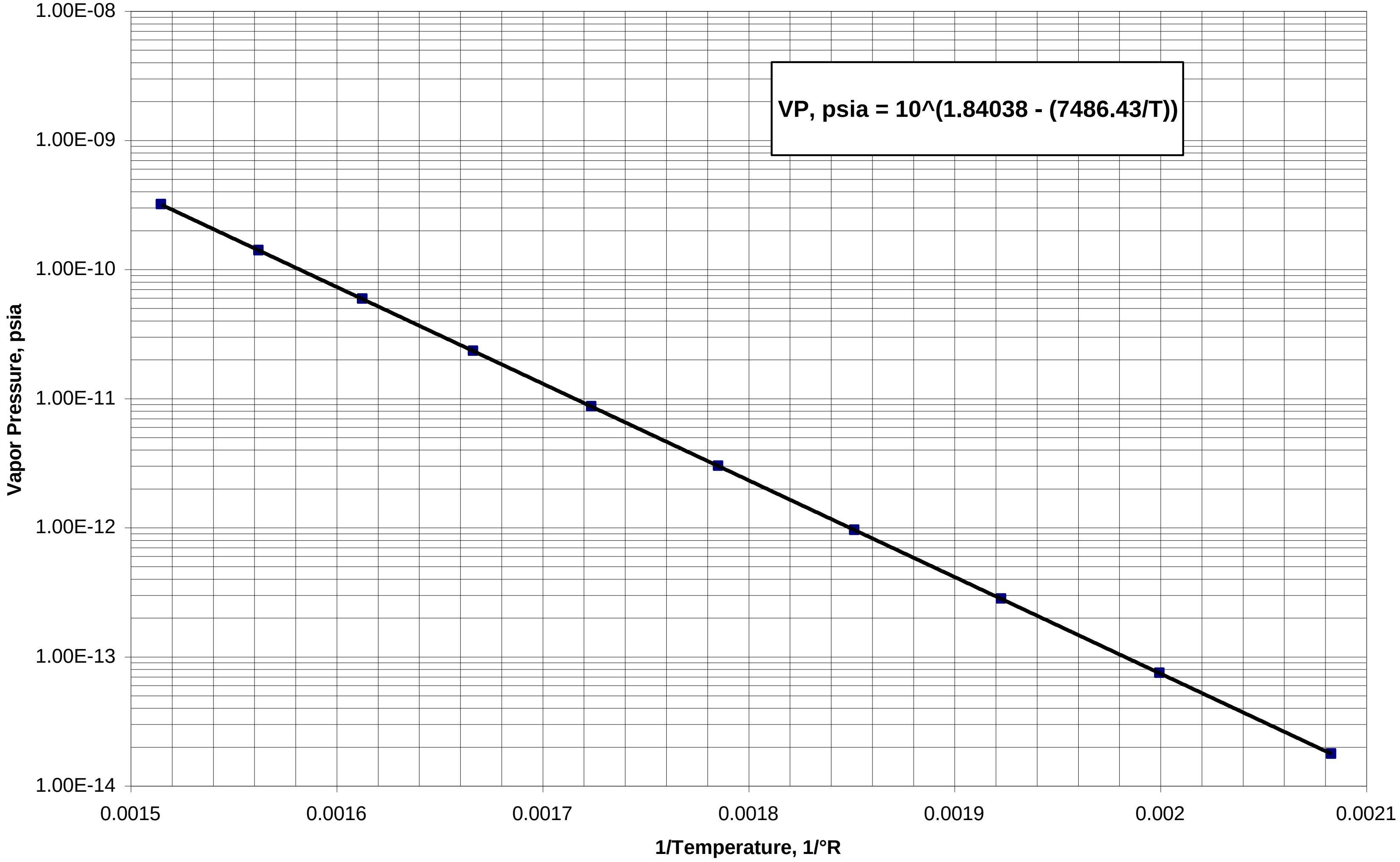
Estimated Vapour Pressures

Actual test data on the vapour pressure of dioxins, furans and hexachlorobenzene (HCB) at varying temperatures were not found in the available literature. As discussed in Appendix 1, the vapour pressure of the congeners of dioxins and furans at 25°C were found in an U.S. EPA reference (U.S. EPA 2000a), and the vapour pressure of HCB at 25°C was found in another published reference (CEH 1973). The physical properties of dioxins, furans and HCB suggest that the slope of the vapour pressure versus temperature line for these compounds should be similar to that of PCP. Based on this assumption, equations to estimate the change in vapour pressure with temperature were developed for dioxins, furans and HCB. Charts of estimated vapour pressures are found in this appendix.

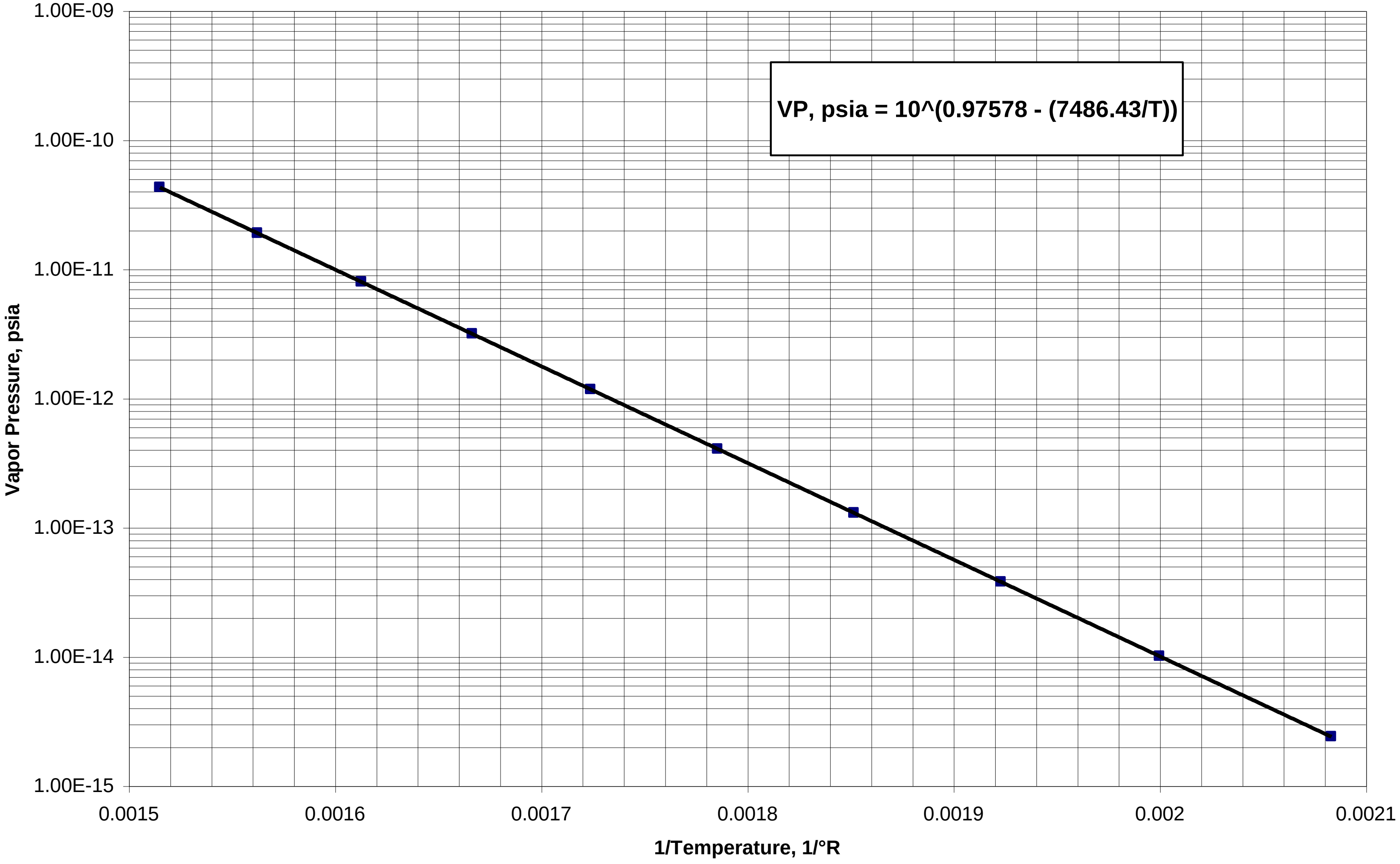
Estimated Vapour Pressure Chart for Pentachlorophenol (PCP)



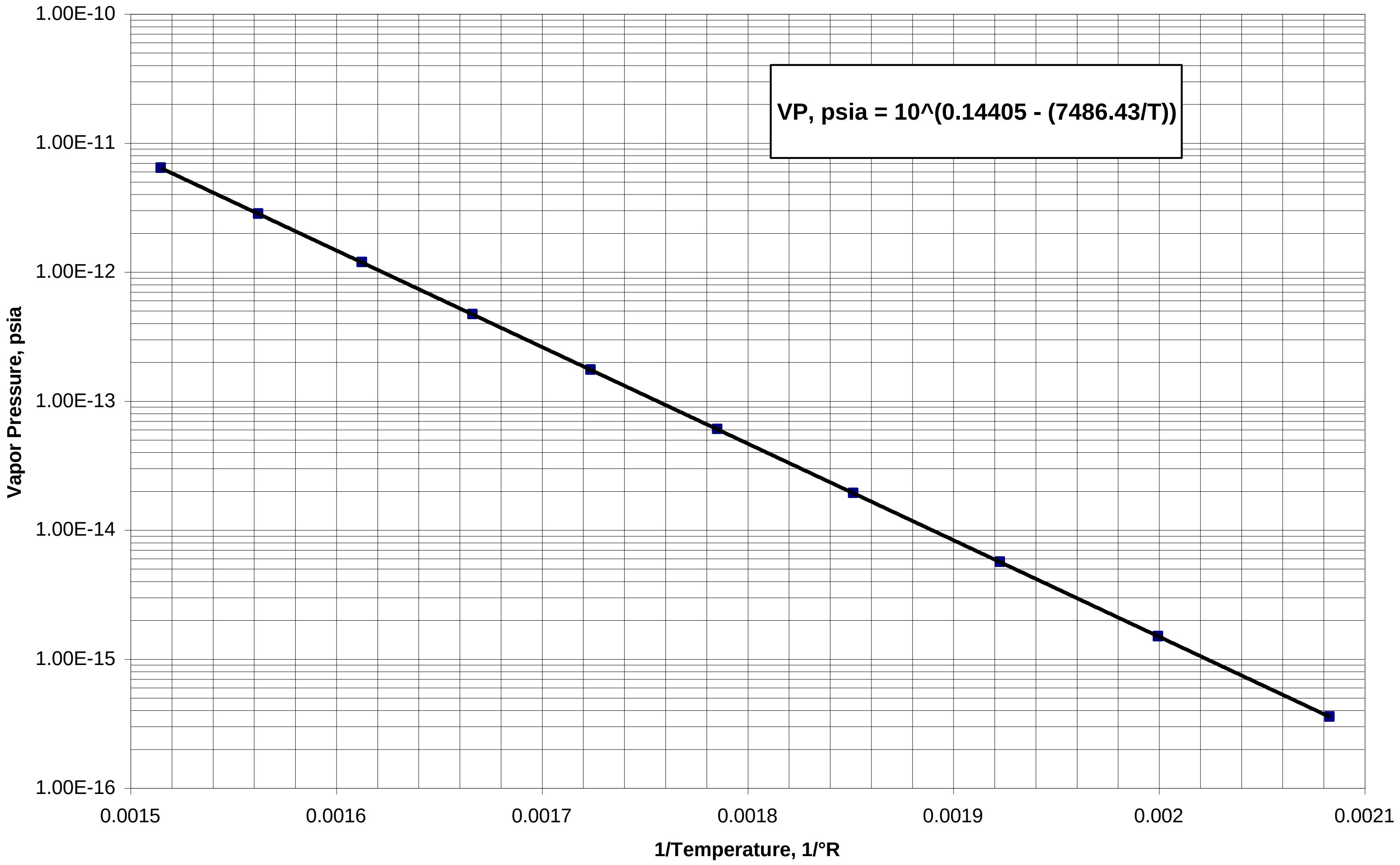
Estimated Vapour Pressure Chart for Hexachlorodibenzodioxin (6CDD)



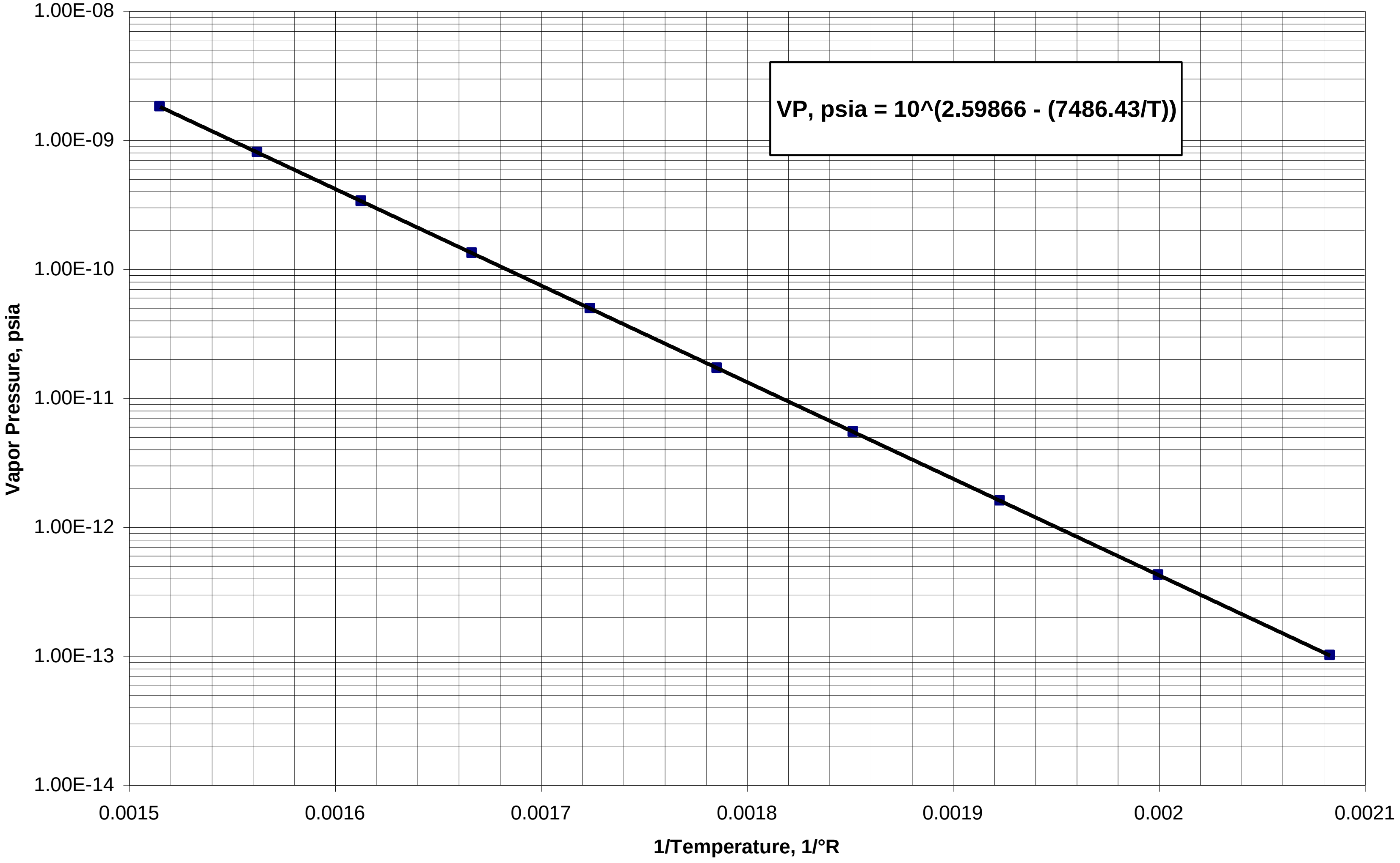
Estimated Vapour Pressure Chart for Heptachlorodibenzodioxin (7CDD)



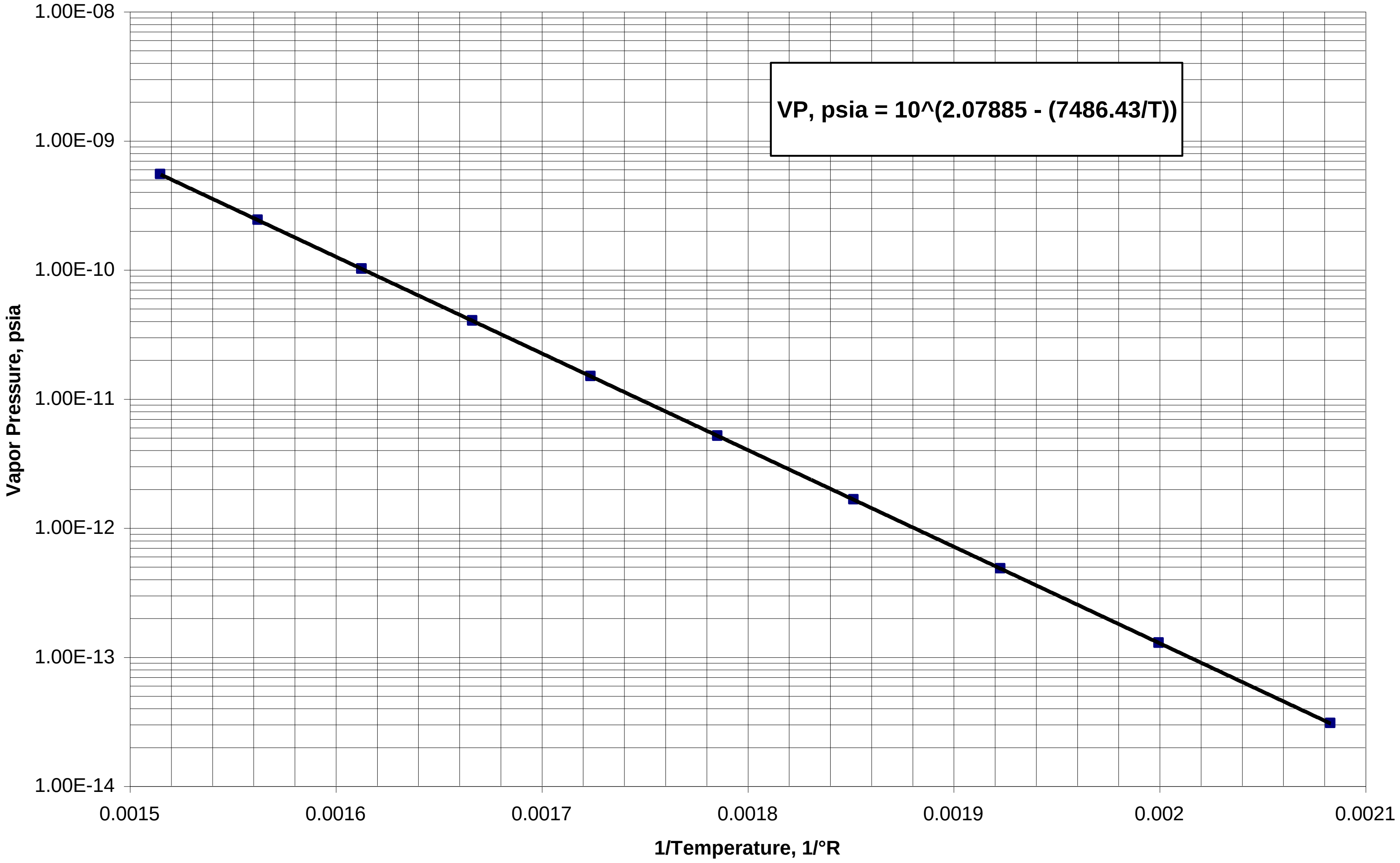
Estimated Vapour Pressure Chart for Octachlorodibenzodioxin (8CDD)



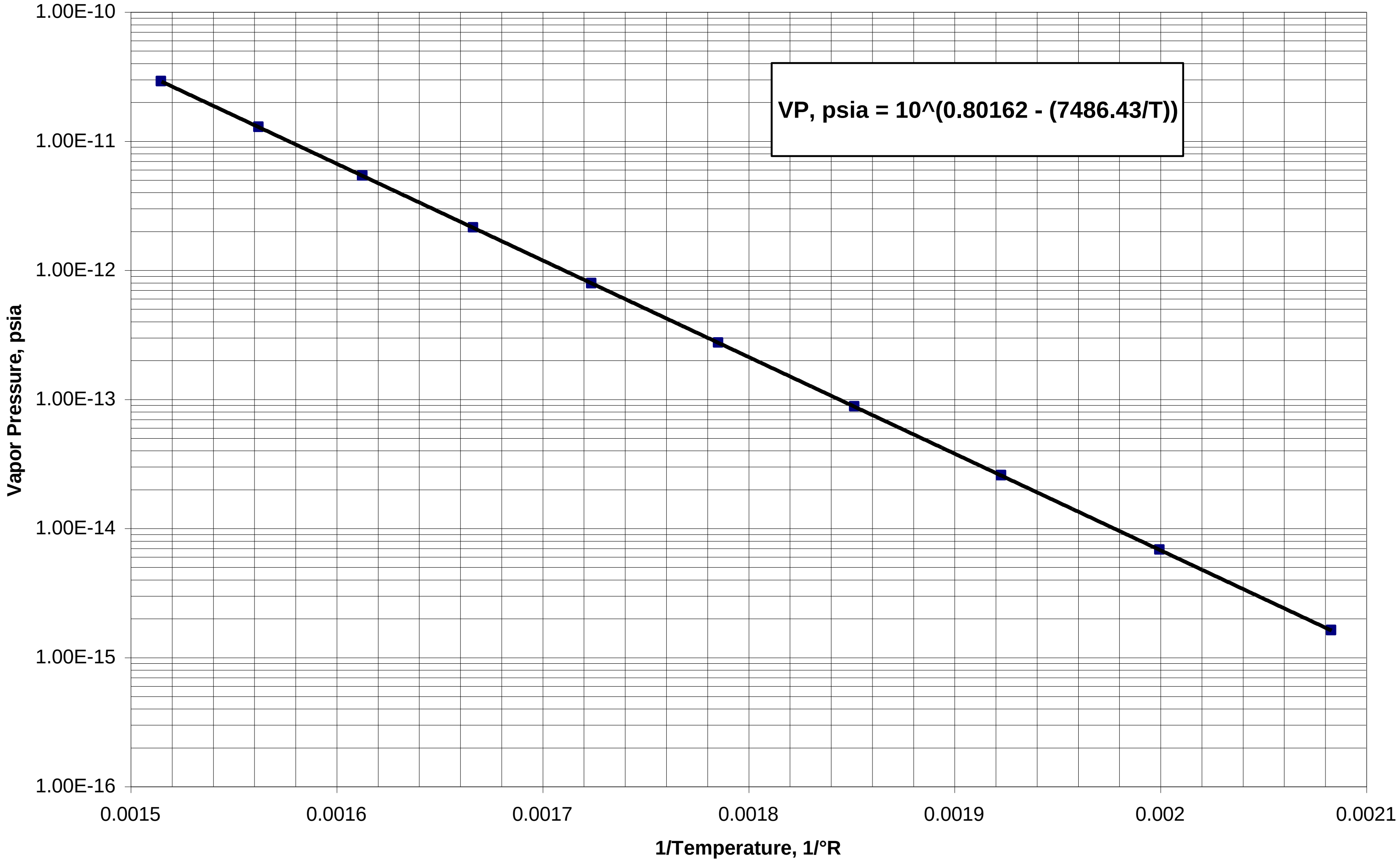
Estimated Vapour Pressure Chart for Hexachlorodibenzofuran (6CDF)



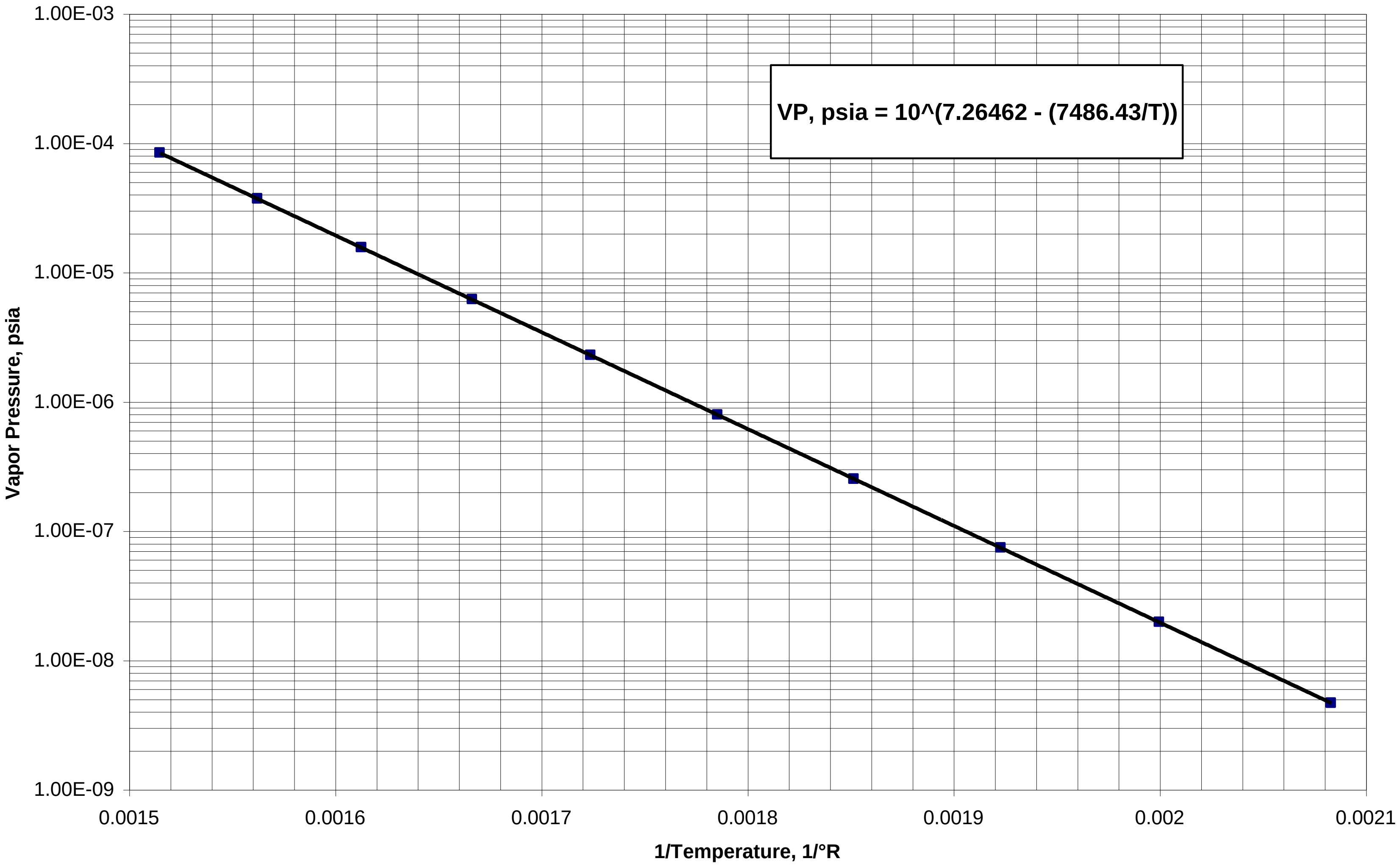
Estimated Vapour Pressure Chart for Heptachlorodibenzofuran (7CDF)



Estimated Vapour Pressure Chart for Octachlorodibenzofuran (8CDF)



Estimated Vapour Pressure Chart for Hexachlorobenzene (HCB)



APPENDIX 8

User's Guide for the Calculation of Releases for Pentachlorophenol Wood Preservation Facilities Reporting to the NPRI

Table of Contents

Introduction

The Microsoft® Excel 97 workbook file, PCPNPRI.xls, found on the disk provided with this documentation was developed to assist pentachlorophenol (PCP) wood treaters in calculating the releases of dioxins/furans (D/F) and hexachlorobenzene (HCB) for reporting to the National Pollutant Release Inventory (NPRI).

The workbook is set up to guide the user through the determination and calculation process by systematically requesting information concerning facility operations, preservative usage, annual production, waste generation, waste treatment, and waste disposal. This User's Guide was prepared to assist PCP wood treaters in completing the necessary data entry and to answer questions that may arise during the use of the spreadsheets.

In order for the PCPNPRI workbook to correctly complete the release computations, the user must have the necessary data to complete the questions asked within each of the data-entry worksheets that apply to the facility. Failure to provide adequate, accurate data may result in incorrect determinations and calculations, and therefore, inaccurate reporting.

Information Needs for Data Entry

Exhibit 1 of this appendix contains copies of all of the data entry sheets used in the spreadsheets. It would be useful to complete these sheets in pencil prior to actually beginning the use of the spreadsheets. To utilize the spreadsheets that make up this workbook, the user will need to gather the applicable items of the information shown below. The data entry sheets in Exhibit 1 will provide specifics regarding the format and units of measure that should be used for this data.

A. Facility Information

- Facility name
- Reporting year

B. General

- Average ambient temperature and wind speed
- Amount of dry PCP used
- Amount of petroleum solvent used to dissolve the PCP
- Numbers of dry PCP mix tanks
- Total volume of the dry PCP mix tanks
- Total liquid surface area of the dry PCP mix tanks
- Average mix concentrations and temperatures, number of mixes, and duration per mix
- Total amount of liquid PCP concentrate used, and PCP content (%)
- Total amount of petroleum solvent mixed with liquid concentrate
- Number of liquid concentrate mix tanks

- Total volume of the liquid concentrate mix tanks
- Total liquid surface area of the liquid concentrate mix tanks
- Average mix concentrations and temperatures, number of mixes, and duration per mix
- Total amount of purchased ready-to-use (RTU) treating solution used, and PCP content (%)
- Number of concentrate, P9-oil, and treating-solution storage tanks
- Total volumes of each of the above categories of tanks
- Average temperatures of each category of tank
- Average treating-solution strength in storage and work tanks, in percent
- Average volume of treated inventory stored on site, $ft.^3$ or m^3

C. Pressure Treaters

- Size of treating cylinders, diameter and length
- Average wood content per charge, each cylinder
- Total number of charges, steam conditioned, each cylinder
- Total number of charges, Boulton dried, each cylinder
- Total number of charges, kiln dried/air dried, each cylinder
- Vacuum surge tank volume, each cylinder
- Average length of initial steam
- Average initial air pressure, psi, Boulton or steam conditioned
- Average initial air pressure, psi, and kiln or air-dried
- Total volume of all treating, or work, tanks used for the pressure-treatment process
- Average temperature of all treating, or work, tanks used for pressure treatment
- Average treating solution strength used for pressure treatment, in percent
- Number of charges given expansion baths
- Average length of expansion baths
- Average expansion bath temperature
- Number of charges final steamed
- Average length of final steam
- Number of final vacuums applied
- Average length of final vacuum
- Previous year production (total $ft.^3$ or m^3 treated with PCP)

D. Thermal Treaters

- Treating tank dimensions (or liquid surface area and average volume used to fill each tank to treating depth)
- Total number of charges, each tank
- Volume of wood treated per charge, each tank
- Total number of hot baths, each tank, per year
- Average hot bath temperature, each tank
- Average hot bath time, per bath, each tank
- Total number of cold baths, each tank, per year

- Average cold bath temperature, each tank
- Average cold bath time, per bath, each tank
- Total number of expansion baths, each tank, per year
- Average expansion bath temperature, each tank
- Average expansion bath time, per bath, each tank
- Total volume of all work tanks used for thermal treatment, in percent
- Average temperature of all work tanks that are used for thermal treatment
- Average treatment-solution strength used for thermal treatment
- Previous year production (just the volume of wood actually treated, if only butt treating), ft.^{3} or m^3

E. Storm Water

- Total annual rainfall at the site
- Total number of storm water outfalls (discharges)
- Size of area draining through each outfall
- Types of uses of each area
- Actual discharge volume, each area (if known)
- Analytical results, each outfall, if available
- Receiving water body name, each outfall (if applicable)

F. On-Site Waste Disposal

- Waste description
- Amount of waste disposed of on site
- Source of the release or treatment, storage, or disposal method
- Analytical results or estimates of constituent concentrations in each waste

G. Wastewater

- Wastewater treatment system information (treatment steps)
- Amount of wastewater generated
- Amount discharged to stream
- Amount discharged to municipal sewage-treatment plant (MSTP)
- Amount evaporated in thermal tanks
- Amount sent to cooling tower
- Amount sent to reuse
- Amount sent off site for disposal (not MSTP)
- Receiving water body name, if applicable
- MSTP information (name, address)
- Analytical results

H. Groundwater

- Groundwater recovery system information, including treatment steps
- Total amount of remedial action water managed
- Amount discharged to MSTP
- Amount discharged to surface waters
- Amount shipped off site for treatment (not MSTP)

- Receiving water body name, if applicable
- Receiving MSTP name, if applicable
- Analytical results

I. Wastes Shipped Off Site Containing NPRI-listed Substances (Hazardous and Non-Hazardous)

- Waste descriptions, quantities, and treatment, storage or disposal methods
- TSD facility information (name, address, code)
- Analytical results or estimates of constituent concentrations in each waste

Getting Started

Copy the file PCPNPRI.xls onto your computer's hard drive. (Do not attempt to use the workbook directly off of the disk provided. This will cause the program to be unable to save the information entered by the user.) The file is in Microsoft® Excel 97 format, so it may be preferable to copy the file into your default Microsoft® Excel directory. Open the file using Microsoft® Excel (97 or higher). The file will open to the ***Home*** worksheet. A pop-up question may appear concerning the enabling of macros. If this appears on your system, be sure to select "Enable Macros".

General Usage

In all of the worksheets in this workbook, the user is asked to provide answers to questions at the beginning of the worksheets. Answers are to be entered in the yellow boxes that follow the questions. These blocks are the only blocks that allow data entry, in order to prevent the inadvertent deletion or over-typing of the calculation equations and logical formulas that are used throughout the sheets.

In most cases, answers will need to be typed in. In some cases, pull-down boxes will offer the user a choice of acceptable answers. To the extent possible, data validation checks have been used to prevent the entry of suspect or bad data. However, it is the responsibility of the user to ensure that all data entered is correct.

Generally, all yellow blocks that can be answered by the user, should be. However, there are many places where there are several options for data entry, depending upon the data available. In those instances, the user will be directed to complete only certain boxes. The user of the calculation workbook will need to inform data gatherers of the specific needs of each section, and will need to clarify the appropriate information when information on more than one option is provided. In all cases, the user should follow the instructions found in the specific worksheet sections that follow and in the worksheets themselves. If any uncertainties exist, the user should contact the program developer.

In addition, in some cases multiple responses are allowed, such as where data is requested on wastes shipped off site. In this case, the user is given the opportunity to report on up to eight different wastes. In all cases such as this, the user should proceed in logical order from 1 to the maximum number needed (i.e., the user should enter the data for the first waste in Waste 1 and the data for the second waste in Waste 2, and not complete information on Waste 1 and then skip to Waste 4 if only two wastes were generated.)

Also, in many worksheets, the user will be requested to provide the average results of available analytical data for each item reported on. Generally, each worksheet will have individual instructions that specify what the user should and should not answer. In some cases, the user will be asked to estimate chemical concentrations, while in others the user will be specifically instructed not to offer estimates. In no cases should the user enter symbols or any other non-numeric values to indicate a result which has been reported as being below the lower detection limit (LDL) for a chemical or compound. If the user's only available data reports that a subject chemical was not detected at the lower detection limit, then the user should follow the guidance specific to that worksheet.

The user may use the TAB key to move through the worksheets, since this key moves only between data entry blocks. Hyperlinks (shown as blue underlined text, such as "Click here") are used throughout the workbook to quickly move the user to other areas in the workbook. When directed to use a hyperlink, the user should simply use the mouse to move the cursor over the link and click.

At the end of the data-entry section in each worksheet, instructions are provided which state how the user should proceed. Normally, the user is directed to print each worksheet as soon as the data has been entered, and then to click a hyperlink that will take the user to the next worksheet.

Printing

After completing the data entry process in each worksheet, the user will be informed as to how many printed pages to expect, and will be instructed to preview how the sheets will print out on the printer in use. This is done by selecting "File", "Print Preview" from the main Microsoft Excel menu, and then examining the preview of each page to be printed.

All of the worksheets have been formatted to print only specific areas, on a set number of pages. Margins and page breaks have been designed so that differing printers' reformatting should not affect the printout. However, in the event that the number of pages shown in Print Preview does not agree with the number stated in the instructions, the user may need to adjust the setup. In most cases, the only action that should be needed would be to reduce the scale, from 100% downward to whatever scale allows the worksheet to print on the correct number of pages. This is done in Print Preview by selecting "Setup..." from the main Print Preview menu, and changing the scaling on the tab marked "Page".

Checking for Errors

Following the completion of data entry, the user is instructed to preview and then print each worksheet. Any errors in data entry should cause answers of “ERROR”, “#VALUE!”, or “#DIV/0!”. If any of these statements are found in a printout of any sheet within this workbook, the user must re-check all data entered to ensure that:

1. All yellow blocks required to be filled in have been, and
2. All entries are correct.

If the cause cannot be identified, the user should contact the program developer.

Specific Use

The following sections will guide the user through each worksheet found within the PCPNPRI workbook.

- **Home:**

The workbook will open to the ***Home*** worksheet each time the program is opened. Be sure to select “Enable Macros” if a pop-up question concerning this is shown. On subsequent re-entry into the program, the user will have to pick the worksheet that they want to work on from the worksheet tabs at the bottom of the sheet.

The ***Home*** worksheet is the central worksheet for all release and transfer calculation worksheets. Part 1 of this worksheet requests the facility name and reporting year. Part 2 contains questions which, when answered by clicking on the “Yes” or “No” found at the end of the questions, take the user either to a calculation worksheet or to the next question.

- **Tanks:**

If the user answers “Yes” to question 1 on the ***Home*** worksheet, the user is sent to the beginning of the ***Tanks*** worksheet. The ***Tanks*** worksheet is used to calculate the following dioxin/furan and hexachlorobenzene releases: 1) to the air from storage, work, or mix tanks, due to breathing, working, and evaporative losses resulting from the receipt, storage, and mixing of oils and chemicals used in the process; and 2) to the air from treated inventory.

The releases from the use of the treating solutions in the wood preserving processes are calculated on subsequent worksheets.

The first information requested concerns the units of measure that will be used in this and other worksheets. The user is asked four questions, each of which has selectable answers in a pull-down box.

The user is then asked to provide meteorological information, specifically the average annual ambient temperature and wind speed, for the facility’s location. This information may be obtained from local or national weather service offices. This information is needed for calculations on the ***Tanks*** worksheet, and is carried forward to each of the process-related worksheets that will be discussed later. This information **must** be furnished.

The next section applies only to facilities that mix treating solutions using dry flake, or block, PCP. If applicable, the user must enter the total amounts of PCP and solvent oils used in this mixing during the reporting year. For facilities that conducted all of their dry PCP mixing operations in treating cylinders or treating tanks during the treating process, no further information is required. Facilities that utilized dedicated mixing tanks must report the total number, total volume, and total liquid surface area of all dry PCP mix tanks used at the facility. These facilities must also report the average mix concentration, in percent PCP, the average mix temperature, the total number of mixes and the average time per mix, whether the tank was closed during mixing, and whether the tank was closed when mixing was not being done.

The next section requests information about concentrate storage tanks. This section should only be filled out if concentrate is stored at the facility unmixed. Informational needs include the total number, total volume, and average temperature for all concentrate storage tanks at the facility.

The next section applies to facilities that purchase pre-mixed, or ready-to-use, treating solutions. Here, the user is asked to provide the total amount used during the year and the average PCP concentration in the solutions used.

Next, if P9 oils are stored on site, unmixed, then the user is asked to provide information on the total number, total volume, and average temperatures of the tanks used.

The next section requests information on the total number of tanks used to store treating solutions at the facility, including storage and treating, or work, tanks, their total volume, their average temperature, and the average treating solution strength, in percent PCP.

Finally, the user is asked to enter the average volume of treated inventory stored at the facility during the year.

Following the completion of the data-entry phase, the user is instructed to print the worksheet. After printing is complete, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

- **Pressure:**

If the user answers “Yes” to question 2 on the ***Home*** worksheet, the user is sent to the beginning of the ***Pressure*** worksheet. This worksheet is used to calculate emissions from operations involving the pressure treatment of wood.

The first information needed is related to the treating cylinders used for treatment of wood with PCP. The user is provided with a block to enter facility-specific nomenclature or identification information on each of the cylinders being reported on. This block is not required to be filled in, and is there solely for the user's tracking purposes. The user must provide sizes, average wood contents, and number of charges (reported as the number of charges steam conditioned, Boulton dried, or kiln/air dried) for each treating cylinder (up to five total) for the year. Additionally, the user must provide the average length of initial steaming and the initial air pressures used, reported as an average of the times and pressures used at each cylinder, and the vacuum surge tank volumes, if present. Please note that a charge should not be reported in more than one place. For instance, if kiln-dried wood is Boultonized, it should not be reported as both a kiln-dried charge and a Boultonized charge. It should only be reported as a Boultonized charge. As a check, the total number of charges times the average charge volume should equal the total production for the year.

The next section requests information on the treating, or work, tanks used for pressure-treating operations. For those facilities that also have thermal-treating operations, only those tanks used in the pressure-treating process should be considered when calculating the total tank volume, average tank temperature, and average treating-solution strength.

If expansion baths are used, the user must fill out the next section. Information to be provided includes the number of charges given expansion baths, when the bath occurs, the length of the bath, and the average temperature.

In the next section, the user should provide information on any final steaming that is conducted in the treating cylinders, to include the average length, number of charges, and when the steam is applied. Once these blocks have been filled in, the user is asked to provide the number and average length of final vacuums.

The last data requested on this sheet concerns previous-year pressure-treatment production, which is used to arrive at a total facility production ratio on a later worksheet. At a facility with both pressure- and thermal-treatment systems, this value should consider only the amount of wood that was pressure treated during the previous year.

Following the completion of the data entry phase, the user is instructed to print the worksheet. After printing is complete, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

- **Thermal:**

If the user answers "Yes" to question 3 on the ***Home*** worksheet, the user is sent to the beginning of the ***Thermal*** worksheet. This worksheet is used to calculate emissions from operations involving thermal or dip treatment.

The first section is used to provide information on the thermal-treating tanks. This section is set up to allow several different ways to report tank dimension information, since the average treating-liquid depth, and not the actual height of the tank, is needed. The worksheet is formatted to prevent the entry of data on more than one tank type per column. The user should either provide: the tank diameter and average depth of liquid used during treating for vertical cylindrical tanks; the length, width and average liquid depth for rectangular tanks; or the surface area and average volume needed to fill the tank to the desired depth for any other shaped tank (to include horizontal semi-cylindrical tanks).

Next, the user is asked to provide production information, to include the number of charges treated, the average volume of wood treated per charge, the total number of hot, cold and expansion baths applied per treating tank for the year, average temperatures of each, and the length of time per bath for each. Please note that the user is asked for the average volume of wood *treated* per charge, and not the total volume of wood processed. Volumetric determinations in the case of butt treatments should therefore be based upon the size of the pole and the length treated.

Additionally, if the facility uses a cooling bath in place of a cold bath, the user must break the total treatment time into that which is considered the hot bath and that which is the cool-down period, and enter those times in the boxes for hot and cold bath times. The cold-bath temperature in this case should be reported on the average temperature of the oil during the cool-down period, or cooling bath.

The next section requests information on the work tanks used for thermal-treating operations. These include the hot-oil and cold-oil tanks and any other storage tanks actually used for the transfer of oil during the treating process. For facilities that also pressure treat, include only those tanks associated with the thermal-treating operation when calculating the total tank volume, average tank temperature, and average treating-solution strength.

Finally, the user is asked to provide information on previous-year thermal-treatment production, based on the amount of wood that was *treated*. This information is used to arrive at a total facility production ratio on a later worksheet. At a facility with both pressure- and thermal-treatment systems, this value should consider only the volume of wood that was thermally treated during the previous year.

Following the completion of the data-entry phase, the user is instructed to print the worksheet. After printing is complete, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

- **Storm_Water:**

This worksheet will estimate releases of the NPRI-listed substances in storm water run-off to surface waters, MSTPs, and/or land.

The first step is to determine if a facility is required to calculate releases in storm water. Where a facility does not have any storm water data available, that facility is not required to determine or report on the releases from storm water because it has no basis for estimating the chemical concentrations in storm water run-off.

The first question asks whether the facility has monitoring data available. If the user answers “Yes,” he is instructed to proceed to the analytical data entry section. If “No,” the user is instructed to stop, to print the worksheet, and is then returned to the “Home” worksheet by clicking on the hyperlink that will appear with a “No” answer.

If analytical data is available, it should be entered in the next section by outfall number. Data is to be entered as parts-per-million (or mg/L). The data that should be entered is dependent upon what data is available. Normally, most PCP wood treating facilities are required to monitor for PCP. Conversely, most facilities are **not** specifically required to monitor for HCB, dioxins or furans for the purposes of reporting to the NPRI. However, Oil & Grease data is commonly monitored and can be used here.

If a facility has data on HCB, it should be entered where available. If a facility has analytical data on dioxins/furans, the user is asked to report a combined Toxic Equivalent (TEQ) concentration for all of the dioxins/furans. The user may calculate the total TEQ concentration using the workbook, TEQCONC.xls, which is found on the diskette supplied with this Guide, or using the manual computation table found in Exhibit 2. The instructions for completing this task are found in that exhibit.

If analytical data is not available for dioxins, furans or HCB, they may be estimated based on other data. The concentrations of dioxins, furans and HCB in technical grade PCP have been used in earlier worksheets within this workbook. An evaluation of relative solubilities suggests that product chemistry data can be used to estimate releases of the micro-contaminants. Therefore, an estimate of D/F and HCB concentrations in storm water run-off can be made based on PCP content. If the facility only has data on Oil & Grease, an estimate of the PCP content will be made based on the assumption that PCP represents approximately 10% of the total Oil & Grease measurements.

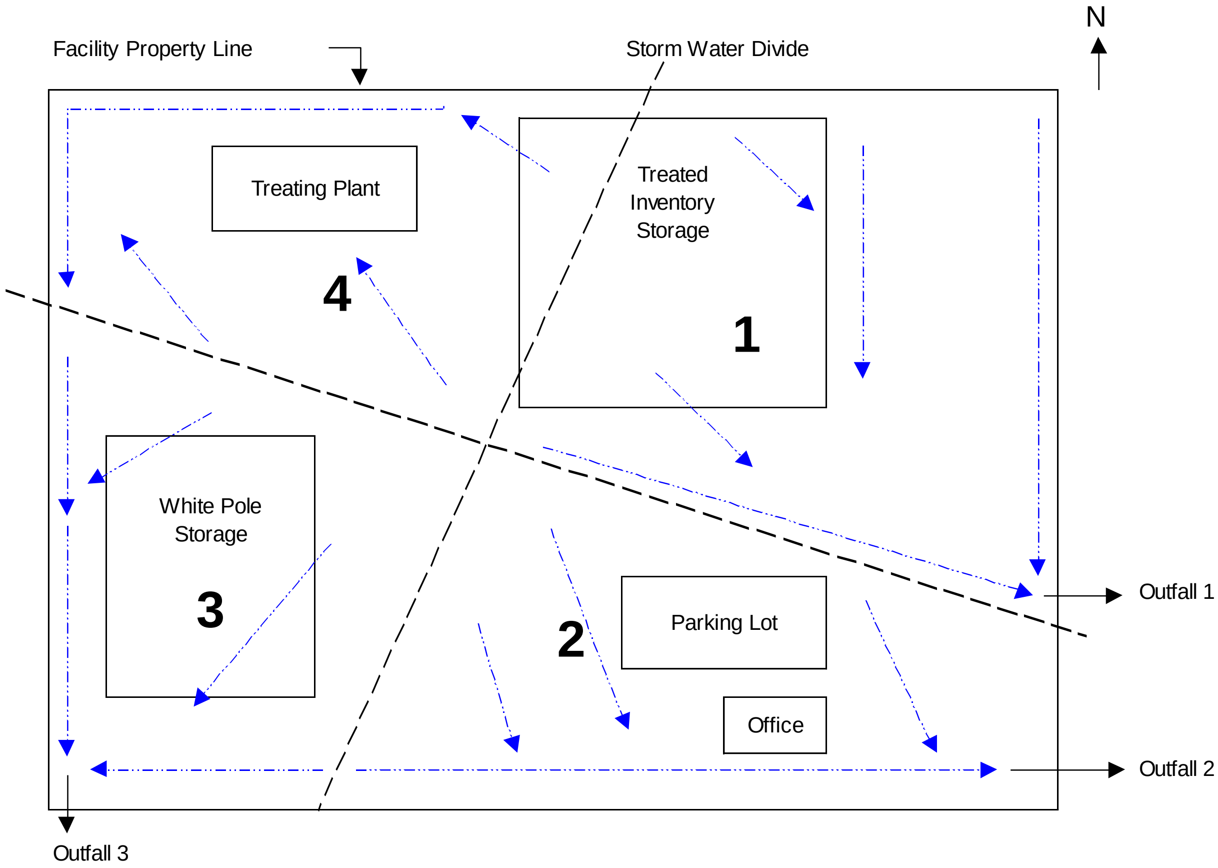
Therefore, if positive data is available, report it for each chemical or chemical category. Where positive data is not available, leave the block empty. Where the only available data for PCP, HCB or Oil & Grease reports the chemical below the laboratory’s lower detection limit (LDL), enter a value equal to zero. Since laboratory lower detection limits may be well above the expected D/F concentration, the user is instructed to leave the D/F TEQ concentration block blank if all available D/F results are reported to be below the LDL. In this case, the program will estimate D/F concentrations by congener based upon the input PCP or Oil & Grease values. **Do not** enter answers of “Less than 10”, “<10”, “ND”, or use any other non-numeric characters.

The next information requested is used to determine how much storm water run-off occurred during the reporting year. First, the user must provide the total amount of rainfall received during the year. This amount may come from facility rain-gauge records, or from local or national weather service stations.

In the Outfall Data and Run-off Coefficients section, the user is asked if the storm water is released to surface waters, MSTPs, or released to land (i.e., no storm water leaves the property in surface flows). Next, the user must enter the approximate drainage area for each of the outfalls. If the actual discharge volume is known for any outfall, it is entered in the next blocks. At those outfalls for which no actual discharge-volume data exists, the user must assign percentages to each land area description or type of use that applies to that area. The user is given five of the land area descriptions/usage types that are found in the U.S. EPA *TRI Instructions Manual* from which to choose to assign percentages. These are heavy industrial, light industrial, paved and/or roofed, railroad yard, and unimproved areas. The total of percentages entered in each column must equal 100%. Facilities with monitoring data that have no actual storm water discharge off site should enter area and usage information for the entire site under Outfall 1.

The following example shows how a facility should determine the information needed for the Outfall Data and Run-off Coefficients section.

Example: Site Storm Water Run-off Analysis



A facility conducted a site survey of its 20-acre property during a rainfall event and determined that storm water drainage was divided into four sub-areas, with the flow patterns shown. Two of these areas (1 and 2) were found to feed individual outfalls, while areas 3 and 4 were found to both feed a third outfall due to the presence of a drainage ditch along the northwestern property line. The facility estimated the outfall areas and area uses as follows:

			Area Usage Percentages				
Outfall	**Area(s)**	**Size**	**Heavy Industrial**	**Light Industrial**	**Paved/ Roofed**	**Railroad**	**Unimproved**
1	1	6	20	50	0	20	10
2	2	4	0	55	25	0	20
3	3 & 4	10	20	60	10	0	10

Finally, the user must identify the water body to which the discharge from each outfall goes. If the discharge is to an MSTP or if no discharge occurs, this field is left blank.

If storm water data is available from which to estimate D/F and HCB concentrations, the program will calculate the quantity contained in storm water that percolates directly into the ground. This release will be reported as an on-site release to land. This release will be added to any other on-site releases on the summary release sheets at the end of the workbook.

Once all of the information above has been entered, the user is instructed to print the worksheet, and then is returned to the ***Home*** sheet by clicking on the hyperlink at the bottom of the page.

0 **On_Site:**

If the user answers “Yes” to question 5 on the ***Home*** worksheet, the user is taken to the ***On_Site*** worksheet. This worksheet is used to calculate releases to land on site from on-site disposal of wastes in landfills or land treatment areas, from spills or leaks, or from other sources.

The first section requires the user to enter waste descriptions and waste quantities, and to select the source of the release or the disposal method for each waste from a pull-down box which has the five choices available for reporting in Section B12.4 of the NPRI report. Next, the user is asked to provide contaminant concentrations in each waste, using analytical data where available, following the instructions on the worksheet where it is not.

As explained earlier, if positive analytical data on D/Fs is available, the user is asked to provide only the combined TEQ concentration. This value may be calculated using the instructions found in Exhibit 2.

Following the completion of the data-entry phase, the user is instructed to print the worksheet. After printing is complete, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

- **Wastewater:**

If the user answers “Yes” to question 6 on the ***Home*** worksheet, the user is taken to the ***Wastewater*** worksheet. This worksheet is used to calculate the amounts of NPRI-listed substances treated on site and/or released or transferred from the site as a result of wastewater management.

The first question requests that the user describe any wastewater treatment by choosing from a list of treatment methods and putting them in the order in which they occur. This is important because the spreadsheet has conservative default concentrations used in later calculations that are dependent upon the answers to this question.

The next section requests information on the total amount of wastewater generated at the facility and the volumetric units, and then requires the user to identify all of the dispositions of this amount, using the same units of volume. Please note that the total of the individual wastewater volumes must equal the total volume generated.

The user is then asked to supply the name of the water body which wastewater are discharged to, if directly released, or the name of the MSTP that receives the waters, if applicable. Normally, this information is available within a facility's discharge permits.

The user is next asked to provide information on contaminant concentrations in the wastewater. Information is requested only on the discharge, or effluent, wastewater. Effluent wastewater are considered to be those that are discharged, evaporated in thermal-evaporation tanks, sent to a cooling tower, reused on site, or sent off site for treatment at other than an MSTP. Effluent concentrations are used to calculate all releases and/or transfers of NPRI-listed substances from the wastewater stream.

If positive data for PCP, Oil & Grease, or HCB exists, it should be entered. If the available data for PCP, Oil & Grease, or HCB reports concentrations below the LDL, the user should enter zero. As explained earlier, if positive analytical data on D/Fs is available, the user is asked to provide only the combined TEQ concentration. This value may be calculated using the instructions found in Exhibit 2. If all available dioxins and furans data are reported as being ND at the LDL, the D/F TEQ concentration block should be left blank. If no data is available, the spreadsheets will use conservative default concentrations based upon experience at wood preserving facilities. For this reason, the user is instructed NOT to offer estimates of any chemicals for the effluent stream.

Following the completion of the data entry phase, the user is instructed to print the worksheet. After printing is complete, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

- **Groundwater:**

If the user answers “Yes” to question 7 on the ***Home*** worksheet, the user is taken to the ***Groundwater*** worksheet, which is used to calculate the amounts of NPRI-listed substances released in wastes generated by corrective actions involving groundwater recovery.

The first question requests that the user describe any groundwater treatment by choosing from a list of treatment methods and putting them in the order in which they occur.

The next section requests information on the total amount of groundwater recovered and/or treated at the facility, and then requires the user to identify all of the dispositions of this amount. Please note that the total of the individual wastewater volumes must equal the total volume entered above.

The user is then asked to supply the name of the water body that the groundwater is discharged to, if directly released, or information on any MSTP that receives the waters, if applicable. Normally, this information is available within a facility's discharge permits.

The user is next asked to provide information on contaminant concentrations in the effluent groundwater. Effluent groundwater is considered to be those that are discharged. Effluent concentrations are used to calculate all releases and/or transfers of NPRI chemical from the groundwater stream.

The user shall enter positive analytical results for each chemical or chemical category, where available. As explained earlier, if positive analytical data on D/Fs is available, the user is asked to provide only the combined TEQ concentration. This value may be calculated using the instructions found in Exhibit 2. If all analytical results for PCP, HCB, or Oil & Grease report the chemical as being below the laboratory's lower detection limit, the user should enter zero. If all D/F results are reported below the LDL, leave the D/F concentration block blank.

Following the completion of the data-entry phase, the user is instructed to print the worksheet. After printing is completed, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

- **Off_Site:**

If the user answers "Yes" to question 8 on the ***Home*** worksheet, the user is taken to the ***Off_Site*** worksheet. This worksheet is used to calculate the amounts of NPRI-listed substances that were transferred off site in hazardous and non-hazardous waste shipments. Up to eight shipments may be reported on this sheet. Multiple shipments of the same waste to the same facility for disposal using the same treatment or recycling method may be combined and reported as one shipment.

The first section requires the user to select a waste description from a pull-down box list; enter a quantity of the waste shipped, in pounds; and select a treatment, storage, or disposal method. Next, the user is asked to provide information on the receiving facility, for comparison to the list of facilities that will be present in the NPRI software database.

Finally, the user is asked to provide contaminant concentrations for each waste. As was done on earlier sheets, the user is asked to report analytical results where available, entering zero for any chemical or compound, except dioxins/furans, which has been reported as being below the laboratory's lower detection limit. As explained earlier, if positive analytical data on D/Fs is available, the user is asked to provide only the combined TEQ concentration. This value may be calculated using the instructions found in Exhibit 2. If data is not available on a specific contaminant, the corresponding block should be left blank. Where no data is available on PCP, Oil & Grease, and either HCB or D/Fs, the user must estimate PCP concentration. For assistance in estimating the PCP content, contact your environmental consultant or your preservative supplier.

Following the completion of the data-entry phase, the user is instructed to print the worksheet. After printing is complete, the user is returned to the ***Home*** page by clicking on the hyperlink at the bottom of the page.

Determination of Total Release/Transfers from the Facility

After answering all eight questions on the ***Home*** worksheet and completing all of the calculation worksheets that are applicable to the facility, the user is instructed to click on a link that goes to the ***Results*** worksheet. The ***Results*** worksheet combines all release and transfer amounts calculated on the individual calculation worksheets, and groups them into sections that correspond to those found within the NPRI report.

At the beginning of each page, the chemical being dealt with is listed. Next, the release reporting sections from the NPRI report are outlined, with the corresponding release or transfer amount to be input in the report displayed to the right.

The first release reporting section is labeled "B12.0, On-Site Releases to the Environment". This section shows the total stack/point source, storage/handling, and fugitive air releases that are reportable in sections B12.1.a, B12.1.b, and B12.1.c.

The next section deals with releases to surface waters, reportable in Section B12.3.a. Since the NPRI report requires the reporting of releases based upon which water body they go to, releases from each storm water outfall, process-wastewater discharge, and/or treated-groundwater discharge are shown. Please note that all releases to the same receiving water body should be combined for reporting.

The automated NPRI software has a list of water bodies from which you will be required to choose for each release. The first step should be to search for the water body name provided by the user and shown on the PCPNPRI ***Results*** worksheet in this list. If the name cannot be found, the user should consider which downstream water body the immediate, non-listed, water body drains to. If this water body is listed, the user should report all releases to the initial water body as releases to the subsequent, listed, water body. If the user cannot determine a subsequent receiving water body, or if the subsequent water body is also not listed, the user may add the initial water body to the list of water bodies. Refer to the *Guide for Reporting to the National Pollutant Release Inventory – 2000* for instructions on how to do this.

The next section shows the releases to land on site that were calculated in the earlier worksheets, ***On_Site*** and ***Storm_Water***. Each release is totaled according to its disposal method or source of release.

Finally, the total releases of each substance are shown for reporting in section B12.5. This value is calculated by adding the total air releases, the total releases to surface waters, and the total releases to land on site.

Section B22 concerns transfers of the substances off site for disposal. This section has nine subsections that deal with how the waste was disposed of. The total quantity transferred off site for disposal is shown for reporting in section B22.2.

The next section is set up similarly, but concerns transfers off site for recycling. Ten different recycling methods are reportable in section B25, and the amount transferred to each method is shown on the ***Results*** sheet.

The final section concerns the facility's production ratio. Here, calculated reporting-year productions are compared to user-input previous year values to arrive at an overall production ratio. This ratio is reportable in section B40.0 of the NPRI report.

Completion of the NPRI Report

Most of the release values needed for completing the release reporting sections of the NPRI report may be found on the ***Results*** worksheet, as explained earlier. However, the user will need to consult the ***Off_Site*** worksheet (and possibly the ***Storm_Water***, ***Wastewater***, and ***Groundwater*** worksheets if the facility discharges to more than one MSTP) to be able to differentiate transfers to each off-site facility, as required in the applicable section of the NPRI software.

The NPRI reporting software will not accept data entries lower than 0.001 grams. The spreadsheets perform release calculations to a higher precision than 0.001 grams, and this precision is maintained in the printed output files. The results sheet sums all of the releases to each reportable category and then rounds to the nearest 0.001gram. For some plants, the estimated releases in some categories will be reported as zero because the estimated total release was less than 0.0005 grams.

Throughout the NPRI Report, the user will be asked to enter a "Basis of Estimate" code. For the calculations performed by this workbook, PCP wood treaters should only need to enter one of the two codes that are applicable. If the releases calculated by a worksheet are from actual analytical data for dioxins/furans and HCB, the user should choose the code "M", for monitoring or direct measurement. If a code "M" is used, a "Detail Code" of "AL" should also be entered. For estimates not based on actual dioxin/furan and HCB analytical data, the basis of the estimate code should be "O" for engineering estimate. No detail code is applicable in this instance.

Exhibit 1

Data Input Sheets for Pentachlorophenol Wood Preservation Facilities

Facility: ***Reporting Year:***

UNITS OF MEASURE

Please enter the temperature scale which will be used on all worksheets:

Please enter the tank volume unit which will be used on all worksheets:

Please enter the liquid volume unit which will be used on all worksheets:

Please enter the surface area unit which will be used on all worksheets:

METEOROLOGICAL INFORMATION (Contact your local weather office for this information)

Annual Average Ambient Temperature:

Annual Average Wind Speed: mph or kph (circle one)

DRY PENTA SYSTEM DATA (Skip this part if dry penta is not used.)

Amount of dry penta dissolved in the reporting year:

Amount of solvent/P-9 oil used to dissolve the dry penta:

Dry Penta Mix Tanks

Total number of dry penta mix tanks used:

Total Volume of all dry penta mix tanks:

Total liquid surface area of all dry penta mix tanks:

Mix Information

Average mix concentration, %		Are the mix tanks closed during mixing?	
Average mixing temperature:		Are the mix tanks closed after mixing?	
Number of mixes during year:		Average time per mix, hours:	

LIQUID PENTA CONCENTRATE DATA (Skip this part if liquid concentrate is not used)

Amount of liquid PCP concentrate used in the reporting year:

Nominal PCP content in the concentrate: %

Amount of P-9 oil mixed with concentrate to make treating solution:

Liquid Concentrate Mix Tanks

Total number of liquid concentrate mix tanks used:

Total Volume of all liquid concentrate mix tanks:

Total liquid surface area of all liquid concentrate mix tanks:

Mix Information

Average mix concentration, %		Are the mix tanks closed during mixing?	
Average mixing temperature:		Are the mix tanks closed after mixing?	
Number of mixes during year:		Average time per mix, hours:	

Facility: **Reporting Year:**

Concentrate Storage Tank Information

Total number of Concentrate storage tanks at the facility:

Total volume of all Concentrate storage tanks at the facility:

Average concentrate storage tank temperature:

READY-TO-USE PCP SOLUTION DATA (Skip this part if R-T-U is not used.)

Amount of Ready-to-Use PCP solution used during the year:

Average nominal PCP solution strength, % PCP:

P9 OIL STORAGE TANK DATA:

Total number of P9 oil storage tanks at the facility:

Total volume of P9 oil storage tanks at the facility:

Average P9 oil storage tank temperature:

TREATING SOLUTION TANK DATA:

Total number of treating solution storage/work tanks at the facility:

Total volume of treating solution storage/work tanks at the facility:

Average treating solution storage/work tank temperature:

Average treating solution strength, % PCP:

TREATED INVENTORY DATA:

Average amount of treated inventory stored during the year: ft^3 or m^3 (circle one)

PRESSURE TREATING INFORMATION

PCP Treating Cylinders	*#1*	*#2*	*#3*	*#4*	*#5*
Facility Nomenclature or ID number					
Diameter, ft					
Length, ft					
Avg. Wood Content, ft^3/charge					
Number of charges steam conditioned					
Number of charges Boulton dried					
Number of charges kiln dried/air dried					
Vacuum surge tank volume					

Vac surge tank volume units

Average initial air, KD/AD, psig

Avg. length of initial steam cycle, hours

Average initial air, Boulton/steam, psig

Facility: ***Reporting Year:***

Information on Treating Solution Storage Tanks Used for this Process

Total Volume of all treating tanks used for pressure treatment:

Average temperature of all treating tanks used for pressure treatment:

Average treating solution strength used for pressure treatment, % PCP:

Expansion Bath Information

Is an expansion bath used? (YES or NO)

Number of charges given an expansion bath:

Is expansion bath "*BEFORE"* or "*AFTER"* final vacuum?

Average length of expansion bath, hours:

Average expansion bath temperature:

Final Steaming Information

Is final steam used? (YES or NO)

Number of charges final steamed:

Is final steam applied "*BEFORE"* or "*AFTER"* final vacuum?

Average length of final steam, hours:

Final Vacuum Information

Number of final vacuums applied:

Average length of final vacuum, hours:

Previous Reporting Year Production, Pressure Treating Ops ft^3 or m^3 (circle one)

THERMAL TREATING INFORMATION

Thermal Treating Tanks	**#1**	**#2**	**#3**	**#4**	**#5**
Facility Nomenclature or ID number					
Is the tank covered when not in use?					
Round tank diameter, ft:					
Round tank average treating depth, ft :					
Rectangular tank length, ft:					
Rectangular tank width, ft:					
Rectangular tank avg treating depth, ft:					

If the treating tank is not rectangular or round, enter the information below:

Treating tank liquid surface area, sq.ft:					
Average gallons to fill:					

Facility: **Reporting Year:**

Production Data

	#1	#2	#3	#4	#5
Number of Charges/year:					
Volume of wood TREATED per charge, cf					
Number of hot baths/year					
Average hot bath temperature					
Hot bath time, hours					
Number of cold baths/year					
Average cold bath temperature					
Cold bath time, hours					
Number of expansion baths/year					
Average expansion bath temp, (if used)					
Expansion bath time, hours (if used)					

Information on Treating Solution Storage Tanks Used for Thermal Treating Operations

Total Volume of all work tanks used for this process	
Average temperature of all work tanks used for this process	
Average treating solution strength used for thermal or dip treatment, % PCP	

Previous Reporting Year Production, Thermal Treating Ops ☐ ft^3 or m^3 (circle one)

(Total volume of wood ***treated*** *in the previous year)*

STORM WATER INFORMATION

Do you have any storm water monitoring data? ☐ (YES/NO)

Average Analytical Results by Outfall:	1	2	3	4
Pentachlorophenol, ppm				
Oil & Grease, ppm				
Hexachlorobenzene, ppm				
Dioxins/Furans, Combined TEQ, ppm				

Total rainfall received during the reporting year? ☐ inches

Outfall Data and Runoff Coefficients

To determine the amount of runoff which your facility experiences, you must determine the size of the area drained by each of the outfalls, and estimate the percentage of each type of usage listed below for each outfall. Runoff coefficients listed below are the average of the ranges presented in the 1999 SARA Toxic Chemical Release Inventory Instruction Book. The weighted average runoff coefficient is calculated as the sum of the percentage of each area times the runoff coefficient for that area.

Facility: **Reporting Year:**

Outfall Number:	1	2	3	4
Releases to: Surface Water, MSTP, No offsite				
Outfall Drainage Area, acres				
Actual Discharge Volume , Imp gals, if known				
% Heavy Industrial Use (RC=0.75)				
% Light Industrial Use (RC=0.65)				
% Paved and/or Roofed (RC=0.90)				
% Railroad Yard Areas (RC=0.30)				
% Unimproved Areas (RC=0.20)				

Receiving Stream or Water Body Name, if applicable

Outfall 1: Outfall 2:

Outfall 3: Outfall 4:

RELEASES DUE TO ON-SITE WASTE DISPOSAL, LEAKS OR SPILLS
Waste Description and Quantity

Waste Number	Waste Description	Quantity, lbs	TSD Method or Source of Release (Landfill, land treatment, leaks, spills, other)
1			
2			
3			
4			

Contaminant Concentrations in the Wastes

Enter the contaminant concentrations in each waste below. Where data is available, enter the chemical-specific results only. If you have more than one set of data for a chemical, enter the average concentration. If a result is reported as being below the lower detection limit, enter zero (except for Dioxins/Furans). If analytical data is unavailable, estimate only the PCP concentration in the wastes. Please convert all concentrations to parts-per-million (ppm, mg/L or mg/kg). If converting percents, multiply the percent by 10,000. For example, a waste with 6% PCP has a concentration equal to 6*10000, or 60,000 ppm.

Waste Number	PCP Concentration in waste, ppm	Oil & Grease concentration, ppm	Hexachlorobenzene concentration, ppm	Combined D/Fs TEQ concentration, ppm
1				
2				
3				
4				

Facility: ***Reporting Year:***

WASTEWATER INFORMATION

Wastewater Treatment System

Describe your wastewater treatment system by sequentially listing all treatment steps, choosing from the list of choices below.

A. Oil/Water Separation B. Filtration C. Flocculation
D. Biological Treatment E. Activated Carbon

Process Wastewater Generation

Amount of process wastewater generated during the reporting year:	
Amount discharged to stream:	
Amount discharged to MSTP:	
Amount evaporated in thermal tanks:	
Amount sent to Cooling Tower:	
Amount sent to Reuse:	
Amount sent off-site for disposal (not MSTP):	

If discharge is to stream or other water body, enter name here:
If discharge is to MSTP, enter name here:

Contaminant Concentrations in Process Wastewater

Do you have monitoring data on the effluent wastewaters? (YES or NO)

	Concentration, ppm
Pentachlorophenol:	
Oil & Grease:	
Hexachlorobenzene:	
Combined D/F TEQ:	

GROUNDWATER INFORMATION

Groundwater Treatment System

Describe your groundwater treatment system by sequentially listing all treatment steps, choosing from the list of choices below.

A. Oil/Water Separation B. Filtration C. Flocculation
D. Biological Treatment E. Activated Carbon

Facility: ***Reporting Year:***

Amount of Groundwater Recovered

Total amount of groundwater recovered and managed during the reporting year:

Amount discharged to stream:

Amount discharged to MSTP:

Amount sent off-site for disposal (not MSTP):

If discharge is to stream or other water body, enter name here:

If discharge is to MSTP, enter name here:

Contaminant Concentrations in Discharged Groundwater

Do you have monitoring data on the effluent wastewaters? (YES or NO)

	Concentration, ppm
Pentachlorophenol:	
Oil & Grease:	
Hexachlorobenzene:	
Combined D/F TEQ:	

OFF-SITE WASTE DISPOSAL INFORMATION
Waste Description and Quantity

Waste Number	Description	Treatment, Storage or Disposal Method
1		
2		
3		
4		
5		
6		
7		
8		

Facility: ***Reporting Year:***

Off-Site Facility Information

Waste Number	Off-Site Facility Name	Code (if known)	Country	
	Street Address	City	Prov	Postal Code
1				
2				
3				
4				
5				
6				
7				
8				

Contaminant Concentrations in the Wastes

Waste Number	PCP Concentration in waste, ppm	Oil & Grease concentration, ppm	Hexachlorobenzene concentration, ppm	Combined D/F TEQ concentration, ppm
1				
2				
3				
4				
5				
6				
7				
8				

Exhibit 2

Calculation of Dioxin/Furan Combined TEQ Concentrations for Pentachlorophenol Wood Preservation Facilities

- **Using the TEQCONC Workbook:**

The **PCPNPRI** workbook allows the entry of dioxin/furan analytical results as a combined total TEQ concentration only. In order to assist the user with the conversion of reported laboratory results to this total dioxin/furan TEQ concentration, a second workbook, titled **TEQCONC**, may be found on the diskette that accompanies this Guide.

This workbook is composed of five worksheets, named to correspond to the worksheets found in the PCPNPRI workbook. The user should select the tab corresponding to the sheet for which positive data is available (i.e., if positive analytical data is available for D/F concentrations in wastewater, the user should select and complete the sheet found at the Wastewater tab).

The ***Storm_Water***, ***On_Site*** and ***Off_Site*** worksheets of the **PCPNPRI** workbook allow the user to report on more than one waste or discharge, thereby requiring more than one D/F TEQ concentration. The worksheets in this workbook are set up to calculate the TEQ concentration of D/Fs only one waste at a time.

Therefore, you may either enter all of the data required for one waste at a time, printing the worksheet after completion, then deleting that data and entering the data for the next waste, continuing this until you have calculated the TEQ concentrations and printed worksheets for all wastes which need reporting on, or you may choose to make copies of the applicable worksheet for each of the wastes by following these steps:

Step 1: Move your cursor down to the tab for the worksheet being used.

Step 2: Right click on the tab to bring up the tab edit menu.

Step 3: Choose “Move or Copy...”

Step 4: On the Move or Copy screen, from the top: ensure that the workbook TEQCONC is selected; click on the name of the worksheet which follows the worksheet you are copying to insert the copied sheet in front of the next worksheet; and select “Make a Copy”.

Step 5: Click OK.

Following the completion of the steps listed above, you will see a new tab titled with the worksheet's name and a copy number, such as “TEQ_On-Site (2)”. You may use this new sheet to report on a second waste. Repeat this as many times as necessary to make separate sheets in the workbook for each waste that you need to calculate TEQ concentrations for. Note: Each subsequent copy should rename the new tab in increments of 1, i.e., TEQ_On-Site (3), TEQ_On-Site (4), etc.

Upon the completion of each sheet used, the user should print the sheet for the facility’s records.

- **Manual Computation**

If the user chooses not to use the workbook for these calculations, a worksheet for manual computation of TEQ concentrations is included in this exhibit. (It is also found as a worksheet titled “TEQ_Manual_Calculation” in the TEQCONC workbook.) The user should make as many copies of this sheet as necessary to cover all wastes or discharges for which the user has positive dioxin/furan analytical data.

When using the manual computation worksheet, the user should first enter the **PCPNPRI** worksheet name and the waste or discharge number of the waste/discharge for which the TEQ concentration is being calculated. Then, the user should follow the steps outlined in the instructions on the worksheet.

An example of a completed manual computation worksheet may be found at the end of this exhibit.

Dioxin/ Furan TEQ Concentration Calculation Worksheet
National Pollutant Release Inventory Report

This worksheet has been set up to assist you with converting dioxin/furan analytical results to a total combined TEQ concentration for use in the release calculation workbook, PCPNPRI.xls. This worksheet is for manual computation of TEQ concentration, as explained in Appendix 10.

To determine the total TEQ concentration, complete the following steps:

Step 1: Enter the concentration of each congener which has a reported positive concentration (i.e., a concentration greater than the laboratory's lower detection limit (LDL)).

Step 2: Enter the units which are shown on the laboratory analytical report for those congeners which have positive concentrations.

Step 3: Convert the reported concentration to concentration in parts-per-million (ppm).

- If units shown are mg/l, mg/kg, or ppm, enter the reported concentration.
- If units shown are ug/l, ug/kg, or ppb, divide the reported concentration by 1,000.
- If units shown are ng/l, ng/kg, or ppt, divide the reported concentration by 1,000,000.
- If units shown are pg/l or pg/kg, divide the reported concentration by 1,000,000,000.

Step 4: Multiply the ppm concentration by the TEF shown for each congener.

Step 5: Add the calculated congener TEQ concentrations to determine the total TEQ concentration, in ppm, for use in the PCPNPRI calculation workbook.

PCPNPRI worksheet:	Off-Site	Waste/discharge number:	2

Congener	Reported Conc	Units	Conc, mg/l (ppm)	TEF	TEQ Conc, ppm
2,3,7,8-Tetrachlorodibenzo-p-dioxin				1	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin				0.5	
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.001	ug/l	1.00E-06	0.1	1.00E-07
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin				0.1	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	1.25	pg/kg	1.25E-09	0.1	1.25E-10
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin				0.1	
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin	0.0045	mg/l	4.50E-03	0.001	4.50E-06
2,3,7,8-Tetrachlorodibenzofuran				0.1	
1,2,3,7,8-Pentachlorodibenzofuran				0.05	
2,3,4,7,8-Pentachlorodibenzofuran				0.5	
1,2,3,4,7,8-Hexachlorodibenzofuran				0.1	
1,2,3,6,7,8-Hexachlorodibenzofuran				0.1	
1,2,3,7,8,9-Hexachlorodibenzofuran	0.0022	ug/l	2.20E-06	0.1	2.20E-07
2,3,4,6,7,8-Hexachlorodibenzofuran				0.1	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	2.25	ng/l	2.25E-06	0.01	2.25E-08
1,2,3,4,7,8,9-Heptachlorodibenzofuran				0.01	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran	1.45	ug/l	1.45E-03	0.001	1.45E-06

Total Dioxin/Furan TEQ Concentration, ppm: 6.29E-06

This worksheet has been set up to assist you with converting dioxin/furan analytical results to a total combined TEQ concentration for use in the release calculation workbook, PCPNPRI.xls. This worksheet is for manual computation of TEQ concentration, as explained in Appendix 10.

To determine the total TEQ concentration, complete the following steps:

Step 1: Enter the concentration of each congener which has a reported positive concentration (i.e., a concentration greater than the laboratory's lower detection limit (LDL)).

Step 2: Enter the units which are shown on the laboratory analytical report for those congeners which have positive concentrations.

Step 3: Convert the reported concentration to concentration in parts-per-million (ppm).

- If units shown are mg/l, mg/kg, or ppm, enter the reported concentration.
- If units shown are ug/l, ug/kg, or ppb, divide the reported concentration by 1,000.
- If units shown are ng/l, ng/kg, or ppt, divide the reported concentration by 1,000,000.
- If units shown are pg/l or pg/kg, divide the reported concentration by 1,000,000,000.

Step 4: Multiply the ppm concentration by the TEF shown for each congener.

Step 5: Add the calculated congener TEQ concentrations to determine the total TEQ concentration, in ppm, for use in the PCPNPRI calculation workbook.

PCPNPRI worksheet: ______ Waste/discharge number: ______

Congener	Reported Conc	Units	Conc, mg/l (ppm)	TEF	TEQ Conc, ppm
2,3,7,8-Tetrachlorodibenzo-p-dioxin				1	
1,2,3,7,8-Pentachlorodibenzo-p-dioxin				0.5	
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin				0.1	
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin				0.1	
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin				0.1	
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin				0.01	
1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin				0.001	
2,3,7,8-Tetrachlorodibenzofuran				0.1	
1,2,3,7,8-Pentachlorodibenzofuran				0.05	
2,3,4,7,8-Pentachlorodibenzofuran				0.5	
1,2,3,4,7,8-Hexachlorodibenzofuran				0.1	
1,2,3,6,7,8-Hexachlorodibenzofuran				0.1	
1,2,3,7,8,9-Hexachlorodibenzofuran				0.1	
2,3,4,6,7,8-Hexachlorodibenzofuran				0.1	
1,2,3,4,6,7,8-Heptachlorodibenzofuran				0.01	
1,2,3,4,7,8,9-Heptachlorodibenzofuran				0.01	
1,2,3,4,6,7,8,9-Octachlorodibenzofuran				0.001	

Total Dioxin/Furan TEQ Concentration, ppm: ______