ENVIRONMENTAL PROTECTION SERVICE, PACIFIC REGION
ENVIRONMENT CANADA

CHARACTERIZATION AND ASSESSMENT OF WOOD PRESERVATION FACILITIES IN BRITISH COLUMBIA

JANUARY 1984

HENNING ENVIRONMENTAL CONSULTANTS
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K. WILE

Characterization and assessment of wood preservation facilities in British Columbia.

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January 28, 1984

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Dear Mr. Wile:

Attached is our report, "Characterization and Assessment of Wood Preservation Facilities in British Columbia". This final report represents the completion of Phase I of the project administered under D.S.S. Contract 06SB-KE603-2-0375.

Our report recommends that a Code of Good Practice should be prepared for the wood preservation industry (as Phase II of the project described in this report). We are confident that the attached assessment report will serve as a comprehensive resource document for the preparation of a Code of Good Practice.

Yours truly,

HENNING ENVIRONMENTAL CONSULTANTS

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ENVIRONMENT CANADA

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JANUARY 1984

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Problem Assessment Reports are part of the Environmental Protection Service Regulatory Process. These reports document investigations and assessments of a potential environmental quality problem and may or may not lead to the development of regulatory instruments such as a Regulation, Guideline or Code.

This report was completed under a scientific contract funded and directed by the Environmental Protection Service. The views and opinions expressed are those of the authors and do not necessarily reflect the views of the Environmental Protection Service.

Enquiries pertaining to the Pacific and Yukon Region Environmental Protection Service reports should be directed to:

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- The Canadian Institute of Treated Wood
- Koppers-Hickson Canada Ltd.
- Osmose Wood Preserving Corporation of America

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SUMMARY

1.0 SUMMARY ASSESSMENT AND RECOMMENDATIONS

1.1 INTRODUCTION

This report describes and assesses all existing wood preservation facilities in British Columbia and concludes the first phase of a project initiated in 1982 by the Environmental Protection Service, Pacific and Yukon Region. Phase two of the project will commence in January, 1984 and will entail the preparation of a code of good practice for the wood preservation industry.

This project was motivated by circumstances surrounding the 1982 decommissioning of a large wood preservation plant which operated for more than fifty years at a site in the Lower Mainland of British Columbia. The environmental assessment which accompanied closure of the facility showed that substantial amounts of wood preservative chemicals had accumulated at the site over its operating life. After clean-up activities directed by government agencies, many questions about the environmental significance of contamination at the site still remain unanswered, although it is now clear that restoration of the site to its original condition is unrealistic, both economically and physically.

The importance of preventing site contamination from occurring in the first place was clearly indicated by this experience. The realization that little was known about most wood preservation plants in B.C. led to the commissioning of phase one of the project described in this report. The objectives of the project were to gather information about the design and operation of existing wood preservation plants through the Province and to assess the effectiveness of in-house and external agency controls for preventing chemical releases to the workplace and to the environment.

The assessment reported herein is primarily based on observations made by the authors during site visits to each of the fifteen operating wood preservation facilities in British Columbia (as of July, 1983) and on detailed discussions with facility management and operators. Interviews were also conducted with:

- wood preservative chemical suppliers,
- industry associations representing B.C. facilities (the Canadian Institute of Treated Wood and the Canadian Wood Preservation Association),
- personnel from regulatory agencies in B.C. including the Environmental Protection Service, the Waste Management Branch of the B.C. Ministry of the Environment, and the B.C. Workers' Compensation Board, and
- numerous expert individuals from international regulatory agencies and industry associations.

This report presents an overview and assessment of all available existing information about B.C. wood preservation facilities. The description and assessment of site-specific information are not linked with company identities, but sufficient detail is provided to clearly describe the range of features and practices at existing facilities.

This report will serve as a resource document for phase two of the project, the preparation of a code of good practice for the wood preservation industry. During site visits for phase one of the project, management and operators at wood preservation plants in British Columbia indicated clear support for the preparation of a code which would provide consistent standards for the industry. This is indicative of the high priority which industry personnel place on the safety of workers and the environment. It is anticipated that the process of preparing a code of practice for the wood preservation industry will serve as a positive example of how industry and regulatory agencies can work co-operatively to achieve responsible management of toxic chemicals.

1.2 INDUSTRY OVERVIEW

The locations of the fifteen existing wood preservation plants in British Columbia are shown in Figure 1.1. Table 1.1 summarizes the preservative chemical(s), types of treated wood products and characteristics of treatment vessels associated with each of these facilities. The listed facilities treat a wide variety of wood products with one or more preservative chemicals to

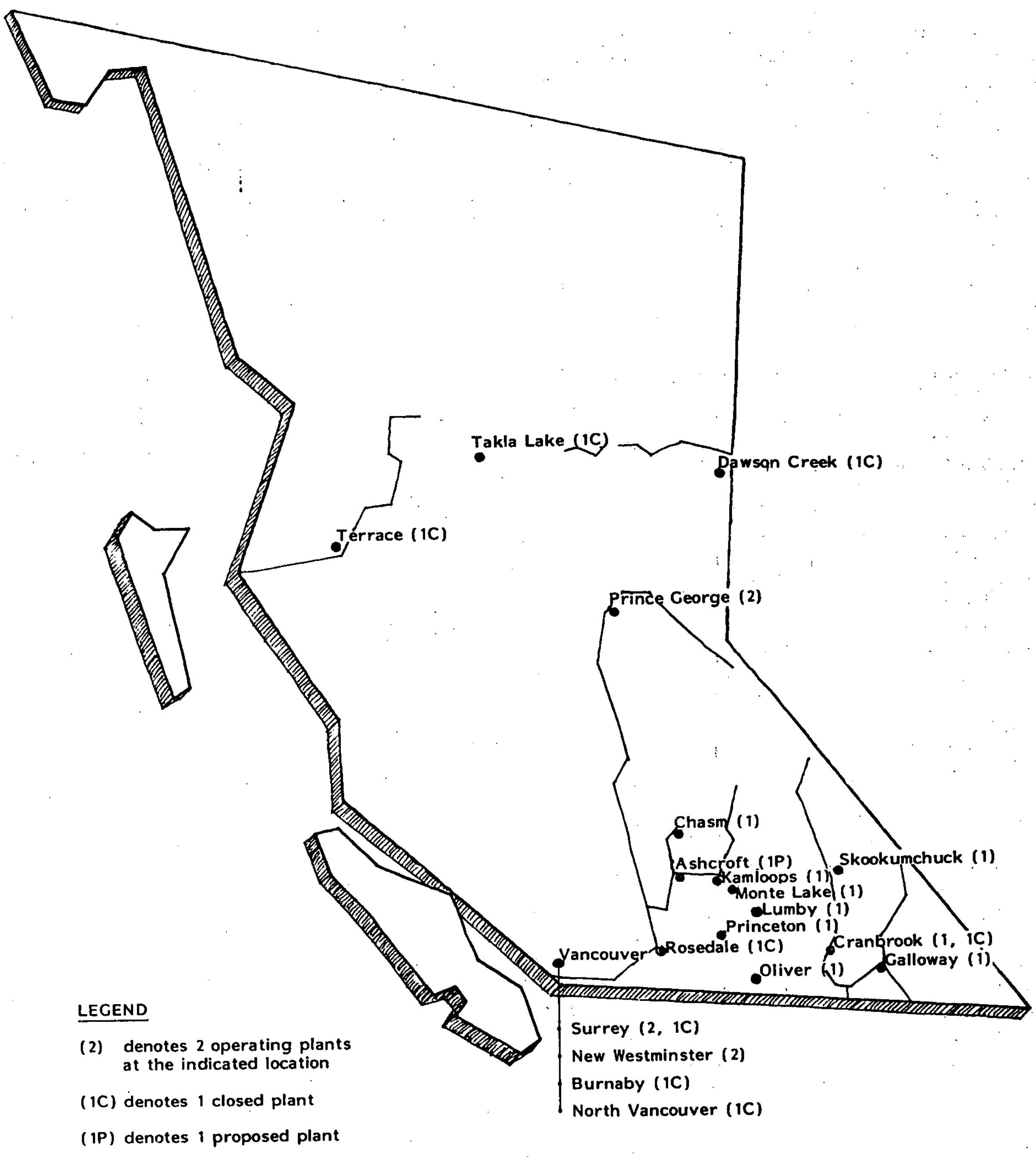


FIGURE 1.1 LOCATION OF WOOD PRESERVATION FACILITIES IN BRITISH COLUMBIA

COMPANY NAME	LOCATION	PRESERVATIVE[1]	TREATMENT VESSELS NO./TYPE	DIMENSIONS[2] (feet) (Dia. x Length)	PRINCIPAL PRODUCTS[3]
ACTIVE PLANTS					
A & A Post and Rail	Kamloops	CCA	1 PRESS. CYL.	4x38	POSTS
Ainsworth Lumber Co. Ltd.	Chasm	CCA	1 PRESS. CYL.	6x51	POSTS
B.C. Clean Wood Preservers Ltd.	Surrey	CCA[4]	2 PRESS. CYL.	6x34 6x106	MIXED
Bell Pole Co. Ltd.	Lumby	PCP (thermal)	1 FULL-LENGTH TANK	8x11x113	POLES
			1 BUTT TANK	14x14x16	
Canada Cedar Pole Preservers	Galloway	PCP (thermal)	3 FULL-LENGTH TANKS	11x10x81 10x11x46 13x10x20	POLES
			2 BUTT TANKS	11x11 EA.	
Domtar Chemicals Ltd.	New Westminster	PCP, Creosote	3 PRESS. CYL.	7x135 7x166 7x166	POLES, TIES
		ACA	1 PRESS. CYL.	6x126	POLES
Domtar Chemicals Ltd.	Prince George	PCP	2 PRESS. CYL.	7x98 7x100	TIES, POLES
Kootenay Wood Preservers Ltd.	Cranbrook	CCA	2 PRESS. CYL.	6x80 EA.	MIXED
MacMillan Bloedel Pole and Piling	New Westminster	ACA	1 PRESS. CYL.		POLES, PILING
Mardis Logging	Skookumchuk	CCA	1 PRESS. CYL.	5x54	POSTS
Pacific Wood Preservation Services Ltd.	Surrey	CCA	1 PRESS. CYL.	6x86	MIXED
Prince George Wood Preserving Ltd.	Prince George	CCA	1 PRESS. CYL.	6x50	MIXED
Princeton Wood Preservers	Princeton	CCA	1 PRESS. CYL.	5x100	POSTS
Summit Wood Preservers	Monte Lake	CCA	1 PRESS. CYL.	5x43	POSTS, MIXED
The Wildflower Place	Oliver	CCA	1 PRESS. CYL.	4x8	POSTS
PROPOSED PLANTS					
Pinette and Therrien Mills Ltd.	Ashcroft	Creosote, PCP	2 PRESS. CYL.	-	TIES
CLOSED PLANTS					
Cranbrook Wood Preservers	Cranbrook	PCP			
Domtar Chemicals Ltd.	Dawson Creek	PCP			
Canadian Creosote Ltd.	North Vancouver	Creosote			
Koppers International Canada Ltd.	Burnaby	PCP, Creosote, CCA			
MacGillis and Gibbs	Terrace	PCP			
Princeton Wood Preservers	Princeton	PCP (see "Active plants")			
Silvacan Resources Ltd.	Takla Lake	PCP, Creosote			
Westcan Wood Preservers	Rosedale	PCP			
Name unknown	Port Kells (Surrey)	?			

[1]Pressure impregnation unless otherwise noted.

[2]Diameter x Length for pressure cylinders; Depth x Width x Length for rectangular thermal tanks; Depth x Diameter for vertical cylindrical thermal tanks.

[3]Major product type only; posts denotes small dimension items such as fence posts and/or rails; poles denotes large dimension items such as utility poles; mixed includes plywood and lumber (for pressure wood foundations, decks), shingles, shakes, fence materials and other lumber products.

[4]Also pressure-impregnation with inorganic and resin-based fire retardants.

TABLE 1.1 KNOWN WOOD PRESERVATION PLANTS IN BRITISH COLUMBIA provide long-term protection of wood against decay or insect damage. Only one facility currently treats wood with fire-retardant chemicals.

The four treatment chemicals in current use in British Columbia are:

- CCA (chromated copper arsenate),
- ACA (ammoniacal copper arsenate),
- Creosote, and
- PCP (pentachlorophenol).

The quantities of active ingredients in these chemicals used annually in B.C. wood preservation plants is of the order of millions of kilograms. The annual quantity of treated wood produced by the industry is of the order of one quarter of a million cubic meters. Much of this production is sold locally, with the balance serving markets primarily in Western Canada and the Western United States. Products range from railway ties to wood intended for residential uses such as preserved wood foundations, decks or playground equipment.

The B.C. industry can be conveniently divided into four segments according to the type of preservative applied (water-borne or oil-borne) and the nature of the treatment process (pressure or thermal). The detailed description of these processes and the physical features of facilities (Section 2.0) is subdivided according to these four major industry segments which are:

- CCA (water-borne) pressure treaters,
- ACA (water-borne) pressure treaters,
- PCP or creosote (oil-borne) pressure treaters, and
- PCP (oil-borne) thermal treaters.

A brief overview of each of these industry segments is presented in the following sections.

1.2.1 CCA PRESSURE TREATERS

The largest industry segment in terms of numbers of facilities is the water-borne CCA pressure treaters, currently comprising ten operations located through British Columbia. Facilities vary considerably with respect to treated products. Some plants produce a single product such as fence posts;

others produce a range of products including posts, poles, lumber, plywood and other building materials for outdoor use.

CCA treatment plants are typically owned by local businessmen, although the chemical suppliers provide a strong unifying influence for this industry segment. All facilities purchase CCA from one of two U.S.-based manufacturers, and both suppliers provide a high level of support services including facility design, routine safety and quality control inspections, analytical services and consulting expertise on operations, maintenance and emergency response procedures. The approach has provided a generally high level of control over preservative use at most B.C. facilities which use CCA. The industry segment can be generally characterized as responsibly and effectively self-regulated with respect to releases of chemical to the workplace and to the environment. Government agencies have played a minor role in regulating CCA releases.

Section 2.1 describes the CCA pressure treating process and assesses the features of B.C. treatment facilities. The treatment chemical is supplied as a pre-mixed concentrate and the handling and application of the chemical generally occurs in closed systems with minimal direct exposure to workers or to the environment. Most facilities provide paved storage pads (roofed at two facilities) to isolate and collect drips from freshly-treated wood. Dry treated wood is generally stored on dirt surfaces pending shipment. CCA plants are designed and operated to recycle all contaminated liquid streams (including contaminated runoff from storage pads) and liquid wastes are not produced. Small quantities of CCA-contaminated debris are generated and the perceived requirements and actual practices for disposal are varied.

Figure 1.2 shows the general movement of CCA through the treatment process and indicates the principal points of worker exposure and environmental release. Table 1.2 presents an overview of the industry segment in terms of worker and environmental exposure.[1]

[1]*Figures 1.2-1.5 and Tables 1.2-1.5 follow Section 1.2.4.*

1.2.2 ACA PRESSURE TREATERS

Two British Columbia facilities pressure-impregnate wood (principally poles) with water-borne ACA preservative. Both facilities are owned by large corporations and facility design and operating practices are individualized. A reasonable level of overall control of preservative chemical is provided at ACA plants. Government agencies have played a significant role in the regulation of treatment chemicals at one of the sites.

Section 2.2 describes the ACA pressure treating process and assesses B.C. facilities. ACA is manually mixed on-site from ingredient chemicals (aqueous ammonia, arsenic acid and copper oxide). Subsequent handling and application of the chemical generally occur in closed systems which are similar in concept to systems employed at CCA facilities. Both ACA plants in B.C. have installed containment systems to collect and recycle chemical drips, although the plants represent different levels of sophistication in terms of the implementation and effectiveness of these features. Neither facility provides drip containment areas for storing freshly-treated wood and treated wood is transferred directly to unsurfaced yards for storage. As with CCA plants, no liquid wastes are generated and disposal requirements are not well-defined for the small quantities of solid debris which are produced.

Figure 1.3 tracks ACA through the treatment process and indicates the principal points of worker exposure and environmental release. Table 1.3 presents an overview of worker and environmental exposure to ACA.

1.2.3 PCP AND CREOSOTE PRESSURE TREATERS

Two B.C. facilities provide oil-borne PCP pressure treatment for poles or railway ties. One of these facilities also provides creosote or oil-borne creosote treatment of poles and ties. Both facilities are owned by the same large corporation and the facility designs are similar. The current level of overall control of treatment chemicals can be characterized as generally acceptable but some improvements in physical facilities and/or operational procedures would be desirable. Containment and process features are generally based on older design concepts at both plants, although there has been a reasonable attempt to compensate for design limitations through stringent operational controls. Government agencies have played a significant role in regulating chemical releases at one of the sites.

Section 2.3 describes the oil-borne pressure treatment process and assesses B.C. facilities. Creosote is delivered in bulk to the single user site and is applied to wood directly or as a fifty percent solution in carrier oil. Mixing is carried out in closed systems and does not require direct contact with workers. PCP is supplied as bagged solid granules which are manually emptied into a carrier oil mixing tank. All subsequent phases of the pressure treating operations with both chemicals are carried out in closed systems.

The chemical tank farms and exterior process areas at both facilities were originally unpaved and process areas have been retrofitted with sand-filled dykes. A staged program of containment improvements is in progress at the older of the two plants and the tank farm is now paved and contained with concrete dykes. These improvements have been initiated at the older site as a result of intensive regulatory agency involvement in response to treatment chemical spills and releases.

Oil-borne plants produce relatively large volumes of contaminated liquid waste (of the order of hundreds of thousands of Igallons annually). One facility currently provides flocculation/activated carbon treatment followed by discharge to a municipal sewer system. "Clean" cooling waters and site runoff are discharged directly to an adjacent river. Both discharges are controlled by regulatory permits. The second facility uses evaporation to reduce the volume of liquid wastes and discharges excess wastes and site runoff to an on-site exfiltration lagoon. Small quantities of solid debris and cleanout sludges are produced and stored at both sites pending the identification of suitable disposal for these wastes.

Figure 1.4 and Table 1.4 track creosote and PCP through the treatment process and provide an overview of worker and environmental exposure to these treatment chemicals.

1.2.4 PCP THERMAL TREATERS

Two British Columbia facilities thermally impregnate wood (principally poles) with oil-borne PCP preservative. Both plants are located in unpopulated areas. One facility is locally owned and has operated at the current site for more than fifty years. The second facility is more modern in design and replaced an older plant which was previously operated at the site by the same company. The plant is owned by a moderately large company which owns and operates other thermal facilities in the United States. Although both facilities use the thermal treatment process, the design and operational practices employed at the two plants are highly individualized.

The overall control of actual environmental releases of PCP is acceptable at both facilities although there is potential for serious environmental contamination at both plants. Government agencies have played a relatively minor role in regulating release of treatment chemicals at the sites.

Section 2.4 describes the thermal treatment process and assesses B.C. facilities. Spill containment is entirely absent at the older plant, although there has been an effective attempt to compensate for this deficiency through careful operation. Good containment is provided for preservative at the second facility although the high water table and adjacent stream constitute a site environment which is more sensitive to PCP releases. Treated wood is stored on unprotected ground at both sites, but the treated product from the thermal process is essentially drip-free and there is no visible ground contamination in treated wood storage areas at either site.

Worker exposure to PCP vapors is a serious potential concern at both sites since the hot oil treatment process is carried out in open tanks. Short-term exposure of treatment operators is carefully controlled at both sites by employing breathing protection and careful operating practices. The long-term exposure of workers to ambient levels of PCP throughout the plant site has not been investigated and the implications of such exposure are currently unknown but are of concern to the authors.

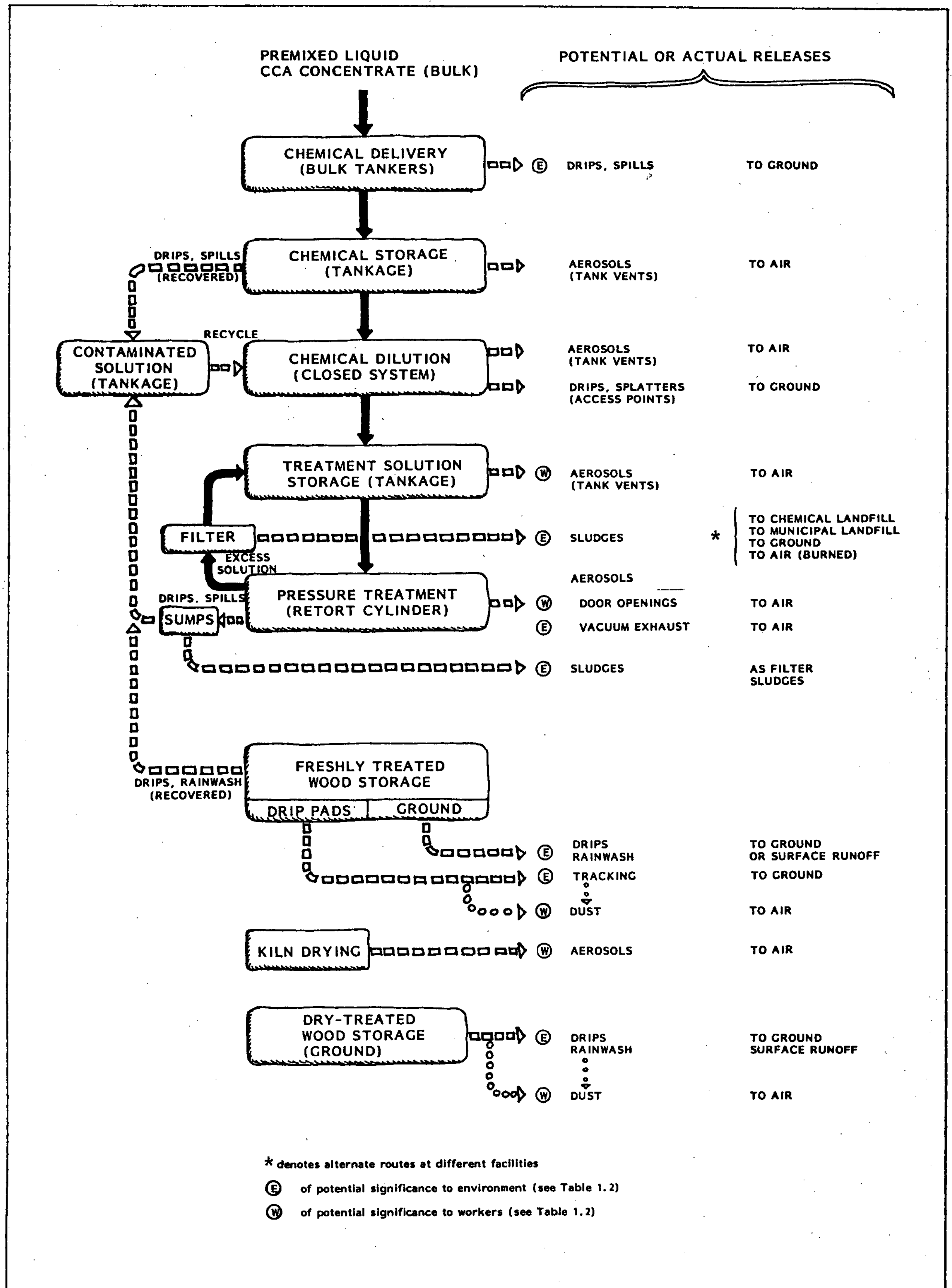


FIGURE 1.2 CHEMICAL RELEASES FROM CCA PRESSURE TREATING PLANTS

EXISTING PLANTS 10	ANNUAL CHEMICAL USE 1,700,000 KILOGRAMS/YEAR (50% liquid concentrate as delivered to site)	
OVERALL CHEMICAL MANAGEMENT[1]	WORKPLACE	EXCELLENT (5), ACCEPTABLE (3), POOR (2)[2]
	SITE ENVIRONMENT	EXCELLENT (6), ACCEPTABLE (3), POOR (1)[2]
OVERALL SPILL CONTAINMENT FEATURES[1]		EXCELLENT (4), ACCEPTABLE (4), POOR (2)[2]
OVERALL SURFACE PROTECTION[1]		EXCELLENT (7), ACCEPTABLE (2), POOR (1)[2]

RELEASES TO THE ENVIRONMENT[3] (FROM ROUTINE OPERATIONS)	SOURCES	ENVIRONMENTAL SIGNIFICANCE[4]
TO LAND	• DRIPS FROM FRESHLY TREATED WOOD	• LOW OF CONCERN (L)
	• TRACKING FROM DRIP PADS FOR FRESHLY TREATED WOOD	• OF CONCERN (L)
	• WASHOFF FROM DRY TREATED WOOD	• OF CONCERN (L)
	• DUMPING OF SOLID WASTES	• UNKNOWN
TO WATER	• EXCESS RUNOFF FROM DRIP PADS	• LOW, LESS THAN DRINKING WATER STANDARDS PRIOR TO POINT OF DISCHARGE
	• RUNOFF FROM TREATED WOOD STORAGE AREAS	• UNKNOWN
TO AIR	• RETORT DOOR OPENINGS	• LOW (SEE WORKER EXPOSURE)
	• TANK VENTS (ROUTINE TRANSFERS)	• LOW (SEE WORKER EXPOSURE)
	• TANK VENTS (RETURN OF RETORT CONTENTS)	• LOW (SEE WORKER EXPOSURE)
	• VACUUM EXHAUST	• OF CONCERN (L)
	• KILN EXHAUST	• OF CONCERN (L)

PROCESS WASTES	SOURCES	DISPOSAL	ENVIRONMENTAL SIGNIFICANCE[4]
LIQUID	• NONE	N/A	NONE
SOLID	• DEBRIS FROM RECYCLE FILTERS AND SUMP CLEAN-OUT SLUDGES	• STORED	• NONE
		• CHEMICAL LANDFILL	• NONE
		• MUNICIPAL LANDFILL	• UNKNOWN
		• DUMPED ON-SITE	• UNKNOWN

WORKER EXPOSURE[3]	SOURCES	SIGNIFICANCE TO WORKERS[4]
TO LIQUID	DRIPS, LEAKS IN PROCESS AREA	• OF CONCERN (S) TO LOW
	SURFACE RESIDUAL IN CONTAINMENT AREAS	• OF CONCERN (L)
	RESIDUAL ON TREATED WOOD	• LOW
TO AEROSOLS OR VAPORS	RETORT DOOR OPENING	• OF CONCERN (L)
	TANK VENTS TO WORKPLACE	• OF CONCERN (L)
	VACUUM EXHAUSTS	• OF CONCERN (L)
	KILN EXHAUST	• OF CONCERN (L)
	PARTICULATES IN YARD DUST	• OF CONCERN (L)

*[1](n) denotes n facilities in the indicated category.
Ratings are subjective judgments of the authors:
Excellent = few or no potential concerns identified;
Acceptable = minor to moderate potential concerns;
Poor = serious potential concerns.*

[2]"Poor" ratings are based on deficient current practices which pose immediate and serious potential hazards.

[3]Lists only releases (as identified in Figure 1.2) of potential significance to workers or the environment at one or more existing facilities.

*[4]Subjective judgments of the authors:
Low = no observed or inferred effects;
Of Concern = short-term (S) or long-term (L) effects may occur or seem likely;
Unknown = insufficient information to judge significance of releases.*

TABLE 1.2 SUMMARY ASSESSMENT OF CCA MANAGEMENT AT EXISTING PRESSURE TREATING PLANTS IN B.C.

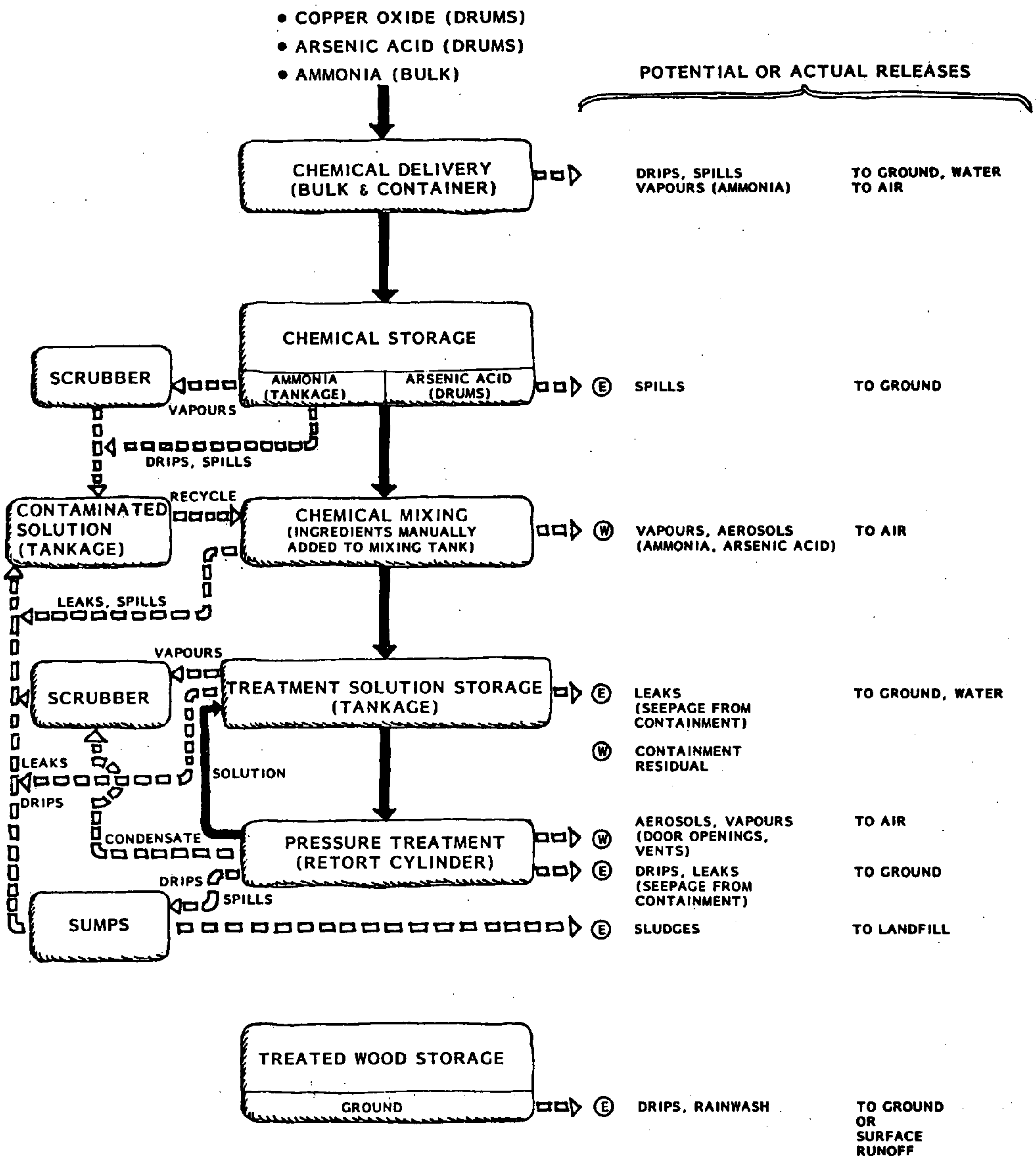


FIGURE 1.3 CHEMICAL RELEASES FROM ACA PRESSURE TREATING PLANTS

EXISTING PLANTS 2	ANNUAL CHEMICAL USE 400,000 IMPERIAL GALLONS (as 3% solution)		
OVERALL CHEMICAL MANAGEMENT	WORKPLACE EXCELLENT (1), ACCEPTABLE (1), POOR ( ) SITE ENVIRONMENT EXCELLENT (1), ACCEPTABLE ( ), POOR (1)[2]		
OVERALL SPILL CONTAINMENT FEATURES	EXCELLENT (1), ACCEPTABLE (1), POOR ( )		
OVERALL SURFACE PROTECTION	EXCELLENT (1), ACCEPTABLE ( ), POOR (1)[2]		
RELEASES TO THE ENVIRONMENT (FROM ROUTINE OPERATIONS)	SOURCES		ENVIRONMENTAL SIGNIFICANCE
TO LAND	• DRIPS FROM FRESHLY TREATED WOOD • WASHOFF FROM TREATED WOOD • DUMPING OF SOLID WASTES		• OF CONCERN (L) • LOW • UNKNOWN
TO WATER	• LEAKAGE FROM CONTAINMENT AREAS • GENERAL SITE RUNOFF		• OF CONCERN (S,L) • UNKNOWN
TO AIR	• RETORT DOOR OPENING • TANK VENTS • VACUUM EXHAUSTS		• LOW • LOW (GENERALLY CONTROLLED WITH SCRUBBERS) — SEE WORKER EXPOSURE
PROCESS WASTES	SOURCES	DISPOSAL	ENVIRONMENTAL SIGNIFICANCE
LIQUID	• NONE	• N/A	• NONE
SOLID	• SLUDGE, DEBRIS FROM CLEANOUT OF DRUMS, RETORTS	• CHEMICAL LANDFILLS OR STORAGE	• UNKNOWN
WORKER EXPOSURE	SOURCES		SIGNIFICANCE TO WORKERS
TO LIQUID	• DRIPS, LEAKS IN PROCESS AREA • SURFACE RESIDUAL, CONTAINMENT AREAS • CHEMICAL MIXING		• OF CONCERN (L) • PROBABLY LOW, OF CONCERN (L) • OF CONCERN (S,L)
TO AEROSOLS OR VAPORS	• RESIDUAL ON TREATED WOOD • RETORT DOOR OPENING • TANK VENTS, VACUUM EXHAUSTS • CHEMICAL MIXING		• LOW • OF CONCERN (S,L) • LOW • OF CONCERN (S,L)

[1]*See explanatory footnotes 1, 3, and 4 on Table 1.2.*

[2]*Poor rating results from past practices and design features which have contributed to extensive site contamination. Current practices and remedial measures are rated as acceptable.*

TABLE 1.3 SUMMARY ASSESSMENT OF ACA MANAGEMENT AT EXISTING PRESSURE TREATING PLANTS IN B.C.

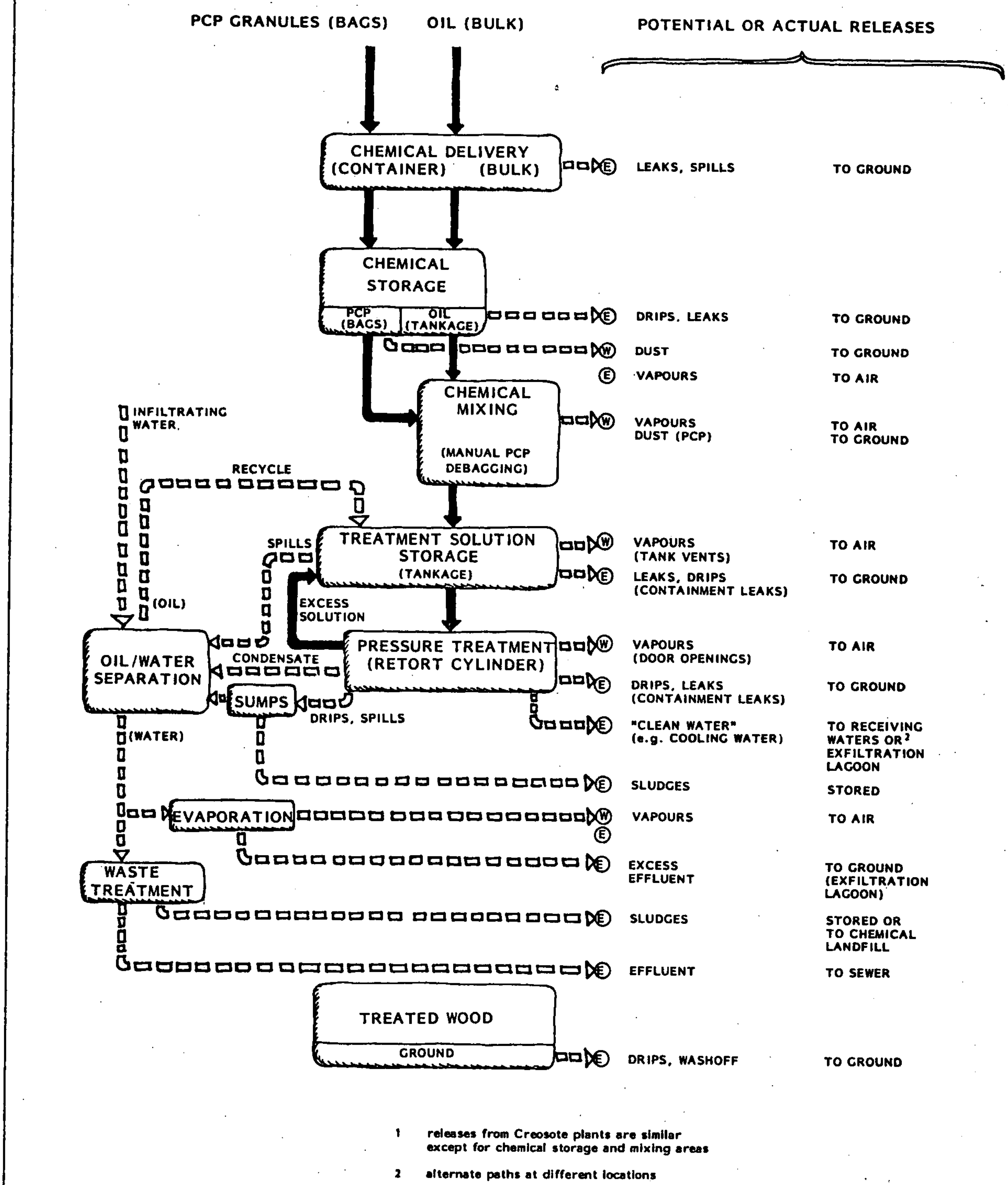


FIGURE 1.4 CHEMICAL RELEASES FROM PCP PRESSURE TREATING PLANTS[1]

EXISTING PLANTS	2		
ANNUAL CHEMICAL USE	PCP 320,000 KILOGRAMS/YEAR (solid granules, as supplied in bags) — Reichhold. CREOSOTE 930,000 IMPERIAL GALLONS/YEAR (bulk liquid, as supplied)		
OVERALL CHEMICAL MANAGEMENT	WORKPLACE EXCELLENT ( ), ACCEPTABLE (2), POOR ( ) SITE ENVIRONMENT EXCELLENT ( ), ACCEPTABLE (1), POOR (1)[2]		
OVERALL SPILL CONTAINMENT FEATURES	EXCELLENT ( ), ACCEPTABLE (2), POOR ( )		
OVERALL SURFACE PROTECTION	EXCELLENT ( ), ACCEPTABLE (1), POOR (1)[2]		
RELEASES TO THE ENVIRONMENT (FROM ROUTINE OPERATIONS)	**SOURCES**		**ENVIRONMENTAL SIGNIFICANCE**
TO LAND	• DRIPS OR SPILLS IN TANK FARMS		• OF CONCERN (L)
	• DRIPS FROM FRESHLY TREATED WOOD		• UNKNOWN, OF POTENTIAL CONCERN (L)
	• WASHOFF FROM DRY TREATED WOOD		• UNKNOWN, OF POTENTIAL CONCERN (L)
	• OIL LOSSES DURING DELIVERY (I)		• OF CONCERN (L) (CONTAINS NO PRESERVATIVE)
	• DUMPING OR BURIAL OF WASTES (I)		• UNKNOWN
TO WATER	• RUNOFF FROM TREATED WOOD STORAGE AREAS		• OF CONCERN (S,L)
	• "CLEAN" COOLING WATERS, STEAM CONDENSATE		• OF CONCERN WHEN CONTAMINATION OCCURS
	• TREATED LIQUID PROCESS WASTES		• LOW WHEN TREATMENT SYSTEM FUNCTIONS PROPERLY
TO AIR	• RETORT DOOR OPENING		• LOW (SEE WORKER EXPOSURE)
	• TANK VENTS		• LOW (SEE WORKER EXPOSURE)
	• VACUUM EXHAUSTS		• LOW (SEE WORKER EXPOSURE)
	• FORCED EVAPORATION OF LIQUID WASTES		• OF CONCERN (L) (SEE WORKER EXPOSURE)
PROCESS WASTES	**SOURCES**	**DISPOSAL**	**ENVIRONMENTAL SIGNIFICANCE**
LIQUID	• TREATED PROCESS EFFLUENT	• TO MUNICIPAL SEWER	• LOW
	• EVAPORATED PROCESS EFFLUENT	• TO EXFILTRATION LAGOON WHEN EVAPORATION CAPACITY IS EXCEEDED	• UNKNOWN
	• "CLEAN" COOLING WATERS AND CONDENSATES	• TO EXFILTRATION LAGOON	• LOW
		• TO ADJACENT RIVER	• OF CONCERN (S,L) (WHEN CONTAMINATION OCCURS)
	• BOILER BLOWDOWN	• TO EXFILTRATION LAGOON	• LOW
SOLID	• DEBRIS FROM SUMPS, RETORTS		• PROBABLY LOW
	• TANK SLUDGES	• RESUSPENDED IN TREATMENT FLUID	• OF POTENTIAL CONCERN (WASHOFF FROM TREATED WOOD IS UNKNOWN)
	• SPENT ACTIVATED CARBON	• REGENERATED FOR RE-USE	• NONE (SIGNIFICANCE AT POINT OF REGENERATION IS UNKNOWN)
WORKER EXPOSURE	**SOURCES**		**SIGNIFICANCE TO WORKERS**
TO LIQUID	• SURFACE RESIDUAL IN CONTAINMENT AREAS		• OF CONCERN (S,L)
	• CREOSOTE MIXING		• LOW
	• PCP MIXING		• OF CONCERN (S,L)
	• ENTERING RETORT (CLEANING, JAMS)		• OF CONCERN (S,L)
TO AEROSOLS OR VAPORS	• TANK VENTS, VACUUM EXHAUSTS		• OF CONCERN (L)
	• PCP MIXING		• OF CONCERN (S,L)
	• ENTERING RETORTS (CLEANING, JAMS)		• OF CONCERN (S,L)
	• RETORT DOOR OPENINGS		• OF CONCERN (L)
TO SOLID	• PCP MIXING (GRANULES)		• OF CONCERN (S,L)

[1]*See explanatory footnotes 1, 3, and 4 on Table 1.2.*

[2]*Poor rating results from past practices and design features which have contributed to extensive site contamination. Current practices and remedial measures are rated as acceptable.*

TABLE 1.4 SUMMARY ASSESSMENT OF PCP AND CREOSOTE MANAGEMENT AT EXISTING PRESSURE TREATING PLANTS IN B.C.

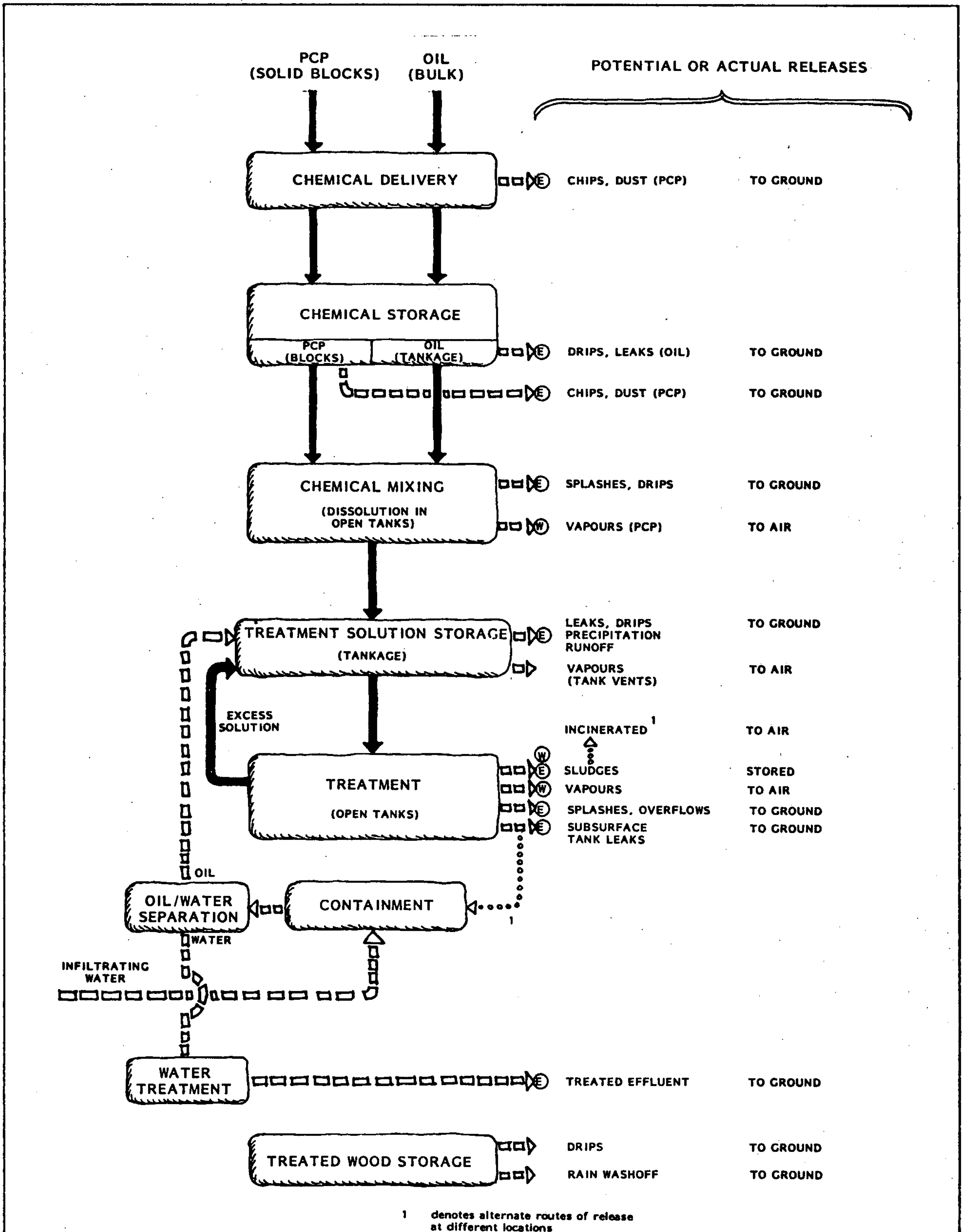


FIGURE 1.5 CHEMICAL RELEASES FROM PCP THERMAL TREATING PLANTS

EXISTING PLANTS 2 ANNUAL CHEMICAL USE 125,000 KILOGRAMS AS SOLID			
OVERALL CHEMICAL MANAGEMENT	WORKPLACE EXCELLENT (1), ACCEPTABLE (1), POOR ( ) SITE ENVIRONMENT EXCELLENT (1), ACCEPTABLE (1), POOR ( )		
OVERALL SPILL CONTAINMENT FEATURES	EXCELLENT (1), ACCEPTABLE ( ), POOR (1)		
OVERALL SURFACE PROTECTION	EXCELLENT (1), ACCEPTABLE ( ), POOR (1)[2]		
RELEASES TO THE ENVIRONMENT (FROM ROUTINE OPERATIONS)	SOURCES		ENVIRONMENTAL SIGNIFICANCE
TO LAND	• DRIPS FROM FRESHLY TREATED WOOD • WASHOFF FROM DRY TREATED WOOD • LEAKAGE/SPILLAGE OF SLUDGE • CHIPPING FROM PCP BLOCKS		• LOW • LOW • OF CONCERN (L) • OF CONCERN (L)
TO WATER	• WASHOFF FROM TREATED WOOD • DISCHARGE OF TREATED INFILTRATING GROUNDWATER		• OF CONCERN (L) • OF CONCERN (L)
TO AIR	• VAPORS FROM TREATING TANKS • VAPORS FROM STORAGE TANK VENTS • EMISSIONS FROM SLUDGE (INCINERATION)		• OF CONCERN (L) • LOW • OF CONCERN (L)
PROCESS WASTES	SOURCES	DISPOSAL	ENVIRONMENTAL SIGNIFICANCE
LIQUID	• GROUNDWATER INFILTRATING TO TANK SHELL	• ON-SITE TREATMENT	• OF CONCERN (L)
SOLID	• TANK SLUDGES	• ON-SITE STORAGE	• OF CONCERN (L)
WORKER EXPOSURE	SOURCES		SIGNIFICANCE TO WORKER
TO SOLID	• STORAGE, TRANSPORT OF PCP BLOCKS		• LOW
TO LIQUID	• TREATMENT TANKS		• OF CONCERN (S)
TO AEROSOLS OR VAPORS	• RESIDUAL ON TREATED WOOD • TREATMENT TANKS • SLUDGE INCINERATION		• LOW • OF CONCERN (L) • OF CONCERN (L)

[1]*See explanatory notes 1, 3, and 4 on Table 1.2.*

[2]*Poor ratings based on high potential risk from unsurfaced ground beneath all workings and chemical storage areas. Careful practices have prevented obvious ground contamination from actually occurring.*

TABLE 1.5 SUMMARY ASSESSMENT OF PCP MANAGEMENT AT EXISTING THERMAL TREATING PLANTS IN B.C.

The principal waste stream produced at thermal facilities is a PCP tank sludge which is generated in moderate quantities (of the order of one thousand Igallons per year). The requirements for safe disposal of PCP sludges are not clearly established. One facility currently has a regulatory permit to incinerate the sludge in a wood waste burner, although the oil content in the sludge has caused the burner to overheat and the practice has been discontinued. Both facilities currently store the sludge on-site and the conditions of storage are inadequate at one of the facilities.

Figure 1.5 and Table 1.5 track PCP through the thermal treating process and provide an overview of worker and environmental exposure to the treatment chemical. Detailed discussion of design and practices at thermal facilities is presented in Section 2.

1.3 A CODE OF GOOD PRACTICE FOR THE INDUSTRY

The authors of this report recommend that a code of good practice be established for the wood preservation industry in British Columbia. This recommendation is motivated by the potential gravity and permanency of environmental and/or human health impacts which can result from major releases of wood preservative chemicals. This has been demonstrated by instances of site contamination which have occurred at facilities no longer in operation. Although the current level of overall control of wood preservative chemicals at existing facilities is generally acceptable (in some cases commendable), the adoption of uniform, industry-wide minimum requirements is needed to ensure that these controls are consistently and effectively applied in the long term.

The general objective of a code of good practice would be to facilitate an appropriate level of environmental and worker protection through the establishment of consistent, industry-wide guidelines for the design and operation of wood preservation facilities. The principal benefits which are anticipated from an effective code of good practices include:

- Improved overall control of wood preservative chemicals,

- Fewer instances of companies gaining unfair competitive advantage by neglecting expenditures for measures to properly control chemical releases,
- The elimination of "moving targets" for control measures required of industry by regulatory agencies, and
- Enhanced communication and liaison between industry and government agencies.

The principal topics which should be addressed in preparing a code of good practice are highlighted in Table 1.6. Detailed discussion of these topics is presented in Sections 2 through 5 of this report. The suggested role of a code of practice in addressing each of these areas of concern is presented in Table 1.6 and briefly discussed below.

■ FACILITY DESIGN

An ideal facility design should provide effective and economical preservative treatment while minimizing chemical releases from spills, drips or washoff from treated wood and while minimizing worker exposure to the chemical. Designs which provide good surface protection, spill containment and worker protection are readily available, although these designs have not been utilized by all existing facilities in B.C.

A code of practice should strive to achieve a reasonable and consistent level of environmental and worker protection by stipulating general conceptual design objectives for key facility elements such as ground protection and spill containment. The code would specify broad objectives, not specific detailed designs for meeting these objectives. New facilities would be expected to provide features which meet the minimum requirements of the design objectives. Existing facilities would be expected to upgrade to these objectives where practicable or to provide an equivalent level of protection through alternative design or operational safeguards.

	SUBJECT AREA	ROLE & SCOPE OF THE CODE
FACILITY DESIGN	•SPILL PREVENTION AND DETECTION •SPILL CONTAINMENT AND RECOVERY •LEAK PREVENTION, DETECTION AND CONTAINMENT •DRIP ISOLATION AND CONTAINMENT •WORKER PROTECTION •CHEMICAL RECYCLE •WASTE TREATMENT •AIR EMISSION CONTROL (ENVIRONMENTAL AND WORKPLACE) •SHELTER •GROUND PROTECTION •SITE RUNOFF CONTROL	•STIPULATE UNIFORM REQUIREMENTS FOR CONCEPTUAL DESIGN OBJECTIVES
IN-HOUSE PROCEDURES	•ROUTINE OPERATIONS AND MAINTENANCE •HOUSEKEEPING •EMERGENCY RESPONSE	•STIPULATE CONSISTENT MINIMUM REQUIREMENTS FOR CONCEPTUAL PROCEDURAL OBJECTIVES
SITE MONITORING PROCEDURES	•PRE-CONSTRUCTION SITE ASSESSMENT •ROUTINE WORKPLACE AND SITE MONITORING •SPILL AND CONTAMINATED SITE ASSESSMENT	•DEFINE UNIFORM MONITORING AND SAMPLING PROTOCOLS AND ESTABLISH CONSISTENT ASSESSMENT CRITERIA AND PROCEDURES
	•DATA PRESERVATION	•ESTABLISH A MECHANISM FOR A PERMANENT DATA ARCHIVE

REGULATORY AGENCY REQUIREMENTS	•SITE SELECTION
	•SITE CLOSURE
	•SOLID WASTE DISPOSAL
	•PERMISSIBLE CONTAMINANT LEVELS
	  •LIQUID EFFLUENT
	  •AIR EMISSIONS TO THE ENVIRONMENT AND WORKPLACE
		•SUMMARIZE ALL RELEVANT POLICIES, GUIDELINES, REGULATIONS
		•ESTABLISH A MECHANISM FOR CLARIFYING AGENCY POLICIES OR PRACTICES
		•IDENTIFY CHANNELS OF INDUSTRY-AGENCY COMMUNICATION

	•WORKPLACE AND ENVIRONMENTAL HAZARD DEFINITION	•ESTABLISH UNIFORM DEFINITION OF CHEMICAL HAZARDS
	•KNOWLEDGE GAPS AND RESEARCH PROGRAMS	•ESTABLISH A MECHANISM FOR FILLING KNOWLEDGE GAPS

TABLE 1.6 OVERVIEW OF A PROPOSED CODE OF GOOD PRACTICE FOR THE B.C. WOOD PRESERVATION INDUSTRY

■ IN-HOUSE PROCEDURES

ROUTINE OPERATIONS OF FACILITIES ■

Most facilities have developed effective policies and procedures for routine operation although specific practices vary widely from plant to plant. While a generally high standard of operational control is observed at most B.C. plants, the present project identified several specific practices which are of potential concern. In some cases, ambiguous regulatory agency requirements have created confusion or inconsistencies. A particular area of concern is the handling, storage and disposal of solid waste residues generated by wood preservation operations. In-house procedures are poorly defined at most B.C. facilities and practices are inconsistent from plant to plant. The requirements of regulatory agencies are ambiguous and adequate off-site disposal facilities are not currently available in B.C.

A code of good practice should strive to establish uniform procedural objectives for operating facilities in a manner which provides adequate protection for workers and for the environment. As with facility design, the code would stipulate minimum requirements in terms of conceptual objectives, leaving the development of specific detailed procedures to facility management.

EMERGENCY RESPONSE REQUIREMENTS ■

General emergency response plans are in existence at most B.C. plants. However, it appears that these plans are often deficient in specific detail and are inadequately rehearsed to function smoothly in actual emergency situations. A code of practice should establish minimum specific requirements for response to emergency situations (such as spills or fires) involving wood preservation chemicals.

■ FACILITY AND SITE MONITORING

It is generally acknowledged that releases of preservative chemical to the environment should be minimized. However, almost no reliable quantitative information is available to support the development of this aspect of facility design and operational procedures. A code of practice should remedy this deficiency by establishing an overall plan for site and facility monitoring including the use of mass balance information to develop a quantitative picture of preservative releases at all steps in the treatment process (from drips during chemical delivery to washoff from treated wood by rain). Pre-facility site assessments should be required to identify and characterize essential site features such as hydrogeology and subsurface soils. Sampling and analytical protocols should be established for routine monitoring of soils, water and air at plant sites. Similar protocols should also be established for monitoring spills and contaminated sites, and a central and official file of monitoring and process information should be established in order to provide an accessible, permanent record of essential data for assessment activities.

■ REGULATORY AGENCY POLICY AND GUIDELINES

Current legislation is adequate for the development of regulatory controls on the release of wood preservative chemicals to the workplace and to the environment. However, the requirements of these controls have not been uniformly communicated or consistently applied to wood preservation plants throughout B.C. In some instances, agency policies have not been developed for areas which are significant for good overall control of toxic chemicals.

A code of practice should present a summary of all relevant regulatory agency policies, guidelines and regulations which affect the management of toxic chemicals at wood preservation plants. Where possible, ambiguous, deficient or inconsistent policies should be clarified and developed by the appropriate agencies in order that industry is presented with a clear statement of expectations and requirements. Other specific items identified in Table 1.6 should also be addressed with a view to clarifying and unifying existing regulations and opening channels of improved interagency and industry-agency communications.

DETAILED REPORT

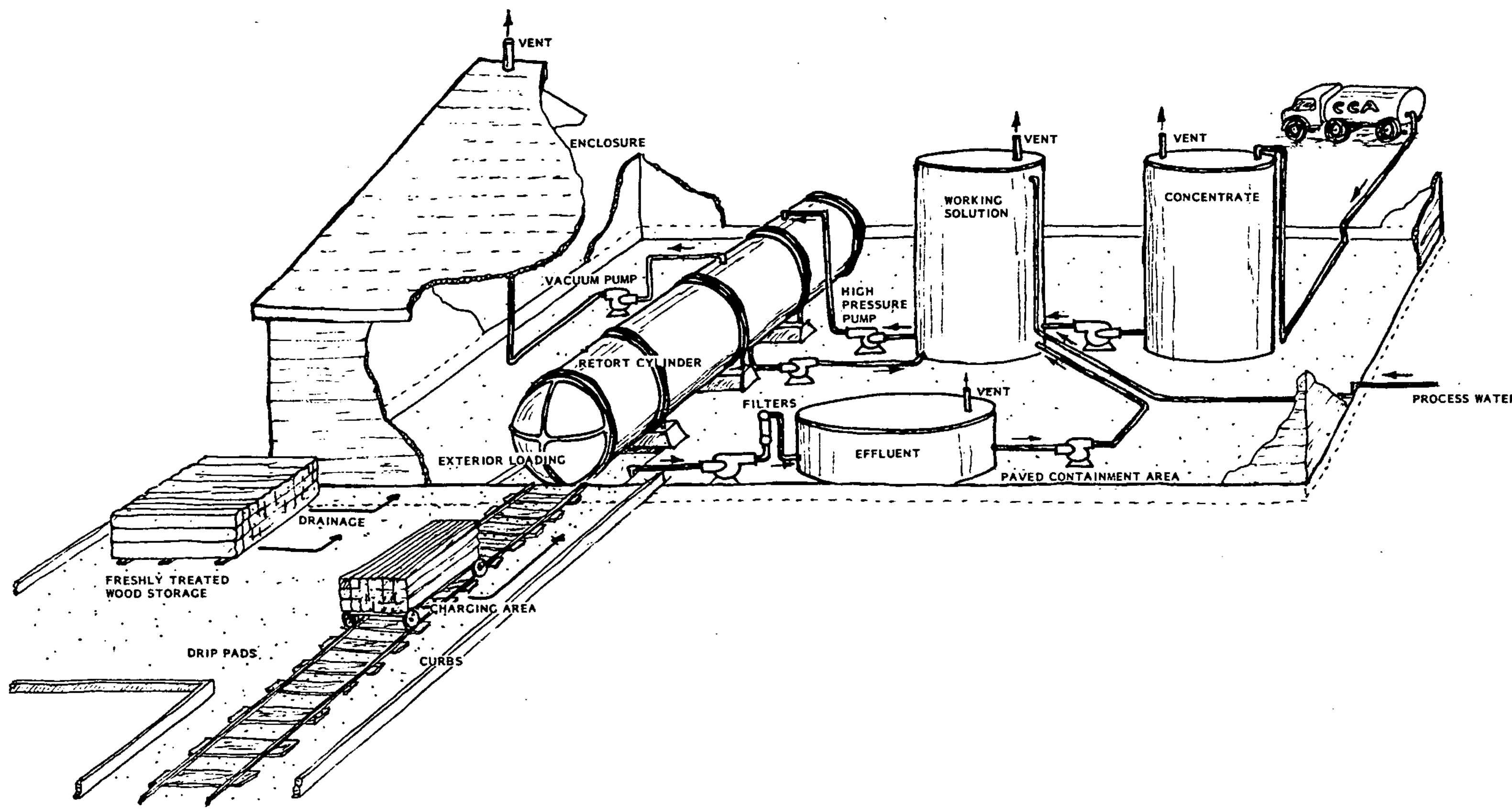


FIGURE 2.1 A TYPICAL CCA PRESSURE TREATING PLANT

2.0 DESCRIPTION AND ASSESSMENT OF PHYSICAL FACILITIES

2.1 CCA PRESSURE TREATMENT PLANTS

2.1.1 FACILITY OVERVIEW

■ GENERAL DESCRIPTION

Ten facilities in British Columbia currently provide treatment of wood with CCA (chromated copper arsenate) preservative. A typical CCA pressure treating plant is shown conceptually in Figure 2.1. The preservative chemical is normally purchased as a 50 percent concentrate which is delivered by bulk truck or rail tanker. The concentrate is stored in tankage and diluted with water to 1.5 to 4.0 percent strength working solution which is applied to the wood in a pressure retort cylinder. The treated wood is usually drained in a segregated drip containment area, followed by kilning and/or removal to dry treated wood storage to await shipment.

PRESERVATIVE APPLICATION ■

The full cell treatment process is always used to apply preservative in CCA treatment plants (see Appendix 1). The treatment cycle is carried out in the pressure retort cylinder and consists of the following steps:

- application of an initial vacuum,
- flooding with CCA working solution and pressurization (at 120 to 150 psig) until the target CCA retention level is achieved,
- draining of the excess CCA working solution (to the working tank for re-use with subsequent charges), and
- application of a final vacuum.

The specific treatment times and pressures are dictated by the species of wood, the type of wood product (for example, plywood or poles) and the moisture content of the wood. A predetermined range of process parameters is defined by the applicable treatment standards (see Appendix 2) and numerous quality control tests are carried out to ensure that a minimum treated product quality is achieved.

CHEMICAL CONTAINMENT AND RECOVERY ■

The toxicity and high cost of the treatment chemicals have led to the utilization of closed treatment systems which contain, collect and re-use the chemical to the greatest possible extent. The use and design of specific features vary significantly from plant to plant. However, the primary elements which may be incorporated in CCA containment and recycle systems are illustrated in Figure 2.1 and include:

- leakproof containment surfaces and dyking of major process components including the retort and CCA tankage,
- containment surfaces for chemical drips from treated wood on the retort charging track and in the freshly-treated wood storage area, and
- a collection sump to receive residual preservative from the retort (following the treatment cycle) and the accumulated contaminated runoff from other containment surfaces.

Contaminated liquids entering the sump are pumped through cartridge filters to remove yard dust and wood debris. The filtered solution is stored in a holding tank(s) and is returned to the process as makeup water for preparing fresh working preservative solution for subsequent charges. Incidental liquid streams (for example, seal water from vacuum pumps) are also collected and returned to the collection tank.

CHEMICAL DISCHARGES ■

Treatment plants with the features described above recycle all contaminated process liquids. Depending on the type, extent and effectiveness of the containment surfaces employed, incidental drips or washoff of treatment chemical from treated wood may be released to ground surfaces or contained in site runoff. The only solid waste generated by CCA facilities is miscellaneous debris which is periodically scooped from the sump and retort and/or removed from the cartridge filters. Intermittent sources of air emissions include the vacuum pump exhaust, retort doors and tank vents. Some preservative chemical may also be entrained in kiln emissions when treated product (such as plywood) is dried following treatment.

2.1.2 TRANSPORTATION AND OFF-LOADING OF CCA

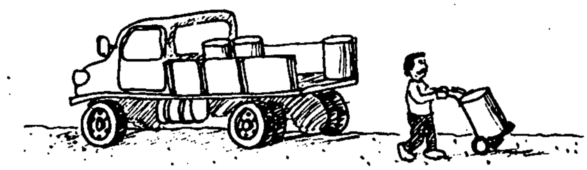
■ DESCRIPTION

The supply and transportation of CCA preservative to B.C. plants is described in Table 2.1. Figure 2.2 illustrates the various configurations for off-loading CCA at plant sites. All CCA used in B.C. is currently supplied as a liquid concentrate by either Koppers-Hickson Canada Ltd. or Osmose Wood Preserving Corporation of America.

SUPPLIER	NO. OF USERS	SUPPLY FORMAT		DELIVERY FORMAT		
		Bulk (50% Strength)	275-Pound Drums (72% Strength)	Rail Tank Car	Tank Truck	Container Freight Truck
KOPPERS-HICKSON CANADA LTD.	3	●			●	
OSMOSE WOOD PRESERVING CORPORATION OF AMERICA	3	●			●	
	2	●		●		
	2		●			●

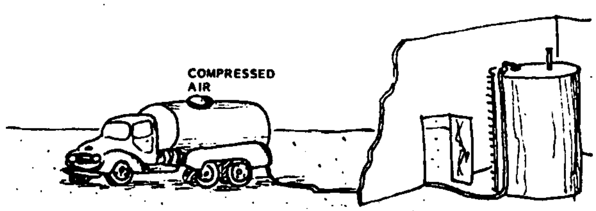
TABLE 2.1 SUPPLY AND DELIVERY OF CCA CONCENTRATE TO B.C. USERS

Two small facilities purchase 72% concentrate in 275-pound metal drum containers. Drums are delivered to one facility by common carrier. The other facility transports the drums in its own vehicle from a pickup point in Spokane, Washington. All other plants purchase 50% concentrate which is supplied in bulk and delivered by tank truck or rail tank cars.



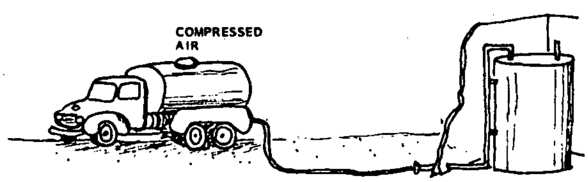
2 FACILITIES

- manual unloading of 275-pound drums of concentrate (72%) to an interior or exterior drum storage area
- unprotected ground in off-loading area



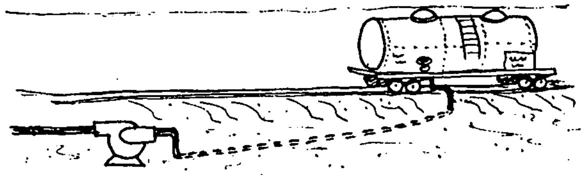
2 FACILITIES

- off-loading of bulk tank trucks via flexible hose through a doorway to a top hatch of the concentrate tank
- unprotected ground in off-loading area



4 FACILITIES

- off-loading of bulk tank trucks via rigid pipe connections to the interior concentrate tank
- unprotected ground in off-loading area



2 FACILITIES

- off-loading of bulk cars via rigid buried pipe or above-ground flexible hose to the interior concentrate tank
- unprotected ground in off-loading area

FIGURE 2.2 OFF-LOADING OF CCA CONCENTRATE AT B.C. PLANTS

Two companies receive bulk concentrate by rail and take responsibility for off-loading operations at their plant sites. In both cases, off-loading from rail tankers takes place over unprotected ground surfaces. In one instance, connection to tankage is via rigid, buried piping. The second plant utilizes a flexible hose system and a rental pump for off-loading.

Six facilities receive CCA via bulk tank truck. CCA is transported directly from the manufacturing facilities in Atlanta, Georgia (for Koppers-Hickson), or Memphis, Tennessee (for Osmose). The tank trucks are owned and operated by the CCA suppliers and the tanks are reportedly of special design with steel reinforcement bands to provide added strength. The transporters retain full responsibility for the chemical until it is transferred into the customer's storage tank. This ensures a high level of specialized control over the chemical throughout all phases of delivery from manufacturer to user. The transporters are specially trained for routine and emergency handling of CCA and follow carefully planned procedures for off-loading CCA concentrate. Delivery runs are made by an established crew so that the delivery personnel develop familiarity with the customer facilities.

Off-loading of CCA is accomplished by pressurizing truck tanks with compressed air. None of the facilities receiving bulk deliveries by truck provides ground protection (paving or curbing) at the point of off-loading, nor is containment provided for major spillage from the delivery tanker. The point of hookup for delivery is at exterior locations for three facilities and requires access to the treatment area at three plants. Two plants do not have permanent rigid-pipe delivery systems and employ temporary flexible hoses for CCA delivery. Locking valves are provided for security at two plants. At three facilities the concentrate storage tank is not directly or easily visible from the tanker hookup.

Visual level indicators (sight gages or interior floats with mechanical tape linkages) are provided at all plants and serve as the only means of indicating fluid level in the concentrate tanks. Overflow (level) alarms or shutoffs are not provided at any facility. Concentrate tank overflow protection (for example, direct piping to a sump or isolated containment area) is provided at two facilities. The high cost of carrying a chemical inventory has generally caused facilities to receive concentrate delivery when the concentrate tank is at a low level and the empty tank capacity exceeds the delivery load. When delivery is received at such times, tank overflow is impossible.

Facility operators generally receive bulk deliveries as soon as possible after the tanker arrives (to avoid car demurrage and/or to facilitate rapid turnaround for drivers after the long haul to B.C.). This often results in a delivery time at night or outside the hours of regular working shift.

■ ASSESSMENT

The supply and delivery of CCA to B.C. plants is generally well-controlled. Although the authors did not witness actual delivery, all reports indicate that procedures are well thought out and conscientiously implemented. Historically, no significant spills of CCA are known to have occurred during the transport or off-loading of CCA preservative in this province. This record reflects the careful procedures which are used by chemical suppliers for this segment of the industry.

The following items have been identified as practices or conditions which contribute to potential risk of a CCA spill and which should receive careful review during the preparation of a code of practice.

GROUND PROTECTION ■

A minimum standard should be established for ground protection at off-loading points. Bulk rail and truck vehicle delivery stations are unsurfaced (unprotected ground) at all existing plants. No facility provides permanent spill containment or drip protection for delivery vehicles.

DELIVERY MODE ■

The relative safety of alternate delivery modes should be reviewed. Delivery of CCA in bulk by rail or in drums by truck is inherently controlled less stringently than bulk truck deliveries. Transport by bulk rail and delivery of drums by truck both involve non-specialized third parties and/or common carriers who do not have specific training to respond to CCA spills. Responsibility for mishap is less clearly defined and is transferred two or more times during shipment. The shipper may not be familiar with specific practices for the safe handling of the chemical in non-routine circumstances. The responsibility of off-loading lies with the user, who may not be as highly qualified or as practiced as manufacturer-trained specialists specifically trained to off-load the chemical.

POINT-OF-DELIVERY CONNECTIONS ■

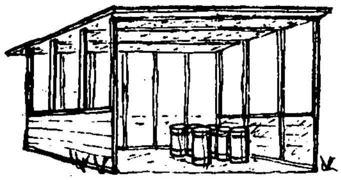
A consistent minimum standard for chemical delivery systems (vehicle to tank) should be adopted. The use of temporary flexible hoses to deliver CCA through tank-top hatches has a relatively high potential for spillage. Leaks are not readily detectable with buried or hidden delivery pipelines. Locking valves and backflow preventors are not universally used.

VISIBILITY OF THE DELIVERY SYSTEM ■

A minimum standard should be established for the visibility of chemical delivery systems. The overall safety of off-loading would be improved if all parts of the delivery system were visible to operators. In several instances, the receiving tank and delivery system cannot be readily observed from the point of connection to the delivery vehicle. This increases the potential for tank overflow or undetected leakage from delivery lines while the preservative is being transferred.

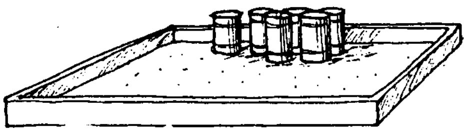
TIME OF DELIVERY ■

Criteria should be developed for determining the time of delivery for CCA shipments. Operator alertness and the availability of emergency response personnel should be factors in determining delivery times. In order to allow fast turnaround, bulk trucks are often off-loaded immediately upon arrival at the user facility. This contributes to the potential for off-loading by personnel who are tired after the long delivery haul. This also results in deliveries at nighttime when facilities are not manned and/or support for emergency response would be difficult to mobilize.



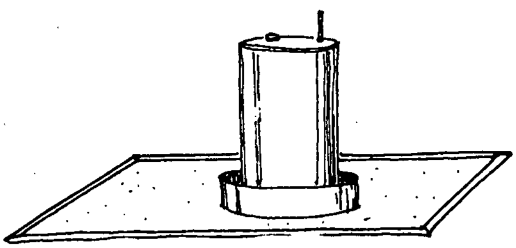
1 FACILITY

- 275-pound drums on unprotected ground (roofed)



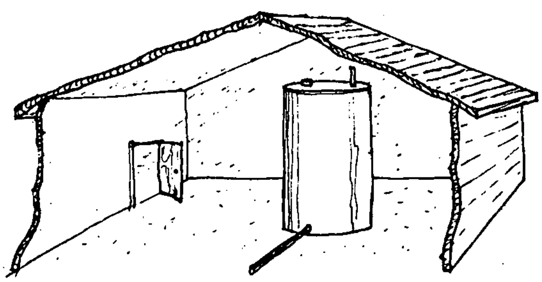
1 FACILITY

- 275-pound drums on exterior dyked, concrete containment pad



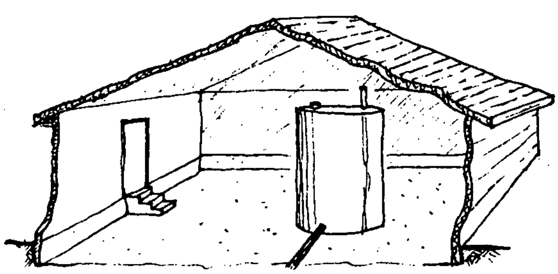
1 FACILITY

- exterior tank on paved surface
- above-ground thin-walled "swimming pool" dyke
- contained runoff from paved surrounding area



2 FACILITIES

- interior tank on paved surface in the process area
- no dyking or curbing of tank or building perimeter



5 FACILITIES

- interior tank on paved surface in the process area
- full or partial spill containment with concrete dyke walls or curbs

FIGURE 2.3 CCA CONCENTRATE STORAGE AT B.C. PLANTS

2.1.3 CCA CONCENTRATE STORAGE

■ DESCRIPTION

Figure 2.3 shows the configurations used for storing CCA concentrate solutions at B.C. facilities. Both plants which purchase 72% concentrate in metal drums also store the solution in these containers. In one instance, storage is under roof on unprotected ground. The other plant stores the drums on an exterior, dyked, concrete pad which contains the retort and treatment area. In both cases, the plants are somewhat remote, and no fencing or locked security is provided.

Storage configurations for facilities which use bulk concentrate are also shown in Figure 2.3. One facility utilizes exterior tankage for concentrate storage. Effective containment is provided by an above-ground, plastic, thin-walled "swimming pool" which surrounds the concentrate tanks. Surfaces are paved and the area is located on a larger drip-pad which is paved, curbed and drains to a collection sump. All surface runoff is collected and pumped to tankage.

Two plants use interior tank storage which is located on level paved floors with no continuous curbing or containment dyking. In both cases, the enclosed tanks are near unprotected ground which is located adjacent to the enclosing structure. Also in both cases, the tankage is adjacent to the retort area so that minor spillage or leakage could be diverted to the retort sump. Major spillage would escape to unprotected ground.

Five plants use enclosed, interior tank storage with partial or full tank capacity spill protection provided by paved, dyked areas served by sumps which could be used to transfer major spills to alternate tankage. Storage area floors are subgrade at four facilities and grade-level with a curbed perimeter at the fifth. At three of these plants, pumps and other major process components are located within the dyked containment area. A major spill of concentrate or solution from the retort or other tankage in the area would flood this equipment and probably render pumps and other electrical equipment inoperable. Two facilities have avoided this potential circumstance by mounting process components above the liquid containment level of a major spill.

Both vertical and horizontal cylindrical tankage are utilized for concentrate storage. The tanks appear to be sound and in good condition at all facilities except one. The latter plant has employed used tanks for solution storage and the tanks are in battered condition with numerous dents, distortions and surface rust.

Concentrate tanks at all plants are in secure locations with respect to mechanical damage from vehicles. Tankage is generally mounted in a physically stable manner and/or anchored. One plant (utilizing a horizontal tank) has not provided permanent anchors and the support blocking could be dislodged by a relatively minor blow or tank movement. Flexible pipe with a force fit connection (no clamping) is used for the discharge piping in this plant. All other facilities utilize permanent rigid piping for process connections to the concentrate storage tank.

■ ASSESSMENT

The concentrate solution is the most potent form of the preservative chemical used at CCA treatment plants. Preventing the direct exposure of workers and the environment to this chemical is a primary objective in the design and operation of CCA plants. B.C. facilities have been generally very successful at achieving this objective although the potential for concentrate spills exists at several facilities. The significant items which should be reviewed in preparing a code of good practice include:

SPILL CONTAINMENT ■

A minimum standard should be established for the design of systems to contain spills of CCA liquid concentrate solution. Full and effective spill containment should be provided for stored quantities of bulk liquid concentrate. Piping should direct tank overflow (should it occur) to isolated sumps or containment areas. Two of the eight facilities would currently lose part or all stored concentrate to unprotected ground in the event of a major concentrate tank spill.

A containment standard should develop criteria for the placement of process components in containment areas. Essential process components such as pumps and controls should be isolated from the potentially-flooded area of containment in order to prevent loss of function during spills.

DRIP CONTAINMENT ■

Guidelines should be established for minimizing and isolating minor leakage from process components. Local containment should be provided to isolate drips of concentrate from flanges, seals and other potential leak points. Most facilities do not currently provide local drip catchment.

FLUID LEVEL INDICATION ■

A consistent standard of safe and accurate level indication should be adopted. The accuracy and reliability of level indication on concentrate tanks at current facilities is highly variable. The use of unprotected or makeshift glass tube sight gages creates potential risk of concentrate spillage in the event of breakage.

LEVEL ALARMS ■

The necessity for tank level alarms should be considered and (if appropriate) a minimum standard should be established. Fluid level alarms to protect against overfilling concentrate tanks are not currently in use at any facility. Overfill protection is prudent for all plants and especially advisable for facilities having concentrate tanks which are not readily visible from control points during filling and transfer operations.

BACKFLOW PREVENTION ■

A consistent standard of safeguards should be adopted to prevent inadvertent fluid transfers to and from the concentrate tank. The types and effectiveness of safeguards at current facilities vary widely. Consideration should be given to locking security valves, double valving and the use of backflow preventors to block loss of concentrate through the delivery line or entry of other solution to the tank through discharge lines.

PIPING SYSTEMS ■

A uniform standard for concentrate fluid piping systems should be considered. Existing plants show wide variation in the permanence, visibility, color-coding (uncommon) and accessibility of piping. Non-permanent, poorly marked and/or unaccessible piping enhances the potential for mishap, reduces the ease and likelihood of maintenance, and makes leak detection and repair difficult.

TANK CONDITION, LOCATION AND MOUNTING ■

A minimum standard should be established for the condition, location and mounting of concentrate tanks. Concentrate storage tanks should be maintained in good physical condition, and securely mounted in a location which is sheltered from the elements, vandalism and vehicle impact. Only one existing facility uses a concentrate tank which is not in satisfactory physical condition. Two facilities have unanchored concentrate tanks which could conceivably be tipped or rolled by accidental impact. All but two facilities have concentrate tanks which are housed in enclosed areas and are reasonably secure against accidental or intentional damage.

2.1.4 TREATMENT PROCESS SYSTEMS

■ DESCRIPTION

All CCA plants are similar in conceptual design and the principal elements of the total facility (as described in Section 2.1.1) include:

- a tracked charging area where wood is trammed to and from the pressure treating cylinder(s),
- a preservative treatment area where preservative concentrate is stored, diluted and applied to the wood in the treatment cylinder, and
- one or more areas for post-treatment dripping, drying and treated product storage.

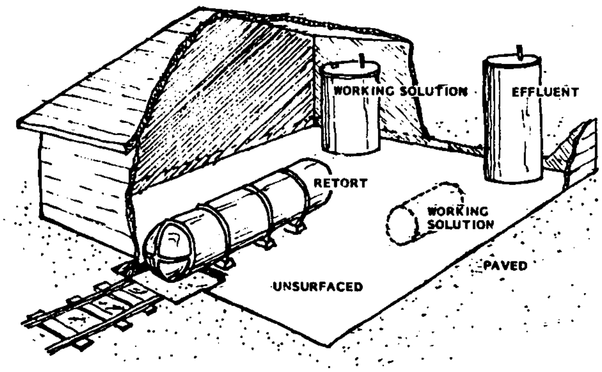
The preservative treatment process area is normally centralized in CCA plants and houses all major process tankage and equipment required for the application and containment of the preservative chemical. The preservative treatment area includes:

- the retort cylinder(s),
- CCA concentrate, mixing and working solution storage tanks,
- process pumps (transfer, pressure and vacuum),
- all piping and controls, and
- the chemical recycling system, including collection sumps, pumps and tankage for storing contaminated surface runoff.

Figure 2.4 shows the major variations for the shelter, containment and placement of process components in treatment areas currently in use in B.C. plants.

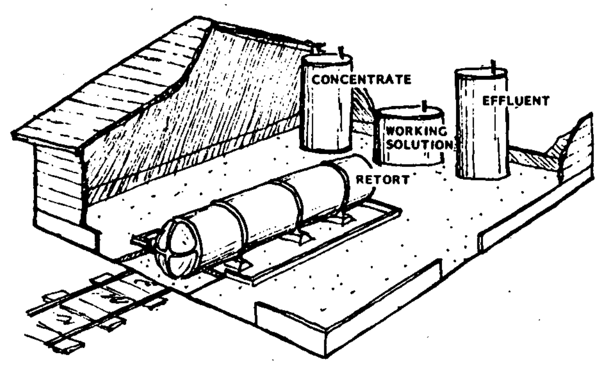
SHELTER ■

The major components of all but one of the B.C. facilities are sheltered by roofed enclosures. The unsheltered facility is totally contained on a subgrade, dyked concrete pad. The facility was newly constructed in 1982 and the owner intends to enclose the plant subject to the successful negotiation of a long-term lease for the site.



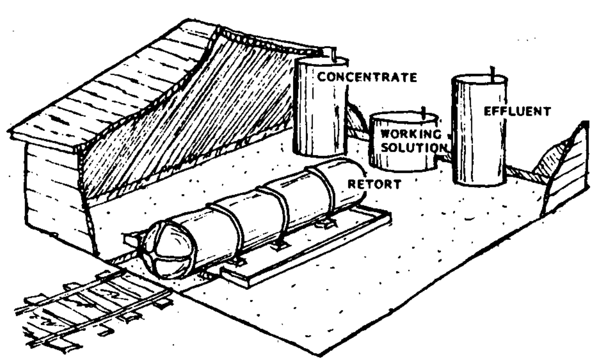
1 FACILITY

- enclosed
- retorts and tanks on subgrade, unsurfaced ground
- one buried working solution tank
- concentrate tank on separate exterior, paved and dyked area



4 FACILITIES

- enclosed
- retorts and tanks on grade-level concrete floor
- discontinuous (or lack of) curbs around area perimeter
- variable use (none to extensive) of curbs around process components



5 FACILITIES

- 4 enclosed, 1 exterior
- retorts and tanks on subgrade concrete floor
- continuous concrete wall dykes around area perimeter
- additional wall dykes segregating tanks and retorts at 1 facility
- (buried effluent tank at 1 facility)

FIGURE 2.4 SHELTER AND CONTAINMENT IN PROCESS AREAS AT CCA PLANTS IN B.C.

The treatment areas of all other facilities are enclosed by buildings, which generally contain all major process components. The only exception is one facility which has exterior concentrate tanks.

SURFACES

Only one facility has an unsurfaced work area in the treatment building. The area beneath the retort and the chemical storage tanks is unsurfaced ground consisting primarily of fine sandy fill material. Access to process components is provided by wooden walkways. Tankage in the area contains working solution of preservative as well as concentrate and working solutions of two flame retardant chemicals. All other facilities have fully paved floors in the process buildings although the nature and extent of perimeter containment vary considerably.

SPILL CONTAINMENT

Figure 2.4 shows the various types of containment measures used in CCA treatment areas. The design and anticipated effectiveness of containment systems vary significantly among the existing facilities.

The single facility which does not have continuous paving in the treatment area has devoted special attention to spill prevention safeguards in order to compensate for the lack of paving. For example, double valving is being installed on all storage tanks and the installation of 24-hour monitored level alarms is under consideration. These safeguards are appropriate, since a major spill in this area would probably result in substantial loss of liquid to the sandy soil beneath the process area.

Four facilities have grade-level concrete floors with noncontinuous or no containment curbs or dykes around the building perimeter. One of these plants has provided effective spill containment by installing concrete curbs around all process components with drainage directed to sumps. It is likely that all but major spills (for example, the rapid loss of the contents of a full tank) would be contained by this system. The other three facilities with grade-level concrete floors provide limited local containment of process components. Moderate to minor spills could be contained and recovered through the sump systems at these plants, although major spillage would probably escape to unprotected ground beyond the treatment buildings.

The remaining five facilities have subgrade concrete floors with dyked perimeters designed to provide full containment of any ruptured tank or cylinder. The containment areas are served by sumps or sump systems to allow return of major or minor spillage to available tankage.

DRIP CONTAINMENT ■

Potential points of leaking or dripping from process components (pump seals, flanges, valves) are not generally provided with local drip containment. These process components are normally located in the larger containment area serving the treatment plant and leaks or drips are periodically washed down to sumps.

CHEMICAL RECYCLE SYSTEMS ■

In all cases, residual preservative solution from the retort, door drippings, and containment runoff or drips from exterior drip pads drain to a sump located beneath the retort door. One retort is mounted with a rear-sloping angle and drains to a sump beneath the back end. The door sumps and/or connecting sumps beneath the retort in the treatment area receive all contaminated liquid streams and serve as collection points for pumping or draining these fluids to an "effluent" tank. This fluid is then filtered and re-used in the preparation of fresh working solution. All but one facility pump drainage from the sumps to above-floor effluent tanks. One facility drains the door sump to a subgrade tank and periodically pumps the contents to surface mounted tankage.

Four facilities provide at least partial segregation of containment surfaces in the different process areas so that minor spills in one area will not spread to floors in other areas. Only three facilities have mounted pumps and electric components above the maximum fluid level of containment (two facilities have elevated pumps, the third has floor level pumps but the sump drains to a subgrade tank). It is likely that all other contained facilities would flood process pumps and piping in the event of a major spill or tank rupture.

PIPING

Interconnecting piping from sumps is buried subgrade at all facilities. Most interconnecting process piping is above grade and relatively visible and physically accessible at all but one plant. The latter facility utilizes considerable sub-floor and/or buried piping. A second plant uses a concentrate feed line consisting of a combination of flexible (non-anchored) above-ground pipe and buried pipe. A third plant uses buried piping to link the door sump to a buried effluent tank. A fourth facility uses exterior flush-mounted drains to return preservative runoff from the adjacent freshly treated storage pad to the segregated retort containment area.

Two facilities have color-coded portions of the process systems although no plant uses a consistent color-coding scheme throughout the process area. The piping at most facilities can be visually traced, but with some difficulty.

PROCESS CONTROL

A wide range of types of process control is employed at CCA plants. The simplest plant is totally manually controlled with no centralized control or indicator panel. The most sophisticated plant is fully-automated with most process functions indicated and recorded on a centralized control panel.

Five plants use centralized control panels with the treatment process being controlled remotely from a control room. Two of these plants are controlled from points adjacent to the process area with at least partial visibility of the retorts and process components. Three of the facilities are controlled from points visually remote from the process area. Only the smaller and simpler plants are controlled from positions from which all parts of the plant (including the cylinder door area) can be readily observed.

RETORT CYLINDERS ■

Retort cylinders are subject to all inspections and certifications required for any pressure vessel. Retorts at all plants are appropriately constructed and rated for the actual service requirements of pressure treatment. Retorts at several facilities were previously installed at other plants but there is no evidence of cracks, structural weakness, leakage or other drainage-related problems. All retorts are supported on concrete piles placed at several locations along the cylinder length. One plant provided longitudinal structural steel reinforcement to minimize the stresses of cylinder expansion from temperature fluctuations during the treatment cycle.

RETORT DOORS ■

Two types of retort doors are employed at CCA facilities. Two facilities use simple non-hinged, gasketed doors which are sealed with multiple bolts around the perimeter flange. Eight facilities use retorts with hinged "quick opening" doors which utilize a rotating flange (on the cylinder) to engage protruding stops spaced at regular intervals around the door perimeter. The closing mechanism on quick-opening doors is hydraulically operated and the actuating switch is mechanically interlocked to a positive warning safety device designed to prevent inadvertant opening of the door while the retort is in use. This device utilizes a small valve which visibly vents preservative fluid to the sump when the retort is full during the treatment cycle. One of the facilities with quick-opening doors has intentionally defeated the function of the warning device on the retort door. One of the two facilities with bolting doors has added a vent-type warning device actuated by a valve adjacent to the door seal. At four facilities, the treatment process is controlled remotely from a central control panel which has electrical interlocks to prevent door openings from occurring while the treatment cycle is in process.

WASTE TREATMENT ■

All contaminated liquids are recovered and returned to the process as described in the description of chemical recycle systems. As a result, no liquid process waste streams are produced at CCA plants in B.C.

Air emissions from tank vents are normally uncontrolled and discharged directly to enclosing structures. Vacuum pump exhausts are normally vented directly to the atmosphere and only two facilities provide devices to reduce and collect entrained preservative droplets.

Contaminated solid residues are produced from the cleanout of sumps and chemical recycle filters. Quantities of debris are reportedly of the order of one 45 Imperial gallon drum annually. One facility dumps this residue on the ground surface adjacent to the treatment area. A second facility burns contaminated residue. A third facility disposes of solid residues at a municipal sanitary landfill. The remaining facilities store solid wastes on site pending identification of acceptable disposal methods.

■ ASSESSMENT

The overall assessment of treatment process systems at CCA treatment plants is positive. The industry segment consists largely of relatively new plants which have been built with the general intent of providing good containment and control of the preservative chemical. This stems from a general awareness and acceptance of the toxic potential of CCA by suppliers and facility operators.

Only one of the existing plants is considered to be generally deficient in the nature and condition of its process treatment systems and the current conditions may represent actual damage to the environment and/or worker health. Serious specific deficiencies were noted at two other facilities. In both cases the deficiencies constitute potential risks but have not caused actual undesirable occurrences.

Nearly all facilities would benefit from upgrading of one or more areas in process treatment systems, and specific items which should be considered in preparing a code of good practice include:

SHELTER, SURFACES, AND SPILL CONTAINMENT ■

There is a need to adopt a uniform standard of facility design which integrates the requirements for shelter, interior work surfaces and spill containment. A degree of uniform design input is provided by the chemical suppliers, although several facilities have failed to develop the most effective housing and containment structures because their systems evolved over a period of time and needs changed as the system developed.

DRIP CONTAINMENT ■

A uniform standard of local drip containment should be developed. Isolation of minor routine drippage from process components would improve the level of chemical control in existing facilities by eliminating the dispersal of minor chemical releases within the general process containment area.

CHEMICAL RECYCLE SYSTEMS ■

A uniform design standard for chemical recycle systems should be developed. This standard should give consideration to the following objectives:

- The overall system should be enclosed, physically sound and effective at containing and recycling the chemical with the least possible dispersal.
- Individual components of the system should be visible and physically accessible.
- Closed components should be used to the greatest possible extent.
- Process areas should be segregated to isolate spills and prevent dispersal to the total containment area.
- Process components should be isolated from, or elevated above the maximum level of spilled fluid in containment areas.
- Sub-floor components should be minimized and should incorporate features for preventing and detecting sub-surface leakage.

Chemical recycle systems constitute a major and integral part of the process plant. Consequently, a design standard for recycle systems should be directed primarily at new facilities. Existing facilities should be encouraged to upgrade to an equivalent standard within a reasonable period of time. Although most existing plants meet most of the general objectives listed above, no facility meets them all. Deficiencies at existing plants are considered to be minor except in one instance. In several cases, deficiencies could be removed or decreased by relatively simple modifications of the existing system.

PIPING

A uniform standard of piping system design should be adopted to facilitate leak detection and repair and to enhance functional control of the process. Existing facilities vary significantly in the complexity of piping systems. Complex and non-visible (or buried) piping systems increase the potential for undetected leaks and increase the difficulty of repair if leaks do occur. Complex piping and the lack of color coding generally reduce the level of functional understanding of the process (by operators) and increase the potential for error during repiping, maintenance and repair operations.

PROCESS CONTROL

A uniform standard of process control should be adopted. Components of the standard should include:

- simplicity,
- a clear relationship between controls and process functions,
- visibility of process components from the control point, and
- emphasis on the use of effective alarms and interlocks to prevent safety-related operator errors.

RETORT CYLINDERS

The current requirements for testing and certifying pressure vessels appear to provide an adequate standard for retort vessel specifications and mechanical condition.

RETORT DOORS ■

A minimum standard for door-opening-linked protective devices should be established. The positive warning devices in current use on quick-opening doors appear to provide reasonable protection against inadvertant door openings when cylinders are filled and pressurized. These devices may not be effective for all parts of the process cycle and the requirement for back-up indicators and process interlocks should be considered, especially where the process is remotely controlled.

WASTE TREATMENT ■

A minimum standard should be established for controlling tank vent emissions and vacuum pump exhausts. The current practices have apparently not been quantitatively assessed and appropriate monitoring studies should be undertaken to provide a basis for determining the significance of the levels of preservative chemicals contained in current emissions. Qualitatively, the discharge of tank vents to the workplace is undesirable in principle. Substantial volumes of emissions are discharged when preservation is transferred from retorts to tanks. In at least two instances, vacuum exhaust systems have resulted in the visible accumulation of preservative on surfaces or soils adjacent to treating areas and improved control of these emissions should be considered.

Unambiguous guidelines should be established for the disposal of solid residues generated by CCA treatment processes. Although waste quantities are minor, there is considerable difference of opinion about the hazards and requirements for handling these wastes and clearly defined disposal options should be determined.

2.1.5 CHEMICAL MIXING AND HANDLING

■ DESCRIPTION

The CCA concentrate is diluted to a working solution of concentration ranging from 1.5 to 4.0 percent. The two plants which use drummed CCA concentrate both handle the concentrate directly in preparing the working solution. At one plant, the concentrate is pumped from an open drum (located in a dyked containment area) into the closed work solution tank and dilution is carried out by recirculation through the closed tank. The operator of the other plant simply pours the required quantity of concentrate into the retort, and pumps the solution from the retort to the work tank where it is diluted to the desired concentration. This facility has no curbing or sump to contain spillage.

The eight facilities which use bulk concentrate carry out the preparation of the dilute working solution by pump transfer between the closed concentrate tank and the work tank. In one case, an intermediate mixing tank is used. The entire mixing process occurs in closed systems at all of these plants and workers do not come into direct contact with the solution at any stage of mixing.

In all but one facility the mixing transfers are controlled from areas which have good visual access to pumps and tanks. The plant which has a remote control area also utilizes sub-floor piping and one work tank which is buried beneath the working area.

Overflow prevention for work tanks is visual only in all cases (by observing tank level indicators or actual overflow if it were to occur). At one plant, working solution overflow would fall directly onto unsurfaced ground adjacent to the tank. At two plants, overflow would fall onto the paved floor in the retort area. Both of these plants are enclosed and there is no continuous curbing or dyking of the tanks which are adjacent to sumps on the building interior and adjacent to unprotected ground on the building exterior.

Several plants have installed backflow preventers or piping configurations which prevent contamination of the water supply systems with CCA. There have been no reported or known instances of water system contamination from chemical backflow in B.C. plants.

Simple pipe vents are provided on tanks. These vents are normally open to the atmosphere and discharge (during filling operations) to the workplace at enclosed facilities. CCA staining was observed on ceilings above working solution tanks at some facilities. Discussion with operators confirmed that liquid preservative solution can be entrained in vent discharges when the solution is transferred under pressure from the treatment cylinder to the storage tank.

■ ASSESSMENT

Eight of ten B.C. plants use liquid bulk CCA concentrate which is diluted, mixed and transferred entirely in closed systems. This pattern of operation is generally clean and very effective in isolating workers from direct contact with the chemical. Two exceptions to the generally good control of chemical were observed, including one facility which was generally deficient in good housekeeping and maintenance procedures. One instance of minor working tank solution overflow was observed. The spilled solution was totally contained. Although this is apparently a rare occurrence, it underscores the importance of providing safeguards against tank overflow. Several specific concerns were identified for consideration in a code of good practice and these include:

FEED SYSTEMS ■

Consideration should be given to a minimum standard which would require chemical concentrate and mixing systems to be totally closed. One existing facility feeds concentrate to the mixing/work tank via an open pipe discharge to a funnel which is joined to the feed pump by sub-floor piping. This arrangement causes considerable spatter of concentrate during transfer operations and unnecessarily exposes workers to the preservative chemical.

PROCESS CONTROL

A minimum standard should be established for the visibility of treatment systems from control points. Ideally, process components (especially tankage) for mixing and transfer should be clearly visible from the point of process control operations. Blind operation increases the potential for tank overflow or incorrect transfer of solution between storage tanks.

OVERFLOW PREVENTION

A standard should be considered for stipulating minimum requirements for devices or alarms intended to prevent tank overflows from occurring. Positive overflow protection should be provided by means of float-switch pump shut-offs and/or level alarms. Existing facilities are generally lacking in level alarms or automated shutdown of tank feeds in case of overfill.

OVERFLOW CONTAINMENT

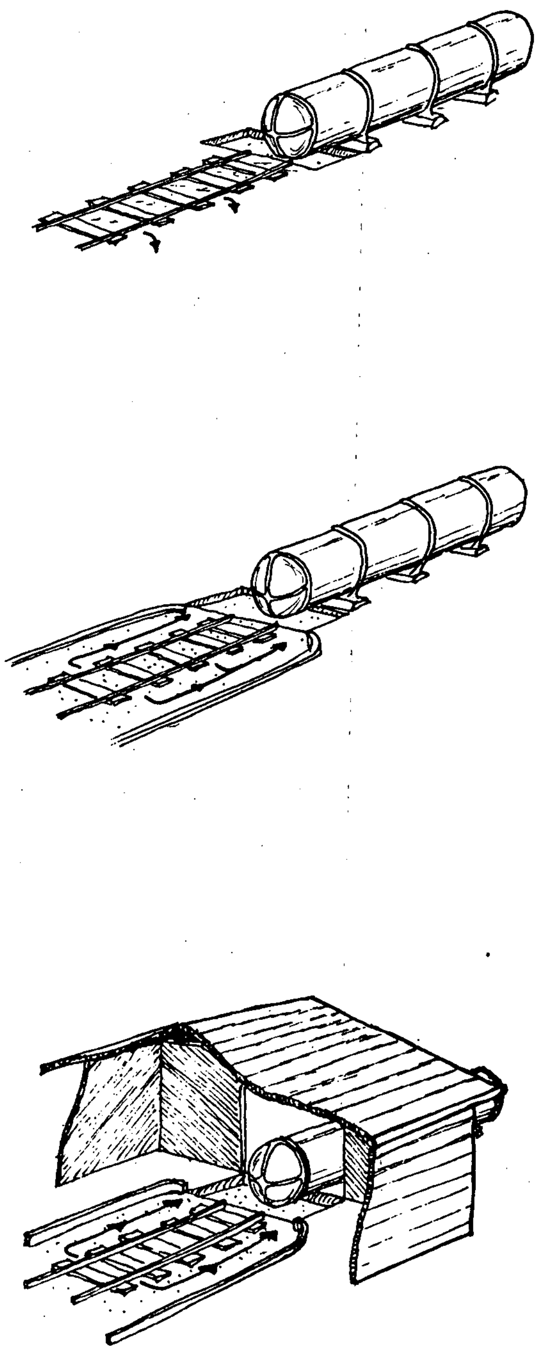
Tank overflow should be isolated (for example, by direct discharge to a sump) to prevent any overflow from flooding the general dyked process containment area. A minimum standard of containment dyking should be adopted to ensure a safe and consistent degree of ground protection against spilled working solution.

BACKFLOW PROTECTION

Backflow preventors on chemical mixing feed lines should be mandatory and a uniform standard should be developed for isolating chemical systems from water supply lines.

TANK VENTS

Emissions from tank vents should be assessed and a standard for allowable emissions should be developed. Vents should be vented externally (rather than to interior workplaces) and emission control devices should be provided (if appropriate).



2 FACILITIES

- tracks on unprotected ground
- CCA drippage and runoff soaks into ground

6 FACILITIES

- tracks on paved drip pad
- CCA drippage and runoff returned to process

2 FACILITIES

- tracks on paved drip pad (roofed and/or enclosed)
- CCA drippage and runoff returned to process

NOTE: Retort enclosures omitted for clarity

FIGURE 2.5 RETORT CHARGING AREAS AT CCA PLANTS IN B.C.

2.1.6 RETORT CHARGING TRACK CONTAINMENT

■ DESCRIPTION

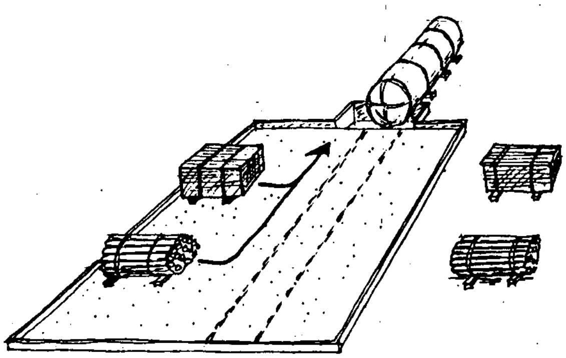
All facilities except one use standard rail trams for loading wood into the treatment retort. The non-standard facility is an atypically small plant using an 8-foot long retort which is manually loaded. The retort and charging area is enclosed and underlain by a grade-level concrete floor with no containment curbs.

Figure 2.5 shows the three basic configurations of charging track areas of the nine other B.C. plants which use CCA preservative. Two facilities provide no ground protection beneath the charging track and drips from freshly-treated wood soak into the ground during unloading. The remaining seven facilities have all installed paving in the charging track area. The width of the paved area varies from a limited pad (the width of the rail trams) to complete surfacing of the charging area. The track pads are generally graded to direct drainage from the tracks to the retort sump for return to process. Six of these facilities employ pads which lack well-defined curbs, although there was no evidence of preservative drainage from the pad edges. Preservative may be tracked from the pads by vehicles which remove treated wood from the trams. Tracking of preservative chemical from pad areas (by vehicles) was actually observed at several facilities which treat high-drip products such as plywood or shakes. Two facilities provide roofing over the total track area, while a third provides partial roofing over the far end of the charging track.

4 FACILITIES

- storage of all treated wood[1] on unprotected ground following initial drippage in the retort (post-treatment holding time in the retort varies with facility - from minutes to hours)
- drips and washoff soak into ground

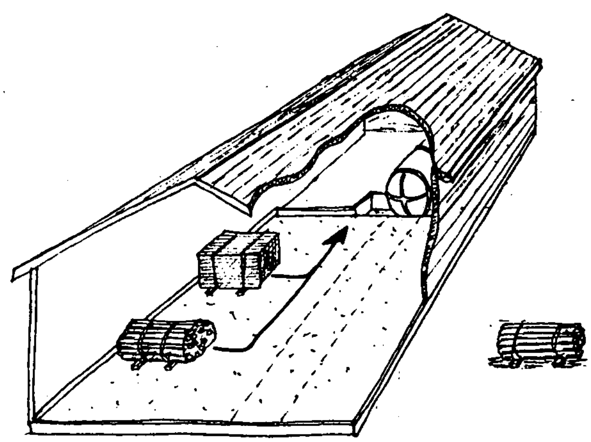
[1]posts at 3 plants, posts/lumber (70/30) at 1 plant



4 FACILITIES

- storage of freshly treated wood[2] on unroofed, paved and curbed drip pads
- drainage and runoff collected and returned to process
- drained or kilned (often plastic-wrapped) treated wood stored on unsurfaced ground (3 plants) or paved yard (1 plant)
- washoff soaks into ground or is contained in site drainage at the paved site

[2]posts or rails at 2 plants, posts and considerable lumber/plywood at 2 plants



2 FACILITIES

- storage of freshly treated wood[3] on roofed, paved drip pads
- drainage collected and returned to process
- drained or kilned (often plastic-wrapped) treated wood stored on unsurfaced ground
- washoff soaks into unsurfaced ground or is contained in site drainage

[3]posts at 1 plant, lumber/plywood at 1 plant

FIGURE 2.6 FRESH AND DRAINED TREATED WOOD STORAGE AT CCA PLANTS IN B.C.

2.1.7 FRESHLY-TREATED WOOD STORAGE

■ DESCRIPTION

Figure 2.6 shows the various types of freshly-treated wood storage used at CCA treatment facilities in B.C. Four facilities have no contained drip areas and deposit freshly-treated wood from the retort directly on unsurfaced ground. Three of these facilities treat predominantly posts or poles (which readily absorb residual surface preservative liquid) and these storage areas show little visible evidence of ground contamination. The fourth facility treats substantial quantities of dimension lumber and ground contamination in the storage area as visually obvious.

Six facilities provide paved drip areas for freshly-treated wood. The drip areas at three facilities are unroofed. One facility has both roofed and unroofed drip areas. Two facilities (one in the Lower Mainland, one in the Northern Interior) provide fully-roofed, paved storage for freshly-treated lumber. In addition, one of these facilities has enclosed the storage area on three sides to prevent infiltration of precipitation and dustfall.

In all cases, paved drip areas are graded to direct drainage to the retort sump(s). Drips and contaminated runoff are pumped to tankage for eventual use as makeup water for working treatment solution. One facility which uses unroofed storage pads is located in the Lower Mainland in an area of heavy coastal winter rainfall. The requirement to collect and store large quantities of contaminated surface runoff causes the plant to discontinue the use of large exterior drip pads during rainy periods. Unused pads are washed down and runoff is discharged off-site to a surface storm water drainage ditch which ultimately discharges to the Fraser River. The other facilities with exterior (unroofed) paved drip pads are located in drier regions, and large quantities of contaminated storm water are not generated.

2.1.8 DRY TREATED WOOD STORAGE

- DESCRIPTION

Figure 2.6 also shows the range of practices for storing treated wood on site pending shipment. The potential for chemical losses from "dry" treated wood in storage areas depends on:

- the type of product,
- the extent to which residual preservative has drained from the freshly-treated product before it is placed in the storage area, and
- the length of the storage time period.

"High-drip" products such as plywood and shakes must be artificially dried following treatment to reduce the moisture content to an acceptable level for transportation and sale. All three facilities which treat these products provide segregated drip areas for freshly-treated wood. The drained product is then kiln-dried before transfer to a dry product storage area while awaiting shipment. Depending on customer requirements, the dried product may be plastic wrapped (top and sides) to protect it from rainfall during storage and while in transit. One facility provides paved storage for dry product and stores part of its dry-treated material under roof. The other two facilities which produce these high-drip products provide exterior storage on unsurfaced ground. Storage times for these materials are usually relatively short, ranging from a few hours to several days.

One facility which produces dimension lumber (a moderate-drip product) provides no initial drip area and all treated material is placed directly on the exterior unsurfaced yard while awaiting shipment. This is the single plant which places wet, dripping wood on unprotected ground for storage.

The remaining six facilities treat primarily posts and poles which are relatively low-drip products. Three of these plants have little or no drip containment for freshly-treated product and the treated posts and poles are removed directly from the retort cylinder to dry wood storage on unprotected ground.

2.1.9 CHARGING AND WOOD STORAGE AREA CONTAINMENT

■ ASSESSMENT

The quantity of preservative chemical lost to the environment is the true measure of the effectiveness of treated wood storage containment systems. None of the CCA preservative plants in B.C. has developed data to allow direct or indirect quantitative estimates of chemical losses. Assessments of containment effectiveness are herein based exclusively on visual evaluation of sites and facilities. On this basis, it is concluded that good overall control of preservative is achieved by the CCA segment of the preservative industry. With one exception, facilities have installed and implemented effective control measures to prevent the obvious loss of treatment chemical contained in drips and wastes from treated wood. A variety of approaches has been used, with individual facilities adopting specific measures which best suit their own process requirements and environmental circumstances. Each approach has strengths and weaknesses and a code of practice can contribute to a more effective overall system design by drawing on the accumulated experience of existing facilities. Specific subjects which should be reviewed in preparing a code include:

QUANTITATIVE CHEMICAL RELEASE SURVEY ■

CCA losses in drips and washoff from treated wood should be quantified and evaluated in light of total chemical losses. The minor release of treatment chemical from wood is unavoidable and occurs at all sites. However, the evaluation of the significance of these losses and the formulation of realistic control measures cannot proceed meaningfully in the absence of data which estimate the absolute and relative magnitude of these losses.

SITE MONITORING STANDARDS ■

Minimum standards should be developed for monitoring preservative chemical levels in site environments (soils, water and air). To date, only one CCA plant (on its own initiative) monitors treatment chemical in its off-site surface runoff. No plants have undertaken any soil monitoring to assess preservative loss to and accumulation in soils or on surfaces of wood storage areas. No facility has undertaken preconstruction site assessments to determine background levels of treatment chemical constituents in the site environment or to identify site characteristics which warrant special consideration in the design and operation of storage area containment. The necessity for these types of monitoring efforts should be determined and uniform procedures should be established for their undertaking.

STORAGE AREA DESIGN STANDARDS ■

Uniform treated wood storage design standards should be adopted and these standards should give integrated consideration to all factors which affect and are affected by area containment. Effective storage area containment must achieve several objectives including:

- effective collection of drips and runoff from freshly-treated and dry-treated wood,
- efficient drainage and recovery of the collected liquids without dispersal from tracking by vehicles or personnel,
- protection of the recycled chemical from infiltrating dust, ash and debris (which must be filtered and disposed of), and
- minimization and containment of contaminated site runoff.

The design and operation of wood storage systems should achieve a balance of these objectives and existing plants are generally deficient in at least one area.

FRESHLY-TREATED WOOD STORAGE ■

A minimum standard should be established for the containment of drips and runoff from freshly-treated wood. Proper containment of freshly-treated wood is essential to prevent CCA contamination of the ground, groundwater and/or off-site drainage. For CCA treatment plants, the freshly-treated wood storage area is the primary interface between exposed treatment chemical and the site environment. Releases of chemical from the subsequent storage of "dry" wood are thought to be relatively minor when sufficient dripping and fixation time is provided in the initial storage of freshly-treated wood.

Although most facilities have implemented reasonable (in some cases excellent) measures to collect obvious drips and runoff, one facility has no ground-protected area for storing high-drip treated product and losses of chemical to the ground are of serious concern at this site. Visual inspection does not indicate serious concerns about ground contamination at plants which treat low-drip products such as posts, but quantitative data should be developed to confirm this conclusion.

Facility operators generally indicate that at least 48 hours is required for fixation of the preservative chemical in treated wood, and a uniform standard should be established for the required safe holding time before subsequent processing. The assessment leading to this standard should include consideration of chemical carry-over and/or release during post-storage steps when the preservative is not completely fixed in the wood. This should include consideration of customer and transporter handling practices and the development of quantitative data describing preservative chemicals in kiln exhaust gases.

Two factors directly influence the design and effectiveness of containment areas for freshly-treated wood:

- the type of treated product, and
- the quantity and frequency of rainfall falling on the wood.

The type of product determines the quantity and duration of preservative drippage from freshly-treated wood. For example, fence posts are highly absorbant, drain quickly during the final vacuum cycle in the retort, and may be nearly dry to the touch immediately following pressure treatment. In contrast, plywood sheets or cedar shakes retain large amounts of preservative liquid as free surface residual, and liquid preservative continues to bleed and drip from treated wood for 24 to 48 hours after removal from the retort.

The amount of precipitation incident on freshly-treated material determines the amount of residual chemical washed from the surface of the wood as well as the total volume of contaminated runoff. The quantity and frequency of precipitation vary substantially with geographical location in B.C. Areas of high rainfall can generate several Imperial gallons of contaminated runoff per square meter of storage surface per hour and facilities with exterior storage must provide holding capacity for thousands of gallons of runoff.

STORAGE TIME FOR FRESHLY-TREATED WOOD ■

Quantitative data should be developed to allow assessment of storage times required for freshly-treated wood prior to subsequent processing, handling and customer pickup. Post storage procedures vary widely and include:

- customer pickup without further treatment,
- transportation by common carrier without further treatment,
- kiln drying.

CONTAINMENT OF SURFACE DRAINAGE ■

A minimum standard should be adopted for the design of effective drainage from surfaces in treated wood storage areas. Existing plants have experienced a variety of difficulties including:

- settlement of paved drainage surfaces (creating pools),
- inadequate slope of drainage surfaces (slowing drainage), and
- inadequate curbing of drainage surfaces (leading to loss of chemical to adjacent areas).

ISOLATION OF CONTAINMENT SURFACES ■

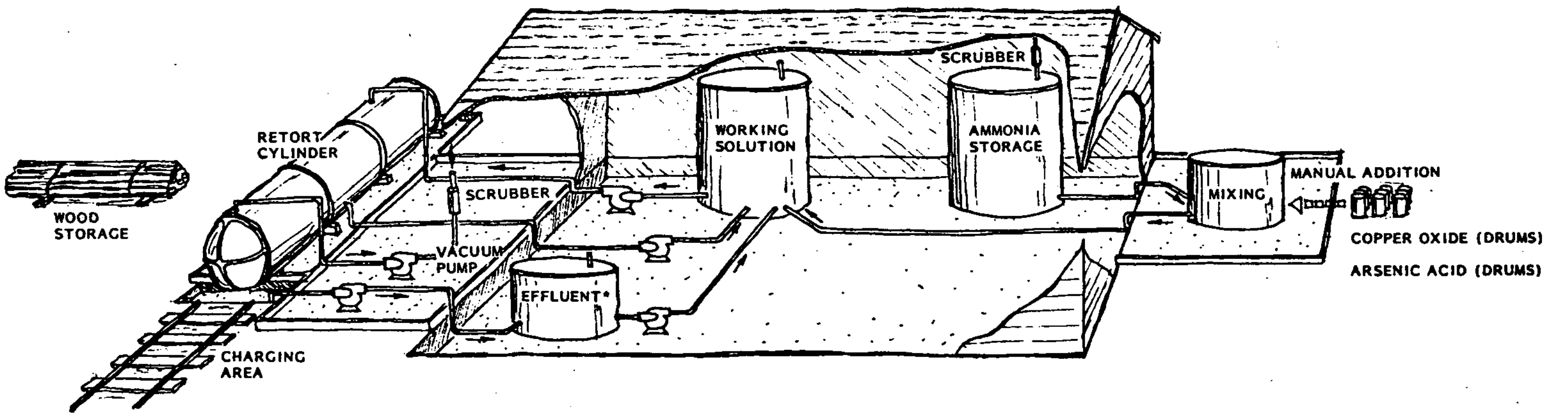
Uniform guidelines should be developed for isolating drainage and runoff return surfaces from vehicle and pedestrian traffic. At least two plants provide extensive paved drip containment systems whose effectiveness is diminished by continual tracking of contaminated liquids from the areas by vehicles and workers. A third plant effectively isolates the wood storage area but returns the drainage to the process via containment surfaces in a work area subjected to frequent pedestrian traffic.

PROTECTION FROM THE ELEMENTS ■

The need for enclosing or sheltering wood storage areas should be assessed and minimum standards should be developed. Site specific factors (such as the amount of rainfall or infiltrating dust) and economic factors (such as the cost of roofing versus the cost of collecting contaminated runoff) have generally dictated specific decisions about enclosure. One factor which has not been assessed is the long-term effect of chemical dispersal via contaminated dust generated from drainage surfaces. It appears that substantial quantities of contaminated dust can be produced at some sites, and the development of enclosure criteria should include the quantitative assessment of this factor.

DRY-TREATED WOOD STORAGE ■

The need for ground protection in dry wood storage areas should be assessed and minimum standards should be developed. Visual inspection of dry wood storage suggests that ground contamination is minor. Quantitative data should be developed to confirm this conclusion and to clarify the long-term adequacy of current practices of storing dry-treated wood on unprotected ground.



*The tank farm containment area serves as runoff storage at one plant.

FIGURE 2.7 A TYPICAL ACA PRESSURE TREATING PLANT

2.2 ACA PRESSURE TREATMENT PLANTS

2.2.1 FACILITY OVERVIEW

■ GENERAL DESCRIPTION

Two facilities in British Columbia currently provide pressure treatment of wood (chiefly poles) with ACA (ammoniacal copper arsenate) preservative. A typical ACA preservative treating plant is shown conceptually in Figure 27. The ACA treatment solution is mixed on-site from copper oxide pellets, arsenic acid and aqueous ammonia. The site-mixed twelve percent concentrate is diluted to a two percent strength working solution which is applied to the wood in a pressure retort cylinder. Treated wood is then removed to a storage yard to await shipment.

PRESERVATIVE APPLICATION ■

The full cell treatment process is always used to apply ACA preservative (see Appendix I). The treatment cycle is analogous to the CCA treatment cycle described in Section 2.1.1.

CHEMICAL CONTAINMENT AND RECOVERY ■

The design and operation of the closed system utilized by ACA plants is similar to that employed by CCA plants (Section 2.1.1). A longer vacuum period (60 minutes) is used in the ACA process. Excess treatment solution is recovered and re-used. Contaminated fluids from containment areas are collected, filtered, stored and re-used as make-up water for preparing new treatment solution. Containment systems are utilized for process areas and tank storage, but B.C. plants do not provide containment surfaces in retort charging or wood storage areas. All treated wood is stored on unprotected ground surfaces.

CHEMICAL DISCHARGES ■

ACA treatment plants attempt to recycle all contaminated process liquids and no process liquid waste streams are discharged. Minor drips or washoff of treatment chemical from treated wood may be released to the ground or contained in site runoff. Debris from the retort sump, the retort and the filters constitutes the only solid waste generated by the process. Intermittent sources of air emissions include the vacuum pump exhaust, tank vents, and fugitive emissions from mixing operations. Air emissions from ammonia storage tanks and vacuum exhaust systems are scrubbed and contaminated fluids are returned to process.

2.2.2 SUPPLY AND STORAGE OF CHEMICALS

■ DESCRIPTION

Both B.C. plants prepare ACA solution on-site by mixing the chemical ingredients. Copper is supplied as solid copper oxide pellets packaged in 227.5 pound metal drums. These drums are stored in an enclosed, paved process area at one facility and on an exterior platform adjacent to the chemical mixing area at the second facility.

Arsenic acid is supplied as 75% concentrate in 450 pound returnable plastic drums. One facility stores the arsenic acid inventory (about 30 drums) with other chemicals in a roofed, concrete block wall building. The building has a flat, drain-free floor which is several centimeters below grade. The second facility stores arsenic acid drums in a fenced, exterior area located on unsurfaced ground with no containment curbs.

Ammonia is supplied as a 29% liquid concentrate which is delivered by bulk tank trucks at both facilities. Full tank containment capacity is provided in a roofed, concrete-paved and dyked storage area at one facility. The delivery pad area is paved but not curbed at this site. The second facility provides limited containment of the exterior ammonia storage tank which is mounted on unsurfaced ground and surrounded by a 0.5 meter high concrete curb. The delivery pad for this tank is located on unprotected ground. The ammonia concentrate storage tanks at both facilities are vented to scrubbers and liquid effluent from the scrubbers is returned to the process as dilution water for preparing the treating solution.

■ ASSESSMENT

No actual mishaps associated with chemical storage were reported at either ACA treatment facility, although several current practices and circumstances contribute to the risk of a mishap which might present significant danger to workers or the environment. The general level of maintenance, housekeeping and safety awareness was exceptionally good at one facility and acceptable but limited by design constraints at the second, older facility. This suggests that a review of operating procedures should be undertaken with a view to establishing minimum standards of design which facilitate maintenance and housekeeping.

The acceptability of unsegregated storage of several chemicals in a common storage area should be reviewed and minimum standards of isolation should be established. One facility stores drums of arsenic acid adjacent to a large inventory of bagged PCP granules. Other non-toxic chemicals are also stored in this area on a casual basis. These circumstances create the potential for the inadvertent (and perhaps undetected) cross-contamination of chemicals. A major spill in the area would create a very difficult cleanup situation.

Minimum standards of shelter should be established for the storage of containerized chemicals. One of the facilities stores arsenic acid in an exterior location. The acceptability of unroofed storage for such highly-toxic, water-soluble chemicals should be carefully reviewed.

Several of the general conditions and requirements for CCA handling and storage (discussed in Sections 2.1.2 and 2.1.3) are also applicable to ACA plants. The specific items which should receive careful review during the preparation of a code of practice include the determination of minimum requirements for:

- ground protection in delivery and storage areas,
- spill and drip containment for ammonia storage,
- fluid level indication for ammonia tanks,
- level alarms and overflow protection, and
- backflow prevention.

Although no spills or overflows of ammonia were reported, there was visual evidence that tank overflow has occurred at one of the facilities. A minimum standard should be established for positive measures to prevent tank overflow spills from occurring. The need for spill prevention is particularly important at the facility which provides dyked tank containment on unsurfaced ground. Rainfall in the exterior, dyked area creates a high potential for groundwater contamination.

2.2.3 CHEMICAL MIXING AND HANDLING

■ DESCRIPTION

Concentrated ACA solution at twelve percent concentration is prepared by mixing the copper oxide, arsenic acid and ammonia in an agitated mixing tank. The concentrate is then further diluted to obtain the working preservative treatment solution of concentration of approximately two percent.

Both facilities prepare the ACA concentrate by manually adding the copper and arsenic ingredients to the mixing tank. Solid copper oxide is added through an access hatch in the mixing tank. One facility uses a top hatch and a permanent mechanical support frame positions and holds the copper oxide drums during addition to the tank. The second facility uses a side hatch located near the bottom of the tank and copper oxide is manually added through the hatch. At both facilities, arsenic acid is pumped directly from the drums to the mixing tank. The tank is then sealed and filled to the appropriate level with ammonia solution.

The mixing tank and platform at one facility is in an exterior location and is totally exposed to the elements. The work area is a wooden platform elevated one meter above grade and underlain by unsurfaced ground contained by a concrete curb. The tank and working area at the second facility are in a totally enclosed building with a paved concrete floor. The mixing tank area is contained by a concrete curb and drains to a larger paved and dyked containment area which is provided for the liquid storage tanks.

■ ASSESSMENT

There are two principal concerns about current facilities and procedures for mixing ACA solutions from chemical ingredients:

- the extent of manual operations required, and
- shelter and containment of the mixing systems.

The preparation of treatment solution from individual ingredients is a process which inherently requires considerable manual handling of the chemicals.

Although the safety procedures at both facilities are well-defined and rigorously implemented, there should be a review of the equipment and procedures to determine if it is possible to reduce the extent of manual handling and direct exposure to the chemicals. This review should give consideration to minimum standards for shelter of the working area. It is likely that the exposed working area at one facility significantly increases the risk of mishap during inclement weather. On the other hand, the exterior working area reduces the probability of exposure to air emissions.

A minimum standard should be established for spill and drip containment in the mixing area. ACA releases to unprotected ground surfaces create the potential for groundwater contamination.

In preparing a code of good practice, the mixing facilities at ACA treatment plants (including tankage for dilution of mixed concentrate to working treatment solution) are generally subject to a review of process features which are similar to those for CCA mixing systems (discussed in Section 2.1.5). This review should include the consideration of minimum standards for:

- solution concentrate feed systems,
- process control,
- overflow prevention and containment, and
- backflow prevention.

2.2.4 TREATMENT PROCESS SYSTEMS

■ DESCRIPTION

Process systems for ACA facilities are similar in concept to the features described for CCA treatment plants (Section 2.1.4). The variations in key features of the two B.C. facilities using ACA preservatives are summarized on the following page:

SHELTER

One facility provides permanent roofing (with exposed sides) over the solution storage tank containment area. Polyethylene tarps have been used to fashion improvised (but effective) shelter for the pressure treating cylinder. Infiltrating precipitation is blocked and the volume of contaminated runoff which is collected by the containment system is greatly reduced. The process components of the second facility are fully exposed to the elements. The treatment process control areas are enclosed at both facilities.

SURFACES AND SPILL CONTAINMENT

All process components at both facilities are isolated by containment curbs or dykes. Curbs are installed on unsurfaced ground at one facility. These curbs are fashioned from concrete poured in vertical plywood forms which have been left in place. The maximum curb height is 0.5 meters and the total containment volume is substantially less than the volume of the largest contained component.

Containment at the second facility consists of concrete curbs or dykes and integral concrete containment floors. The contained volume is substantially greater than the volume of the largest single process component and tankage is available to provide additional containment volume for contaminated precipitation which is collected by the dyked containment system.

DRIP CONTAINMENT

Effective local drip containment is provided for pumps and valving located in the enclosed process area of one facility. No local drip containment is provided at the second facility and leaks from pump seals, flanges or valves mix with other fluids which accumulate in the curbed process area.

CHEMICAL RECYCLE SYSTEMS

Both facilities collect and re-use treatment solution and contaminated runoff in the same manner as that described for CCA plants (Section 2.1.4). Both facilities use subgrade door sumps as the primary collection point for residual treatment solution which drains from the treatment cylinder. Both facilities accumulate returned fluids in above-ground tankage. Substantial reserve capacity is provided for storing infiltrating precipitation at one facility and pumps are located above the maximum fluid level of the subgrade spill containment area. Major process components at this facility are isolated from each other by containment curbing. The second facility does not isolate individual process components and transfer pumps are located below the maximum fluid level of the common containment area.

PIPING ■

Most interconnecting piping at both facilities is above ground and reasonably accessible. Piping is generally located over containment areas and one facility provides accessible containment channels for subgrade piping which connects the isolated retort, process and tankage areas.

PROCESS CONTROLS ■

Both plants use centralized control panels with control of the treatment process from a remote area. Visibility of the treatment area from the control point is reasonably good at one facility, and poor at the second.

RETORT CYLINDERS AND DOORS ■

Both facilities use typical pressure retort cylinders with conventional positive warning devices to prevent inadvertent door opening when the cylinder is pressurized with fluid. One facility uses a hinged, quick-opening door and the second uses a suspended door which is sealed with multiple bolts.

WASTE TREATMENT ■

ACA plants operate as closed systems and do not require waste treatment facilities. All contaminated liquids are recovered and returned to the process as described previously. As a result, no liquid process waste streams are produced directly by ACA plants in B.C.

Ammonia storage tank vent emissions exhausted from the vacuum pump systems are discharged through scrubbers and all fluids are re-used as make-up water for preparing treating solutions.

Small quantities of solid debris are produced from cleanout of the retorts and retort sumps (reportedly no more than a few drums annually) and this material is stored on-site pending identification of suitable disposal.

■ ASSESSMENT

The two existing ACA facilities represent different levels of sophistication in design safeguards. One facility generally exhibits a wider range of safeguards which were incorporated as a part of a total system design and installed during the construction of the plant. The other facility was originally built without containment systems and many of the current safeguards have been added on over the years. This forms a practical constraint to the effectiveness of safeguards which have been or could be retro-fitted at the latter facility. It is likely that significant additional upgrading at this facility cannot occur without substantial renovating and reconstruction.

Specific features which should be considered in preparing a code of good practice are the same as those discussed for CCA plants (Section 2.1.4) and include the development of minimum standards for:

- shelter, surfaces and spill containment,
- drip containment,
- chemical recycle systems,
- piping,
- process controls,
- retort cylinders and doors, and
- disposition of solid process residues.

2.2.5 CHARGING AND WOOD STORAGE AREA CONTAINMENT

■ DESCRIPTION AND ASSESSMENT

The charging track and treated wood storage at both ACA facilities are located on exterior, unsurfaced ground. Both facilities are primarily used for treating poles, which are relatively low-drip products (compared to high-drip products such as lumber and plywood). A major problem of ground contamination is not apparent from visual inspections of either facility although occasional evidence of chemical drippage can be found. As with the CCA industry, there is an inadequate quantitative information base for evaluating chemical losses from treated wood. Limited site monitoring has been undertaken at both ACA sites and these data are discussed in Section 4.3.2. Although the containment requirements for poles are less stringent than for high-drip products, the specific subjects which should be considered in preparing a code are identical to those discussed in the assessment of the CCA industry (Section 2.1.9). This review should establish minimum requirements for:

- a quantitative chemical release survey,
- site monitoring standards,
- wood storage area design standards,
- freshly-treated wood storage containment and minimum storage time,
- containment and isolation of site drainage,
- protection from the elements, and
- dry treated wood storage.

2.3 CREOSOTE AND PCP PRESSURE TREATMENT PLANTS

2.3.1 FACILITY OVERVIEW

■ GENERAL DESCRIPTION

Two British Columbia facilities currently provide oil-borne creosote and/or oil-borne PCP pressure treatment of wood. A typical oil-borne pressure treatment plant is shown conceptually in Figure 2.8. Creosote and heavy and light petroleum oils (carriers for creosote and PCP) are delivered by bulk truck or rail tanker and stored in a tank farm. PCP is supplied as solid granules and mixed with the light petroleum oil to form a 5 percent strength PCP treating solution. Creosote is applied directly or as a 50 percent solution in heavy petroleum oil. All treating solutions are applied to wood in pressure retort cylinders. The treated wood is then removed directly to yard storage to await shipment.

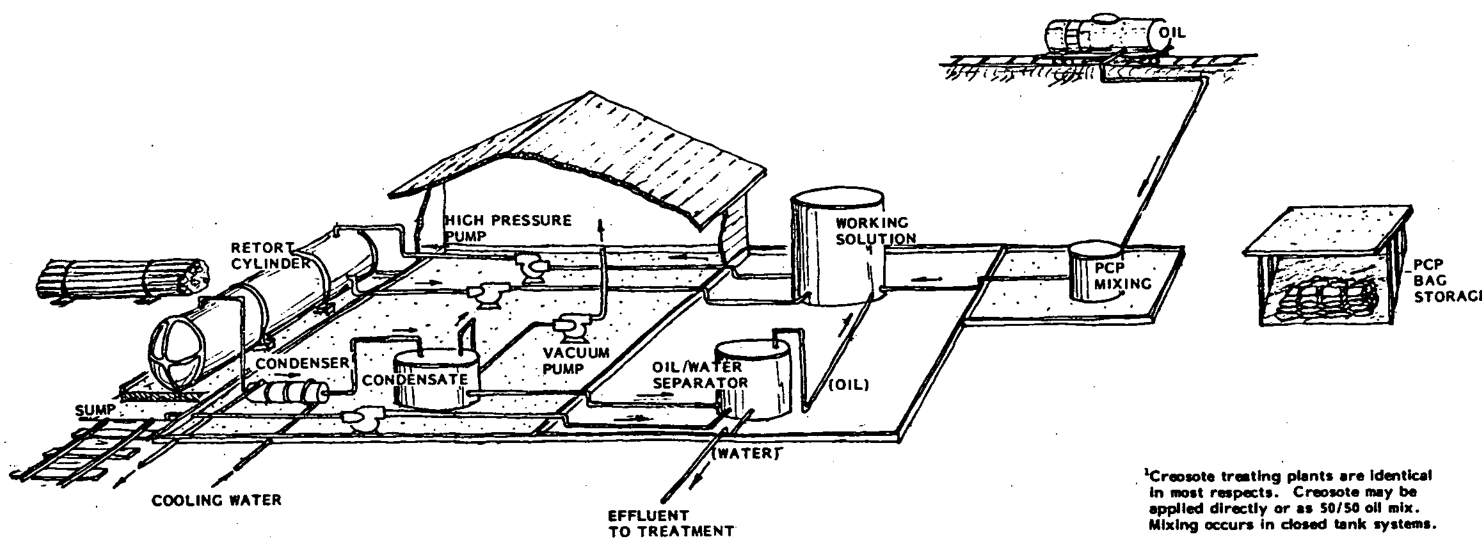
WOOD CONDITIONING ■

One of several conditioning processes is used to reduce the moisture content of the wood to the proper level for preservative application (Appendix 1). Conditioning processes which are carried out in the treatment cylinder include direct or indirect steaming, heating under pressure, and boiling under a vacuum in the presence of the treating solution (Boultonizing). Specific allowable conditioning processes are stipulated by CSA and AWPA standards for given wood products (Appendix 2).

PRESERVATIVE APPLICATION ■

Both full cell and empty cell treatment processes are used to apply oil-borne preservatives (Appendix 1). The treatment cycle is carried out in the pressure retort cylinder and consists of some combination of the following steps:

- conditioning (as described above),
- flooding of the cylinder with hot oil, *or*,



[1]Creosote treating plants are identical in most respects. Creosote may be applied directly or as 50/50 oil mix. Mixing occurs in closed tank systems.

FIGURE 2.8 A TYPICAL OIL-BORNE PCP[1] PRESSURE TREATING PLANT

- application of air pressure and flooding of the cylinder with hot oil while maintaining this pressure,
- pressurization until the target preservative retention level is achieved,
- application of an "expansion bath" (reheating to the maximum temperature), draining of the excess preservative to the work tank (for subsequent re-use), and,
- application of a final vacuum and/or steaming.

The specific allowable processes for a given wood product are dictated by CSA and AWPA standards (Appendix 2). These standards also define the acceptable range of treatment times, temperature and pressures.

CHEMICAL CONTAINMENT AND RECOVERY ■

Oil-borne pressure treatment facilities in B.C. do not provide the same degree of chemical containment and recovery found in most water-borne systems. Water from wood moisture and infiltrating precipitation limit the recovery and re-use of treatment oils. The difficulty and high cost of separating and treating oil-water mixtures have retarded the development of recovery systems at these plants.

Both existing facilities have provided collection sumps to recover residual preservative from door drippings. Containment surfaces have not been provided for the retort charging track areas or the treated wood storage areas at either facility in B.C. Neither plant provided retort nor tank farm containment in the original design and both plants have been upgraded with improvised perimeter dykes.

CHEMICAL DISCHARGES ■

Oil-borne treatment plants produce substantial quantities of preservative contaminated process water which is composed of:

- condensed moisture extracted from wood,
- infiltrating precipitation, and,
- miscellaneous washdown, sealing, and cooling waters.

B.C. plants currently provide or plan to provide wastewater treatment for these liquid discharges. "Uncontaminated" process liquids (such as indirect cooling water) are generated and discharged without treatment at both plants. As with other types of facilities, minor drips or washoff of treatment chemicals from treated wood may be released to the ground or contained in site runoff.

In addition to solid wastes consisting of sump and retort debris, one oil-borne plant in B.C. generates sludges from wastewater flocculation and spent carbon wastes from activated carbon treatment systems. All of these solid wastes are contaminated with preservative chemicals. Spent carbon is currently regenerated in the U.S.A. All other solid wastes are stored on-site and economical, approved disposal alternatives have not been identified.

Sources of intermittent air emissions include vacuum system condenser exhausts, retort doors, and tank vents. Fugitive emissions of PCP dust and vapors may also be produced during mixing operations. No treatment of discharges to air is currently provided at either B.C. facility.

2.3.2 TRANSPORTATION, OFF-LOADING AND STORAGE OF CHEMICALS

■ DESCRIPTION

PCP ■

Both facilities currently use solid PCP granules which are packaged in 50-pound plastic bags. These granules are manufactured by UniRoyal at Fort Saskatchewan, Alberta for distribution by Domtar Chemicals Inc.[1] The bags are palletized with a plastic overwrap and delivered by truck or rail.

Both facilities maintain an inventory of several hundred bags of PCP. Storage for PCP is enclosed at both plants. One facility stores PCP with other chemicals in a roofed, concrete block wall building which is segregated from the treatment area. The building has a flat, drain-free floor which is several centimeters below grade. The second facility stores PCP in a roofed and enclosed building which houses the PCP/oil mixing facility. The elevated floor of the storage area also serves as the unloading platform for rail deliveries of PCP.

CREOSOTE ■

Creosote is used at only one facility in B.C. and is manufactured by Domtar in Hamilton, Ontario and delivered by bulk rail or truck tankers. Unloading points are located on unsurfaced ground with no containment dyking. At the time of delivery, creosote is pumped directly to tank storage via permanent piping systems which incorporate both above-ground and buried piping. Bulk creosote tanks are located in a tank farm which also contains storage tanks for creosote/heavy oil and PCP/light oil treating solutions. The tank farm is segregated, paved with asphalt, and surrounded by a concrete dyke designed to contain the volume of the largest tank.

PETROLEUM OILS ■

A heavy petroleum oil is used to dilute creosote to 50 percent solution for treating wood products which do not require treatment with pure creosote. A

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[1]*PCP production by this company was discontinued in December 1983.*

light petroleum oil is used for preparing the 5 percent treating solution of PCP. These oils are delivered by bulk truck or rail tankers and the oils are normally mixed with the appropriate preservative chemical at the time of unloading (Section 2.3.3). Unloading points at both facilities are located on unsurfaced ground with no containment dyking.

Petroleum oil storage at one facility is in the paved, dyked and segregated tank farm described above. Storage of oils at the second facility is in a tank farm located on unsurfaced ground and dyked by sand-filled plywood curbs designed to contain the volume of the largest tank. The tank farm is not totally segregated from the adjacent treatment facility and some of the tanks are contained by dyking which also encompasses the retort cylinders and other equipment in the treatment area.

■ ASSESSMENT

Visual evidence (chemical stains on tank sides) indicates that minor spills or storage tank overflows have occurred at oil-borne treatment facilities although the circumstances of these releases have not been documented. There is also substantial accumulation of petroleum oil (preservative-free) in surface soils at the rail off-loading site at one facility. This residue reportedly originates from drippage of oil from the exterior of rail cars contaminated during cold weather loading at the source of supply. The congealed oil is reliquified and lost to ground when the contents of the rail cars are heated during off-loading operations in cold weather. These oil releases are uncontained and enter the surface drainage ditch system serving the site.

These examples underscore the need for a careful review of the adequacy of current spill or drip prevention and containment measures in off-loading and storage areas at oil-borne preservative treatment facilities. Specific factors which should receive special attention during the review include:

- the detection of leaks in insulated tanks,
- the adequacy of unprotected ground as a surface in areas subject to spills and drips of preservative chemicals, and,

- the feasibility and effectiveness of recovery and clean-up operations if a spill were to occur in an unsurfaced containment area.

Consistent minimum standards of isolation should be developed for bagged PCP storage areas. One facility stores PCP adjacent to other toxic chemicals (arsenic acid) and other non-toxic materials are stored in the enclosure on a casual basis. The second facility stores bagged PCP in a multi-use area which includes activities associated with the off-loading from bulk rail tankers.

In addition to consideration of the above items, many of the general conditions and requirements for chemical handling and storage (discussed in Section 2.1.3) are applicable to oil-borne treatment plants. Items which should receive careful review during the preparation of a code of practice include the determination of minimum requirements for:

- fluid level indication,
- level alarms and overflow protection, and,
- piping standards.

2.3.3 CHEMICAL MIXING AND HANDLING

■ DESCRIPTION

PCP ■

The equipment and procedures for preparing PCP/light oil treating solutions are similar at the two existing plants in B.C. In order to reduce storage and handling requirements, the mixing procedure is normally carried out when the light petroleum oil is off-loaded. The required quantity of PCP granules is added to oil in a blending tank, mixed, and recirculated through the treating oil storage tank to ensure a uniform concentration.

The blending tank is a non-agitated, closed vessel of approximately 350 Imperial gallons capacity. Unlike U.S. practices for handling bulk PCP granules (NIOSH, 1983), bagged PCP granules are added manually through a top hatch and the door of the hatch is then sealed while the initial mixing takes place (by recirculation). Full protective equipment is required for workers during handling operations with PCP and detailed safety procedures are stipulated (see Section 5.4.3).

The mixing tank at one facility is located within the paved and dyked containment area of the oil tank farm. The area is segregated from the tank farm containment by a concrete curb which encompasses the mixing tank and associated pump and piping. The curbed area is roofed but not enclosed.

The mixing tank at the second facility is located in an enclosed, corrugated metal building. The elevated working platform also serves as the storage area for PCP bags and the unloading platform for rail deliveries of the bagged chemical and bulk oils. The mixing tank is located on a concrete floor which has a low (5 centimeters) concrete curb around the perimeter. The entire building area is served by an exhaust fan, and a sheet metal hood above the tank loading hatch provides local ventilation during PCP handling operations.

CREOSOTE ■

Creosote blending with oil occurs in a closed piping system. Mixing occurs within the tank farm area which is described in Section 2.3.2. Mixing operations are normally undertaken when oil is delivered in order to minimize the number of transfer operations.

■ ASSESSMENT

PCP ■

The primary concerns about the mixing and handling of chemicals at oil-borne preservative plants are related to the exposure of the workers to PCP. Current practices at both plants require the manual dumping of PCP granules from bags to the open hatch of a mixing vessel. Although stringent procedural safeguards are applied, the potential for worker exposure is inherent to this "open" transfer process. It is recommended that the preparation of a code of practice include an assessment of the feasibility of utilizing totally enclosed hatch systems which would eliminate direct worker exposure to dust or vapors from PCP during debagging. If open transfer systems are to be retained, there should be a review of the effectiveness of measures for worker protection which are currently required during PCP mixing operations. This review should include a quantitative assessment of fugitive PCP dust levels in mixing areas and should lead to:

- the establishment of minimum requirements for face and breathing protection used during PCP handling operations, and,
- minimum standards for local and area ventilation in interior mixing areas.

CREOSOTE ■

No serious design deficiencies were identified for physical facilities for mixing and handling creosote. Mixing and transfer of creosote and creosote-containing oils are carried out in closed systems at the single B.C. plant which uses these preservative fluids, and improper exposure to workers and the environment does not occur under normal circumstances. As noted in Section 5.5.3, an apparent complacency of workers about the potential hazards of creosote exposure suggests that the effectiveness of worker education programs should be reviewed.

2.3.4 TREATMENT PROCESS SYSTEMS

■ DESCRIPTION

Process systems for oil-borne preservative facilities are similar in concept to those described for CCA treatment plants (Section 2.1.4). As described in Section 2.3.1, the principal differences between the two systems arise from the unavoidable presence of oil/water mixtures in the oil-borne treatment process and the subsequent requirements for containing and treating these mixtures.

The older of the two B.C. oil-borne plants was established in 1930. The historical development of this facility took place prior to the development of the current level of environmental awareness and economic pressures to recover treatment chemicals. As a consequence, containment and chemical recovery systems for oil-borne plants are less sophisticated than CCA plant systems which have generally developed in the last decade. In contrast with CCA facilities, oil-borne plants have evolved waste treatment systems to treat aqueous waste streams which are generated by the process and cannot be recycled because they are incompatible with the preservative oil.

SHELTER ▪

Both B.C. facilities are similar in the type and extent of shelter. Retorts and tank farms are exterior. One of the facilities provides roofing (but not enclosure) of the retorts to minimize infiltration of precipitation to local containment curbs around the retorts. Major process components (including pumps, valving, and process control components) are centralized and located in heated enclosed buildings.

SURFACES AND SPILL CONTAINMENT ▪

The process treatment buildings at both facilities have paved concrete floors. Pumps for transferring preservative between the retort and tankage are located in a subgrade work area at both facilities. Fluids which leak or infiltrate to these areas are collected and pumped to the waste treatment system. All other process components in the treatment building are located at or above grade level. Neither facility has provided curbs or dykes around the foundation perimeter of the treatment building, but the buildings at both facilities are within the larger dyked areas which contain the treatment retorts.

A common feature at both facilities is the use of sandfilled plywood dykes surrounding the perimeter of the treatment area (including the process building and the retorts). Except for the process buildings, the exposed ground within this containment area is unsurfaced at both facilities.

Containment features which are different at the two facilities including the following:

1. One facility provides no segregation of the retorts, which are mounted on unsurfaced ground within the larger dyked treatment area. Incidental precipitation soaks into the ground surface. The second facility provides concrete curbs around each retort to isolate it from the larger dyked process area. Surface runoff from the dyked area is collected and pumped to the waste treatment system.

2. The dyked process area contains the complete tank farm at one facility. The second facility has a segregated tank farm. Working preservative solution tanks at this facility are located above the process building within the dyked treatment area.

3. The PCP mixing building is contained within the treatment area at one facility. At the second plant the PCP mixing facility is located outside the treatment area (in the segregated tank farm).

DRIP CONTAINMENT ■

Local containment of drips from valves, flanges, pumps, seals and other process equipment is not provided at either facility. Drips are generally confined to the larger containment surfaces within the treatment process area. Within the process building, drips are washed down to sumps and pumped to the waste handling system with other contaminated liquids. Incidental drips in exterior contained areas generally accumulate on ground surfaces.

CHEMICAL RECYCLE SYSTEMS ■

Vapors withdrawn from the retort cylinder during the conditioning portion of the treatment cycle contain both oil-borne preservative and water. This vapor stream is condensed, collected in "drip" tanks and pumped to settling tanks where the oil phase is separated from the water phase. The preservative oil is returned to the storage tanks for re-use and the contaminated water is pumped to the waste treatment systems described in a subsequent section. Other miscellaneous contaminated mixtures generated in the treatment process (for example, drips from door sumps, wash waters and leakes from glands, valves and fittings) are also settled to recover the free preservative fluid and the aqueous phase is then treated.

PIPING ■

Both facilities are of older design and piping systems are complex relative to CCA plants. The older of the two plants has undergone considerable modification in its fifty-plus years of existence and much of the piping is buried or inaccessible.

PROCESS CONTROL ■

Monitoring of process parameters (temperatures, pressures and preservative fluid working tank levels) is centralized at both plants. Most process valving and component functions are controlled manually at the location of the process component.

RETORT CYLINDERS AND DOORS ■

Conventional retort cylinders are employed at both facilities. These cylinders are subject to all inspections and certifications required for any pressure vessel. As with other types of preservative plants, the cylinders are supported on concrete piles placed at intervals along the length of the cylinder. Hinged, bolt closure doors and hydraulically operated "quick-opening" doors are used at both facilities.

WASTE TREATMENT SYSTEMS ■

LIQUID WASTES □

A process diagram of waste treatment systems employed at one of the facilities is shown in Figure 2.9. Contaminated process streams are collected in settling tanks to recover preservative oil. The aqueous phase is then

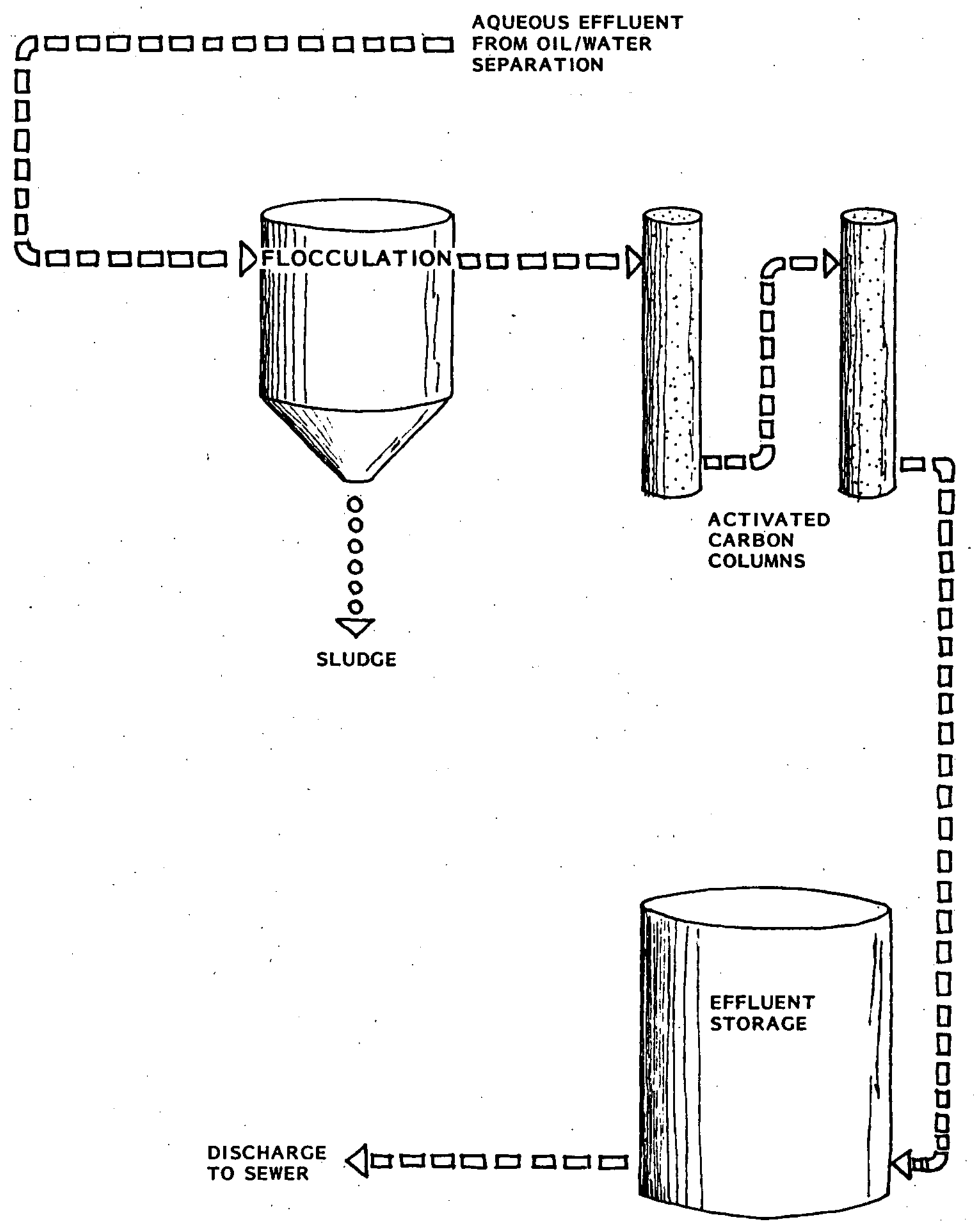


FIGURE 2.9 CREOSOTE/PCP LIQUID EFFLUENT TREATMENT SYSTEM

treated with polymer and flocculated to remove emulsified oils. The sludge is removed for disposal (to an approved secure chemical landfill in the United States) and the aqueous effluent is then passed through two activated carbon columns in series to remove phenols, chlorophenols and dissolved oils. Treated effluent is discharged to a municipal sanitary sewer system under the terms of a permit administered by the Greater Vancouver Regional District.

General surface drainage from the yard, steam condensate and condenser cooling water from closed systems are treated as uncontaminated fluids. These streams are discharged via surface drainage ditches to an adjacent river and this discharge is regulated under the terms of a Waste Management Branch permit (see Section 4.4.3).

The second facility does not currently have a comparable waste treatment system although the installation of sand filters and activated carbon treatment columns is planned. Settling is currently provided for contaminated waste streams. The settled water is then accumulated in a storage tank, heated to concentrate the oil phase by evaporating water, skimmed and discharged to an on-site exfiltration lagoon located adjacent to the wood treating area. The lagoon also receives site surface drainage, boiler blowdown from on-site steam generation, compressor cooling water and backwash from water softeners. Waste streams discharged to the lagoon are regulated under the terms of a permit administered by the regional Waste Management Branch.

SOLID WASTES □

Solid wastes produced at oil-borne treatment plants include:

- waste treatment system residues (flocculation sludge and spent activated carbon), and,
- sludge and debris from infrequent periodic cleaning of retorts.

Waste treatment residues are currently produced at only one site. Flocculation sludges are drummed and stored on-site pending the development of approved disposal options in B.C. Activated carbon is shipped to a U.S. firm for regeneration. Reportedly, small quantities of miscellaneous cleanout sludge and debris are produced at both sites (of the order of a few drums per year). This residue is currently drummed and stored pending identification of an acceptable disposal method. Until recently, one of the facilities burned sludge and solid debris from the treatment process.

AIR EMISSIONS □

Intermittent air emissions containing PCP and creosote vapors are produced at various process points including:

- tank vents,
- vacuum system exhausts,
- condenser exhausts, and,
- retort doors.

Although vapor and odor control systems have been installed at similar oil-borne plants in other provinces, neither B.C. facility currently provides treatment of any of its discharges to air.

■ ASSESSMENT

This statement of assessment for existing oil-borne pressure treatment facilities acknowledges that the older of the two existing B.C. facilities was designed and built in an era of low environmental awareness relative to current standards. The age and design of the physical facilities place inherent constraints on the feasibility of retrofitting this facility with modern process and containment features. It is also acknowledged that many of the more obvious deficiencies of the plant have been recognized by the plant management and are being mitigated by a planned program of improvements which has been negotiated between the plant management and the B.C. Waste Management Branch.

SHELTER, SURFACES AND SPILL CONTAINMENT ■

There is a need to adopt a uniform standard of facility conceptual design which integrates the requirements for shelter, surfaces and spill containment. This standard should stipulate minimum requirements for shelter and ground surfaces in process treatment areas. Unsheltered, unsurfaced, dyked areas do not provide effective containment for spills. Cleanup of major spills from such areas would be cumbersome and inefficient. Infiltrating rainfall generates contaminated aqueous wastes and unsurfaced ground creates the potential for ongoing contamination of groundwater beneath the process area.

A minimum standard should be established for the construction and effectiveness of containment dykes. Reinforced concrete curbs or dykes are in common use in most industries and sand- or earth-filled dykes are outdated and of questionable effectiveness.

A minimum standard should be established for process component segregation. Containment curbs currently in use at both B.C. facilities generally encompass large areas. Isolation of major individual process components by local curbing or dyking within these areas would enhance control and cleanup of spills.

The requirement for subgrade pump mounting should be critically assessed at sites which have high water tables. A minimum standard for hydrogeological isolation should be established for circumstances which require subgrade installations. Groundwater infiltration to subgrade pump mounting areas generates substantial quantities of contaminated water at one of the existing facilities.

Minimum requirements should also be determined for features which would facilitate the cleanup of spills which might occur in contained areas. For example, controlled drainage to pump out sumps should be provided in spill containment areas. Potentially flooded surfaces within these areas should be accessible and cleanable. Containment areas at existing facilities do not fulfill these requirements.

DRIP CONTAINMENT

A minimum requirement should be established for features to localize minor drippage from process components.

CHEMICAL RECYCLE SYSTEMS

The chemical recycle systems at existing facilities have evolved over the life of the plants and neither facility was designed for high efficiency recovery of preservative chemicals. The older facility utilizes steam ejectors for producing vacuum in some of the retort systems and this contributes to the volume of aqueous waste which is produced. Because of its age and location in an area of high rainfall, the facility is generally subject to extensive infiltration of groundwater and precipitation. These conditions interfere with efficient chemical recovery.

The second facility is similar to the first in design and construction of recycle systems but currently has less efficient separation capability for recovering oils from oil/water mixtures (see Waste Treatment Systems). However, it is likely that better overall control of preservative is achieved at the younger facility because of its generally better physical condition and more careful attention to maintenance and housekeeping.

If new oil-borne pressure treatment plants are built within B.C., a stringent and comprehensive conceptual design standard should be established for chemical recycle systems. New plants should be subject to the requirements of this standard.

The requirements of a new design standard would impose major modifications on both existing facilities and this is unrealistic. A more productive approach would entail a review of existing recycle systems to quantitatively assess the efficiency of chemical recovery and to identify points of significant chemical loss from existing systems. A minimum requirement should be established for overall chemical recovery of preservative at existing oil-borne treatment facilities. This would first require a quantitative mass balance to determine current recovery efficiencies and to identify routes of preservative loss that can be improved or eliminated. It is acknowledged that precise quantification of preservative movement in recovery systems is unrealistic. The objective of the mass balance approach is to provide a tool for assessing (and therefore improving) the current performance of recovery systems.

A minimum standard should be established for containment area conceptual design to prevent tracking and unnecessary exposure of workers to accumulated preservative fluids. For example, one facility uses a door sump configuration which requires workers to stand in accumulated drippings and debris on the sump floor while the retort door is being positioned or secured. The second facility overcomes this difficulty by using over-floor grates to provide a clean, sound footing for workers during this activity.

PIPING ■

A minimum standard should be established for the conceptual design and maintenance of piping systems. This standard should strive for simplicity and accessibility. Where practicable, existing plants should upgrade piping systems to meet this standard. One undesirable feature of existing facilities (particularly the older plant) is the extensive use of buried and inaccessible piping. This contributes to the potential for undetected leaks. A second feature inherent to older plants is the complexity of the piping systems (as a result of modifications and disused piping). This obscures the functional relationship between process components and contributes to the potential for operator error or neglect of proper maintenance and housekeeping.

PROCESS CONTROL ■

A uniform standard of process control should be established. Where practicable, existing facilities should upgrade any deficient control systems to comply with this standard. Components of the standard should include:

- simplicity,
- clarity of relationship between controls and process functions,

- visibility of process components from the control point, and,
- emphasis on the use of effective alarms and interlocks to prevent safety-related operator errors.

RETORT CYLINDERS AND DOORS ■

No problems directly involving retort cylinders or doors were identified. The current requirements for testing and certifying pressure vessels appear to provide an adequate standard for retort vessel specifications and mechanical condition. A minimum requirement should be established for the provision of protective devices to prevent inadvertant door openings and a mandatory requirement for door opening indicators and process interlocks should be considered where control points are remotely located (as is the case with both existing facilities).

WASTE TREATMENT SYSTEMS ■

LIQUID WASTES □

A consistent minimum standard should be established for the treatment, monitoring and analysis of liquid wastes which are discharged from the sites of oil-borne treatment facilities. These wastes can be adequately treated using conventional physical/chemical processes which have been developed by the industry. Although the discharge of liquid wastes now appears to be adequately regulated at the one facility which provides treatment (see Section 4.4.2), the proper disposition of these wastes is relatively recent. During the early history of the plant, these wastes were discharged to vacant portions of the site, released to the adjacent river or "incinerated" in an ineffective liquid waste burner. The second facility currently controls dispersal of the untreated liquid waste streams by discharge to an on-site "exfiltration" lagoon. The facility is located in a relatively dry climate and the liquids eventually soak into the ground. The installation of a waste treatment system is being planned although a firm commitment to this improvement is contingent upon the overall economic performance of the plant.

SOLID WASTES □

Acceptable disposal options should be identified and stipulated as mandatory for PCP and creosote containing solid waste residues. An approved, controlled, in-Province disposal facility is needed for the proper ongoing disposal of these wastes.

AIR EMISSIONS □

A minimum standard should be established for controlling the numerous sources of PCP and creosote vapor emissions to air. Although most of these discharges are vented directly to the atmosphere (as opposed to the workplace), it appears that these emissions have not been quantitatively assessed to determine the significance of emissions to the workplace or to the environment. This is not thought to be a significant problem, but the appropriate monitoring studies should be undertaken to provide a sound quantitative basis for regulatory decision making.

2.3.5 CHARGING AND TREATED WOOD STORAGE CONTAINMENT

■ DESCRIPTION

Both existing British Columbia oil-borne pressure treatment plants use standard rail trams for charging the treatment retorts. At both facilities, the charging areas and all wood storage areas are located on exterior, unsurfaced ground. It is characteristic of these plants that wood storage areas are extensive (of the order of fifty acres) and wood storage times may be long (of the order of months).

■ ASSESSMENT

Based on visual evaluation, it appears that acceptable overall control of preservative losses to ground is achieved at wood storage areas on both existing sites. Occasional minor drippage of preservative to ground was observed in wood storage areas. Charging areas were more visibly contaminated. A borehole in the charging track area at one facility showed high concentrations of oils and phenols to a distance of 12 feet below ground level (see Section 4.4.2).

Neither existing plant has developed comprehensive data to allow quantitative estimates of chemical losses, and the extent and long-term significance of chemical migration off-site (in surface or groundwaters) is not clear. It is acknowledged that site-specific factors strongly influence such an assessment. These considerations should be reviewed in preparing a code of practice and the following specific items should be addressed:

QUANTITATIVE CHEMICAL RELEASE SURVEY ■

As with CCA release (Section 2.1.9), a chemical release survey should be undertaken to quantify releases of treatment chemicals from treated wood. The formulations of realistic control measures should be based on data which will allow an evaluation of the significance of chemical losses in the context of losses which occur throughout the treatment process.

SITE MONITORING STANDARDS ■

Minimum requirements should be developed for monitoring preservative chemical levels in site environments (soils, groundwaters and surface runoff). The required types of monitoring should be identified and uniform procedures should be established for their undertaking.

SURFACES ■

A minimum conceptual design standard should be established for surface protection and containment of drip areas. The requirements for surface protection should be based on the assessment of the quantitative release survey described above and should determine and specify the necessity for paved surfaces in charging and freshly-treated wood storage areas. If appropriate, storage area design standards should be stipulated.

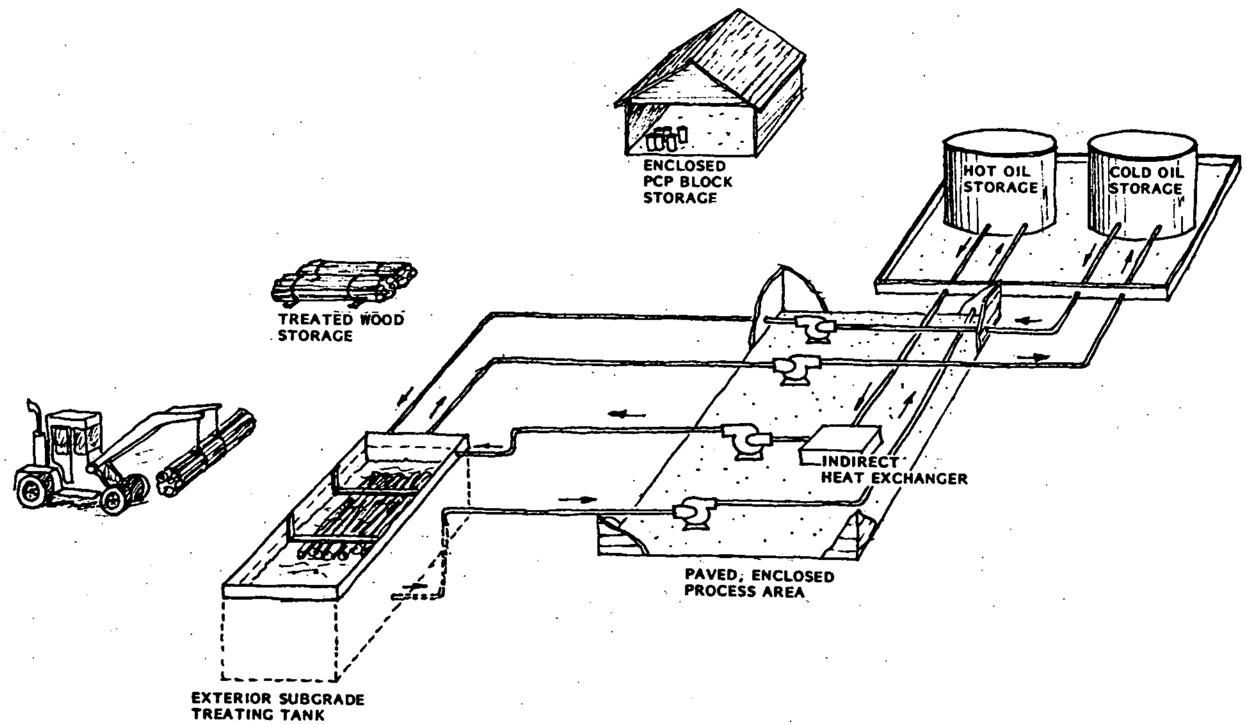


FIGURE 2.10 A TYPICAL OIL-BORNE PCP THERMAL TREATING PLANT

2.4 PCP THERMAL TREATMENT PLANTS

2.4.1 FACILITY OVERVIEW

■ GENERAL DESCRIPTION

Two facilities in British Columbia currently provide thermal treatment of wood (chiefly poles) with PCP (pentachlorophenol). A typical PCP thermal treatment plant is shown in Figure 2.10. The preservative chemical is purchased as a solid in 1000 or 2000 pound blocks which are delivered by truck. Treatment solution is prepared by dissolving these blocks in P-9 oil (AWPA standard, Appendix 2) to a concentration of 5 percent. Successive applications of hot and cold treatment solutions are applied to poles in open immersion tanks. The excess oil is then returned to storage tanks, the poles are drained in place in the treatment tanks, and the poles are removed to treated wood storage to await shipment.

PRESERVATIVE APPLICATION ■

Thermal treatment with PCP in oil is a non-pressure process which is analogous to the full cell pressure treating process (see Appendix 1). The treatment cycle is carried out in horizontal, rectangular tanks with hold-down bars for full-pole treatment and in horizontal, rectangular or vertical, cylindrical tanks for upright butt treatment of pole ends. Full length tanks are normally covered with simple plywood lids during treatment. The treatment cycle consists of the following steps:

- flooding of the tank with hot treating oil (220 to 230 degrees F),
- immersion until sufficient moisture has been driven from the poles (generally two to ten hours),
- return of the hot oil to storage tanks and flooding of the treatment tank with cold oil (125 degrees F) for a period of one to six hours,
- return of the cold oil to the storage tank and draining of the poles in place.

Specific treatment times and temperatures are stipulated by standards (Appendix 2) and vary with the species and moisture content of the wood.

Operator judgment is involved in regulating the treatment of specific charges to a much greater extent than for pressure treatment.

CHEMICAL CONTAINMENT AND RECOVERY

Treatment oils are returned to bulk tankage following the treatment cycle. Spill containment for storage and treatment tanks is provided at one of the existing facilities. Both plants drain poles in place in the treatment tanks and treated poles are subsequently stored on unprotected ground.

CHEMICAL DISCHARGES

Based on visual inspection of storage areas, little chemical is lost to the ground as drippage from treated poles during storage. Washoff of preservative chemical may be released to the ground or contained in site runoff. Spills, drips or splashes of preservative oil are occasionally lost to the ground adjacent to the open treatment tanks. Containment of treating tanks is not universal. Groundwater which infiltrates the tank containment system at one site receives treatment as a waste stream prior to discharge. The only solid waste produced during treatment is an oily sludge which is periodically scraped from the treatment tanks. These sludges are currently stored on-site (indefinitely) or are burned in wood waste burners. Intermittent sources of air emissions from the thermal treating process include tank vents and vapors which escape from the treatment tanks during the treatment cycle.

2.4.2 TRANSPORTATION, OFF-LOADING AND STORAGE OF PCP

■ DESCRIPTION

Both thermal treatment facilities in British Columbia use solid PCP supplied as 1000 or 2000 pound blocks. The blocks are supplied exclusively by Reichhold Limited from their manufacturing facility in Tacoma, Washington (via Reichhold's sales offices in Port Moody, B.C.). The blocks are wrapped in heavy plastic and shipped on pallets by common carrier from the point of supply to the point of use.

Both facilities maintain an inventory of several PCP blocks. Storage is provided in roofed wooden shelters which are enclosed on three sides and open on the front (without doors). The blocks are stored on unprotected ground at both facilities. One facility also uses the PCP shed for the storage of other materials including heat transfer oil.

One facility uses bagged PCP granules for adjusting the PCP concentration of the final treatment oil mix. Up to 200 bags are stored in a separate enclosed metal building with a concrete floor.

■ ASSESSMENT

The handling and storage of solid PCP blocks is inherently safer than the management of chemical flakes. Although significant workplace or environmental concerns were not identified at either B.C. thermal treatment facility, storage and handling practices are somewhat casual and potential risks can be largely eliminated by attention to the following areas:

TRANSPORTATION ■

Standards of packaging and practices for handling PCP blocks in transit will ultimately be dictated by the Transportation of Dangerous Goods Act. It appears that blocks may be damaged in transit and current packaging and shipping practices should be evaluated and modified in anticipation of specific proposed Regulations under the Act.

SECURITY

A standard of security should be developed for chemical storage areas. PCP is stored in semi-enclosed structures at both B.C. plants and unauthorized workers or non-employees have relatively free access to the area. This is an inadequate level of security for the storage of toxic chemicals such as PCP. Furthermore, storage under non-secure conditions is in itself an inappropriate implicit message to employees about the need for careful management of PCP.

STORAGE AREA DESIGN

Minimum standards should be established for the conceptual design of PCP block storage areas. Improved mechanical protection for blocks should be provided. Impact chipping and breakage of block edges was observed and this creates PCP dust which is lost to the ground and/or exposes workers. Blocks are loosely wrapped with heavy plastic which provides inadequate containment of dust from minor block damage during storage or transit. Ground protection is not provided at either facility so that PCP chips or dust cannot be contained and accumulates on the ground in the storage area.

Blocks are not totally protected from the elements and PCP dust lost to the ground may migrate with runoff. Other materials (for example, drums of heat exchange fluid) are stored and piled adjacent to the blocks at one facility. This contributes to the potential for mechanical damage of blocks, potential fire hazards, and use of the area by personnel who may not recognize PCP hazards. The storage building and contained materials at both sites are wooden and easily combustible, a potentially highly dangerous circumstance.

Storage areas for PCP blocks are well ventilated at both plants and reasonably (but not totally) protected from the elements. If more stringent standards for enclosure evolve, appropriate consideration must be given to maintaining adequate ventilation for worker protection.

2.4.3 CHEMICAL MIXING AND HANDLING

DESCRIPTION

The blocks of solid PCP are dissolved in hot treatment oil to a final concentration of 5 percent. The P-9 treatment oil (approximately equivalent to number 3 diesel oil) is delivered in bulk by rail tanker and dissolution of the PCP is normally carried out when the oil is off-loaded. The required number of PCP blocks are transferred to a treating tank with a front-end loader, utilizing a steel lifting hook which is imbedded in the top of each block. The treatment tank is then covered and flooded with hot treating oil (at about 200 degrees F) which is recirculated through the storage tank until the blocks are completely dissolved. One facility adds bagged PCP granules to the tank to make final adjustments of the PCP concentration.

ASSESSMENT

PCP BLOCKS

The dissolution of solid PCP blocks in treatment tanks entails minimal exposure of the chemical to workers or to the environment and the overall process is judged to be reasonably safe. Neither plant reported the occurrence of actual dangerous events associated with the mixing process. The potential risks of circulating large volumes of hot PCP oil through the open treatment tanks are considered in Section 2.4.5.

An improved standard should be considered for the containment of PCP blocks during transit from storage to the tanks since any flaking from the blocks is lost to the unprotected ground during this transfer. The distance between storage and mixing points is of the order of 500 feet at both facilities.

BAGGED PCP

A minimum standard of safety should be established for the design and operation of facilities using bagged PCP granules. These bagged materials are inherently more susceptible to dispersal during mixing operations and stringent safety precautions are required for workers engaged in mixing activities. The necessity of using bagged PCP at thermal plants should be carefully reviewed and consideration should be given to alternative procedures which would allow the exclusive use of PCP blocks. If the continued use of bagged PCP is necessary, the feasibility of utilizing "closed" debagging equipment should be considered.

2.4.4 TREATING OIL STORAGE

■ DESCRIPTION

Hot and cold treating oil are stored in exterior bulk tanks at both British Columbia facilities. The storage tanks are in a segregated common area at one facility and asphalt ground cover and full-capacity containment dyking has been installed. Runoff which accumulates in the dyked area is discharged to the ground adjacent to the storage area. Tanks are scattered throughout the treating area at the second facility and no ground cover or containment dyking is provided.

Level indication is by sight gages at one facility. The second facility uses float gages linked by steel tape to external indicators. Overflow alarms on storage tanks are absent at both facilities.

■ ASSESSMENT

Minimum design and containment standards should be established for PCP treating oil storage facilities. Several of the considerations discussed in Seciton 2.1.3 are applicable to PCP treating oil storage and should be reviewed in preparing a code of good practice. These include the determination of minimum standards for:

- spill containment,
- drip containment,
- fluid level indication,
- level alarms, and,
- tank condition, location and security.

Although no major releases of oil have been reported at either facility, tanks at both plants show evidence of minor releases from overfilling. Positive measures (both design and procedural) should be taken to prevent overfilling and to contain spillage when it does occur.

2.4.5 TREATMENT PROCESS SYSTEMS

■ DESCRIPTION

The treatment process systems for both British Columbia facilities are relatively straightforward, consisting chiefly of oil storage tanks, transfer pumps and piping, and an indirect heat exchange system for heating the preservative oil.

SHELTER ■

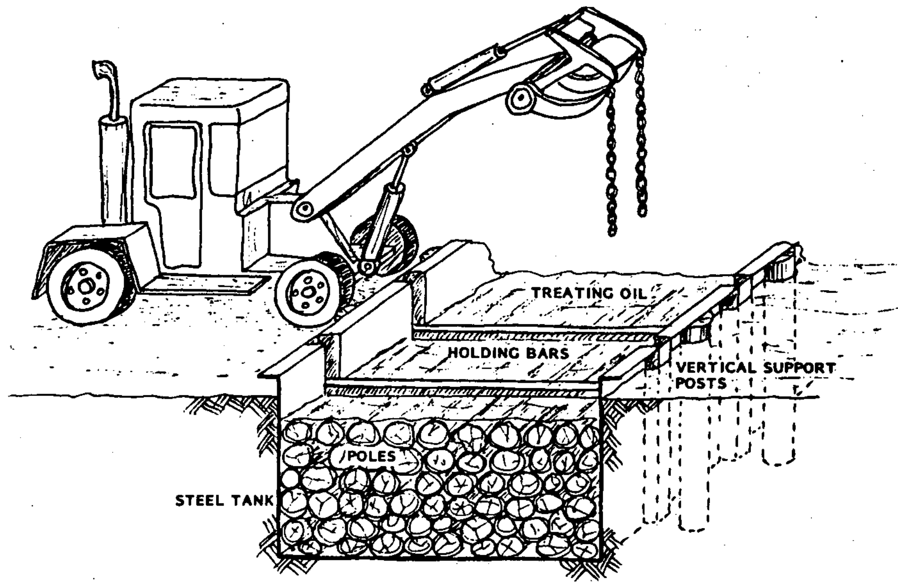
Both facilities provide only limited enclosure for process components. Electrical controls and heat exchange equipment are housed and both plants provide enclosure for some of the process piping and valving. Storage tanks and all treatment tanks are fully exposed to the elements at both facilities. Removable plywood or steel lids are used to cover the treatment tanks and the lids are lifted from the tanks (by crane or front-end loader) and set aside during the loading and unloading of poles.

SURFACES ■

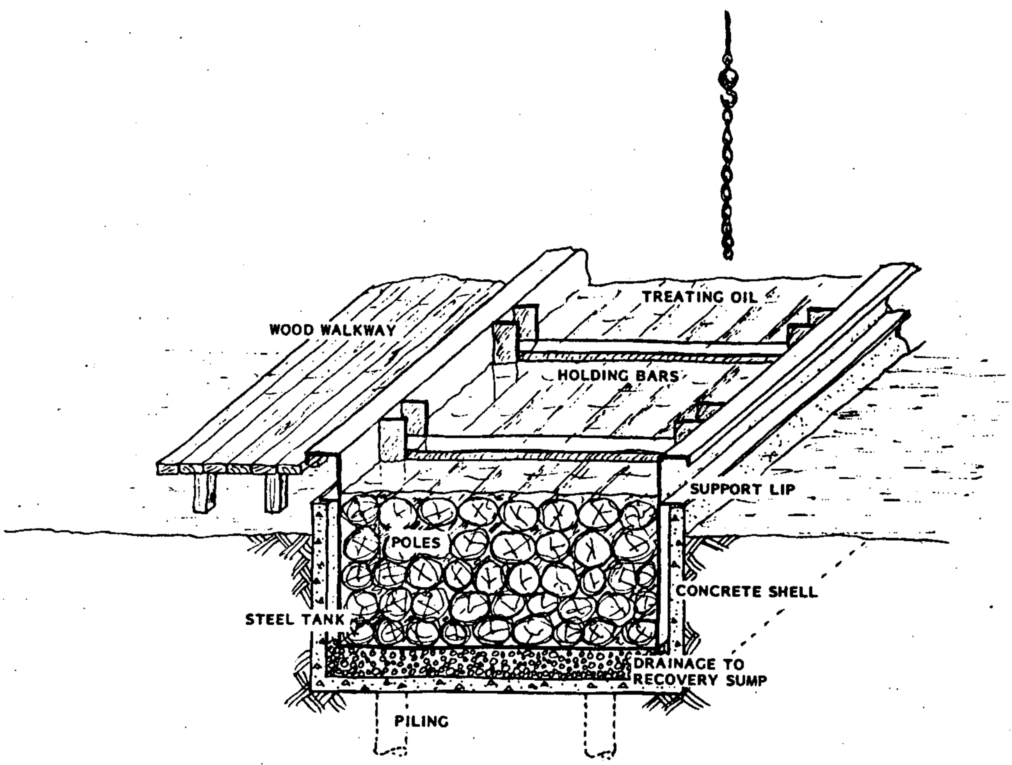
Ground surfaces in exterior areas are generally unsurfaced (with the exception of the dyked tank storage area at one facility). Both facilities utilize above-ground planking for walkways between process components and around tanks, although walkways are limited to the tank perimeter at one facility. The ground adjacent to treating tanks is unsurfaced at both plants.

SPILL AND DRIP CONTAINMENT ■

One facility provides no spill or drip containment for any of its tankage or process components. The second facility provides full spill containment for



TANK MOUNTING WITHOUT CONTAINMENT



TANK MOUNTING WITH CONTAINMENT

FIGURE 2.11 CONSTRUCTION AND CONTAINMENT OF THERMAL TREATING PLANTS the segregated oil tankage and has installed sub-grade containment for leaks from the treating tank. Neither facility provides collection or containment of surface runoff from process areas or wood storage areas.

VAPOR CONTAINMENT ▪

As described under SHELTER (this Section), removable steel or plywood lids are used to cover full-pole treating tanks during the treating cycle. The lids are not gasketed and simply rest on the tank edges. These lids are intended to protect the treating oil from the elements rather than to provide a barrier for PCP vapor release (although they presumably do significantly reduce vapor emissions). Butt treating tanks remain open to the atmosphere during the treating cycle.

TREATING TANKS ▪

CONSTRUCTION AND CONFIGURATION □

Horizontal tanks for treating whole poles are rectangular and constructed of heavy steel plate (for example 7/16 inch thickness) with appropriate external steel reinforcement and bracing to provide strength and rigidity. Tank sizes vary with the dimensions of poles treated at a particular facility, ranging from 51 feet x 11 feet x 10 feet (length by width by depth) to 112.5 feet x 11 feet x 8 feet. Smaller rectangular tanks are used for butt-treating poles at both facilities and one plant also uses two vertical, cylindrical tanks for butt-treating (11 feet diameter x 11 feet depth).

MOUNTING AND CONTAINMENT □

Treating tanks are mounted partially below grade to provide thermal insulation, structural support, and to facilitate top-loading of poles from ground level. The older of the two B.C. facilities uses a traditional mounting achieved by simple excavation of the ground and burial of the tanks with about 2 feet protruding above ground level. The liquid level in the filled tanks is approximately at grade (Figure 2.11). Earth has been backfilled to the tank wall and vertical wooden posts are buried in place against the tank exterior walls to provide structural support for the tank. No spill or leak containment has been provided with this type of mounting.

Mounting for the tanks at the newer facility is much more sophisticated and designed to provide *in-situ* containment of treating oil leakage (Figure 2.11). The tanks are mounted with the bottoms 5 to 6 feet below grade, and a concrete "bath tub" outer shell has been installed to contain and collect tank leakage. The base of the concrete shell is mounted on pilings and the shell walls extend vertically above grade level. The tank is structurally supported by a lip on the side of the tank which rests on the top of the concrete shell. Drainage for tank leaks is provided by gravel fill between the concrete base and the tank bottom. An enclosed collection sump has been installed at one end of the tank to allow recovery of any treating oil leakage which occurs.

TANK OVERFLOW PROTECTION □

During the treatment cycle, oil is recirculated through the oil heaters. One facility has installed a level alarm on its full-length treating tank to provide an audible warning of overfill when the tank is initially flooded. No alarms are provided on tanks at the second facility.

OIL HEATING SYSTEMS ■

Both B.C. plants use gas-fired heaters to warm a heat exchange medium which is recirculated to oil storage tanks in a closed system. Energy from the heat exchange medium is then transferred to the preservative oil by standard shell and tube heat exchanger.

PIPING ■

Piping systems at both facilities are partially above-ground and partially buried. Buried systems have been used for bottom connections to treating tanks (for draining oil). Much of the interconnecting piping at one facility is located in concrete channels which form part of the tank containment system. No containment is provided for any of the piping at the second facility.

PROCESS CONTROLS ■

Valving and process controls are predominantly manual at both facilities. Many of the control functions have been centralized in an enclosed area at one facility. Controls are generally decentralized at the second plant.

■ ASSESSMENT

There have been no reported major releases of PCP-containing chemicals from existing thermal plants. At one of the facilities, relatively careful operating procedures have compensated for generally inadequate containment systems. A code of good practice should consider design safeguards and improvements in several areas including:

SHELTER, SURFACES AND CONTAINMENT ■

There is need to adopt a uniform standard of facility conceptual design integrating the requirements for shelter, surfacing and drip and surface spill containment in the treatment process area. Because of the general lack of ground surfacing at one facility, the potential for PCP oil loss to the ground is especially high. It is emphasized that actual significant losses have apparently not occurred because of carefully controlled operating procedures.

A minimum standard should be developed for the conceptual design of ground protection and spill containment around the treatment tanks. The ground surface adjacent to treatment tanks is unprotected at both facilities and ground contamination is visually apparent at both sites. There has been no quantitative assessment of this contamination, but the lack of ground protection around the treatment tanks should not be acceptable.

PCP VAPOR LOSS FROM TREATING TANKS ■

A quantitative assessment should be undertaken to determine the magnitude and significance of PCP vapor losses from treating tanks during the treating cycle. It appears that substantial quantities of PCP-containing vapor are released from treating tanks even though full lids are now used to cover all full-pole treating tanks. Assessments of PCP losses to air have been limited (see Section 5.4.2) and concerned solely with PCP vapor concentrations in working areas immediately adjacent to the tank. There have been no assessments of downwind PCP levels or the significance of long-term releases to the site environment via tank vapor emissions. The presumed insignificance of these emissions should be confirmed by monitoring studies.

TREATING TANK DESIGN AND CONTAINMENT

Comprehensive standards should be established for the design of treatment tanks and subgrade containment systems. These standards should give careful consideration to site-specific factors such as groundwater hydrogeology. Tanks are subject to substantial static and impact loads as well as thermal stresses during the operating cycle. Although no instances of actual tank leakage or rupture were reported, provision should be made for detecting and containing subgrade tank leakage. Minor but ongoing subgrade leakage can lead to substantial release of chemical over a prolonged time period. The facility which has uncontained treatment tanks is at high risk with respect to this potential occurrence. The migration of such subsurface contamination at this site does not appear likely, although this conclusion is based on observation of superficial site conditions and has not been confirmed by a scientific assessment of subsurface soils and hydrogeology.

The subsurface containment system which has been installed at the second facility adequately meets requirements for containing minor or major tank ruptures. Early detection of minor leakage would be retarded by the limited accessibility for visual inspection. Considerable leakage from the tank could occur before contaminated oil would visually appear at the collection sump for the containment system. This is unavoidable with integral containment shells and the feasibility of containment systems which allow access for inspection should be considered.

Design of containment shells should provide protection against groundwater infiltration. The sump of the existing containment system is frequently flooded with groundwater which leaks through joints and cracks in the containment shell. Significant quantities of contaminated water must be continually removed from the containment system and treated to remove PCP. If a major volume of treatment oil were released from the tank to the containment shell, the cleanup would be significantly complicated by the infiltrating groundwater.

TANK OVERFLOW PROTECTION ■

A standard should be developed for the conceptual design of features to prevent treatment tank overflow. Although one facility has installed level alarms, rapid filling of the treatment tanks has still caused minor occasional overflow and loss of oil to the ground. Neither facility has positive design measures to prevent overflow or to recycle spillage to the tank when it does occur.

OIL HEATING SYSTEMS ■

The indirect closed heat exchange system employed at both B.C. facilities provides effective isolation of the gas-fired heaters from the PCP treatment oil. A standard procedure should be established for routine monitoring of the heat exchange medium to detect any contamination with PCP from leaks which might develop in the heat exchanger.

PIPING ■

A standard should be developed for the conceptual design of containment for process piping systems. Consideration should also be given to provisions for inspection and maintenance accessibility of piping systems and effective routine procedures should be developed for checking the integrity of buried or inaccessible piping.

PROCESS CONTROLS ■

A uniform standard of process control should be adopted for thermal treatment plants. Development of the standard should include consideration of the following:

- simplicity,
- a clear relationship between controls and process functions,
- visibility of process components from the control point,
- emphasis on the use of effective alarms and interlocks to prevent safety-related operator errors, and,
- emergency override switches adjacent to operating components which are remote from the control point.

2.4.6 WASTE TREATMENT

■ DESCRIPTION

SOLID WASTES ■

The only process waste produced at thermal plants is the pentachlorophenol sludge which precipitates from the treating oil during the treating cycle. This sludge also contains dust and fly ash which is carried into treating tanks on the poles. The total volume of this sludge is of the order of hundreds of Imperial gallons per year and the sludge is manually removed from the treatment tanks at both facilities. Although one of the facilities has a current Waste Management Branch Permit to dispose of the sludge in its wood waste burner, the burner overheats when sludge is fed and sludge burning has been discontinued. As a consequence, both plants now store sludge on-site pending identification of a satisfactory disposal method. One facility uses a closed 5000 Imperial gallon tank for sludge storage. The second facility uses an exterior, open-top cylindrical tank of approximately 1000 Imperial gallon capacity. The tank is located on unprotected ground with no provision for containing spillage.

LIQUID WASTES ■

Liquid process wastes are not generated by the thermal treating process. However, a contaminated water discharge is generated at one facility and a treatment system has been devised to treat this liquid. The discharge originates from groundwater which infiltrates through the walls of the concrete shell containing the leakage from the treatment tank. The high water table at the site causes groundwater to leak into the drainage system beneath the treating tank at an estimated average rate of 3000 Imperial gallons per day.

A filtration/adsorption system is used to treat infiltrating groundwater. The water is pumped to holding tanks where separation of entrained oil takes place (negligible amounts of oil are recovered). Effluent from the holding tanks flows by gravity to two 250 Imperial gallon filtration units in series configuration. Each filter consists of an open-top tank containing bark sawdust held within a metal cage and covered with fiberglass mats. Contaminated water is sprayed onto the fiberglass and trickles through the bark dust which absorbs the treating oil contained in the water feed. Effluent from these filters passes through a 45 Imperial gallon drum containing additional fiberglass mats and activated charcoal to adsorb any remaining treating oil. The effluent from this system is discharged to the ground surface adjacent to the treating area. Solid bark residue from the filters is removed biweekly and disposed of in the wood waste burner. Disposal procedures for spent carbon have not yet been determined.

AIR EMISSIONS ■

No continuous process air emissions are produced by the thermal treating process. Intermittent emissions of PCP vapor are released from storage tank vents and from treating tanks during the treatment cycle (see VAPOR CONTAINMENT, Section 2.4.5). No air emission control devices are used for any of these discharges to air.

■ ASSESSMENT

SOLID WASTES ■

A consistent technical and regulatory standard should be developed for the acceptable disposal of chlorophenol sludges and other solids contaminated with PCP treating oil. The Waste Management Branch does not currently have established criteria for determining the acceptability of PCP sludge disposal in specific wood waste burners and the Regional Waste Management Branch Offices are inconsistent in their requirements. Where air emission permits have been issued for PCP sludge disposal in burners, there are inadequate technical and regulatory controls on combustion conditions when sludge is being burned. Smoke opacity is generally used as the criterion for judging the acceptability of combustion conditions and documentation of sludge burning is not required.

Uniform minimum standards should be established for sludge storage pending disposal. There is visual evidence that sludge has overflowed from the open tank storage utilized at one facility. Such uncontrolled storage of PCP-containing substances is inappropriate.

LIQUID WASTES ■

Liquid waste treatment systems are not normally required by thermal plant operators. The treatment system for contaminated infiltrating groundwater at one facility has been installed at the initiative of the plant management. PCP levels in the treated groundwater are currently being monitored and the efficiency of the treatment system should be reviewed in light of these data.

AIR EMISSIONS ■

As discussed in Section 2.4.5, PCP vapor emissions from thermal treating tanks should be quantitatively assessed. If appropriate, minimum standards for vapor control systems should be established on the basis of this assessment.

2.4.7 TREATED WOOD STORAGE

■ DESCRIPTION

Unprotected ground is used for treated wood storage at both British Columbia facilities. Poles are normally held in the drained treatment tanks following the treatment cycle in order to contain the initial drippage and to allow time for absorption of residual treatment oil left on the surface of the poles.

■ ASSESSMENT

A chemical release survey should be undertaken to quantify the current levels of PCP release from treated wood to the sites of thermal treating plants. Visual inspection of the unloading and treated pole storage areas indicates that there is no detectable drippage of treatment oil from the treated poles. The poles are highly absorptive and dry to the touch when removed from the treatment tanks. There is no discoloration of ground surfaces in pole storage areas and the visual inspection suggests that current pole storage practices are adequate.

As with CCA facilities (Section 2.1.9), quantitative data have not been developed to confirm this visual assessment and to quantify the amounts of PCP washed from the poles by rain or lost by minor drippage which cannot be detected visually. This information should be developed in support of a detailed assessment to determine the significance of PCP losses and to define an effective strategy for controlling PCP release to the sites of thermal treating plants.

3.0 DESCRIPTION AND ASSESSMENT OF PROCEDURAL AND LEGISLATIVE CONTROLS

3.1 OVERVIEW

SUMMARY ■

Three types of control measures are currently used to manage the use and release of wood preservative chemicals at treatment plants in British Columbia:

- direct physical controls incorporated into the facility design,
- procedural controls stipulated by the plant management, and,
- legislative controls externally imposed by regulatory agencies.

Physical controls which are related to facility design are discussed in Section 2. To complement good physical design, a wood preservation facility must also have effective in-house procedural controls to minimize environmental releases and to minimize worker hazards. In addition to operating and maintenance practices, these procedural controls include worker educational programs, facility evaluations by external expertise, and definition of emergency actions.

An additional level of institutional control measures are those of government legislation which is externally imposed on industrial plants. The dominant agencies in B.C. which can influence the operation of wood preservation facilities under federal and/or provincial legislation include:

- The B.C. Workers' Compensation Board,
- The B.C. Ministry of Environment,
- The Environmental Protection Service of Environment Canada, and,
- The Department of Fisheries and Oceans.

Overall, the in-house and external institutional controls for the B.C. wood preservation industry are quite extensive. Table 3.1 provides an overview of these control measures and summarizes the problems in implementation and interpretation which have occasionally occurred. The information in Table 3.1 reflects the assessment of the authors and is based on detailed discussion with industry personnel.

SECTOR	CONTROLS	CONCERNS[1]	RECOMMENDED ACTIONS[2]
CCA SUPPLIERS	•PROVISION OF DETAILED TECHNICAL INFORMATION, PLANT ASSESSMENTS, EMERGENCY SERVICES, OPERATOR TRAINING.	•SUPPLIERS' ASSESSMENTS OF HEALTH AND ENVIRONMENTAL HAZARDS OF CCA REQUIRE OBJECTIVE REVIEW.	•REVIEW SUPPLIER ASSESSMENTS OF CCA HEALTH HAZARDS.
		•LIAISON WITH CANADIAN REGULATORY AGENCIES SHOULD BE IMPROVED.	•ENCOURAGE IMPROVED COMMUNICATION WITH REGULATORY AGENCIES.
CCA USERS	•DEFINITION OF OPERATING AND MAINTENANCE PRACTICES.	•EXCEPTIONS TO GOOD OPERATIONS EXIST. COMPLIANCE LIMITED BY FINANCIAL RESOURCES. DISPOSAL PRACTICES NOT DEFINED.	•DEFINE MINIMUM REQUIREMENTS FOR O&M, HEALTH PROTECTION AND ENVIRONMENTAL CONTROL.
	•PARTICIPATION IN EDUCATIONAL PROGRAMS.	•EDUCATIONAL PROGRAMS LIMITED BY RESOURCES AND ATTITUDES. WEAKNESS IN HAZARD ASSESSMENTS HINDERS EDUCATIONAL PROGRAMS.	•EVALUATE EXISTING INFORMATION ON ENVIRONMENTAL AND HEALTH EFFECTS OF ARSENIC, CHROMIUM, AND COPPER.
	•DEFINITION OF EMERGENCY RESPONSE MEASURES.	•EMERGENCY RESPONSE MEASURES VARIABLE IN QUALITY AND READINESS FOR IMPLEMENTATION. SITE-SPECIFIC CONDITIONS OFTEN NOT CONSIDERED.	•DEFINE MINIMUM RESPONSE REQUIREMENTS IN ACCORDANCE WITH B.C. AND CANADIAN REGULATIONS.
ACA SUPPLIERS	•PROVISION OF TECHNICAL INFORMATION ON CHEMICAL CONTAINERS.	•PRODUCT TECHNICAL INFORMATION IS MINIMAL AND MAY BE INADEQUATE FOR SAFEGUARD PLANNING.	•ASSESS RESPONSIBILITIES OF CHEMICAL SUPPLIERS.
ACA USERS	•DEFINITION OF OPERATION AND MAINTENANCE PRACTICES.	•DEGREE OF MANUAL HANDLING OF CHEMICALS IS VERY HIGH. DISPOSAL PRACTICES UNDEFINED.	•ASSESS AND DEFINE WORKER SAFETY REQUIREMENTS FOR HANDLING OF CHEMICALS. DEFINE CONSISTENT DISPOSAL PRACTICES.
	•DEFINITION OF EMERGENCY RESPONSE MEASURES.	•CONTINGENCY MEASURES ARE INCONSISTENT IN SCOPE AND EXTENT.	•ASSESS AND DEFINE ADEQUATE CONTINGENCY MEASURES.
	•UNDERTAKING OF HEALTH AND ENVIRONMENTAL MONITORING TO ENSURE ADEQUATE CONTROLS.	•MONITORING CRITERIA AND PROCEDURES ARE INCONSISTENT.	•ESTABLISH UNIFORM MONITORING REQUIREMENTS.
PCP SUPPLIERS	•PROVISION OF LIMITED TECHNICAL INFORMATION ON PACKAGES.	•ACCURACY OF INTERPRETATION OF INFORMATION BY USERS IS UNCERTAIN.	•ASSESS RESPONSIBILITIES OF SUPPLIERS.
	•DETAILED TECHNICAL INFORMATION PROVIDED ON REQUEST.	•MINIMAL INTERACTION WITH USERS.	•ENCOURAGE SUPPLIER INTERACTIONS WITH USERS.
PCP USERS	•DEFINITION OF OPERATION AND MAINTENANCE PROCEDURES.	•OPERATIONAL PROCEDURES MAY BE INADEQUATE, PARTICULARLY IN USE OF PCP GRANULES. DISPOSAL PROCEDURES FOR PCP SLUDGES AND EFFLUENTS MAY BE INADEQUATE. HAZARDS WITH PCP VAPORS ARE POORLY DEFINED. EDUCATIONAL PROGRAMS FOR OPERATORS ARE LIMITED.	•DEFINE MINIMUM REQUIREMENTS FOR OPERATION AND MAINTENANCE PROCEDURES. •DEFINE MINIMUM REQUIREMENTS FOR HANDLING AND STORAGE OF PCP. •ASSESS AND DEFINE DISPOSAL OPTIONS FOR EFFLUENTS AND SOLIDS. •ASSESS ADEQUACY OF EXISTING PCP AIR STANDARDS. •OPERATOR SELECTION CRITERIA AND TRAINING PROGRAMS.
	•DEFINITION OF EMERGENCY RESPONSE PROCEDURES	•EMERGENCY RESPONSE PROCEDURES ARE INCOMPLETE, ESPECIALLY FOR FIRE RESPONSE.	•DEFINE ADEQUATE CONTINGENCY MEASURES.

TABLE 3.1 OVERVIEW OF PROCEDURAL AND LEGISLATIVE CONTROL MEASURES FOR WOOD PRESERVATION PLANTS IN B.C.

SECTOR	CONTROLS	CONCERNS[1]	RECOMMENDED ACTIONS[2]
CREOSOTE SUPPLIERS AND USERS	•DEFINITION OF OPERATION AND MAINTENANCE PROCEDURES.	•WORKER ATTITUDES SOMEWHAT "LAX" TOWARDS CREOSOTE.	•ASSESS (ON BASIS OF EXISTING KNOWLEDGE) IMPACT OF CREOSOTE TO WORKERS AND THE ENVIRONMENT. •DEFINE MINIMUM REQUIREMENTS FOR OPERATION AND MAINTENANCE PROCEDURES.
		•ACCEPTABLE DISPOSAL PRACTICES FOR SOLID WASTES NOT DEFINED.	•DEFINE WASTE DISPOSAL PRACTICES.
PROVINCIAL GOVERNMENT •MINISTRY OF ENVIRONMENT	•ISSUE PERMITS FOR WASTE DISCHARGES. •ISSUE WORK ORDERS TO STIPULATE REMEDIAL MEASURES. •LAY LEGAL CHARGES AGAINST OFFENDERS.	•INCONSISTENT CONSIDERATION OF FACILITIES. •REGIONAL PERSONNEL OFTEN NOT FAMILIAR WITH WOOD PRESERVATION PROCESSES. •RAPPORT WITH INDUSTRY NEEDS IMPROVEMENT. •DISPOSAL PRACTICES NOT DEFINED.	•STIPULATE CONSISTENT MINIMUM REQUIREMENTS FOR EFFLUENT DISCHARGE, DISPOSAL. •DEFINE MEANS TO ACHIEVE BETTER INDUSTRY-GOVERNMENT LIAISON. •OTHER REQUIRED ACTIONS ARE INTERNAL IN NATURE.
•WCB	•INSPECTION AND WORK ORDERS.	•ASSESSMENTS EMPHASIZE MECHANICAL RATHER THAN CHEMICAL HAZARDS. •REGIONAL PERSONNEL OFTEN NOT FAMILIAR WITH WOOD PRESERVATION PROCESSES. •INTERACTION WITH ENVIRONMENTAL AGENCIES INADEQUATE.	•DEFINE MINIMUM ASSESSMENT PROCEDURES FOR HEALTH PROTECTION. •DEFINE MEANS TO ACHIEVE LIAISON WITH ENVIRONMENTAL AGENCIES.
FEDERAL GOVERNMENT •EPS •FISHERIES & OCEANS	•POLLUTION CONTROL TECHNOLOGY DEVELOPMENT. •FISHERIES ACT ENFORCEMENT •PLANT INSPECTIONS •LEGAL CHARGES	•COMMENTS FOR MOE (ABOVE) APPLICABLE FOR FEDERAL AGENCIES. •FEDERAL-PROVINCIAL LIAISON NEEDS IMPROVEMENT. •INTERAGENCY LIAISON NEEDS IMPROVEMENT.	•ENCOURAGE MORE EFFECTIVE LIAISON WITH INDUSTRY AND OTHER AGENCIES.
		•OVERLAPPING MANDATES PERCEIVED BY INDUSTRY	•CLARIFY MANDATES OF FEDERAL DEPARTMENTS.

[1] *These concerns should be evaluated in the context of the overall effectiveness of controls as described in the report text. For example, many in-house procedural controls are highly effective, but would be improved by addressing the identified concern.*

[2] *Some recommended actions are beyond the scope of a code of good practice.*

TABLE 3.1 OVERVIEW OF PROCEDURAL AND LEGISLATIVE CONTROL MEASURES FOR WOOD PRESERVATION PLANTS IN B.C.

Although there are industry-wide inconsistencies in the scope and implementation of design and in-house procedural controls, these forms of self-regulation have been generally effective and have provided the dominant controls on chemical use in the wood preservation industry in British Columbia. Current legislation provides an adequate framework for governmental regulation of the use of wood preservation chemicals. However the authors believe that the approaches of regulatory agencies in complementing the self-regulating activities of industry could be improved.

IN-HOUSE PROCEDURAL CONTROLS ■

In-house procedural controls vary considerably among members of the B.C. wood preservation industry. Most facilities have at least some operational and maintenance procedures which are implemented as part of company policy. The degree of formality in company policy usually increases proportionately with company size. In general, procedural controls at facilities have improved considerably over the years because of the increasing concerns about chemical safety and because of legislation to improve environmental and worker safety. Problems in appropriate implementation of company procedural controls still do occur, in part because:

- there is confusion about the actual health hazards of exposure to wood preservation chemicals,
- individual companies vary in the allocation of resources for control measures, and,
- there is poor liaison between industry and government agencies.

LEGISLATIVE CONTROLS ■

Legislation is an important institutional control on the safe use of preservative chemicals. However, the implementation of legislative controls in B.C. should be cimproved for reasons detailed in Table 3.1. The effectiveness of controls would be improved by:

- encouraging a generally preventative (as opposed to reactive) stance by regulatory agencies,
- increasing the degree of industry-specific expertise among government agencies,

- striving for improved continuity in government requirements of the industry when personnel or government policies change, and
- enhancing inter-agency liaison.

RECOMMENDED ACTIONS ■

Table 3.1 summarizes several actions which would lead to a more consistent statement and implementation of in-house and external regulatory measures in the wood preservation industry. A code of good practice could play a significant role in achieving this end by defining industry-wide minimum standards for crucial areas of operation. Key subjects which should be addressed by a code of good practice include:

- operations and maintenance policy and procedures,
- emergency response procedures,
- operator selection and training,
- clarification of environmental and health effects of wood preservative chemicals, and,
- government agency-industry liaison,
- waste disposal procedures.

3.2 CONTROL MEASURES OF PRESERVATIVE SUPPLIERS AND USERS

3.2.1 CCA

■ DESCRIPTION

SUPPLIERS ■

At the time of this study, all CCA used in British Columbia was provided by two suppliers: Koppers-Hickson Canada Ltd. and Osmose Wood Preserving Corporation of America (Section 2.1.2). Both suppliers are very competitive and offer a wide range of technical support services to attract customers. These services are highly regarded by users, and it appears that the CCA supplier strategy is to assure good self-regulation so that government regulation will not be required. Services offered by suppliers are provided at no extra cost and include:

- *Design and engineering services* for the construction of new plants, alterations to existing plants, and improvements for containment of the treatment chemical.

- *Annual assessments* of plant operations and maintenance procedures. Assessments are undertaken by experienced specialists and emphasize minimization of CCA release with assurance of appropriate product quality. Plant design, equipment condition and operating practices are evaluated. Minor repairs and fine tuning of process equipment may also occur during inspections. Recommendations of the specialists are reported in writing to plant management. Users of CCA supplier-registered trademarks generally heed recommendations, particularly when quality control of product may be affected. Non-users of registered trademarks have variable responses to recommendations.

- *Emergency services* by provision of information by telephone or by presence of specialists.

- *Provision of technical information* by telephone or by mailing of written material. The written material supplements the already extensive background information provided to operators.

- *Operator training seminars.*

- *Analytical services* for determination of CCA concentrations in work solutions, surface runoff, groundwaters, and in soils.

USERS ■

The greatest incentive for users to control CCA releases is the high cost of the chemical (approximately $2.00 per pound). Consequently, B.C. plants incorporate many design features for CCA containment (Section 2.1). Since most users of CCA can be considered as "small business operations" (one owner, one site), the incorporation of design controls has often been limited by the availability of capital and/or the in-house expertise used for site design.

Most users rely solely on suppliers' expertise for definition of proper operating and maintenance procedures. Two plants supplement suppliers' information with more precise operating, maintenance and emergency procedures. Users who maintain trademark and/or standards certification often use more strict operating procedures. For example, CSA standards require that all equipment must be well maintained in accordance with certification inspections. Coincidentally, the probability of emissions from such equipment is decreased.

All but two facilities post suppliers' emergency procedures in the operations areas. However, site-specific response procedures have not been developed at most facilities. Users express a moderate degree of concern about potential health and environmental hazards of CCA, consistent with suppliers' claims about the relative health safety of the chemical (see Section 5).

ASSESSMENT ■

The visual inspections at CCA facilities showed that the technology is available to design and operate systems which are essentially "pollution-free" and which safely control hazards to workers. The general operation and maintenance of CCA facilities in B.C. is very good, with at least one exception. CCA suppliers have played a significant role in assisting facilities to achieve good overall control of the preservative chemical.

Some inconsistencies in the control efforts of CCA users were identified during this study. These inconsistencies often stem from users' reluctance to implement controls which have been recommended by suppliers (as opposed to users not knowing what improvements are advisable). Capital expenditures for these controls reduce profits or raise prices and affect the user's competitive advantage in the marketplace. A code of practice should attempt to achieve an industry-wide concensus about the minimum requirements for controls, thereby reducing the temptation for users to operate substandard facilities in order to gain competitive advantage.

Specific subjects which should be addressed during the preparation of a code of good practice include:

OPERATIONS AND MAINTENANCE POLICY AND PROCEDURES ■

Consistent industry-wide minimum standards should be established for operations and maintenance policy and procedures. These standards should be objective-oriented in order to maximize the flexibility of facility management in stipulating specific detail of how these objectives are to be achieved. In the case of the CCA industry, supplier-developed procedures appear to be carefully and competently prepared. It is suggested that a code of practice should endorse these procedures (after appropriate review) as one acceptable means of fulfilling the objectives which evolve and are specified by the code of practice.

EMERGENCY RESPONSE PROCEDURES ■

Uniform emergency response procedures (including reporting requirements) should be developed. Despite technical assistance by suppliers, emergency procedures to deal with major spills or worker exposure vary considerably in scope and detail. Some plants have developed extensive adaptations of suppliers' recommended procedures, and responsibilities of personnel are well-defined to enable rapid and co-ordinated responses to emergencies. On the other hand, one plant has no defined emergency plan. Most plants fall between these two extremes.

The suppliers' emergency procedures are adequate in concept and technical content. However, they are oriented to U.S. customers and local or provincial requirements have not been adequately considered at some existing plants.

CLARIFICATION OF HUMAN HEALTH EFFECTS ■

Suppliers' claims about health effects of CCA should be objectively evaluated in light of the differing assessments of some health authorities (see Section 5.2.4). For example, suppliers claim that the chemical form of arsenic present in CCA is non-cumulative and it is implied that human intake of this form is relatively safe compared to intake of arsenic with other chemical valences. A distinctly different attitude is expressed by many Canadian health authorities and by NIOSH in the U.S. Since users often determine the extent of safety procedures on the basis of suppliers' claims, confirmation of the validity of health effect information is extremely important.

GOVERNMENT-INDUSTRY LIAISON ■

Increased information exchange between regulatory agencies and chemical suppliers would be beneficial. More interaction with chemical suppliers would enhance the familiarity of regulatory agencies with existing processes and control measures and perhaps eliminate some of the misunderstandings which exist between government and the industry with respect to existing procedural controls (see Section 3.3). It is anticipated that improved liaison would occur as a natural outgrowth of the government agency-industry interaction which would take place during the preparation of a code of good practice.

3.2.2 ACA

■ DESCRIPTION

SUPPLIERS ■

Copper oxide pellets, arsenic acid, and bulk liquid ammonia are used to prepare ACA on-site (Section 2.2). Supplier involvement regarding proper use of ACA is limited to labelling of copper oxide and arsenic acid containers and providing information on possible hazards and emergency procedures.

USERS ■

The two existing users of ACA are operating divisions of two large Canadian corporations, and have access to technical expertise which would not normally be available to small business operations. Therefore, both ACA wood preservation plants have developed their own work standards for ACA preparation and these standards are defined in detailed operations manuals which are provided to operators. The standards are thorough and contain background information on toxicity and proper practices for the preparation and handling of ACA. The recommended handling practices appear to be rigidly enforced at both sites. For example, the management at one plant site requires individuals who prepare ACA solutions to sign a statement that all precautions have been taken. The precautions include the use of a full-face canister mask, gloves and coveralls. A shower is required after completion of the chemical mixing task. Post-use handling procedures for gloves, coveralls and face mask are also defined. Facility operators indicate a high level of compliance with these procedures, although rare exceptions were reported.

The operating manuals at both plant sites also describe all components of the process equipment and the required maintenance procedures. Emergency response plans for spills, fires and electrical problems are well detailed. Responsibilities of personnel are defined in case of emergencies.

Environmental monitoring has occurred at both ACA plant sites for compliance with regulatory requirements and/or for self-assessment of efficiency of control efforts. The industrial hygiene division of one company has reportedly undertaken air monitoring studies to assess worker exposure to ACA.

ASSESSMENT ■

As in the case of CCA facilities, the technology is readily available to design and operate ACA systems which are essentially "pollution-free" and which safely control hazards to workers. Procedural controls are well-developed and compliance with these controls is strictly enforced. In some cases, weaknesses in design features diminish the effectiveness of procedural controls. There are significant differences in design features of the two existing ACA facilities (see Section 2.2) and this imposes different constraints for operation of the two plants. It is recommended that design features be reviewed to identify minimum requirements for features which are consistent with the implementation of effective procedural controls.

In addition to establishing design features which complement procedural controls, it is recommended that the following items be considered within a code of good practice to assure the continued minimal exposure of the environment and workers to ACA:

OPERATIONS AND MAINTENANCE POLICY AND PROCEDURES

As in the case of CCA facilities, consistent industry-wide minimum standards should be established for operations and maintenance policy and procedures. Operational standards for ACA facilities already exist at individual facilities, and it is suggested that the code of practice should review, and if acceptable, endorse those standards as complying with the requirements of the code of good practice.

EMERGENCY RESPONSE PROCEDURES

Uniform emergency response procedures (including reporting requirements) should be developed for the ACA industry. Unlike CCA users, ACA facility personnel are dependent solely on their own resources for information on appropriate emergency response procedures. Each of the two ACA facilities has its own response procedures, and the code of good practice should review, and if acceptable, endorse those procedures.

CLARIFICATION OF ENVIRONMENTAL AND HEALTH EFFECTS

Adequate data exist on the environmental and health effects of ammonia and copper. However, the industry is unclear about the potential effects of the valence (+5) form of arsenic used in the ACA treatment process. Generally, the CCA and ACA industry are under the impression that this form of arsenic is essentially not of great concern to human health or the environment. Procedural controls for arsenic concentrate storage and handling are in accordance with this perception. Therefore it is suggested that environmental and health effect information about arsenic be assessed and clarified during the preparation of a code of good practice.

HANDLING AND MIXING PROCEDURES

Handling and mixing procedures associated with ACA solution preparation vary considerably within the industry. Extensive manual handling of the components is required. The proposed code of good practice should review and suggest minimum requirements for handling and mixing procedures.

GOVERNMENT-INDUSTRY LIAISON ■

Improved government-industry liaison would facilitate the development of procedural controls which meet the requirements of regulatory agencies.

3.2.3 PCP

■ DESCRIPTION

SUPPLIERS ■

The two existing thermal treatment facilities purchase PCP in 1,000 and 2,000 pound blocks from Reichhold Ltd. (Section 2.4). Although the sales are handled by Reichhold's Port Moody, B.C. office, the blocks are delivered directly to the facilities from Tacoma, Washington. General information on handling and toxicity of PCP blocks is provided on the polyethylene wrapping used to envelop the blocks.

Both of the existing pressure treatment facilities use UNIROYAL granular PCP which was distributed in Canada by the DOMTAR Chemicals Group (Section 2.3).[1] Information on handling and toxicity is contained on each 45 pound package of the PCP granules. No bulk deliveries of granular PCP occur in B.C.

Specific information on handling, toxicity or emergency procedures is provided on request by the PCP manufacturers who are well-qualified to provide such information. Unlike CCA suppliers, however, PCP manufacturers do not provide inspection services or educational programs to assure the proper implementation of handling practices by users.

USERS ■

All four users of PCP have a high degree of respect for hazards associated with the use of the compound. The in-house procedural control measures at the four sites are highlighted in Table 3.2.

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[1]*See footnote page 75.*

TREATMENT PROCESS	COMPANY AFFILIATION	PCP FORM	OPERATING MANUALS	HYGIENE PRACTICES	EMERGENCY RESPONSE PROCEDURES
PRESSURE	CANADIAN CORPORATION	GRANULAR	COMPREHENSIVE	MINIMUM PRACTICES DEFINED. ADEQUACY NOT EVALUATED.	DEFINED
PRESSURE	CANADIAN CORPORATION	GRANULAR	COMPREHENSIVE	MINIMUM PRACTICES DEFINED. ADEQUACY NOT EVALUATED.	DEFINED
THERMAL	U.S. CORPORATION	BLOCK	MODERATELY DETAILED	DEFINED PRACTICES. APPARENTLY ADE-QUATE. EXCEPTIONAL HOUSE-KEEPING	DEFINED
THERMAL	INDEPENDENTLY OWNED	BLOCK	MINIMAL. REFERENCE TO EPA DOCUMEN-TATION FOR HAZARD ASSESSMENT	NOT WELL DEFINED BUT CARE IS OBSERVED	NOT APPARENT. RELIANCE ON PLANT MANAGER FOR DIRECTION IN EACH SITUA-TION

TABLE 3.2 IN-HOUSE PROCEDURAL CONTROLS ON PCP USE AT FOUR B.C. FACILITIES

The two PCP pressure treatment facilities in B.C. are both owned by one company. Technical resources are available from the company's headquarters office in Eastern Canada. The headquarters technical staff developed the existing operating and emergency response procedures. These procedures are supplemented with information on local and provincial requirements. The management at each plant has autonomy in implementing procedures and operating, maintenance, and control measures vary considerably at the two B.C. sites.

The two PCP thermal treatment plants in B.C. function with more independence than their counterparts in the pressure treating industry. Although one operation is part of a U.S. corporation, the facility procedures are entirely derived by the local site management. The other thermal plant operation is independently owned and operating practices are defined by site management. The practices at this facility are reportedly conveyed to plant personnel verbally and by example. Hardcopy procedures are not available at this plant, and the management does not consider this to be a deficiency.

ASSESSMENT ■

There is a trend among PCP treaters towards minimizing of worker contact with PCP and PCP-treated products. This change is being accomplished by increasing the use of remote operations, by reducing worker contact time with the chemical, and/or by increasing the use of safety equipment. There is a need for a code of good practice which, in addition to consideration of design features (Sections 2.3 and 2.4), will address the following topics:

OPERATIONS AND MAINTENANCE POLICY AND PROCEDURES ■

Differences in operating practices were observed at PCP treatment facilities. There is a need to assure that minimum standards of operation and maintenance are achieved. The lack of such guidelines was in part responsible for existing contamination at two closed facility sites (Section 4.4.2).

EMERGENCY RESPONSE PROCEDURES ■

Uniform emergency response procedures (including reporting requirements) should be developed, with special attention to spill and fire emergencies. All four existing facilities have evolved procedures which would be used in case of large scale spills. However, fire contingency procedures are judged to be inadequate at most facilities, in particular with respect to fire control methodology and the protection of firefighters.

CLARIFICATION OF ENVIRONMENTAL EFFECTS ■

Plant managers and operators have at hand many different sources of information on environmental persistence and health effects of PCP. This information is not always in agreement with data which form the basis for policy development by regulatory agencies. For example, managers and operators at treatment facilities frequently referred to data indicative of low PCP persistence (high biodegradation) in the environment. Procedural controls for the handling and storage of PCP and/or PCP-treated wood at these facilities have been developed in accordance with this information. Other data in the literature suggest that PCP is highly persistent.

Since handling procedures are based on perceptions of hazards, it is recommended that the preparation of a code of good practice should include a review by environmental agencies of existing data to provide an "official assessment" of environmental persistence and effects of PCP.

OPERATOR SELECTION AND TRAINING ■

A code of good practice should stipulate minimum requirements for operator selection criteria based on health considerations. Medical prescreening of employees should be considered by the industry to assure that employees with potential sensitivity to PCP are not assigned inappropriate tasks. Minimum standards should also be established for operator training programs. Operator awareness of processes and equipment functions is necessary to alleviate dangerous actions or inappropriate PCP exposure. Some shift operators interviewed during this study were not adequately aware of the use and functions of process equipment which is employed outside of their immediate area of responsibility.

PCP HANDLING AND STORAGE PROCEDURES ■

Minimum requirements should be defined for PCP handling procedures. Casual practices were observed for storage of PCP at some sites (see Sections 2.3.2 and 2.4.2). Granules of PCP were found on the floors of storage areas for bagged PCP. At two sites other chemicals such as arsenic acid and heat transfer oil were stored with PCP. Storage areas varied from well contained to freely accessible to unauthorized personnel.

Manual handling of PCP blocks is minimal compared to the handling requirements for bagged granules. Dust levels during cutting and emptying of bagged PCP are generally high and control requirements may be elaborate (see Sections 2.3.3 and 2.4.3). This aspect is discussed further in the following chapter on health effects.

SLUDGE HANDLING PROCEDURES ■

Minimum requirements should be established for PCP sludge handling and storage procedures. Precautions for handling and storing PCP sludges are inconsistent among existing facilities, and procedures are generally not clearly defined. Worker precautions during cleanup or transfer operations with PCP sludges are lacking or casually implemented at some facilities.

GOVERNMENT-INDUSTRY LIAISON ■

Improved government-industry liaison is required to facilitate the development of procedural controls which meet the requirements of regulatory agencies.

3.2.4 CREOSOTE

■ DESCRIPTION

SUPPLIERS AND USERS ■

The supplier and user of creosote at the single existing creosote pressure treating plant in B.C. are both under the same company structure. Creosote is shipped in bulk from Eastern Canada. Procedures for handling creosote were primarily developed by the user's headquarters office in Eastern Canada and give consideration to local and provincial requirements. The control of environmental emissions and precautions necessary for protection of human health are both addressed by the procedures.

The creosote treating facility is the oldest operating plant in B.C., and was designed much prior to the time of concern about environmental pollution. The plant is currently under Waste Management Branch Order to enhance containment features, and compliance with the Order should be completed by 1984.

ASSESSMENT ■

Improvements to physical features at the existing creosote treating facility are stipulated by the existing Waste Management Branch Order. The required modifications will substantially improve creosote containment at the plant and the terms of the Order are realistic with respect to physical constraints imposed by the original design and location of the plant.

As in the case of PCP facilities, there is a need for a code of good practice to develop uniform guidelines for the following areas:

OPERATIONS AND MAINTENANCE POLICY AND PROCEDURES ■

The lack of guidelines or minimum standards for operation and maintenance procedures were in part responsible for creosote contamination which occurred at the sites of two creosote treating facilities which are now closed (see Section 4.5.2). Although only one facility currently uses creosote in

B.C., another facility is planned and this plant will be located near an ecologically sensitive area. This underscores the need for an immediate definition of minimum requirements for operations and maintenance at creosote treating plants.

EMERGENCY RESPONSE PROCEDURES ■

Minimum requirements should be established for emergency response procedures at creosote treating plants. Creosote is a mixture of many compounds. Upon addition of creosote to water, some components float, others remain suspended in the water column, and others sink to the bottom. It appears that existing spill control contingency measures have not adequately considered the behavior of such heterogeneous mixtures. Furthermore the adequacy of existing fire control procedures should be reviewed.

CLARIFICATION OF ENVIRONMENTAL AND HEALTH EFFECTS ■

Many of the compounds found in creosote have been described as carcinogens or co-carcinogens. Some workers who have used creosote for many years have casual regard for safety precautions. Familiarity with creosote has softened perceptions of potential hazards of exposure or releases to the environment. An assessment of epidemiological and environmental data is required to provide an accurate definition of potential hazards associated with creosote usage. A code of good practice should present the official position of regulatory agencies regarding these issues.

OPERATOR SELECTION CRITERIA AND SUBSEQUENT TRAINING PROGRAMS ■

A code of good practice should stipulate minimum requirements for operator selection criteria based on health considerations. Individuals may have particular sensitivities to creosote, and medical prescreening should be required prior to employment. Operator understanding of processes and equipment function should be enhanced through expanded training programs. Minimum requirements for such training programs should be established and specified in a code of good practice.

HANDLING PROCEDURES FOR CREOSOTE-CONTAMINATED WASTES ■

Minimum requirements should be defined for precautions for handling and storing creosote sludges. Due to the physical nature of creosote, such sludges are difficult to handle, and equipment, facilities, and clothing are easily contaminated.

GOVERNMENT-INDUSTRY LIAISON ■

As noted for other segments of the wood preservation industry, improved government-industry liaison is needed to assure the development of procedural controls which meet the requirements of regulatory agencies.

3.3 CONTROL MEASURES OF UNIONS

Inquiries for the purposes of this study were not made directly to unions. Discussions with employees and management revealed no previous union complaints specifically associated with the use of any preservative chemical formulations.

All unionized wood preservation facilities are staffed by IWA members. These facilities include all PCP plants (and the single creosote plant), one ACA plant and three CCA plants.

3.4 CONTROL MEASURES OF REGULATORY AGENCIES

The several regulatory agencies which have been involved in the assessment of wood preservation facilities are listed in Table 3.3. This table indicates the legislative acts which empower these regulatory agencies, and indicates the manner and scope of their assessment and regulatory activities. The description and assessment which follow represent the opinion of the authors based on detailed discussions with industry personnel.

REGULATORY AGENCY	ENABLING LEGISLATION	REGULATORY MECHANISM	PRINCIPAL ACTIVITIES
PROVINCIAL:			
• B.C. WORKERS' COMPENSATION BOARD	WORKERS' COMPENSATION ACT	INSPECTION AND ORDER	*HUMAN HEALTH AND SAFETY:* • EVALUATION OF AIR EMISSIONS (LIMITED) • URINALYSIS (LIMITED) • MECHANICAL SAFETY EVALUATION
• B.C. WASTE MANAGEMENT BRANCH	WASTE MANAGEMENT ACT	INSPECTION, PERMIT OR ORDER, LEGAL CHARGES	*ENVIRONMENTAL PROTECTION:* • ASSESSMENT OF RELEASES TO ENVIRONMENT
• B.C. MINISTRY OF LABOUR	POWER ENGINEERS BOILER AND PRESSURE VESSEL SAFETY ACT	INSPECTION AND CERTIFICATION	*WORKER SAFETY:* • RETORT TANK INTEGRITY
FEDERAL:			
• INLAND WATERS DIRECTORATE	CANADA WATER ACT	ENVIRONMENTAL MONITORING	*ENVIRONMENTAL PROTECTION:* • GROUNDWATER ASSESSMENT • SURFACE WATER QUALITY
• ENVIRONMENTAL PROTECTION SERVICE	FISHERIES ACT	INFORMATION GATHERING AND ASSESSMENT • INSPECTION, LEGAL CHARGES, REVIEW OF PROVINCIAL REGULATORY PERMITS	*ENVIRONMENTAL PROTECTION:* • RECEIVING WATER QUALITY AND REMEDIAL PROGRAM ASSESSMENT
	ENVIRONMENTAL CONTAMINANTS ACT	INFORMATION GATHERING AND ASSESSMENT • IMPOSITION OF USE, IMPORT AND RELEASE RESTRICTIONS	*ENVIRONMENTAL PROTECTION:* • INVENTORY OF CHEMICAL USAGE • DEVELOPMENT OF GUIDELINES AND REGULATIONS
• FISHERIES AND OCEANS	FISHERIES ACT	INSPECTION, LEGAL CHARGES	*PROTECTION OF FISHERY RESOURCES:* • RECEIVING WATER QUALITY
• HEALTH AND WELFARE	CANADA HEALTH ACT	ADVISE OTHER AGENCIES	*ASSESSMENT OF HUMAN HEALTH EFFECTS*

TABLE 3.3 OVERVIEW OF REGULATORY AGENCY ASSESSMENTS AT B.C. WOOD PRESERVATION FACILITIES

3.4.1 WORKERS' COMPENSATION BOARD OF BRITISH COLUMBIA (WCB)

■ DESCRIPTION

Under the Workers' Compensation Act of British Columbia, the Board is charged with the responsibility of inspecting places of employment and subsequently with issuing orders and directions (where necessary) which specify the means for the prevention of injuries and industrial diseases. Officers of the Board are also responsible for the investigation of accidents and causes of industrial diseases, for assisting and advising employers and employees in the development of industrial health and safety programs, and for the education in industrial health and safety matters, of persons employed in British Columbia industry.

ASSESSMENT ■

In 1976 a review and assessment of the overall industry was prepared by the Industrial Hygiene Department of WCB (Whitehead and Riegert). The recommendations of the review do not appear to have been implemented. Subsequently, in 1978, the WCB assessed PCP concentrations in air at four facilities. The results are shown and discussed in Section 5.

Interviews (conducted by the authors of this report) with facility management and employees indicated that most regional WCB assessments have emphasized mechanical safety and the evaluation of noise, light and dust levels. To date, field assessments of the adequacy of chemical handling procedures have been minimal. Field inspectors appear to be unaware of the review and recommendations of Whitehead and Riegert. Discussions with WCB field personnel indicate that more emphasis on chemical safety will occur in the future. For example, the industrial hygiene division of WCB will be decentralized to some extent with transfer of occupational health inspectors to other areas of B.C.

It is suggested that the effectiveness of the WCB in the wood preservation workplace would be improved if consistent evaluations of chemical safety were conducted on an industry-wide basis. This might be accomplished by providing field inspectors with ready access to a higher degree of in-house chemical safety expertise specifically relevant to the use of wood preservatives.

It is further suggested that improved liaison of the WCB with environmental agencies should be encouraged. WCB inspectors are frequent visitors to many wood preservation facilities and their activities could effectively complement the activities of local WMB officers. WCB inspectors should be trained to identify the circumstances of significant actual or potential environmental contamination. When situations of environmental concern are identified, local WMB officers should be alerted.

3.4.2 WASTE MANAGEMENT BRANCH (WMB), B.C. MINISTRY OF THE ENVIRONMENT

■ DESCRIPTION

The Waste Management Branch (WMB) of the B.C. Ministry of the Environment is charged with the responsibility of assuring that industry is in compliance with the Waste Management Act (1982). The Act empowers the WMB to regulate the on-site storage, transportation and ultimate disposal of wood preservative wastes which fall into the category of "special wastes". The Act also contains provisions which allow the WMB to regulate discharges to water, land and air by requiring compliance with Permits issued by the Waste Management Branch. The Waste Management Branch is the agency with the most important ongoing and potential legislative control of the wood preservation industry in British Columbia.

Past WMB assessments of wood preservation plants range from visual site inspections to intensive sampling and analysis of site soils and adjacent streams and water bodies. However, only one region has attempted a holistic assessment which integrates the consideration of chemical use practices and emissions to air, water and land. Only 2 of the 15 wood preservation facilities currently have wastewater discharge permits. Other facilities have air discharge permits for incineration of bark and wood debris. Incineration of PCP sludges is inconsistently regulated. All permit holders are required to undertake (at specified intervals) analyses of air or wastewater discharges. The quality of wastewater discharges from the two permitted facilities is discussed in Section 4.

ASSESSMENT

Assessment procedures and regulation of environmental discharges from wood preservation plants could be improved. Presently, resources at the regional level are restrained. Inspectors at regional offices must deal with a wide range of industries, and rarely have the opportunity to specialize in particular processes. In some regions wood preservation processes are not given high priority because the industry is considered to use "closed processes" with minimal discharge to the environment. As a result, WMB has not carried out detailed assessments at most facilities, and their activities have been generally limited to responsive action in emergency situations such as spills or fires which have occurred at specific facilities.

It is suggested that the assessment of wood preservation facilities by the WMB would be facilitated by the establishment of industry-specific expertise in order to:

- provide consistent assessments of wood preservation plants throughout the Province,
- encourage the development of improved industry-agency liaison,
- support provincial emergency response measures,
- provide consistent regulatory targets for the industry, and,
- fulfill a need of the industry by acting as a resource to aid in alleviating environmental concerns.

Industry personnel conveyed a general consensus that agency specialists should have an appreciation for economic viability and furthermore should be in a position to act on behalf of their agency.

3.4.3 B.C. MINISTRY OF LABOUR

■ DESCRIPTION

Among the requirements of this Ministry is the implementation of regulations under the 1982 Power Engineers Boiler and Pressure Vessel Safety Act. This act (and its predecessor) are used to assure the integrity of pressure retorts including those of the wood preservation industry. All retorts must be built to a pressure vessel code listed in the regulations. The design must be registered with the Ministry. The unit is inspected on installation and a certificate of inspection is given upon approval. Subsequent inspections occur at frequencies dependent upon location and usage factors. For example, retorts with quick opening doors are subject to more frequent subsequent inspections. These inspections would include an assessment of pressure-release valves and safety piping. Steam coils which are used to heat retorts are also inspected, although associated pumps, gauges and valves are not.

ASSESSMENT ■

The tests and certifications of the Ministry play an important role in minimizing the probability of major spills due to tank ruptures. The activities of Ministry personnel appear to be reasonably matched to the requirements of fulfilling the Ministry's regulatory role at wood preservation plants. It should be noted that the data bank of the Safety Engineering Services Division contains information on all existing retorts in B.C. Since retorts from closed plants are generally re-used at other facilities, the data bank may provide a source of information on previous operations.

3.4.4 CANADIAN FEDERAL GOVERNMENT AGENCIES

■ DESCRIPTION

Environmental protection in Canada is a shared responsibility of the provinces and the Federal Government. Federal involvement occurs:

- when transboundary waters or marine waters are involved,
- when migratory fish and wildlife species are involved,
- where joint federal-provincial agreements exist,
- when federal legislation exists (e.g. The Clean Air Act, The Contaminants Act),
- when federal lands and activities are involved.

Table 3.3 outlines some of the activities of Canadian federal agencies which are relevant to the wood preservation industry. It is the opinion of the authors of this study that many of the smaller facilities have minimal appreciation of the responsibilities and resources of any Federal Government environmental agency. The greatest degree of federal agency participation with the B.C. wood preservation industry (prior to the current project reported herein) occurred during an assessment and site clean-up of a now-closed wood preservation site in the Lower Mainland. The development of decommissioning procedures and site clean-up measures involved representatives of the wood preservation plant management and representatives of the following agencies:

- B.C. Waste Management Branch,
- Environmental Protection Service and the Inland Waters Directorate of Environment Canada, and,
- Department of Fisheries and Oceans.

Interactions among the different groups did result in a remedial plan which required considerable compromise by all parties.

Other federal-industry interactions have occurred during previous nationwide assessments including:

- A 1974 EPS survey of wastewater characteristics of 100 Canadian wood preservation plants, as part of an assessment of abatement technology in the wood and timber processing industry (Report Number EPS-3WP-77-2).
- A 1980 study by the Wastewater Technology Centre of EPS to improve wood preservation plant effluent treatment, and to characterize wastes from various facilities.
- A 1976 investigation by Health and Welfare Canada representatives of wood preservation plants in B.C. to assess worker protection measures, with particular emphasis on handling of PCP.

On a local basis, one wood preserver requested EPS, Pacific and Yukon Region, to assess the adequacy of runoff control measures to prevent the eventual discharge of CCA components to the Fraser River.

ASSESSMENT ■

Federal agencies have been increasingly active in undertaking programs to provide environmental and health overviews and assessments of industry. These programs generally involve other key regulatory agencies and, while not fully successful in the past, these efforts have generally fostered a heightened awareness of the need for improved co-ordination and co-operation among regulatory agencies.

A review of federal agency activities at wood preservation plants identified several areas where improvements could be made to enhance the effectiveness of regulatory programs. These improvements include the following:

- There is a need for the development of internal guidelines for the assessment of wood preservation plants. Past circumstances have occasionally necessitated the involvement of agency personnel not familiar with wood preservation processes.
- Improved co-ordination between all agencies is required in order to achieve more cohesive and holistic responses to environmental concerns in the industry. Variances have occasionally occurred because

assessments have been carried out independently by different environmental agencies.

- An improved mechanism for industry-agency communication is needed. For example, considerable efforts have been expended on government agency assessments of PCP control measures during the past six years. Despite this, few results of the assessments are known to the plant operators. PCP users have expressed the opinion that U.S. EPA documentation is more readily available.

Several of the above-listed concerns can be addressed only indirectly by a code of good practice. However, it is anticipated that the process of preparing and approving a code would in itself provide an improved level of communications between agencies and industry. Insofar as possible, the code should also attempt to clarify jurisdictional ambiguities between agencies and to clearly communicate regulatory agency expectations to industry.

4.0 DESCRIPTION AND ASSESSMENT OF ENVIRONMENTAL IMPACTS

4.1 OVERVIEW

The wood preservatives currently used in British Columbia are generally classed as highly toxic chemicals. The *potential* environmental impacts from the improper release of these chemicals can be substantial. The documentation of *actual* impacts at B.C. sites can best be characterized as sketchy, and the real-world significance of such releases is not known.

Historical evidence does show that extensive site contamination has occurred at older wood preservation plants in B.C. This contamination resulted from spillage and from minor ongoing releases associated with:

- poor containment design,
- inadequate maintenance, operating and housekeeping procedures, and,
- improper on-site disposal of liquid and solid wastes.

The environmental significance of this contamination and the nature and extent of its migration off-site are simply not known. What is clear is that once major contamination does occur, a thorough and proper cleanup (which removes constraints on future site use) becomes physically impossible and prohibitively expensive.

The serious problems associated with decommissioning a contaminated site were recently illustrated when a large B.C. wood preservation plant was closed after fifty years of operation. Soils and groundwater were found to be extensively contaminated with wood preservative chemicals throughout the 25-acre site. The concentration of contaminants ranged from trace levels (parts per billion) to high concentrations (percent), and contamination extended to a depth of sixty feet. Begging the question of the significance of this contamination (the question has not been definitively answered), restoration of the site to its original condition is realistically impossible. The cost of a partial site cleanup now totals in the hundreds of thousands of dollars.

This section summarizes the general status of existing knowledge about environmental impacts from releases of wood preservative chemicals at sites in British Columbia. The intent is to present an overview of environmental considerations for the industry as a whole, rather than to characterize detailed impacts at individual sites. The key elements of the overall picture include the following conclusions:

- *Environmental assessments of B.C. sites have been few and limited in scope.*

  Most sites have not been assessed at all. The assessments which have occurred have generally been superficial, limited in scope and inconsistent in approach. No sites have undertaken preconstruction assessments. Routine monitoring of site environments is rare.

- *Past environmental assessments at B.C. sites have not clearly defined actual impacts from environmental releases of wood preservation chemicals.*

  This situation has resulted from numerous factors including:
  - the high cost of assessment,
  - the lack of defined protocols for sampling and analysis of soils and groundwaters,
  - the lack of adequate scientific information on the environmental fate of wood preservation chemicals,
  - the failure to consider (and/or the inability to obtain) site history in designing monitoring programs and interpreting results,
  - the design of sampling programs which addressed specific problems in isolation rather than in a holistic context of total emissions from all activities at the plant site, and,
  - the failure of regulatory agencies to integrate and co-ordinate their efforts and requirements.

- *The significance of environmental releases of wood preservative chemicals is not known.*

  This results in part from inadequacies and conflicts in the base of scientific knowledge (both site-specific and general) and in part from the failure of environmental regulatory agencies to address the isssue of significance. The overall regulatory process in B.C. is at a relatively immature stage of development and is significantly influenced by economic and potential constraints.

- *Spills or accumulated minor ongoing chemical releases (such as drips or washoff from treated lumber) probably constitute the primary potential sources of significant environmental contamination at modern wood preservation facilities in B.C.*

  With the exception of two oil-borne pressure treating facilities, continuous liquid waste streams are not produced at B.C. plants. Solid wastes are produced intermittently and are relatively small in volume. A quantitative mass balance approach has not been applied to the movement of wood preservative chemicals at treatment sites, and such a quantitative approach is required to accurately identify and define chemical releases at wood preservation plants.

A code of good practice can play a significant role in improving the consistency and effectiveness of measures to monitor and assess environmental releases of wood preservative chemicals. This improvement would be achieved through establishing minimum industry-wide requirements and protocols for:

- pre-facility site monitoring and development,
- ongoing routine site monitoring,
- assessment of contaminated sites,
- disposal of contaminated solid wastes,
- facility decommissioning and site closure, and,
- archiving of historical and assessment information about wood preservation facilities and sites.

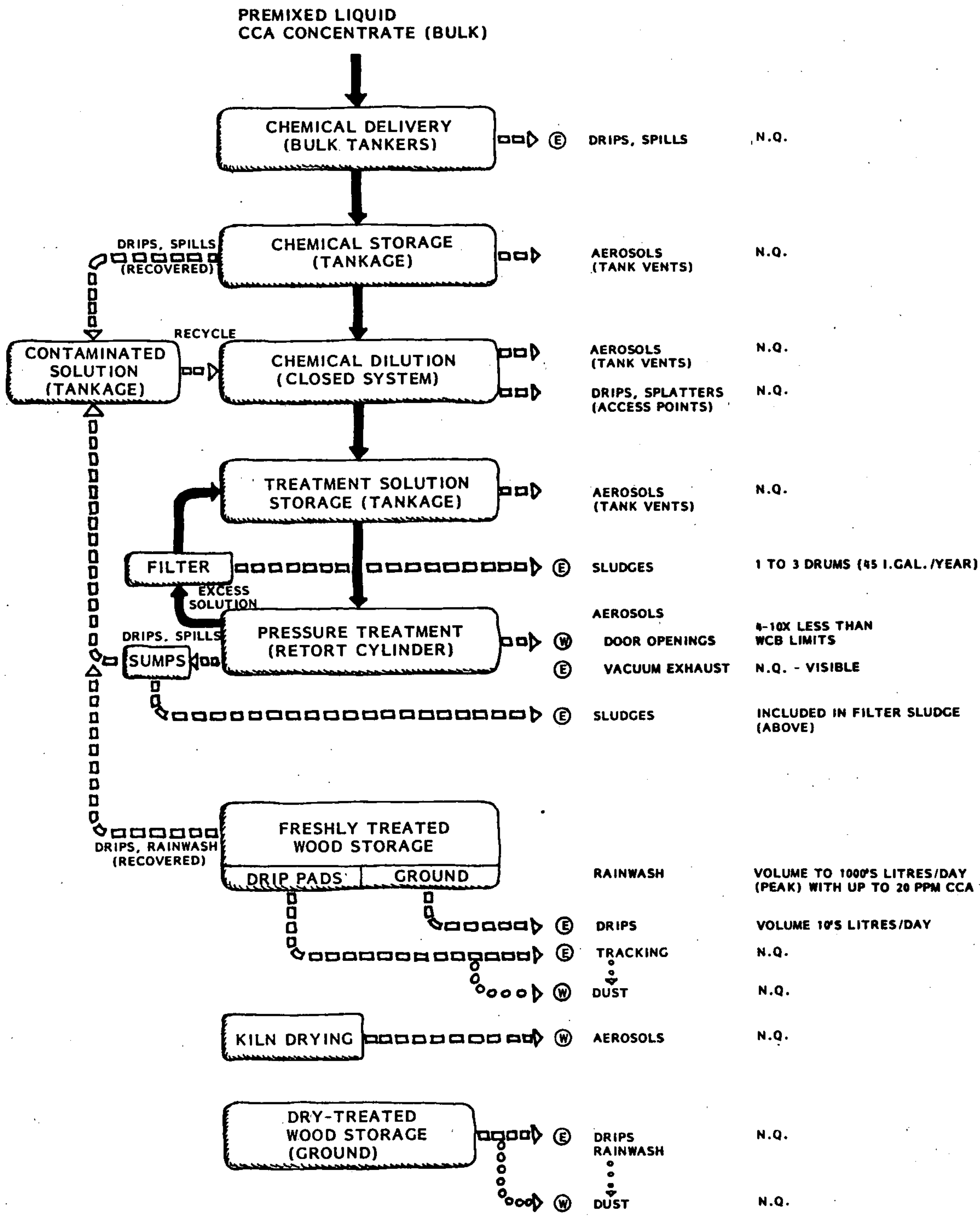

FIGURE 4.1 QUANTITIES OF CHEMICAL RELEASE FROM CCA PRESSURE TREATING PLANTS

4.2 CCA FACILITIES

4.2.1 REVIEW OF CCA RELEASES

The potential sources of CCA releases from routine activities at wood preservation plants were identified in Section 2.1. The sources and reported or estimated approximate quantities of releases from routine operations are summarized in Figure 4.1. The figure does not include estimates of releases from accidental major spills. The figure indicates that under normal operating conditions, releases of CCA to the environment should be minimal. The most probable source of release, if any, during normal conditions, likely occurs during drippage of freshly treated wood, especially when drip pads are not provided. There have been no known efforts to quantify the dripped solution nor to assess the possible environmental impacts of CCA dispersal on site soils.

4.2.2 REVIEW OF ENVIRONMENTAL MONITORING STUDIES

EXISTING PLANT SITES

As indicated in Section 2.1, visual inspections at most existing CCA plants found minimal evidence of obvious site contamination. No pre-facility site assessments have been made at any existing CCA plants. As a result, background concentrations of copper, chromium or arsenic are not known and little or no information is available about site soils and hydrogeology.

Only one of the ten existing CCA plant sites undertakes any type of periodic on-site monitoring. This assessment was self-initiated by the company in January 1983 to evaluate the effectiveness of its control of contaminated surface runoff water. The analyses of site runoff water in drainage ditches adjacent to the site show that releases of CCA components do occur. However, concentrations in downstream ditch waters (which eventually reach a flowing stream) were less than published water quality criteria values for protection of aquatic biota (U.S. EPA, 1976; International Joint Commission, 1979).

CLOSED PLANT SITES ■

There are at least two sites in B.C. on which CCA facilities were previously located. The exact location of one site is not known, but it is said to have been at Port Kells (currently within the Surrey municipality). There is no known documentation of activities at this site.

The second facility was located on the banks of the Fraser River in the Lower Mainland. Pressure treatment of wood with CCA took place at this site during a portion of the facility's fifty year life span. Operations were discontinued in 1982 and the site was intensively studied by industry and government. Arsenic was used as an indicator of CCA pollution at the site, and the highest concentrations (7 and 11 milligrams per liter) were found in groundwater wells in the vicinity of the CCA retort. Other groundwaters from depths to fifty feet beneath the yard had concentrations of arsenic ranging from 0.002 to 4.95 milligrams per liter. The Canadian Drinking Water Objective is a maximum of 0.05 milligrams per liter (Health and Welfare Canada, 1978). Dispersal of arsenic was sporadic throughout the yard, indicating multiple points of contamination from poor operating practices as well as migration of CCA from the points of contamination. Arsenic in excess of 170 milligrams per kilogram and chromium in excess of 200 milligrams per kilogram were found in several soil samples from the yard. Background values for arsenic and chromium were estimated to be in the vicinity of 3 milligrams per kilogram and 10-20 milligrams per kilogram, respectively. During excavation of soils near the CCA retort, large quantities of crystalline CCA were found. The origin of this contamination is not known although possible sources of the crystals include:

- dripped CCA solution from freshly treated wood,
- dumped, improperly blended CCA concentrate, and,
- storage and retort tank sludges.

Definition of cleanup procedures for this site presented a dilemma to environmental regulatory agencies. Significant gaps in site assessments and general scientific knowledge prevented the agencies from making a definitive assessment of the actual hazard posed by the chemicals in soil and groundwater at the site. In view of the high costs of complete cleanup, the agencies required that the company remove only high-contaminated soils for disposal at a secure landfill in the U.S. The closed plant site is now blacktopped, and contaminant levels in groundwaters will be monitored at regular intervals. Future industrial/commercial activities (primarily warehousing) are planned for the site.

4.2.3 ASSESSMENT

Environmental monitoring of CCA facilities in B.C. has been limited to groundwater (1 site), soils (1 site) and runoff waters (1 site). Ambient air or water bodies adjacent to facilities have not been assessed. Nevertheless, the data reported in Section 4.2.2 suggest that CCA facilities have the potential for serious contamination of the site environment. The contamination of the closed site described above is attributed to serious deficiencies in design and to poor operating and maintenance procedures. It is quite likely that containment designs and more carefully controlled operating practices employed at the more modern existing CCA plants will largely eliminate the type of extensive site contamination seen at the older plant.

There are no obvious short-term environmental impacts from existing CCA facilities. The existing information base is inadequate to quantify and to properly assess potential and actual long-term environmental impacts of these facilities. In order to remedy this deficiency, the code of practice should give consideration to a mechanism for developing guidelines and minimum standards for the following:

PRE-FACILITY STUDIES ■

Pre-facility site monitoring and development requirements should be established (see Section 2.1.9). No CCA facility in B.C. has background information on groundwater or soil characteristics prior to facility development. Most facilities have little knowledge of groundwater depths or movement below their sites. Pre-site assessment requirements should be defined for wood preservation plants to support the site-specific design of effective containment features and to provide a baseline for the evaluation of potential environmental impacts.

ROUTINE SITE MONITORING ■

Routine site monitoring requirements should be defined (see Section 2.1.9). Existing scientific information on chromium, copper and arsenic surface and subsurface migration and subsequent environmental effects should be reviewed, and used to assist the determination of monitoring requirements for CCA facilities. Monitoring requirements for air, water and soils should be considered. The review may indicate that only sites adjacent to water bodies or with high groundwater levels require frequent monitoring efforts. Consideration of water quality will require consultation with regulatory agencies since the Waste Management Branch currently has no formal water quality objectives or standards.

ASSESSMENT OF CONTAMINATION ■

Site contamination assessment requirements should be determined (see Section 2.1.9). Guidelines are required for assessing sites which have been contaminated by spills or ongoing releases of chemicals. These guidelines should specify approved sampling methodologies, analytical requirements, and reporting procedures.

SOLID WASTE DISPOSAL ■

As described in Section 2.1.4, minor quantities of solid waste are generated by CCA treatment systems. Disposal options for CCA-contaminated wastes should be assessed, and "best practice" disposal procedures should be developed. There is considerable uncertainty and disparity among users regarding disposal practices of CCA contaminated solid wastes. Current disposal practices include: shipment to a secure landfill site in the U.S.; disposal in local sanitary landfills; storage in drums with undefined plans for disposal; and, dispersal or storage on the ground at the yard site.

SITE CLOSURE REQUIREMENTS ■

Site closure procedures should be established. As a pre-requisite, consistent objectives for site closures must be developed by regulatory agencies. For example, one possible objective would be to assure that the site is left as it was prior to establishment of the treatment facility. "Acceptable" levels of contamination should be defined for the closed site. Minimum standards and procedures for decommissioning the site should be established and standard procedures for assessing and approving the closed site should be specified.

SITE DATA RETRIEVAL ■

Historical archives should be established for site information. There is a need to preserve and centralize information which documents process activities and site monitoring data. The establishment of an archive would assure accessibility and long-term availability of information required by regulatory agencies. This approach would eliminate duplication of information-gathering efforts by regulatory agencies, would provide an accurate and consistent record for site evaluations, and would provide a permanent record of information for assessing land use constraints for closed sites.

Existing information on industrial sites is fragmented, dispersed among numerous agencies, and often not current or complete. Closed files are often difficult to access and key information on future land use is not flagged. For example, this study identified the existence of several closed sites of wood preservation plants which can no longer be specifically located. If serious contamination exists at these sites, future developers may be faced with dangerous or expensive assessment and site reclamation.

4.3 ACA FACILITIES

4.3.1 REVIEW OF ACA RELEASES

The potential sources of ACA release from wood preservation operations were identified in Section 2.2. The sources and reported or estimated approximate quantities of the routine releases are summarized in Figure 4.2. The figure does not include estimates of releases from accidental major spills. The figure indicates that releases of ACA to the environment are expected to be minimal. Sources, if any, during normal operating procedures include release of ACA from stored timbers during rainfall events and air emissions during removal of charges. There have been no efforts to accurately quantify chemical releases from ACA facilities.

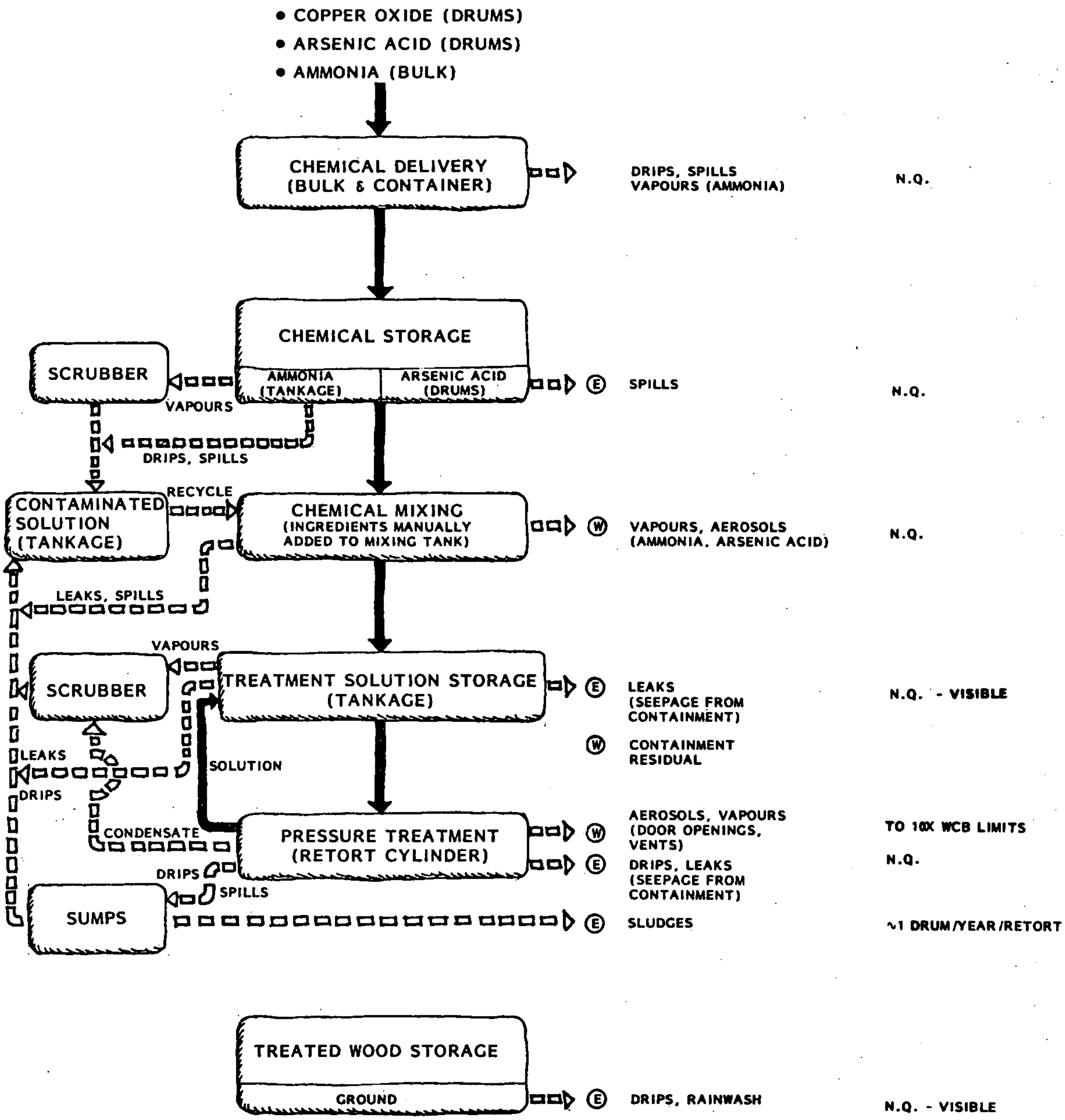

FIGURE 4.2 QUANTITIES OF CHEMICAL RELEASE FROM ACA PRESSURE TREATING PLANTS

4.3.2 REVIEW OF ENVIRONMENTAL MONITORING STUDIES

No pre-facility assessments have been undertaken for either of the two existing ACA facilities. Environmental monitoring of wood preservative chemicals at the sites has been limited to assessments of soil and groundwater contamination. Ammonia emissions to air are controlled by scrubbers and regulated by air emission permits.

One of the sites has been assessed by two different private consultants who were hired by the company to obtain data for a Waste Management Branch review. A program of facility improvements is currently being undertaken by the plant management after extensive negotiations with the WMB. The plant provides pressure treatment of wood with ACA and oil-borne preservatives and has been in operation for more than fifty years. ACA has been used on the site for the past 10 years.

The site was assessed by use of 20 drill holes (from 20 to 50 feet in depth) which were arranged in a large grid pattern. Trace contamination by copper and arsenic was evident in soils throughout the yard. Most of the contamination was confined to surface soils. Arsenic appeared to be the most mobile component of ACA and it was found at levels above background in most monitoring wells. With the exception of one sample (near the retort), concentrations of arsenic were below the Canadian Drinking Water Objective of 0.05 milligrams per liter.

The dispersal patterns of ACA components in surface soils throughout the yard appeared to be consistent with surface water drainage patterns and storage sites for treated timbers and sludge wastes. No evidence could be found to indicate that ACA components have migrated from the yard. Copper or arsenic were not found in soils outside the yard or in foreshore samples from an adjacent river. The impact of existing ACA contamination was judged by the consultant to be insignificant to the environment outside the yard.

The second existing plant is of relatively modern design and appears to have provided good overall control of preservative releases. Three groundwater monitoring wells have been installed at 4-foot depths in the vicinity of the treatment plant to warn of ACA seepage. No evidence of contamination was reported, although the data were not available for review by the authors of the present report.

CLOSED SITES ■

There are no known closed ACA treatment facilities in B.C., and environmental evaluations of ACA facilities are limited to the two instances described above.

4.3.3 ASSESSMENT

As with CCA facilities, ACA plants have the potential for serious contamination of the environment, particuarly when deficiencies exist in design, or in operating and maintenance procedures. Good overall control of ACA can be achieved with available technology. There are some deficiencies in the containment features employed at one of the existing facilities, although upgrading by retrofitting would be difficult.

There is no obvious visual evidence of ACA contamination at existing sites. On the basis of existing knowledge, it is difficult to assess the actual environmental implications of the low to moderate degrees of contamination which are indicated by monitoring at one of the sites.

The proper assessment of existing and potential environmental impacts of ACA facilities will require the development of guidelines similar to those suggested for CCA plants (Section 4.2.3). These guidelines should address the requirements for:

- pre-facility monitoring and development,
- routine site monitoring, and,
- site contamination assessment (see also Section 2.2.5).

Guidelines should also be established for:

- solid waste disposal requirements (see Section 2.2.4),
- site closure, and,
- archiving of historical site and facility information.

4.4 PCP FACILITIES

4.4.1 REVIEW OF PCP RELEASES

The potential sources of PCP releases from routine activities at pressure and thermal wood preservation plants were identified in Section 2.3 and 2.4. The sources and reported or estimated approximate quantities of normal releases are summarized in Figures 4.3 (for pressure treatment) and 4.4 (for thermal treatment). Figure 4.3 indicates that unlike CCA, ACA or PCP thermal facilities, waste water effluents are important sources of chemical release from PCP pressure facilities. Drippage from freshly treated wood and sludges is also an important potential source of PCP release during normal operating conditions. Efforts to quantify chemical releases have not occurred. Thermal facilities as shown in Table 4.4 have several sources of release during normal operating conditions which include vapor release from the thermal tank and sludges from the treatment tanks. PCP releases due to frothing of the thermal tanks or due to spillage from the tanks are also highly probable. Again, releases have not been quantified.

4.4.2 REVIEW OF ENVIRONMENTAL MONITORING STUDIES

Due to its high aquatic toxicity, pentachlorophenol has a greater potential for causing environmental effects than does any other wood preservative. The known environmental studies at existing and closed PCP wood preservation facilities in British Columbia are summarized in Table 4.1. The table shows that environmental monitoring at or near PCP treatment facilities has been relatively more extensive than monitoring at other types of wood preservative plants. Monitoring has included the analysis of soil, groundwater and surface runoff samples. Foreshore (riverbank) sediments have been analysed at two sites, as have water and biota from an area adjacent to one site. It should be noted that most PCP monitoring has been undertaken since 1980 even though two of the four PCP facilities have been in operation for several decades.

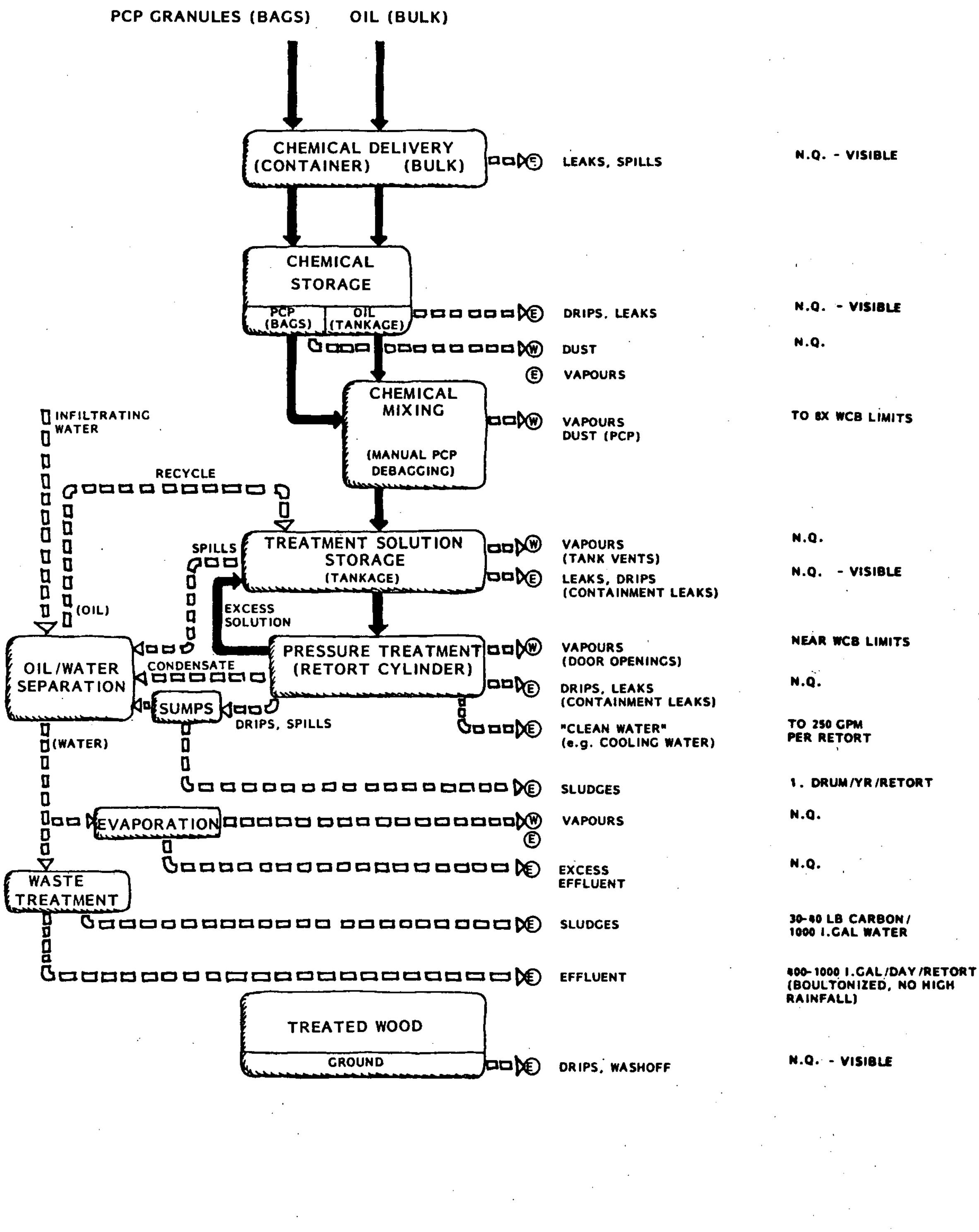

FIGURE 4.3 QUANTITIES OF CHEMICAL RELEASE FROM PCP PRESSURE TREATING PLANTS

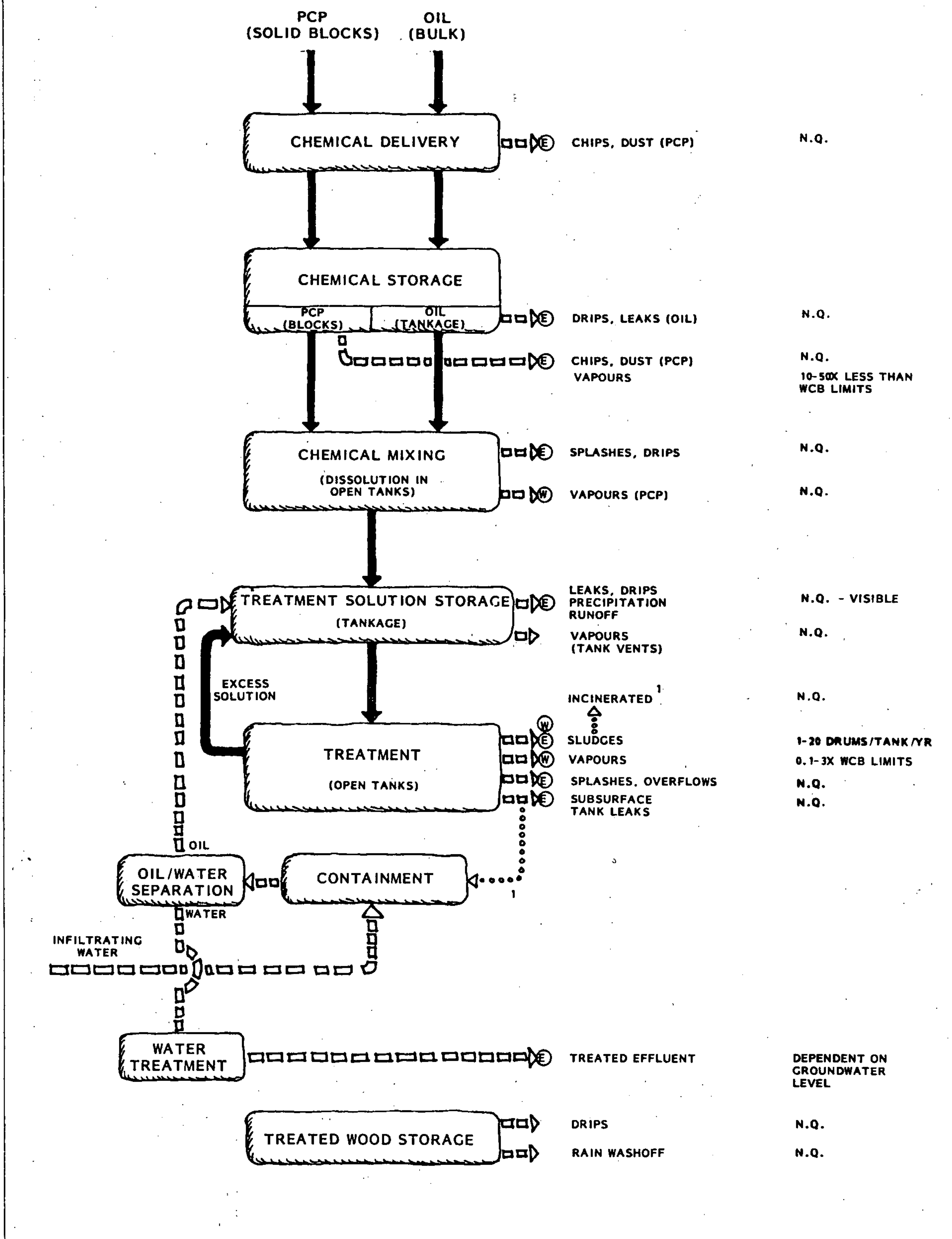

FIGURE 4.4 QUANTITIES OF CHEMICAL RELEASE FROM PCP THERMAL TREATING PLANTS

TABLE 4.1 ENVIRONMENTAL ASSESSMENTS OF PCP WOOD PRESERVATION FACILITIES IN B.C.

FACILITY TYPE	PAST AND PRESENT POLLUTION CONTROL FACILITIES	STUDY GROUP	STUDY ORIENTATION	RESULTS	EXISTING PERMITS AND/OR REGULATORY REQUIREMENTS	PROXIMITY TO WATERBODIES
EXISTING FACILITIES				DOMTAR - New West		
PRESSURE TREATMENT	UNTIL 1963, CYLINDER EFFLUENT WAS SETTLED AND DISCHARGED TO AN ADJACENT WATERCOURSE. A LIQUID EFFLUENT "INCINERATOR" WAS ADDED IN 1963 AND REPLACED WITH FLOCCULATION AND ACTIVATED CARBON TREATMENT IN 1978. TREATED WATERS ARE NOW ACCUMULATED IN A BATCH TANK, ANALYSED AND THEN DISCHARGED TO CITY SEWER WHEN ANALYSES INDICATE TREATED WATER IS WITHIN MUNICIPAL LIMITS. SOLID WASTES ARE SHIPPED TO A SECURE CHEMICAL LANDFILL.	CONSULTANT 1979	ASSESSMENT OF PCP USAGE IN B.C. ANALYSES OF SEDIMENTS, WATER AND BIOTA FROM ADJACENT RIVER.	ONE-HALF OF RIVER SEDIMENT SAMPLES, NON-DETECTABLE OR TRACE LEVELS OF PCP. OTHER SAMPLES HAD 0.007 TO 0.03 PPM PCP. TCP CONCENTRATIONS HIGHER FROM 0.006 TO 0.08 PPM. WATER SAMPLE HAD 0.00025 PPM PCP. FISH MUSCLE, 10 SAMPLES NON-DETECTABLE, 2 SAMPLES 0.014 PPM. LIVER SAMPLES 0.6 PPM. SITE DOWNSTREAM FROM PCP-TCP WOOD PROTECTION FACILITY.		
		COMPANY HEAD-QUARTERS 1980	RUNOFF WATERS AND ADJACENT CREEK	OIL FROM N.D. TO 2.6 PPM WITH ONE 21 PPM VALUE. PCP LESS THAN 0.01 PPM AND TCP BETWEEN 0.02 TO 0.04 PPM.	INFLUENT AND EFFLUENT OF TREATMENT PLANT MONITORED DAILY FOR PHENOLS. QUARTERLY REPORTS SENT TO GVRD. WMB PERMIT FOR DISCHARGE TO DITCH: DITCH SAMPLES ANALYSED AND QUARTERLY REPORT SENT TO WMB. ANALYSES INCLUDE PHENOLS, OIL AND GREASE, CHLOROPHENOLS, ARSENIC AND COPPER.	CLOSE, WITH 200 YD BUFFER STRIP BETWEEN RIVER AND PLANT SITE.
		CONSULTANT 1980	SURFACE AND SUBSURFACE SOILS (6 BOREHOLES)	SURFACE CONTAMINATION BY OIL NEAR RETORTS AND STORAGE TANKS. HIGH PCP LEVELS IN SOILS TO 12 FEET REPORTED, ALTHOUGH ACCURACY OF ANALYSES DOUBTFUL.		
		CONSULTANT 1981	SUBSURFACE SOILS MIGRATION ASSESSMENT (20 BOREHOLES)	AREA NEAR RETORT WITH PCP CONTAMINATION TO 40 FEET. PCP AT PPM LEVELS IN SUBSURFACE WATERS TO 50 FEET. FORESHORE CORES SHOWED NO EVIDENCE OF SUBSURFACE MIGRATION.		
		MOE 1982	ADJACENT DITCH WATERS AND CREEK	DITCH WATERS WITH 0.006 TO 0.072 PPM TCP AND 0.017 TO 0.25 PPM PCP. CREEK HAD ABOUT 0.001 PPM PCP AND TCP.		
PRESSURE TREATMENT	PREVIOUSLY USED WASTE WATER INCINERATOR. EFFLUENT NOW EVAPORATED WITH DISCHARGE OF EXCESS TO ADJACENT PONDS. CARBON COLUMN TO BE INSTALLED IN 1983. RAINFALL LOW, RUNOFF MINIMAL, SOLID WASTES PREVIOUSLY BURNED IN OPEN PIT.	COMPANY ONGOING	EFFLUENT EVALUATION FOR PERMIT REQUIREMENTS	GENERALLY LOW. HIGHEST RESULTS WERE 10 PPM OIL AND GREASE, 0.1 PPM PHENOLS AND 0.25 PPM PCP. DOMTAR P.G.	WMB EFFLUENT PERMIT WITH QUARTERLY MONITORING REPORTS. WMB AIR EMISSION PERMIT FOR BARK WASTE INCINERATION.	MODERATE. 3/4 MILE FROM RIVER.
		MOE	EFFLUENT, SOILS IN POND	ANALYSES USUALLY HIGHER THAN COMPANY RESULTS. EARLY ANALYSES PROBABLY MUCH IN ERROR.		
THERMAL TREATMENT	RECENT INSTALLATION OF SEEPAGE WATER TREATMENT SYSTEM - FILTRATION THROUGH WOOD CHIPS AND CHARCOAL. SLUDGE STORED IN OPEN TANK. DEBRIS BURNED.	COMPANY 1983	EFFECTIVENESS OF WASTE TREATMENT SYSTEM	UNKNOWN - ANALYSES UNDERWAY AT TIME OF VISIT.	AIR PERMIT FOR BURNER	CLOSE. CREEK BORDERS ON SITE.
THERMAL TREATMENT	SLUDGE STORED IN OPEN TANK. BURNING OF SLUDGE OCCURS.	NONE	NONE	NONE	AIR PERMIT FOR BURNER	FAR.

TABLE 4.1 ENVIRONMENTAL ASSESSMENTS OF PCP WOOD PRESERVATION FACILITIES IN B.C.

FACILITY TYPE	PAST AND PRESENT POLLUTION CONTROL FACILITIES	STUDY GROUP	STUDY ORIENTATION	RESULTS	EXISTING PERMITS AND/OR REGULATORY REQUIREMENTS	PROXIMITY TO WATERBODIES
CLOSED FACILITIES PRESSURE TREATMENT	N/A	CONSULTANT 1981	SUBSURFACE SOILS AND GROUNDWATERS (38 BOREHOLES)	Koppers PCP FOUND IN GROUNDWATERS AT CONCENTRATIONS FROM 0.006 TO 0.61 PPM. GROUNDWATERS HIGHLY TOXIC WITH 100% DEATH WITHIN 15 MINUTES. MIGRATION DIFFICULT TO ASSESS.	ASSESSMENTS BASED ON WMB REQUIREMENT TO DETERMINE AREAS OF CONTAMINATION WITH SUBSEQUENT CLEANUP.	CLOSE. ON RIVER BANK.
			FORESHORE SAMPLES	PCP CONCENTRATIONS FROM 0.005 TO 0.42 PPM IN FORESHORE SEDIMENTS. TOXIC SEDIMENTS LOCALIZED IN IMMEDIATE AREA OF DISCHARGE. *IN-SITU* AND LAB BIOASSAYS SHOWED RIVER WATER WAS NOT TOXIC.		
		HEAD-QUARTERS STAFF OF COMPANY 1982	SURFACE, SUB-SURFACE SOILS AND GROUND-WATERS (18 OBSERVATION WELLS AND 25 BOREHOLES)	MORE MONITORING HOLES IN ADDITION TO ABOVE. GROUNDWATERS CONTAIN UP TO 7.4 PPM PCP. SURFACE SOILS UP TO 550 PPM PCP. SUBSURFACE (5 FEET) UP TO 37 PPM. HIGHEST CONCENTRATIONS NEAR RETORT AND UNLOADING AREA. MIGRATION UNCERTAIN DUE TO HIGH DEGREE OF PREVIOUS SPILLAGE THROUGH YARD. PCP LEVELS IN SHALLOW WELL WATER (20 FEET) MUCH GREATER THAN IN DEEP WELLS (45-60 FEET).		
		MINISTRY OF ENVIRON-MENT 1981	FORESHORE SEDIMENTS	PCP IN TWO SAMPLES AT 11 AND 64 PPM. OTHER SAMPLES LESS THAN 1 PPM.		
PRESSURE TREATMENT Domtar Dawson Creek.	EVAPORATION POND	MINISTRY OF ENVIRON-MENT 1972	COMPLIANCE MONITORING OF DISCHARGE TO POND	ONLY PHENOL AND BOD ANALYSES. PHENOLS 0.57 TO 2 MG/L	WMB DISCHARGE PERMIT	
		MINISTRY OF ENVIRON-MENT	EVALUATE IMPACT OF EMERGENCY DISCHARGE OF PCP-OIL TO EVAPORATION POND FOLLOWING EXPLOSION AT PLANT.	WATER LAYER IN POND HAD 62 PPM. OIL LAYER HAD 23% PCP.	WMB REMEDIAL ACTION. WATER REMOVED FROM PIT, SHAVINGS ADDED. CLAY BACKFILL. VISUAL CHECKS REPORTED UNTIL 1982 FOR SURFACE SEEPAGE	
PRESSURE TREATMENT	UNKNOWN	UNKNOWN			SITE SAID TO HAVE BEEN ABANDONED WITH RUSTING PCP CONTAINERS. REMEDIAL MEASURES UNKNOWN.	

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4.4.3 ASSESSMENT

Of those sites evaluated and summarized in Table 4.1, on-site releases of PCP to ground were evident particularly at older plants which were initially designed and operated before the importance of environmental control was recognized. Table 4.1 also shows that thermal facility sites have not been evaluated as frequently nor as extensively as pressure facility sites.

POTENTIAL IMPACTS ■

Several environmental studies have been carried out at one PCP facility site in B.C., and the results illustrate the potential severity of PCP releases to the environment. Fish placed in contaminated groundwaters from the closed site reacted immediately and died within 15 minutes. Water mixed with contaminated foreshore sediments obtained adjacent to the closed site showed a high degree of toxicity to aquatic organisms in the laboratory.

ACTUAL IMPACTS ■

Although the site described above is considered to be seriously contaminated, biological effects on natural populations have not been documented in the water body adjacent to the site. More generally, *in-situ* environmental impacts have been neither observed nor documented adjacent to contaminated sites except when direct spills have occurred. It is not known whether the lack of observed effects is accurately descriptive or simply reflects limitations in the field monitoring studies.

CONTAMINANT MIGRATION ■

The analytical data available indicate that the soils and groundwaters of some B.C. sites are contaminated to a high degree. The ability of PCP to migrate to surface waters via groundwaters and soils is unknown. Migration studies were attempted at one closed site, but contaminant migration could not be verified because of the high degree of previous sporadic spillage which contaminated many areas of the site. It is acknowledged that groundwaters may be substantially diluted in waters adjacent to existing sites, however it is the view of the investigators that pentachlorophenol contamination of soils and groundwaters constitutes a problem of undefined magnitude and requires more investigation.

SAMPLING PROTOCOL ■

Due to the lack of knowledge on sub-surface contaminant migration, there are no standard protocols for environmental assessments of contaminated land sites. At one PCP facility site, different approaches were taken by 3 study groups and occasionally there was not complete agreement during the subsequent assessment efforts. Differences occurred in:

- sampling protocols (borehole sizes, casing, depth and grid patterns),
- groundwater sampling methods,
- chemical analyses (total phenols versus PCP), and,
- groundwater movement assessments.

In several instances, total phenol analyses were erroneously assumed to include PCP, despite the limitations defined in Standard Methods (APHA-AWWA-WPCF, 1980). The results of the studies are therefore difficult to compare. Much of the data describing PCP concentrations were found to underestimate actual levels.

CLEANUP COSTS ■

The costs for assessment and cleanup of contaminated sites can be substantial. At one recently closed site near a major river, many options for removal and disposal of contaminated soils were considered on the basis of both technical and economic feasibility. Direct costs to the company for assessing site contamination and formulating remedial measures were estimated to be of the order of $200,000. The site cleanup required by the WMB was limited to excavation of areas of high contamination and disposal of this material at a secure landfill in the U.S. The costs of excavation and disposal were estimated to be an additional $200,000.

REGULATORY APPROACH ■

The studies and deliberations involving the closed site mentioned previously have fostered an increased awareness by regulatory agency personnel of the potential environmental hazards of wood preservation chemicals. The situation did exemplify the urgent need for hazardous waste disposal facilities in B.C., the need for more careful and holistic assessment of the industry, and the need for consistency of approach by regulatory agencies.

RECOMMENDED ACTIONS ■

As described for CCA plant sites (Section 4.2.3), guidelines should be developed to facilitate the proper assessment of potential and existing environmental impacts from PCP facilities. These guidelines should include the minimum standards and requirements for:

- *Pre-facility monitoring and development.*
- *Routine site monitoring for PCP in air, water and soils.*

  Particular attention is required for definition of analytical methodologies for PCP. Large discrepancies were found in results reported by different laboratories. Some analyses of water report PCP concentrations which greatly exceed known solubilities of PCP. Of particular concern is the common misconception that the Standard Methods test for "total phenols" includes pentachlorophenol. Techniques used in commercial laboratories for "total phenols" do not simultaneously quantitate (and include) pentachlorophenol. Many environmental assessments of PCP facilities in B.C. have shown PCP concentrations (determined by gas chromatography) to be greater than "total phenols" (determined colorimetrically).
- *Site contamination assessment.*
- *Solid waste disposal.*
- *Site closure procedures.*
- *Historical archiving of site data.*

In addition to the above requirements, several specific research needs were identified during the course of the current review. These include the need for:

- the determination of PCP migration and persistence in various soil types and clarification of the influence of oil phase, oxygen levels, pH, and groundwater migration rates,
- development of a methodology for more accurate determination of the direction and rate of PCP movement in groundwaters under field conditions,
- formulation of cost-effective assessment procedures for contaminated sites,

- determination of the degradation rates of PCP under surface and sub-surface conditions,
- development of simplified laboratory and field procedures for PCP analysis,
- definition of monitoring requirements for facilities which incinerate PCP sludges, and,
- determination of overall mass balances for PCP in both pressure and thermal treatment facilities.

4.5 CREOSOTE FACILITIES

4.5.1 REVIEW OF CREOSOTE RELEASES

Section 2 discusses potential sources of creosote releases from wood preservation activities and indicates design features which are currently in use to minimize such releases. The sources and reported or estimated quantities of normal releases from these activities are summarized in Figure 4.5. Due to the similarity of the PCP and creosote pressure treatment processes, Figure 4.5 closely resembles Figure 4.3. Figure 4.5 indicates that retort sludges and drippage from freshly treated wood are the major potential sources of release of creosote to the environment, in addition to the condensate waters. As for other wood preservatives, the releases have not been accurately quantified.

4.5.2 REVIEW OF ENVIRONMENTAL MONITORING STUDIES

SITES OF EXISTING FACILITIES

Only one creosote wood preservation plant remains in the Province. The facility has been in operation for more than fifty years and also provides pressure treatment of wood with PCP and ACA. Two separate consultant evaluations of creosote distribution occurred at the yard site during 1980 and 1981. "Oil and grease" analyses were used as indicators of creosote contamination by both consultants. Contamination was evident in soils throughout the yard as indicated by "oil and grease" concentrations ranging from 13 parts per million to 12000 parts per million. Except in the immediate

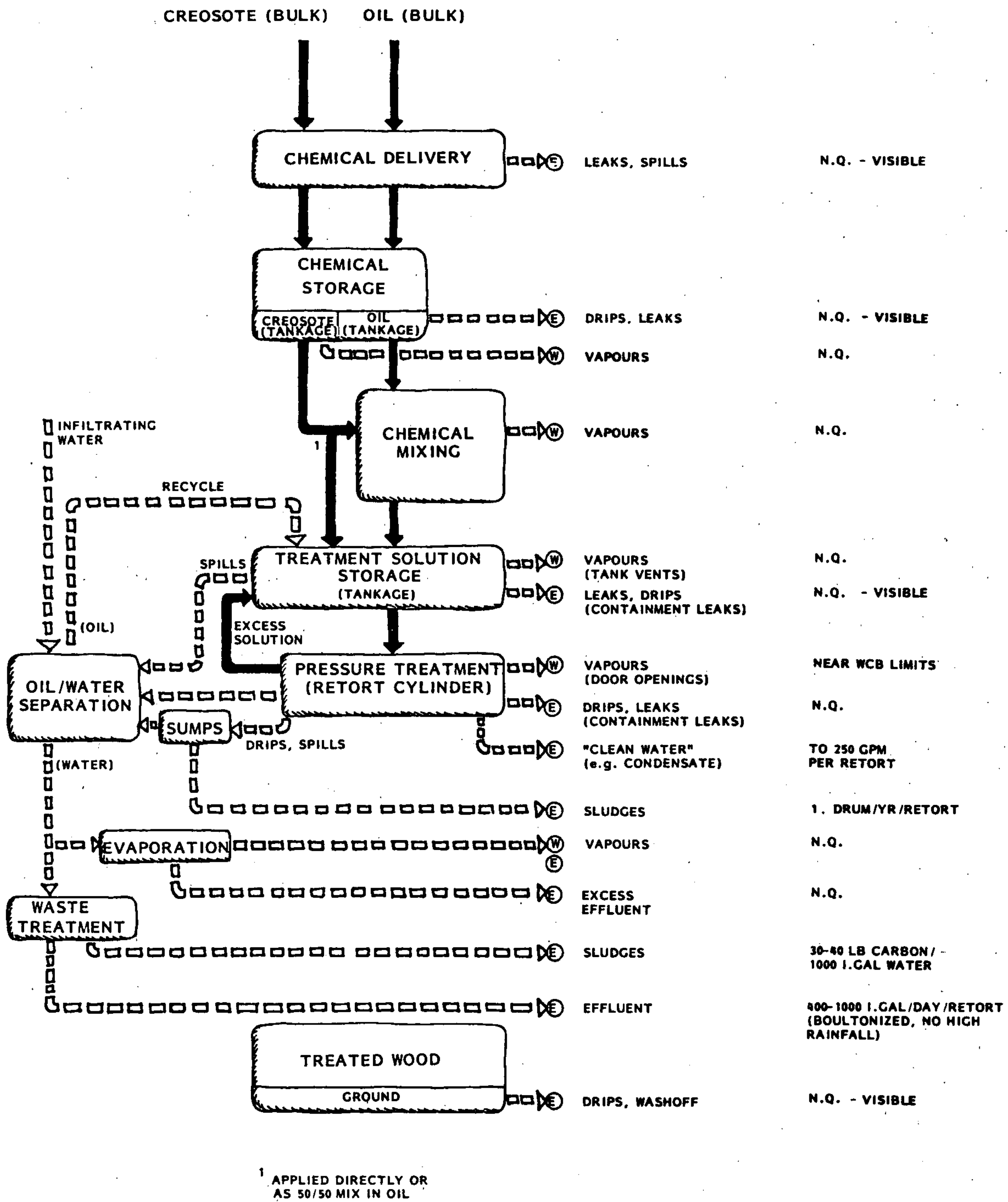

FIGURE 4.5 QUANTITIES OF CHEMICAL RELEASE FROM CREOSOTE PRESSURE TREATING PLANTS

area of the retort, the widespread distribution of creosote was mostly on surface soils and was attributed to the accumulated releases from routine operations at the site over fifty years. Groundwaters 20 feet below the PCP and creosote retorts were contaminated with layers of oil. Although the oil layer was found to contain large quantities of PCP, it was not known what fraction of the oil was due to the creosote treating process. Boreholes outside the retort area showed little or no "oil and grease" or pentachlorophenol and the consultants concluded that there was no evidence of creosote migration from the site.

The company is under WMB order to excavate the more contaminated soils near the retorts. The currently unsurfaced ground in these areas will subsequently be resurfaced with an impermeable material such as concrete.

CLOSED SITES ■

There are two known closed sites in B.C. where creosote treatment plants were formerly located. One site was located in a remote area of Northern B.C. and reportedly the operation was unknown to regulatory agencies prior to a major creosote spill. Regional WMB files indicate that a creosote spill occurred at the site in 1975. The spill was covered with wood shavings and soil in accordance with discussions with the WMB. When the operation was closed in 1975, the site structures were burned at the direction of the WMB.

The second facility was located in the Lower Mainland and provided creosote, PCP and CCA pressure treatment of wood over a fifty-year period. The operation was dismantled in 1982 and the closed facility was subjected to considerable investigation. Three methods for assessing creosote distribution were used:

- fluorometric analyses,
- polyaromatic hydrocarbon (PAH) analyses, and,
- phenol analyses.

Fluorometric and phenol analyses were used to minimize analytic costs. The fluorometric analytical procedure was readily adaptable for field analyses. The analyses showed high levels of surface contamination in various sections of the plant site. Areas near retorts were reported to have bands of high creosote concentrations at 15 feet below the surface. These bands were caused by the layering of the oil-borne contaminants on subsurface clay deposits. The degree of creosote contaminations was assessed on the basis of simultaneous PCP analyses. Certain areas with high concentrations of oil were found to have low PCP concentrations and thus were attributed to creosote contamination.

Analyses for phenols showed high concentrations of phenols in groundwaters obtained from test well sites near areas of known creosote usage. Phenols were found in concentrations as high as 161 milligrams per liter.

Historically, a high degree of creosote spillage reportedly occurred throughout the entire yard. As a result, studies were unsuccessful in assessing the degree of migration of creosote or components of creosote. Polyaromatic hydrocarbons (PAHs) analyses were used to assess the acceptability of ocean dumping of foreshore sediments from the adjacent river. PAH levels were elevated and it is not known if the observed concentrations were due to sub-surface migration from the yard site or due to contaminated surface runoff from the yard. Prior to complete closure of the site in 1983, the company was required to dredge foreshore sediments and to excavate areas of the yard which were heavily contaminated with wood preservative chemicals.

4.5.3 ASSESSMENT

Creosote is a complex mixture of chemicals which includes at least 160 PAH compounds. Some PAHs are slightly soluble in water, although the mixture is essentially nonsoluble. As a result, any environmental contamination by creosote can be considered "long-term" and serious contamination of the site would limit future alternate land uses for many years. Many of the PAH compounds in creosote have been identified as potential or actual carcinogens and this supports the need for concern about the impact of creosote-contaminated sites on the environment.

Environmental contamination by creosote has occurred at all past and present B.C. creosote treatment facilities. However, the significance of this contamination is difficult to define. Some components of creosote are biodegradable (Konasewich *et al.*, 1982) whereas others are persistent in the environment for many years. Data on the mobility and toxicity of the persistent components are generally limited. Furthermore, analytical assessments of site contamination are difficult to undertake due to the complexity of the creosote mixture. It is not known which of oil and grease, total phenols, fluorometric or PAH analyses are adequate as indicators to assess dispersal of creosote in the environment.

There is a clear need for uniformity in the assessment of creosote treatment facilities. As described in previous sections, guidelines should be developed to establish minimum standards and uniform requirements for:

- *Pre-facility site monitoring and development.*
- *Routine site monitoring.*

  Special attention should be given to identifying reliable tracer compounds which can be used to monitor creosote migration.
- *Site contamination assessment.*
- *Site closure procedures.*
- *Historical archiving of site information.*

5.0 DESCRIPTION AND ASSESSMENT OF HUMAN HEALTH CONCERNS

5.1 OVERVIEW

Wood preservatives are potentially dangerous chemicals which should present little or no hazard to workers if appropriate protective measures are observed. Existing information suggests that relatively little occupational illness has been attributed to the use of wood preservatives at workplaces in British Columbia (Whitehead, 1976). The current study of the B.C. wood preservation industry found no reported evidence of severe acute (short-term) health effects resulting from exposure to the chemicals in use. The effects identified during the study were restricted to skin rashes and respiratory responses (coughing). There have been no epidemiological health studies to assess whether wood preservation workers in B.C. suffer from effects due to long-term exposure (for example, cancer, heart attacks). There has been no evidence in the literature that such effects occur from routine workplace exposure.

In 1976 a review of the industry was provided by two WCB representatives (Whitehead, Riegert). Their recommendations still remain valid, and include:

- the need for medical testing to identify employees most likely at risk,
- the need for education at all levels to make workers aware of hazards, how they occur and how they may affect an individual,
- the use of mechanized systems to minimize skin contact with preservatives,
- the use of strict work schedules for general plant maintenance and housekeeping, and,
- the use of proper protective clothing.

Specific concern was expressed about worker exposure during the handling of PCP granules and the opening of PCP or creosote retorts. Whitehead and Riegert observed a high degree of variability in worker practices in handling wood preservatives and suggested that consistent guidelines are required for the industry. The necessary precautions were noted to be generally quite simple, and investigators stated that there should be no excuse for misuse of wood preservation chemicals in the workplace.

The authors of this report are in general agreement with the observations and conclusions of the WCB review cited above. Ironically, the WCB has played a relatively minor role in monitoring and assessing chemical safety at wood preservation plants since the 1976 overview assessment. It is recommended that the WCB become more active in programs directed at ensuring that the objectives of the 1976 assessment are fulfilled, in particular increasing the level of workplace monitoring of chemical exposure levels in the wood preservation industry. The consistent implementation of WCB objectives should be assisted and complemented by a code of good practice. The code should provide:

- clarification of the potential hazards associated with exposure to wood preservative chemicals, and,
- establishment of consistent requirements for workplace procedures and precautions which will ensure worker safety.

5.2 CCA FACILITIES

5.2.1 HEALTH STUDIES REPORTED IN THE LITERATURE

The occupational exposure of workers to CCA has been assessed in at least three separate studies conducted by NIOSH (the U.S. National Institute of Occupational Safety and Health). In a NIOSH sponsored study of a U.S. Weyerhaeuser plant, it was found that arsenic in urine of CCA wood preservation workers was at levels not significantly different from control samples (Markeland and Lucas, 1979). A 1983 study at a second plant indicated the absence of measurable emissions of chromium, copper or arsenic in air collected adjacent to a cylinder door during opening and adjacent to freshly treated wood (Todd and Timbie, 1983). One low positive result for chromium was obtained from air in the treatment building adjacent to the concentrate mix tank. The study team expressed concern about the possibility of exposure to CCA by skin contact. Swab samples of freshly treated wet and dry wood showed potential for the transfer of chromium, copper or arsenic to skin if proper precautions were not taken by workers.

The results of the studies reported above differ with the findings of a third NIOSH assessment of a Tacoma wood preservation plant (Todd and Timbie, 1981. Concentrations of arsenic and copper in air were found to approach permissible limits near the CCA retort during door openings.

5.2.2 HEALTH STUDIES IN B.C.

Only one of the ten existing CCA facilities in B.C. has been studied to assess exposure of workers to CCA. A WCB study was reportedly undertaken at the request of management, and found arsenic, copper and chromium to be much below acceptable concentrations in workplace air and in urine of the two workers tested. The results of the study are summarized in Table 5.1. It should be noted that workplace precautions at the tested facility are generally above average for the CCA wood preservation industry in British Columbia. WCB evaluations at other CCA facilities have been limited to assessments of mechanical safety.

Chemical	Concentration in Air (mg/m^3)	WMB Limit in Air (mg/m)[2]	Concentration in Urine (ppm)
As	0.002-0.004 (n=4)[1]	0.5	
Cr	0.005-0.012 (n=6)	0.05	
Cu	0.005-0.018 (n=6)	0.2	
As			0.048-0.060 (n=2) WCB limit: 1.5

[1]n = number of samples analysed

[2]Permissible concentrations specified in Appendix A of the B.C. WCB Regulations

TABLE 5.1 LEVELS OF CCA IN THE WORKPLACE AT ONE CCA FACILITY IN B.C.

5.2.3 HEALTH PRECAUTIONS IN B.C.

Warning signs, handling procedures, recommended hygiene practices and spill control measures are provided by suppliers of CCA (see Section 3.2.1). At most plant sites in B.C., the CCA warning signs are prominently posted and notebooks with the suppliers' information are readily available, generally at the operator's desk. Most users have attended previous training seminars which were sponsored by the suppliers. These seminars include consideration of safety measures in the use of CCA.

As noted in Section 3.2.1, suppliers provide yearly facility inspections which include assessments of safety practices. In most instances, the advice of inspectors is heeded, although some exceptions were observed during inspections of facilities by the authors of this report. For example, worker precautions were atypically poor at one site where it was observed that:

- workers were exposed to CCA from leaking pumps and valves,
- eating and smoking occurred in the process areas,
- emergency procedures were not defined,
- personnel wore CCA-soaked clothing, and,
- the plant site was freely accessible to all personnel and pets.

Workers at most CCA facilities usually wear gloves when handling treated lumber. Some workers were observed to wear CCA-soaked gloves which would provide little protection. Another concern is the disparity among CCA plants in providing emergency eyewash fountains and/or showers. These facilities are considered to be a luxury at some plant sites, and considered to be essential by other employers.

Employee attitudes about CCA vary considerably. Most operators typically voiced respect for potential hazards of CCA exposure. Some operators noted differences in hazard assessment by suppliers and by regulatory agencies. In an extreme case, one operator concluded that exposure is not serious because he experienced no burning sensation during direct skin contact.

5.2.4 ASSESSMENT

The human health precautions taken by workers and employers in the use of CCA are generally quite good. CCA is handled in closed systems which are highly mechanized and minimal skin contact occurs at existing facilities in B.C. Suppliers play a significant role in developing good worker safety practices. Although the degree of self-regulation by the industry is impressive, it is likely that a higher and more uniform level of worker safety would be achieved if the following areas were addressed:

WCB ROLE ■

It is recommended that the WCB establish a more active role in assessing worker precautions for chemical handling at CCA facilities. Most WCB assessments to date have addressed mechanical safety with little or no attention paid to chemical safety (see Section 3.4.1). Conflicting literature and information about air levels of CCA at treatment plants, a general lack of quantitative monitoring studies at B.C. facilities, and widely varying practices in the workplace at CCA plants in B.C. all indicate the need for an increased level of field assessment and support on the part of the WCB.

STANDARDS OF WORKER PROTECTION ■

It is recommended that a code of practice should establish industry-wide minimum standards and uniform guidelines for measures to protect human health in the workplace. Suppliers' existing manuals and expertise can provide an invaluable resource for this task. The endorsement of suppliers' guidelines by the code is suggested (with modifications only as required). It is likely that this would achieve a higher degree of uniformity in the acceptance and implementation of procedures and precautions which are recommended by suppliers.

CLARIFICATION OF HUMAN HEALTH EFFECTS ■

It is recommended that existing information on potential health effects of CCA be critically reviewed by regulatory health agencies, and the results of those assessments should be applied to guideline development (see Section 3.2.1). Workers in the industry express some confusion about the "real" hazards of CCA exposure. This confusion apparently stems from differences in assessments by the suppliers and by various health agencies. For example, suppliers claim that the chemical form of arsenic found in CCA is not cumulative in animal and human systems and is of limited toxicity. This is in conflict with NIOSH assessments which suggest that chromium and arsenic have the potential for serious health effects if overexposure does occur (Todd and Timbie, 1983).

GUIDELINES FOR
TREATED PRODUCT HANDLING

CCA-treated products have the potential for a greater degree of handling by the general public than other treated woods because of the wide variety of CCA-treated products which include playground equipment, patio wood and cedar shingles. The need for public awareness of necessary precautions associated with the use of CCA-treated wood should be considered. This should include consideration of the acceptability of burning treated wood debris. Some (not all) treatment facilities in B.C. distribute precautionary literature to purchasers of treated wood, although this information often is not passed on to the end user by contractors or distributors.

Another concern associated with handling is the acceptability of some existing transport practices. Personnel interviewed during this study reported that trucks which haul grain from Alberta to B.C. may return to Alberta with CCA-treated products in the truck holds. The possible effects of this practice on subsequent grain containment in the truck holds should be assessed.

5.3 ACA FACILITIES

5.3.1 HEALTH STUDIES REPORTED IN THE LITERATURE

Worker safety was recently evaluated at one ACA facility in the U.S. (Todd and Timbie, 1983). Air samples were taken adjacent to the cylinder door and above freshly treated lumber. Airborne levels of arsenic and copper were below the limits of analytical detection, and the investigators concluded "that there were negligible emissions of trace metal contaminants during the cylinder opening". However, "ammonia levels were readily evident by odor and eye irritation at the cylinder door and adjacent to freshly treated wood".

Grab samples for ammonia during ACA cylinder door openings showed airborne levels as high as 250 ppm. Operators at the test site wore canister respirators approved for ammonia fumes, and worker exposure was assumed to be unmeasurable. A sample two feet downwind of treated material after its removal from the cylinder also showed 250 ppm ammonia. A 15-minute maximum permissible limit of 35 ppm ammonia is stipulated by the Workers' Compensation Board of B.C. (1980). This suggests that occasional exposure of workers to excessive levels of ammonia can occur at ACA facilities when proper precautions are not observed.

Wipe-sample analyses of air-dried ACA-treated wood indicated that surface salts are more readily removable than with CCA-treated material. The data suggest possible skin contamination problems if freshly treated wood is handled directly without gloves.

5.3.2 HEALTH STUDIES IN B.C.

No assessments of ACA facilities were reported by the WCB, although the management at one existing plant reported that the WCB had evaluated the facility and found no problems with emissions or existing worker precautions. The same facility is said to be assessed periodically by its in-house industrial hygiene department.

5.3.3 HEALTH PRECAUTIONS IN B.C.

Both existing ACA facilities in B.C. are owned and operated by major Canadian corporations. Both facilities have readily available access to technical and health expertise, although one of the corporations has recently eliminated its occupational health department. Both facilities have elaborate written procedures for handling of ACA to minimize any possible health hazards.

At both user sites, plant personnel wear special clothing and face-shields during the preparation of ACA solution. Copper and arsenic formulations are containerized, and direct handling of small drums is required. Arsenic acid is pumped manually from the drums. Following the completion of the ACA stock solution preparation, personnel involved with the preparation are required to shower immediately. One site requires the operator to certify that all stipulated precautions have been observed.

5.3.4 ASSESSMENT

Extensive workplace procedures and precautions have been stipulated and implemented at existing ACA facilities in B.C. However, it is difficult to assess the adequacy of health precautions because of the absence of workplace assessments by the WCB. The substantial design differences at the two facilities (see Section 2.2) have resulted in significantly different constraints for operating procedures at the two plants. The absence of shelter in the mixing area of one plant and apparent differences in housekeeping and procedural standards at the two plants suggest that the role of a code of practice should be to establish minimum requirements for health protection at ACA plants. Consistent guidelines should be established for implementing the required safety measures.

5.4 PCP FACILITIES

5.4.1 HEALTH STUDIES REPORTED IN THE LITERATURE

Reported assessments of PCP facilities have included evaluations of health symptoms and determinations of PCP concentrations in air. Air monitoring studies have generally been constrained by problems with sampling and analytical procedures (Todd and Timbie, 1979; Stewart-Todd Assoc., 1979; Todd and Timbie, 1983). Errors as great as ten-fold (both too high and too low) were found during quality control studies using NIOSH standard procedures (Todd and Timbie, 1983). A method developed by Dow reportedly gives more acceptable results (Todd and Timbie, 1983).

Results of health symptoms and effect studies are therefore more meaningful for PCP evaluations. In a study of workers at a Weyerhaeuser plant in the U.S. (described as the world's largest wood preservation facility), the most apparent hazard was associated with the manual dumping of bagged PCP (Markel and Lucas, 1975). Handlers of the bagged material had high levels of PCP in urine, marked chloracne, hypertension and possible hepatic dysfunction. PCP concentrations in urine of all facility workers varied from 0.11 to 1.85 ppm. The level of influence of PCP in urine is reportedly 1 ppm (Markel and Lucas, 1975). The higher concentrations (greater than 1 ppm) were found in urine of handlers of bagged PCP. Six of twelve air samples from the manual dumping area exceeded the A.C.G.I.H. Threshold Limit Value (TLV) of 0.5 milligrams per cubic meter. PCP concentrations at other sites within the Weyerhaeuser plant were judged to be well below the maximum allowable concentrations.

During a Koppers site evaluation in the U.S., 9 of 10 workers related that they had occasionally experienced burning or redness of the eyes, and 4 of 11 experienced skin discoloration (Markel *et al.*, 1977). No chloracne was observed. PCP levels in urine of workers from the Koppers site varied from 0.01 to 5.2 ppm.

Klemmer *et al.* (1980), in an investigation of 47 wood treatment workers, concluded that PCP-exposed workers had not developed any serious exposure-related health effects. The study determined that open vat operators had concentrations of PCP in blood serum and in urine more than double the blood and urine levels of pressure tank wood treatment workers (3.78 ppm versus 1.72 ppm in blood serum; 0.95 ppm versus 0.27 in urine). Normally unexposed (background) individuals had 0.32 ppm PCP in blood serum and 0.03 ppm in urine. Conjuctivitis, chronic sinusitis and chronic upper respiratory disorders were significantly more frequent among PCP-exposed workers.

A more recent study found that PCP exposure levels in air at a thermal treatment and a pressure treatment facility were less than the current permissible occupational limit of 0.5 milligrams per cubic meter (Todd and Timbie, 1983). At the thermal facility, the pole inspector was exposed to the highest level of PCP (34% of the permissible limit). The exposure occurred when the worker was taking routine pole borings from the treated wood before it was removed from the full-length treatment tanks. The exposure of treatment process oprators varied from 0.005 to 0.275 milligrams per cubic meter and the magnitude of exposure was related to wind direction and velocity.

Treatment operators, locomotive crew members and/or forklift operators were the most significantly exposed personnel at the pressure treating facility. Exposures were highest during cylinder opening and unloading and varied from 0.013 to 0.137 milligrams per cubic meter. One sample was taken in a PCP block storage area, and an airborne level of 0.011 milligrams per cubic meter was determined. The exposure was not significant, but indicates that sublimation of PCP occurs and underscores the requirement for proper ventilation. Although concentrations of PCP in air were generally low, the authors of the study expressed concern about yard crew skin contact with freshly treated wood during sorting and stacking.

5.4.2 HEALTH STUDIES IN B.C.

Workplace monitoring for PCP at B.C. treatment facilities has been quite limited in scope and extent. Sampling for PCP exposure is generally not part of routine WCB assessments.

The WCB has conducted air emission studies at four PCP wood preservation facilities during two occasions (1976 and 1980). One of the facilities is no longer in operation. The results are summarized in Table 5.2.

The WCB data suggest that occupational hazards may exist with the use of pentachlorophenol. One sampling at a thermal treatment facility showed a PCP concentration in air (1.2 milligrams per cubic meter) which was above the WCB limit of 0.5 milligrams per cubic meter. The WCB has subsequently suggested that respirators be worn by operators working in the vicinity of thermal treatment tanks.

TYPE OF FACILITY	CHEMICAL	LOCATION	CONCENTRATION IN AIR (mg/M³)	CONCENTRATION IN URINE OF EXPOSED WORKERS (mg/L=ppm)
THERMAL TREATING	PCP	96' FROM TREATING TANK	0.064	
		12' FROM TREATING TANK	0.215	
	PCP			0.073-0.809 (n=5)[2]
	TCP[1]			< 0.01-0.069 (n=5)
THERMAL TREATING	PCP (1980)	AT TANK	1.2	
	TCP		0.3	
	PCP (1976)	TANK WALKWAY	0.1	
	TCP		0.03	
THERMAL TREATING	PCP			0.438-1.701 (n=4)
	TCP			<0.01-0.07
PRESSURE TREATING	PCP			0.028-0.325 (n=2)
	TCP			0.01

[1] *Trichlorophenol*

[2] *n = number of samples*

TABLE 5.2 RESULTS OF WCB AIR MONITORING STUDIES AT PCP FACILITIES

The WCB has also monitored the urine of workers exposed to PCP at three treatment facilities in B.C. Only one urine sample (1.7 ppm) exceeded the 1 ppm level of influence suggested by NIOSH (Markel and Lucas, 1975). Of the 11 urinalyses results obtained from the WCB, 7 samples were in excess of 0.4 ppm.

5.4.3 HEALTH PRECAUTIONS IN B.C.

All PCP wood preservation plants have implemented relatively stringent precautions for worker protection. The precautions for PCP use are almost entirely derived by the users rather than by the suppliers. The precautions are usually quite elaborate, and based on assessments by company personnel responsible for plant safety. U.S. EPA documentation is generally at hand and constitutes a major information source.

No special concerns about PCP exposure were expressed by workers at the two sites where PCP blocks were used. Blocks are labelled by the suppliers and actual skin contact with PCP is unlikely.

Workers did express concerns about the unloading of bagged PCP granules which are used at three of the existing plant sites. These concerns addressed the adequacy of existing ventilation in loading areas. At the pressure treatment facilities, PCP bags are opened manually, lifted and emptied through a hatch into a hot oil mixing tank. Rigid handling procedures have been developed for these activities and workers must sign a statement verifying that the stipulated precautions have been followed. These precautions include:

- the use of a local fume-hood over the hatch door of the hot oil tank,
- the use of a self-contained "air purifying helmet" type respiratory protection during opening and emptying of the bags,
- the one-time use of a disposal worksuit,
- the use of gloves, and,
- showering immediately after completion of the task.

At the thermal treating operations, different approaches for personnel safety are used. At one facility handling procedures are quite rigid and defined in writing. Housekeeping at this plant site was exceptionally good. Workplace clothing must remain at the plant site. Laundering is provided by the employer, who expressed concern that commercial launderers were not segregating this clothing from the clothing of other clients, despite being warned about the use of PCP at the plant site.

The second thermal treating facility reportedly uses rigorous personnel precautions, although procedures are not defined in writing. The management of this facility considers the use of verbal instructions and teaching by example, to be effective in maintaining a safe level of worker precautions in handling PCP.

5.4.4 ASSESSMENT

PCP is given a high degree of respect among industry personnel due to recent publicity about possible long-term human health and environmental effects. In most cases, precautions are formal and elaborate. Based on the existing literature it appears that additional safeguards for PCP handling should be recommended for the B.C. industry. The safeguards should be consistently applied at all facilities and should include consideration of:

- procedures for handling PCP granules,
- change of clothing requirements,
- ventilation requirements in control rooms and pump room facilities,
- design features to minimize the degree and duration of exposure, and,
- procedures for pre-employment and periodic ongoing medical surveillance.

Furthermore, the adequacy of the existing WCB permissible limit for exposure to PCP in air should be assessed in view of uncertainties about the accuracy of PCP monitoring techniques which are identified in the current literature. The consistent implementation of these measures should be achieved through a code of good practice which establishes minimum requirements for safety precautions and procedures for handling PCP.

5.5 CREOSOTE FACILITIES

5.5.1 HEALTH STUDIES REPORTED IN THE LITERATURE

As with PCP, analytical problems are encountered in determination of creosote concentrations in air. The use of different techniques has resulted in ten-fold disparities in measured concentrations (Todd and Timbie, 1983). Nonetheless, data reported in the literature suggest that the potential for significant exposures to creosote can occur for very brief periods of time during cylinder or tank unloading.

A study at a Tacoma wood preserving facility (Todd and Timbie, 1981) found that high exposure to creosote vapors could occur upon opening of the cylinder door. The concentrations of creosote occasionally approached the recommended limits of 0.2 milligrams per cubic meter. For example, the maximum measured concentration of creosote in air was 0.112 milligrams per cubic meter.

Photosensitization is a common effect on workers who experience skin contact with creosote and/or its vapors (Markel *et al.*, 1977; NIOSH, 1980). The effect is essentially that of an enhanced sunburn, which results in intense burning and itching. Photosensitization can be reduced by the use of barrier creams (Stewart-Todd Assoc., 1979). Other symptoms of exposure to creosote include mild oil folliculitis and pitch warts (Markel *et al.*, 1977). Many components of creosote are reported to be known or suspected carcinogens (Todd and Timbie, 1983).

5.5.2 HEALTH STUDIES IN B.C.

No health assessments at creosote facilities are known to have occurred in B.C.

5.5.3 HEALTH PRECAUTIONS IN B.C.

Creosote is used at one existing B.C. facility. Precautions for use have been developed by the facility's headquarters personnel. The precautions include use of protective clothing, respiratory equipment and defined handling and emergency procedures. Most operators at the site have long-term experience with creosote and occupational exposure may have occurred over periods as long as 25 to 35 years. The operators generally claim that no ill effects have resulted from exposure to creosote.

5.5.4 ASSESSMENT

Assessment of the adequacy of human health precautions at the single B.C. creosote treating facility is beyond the scope of this study. Occupational exposure to low concentrations of creosote vapors occurs constantly at this site due to the continual odors which were noticed during all visits to the site. Although the concentratins are probably lower than existing health standards, the adequacy of the standards is unknown. This situation exists because current standards are based on the use of a "gross measurable parameter" which is assumed to be a reliable indicator for creosote concentration. For example, n-hexane extractables or ultraviolet absorption may be used to monitor creosote presence, but investigators are uncertain of whether these parameters are truly representative of actual creosote concentrations.

In the absence of reliable methods to monitor worker exposure, it is important to minimize worker contact with creosote and its vapors and to periodically monitor the health of workers. A code of practice should establish minimum standards for worker protection consistent with current knowledge about creosote exposure.

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APPENDICES

APPENDIX I WOOD PRESERVATION PROCESSES

It is beyond the scope of this report to provide detailed descriptions of industrial processes for conditioning and applying preservatives to wood. As helpful background for lay readers, this Appendix presents excerpts from a reference text which generally describes the major processes utilized at wood preservation facilities in British Columbia. The text cited is: *Wood Preservation*, by Barry A. Richardson, published in 1978 by the Construction Press, Lancaster, London and New York.

Whilst the increasing sophistication of the chemical industry threatened to reduce the effectiveness of creosote it was also ultimately responsible for the development of compounds such as pentachlorophenol and the organo-chlorine insecticides which made the formulation of organic solvent-based preservatives possible, as described in Chapter 4. Fortunately Tidy had already shown that anthracene had only weak timber-preserving properties so that there was no "tug of war" between dye manufacturers and creosote users. Other changes in the composition of creosote were caused by the different methods of coking used and the varying grades of coal. All this made it more important that the principal wood-preserving components in creosote should be determined. Work has continued to the present day but despite improved methods the preservative action of creosote is still imperfectly understood. In 1951 Mayfield concluded that "the toxicity of creosote is not due to one or a very few highly effective materials but is due to the many and varied compounds which occur throughout the boiling range. The value of creosote as a wood preservative depends largely on whether or not it remains in the wood under the conditions and throughout the period of service." Essentially this means that a particular grade of creosote cannot be said to be efficient on the merits of its chemical composition alone. The only true test is to use it and to see how it stands up to the conditions. The difficulty is the length of life expected of creosote; the fence tested by Boulton in 1884 lasted about 70 years. Even then it was demolished only to make way for another structure and was still reasonably preserved. Any field test would take as long so that evaluation of new preservatives is often based on laboratory comparisons of preservative toxicity.

Application methods

Little has been said of the methods used for applying preservatives. An effective preservative can be a complete failure if inefficiently applied and this is the explanation of the early failures of creosote in the United States. Vacuum and pressure methods of impregnation undoubtedly give the greatest certainty of lasting preservation. Breant is said to have been the inventor of the process when he took out a patent in 1831 but in Great Britain Bethell was granted a patent in 1838 which included amongst other substances creosote applied by this means. The method soon became known as the full-cell or Bethell process, although it was modified to its present commercial form, which will be described in detail in Chapter 3, by Burt who was granted a patent for his improvements to the method. With creosote the method is ineffective when applied to unseasoned or wet wood, which means that extensive storage facilities are required for drying and seasoning. In 1879 Boulton was granted a patent for his "Boiling under Vacuum" process, using hot creosote to boil off the water in the wood. This process may be followed by the full-cell process or an empty-cell process such as the Rüping process. Steaming and steaming-and-vacuum processes were tried as alternatives to the Boulton process but with no great success.

There are several difficulties encountered with the full-cell process. "Bleeding" is likely to occur, an annoying factor in the case of fences and poles that pedestrians and animals are likely to encounter. Another aspect is the quantity of preservative used, a very important point in countries where preservatives, especially creosote, are scarce and expensive. The empty-cell processes are a great improvement for bleeding is less likely to occur and there is a 40-60% reduction in the use of preservative. The latter is especially important in the case of particularly permeable timbers and those with a high proportion of sapwood. The empty-cell methods in common use, the Rüping and Lowry processes, will be described in Chapter 3.

The Rüping process was initially patented by Wassermann in Germany in 1902, although Rüping applied the process commercially and American patents were subsequently granted in his name. The process is commenced by the application of an initial air pressure. When the entire process is complete the pressure is released, the compressed air in the cells drives out some of the preservative and a short period of vacuum recovers more preservative so that the net retention in the wood is only about 40% of the gross absorption, a saving in preservative of 60%. The Lowry process, which was patented in America in 1906, differs only in that it relies on compression of air at atmospheric pressure for return of excess preservative so that there is no initial compression stage. The recovery of preservative is about 40%.

Other similar processes due to Hülsbert, including the Nordheim process, 1907, have been entirely superseded by the Rüping process. In 1912 Rütgerswerke AG were granted a patent for treatment of insufficiently dry timber by the Rüping process. It is identical with Boulton's patent except that an oil used for evaporating the water is drawn off before the Rüping process is applied. The vacuum and pressure methods are the most important and most effective methods used for the application of wood preservatives. They suffer, however, from the great disadvantage that the plant required is considerable and it is often impossible or uneconomical to send wood to the plant to undergo treatment.Numerous non-pressure methods are available but are suitable for use only with specially developed preservatives such as the low viscosity, organic solvent products for spray and dip treatment of dry wood and the concentrated borate solutions which can be used for diffusion treatment of high moisture content, freshly-felled wood. Preservation processes are discussed in detail in Chapter 3.

1.1 Preservation principles

The simplest method to avoid deterioration is to use only naturally durable wood. Durability is an embarrassment in nature as it delays the disposal of dead trees and it can therefore be appreciated that only a limited number of wood species are, in fact, truly durable. This durability is almost invariably confined to the heartwood but the elimination of sapwood, coupled with selection from a very limited range of species, is now unrealistic unless unusually high costs can be tolerated. Usually it is far more realistic to select the wood species for its physical properties and then to take suitable precautions to ensure that deterioration is avoided. This does not necessarily mean the use of preservation treatments. For example, the most efficient method to avoid fungal decay is to keep wood dry, and this is most simply achieved by structural design, such as the incorporation of overhanging eaves and gutters to dispose of rainfall and damp-proof membranes to isolate structural wood from dampness in the

Pressure and vacuum units

Wood impregnation in cylinders can be achieved using a variety of treatment cycles but before discussing these in detail it is necessary to consider the units of pressure and vacuum which are used to describe them. Firstly it must be remembered that the atmosphere is under a pressure, most conveniently described as 1 atmosphere (atm). Drawing a vacuum is an attempt to decrease this pressure to 0. One method to describe both pressure and vacuum is to consider that a complete vacuum has 0 absolute pressure, so that the atmosphere is at an absolute pressure of 1 atm, and any additional pressure applied on top of atmospheric pressure is, of course, additional. Thus the application of 5 atm will result in an absolute pressure of 6 atm, whilst the drawing of a complete vacuum will result in an absolute pressure of 0 atm. This book is intended to be practical and, whilst it is necessary to interpret some of the more complex treatment cycles in terms of absolute pressure, it is far more convenient to consider the actual plant requirements, so that cycles will be quoted in terms of the pressure in atm that must actually be applied and the efficiency of the vacuum, as a percentage, that must be drawn. Whilst some perfectionists will object to the use of atm as the pressure unit and percentage as the vacuum unit it must be clearly understood that these are, in fact, the only universal units that are widely understood by scientists, technologists and plant operators.

Atmospheric pressure is sometimes described as 1 bar (b), a unit of pressure that gives rise to the more familiar millibar (mb) used by meteorologists. Atmospheric pressure is also frequently derived directly from the height of a mercury barometer and described as 760 mm Hg or 30" Hg. In the metric system pressure is expressed in terms of dynes (dyn) or Newtons (N) per unit area, and for all practical purposes it can be assumed that 1 atm is equivalent to 100 kN/m^2 or 1 000 000 dyn/cm^2. Whilst the current metric standards demand that we should use the units involving Newtons, they are still not widely understood and it is more usual at commercial plants to use traditional units; thus 1 atm becomes, for practical purposes, 15 lb/in^2 or 1 kg/cm^2. The torr has also been fairly widely adopted as a unit of low pressure, particularly vacuum-expressed on the absolute scale. A torr is, in fact, 1 mm Hg, so that complete vacuum is 0 torr whilst atmospheric pressure is 760 torr. In view of the maze of current units that are used to express pressure and vacuum the need to confine our descriptions to very simple units, the atmosphere for pressure and the percentage for vacuum, becomes clearly apparent.

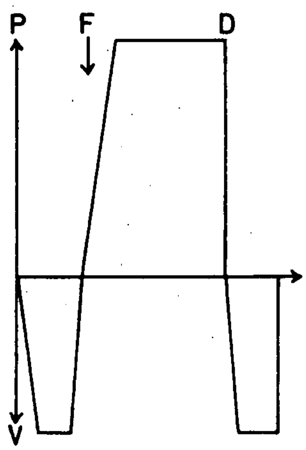
Full-cell impregnation

In a full-cell process the aim is to achieve the complete impregnation of the porous spaces within wood in the hope that a proportion of the preservative will penetrate the surrounding cell walls or that they will at least be protected by the very high loadings of preservative around them. In the empty-cell process the initial impregnation treatment is basically similar but this is followed by a recovery process designed to empty the porous spaces whilst leaving an adequate coating of preservatives on the cell walls.

Bethell process

In the traditional full-cell process a sequence of vacuum and pressure is employed to achieve complete impregnation of all the porous spaces within the wood. This impregnation process is currently known as the Bethell method, although it was actually first developed by Breant, and Bethell was responsible only for its adaptation to creosote treatments. In the normal commercial process the wood is introduced into the cylinder and a vacuum drawn of 90% or more, the time varying from 15 minutes to several hours, depending upon the permeability and cross-section of the wood involved. The vacuum, which removes most of the air from the porous spaces within the wood, is maintained whilst the cylinder is flooded with preservative; water-borne preservatives are generally used at ambient temperatures, perhaps warmed only to prevent freezing, crystallisation or sludging in cold climates, whereas creosote is typically applied at 140-176°F (60-80°C), principally to reduce the viscosity and improve penetration. When the cylinder is full the vacuum is released and the preservative commences to move into the porous spaces in the wood under the influence of atmospheric pressure.

Figure 3.5 Bethell full-cell cycle (F, flood; D, drain).



In order to encourage penetration a pressure is then applied, typically 7-14 atm, and maintained for as long as is necessary to achieve the desired penetration and retention, typically 1-5 hours but occasionally several days, depending upon permeability and cross-section. Sometimes treatment is specified "to refusal", indicating that the pressure must be maintained until gauges fitted to the plant indicate that there is no further absorption. With some species of wood, particularly Eucalypts in Australia, much higher pressures are employed but this is unrealistic with, for example, the softwoods grown in temperate climates where physical damage known as collapse or washboarding is liable to occur if excessive pressures are applied. With some very permeable species of wood the atmospheric pressure on release of the vacuum is sufficient to ensure the necessary penetration, or only a relatively low pressure of 1 or 2 atm is necessary; a process involving a vacuum without a superimposed pressure stage is known as a vacuum process whilst one involving a superimposed pressure of less than 5 atm is described as a low pressure process. After the necessary period the pressure is released and the preservative is removed from the treatment cylinder. Typically a final vacuum is then drawn in an attempt to prevent the bleeding of the preservative from the treated wood after its removal from the cylinder.

In theory this final vacuum is intended to induce the expansion of any residual trapped air within the wood, forcing excess preservative to the surface where it can drip clear, although in practice the process often leads to excessive surface deposits of high viscosity preservatives such as creosote. A more important function of the final vacuum is perhaps to relieve the compressed state of the wood, thus allowing any excess preservative to be properly absorbed. Whatever the true mechanism, resistance to bleeding can be achieved with creosote only if heating is maintained throughout the treatment process so that the viscosity of the preservative remains relatively low.

With a creosote treatment the nett retention, defined as the loading of perservative that remains after completion of the entire cycle, varies from 5-15.6 lb/f^{3} (80-250 kg/m^{3}) in softwoods, depending upon the species, the cross-section and the proportion of heartwood and sapwood present. In the case of a water-borne salt preservative the nett retention depends, of course, upon the concentration of salt in the preservative solution but typically 0.25-1.75 lb/f^{3} (4-28 kg/m^{3}) of dry salt is achieved, depending upon the nature of the preservative involved and the purpose for which the treatment is intended. The Bethell full-cell process is normally used for the application of water-borne preservatives and also for creosote where exceptionally high nett retentions are required in wood for use in extreme hazard situations, such as for marine piles. Full-cell impregnation, but without the use of a superimposed pressure, is also normally used in the laboratory for the impregnation of standard test blocks with preservatives for biocidal evaluation.

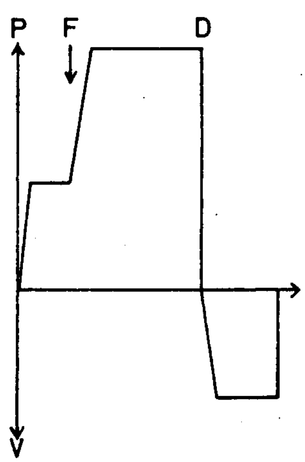
Empty-cell impregnation

In empty-cell processes wood is impregnated with preservative under high pressure on top of air trapped within the wood. This trapped air is later permitted to expand, ejecting preservative from the porous spaces but leaving the cell walls impregnated or coated with preservative. With empty-cell processes it is far easier to achieve treatments that are free from bleeding in service, but empty-cell treatments can be used only when the necessary retentions can be achieved despite the recovery of preservative from the porous spaces within the wood.

Rüping process

There are two empty-cell processes in common use, both originally designed for use with creosote. The earliest empty-cell process was developed by Wassermann but it is usually known by the name of Rüping, who first developed the process commercially. After the cylinder has been loaded and sealed an air pressure is applied, usually 1.7-4.0 atm for a period of 10-60 minutes depending upon the permeability and sizes of the pieces of wood in the charge. The cylinder is then flooded with preservative, usually creosote, without releasing the pressure, which is then increased up to perhaps 14 atm, about 10 atm above the original air pressure, and this pressure is maintained until the required gross absorption of preservative is obtained, as indicated by the plant gauges. The pressure is then released and the preservative removed from the cylinder, permitting the air trapped within the wood to expand and eject preservative from the porous spaces.

Figure 3.6 Rüping empty-cell cycle (F, flood; D, drain).



In practice a vacuum of about 60% is drawn during this stage to encourage the expansion of the trapped air and to ensure that, despite the relatively high viscosity of the preservative, there are no pockets of air at a pressure in excess of atmospheric; if the pressure is not released in this way there is a danger that the remaining pressurised air will cause continuing bleeding of preservative at the surface of the wood, whereas the drawing of a vacuum will tend to reduce the pressure of the trapped air to below atmospheric and result in a tendency for excess preservative to move inwards under the influence of atmospheric pressure when the vacuum is released, giving a particularly clean treated surface. Although this final vacuum was not incorporated in the original Rüping process, its value in reducing bleeding from empty-cell treated wood will be apparent from these comments. Indeed, whatever the empty-cell process, it is essential, if bleeding is to be avoided, to ensure that any trapped air is under vacuum at the completion of the process if subsequent bleeding is to be avoided.

The required gross absorption during the pressure stage is generally defined for individual species of wood taking account of their permeabilities, so that a gross absorption requirement is really a means to ensure adequate penetration. When the pressure is released and the vacuum recovery period completed a substantial proportion of the preservative will have been removed from the open, porous spaces within the wood so that the nett retention of preservative may be as low as 40% of the gross absorption, slightly less than 40% of the retention from a full-cell process, whilst achieving almost as good penetration. For example, in transmission poles penetration is essential but, in most temperate areas, a full-cell process is unnecessary with creosote as it will achieve an unnecessarily high retention. Typically a retention of perhaps 15.6 lb/f³ (250 kg/m³) will be achieved with a full-cell process but with the Rüping empty-cell process the penetration will be virtually the same but with a retention of only about 6.87 lb/f³ (110 kg/m³). Preservative usage is thus substantially reduced, yet this nett retention is still adequate to prevent the fungal degradation at the ground line that represents the principal hazard, and the empty-cell process can, of course, achieve freedom from surface bleeding. However, it must be fully appreciated that good penetration coupled with high recovery and low nett retention can be achieved only with preservatives of relatively low viscosity and this necessarily means that creosote can be used only at relatively high temperatures. In addition, creosote will not satisfactorily coat or penetrate the cell walls if the wood has a moisture content in excess of about 20%.

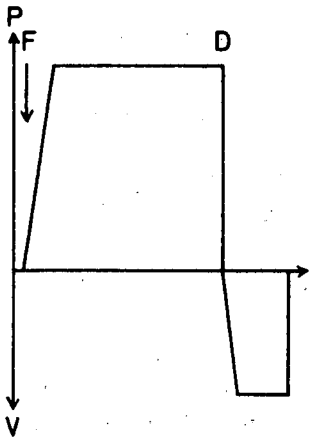
The Rüping and other empty-cell processes are generally employed for creosote treatments, although they can also be used with water-borne preservatives possessing slow fixation reactions, particularly those that fix only when a component is lost, such as the ammonia-based preservatives which fix as a result of the pH change which occurs when the ammonia volatilises. Empty-cell processes are also particularly suitable for the application of low viscosity, organic-solvent preservatives, achieving excellent distribution combined with limited consumption of preservative, although with these low viscosity systems it is unnecessary to use high pressures to achieve the required penetration; a description will be given later of a double vacuum process which is a normal empty-cell process operating with very low pressure differentials.

Whilst Rüping is the most widely used empty-cell process, particularly for the treatment of transmission poles with creosote in Europe, there are a number of other empty-cell processes of importance. The double Rüping process was used on the German railways from about 1909. This process involved a normal Rüping cycle except that, during the impregnation stage, a short period of pressure was followed by a vacuum, without emptying the cylinder, and then a return to pressure and the completion of a normal Rüping pressure cycle. The advantages of this modified process are not clear. The additional vacuum would appear to serve only to reduce the effect of the initial pressure, perhaps thus improving penetration compared with a normal Rüping cycle but also increasing the nett retention. The process would also appear to have an unnecessarily high energy demand arising from the application of an initially high air pressure which is later effectively reduced by the application of a vacuum involving the expenditure of further energy. In theory it would seem to be more sensible to reduce the initial pressure alone, but this is effectively the Lowry empty-cell process that was developed as an alternative to the Rüping process in the United States.

Lowry process

In the Lowry process there is no initial air pressure and the preservative is therefore impregnated on top of air at normal atmospheric pressure. A more intense final vacuum is desirable, perhaps as high as 90%, so as to

Figure 3.7 Lowry empty-cell cycle (F, flood; D, drain).



achieve the maximum recovery but, in this respect, the Lowry process is never as efficient as the Rüping process; the final nett retention is typically about 60% of the gross absorption compared with as low as 40% with the Rüping process using a low viscosity preservative. However, Lowry treatment results in less bleeding than the Rüping process, clearly because any air trapped at the end of the treatment cycle is at a lower pressure. In addition a Lowry treatment plant is less elaborate than a Rüping plant as there is no need for a separate air pressure pump. This was at one time considered to be an important economic factor but it is less significant today as many air vacuum pumps can also function as pressure pumps, so that an initial air pressure can be achieved simply at the cost of additional pipe work and valves.

The Nordheim process was an adaptation of the Lowry process, which attempted to achieve further operating economies. During the impregnation stage the pressure was raised to between 2 and 7 atm and the cylinder valves then sealed, avoiding the necessity for continuous pumping to maintain the pressure. In fact the pressure reduced steadily as the preservative penetrated into the wood or through leaks in the plant, giving erratic results, so the process was eventually abandoned.

Energy considerations

It is unfortunate that impregnation processes are often developed by wood technologists with chemical or biological training as such specialists largely ignore energy considerations when designing treatment cycles or preparing plant performance specifications. During the impregnation stage it is important to pressurise using a preservative feed pump as this ensures that the level is maintained while the preservative is being absorbed into the wood. A pressure pump of this type, usually a piston pump, need have only a relatively low capacity in view of the slow rate of penetration of preservative into wood and the relative ease with which a fluid can be pressurised in a short period due to its non-compressibility. However, a high pressure pump of low capacity is quite unsuitable for transferring preservative between the storage tank and pressure cylinder. The pump can, of course, be increased in capacity but this also increases the power consumption whilst maintaining the pressure and it may be more economic to provide a second, centrifugal, high capacity pump to achieve rapid fluid transfer.

During the impregnation stage it is essential that the cylinder should be filled with preservative without any air space being left at the top as the compression of this trapped air would absorb considerable energy, delaying the pressurising of the cylinder and increasing the cost of operation without achieving any advantage. Pressurising air or drawing a vacuum in air also requires considerable energy and it is therefore essential to ensure that the cylinder is loaded with the maximum charge that can be accommodated in order to ensure that air space is at a minimum. One possibility is to flood with preservative before drawing a vacuum but, whilst the vacuum can certainly be achieved more quickly, capillary forces between the preservative and the wood result in the full effect of the vacuum not being transferred to spaces within the wood; a 90% vacuum above the preservative may represent a 60% vacuum or less within the wood. In addition simple hydrostatic forces are significant in a large cylinder so that the effective vacuum within the wood is considerably reduced at the bottom of the cylinder, where wood is subjected to the hydrostatic typically giving a retention of 5 lb/f³ (80 kg/m³) for the butt but only 2.5 lb/f³ (40 kg/m³) for the rest of the pole.

Boulton process

One problem is the limited penetration that can be achieved when wood is wet. Even with water-borne preservatives there must be sufficient space within the wood to accommodate the necessary absorption of preservative solution and this means that preservative should never be applied when wood has a moisture content in excess of the fibre saturation point of about 30%. With creosote and other preservatives that are largely immiscible with water a much lower moisture content is desirable in order to ensure penetration of the cell wall, although in practice a maximum moisture content of about 25% is usually specified. If the moisture content is higher and kiln-seasoning is unrealistic, as with transmission poles to be treated during the winter months, it is possible to remove water during the treatment process. Creosote is generally heated to reduce its viscosity and, in the Boulton process, this hot creosote is used to boil off the water. Generally the creosote is heated to about 140°F (60°C) and a vacuum applied to induce boiling. When foaming ceases pressure is applied as in a normal Bethell full-cell process. When Boulton originally introduced the process, boiling under vacuum was used to avoid the necessity of heating the creosote above 212°F (100°C); some creosotes at that time possessed very high phenol contents which were appreciably volatile at that temperature, particularly in steam, and it was also feared that high temperatures would damage the wood. In fact damage does not occur and some treatment plant operators are now using 248°F (120°C), boiling off water during a normal Rüping or Lowry empty-cell process without the need for an additional vacuum stage.

The use of very hot creosote also helps to reduce bleeding as the viscosity of the preservative is low, achieving both good penetration and recovery, although it must be appreciated that bleeding can be avoided completely only if the cycle is designed to ensure that, at the end of the process, any trapped air has a pressure below atmospheric. Thus any movement of preservative will be inwards rather than outwards. In view of the volatile losses that can occur from creosote during Boultonising a modified technique was devised by Rütgerswerke, in which the cylinder was first flooded with a separate, hot oil for the water removal stage, if necessary with the application of a vacuum to induce boiling. This heating oil was then removed and creosote applied using a normal Rüping cycle.

Bleeding after empty-cell treatment

The normal Bethell, Rüping and Lowry impregnation processes have been used for many years and enjoy considerable success provided appropriate precautions are taken to ensure that the moisture content of wood is sufficiently low and that the species used are sufficiently permeable. In recent years the major problem has been bleeding, largely because of the complete lack of appreciation that trapped air must have a pressure of less than atmospheric at the completion of an empty-cell treatment cycle.

The most serious bleeding is associated with the Rüping process, which involves an initial air pressure followed by impregnation with preservative. In the original process the pressure in the trapped air was relied upon to eject excess preservative from the wood but this expulsion would continue, particularly with creosote of relatively high viscosity, for a considerable period after the timber was removed from the treatment cylinder. In many yards poles were stored for 6 to 12 months to permit the creosote

APPENDIX 2 WOOD PRESERVATION STANDARDS AND CERTIFICATION

The application and use of wood preservation chemicals is the subject of standards and/or certifications issued by several organizations including:

- The Canadian Standards Association (CSA),
- The American Wood Preservers Association (AWPA),
- Underwriters Laboratories of Canada (ULC), and,
- The International Conference of Building Officials (ICBO).

CSA STANDARD 080 is the most important Canadian standard which governs the use of preservative chemicals. This comprehensive document addresses the use of oil-borne preservatives, water-borne preservatives, carrier solvents and fire retardants.

Specific standards stipulate:

- the composition of preservative chemicals,
- methods of chemical analysis,
- seasoning, pre-treatment and treatment conditions, and process parameters,
- methods for treated product inspection and quality control, and,
- allowable uses of treated products.

Selected pages from CSA 080 are reproduced in this appendix to illustrate the scope and level of detail of this standard. CSA also provides a certification service for manufacturers who (under license from CSA) wish to use registered CSA Marks on products which have been treated in conformity with CSA Standards. Certification is voluntary and requires detailed periodic facility and product inspections.

The AWPA issues standards similar to CSA 080 which govern wood preservation in the U.S. Canadian facilities frequently use AWPA standards as resource documents and Canadian treated product which is exported to the U.S. must comply with AWPA Standards. Compliance is designated by a product stamp applied in accordance with the AWP Bureau.

U.L.C. is a policing body which issues procedural instructions for the use of treated wood products in order to comply with defined classes of safety. U.L.C. Marks and instruction labels are used in B.C. only in conjunction with fire retardant treated materials such as shakes or shingles. In Canada, instruction labels stipulate details of installation (as per the National Building Code of Canada) to comply with Class "B" or "C" fire retardant ratings. The Class "C" system is further recognized by the I.C.B.O. and is so indicated on treated products exported for use in the U.S.

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CSA STANDARD O80
1974 LOOSELEAF EDITION

WOOD PRESERVATION

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P5-77

STANDARDS FOR WATER-BORNE PRESERVATIVES

Replace Clauses 2, 3, 4, and 5 of P5 with the following Clauses 2 and 3:

2. AMMONIACAL COPPER ARSENATE (ACA)

2.1 Ammoniacal copper arsenate shall have the following composition:

Copper as CuO .... 49.8% to 63.0%

Arsenic as As_2O_5 .... 37.0% to 50.2%

subject to the tolerances listed in Clause 2.2.

2.2 The composition of the preservative present in a treating solution may vary within the following limits:

	Min. %	Max. %
Copper as CuO	47.7	63.0
Arsenic as As_2O_5	36.0	50.2

2.3 The solid preservative or treating solution shall be made up of compounds selected from the following groups, each in excess of 95 per cent purity on an anhydrous basis:

Copper, e.g., hydrated copper oxide, basic copper sulphate, copper carbonate, copper metal;

Arsenic, e.g., arsenic trioxide
arsenic pentoxide
arsenic acid

Carbonate, e.g., ammonium carbonate
ammonium bicarbonate

The general preservative shall be labelled as to its total content of active ingredients listed in Clause 2.1.

2.4 The treating solution shall be made up by dissolving the selected compounds in a solution of ammonia (NH_3) in water, in the presence of air, so as to ensure the conversion of the arsenic to the pentavalent form. The weight of ammonia contained in a treating solution shall be from 1.5 to 3.5 times the weight of the copper oxide. The weight of the carbonate (*expressed as CO_2*) in the treating solution shall be sufficient to ensure solubility of the selected compounds and will range 0 to 0.8 times the weight of copper oxide.

2.5 Tests to establish conformity with the foregoing requirements shall be made in accordance with the standard methods of analysis contained in CSA Standard O80.A2, Standard Methods for Analysis of Water-Borne Preservatives and Fire-Retardant Formulations.

P9—77

STANDARD FOR SOLVENTS FOR ORGANIC PRESERVATIVE SYSTEMS

Revise P9 to read as follows:

STANDARD FOR HYDROCARBON SOLVENTS FOR PRESERVATIVES

1. SCOPE

1.1 This Standard covers hydrocarbon solvents for preparing solutions of preservatives.

2. TYPES

2.1 The hydrocarbon solvents covered by this Standard include four types as follows:

(a) **Type A** — For preparing solutions of pentachlorophenol and copper naphthenate;

(b) **Type B** (Volatile Petroleum Solvent-LPG) — For preparing solutions of pentachlorophenol, naphthenate and copper-8-quinolinolate;

(c) **Type C** (Light Hydrocarbon Solvent with Auxiliary Solvent) — For preparing solutions of pentachlorophenol;

(d) **Type D** (Chlorinated Hydrocarbon Solvent-inhibited grade of methylene chloride) — For preparing solutions of pentachlorophenol.

3. TYPE A HYDROCARBON SOLVENT

3.1 Physical Requirements. Type A Hydrocarbon Solvent shall conform to the requirements prescribed in Table 1.

TABLE 1

REQUIREMENTS FOR TYPE A HYDROCARBON SOLVENT

Property	Maximum	Minimum
Specific Gravity, 60/60°F*	—	0.85
Water and Sediment, per cent	0.5	—
Flash Point (Pensky-Martens Closed Tester)	—	150°F
Distillation:		
Total volume of fractions distilling below 500°F, per cent by volume	50	—
Total volume of fractions distilling below 600°F, per cent by volume	90	—
Kinematic Viscosity at 100°F, centistokes†	13.0	—
Solvency at 75°F, per cent by weight‡	—	10

**Equivalent API Gravity is 35° maximum by ASTM Standard D287, API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method).*

†Equivalent Saybolt Viscosity at 100°F is 69.7 SUS maximum by ASTM Standard D88, Saybolt Viscosity. Petroleum oils of higher viscosity may be used provided penetration requirements are met.

‡This requirement does not apply to solvents used to prepare copper naphthenate solution.

3.2 Methods of Test. The properties enumerated in Table 1 shall be determined in accordance with the appropriate Standard listed below:

(a) **Specific Gravity** — ASTM Standard D1298, Density, Specific Gravity or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method;

(b) **Water and Sediment** — ASTM Standard D96, Water and Sediment in Crude Oils;

(c) **Flash Point** — ASTM Standard D93, Flash Point by Pensky-Martens Closed Tester;

(d) **Distillation** — ASTM Standard D86, Distillation of Petroleum Products;

(e) **Kinematic Viscosity** — ASTM Standard D445, Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity);

(f) **Solvency** — CSA Standard O80-A5, Standard Methods for Analysis of Oil-Borne Preservatives.

4. TYPE B HYDROCARBON SOLVENT

4.1 Physical Requirements

4.1.1 Type B Hydrocarbon Solvent shall conform to the requirements prescribed in Table 2.

TABLE 2

REQUIREMENTS FOR TYPE B HYDROCARBON SOLVENT

Property	Maximum	Minimum
Vapour pressure at 100°F, psig	200	—
Distillation, 95 per cent volume distilling point	36°F	—

NOTE: *An auxiliary solvent may be used providing it conforms to the requirements prescribed in Clause 4.1.2.*

4.1.2 The auxiliary solvent shall conform to the following requirements:

(a) **Dry Point** — The dry point shall be not more than 160°F;

(b) The auxiliary solvent shall not exceed 5 per cent of the total volume of the combined solvent and which will not increase the 95 per cent boiling point of the liquefied petroleum gas above 36°F.

NOTE: *In using pentachlorophenol dissolved in Type B Hydrocarbon Solvent, the usual requirement for solution concentration does not apply. The wood is treated using a full cell process and the retention is controlled by adjusting the solution concentration. Results of treatment, with respect to retention, are determined either by assaying the treated wood or by inventorying the preservative in solution before and after a charge.*

APPENDIX A

The American Wood-Preservers' Association Standards and ASTM Standards listed in this Appendix are adopted by the Canadian Standards Association under Clause 2.1 of CSA Standard O80. The two figures following the designation number of each Standard indicate the year of issue.

	Introduction to Book of Standards;
A1—77	Standard Methods for Analysis of Creosote and Oil-Type Preservatives;
A2—77§	Standard Methods for Analysis of Water-Borne Preservatives and Fire-Retardant Formulations (see also Clause 4, herein);
A3—77	Standard Methods for Determining Penetration of Preservatives and Fire Retardants;
A4—56	Standard Methods for Sampling Wood Preservatives;
A5—77	Standard Methods for Analysis of Oil-Borne Preservatives (see also Clause 4, herein);
A6—76	Method for the Determination of Oil-Type Preservatives and Water in Wood;
A7—75	Standard Wet Ashing Procedure for Preparing Wood for Chemical Analysis;
A8—67	Qualitative Recovery of Creosote or Creosote-Coal Tar Solution from Freshly Treated Piles, Poles, or Timber (Squeeze Method);
A9—70*	Standard Method for Analysis of Treated Wood and Treating Solutions by X-Ray Emission Spectroscopy;
A10—72	Standard Methods of Analysis of CCA Treating Solutions and CCA Treated Wood by Colorimetry;
A11—74	Standard Method for Analysis of Treated Wood and Treating Solutions by Atomic Absorption Spectroscopy;
F1—51	Volume and Specific Gravity Correction Tables for Creosote, Creosote-Coal Tar Solution (up to 50% Tar) and Coal Tar (Coke Oven Tar);
F2—74	Standard Abridged Volume and Specific Gravity Correction Tables for Petroleum Oils and Pentachlorophenol Solutions;
F3—77	Standard Volumes of Round Forest Products;
F4—51	Standard Volume Correction Table for Creosote-Petroleum Solutions;
F5—51	Volume Correction Factors for Preservative Salt Solutions;
F6—72	Miscellaneous Conversion Factors and Correction Tables;
M1—76	Standard for the Purchase of Treated Wood Products (see also Clause 4, herein);
M2—77†	Standard for Inspection of Treated Timber Products (see also Clause 4, herein);
M3—70	Standard Quality Control Procedures for Wood Preserving Plants;
M4—77	Standard for the Care of Preservative-Treated Wood Products (see also Clause 4, herein);
M5—77	Glossary of Terms Used in Wood Preservation;
M7—73	Standard Methods for Field Tests with Stakes;
M8—56	Standard Method for Field Tests with Posts;
M10—77	Standard Method of Testing Wood Preservatives by Laboratory Soil-Block Cultures;
M11—66	Standard Method to Determine Comparative Leachability of Wood Preservatives;
M12—72	Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites;
M13—72	A Guideline for the Physical Inspection of Poles in Service;
M14—72	Standard Method of Conducting Controlled Velocity Laboratory Corrosion Tests;
M15—74	Guide to Standards for Testing Plant Effluents;
M16—77	Performance Index of Preservatives in Stake and Post Tests;
D2481—66T‡	Accelerated Evaluating of Wood Preservatives for Marine Service by Means of Small-Size Specimens;
D2688—68‡	Test for Corrosivity of Water in the Absence of Heat Transfer (Methods B and D only);
P1—65	Standard for Coal Tar Creosote for Land and Fresh Water Use;
P3—67	Standard for Creosote-Petroleum Oil Solution;
P4—70	Standard for Petroleum Oil for Blending with Creosote;
P5—77	Standards for Water-Borne Preservatives (see also Clause 4, herein);
P7—72	Standard for Creosote for Brush or Spray Treatment for Field Cuts;
P8—77	Standards for Oil-Borne Preservatives (see also Clause 4, herein);
P9—77	Standard for Solvents for Organic Preservative Systems (see also Clause 4, herein);
P11—70	Standard for Creosote-Pentachlorophenol Wood Preservative Solution;
P12—68	Standard for Creosote-Coal Tar Solution to be Used in the Treatment of Marine (Coastal Waters) Piles and Timbers;
P13—65	Standard for Coal Tar Creosote to be Used in the Treatment of Marine (Coastal Waters) Piles and Timbers.

**Approved with exception of Clause 12.2.4. Clause 12.2.5 now becomes 12.2.4 with the first line revised as follows: "12.2.4 Example IV CCA, Compressed . . .". Clause 12.2.6 becomes 12.2.5 and is reworded as follows: "The calculation procedures for other water-borne preservatives and fire-retardants is apparent from Example IV".*

†In ninth line, Clause 5.4, revise "one-tenth" to "one-eighth", and, in Clause 5.94, revise paragraph dealing with poles as follows: "Borings shall be taken from poles to a depth at least equal to the maximum depth of the zone specified for assay."

‡ASTM Standards.

§Delete footnote "b".

PRESERVATIVE TREATMENT OF ALL TIMBER PRODUCTS BY PRESSURE PROCESSES

NOTE: *This Standard consists of 4 pages dated as follows: 29, 07/79; 30-31, 12/76; and 32, 07/79.*

1. SCOPE

1.1 This Standard covers the preservative treatment of all timber products by pressure processes.

2. GENERAL REQUIREMENTS

2.1 General

2.1.1 The requirements of this Standard, except as modified or supplemented by the other CSA Commodity Standards for the various species and types of material, shall apply to each of the treating processes and to all species and types of material. If these requirements are to be otherwise modified to meet special conditions, complete detailed instructions shall be given.

2.1.2 Maximum time duration (total elapsed time of a treating phase) maximum temperature, and maximum pressure limits shall not be exceeded. A phase shall begin when a change in conditions within the cylinder is initiated and shall end when either new conditions are imposed or the cylinder is emptied of preservative. For example, the period of steaming shall begin when steam is first introduced to the cylinder and end when the steam is shut off from the cylinder and the cylinder vented.

2.1.3 The minimum time duration when stipulated for a phase, shall be the period of time after the minimum conditions have been attained and until the end of that phase.

2.2 Plant Equipment. Treating plants shall be equipped with the thermometers and gauges necessary to indicate and record accurately the conditions at all stages of treatment, and all equipment shall be maintained in acceptable, proper working condition. The apparatus and chemicals necessary for making the analyses and tests required by the purchaser also shall be provided by plant operators, and kept in condition for use at all times. If the plant operators do not provide for laboratory facilities at the treating plants for the analysis and assays or other tests for retention of water-borne preservatives, they shall provide for these at a central laboratory.

2.3 Conditioning

2.3.1 Material shall be conditioned by air-seasoning, by kiln-drying, by steaming, by heating in the preservative either at atmospheric pressure or under vacuum, or by a combination of them as agreed upon, in such a manner as will not cause damage for the use intended. Ice-coated or frozen material may be steamed prior to conditioning or treatment for a total period not to exceed 2 hours; the temperature shall not exceed 240°F.

2.3.2 When air-seasoning is used, it shall be done as far as practicable, according to CSA Standard O80-M1, Standard for the Purchase of Treated Wood Products.

2.3.3 When steam conditioning is used, material shall be steamed in the cylinder at the temperature specified for the individual type of material or species but, in any case, the maximum temperature specified shall not be reached in less than 1 hour. The cylinder shall be provided with vents to relieve it of air and ensure proper distribution of steam. Two types of steam sources are allowable; steam directly from the boiler (live steam) and steam generated within the cylinder by the use of water over the heating coils (closed steam). With live steam, the cylinder shall be drained continuously or frequently enough during the steaming to prevent condensate from accumulating in sufficient quantity to reach the wood. With closed steam, the water level will be limited to covering the heating coils and no venting is needed after maximum temperature levels are reached. After steaming is completed, a vacuum as specified for the individual type of material or species may be created in the cylinder. Before the preservative is introduced, the cylinder shall be drained of condensate.

When material to be treated with either chromated copper arsenate preservative or acid cupric chromate preservative is presteamed prior to treatment, the material must be removed from the cylinder following the conditioning phase of the cycle and cooled to 120°F or below. Following the cooling, the material shall be returned to the cylinder and treated by appropriate standard procedure. With CCA and ACC preservatives, steam conditioning is limited to ice-coated or frozen material.

2.3.4 When conditioning by heating in the preservative is used, the preservative shall cover the material in the cylinder. The temperature of the preservative during the conditioning period shall not exceed the maximum specified for the individual type of material or species.

2.3.5 If a vacuum is drawn during the conditioning period, it shall be of sufficient intensity to evaporate water from the material at the temperature of the preservative. The intensity of the vacuum, or the temperature of the preservative, or both, shall be adjusted so as to regulate the evaporation of the water satisfactorily. The conditioning shall continue until the material is sufficiently heated and enough water removed to permit proper penetration. The preservative shall be removed from the cylinder and air admitted before an empty-cell process is applied.

2.4 Sorting and Spacing. Whenever it is practicable, the material in any charge shall consist of pieces of the same species similar in form and size, moisture content and receptivity to treatment, and so separated as to ensure contact of treating medium with all surfaces.

2.5 Machining. All cutting, such as adzing, boring, chamfering, framing, gaining, surfacing, trimming, etc., shall be done prior to treatment. In the event that cutting becomes absolutely necessary after treatment, the cut surfaces shall be treated in accordance with CSA Standard O80-M4, Standard for the Care of Pressure-Treated Wood Products.

2.6 Incising. Woods which are difficult to penetrate shall be incised. When required or recommended in subsequent Standards, material shall be incised prior to treatment by a method that will provide at least the minimum penetration specified without damage and with the least loss in strength with the exception that incising shall be waived when it will make the material unfit for the use intended.

3. TREATMENT

3.1 Manner of Treatment. The material shall be impregnated with preservative by a combination of such processes and under such conditions as will produce a satisfactory product for the use intended.

3.2 Oil Treatment. Following the conditioning period, the material shall be treated by an empty-cell process whenever practicable, unless otherwise specified, to obtain as deep and uniform penetration as possible with the retention of preservative stipulated. Material shall be treated by the full-cell process only when the maximum net retention is desired and where pressure is held to refusal, or when the stipulated retention is greater than can be obtained by the use of an empty-cell process.

3.3 Salt Treatment. Following the conditioning period all round material of any size and sawn material 5 inches and over in thickness shall be treated by the full-cell process.

Lumber less than 5 inches in thickness, and plywood shall be treated by a Lowry, a full-cell or a modified full-cell process. Using the modified full-cell process, the cylinder pressure shall be adjusted prior to filling, to any desired level between atmospheric pressure and total vacuum.

3.4 Standard Processes

3.4.1 Initial Air Pressure or Vacuum

3.4.1.1 General. The initial air pressure or vacuum shall be maintained while the cylinder is being filled with preservative.

3.4.1.2 Empty-Cell. Material shall be subjected to atmospheric air pressure (Lowry) or to higher air pressure (Rueping) of the necessary intensity and duration.

3.4.1.3 Full-Cell. Material shall be subjected to a vacuum of not less than 22 inches at sea level for not less than 30 minutes either before the cylinder is filled or during the period of heating in preservative.

3.4.1.4 Refusal. When maximum possible retention by full-cell process or treatment to refusal is specified, the pressure and temperature shall be maintained constant or be increased within a range consistent with good practice for the material being treated until the quantity of preservative absorbed in each of any two consecutive 1/2 hours is not more than 2 per cent of the amount already injected.

3.4.2 Pressure Period

3.4.2.1 General. Pressure shall be increased to at least the minimum but not higher than the maximum specified and shall be maintained until the desired volumetric injection has been obtained. Pressure shall be reduced to atmospheric either before or while the cylinder is emptied of preservative. A vacuum of not less than 22 inches at sea level shall be created and maintained until the wood can be removed free of dripping preservative, except that a vacuum need not be used after a full-cell or refusal treatment when the maximum possible retention is desired.

3.4.2.2 Temperature of Preservative. The temperature of the preservative during the entire pressure period shall not exceed the maximum temperatures specified in Table 1.

TABLE 1
TEMPERATURE OF PRESERVATIVES

Preservative	Temperature Maximum °F
Creosote or Creosote Solutions	
Western Red Cedar	200
All other species	210
Oil-Borne Preservatives	
Ponderosa, Jack, Red and Lodgepole Pines	210
Western Red Cedar	200
All other species	210
Water-Borne Preservatives	
Acid copper chromate (ACC)	120
Ammoniacal copper arsenate (ACA)	150
Chromated copper arsenate (CCA)	120
Chromated zinc chloride (CZC)	140
Fluorchrome arsenate phenol (FCAP)	140

3.4.3 Expansion Bath. When permitted by CSA Standards O80.2, Preservative Treatment of Lumber, Timber, Bridge Ties and Mine Ties by Pressure Processes, O80.3, Preservative Treatment of Piles by Pressure Processes, O80.4, Preservative Treatment of Poles by Pressure Processes O80.5, Preservative Treatment of Posts by Pressure Processes, O80.6, Preservative Treatment of Crossties and Switch Ties by Pressure Processes, O80.11, Preservative Treatment of Wood Blocks for Floors and Platforms by Pressure Processes, or O80.25, Preservative Treatment of Sawn Crossarms by Pressure Processes, an expansion bath may be applied after pressure of an oil treatment is completed and before removal of preservative from the cylinder, by quickly reheating the oil surrounding the material to the maximum temperature permitted by the individual species specification, either at atmospheric pressure or under vacuum, the steam to be turned off the heating coils immediately the maximum temperature is reached. The cylinder shall then be emptied speedily of preservative and a vacuum of not less than 22 inches at sea level created promptly and maintained until the wood can be removed from the cylinder free of dripping preservative.

3.4.4 Final Steaming. At the completion of an oil treatment, material may be cleaned by final steaming as specified for the individual type of material or species.

4. RESULTS OF TREATMENT

4.1 Retention of Preservative

4.1.1 General

NOTE: *The retention may be specified by the purchaser in accordance with the use requirements but should be not less than that specified for the type of material or species.*

4.1.1.1 The amount of preservative solution retained shall be determined from readings of working tank gauges or scales, or from weights before and after treatment of loaded trams on suitable track scales, with the necessary corrections for changes in moisture content.

If retention is determined from readings of working tank gauges or scales, the retention of preservatives shall be calculated after correcting the volume of creosote type preservative to 100°F and of penta-petroleum type preservative to 60°F. Corrections of volume or specific gravity shall be made using the factors contained in CSA O80-F Series of Standards (Conversion Factors and Correction Tables).

PRESERVATIVE TREATMENT OF PILES BY PRESSURE PROCESSES

NOTE: *This Standard consists of 4 pages from 37 to 40 dated 07/79.*

FOREWORD

This Standard is to be used in conjunction with, and is supplementary to, the requirements of CSA Standard O80.1, Preservative Treatment of All Timber Products by Pressure Processes.

1. SCOPE

1.1 This Standard covers the preservative treatment by pressure processes of land and fresh water piles and foundation piles of the following species; Pacific Coast Douglas Fir, Western Larch, Intermountain Douglas Fir, Jack Pine, Lodgepole Pine, Red Pine, Ponderosa Pine, Southern Yellow Pine and Oak; and marine piles of the following species; Pacific Coast Douglas Fir, Jack Pine, Red Pine, and Southern Yellow Pine.

2. GENERAL REQUIREMENTS

2.1 General. All piles selected for preservative treatment shall meet the requirements of CSA Standard O56, Round Timber Piles.

2.2 Land and Fresh Water Piles. Land and fresh water piles shall be treated in accordance with the requirements of CSA Standard O80.1, except as modified or supplemented by Table 1.

2.3 Marine Piles. Marine piles shall be treated in accordance with the requirements of CSA Standard O80.1, except as modified or supplemented by Table 2.

2.4 Foundation Piles. Foundation piles shall be treated in accordance with the requirements of CSA Standard O80.1, except as modified or supplemented by Table 3.

3. CARE AFTER TREATMENT

3.1 Care After Treatment. Pile heads, after making final cutoff, shall be given two heavy coats of hot creosote, followed by the application of a heavy coat of coal-tar pitch. There shall be sufficient interval between applications to permit absorption of each coat before the succeeding one is applied. Kiln drying of pile after treatment with ACA or CCA is not permitted.

TABLE 1
SPECIFIC REQUIREMENTS – LAND AND FRESH WATER PILES

	Pacific Coast Douglas Fir	Western Larch	Intermountain Douglas Fir	Jack Pine Lodgepole Pine	Red Pine	Southern Yellow Pine Ponderosa Pine	Oak
Conditioning	Air-seasoning, kiln-drying, Boulton drying, heating in the preservative or a combination.			Air-seasoning, kiln-drying, steaming (for ice-coated or frozen piles only), heating in the preservative, or a combination ‡. (Boulton drying is permitted for Jack Pine and Lodgepole Pine)		Air-seasoning, kiln-drying, steaming, heating in the preservative, or a combination.	Air-seasoning, kiln-drying, heating in the preservative, or a combination.
Steaming	Not Permitted	Not Permitted	Not Permitted				Not Permitted
Temperature – Maximum F				240	240	245	
Duration – Maximum Hours				6	6	20†	
Vacuum							
Inches at Sea Level – Minimum				22	22	22	
Heating in Preservative							
Temperature – Maximum F	Seasoned; 210 and 6 hours: Green or partially seasoned; 220 and no time limit.			220	220	220	220
Duration – Maximum Hours				No Time Limit	No Time Limit	No Time Limit	No Time Limit
Treatment							
Pressure – Minimum psig	75	75	75	100	100	125	150
Maximum psig	150	150	150	150	150	200	200
Expansion Bath							
Temperature – Maximum F	220	220	–	220	220	220	220
Final Steaming							
Temperature – Maximum F	240	240	220	240	240	245	Not Permitted
Duration – Maximum Hours	2	0.5	3	2	2	3*	
Results of Treatment							
Retention – Minimum pcf							
Sampling Zone for Assay							
Inches from surface	0 to 1.0	0 to 1.0	0 to 1.0	0 to 1.0	0 to 2.0	0 to 3.0	0 to 2.0
Number of Borings Per Charge	20	20	20	20	20	20	20
Creosote							
By gauge or weight	8, 10	8, 10	8	8, 10	10, 12	10, 12	6
By assay†	12, 15	12, 15	10	10, 12	12	12	
Creosote – Petroleum							
Solution							
By gauge or weight	8, 10	8, 10	8	8, 10	10, 12	10, 12	6
By assay†	12, 15	12, 15	10	10, 12	12	12	
Pentachlorophenol §							
By gauge or weight	0.40, 0.50	0.4, 0.5	0.4	0.4, 0.5	0.5, 0.6	0.5, 0.6	0.3
By assay† **	0.60, 0.75	0.6, 0.75	0.5	0.5, 0.6	0.6	0.6	
Water-Borne Preservatives							
By gauge or weight							
ACA	0.8	0.6	0.6	0.8	0.8	0.8	0.8
CCA	0.8	0.6	0.6	0.8	0.8	0.8	0.8
Penetration in Inches or Per Cent of Sapwood – Minimum	0.75 and 85 per cent up to a maximum of 1.625	0.5 or 85	0.5 or 85	1.0 and 85	2.5 or 85	3.5 or 90 per cent	100 per cent of sapwood
Determination of Penetration	A borer core shall be taken midway between the butt and top of each pile in each charge. Only those piles meeting the penetration requirements shall be accepted.						
Preservatives	All standard preservatives listed above.						
Re-Treatment	Piles which have been in storage for longer than 1 year shall be re-assayed before shipment. When the re-assay results are less than the minimum in this Standard, the piles shall be re-treated.						

**Total steaming time including pre-treatment conditioning and final steaming shall not exceed 20 hours.*
†Assay retentions are optional.
‡Air-seasoning is the preferred method of conditioning; however, when climatic conditions are unfavourable or delivery will be delayed because of the conditioning requirements stated above, the material may be steamed for a total of not more than 6 hours at temperatures not in excess of 245F.
§Using Hydrocarbon Solvent, Type A conforming to CSA Standard O80-P9, Standard for Hydrocarbon Solvents for Preservatives.
*** Retention by lime ignition method. When copper pyridine method is used, multiply the result by 1.1 to convert to lime ignition result.*
NOTE: *The higher retentions are recommended for large piles or severe service conditions.*

TABLE 2

SPECIFIC REQUIREMENTS–MARINE PILES

	Pacific Coast Douglas Fir		Jack Pine		Red Pine		Southern Yellow Pine	
Conditioning	Air-seasoning or kiln-drying or heating in preservative or a combination.		Air-seasoning or kiln-drying or steaming (for ice-coated or frozen piles only) or heating in preservative or a combination*				Air-seasoning, kiln-drying, heating in the preservative or a combination.	
Steaming	Not Permitted							
Temperature–Maximum F	–		240		240		240	
Duration–Maximum Hours	–		6		6		20	
Vacuum– Inches at Sea Level–Minimum	–		22		22		22	
Heating in Preservative	Seasoned	Green						
Temperature–Maximum F	210	220	220		220		220	
Duration–Maximum Hours	6	No Limit	Optional		Optional		Optional	
Treatment								
Pressure–Minimum psig	75		100		100		125	
Maximum psig	150		150		150		200	
Expansion Bath								
Temperature–Maximum F	220		220		220		220	
Duration–Maximum Hours	1 hour		1 hour		1 hour		1 hour	
Final Steaming	Not Permitted		Not Permitted		Not Permitted		Not Permitted	
Results of Treatment	**Pacific Coast**	**Atlantic Coast**	**Pacific Coast**	**Atlantic Coast**	**Pacific Coast**	**Atlantic Coast**	**Pacific Coast**	**Atlantic Coast**
Retention–Minimum pcf†								
Creosote‡ By gauge or weight	14 full-cell	12 full-cell	14 full-cell	12 full-cell	18 full-cell	16 full-cell	20 full-cell	18 full-cell
Water-Borne Preservatives By gauge or weight								
ACA	1.2		1.2		1.5		2.0	
CCA	1.2		1.2		1.5		2.0	
Penetration in Inches or Per Cent of Sapwood–Minimum §	7/8	3/4	1.0 and 85		2.5 or 85		4.0 or 90	
Determination of Penetration	Four borer cores shall be taken in each pile. These four borer cores shall be evenly spaced longitudinally and radially throughout the middle third of the pile. All four borer cores shall meet the penetration requirements.							
Preservatives	All standard preservatives listed above.							

* *Air-seasoning is the preferred method of conditioning; however, when climatic conditions are unfavourable or delivery will be delayed because of conditioning requirements stated above, the material may be steamed for a total of not more than 6 hours at temperatures not in excess of 245° F, except Southern Yellow Pine, which can be steamed up to 20 hours.*

† *The recommended lower retention for the Atlantic Coast is a generalization. If for any reason, Limnoria activity is increasing, the higher retention recommended for the Pacific Coast should be used.*

‡ *Creosote shall conform to CSA Standard O80-P13, Standard for Coal Tar Creosote to be Used in the Treatment of Marine (Coastal Waters) Piles and Timbers.*

§ *Effective penetration must be continuously black and concentrated with both summerwood and springwood penetrated.*

NOTE: *If the concentration of preservative in a pile is in doubt, the four borer cores from each of the doubtful piles shall be assayed. These borer cores shall be cut to the length of the specified depth of penetration, ± 1/32 inch and the concentration of preservative in the assayed cores shall be not less than the following quantity:*

(a) Pacific Coast Douglas Fir – 26 pounds per cubic foot;
(b) Jack and Red Pine – 20 pounds per cubic foot;
(c) Southern Yellow Pine – 20 pounds per cubic foot.

TABLE 3

SPECIFIC REQUIREMENTS – FOUNDATION PILES

	Pacific Coast Douglas Fir	Western Larch	Intermountain Douglas Fir	Jack Pine Lodgepole Pine	Red Pine	Ponderosa Pine Southern Yellow Pine	Oak
Conditioning	Air-seasoning, kiln-drying, Boulton drying, heating in the preservative or a combination.			Air-seasoning, kiln-drying, steaming (for ice-coated or frozen piles only), heating in the preservative, or a combination ‡. (Boulton drying is permitted for Jack Pine and Lodgepole Pine)		Air-seasoning, kiln-drying, steaming, heating in the preservative, or a combination.	Air-seasoning, kiln-drying, heating in the preservative, or a combination.
Steaming	Not Permitted	Not Permitted	Not Permitted				Not Permitted
Temperature–Maximum F				240	240	245	
Duration–Maximum Hours				6	6	20†	
Vacuum							
Inches at Sea Level–Minimum				22	22	22	
Heating in Preservative							
Temperature–Maximum F Duration–Maximum Hours	Seasoned; 210 and 6 hours: Green or partially seasoned; 220 and no time limit.			220 No Time Limit	220 No Time Limit	220 No Time Limit	220 No Time Limit
Treatment							
Pressure–Minimum psig	75	75	75	100	100	125	150
Maximum psig	150	150	150	150	150	200	200
Expansion Bath							
Temperature–Maximum F	220	220	–	220	220	220	220
Final Steaming							
Temperature–Maximum F	240	240	220	240	240	245	Not Permitted
Duration–Maximum Hours	2	0.5	3	2	2	3*	
Results of Treatment							
Retention–Minimum pcf							
Sampling Zone for Assay							
Inches from surface	0 to 1.0	0 to 1.0	0 to 1.0	0 to 1.5	0 to 2.0	0 to 3.0	0 to 2.0
Number of Borings Per Charge	20	20	20	20	20	20	20
Creosote							
By gauge or weight	10	8	8	10	12	12	6
By assay†	15	12	10	12	12	12	
Creosote–Petroleum Solution							
By gauge or weight	10	8	8	10	12	12	6
By assay†	15	12	10	12	12	12	
Pentachlorophenol §							
By gauge or weight	0.50	0.4	0.4	0.5	0.6	0.6	0.3
By assay† **	0.75	0.6	0.5	0.6	0.6	0.6	
Water-Borne Preservatives							
By gauge or weight							
ACA	0.8	0.6	0.6	0.8	0.8	0.8	0.6
CCA	0.8	0.6	0.6	0.8	0.8	0.8	0.6
Penetration in Inches or Per Cent of Sapwood–Minimum	0.75 and 85 per cent up to a maximum of 1.625	0.5 or 85	0.5 and 85	1.0 and 85	2.5 or 85	3.5 or 90 per cent	100 per cent of sapwood
Determination of Penetration	A borer core shall be taken midway between the butt and top of each pile in each charge. Only those piles meeting the penetration requirements shall be accepted.						
Preservatives	All standard preservatives listed above.						
Re-Treatment	Piles which have been in storage for longer than 1 year shall be re-assayed before shipment. When the re-assay results are less than the minimum in this Standard, the piles shall be re-treated.						

** Total steaming time including pre-treatment conditioning and final steaming shall not exceed 20 hours.*
† Assay retentions are optional.
‡ Air-seasoning is the preferred method of conditioning; however, when climatic conditions are unfavourable or delivery will be delayed because of the conditioning requirements stated above, the material may be steamed for a total of not more than 6 hours at temperatures not in excess of 245F.
§ Using Hydrocarbon Solvent Type A conforming to CSA Standard O80-P9, Standard for Hydrocarbon Solvents for Preservatives.
*** Retention by lime ignition method. When copper pyridine method is used, multiply the result by 1.1 to convert to lime ignition result.*