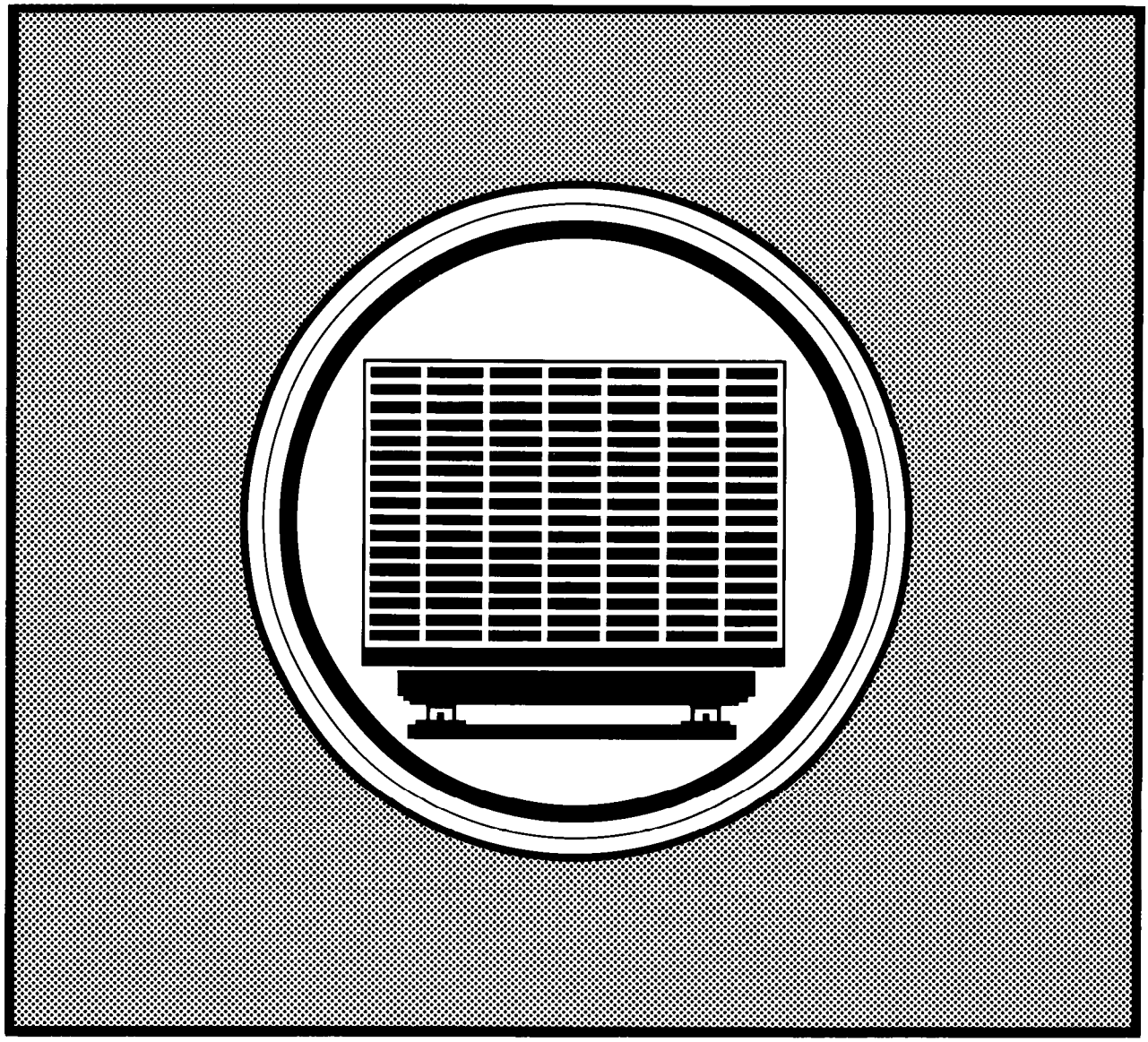
Creosote Wood Preservation Facilities

Recommendations for Design and Operation

Report EPS 2/WP/1
April 1988



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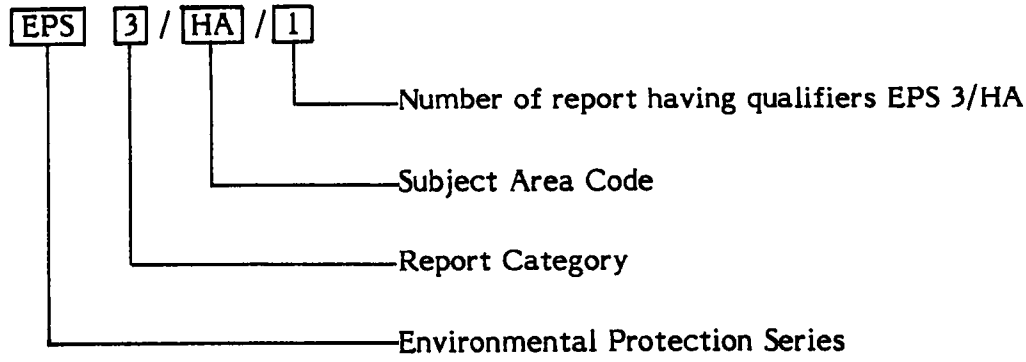

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CREOSOTE WOOD PRESERVATION FACILITIES

Recommendations for Design and Operation

prepared by

D.E. Konasewich and F.A. Henning
Envirochem Services

under the direction of the
Wood Preservation Industry Technical Steering Committee

Report EPS 2/WP/1
April 1988

COMMENTS

Comments on the content of this report should be directed to:

Chief
Renewable Resources and Processing Extraction Division
Industrial Programs Branch
Environmental Protection Directorate
Environment Canada
Ottawa, Ontario
K1A 0H3

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FOREWORD

As part of a federal strategy to protect the environment and human health from potentially toxic commercial chemicals Environment Canada has evaluated chemical use practices within the wood preservation industry. Envirochem Services were retained to visit and review practices at 19 wood preservation facilities operating in four Canadian provinces, and to document its findings. In July 1984, Environment Canada established the Wood Preservation Industry Technical Steering Committee to develop technical recommendations for wood preservation facility design and for operational measures which would:

- reduce or eliminate the release of wood preservation chemicals to the environment; and
- reduce to a minimum the exposure of workers to wood preservation chemicals.

The Steering Committee included representatives from federal and provincial government agencies, wood preservation companies, forest industry labour unions and worker compensation boards (see page xi).

Envirochem Services was subsequently retained to develop an initial draft technical recommendations document for review by the Steering Committee. During the review, input was also obtained from other experts in both industry and government. This technical recommendations report is the result of this comprehensive development and review process.

The design and operational measures presented in this report are based on current knowledge of existing technology and the physical, chemical and biological properties of creosote and its components. Although the recommendations are not part of any environmental legislation, they reflect the intent of the Federal Fisheries Act, and the intent of provincial environmental and worker health and safety legislation and regulations.

The Steering Committee recommends that new creosote pressure treatment facilities comply with the objectives in this technical recommendations document. Although methods to achieve those objectives are provided, the Committee fully supports the option of industry to achieve those objectives using other design features or operational procedures that can be shown to be as effective.

The Steering Committee recommends that existing facilities make all practicable modifications necessary to meet the objectives of the recommendations. Site-specific circumstances will influence the applicability and implementation of specific measures at both new and existing facilities. It is further recognized that the recommendations are based on existing knowledge, and ongoing and future studies may suggest the need for modifying these recommendations. The authors therefore recommend a definitive periodic review of the technical recommendations.

The Technical Steering Committee believes that the proper implementation of of the recommendations will allow the continued beneficial use of creosote as a wood preservative and will protect both the environment and workers from potential harmful effects.

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ACKNOWLEDGEMENTS

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Dr. R. Kobylnyk Pesticide Control Branch B.C. Ministry of Environment	Technical Review

WOOD PRESERVATION INDUSTRY TECHNICAL STEERING COMMITTEE

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Mr. E. Ricard	International Woodworkers of America
Dr. J. Ruddick	Canadian Wood Preservers' Association
Mr. D. Wilson	Conservation and Protection Environment Canada

1 THE NEED FOR WOOD PRESERVATION

1.1 Introduction

Wood preservation is the pressure or thermal impregnation of chemicals into wood to a depth that will provide effective long-term resistance to attack by fungi, insects, and marine borers. By extending the service life of available timber, wood preservation reduces the harvest of already stressed forestry resources, reduces operating costs in industries such as utilities and railroads, and ensures safe working conditions where timbers are used as support structures.

The chemicals predominantly used in Canada for wood preservation are (1,2,3):

- pentachlorophenol,
- creosote, and
- aqueous formulations of arsenic, copper, chromium or ammonia.

The wood preservation process deposits or fixes these chemicals in the wood, and the toxic nature of the chemicals effectively prevents the attack of living organisms on the wood. Because the chemicals are also toxic in varying degrees to humans and aquatic organisms, their use in industry must be carefully controlled. This document is intended to provide consistent guidelines for the design and operation of wood preservation facilities in a manner that will protect workers and the environment from harmful exposure to wood preservation chemicals.

1.2 Wood Deterioration

Timber is subject to several types of deterioration following its removal from the forest. Wood-decaying fungi and bacteria drastically reduce the usefulness of unprotected lumber and other forest products. As an example, untreated timbers used in underground workings of mines could have a life-time of no greater than two years because the temperature and moisture conditions in mines favour decay. Another example is the railway cross-ties used in North America, which would have an average life of five years without treatment. Protection is also required against wood-boring biota. For example, termites are responsible for extensive damage to wood in storage and in service. Marine structures such as untreated dock pilings along the North American coast can be destroyed by marine borers in less than one year.

The growth of wood-destroying fungi depends on temperature, oxygen level, the moisture content of the wood and the nature of the food source (the wood). Wood

products such as railroad ties, bridge and mine timbers, and utility poles are usually in direct contact with moist soil or in locations where moisture collects and cannot readily evaporate. When there is no practical means of limiting moisture content, oxygen levels or temperature, the option for the protection of such wood products is limited to the application of chemicals which act as agents to limit fungal growth by "poisoning" the wood food source. Simultaneously, the treatment can limit the other wood-destroying organisms such as insects and wood-borers.

1.3 Wood Preservation Chemicals

Historically, the preservation of wood by chemical means can be traced back over 4 000 years, to the time when the Egyptians apparently used bitumen to treat wooden dowel-pins in the stonework of temples (4). At the time of the Roman Empire, tar, linseed oil, oil of cedar, and mixtures of garlic and vinegar were used for the preservation of wooden statues. Alexander the Great of Persia is reported to have ordered piles and other timber for bridge building to be covered with olive oil as a precaution against decay (5). Investigations to define alternative wood preservation agents were reported in the late 1600's with escalating efforts during the 1800s. A review of the many chemicals and chemical formulations used historically and currently can be found in the above references and in texts such as those written by Hunt and Garratt (6) and Wilkensen (7).

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

- be toxic to attacking organisms;
- be able to penetrate wood;
- be chemically stable;
- be safe to handle;
- be economical to use;
- not weaken the structural strength of the wood; and
- not cause significant dimensional changes within the wood.

Other factors which determine the selection of wood preservation chemicals or formulations include: fire resistance; colour or odour; paintability; corrosiveness; electrical conductivity; and, leachability from wood.

In Canada the predominant wood preservative chemicals or formulations in use are:

- CCA (chromated copper arsenate). Major CCA-treated products include: fence posts, lumber for patios and landscaping, and foundation lumber and plywood.
- ACA (ammoniacal copper arsenate). Major ACA-treated products include: utility poles and landscaping timbers.
- PCP (pentachlorophenol). Major PCP-treated products include: railway ties and utility poles.
- Creosote. Major uses include treatment of railroad ties, marine piling/timber and other construction timber.

Although other wood preservatives have been used in the past in Canada, the four chemicals or formulations noted above are the only preservatives in use in Canada since 1985. The development of alternative chemicals for wood preservation is the subject of ongoing research. The actual use of alternative chemicals will depend on industry and safety evaluations, and on approval under the Federal Pest Control Products Act administered by Agriculture Canada.

1.4 The Value of Wood Preservation

Controlled studies have shown that wood preservation enhances the life-time utility of wood by factors of 5 to 15, depending on the wood species, use and efficacy of treatment. It has been estimated that, if in the U.S.A. "untreated wood were used for the applications now employing preservative-treated wood, the added annual cost to the transportation, utility, and construction industries would be over $15 billion dollars. Energy savings, depending on the substitute materials envisioned, are from 19 to 32 million barrels of petroleum per year" (8).

It has also been estimated that if wood were not treated with preservation chemicals, timber requirements would increase by three- to six-fold. Such requirements would have exhausted many timber resources required for railway, utility, construction, and marine industries (6). Wood preservation also enables the use of smaller and faster growing trees such as lodgepole pine. Prior to the wide-spread use of wood preservation, timbers used in structures such as railway bridges were required to be over-sized in order to accommodate a degree of decay.

2 OVERVIEW OF CREOSOTE WOOD PRESERVATION FACILITIES

2.1 Description of Process

Wood preservation requires the penetration of chemical agents several centimetres into the wood. Pressure treatment (as shown in Figure 2.1) is used to achieve penetration and subsequent fixation of creosote within wood.

Creosote is used either in a mixture of 50:50 creosote/petroleum oil or alone (full strength). Creosote and petroleum oil are delivered to wood preservation facilities by ship, bulk truck or rail tanker, and stored in a bulk storage tank. After delivery of the creosote and petroleum oil, the following process steps occur.

2.1.1 Chemical Mixing. In Canada creosote/petroleum oil mixtures are blended by pumping transfers and recirculation between bulk tanks. The benefits of blending creosote with oil are lower cost and improved penetration (lower viscosity) in applications such as railway ties, where conditions of use afford less protection than that usually provided by 100% creosote. The physical properties of wood treated with a mix are quite similar to those of material treated with 100% creosote, i.e., better dimensional stability (compared with untreated or water-borne treated wood), improved mechanical wear, corrosion inhibition, resistance to chemicals and water repellency. Full strength creosote is used where maximum biocidal protection is required, such as for timbers exposed to marine borers.

2.1.2 Wood Conditioning. In order to enhance penetration of the wood cell wall by water-immiscible preservatives such as creosote, the moisture content of the wood is reduced by a conditioning process. Conditioning may be achieved by air-seasoning, kiln drying or by processes carried out in the treatment cylinder, i.e., application of steam and subsequent vacuum, or boiling under a vacuum in the presence of the treating solution (Boultonizing). Boultonizing is a common means of conditioning in Canada (1,2,3). For given wood products, conditioning procedures are stipulated by the Canadian Standards Association (9).

2.1.3 Preservative Application. The wood to be treated is placed on trams which are pushed into a pressure cylinder that may be up to 45 m long and 2 m in diameter. Depending on the species of wood, the wood product and the moisture content of the wood, the operator of the facility determines the required treatment process (full cell or empty cell), and the pressure, temperature, and times for various process sequences.

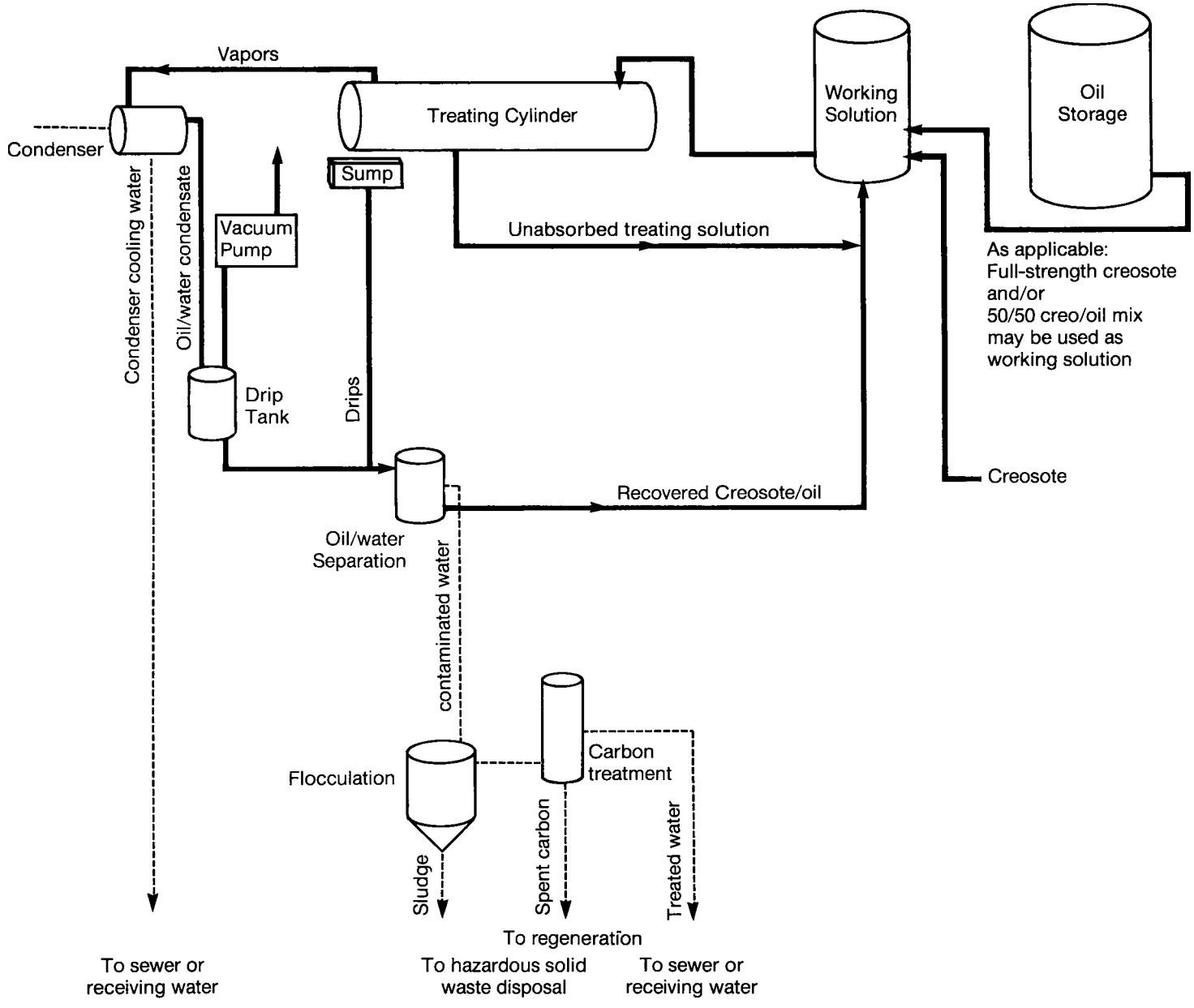

FIGURE 2.1 PROCESS FLOW DIAGRAM OF A CREOSOTE PRESSURE TREATMENT PLANT

Many of the operating parameters, preservative standards and product quality requirements (e.g., degree of preservative penetration and retention) are defined by the Canadian Standards Association (9).

If Boultonizing or steam-vacuum processes have been used for conditioning, creosote is applied in the following step either by the full-cell treatment process or the empty-cell treatment process.

2.1.3.1 Full-cell treatment. The full-cell treatment process is so named because it results in the highest net retention of preservative in the wood, i.e., wood cells are completely filled. Marine pilings are examples of wood products requiring such a high retention of creosote. The process is illustrated in Figure 2.2 and the steps are outlined below:

a) A vacuum is applied to remove air trapped in the wood cells. The CSA standard stipulates that for full-cell treatment the "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" (9).
b) While the vacuum is maintained, the cylinder is completely filled with heated (60-80°C) creosote solution. The vacuum is released and the preservative moves into the porous spaces of the wood. The creosote is applied in a heated form to reduce its viscosity and enhance its penetration into the wood.
c) Pressure is then applied to force the solution into the wood; this may be air pressure, or pressure applied from an auxiliary tank of preservative solution connected to the system or a pump. The pressure is applied until the target preservative retention level is achieved.
d) The oil surrounding the wood product is then heated to the maximum CSA standard of 105°C. This step is referred to as an "expansion bath".
e) The preservative is rapidly emptied from the cylinder. A vacuum of not less than 22 inches at sea level is quickly applied and maintained until the wood is free of dripping preservative and can be removed from the cylinder.

2.1.3.2 Empty-cell treatment. The empty-cell processes, illustrated in Figure 2.2, utilize the air trapped in the wood cells to limit the retention of preservative in wood, typically to 140 kg of preservative per cubic metre of wood. A potential 430 kg/m^3 can be retained during full-cell treatment. Lower treatment costs are associated with the lower preservative retention in wood products not requiring maximum preservation.

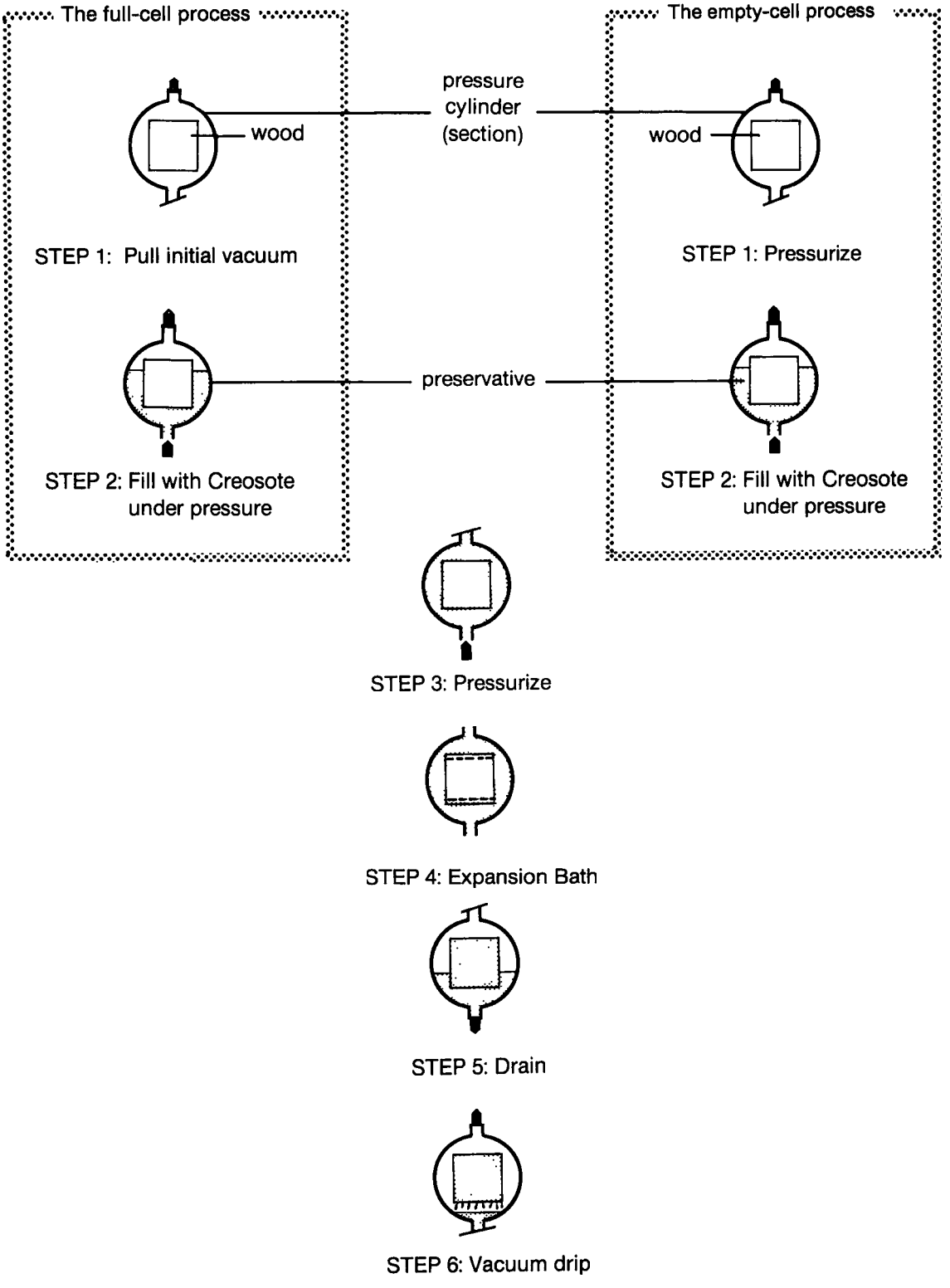

FIGURE 2.2 OIL-BORNE WOOD PRESERVATIVE PRESSURE TREATMENT PROCESSES

Long-term "bleeding" of preservative from the treated wood is also minimized. For example, bleeding from utility poles is not desirable. Two empty-cell processes are in common use. The process sequence is similar to the full-cell process, with the following exceptions.

The Rüping empty-cell process uses an initial pressurization step to compress the air in the interior wood cells after which the cylinder is filled with preservative at constant pressure. The pressure is then increased until the target preservative retention level is reached. Finally, the pressure is relieved as the cylinder is emptied and preservative is expelled from the interior wood cells by the escaping air. Deep penetration is achieved, but the wood cells remain relatively empty and the treatment chemical is confined to that adhering to the cell walls.

The Lowry empty-cell process uses no initial pressurization and the treatment vessel is flooded against ambient pressure. Preservative retention for the Lowry process is intermediate between the Rüping empty-cell process and the full-cell process.

Following the drain cycle in both empty-cell processes, a vacuum is applied to encourage removal of excess preservative and removal of pressurized air from the wood cells. This minimizes preservative "bleeding" from the treated product.

2.1.4 Storage of Treated Product. The treated wood is withdrawn from the treating cylinder and put on a drip pad. The time on the drip pad depends upon the schedule and facility design. For example, at a facility with a double tracking system, the drippage time may be equivalent to the duration of a treatment cycle for another charge. A facility may also vary its schedule with the quality of material and the treatment level required. The treated wood is removed from the drip pad by a fork lift and stored in a designated area until shipment to the customer.

2.2 Chemical Releases

Creosote wood preservation facility design and operational practices vary (1,2,3), and each facility has potential sources of emissions that could affect worker health and/or the environment. The potential sources and releases are illustrated in Figure 2.3. Section 8 of this report provides more detailed discussion of the potential chemical releases and control/disposal options.

2.2.1 Liquid Discharges. Leaks and drips of oil solutions can be contained and reused in the oil-borne treatment process. Liquids that cannot be recycled and reused include:

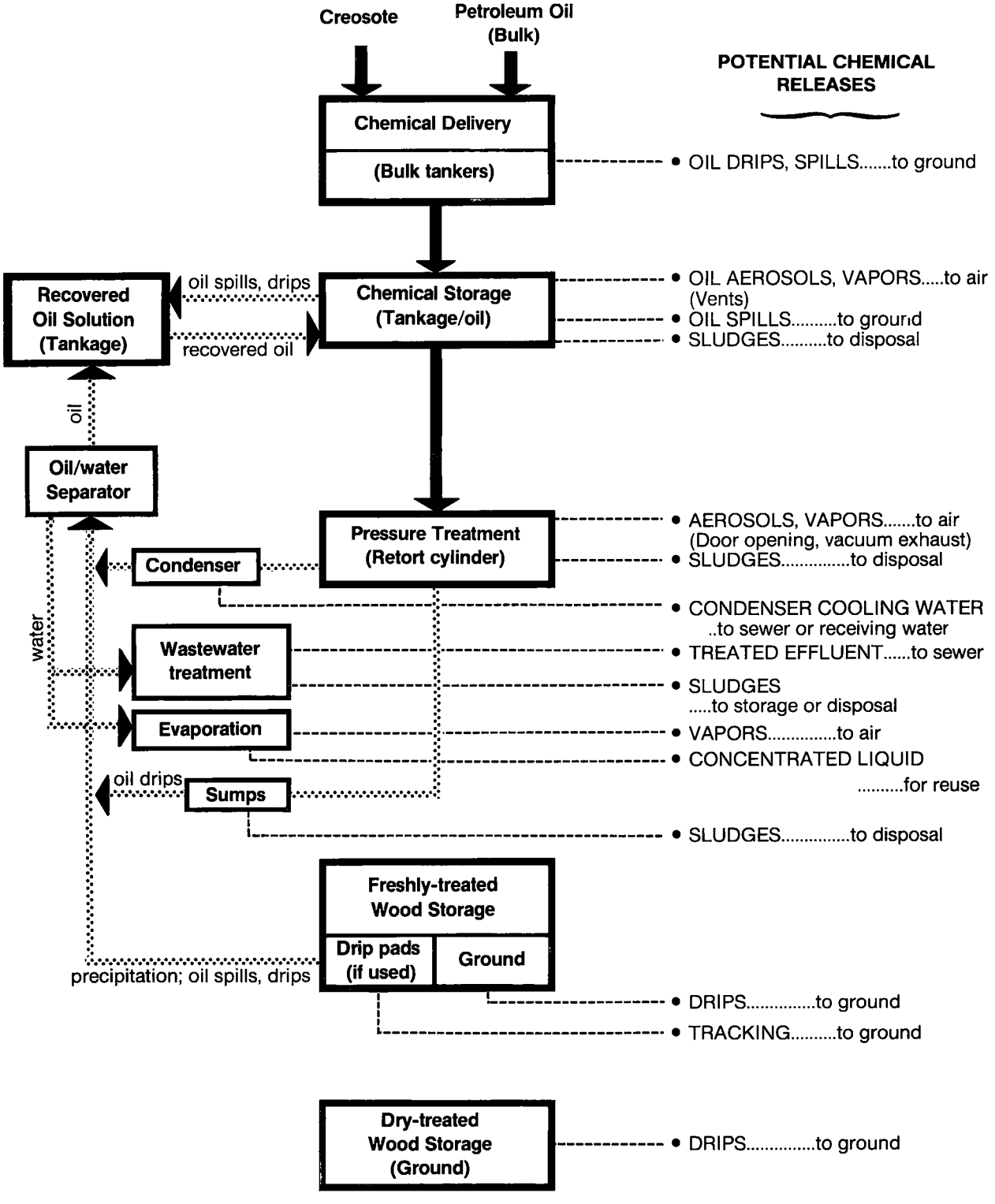

FIGURE 2.3 POTENTIAL CHEMICAL RELEASES FROM CREOSOTE PRESSURE TREATMENT PLANTS

- condensates removed from wood during the conditioning and during the initial application of vacuum ;
- water released by the wood during the treating cycle and subsequently separated from the unabsorbed treatment oil prior to recycling of the oil; and
- wash waters.

These liquids can contain creosote and must be treated before discharge as a waste stream.

Other liquids that are released from oil-borne creosote facilities include the following:

- Steam condensates from indirect heat transfer in cooling and heating coils, which are generally checked for contamination prior to discharge.
- condenser cooling waters, which are not normally contaminated and are discharged without treatment; and
- surface runoff from treated wood storage areas contaminated by preservative.

The creosote content in runoff waters depends on many factors, including drip and vacuum time in the last step of the pressure process; viscosity of the wood preservative; wood species; moisture content of the wood prior to application of preservative; specific treatment process (i.e., full-cell versus empty cell); and exposure to the weather. The need for control of runoff waters would depend upon analytical and/or bioassay evaluations and regulatory requirements.

2.2.2 Solid Wastes. Solid wastes from creosote treatment facilities include:

- sludges from tanks, sumps and pressure cylinders;
- sludges from wastewater treatment processes (e.g., flocculated material); and
- contaminated soils.

Disposal methods for solid wastes are recommended in Section 8.

2.2.3 Air Emissions. Air emissions from creosote treatment facilities are generally localized, and include:

- emissions during application of vacuum for wood conditioning, for the full-cell process or during the final vacuum step;

- vapours from tank vents;
- vapours from treating cylinders;
- vapours from opening of cylinder doors; and
- vapours from freshly treated charges.

Means to control localized air emissions are suggested in Sections 5 and 8.

Evaporation tanks, if used, are usually the only potential source of air emissions from creosote facilities that could disperse beyond the plant boundaries. An evaporation tank may be used to evaporate plant process wastewaters, with the residual preservative that accumulates being returned to the treatment system for reuse. A preliminary study of emissions from a creosote facility evaporation tank identified various polyaromatic hydrocarbons, alkyl benzenes and long-chain alkanes which represent a cross-section of hydrocarbons present in creosote and petroleum oils (10).

2.2.4 Potential Effects. The actual impact of any chemical released to the environment depends on many factors, including the location of the wood preservation facility relative to ground or surface waters, the species of aquatic biota in adjacent surface waters, and the amount of preservative released. Variables that can influence effects on worker health include ambient concentrations, frequency of exposure and protective measures during the time(s) of exposure.

All creosote manufacturing and user facilities could affect the environment, as could any chemical manufacturing and chemical user industry, if improper control measures are not in place. Documented releases of creosote from wood preservation facilities have been due to either poor design or poor operating practices. The effects of these releases appeared to be either localized at the plant site (i.e., soil and groundwater contamination) or in the immediate environment adjacent to the plant site.

Localized site contamination of soil and groundwater have been reported at three creosote treatment operations in Canada (11,12,13,14). Two of the sites were adjacent to environmentally-sensitive areas (the Fraser River in B.C. and Lake Superior in Ontario), and extensive control and cleanup measures were required at both sites to mitigate contaminated groundwater movement. At the Fraser River site, both groundwater movement and condensates discharged directly to the river eliminated biological life in adjacent river sediments (11). Creosote was one of three wood preservatives used at the Fraser River site, and the effects attributable solely to creosote could not be identified. Several creosote wood preservation facilities in the U.S. have been subject to investiga-

tion and cleanup (15,16,17). Poor operating practices and poor facility design had resulted in contamination of groundwater and/or contamination of adjacent environments.

Human health could be affected if appropriate precautions are not taken during spills of creosote and residues, and handling of treated products. Skin burns and allergic reactions were reported in a survey of the accident history of 50 pressure treatment plants (18). A review of the literature by Todd and Timbie (19), concluded that "there is neither positive nor negative human experience data in the wood treating industry to indicate that additional or less restrictive exposure control is appropriate". Detailed discussion of the potential effects of releases of creosote is provided in Section 3.

2.3 Chemical Management at Creosote Facilities

Environment Canada surveys have found that technical support services at creosote facilities depended upon internal resources (1,2,3). Design and operating practices were highly individualized, and the contractors who conducted the Environment Canada surveys characterized the industry as highly variable in the overall control of creosote (3). The variability was attributed to:

Differences in design features

- control of drips from freshly treated wood,
- control of vacuum exhausts,
- containment of chemical storage and process areas,
- containment of surface runoff from treated wood storage areas,
- prevention of tracking from drip pads, and
- control of air and liquid emissions and solid wastes.

Differences in operational procedures

- worker safety precautions, particularly for handling creosote and freshly treated wood,
- housekeeping requirements and equipment maintenance,
- training of personnel, re routine and emergency situations,
- requirements for pre-employment medical examinations (to determine sensitivity of individuals) and ongoing medical surveillance, and
- monitoring of chemical losses to the workplace and the environment.

In an overview assessment of the industry, the contractors for the Environment Canada surveys noted that exceptions to "good" control of chemical releases did exist and, in such cases, improvements in physical facilities and/or operational procedures would be desirable to protect human health and the environment (3). The intent of this document is to define objectives to protect the environment and workers from harmful effects and to suggest means of achieving these objectives within the wood treatment industry.

3 CREOSOTE

3.1 Production and Use

The American Wood Preservation Association describes creosote, as used by the wood preservation industry, as: "a distillate of coal-tar produced by high temperature carbonization of bituminous coal; it consists principally of liquid and solid aromatic hydrocarbons and contains appreciable quantities of tar acids and tar bases; it is heavier than water, and has a continuous boiling range of at least 125°C, beginning at about 200°C" (20).

During distillation of coal tar, the first fractions contain the light oils (or low molecular weight oils) and the residue left after completion of the process is the pitch. The higher boiling point liquid fraction recovered between these two general classes of materials is designated creosote. Because the character of the tar, details of the distillation process, and proportion of distillate included in the creosote fraction all influence the chemical and physical characteristics of the creosote, relative concentrations of creosote components can vary from batch to batch.

Creosote has been known for its preservative properties since 1706. In 1838 the Bethell (full cell) process using creosote was patented (6) and wood preservation remains its principal use. It is also used as pitch for roofing, as an animal dip, as fuel and as a lubricant for die moulds (21). Creosote has been described as one of the most effective substances known for the protection of wood against all forms of wood-destroying organisms (6). It has a marked toxicity to a wide spectrum of wood-destroying fungi, marine borers and insects.

Creosote's attributes aside from its broad spectrum efficacy are: water repellency, improved dimensional stability and mechanical wear, corrosion resistance, reduced electrical conductivity, increased resistance to corrosive chemicals, and its ease of application.

As of 1986 creosote was the only wood preservation chemical produced in Canada. It is used primarily for treatment of railroad ties, marine pilings and timber, and other construction timbers. Table 3.1 provides an overview of creosote usage in Canadian pressure treatment facilities.

3.2 Physical and Chemical Properties

Polyaromatic hydrocarbons (PAHs) are the main components of creosote. Other components include tar acids (e.g., phenols, cresols and cresylic acid) and tar bases

TABLE 3.1 OVERVIEW OF CREOSOTE USAGE IN CANADA (Pressure Treatment Facilities)

Feature	Characteristics
Delivery format	Bulk, rail, truck, ship
Chemical family	A distillate of coal tar whose major components include naphthalene, phenanthrene and fluoranthrene
Suppliers to Canadian facilities (1986)	• Domtar Chemicals Group, Hamilton, Ontario • Currie Products, Hamilton, Ontario • Allied Chemicals Corporation, Detroit, Michigan • Koppers Company Inc., Pittsburgh, Pennsylvania • United States Steel Corporation, Pittsburgh, Pennsylvania
Estimated use quantity (1986) Canadian Pressure Treaters	20 000 tonnes
Concentration of work solutions	Either 100% creosote or 50:50 mixture of creosote and petroleum oil
Typical preservative retention in treated wood	96 - 430 kilograms creosote/cubic metre treated wood (6 - 27 pounds/cubic foot); typically 128 kg/cubic metre of wood
Major products treated in Canada	Railroad ties, marine pilings and timber, construction timbers

(e.g., pyridines, quinolines and acridines) (22). Table 3.2 lists the major components and the concentrations identified in one batch of creosote produced in Canada (23).

The many components in creosote actually complement each other in effecting wood preservation. The lighter molecular weight PAHs in creosote are generally more toxic to decay organisms. The heavier molecular weight components of creosote help "retain" the more toxic lighter components within the wood by minimizing leaching or volatilization. The heavier residues of creosote, when impregnated into wood, prevent moisture changes and subsequently minimize splitting of wood (6).

TABLE 3.2 MAJOR COMPONENTS OF CANADIAN-PRODUCED CREOSOTE (23)

Components	Percent
Carbazole	2.1
Naphthalene	17.5
Acenaphthylene	2.0
Acenaphthene	5.6
Fluorene	5.1
Phenanthrene	10.2
Anthracene	2.3
Fluoranthene	9.9
Pyrene	4.4
Benz(a)anthracene	1.1
Chrysene	1.0
Benzo(b)fluoranthene	0.6
Benzo(k)fluoranthene	0.4
Dibenz(a,h)anthracene	0.2
Benzo(g,h,i)perylene	0.1
Indeno(1,2,3-c,d)pyrene	0.1

Because of the many components of creosote and their varying concentrations, the physical and chemical properties of creosote per se can only be generalized. Table 3.3 summarizes properties that have been compiled in various documents (24,25,26,27). Properties that warrant special consideration for the safe handling of creosote include its:

- flammability,
- moderate vapour pressure,
- solubility of certain fractions in water, and
- density, which is greater than water, implying that creosote will sink to the bottom of fresh and marine waters.

3.3 Environmental Effects

The exposure of aquatic organisms to components of creosote could result in both short-term (acute) and long-term (chronic) toxic effects. The environmental degradation rates, aquatic toxicities and biological uptake efficiencies of individual

TABLE 3.3 PHYSICAL AND CHEMICAL PROPERTIES OF CREOSOTE

Identification

Common: Creosote oil
Synonyms: Coal tar creosote
(past and Cresotum
current) Naphthalene oil
CAS Registry Number: 8001-58-9

Manufacturers:
- Domtar Chemicals Group, Hamilton, Ontario
- Currie Products, Hamilton, Ontario
- Allied Chemical Corporation, Detroit, Michigan
- Koppers Company Inc., Pittsburgh, Pennsylvania

Transportation and Storage Information

Shipping State: Liquid
Chemical Family: Coal tar distillate
Classification: Combustible
Storage Temperature: Ambient

Inert Atmosphere: No requirement
Venting: Open (flame arrestor)
Containers/Materials: Tankers, tank cars, tank trucks: steel

Labels: Red and White
Class: Check with Transport Canada

Physical and Chemical Properties

Physical State: Liquid

Solubility: Practically insoluble in water. Soluble in alcohol, benzene and toluene.

Floatability: Sinks in fresh and marine waters)

Specific Gravity: 1.05 - 1.09 at 15°C
Vapour Pressure: Variable
Boiling Point: 200 - 450°C
Odour: Acrid, tarry aromatic
Vapour Density: Variable (typically 3 to 5)

Appearance: Yellow to black oily liquid with sharp, smokey or tarry odour
Melting Point: Varies (-60 to -20°C)
Flash Point: >74°C - combustible liquid
Explosive Limits: Variable, 1 to 7%

Hazard Data

Fire

Extinguishing Data: Use dry chemical, foam or carbon dioxide. Use water to cool fire-exposed containers.
Fire Behaviour: Forms irritating heavy black smoke.
Ignition Temperature: Variable, typically 400°C
Burning Rate: 4 mm/min.

Reactivity

With Water: No reaction, insoluble
With Common Materials: May react with oxidizing agents or strong acids.
Stability: Stable

components vary. The environmental effects of creosote releases to the environment would depend on a complex array of parameters, including the concentration of components, ambient pH, potential for adsorption to suspended solids, temperature, biodegradation rate, and photodecomposition rate.

3.3.1 Distribution in the Natural Environment. A comprehensive perspective on sources and distribution of polyaromatic hydrocarbons (PAHs) in the Great Lakes is provided in the 1983 report of the IJC's Aquatic Ecosystem Objectives Committee (29). The report indicates that the major sources of PAHs in the environment are fuel combustion (coal, oil and wood burning), refuse combustion and coke production. Fossil fuels such as crude or bunker oil contain PAHs and accidental spills from boating and shipping activities contribute considerably to PAH contamination in coastal waters. Levels of PAHs in waters, air and sediments in the vicinity of populated and industrial areas are frequently significantly higher than in non-populated areas.

Since PAHs are also produced during forest fires and volcanic eruptions (29), they can be considered natural compounds. It has been estimated that forest fires contributed 10% of total PAH emissions in the United States during the mid-1970's (30). To illustrate PAH levels in the environment, Table 3.4 lists concentrations found in sediments, water and biota of the Great Lakes. The sediment data show the influence of anthropogenic sources on PAH levels in the environment, e.g., Lake Superior versus Lake Erie.

Releases from creosote wood preservation facilities are probably confined to historical events resulting from poor operating practices. These releases were relatively small compared to releases from other sources. The available evidence, which is limited and not very conclusive, indicates that the quantities of PAHs entering the environment from treated wood in service are also small (28).

3.3.2 Aquatic Toxicity. A definitive assessment of the effects of creosote in the environment is difficult, given the many components of creosote. Each component has a different individual toxicity, persistence in the environment and biological availability. In addition, the effects of the acidic and basic components are pH dependent, and the toxic effects of some PAHs may be influenced by salinity. This section is therefore limited to a general overview of toxicity information on creosote and some components of creosote for the purpose of illustrating the importance of controlling environmental releases.

Table 3.5 provides examples of aquatic toxicity values reported for creosote and of three components which have been detected in raw wastewaters from creosote

TABLE 3.4 EXAMPLES OF PAH CONCENTRATIONS IN THE GREAT LAKES ECOSYSTEM (29)

PAH	Lake Superior	Lake Erie	Lake Ontario
	Sediments (µg/kg)		
Phenanthrene	0.034	0.346 ± 0.092	0.0585
Benzo(a)pyrene	0.028	0.255 ± 0.152	0.076 - 0.306
	Fish (µg/kg)		
Benzo(a)pyrene		0.046 ± 0.041 (Detroit River)	0.069 ± 0.044
	Herring Gull Lipid (µg/kg)		
Phenanthrene			0.002
Benzo(a)pyrene			0.030 - 0.038
	Water (µg/L)		
Phenanthrene	Mean for great lakes water system: 0.024		
Benzo(a)pyrene	Mean for great lakes water system: 0.012		

facilities. The evaluation of creosote toxicity to aquatic species is difficult because creosote is not readily dissolved in water. Different approaches in toxicity testing, e.g., dispersion of creosote in water versus dissolving creosote in acetone, have resulted in different toxicity results. For example, Webb (31) has reported a 96-hour LC_{50} value of 0.2 mg/L and a "no-effect level" of 0.08 mg/L creosote in experiments with rainbow trout, while Domtar Inc. reported a 96-hour LC_{50} of greater than 10 mg/L (32). The data base on the toxicity of creosote to aquatic biota is limited, but shows that some species may be highly sensitive. For example, studies on the effects of creosote on lobsters have shown that a dilution of 50 000 000 would be required to protect larval lobsters (33).

A larger data base is available on the aquatic toxicity of the many components of creosote. Several generalities can be noted:

a) Higher molecular weight PAHs probably play a minor role in acute toxicity. Such PAHs have very low solubility in water, adsorb readily to particulate material and are therefore not readily available for uptake by biota. "The levels of PAHs demonstrated to be (acutely) toxic to aquatic animals are generally much higher

TABLE 3.5 TOXICITY OF CREOSOTE AND SELECTED COMPONENTS TO AQUATIC BIOTA

Test Substrate and Concentration milligrams/litre (parts per million)	Effect
Creosote 0.08 - 0.32	No effect level for rainbow trout (31)
Creosote 0.20 - 0.56	50% of rainbow trout test fish are killed within 96 hours (equivalent to the median lethal concentration, i.e., the 96-hour LC_{50}*) (31)
Creosote >10	Fish kills inadequate to assess LC_{50} (32)
Creosote 0.02	96-hour LC_{50} for larval lobsters (33)
Naphthalene 0.008 - 0.012	100% mortality for newly hatched crab and young spot shrimp (34)
Naphthalene 2.3	96-hour LC_{50} for rainbow trout (35)
Phenol 4.2 - 9.4	48-hour LC_{50} for rainbow trout (36)

* LC_{50} is defined as that concentration which results in death of 50% of the fish population within 96 hours.

than levels found in the aquatic environment, except for PAH concentrations that might be found at sites such as in the immediate vicinity of oil spills" (37).

b) There are differences in interpretation of the possible implications of PAHs in the environment. A review by an IJC Committee concluded that: "there is evidence of both chronic effects and carcinogenic/mutagenic responses in fish populations exposed to PAHs" (29). Carcinogenic properties of PAHs in fish have been attributed primarily to metabolites of PAHs rather than the actual PAH molecules themselves (38, 39). Varanasi et al. (40) found that English sole can extensively metabolize benzo(a)pyrene to intermediates that interact with DNA; such interactions are believed to initiate tumor formation in fish. Despite these data, a review by the National Research Council of Canada states: "To date, PAHs have not been

unequivocally identified as the specific causative agents for cancer in any natural population of aquatic animals; instead, the usual situation has been to find traces of PAHs in association with a myriad of other chemicals, although there are some instances of increased tumor frequency where PAHs may have been the dominant pollutant" (37).

c) The sensitivity of aquatic organisms to PAHs is affected by salinity. For example, zoeae of the mud crab have higher mortality rates when exposed to phenanthrene and naphthalene at low salinities than at high salinity or in freshwater. Estuaries, therefore, may be the most biologically sensitive areas to contamination by PAHs (41).

A review of PAH toxicity data by the Aquatic Ecosystem Objectives Committee of the IJC concluded that "such compounds, whether parent PAH or metabolites, are deemed of concern. As a consequence, anthropogenic inputs are considered undesirable" (29). The Committee's report was reviewed by the IJC Science Advisory Board, which further noted the many unknowns related to the presence of PAHs in the environment (42). The Committee's conclusions and recommendations were endorsed by the Board, which recommended that the International Joint Commission encourage the Governments of Canada and the United States "to find ways of reducing anthropogenic sources of PAHs and to ensure that the role of these compounds with respect to the health of the living components of the Great Lakes ecosystem is fully investigated" (42).

3.3.3 Bioaccumulation. Analytical data for biota in freshwater and marine ecosystems indicate that PAHs do not bioaccumulate appreciably in the flesh of fish or of predators of fish (e.g., herring gulls) (29). However, PAHs and their metabolites have been found in elevated concentrations in livers of fish exposed to PAHs (40). Evidence of bioaccumulation of PAHs is more readily observed in species at lower trophic levels, such as clams, snails and midges in freshwater systems, and clams, crabs and shrimp in marine systems (29,43).

3.3.4 Environmental Criteria. Although there are no water quality objectives or standards specifically for creosote, water quality criteria do exist for component compounds or indicators of creosote (29,44,45,46). These criteria are summarized in Table 3.6. However, the Canadian Council of Resource and Environment Ministers' Water Quality Guidelines state that "there is insufficent information to recommend guidelines for polycyclic aromatic hydrocarbons" (47).

TABLE 3.6 REGULATORY LIMITATIONS FOR CREOSOTE OR COMPONENTS OF CREOSOTE IN NATURAL WATERBODIES

Limit Type	Limit Value	Basis	Agency
Objective	0.01 µg/L benzo(a)pyrene* in water	Protection of fish and other aquatic organisms from carcinogenic or tumorigenic effects	International Joint Commission (29)
	1.0 µg/L benzo(a)pyrene in sediments or in organisms serving as food sources for fish	Protection of fish	
Guideline	0.01 µg/L benzo(a)pyrene in water	To protect drinking water	World Health Organization (45)
Maximum Acceptable Concentration	2 µg/L phenols	To protect drinking water (aesthetic considerations)	Health and Welfare Canada (44)
Objective	0.05 of 96-h LC_{50} for unspecified, non-persistent toxic substances	To protect aquatic organisms	International Joint Commission (46)

* Benzo(a)pyrene was selected because limitations on benzo(a)pyrene were considered effective in limiting other PAHs.

3.4 Human Health Concerns

A safety objective for industrial use of any chemical, including creosote, is to minimize worker exposure. If safeguards are not provided or not implemented, a variety of human health effects can occur, depending on: the duration and manner of exposure; concentration of the chemical to which exposure has occurred; varying metabolic sensitivities of individual workers. On the basis of information from existing literature, Table 3.7 outlines the spectrum of human health effects that could result from various degrees of exposure to creosote.

Many reviews have been published on the potential and known health effects of over-exposure to coal tar derivatives, including creosote. Examples include those of the International Agency for Research on Cancer (48), the American Conference of

TABLE 3.7 EFFECTS OF CREOSOTE ON HUMAN HEALTH

Exposure	Degree of Exposure*	Documented Health Effects
Inhalation	Brief inhalation of vapours in excess of TLV	Irritation of nose and throat (21)
	Repeated or prolonged inhalation of mists or of vapours in excess of of TLV	Sweating, thirst, nausea, vomiting, stomach pain, with subsequent convulsions or coma (52)
Eyes	Repeated or prolonged exposure to mist or vapours	Irritation
	Direct contact with liquid (i.e. splattering)	Severe burns (50)
Skin	Occasional direct contact with liquid, vapours, or mists	Reddening and itching (contact dermatitis) (21,52)
		Effects enhanced by exposure to sunlight (19,21)
		Burning may result if creosote is not removed from skin (49)
	Extensive exposure (i.e., total immersion of worker in tank, improper protective measures inside storage tank or retort)	Absorption of creosote through skin causes discoloration of skin, sweating, thirst, vomiting, diarrhea and stomach pains (50,52)
	Heavy regular contact over long period of time	Potential for skin cancer has been reported (48,50)
Ingestion	One-time ingestion	Burns mouth, throat and stomach (52)
		Subsequent salivation, vomiting, respiratory difficulties, thready pulse, vertigo, headache, loss of pupillary reflexes, hyperthermia, cyanosis and convulsions (52)
		Fatal dose: 7 - 10 g (21, 52) 30 - 50 g** (53)
		Death would be due to circulatory collapse and respiratory failure (21)

* Workers may have varying sensitivities to exposure.
** Calculated from animal feeding studies.

Governmental and Industrial Hygienists (49), the International Labor Organization (21), the U.S. National Institute for Occupational Safety and Health (19,50) and the U.S. Department of Agriculture (51). Table 3.8 provides excerpts from several reviews to illustrate the potential pathological, physiological and biochemical effects of overexposure to creosote. The table also indicates that although many potential effects have been suggested in the literature, epidemiological studies of wood preservation workers have not shown an increased cancer risk; skin irritations were the most commonly observed effect.

3.4.1 Short-Term (Acute) Health Effects. Documented occupational health effects of creosote on workers at wood preservation facilities under normal operating conditions have generally been restricted to skin reactions upon contact with creosote-solutions, creosote-treated wood, or vapours (18). Skin contact with creosote can cause an irritant contact dermatitis, which in the mild form simply appears as a reddening on the skin but may progress to papular vesicular lesions followed by ulceration. Exposed skin may display a markedly enhanced sunburn response, with subsequent hyperpigmentation of exposed skin areas (50).

Absorption of vapours through the respiratory tract may result in coughing and breathing difficulties. Ingestion of creosote may result in subsequent sweating, tremor and convulsions, circulatory collapse and respiratory failure (52).

3.4.2 Long-Term (Chronic) Health Effects. Laboratory animal studies have shown that many components of creosote have the potential to act as accelerators or promotors of the carcinogenic process. The components of concern include the aromatic amines and sulphur compounds, benzo(a)pyrene and dibenzanthracene. Repeated long-term contact with creosote has been suggested to be responsible for skin cancer (21,48). A scientific panel of the U.S. Environmental Protection Agency has suggested that additional epidemiological studies of wood preservation plant workers, and more extensive exposure studies in such plants, be carried out so that risk assessment can be improved (55).

3.4.3 Special Sensitivity. Natural sensitivity to creosote exposure, particularly skin sensitivity, varies widely (50). As a result, NIOSH has suggested the need for pre-employment and regular medical surveillance of workers (50). Prior to employment, workers should be informed of such sensivities. The information should not be used to bar workers from employment but should be used to assure that proper precautions are applied.

TABLE 3.8 SUMMARIES OF POTENTIAL HEALTH EFFECTS OF OVEREXPOSURE TO COAL TAR DERIVATIVES, INCLUDING CREOSOTE

IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans (48)

* Sufficient evidence exists for the carcinogenicity in experimental animals of coal-tars, creosotes, creosote oils, anthracene oils and coal-tar pitches.
* Limited evidence exists that coal-tar-derived creosotes are carcinogenic in humans.
* Taken together, the data indicate that coal-tars and coal-tar pitches are causally associated with cancer in humans and that creosotes derived from coal-tars are probably carcinogenic in humans.

International Labor Organization (21)

* Creosote causes irritation of the skin, mucous membranes and conjunctiva. The skin can become red, papular, vesicular or ulcerative, depending upon the concentration of the material and length of time of contact. Repeated contact over long periods of time may be responsible for the development of cutaneous neoplasms.
* Following ingestion of creosote, irritation of the gastrointestinal tract and cardiovascular collapse may occur. Systemic intoxication is similar to that of phenol, probably because of high concentrations of phenolic compounds in creosote. Some of the material is excreted unchanged in the urine, some is conjugated with other compounds, and some is detoxified by oxidation.
* The fatal dose is about 0.1 g/kg of body weight.
* Ingestion is followed by nausea and vomiting, salivation, abdominal discomfort, respiratory distress, cyanosis, pupillary changes, convulsive movements, rapid pulse and vascular collapse.
* Protective clothing is generally adequate to prevent skin contact. Treatment is symptomatic and supportive.

Todd and Timbie (19)

* Individual compounds in the creosote mixtures, independently or in combination, can act as carcinogens directly, or as accelerators, promoters, and carcinogenic inhibitors.
* Direct skin contact with creosote, if not properly removed, causes chemical skin burns. The Pesticide Exposure Response System of the U.S. Environmental Protection Agency contains a number of reports of skin erythema and frequent chemical burns in personnel handling creosote-treated wood products. Skin burns and allergic reactions from creosote contact have also been reported in a survey of the accident history of 50 pressure treatment plants.
* Surveys on occupational exposure to creosote materials in wood treating operations indicate that most personnel exposures do not routinely exceed the current coal tar pitch volatile (CTPV) occupational standard of 0.2 mg/m^3. Personnel most exposed are those working adjacent to the pressure cylinders during opening, wood removal, and re-filling. Other personnel assisting in loading and unloading, sorting timber, etc., appeared to have less exposure, and these were consistently well below the limits for benzene-soluble airborne particulates.
* Creosote is commonly handled and controlled as though similar to coal tar in health effects, as a contact irritant, photosensitizer, and potential carcinogen with routine, prolonged contact, or inhalation. Neither positive nor negative human experience data exists in the wood treating industry to indicate that additional control is appropriate.
* Preplacement physical examinations are recommended. The medical and work history questionnaire should include questions regarding photo-sensitivity and skin irritations or sensitivity. In addition to the regular pre-placement physical examination and appropriate laboratory tests, all skin areas should be thoroughly examined. Subsequent regular physical and skin examinations are recommended.

NIOSH (50)

* NIOSH recommends that occupational exposure to coal tar products in the workplace be controlled so that employees are not exposed to coal tar, coal tar pitch, creosote, or mixtures of these substances at a concentration greater than 0.1 mg/m^3 of air of the cyclohexane-extractable fraction of the sample, determined as a time-weighted average concentration for up to a 10-hour work shift in a 40-hour work week.
* Medical surveillance is recommended, including preplacement medical examinations and periodic examinations at least annually. Medical records should be kept at least 30 years after termination of employment.
* Exposure to coal tar products has been reported to produce phototoxic effects such as skin erythema and burning and itching skin, photophobia, conjunctivitis, and skin and lung cancer in humans. (No increase has been observed in skin and lung cancer in workers at creosote wood preservation plants.)

ACGIH Documentation of TLVs (49)

* In the absence of more definitive information on the identity of the components of coal tar pitch aerosols responsible for carcinogenic effects, a threshold limit value (TLV) based on the benzene (or other suitable solvent) soluble fraction appears to be a practical compromise. If the concentration of aerosols from coal tar, on this basis, is maintained below 0.2 mg/m^3, any increase in the incidence of lung and other tumors due to occupational exposure should be minimal.

Alscher and Lohnert (54)

* No increased cancer risk was observed in a study by the Norwegian Cancer Research Institute of 665 male workers employed at a creosote treatment plant from 1953 to 1980.
* In a survey of 1800 employees who handled creosote in 90 German companies, no chronic health effects were reported, although a significant proportion had skin irritations.

3.5 Conclusions

Creosote or some of its components can have adverse effects on human health and on the environment, as indicated by reviews of the available evidence by regulatory bodies, the International Labour Organization (ILO), the American Conference of Governmental Industrial Hygienists (ACGIH) and the U.S. National Institute of Occupational Health and Safety (NIOSH). The available evidence indicates that precautions are necessary in the handling and use of creosote.

The authors of this document also accept the conclusion of the ILO (21) and of others (19,56) that creosote can be used in industry without undue health risks to occupationally exposed workers if the workers have adequate training and proper protective equipment, if they practice proper work hygiene, and if the plants are designed to minimize the levels of creosote in the air and the extent of skin contact with creosote. In the absence of a threshold limit value (TLV) for creosote, suitable limit values for air levels would be the TLV of 0.2 mg/m^3 for coal tar pitch volatiles (49) or the limit of 0.1 mg/mg^3 for cyclohexane-extractable volatiles suggested by NIOSH (50). Consideration should also be given to preplacement and annual medical examination of employees, and to establishing medical records for employees.

4 PERSONNEL PROTECTION

4.1 Precautions and First Aid

The potential hazards of exposure to creosote include immediate and long-term toxic effects from ingestion, skin contact, eye contact, or inhalation of vapours (Tables 3.7 and 3.8). It is emphasized that these potential hazards can be adequately controlled by proper protective measures. The severity and speed of damage to tissue and probability of health effects following contact with creosote are highest with pure creosote and with creosote/oil mixtures. Both factors diminish with aqueous solutions. The general rule is: For work with creosote, creosote-oil mixtures and/or sludges, there is a need for protective measures and immediate response if contact occurs.

Table 4.1 describes first aid procedures to be used for creosote exposures (52). In all cases, it is important that first aid personnel maintain regular contact with industrial medical advisors for information on up-to-date response measures. Table 4.2 outlines specific objectives for a worker protection program in a creosote wood preservation facility. Means to achieve the objectives are presented the table, although the recommendations may not be the sole options available to attain the objectives. Alternative approaches may equally effective or may be more suitable for site-specific conditions. When programs are developed for a particular facility, the specific recommendations provided may be modified if it can be demonstrated that an alternative approach, more suitable to the plant, would be equally effective in attaining the desired objective.

With the use of creosote, it is particularly important that protection be provided for all potential types of exposure — eye contact, skin contact and inhalation. Many work situations require protection against more than one type of exposure, e.g., when creosote aerosols or vapours are produced. For example, the use of nose-mouth respirators which do not cover the eyes and facial skin around eyes may lead to a false sense of security (57). Full face shields or full face cartridge respirators are recommended.

4.2 Regulatory Controls

Specific provincial regulatory limits for worker protection are found in Appendix A of this document. Most regulatory criteria established by worker protection agencies are based on "Threshold Limit Values (TLVs)" and "Biological Exposure Indices", as recommended by the American Conference of Governmental Industrial Hygienists

TABLE 4.1 FIRST AID FOR CREOSOTE EXPOSURE*

Exposure	First Action	Second Action
Eye Contact	• Immediately flush eyes with flowing water, occasionally lifting the upper and lower lids. • Flush eyes for at least 15 minutes.	• Get medical attention.
Skin Contact	• Immediately remove soaked clothing or articles in contact with the skin. • Immediately wash contaminated skin thoroughly with soap or mild detergent and water.	• Get prompt medical attention if the skin becomes inflamed (redness, itch or pain).
Inhalation	• Immediately move the person to fresh air.	• Apply cardio-pulmonary respiration if breathing has stopped. • Do not use mouth-to-mouth respiration. • Keep affected person warm and quiet. • Get medical attention.
Ingestion**	• If conscious, induce vomiting (56).	• Call a physician and continue to induce vomiting until physician arrives. In the absence of medical attention and if person is conscious give 60 mL of castor oil (after vomiting). Then give 30-60 mL of Fleet's Phospho-Soda diluted 1:4 water (56).
Chronic Symptoms, Requiring Medical Referral	• Skin irritations, sensitivity • Skin lesions	

* Potential exposure to creosote in pressure treating facilities includes exposure to creosote, creosote treating solutions and sludges, and contaminated aqueous solutions. Inhalation exposure can occur from vapours or aerosols.

** Regularly consult with competent medical advisors for updated recommended first and second actions.

TABLE 4.2 SAFETY PRECAUTIONS FOR PERSONNEL WORKING WITH CREOSOTE SOLUTIONS

Objective	Recommendations
General Precautions	
Assure that workers are familiar with all aspects of creosote usage	• Provide documentation and training to educate workers about the chemical properties, hazards of exposure, and emergency procedures associated with creosote use. • Implement preventative measures to minimize ingestion, inhalation, and skin or eye contact with creosote solutions and contaminated waters.
Assure that first aid can be applied when required	• Install and regularly check emergency eyewashes and showers. • Provide all required first aid equipment for first response as indicated in Table 4.1. • Ensure that first aid is always available by qualified (trained) personnel. (Trained personnel may include supervisors and managers.) • Ensure familiarity of first aid personal with updated emergency procedures. • Identify medical contacts who are readily available during all working hours.
Personal Hygiene	
Encourage personal hygiene practices that minimize potential exposure to creosote	• Do not carry, store or consume food or drink in working areas (e.g., areas where creosote is stored or used, or where freshly treated wood is stored). • Do not carry or smoke cigarettes in working areas. • Wash hands thoroughly before leaving working areas and before eating, drinking, smoking, or using the toilet facilities. • Do not expose cuts or abrasions to creosote solutions. • Wash skin immediately if contact with creosote occurs. • Get immediate first aid (Table 4.1) if eyes contact creosote solutions. Even small contact exposures should receive immediate cleansing and treatment. • Change outer clothing immediately if splashed with creosote (50). Change clothing daily if any incidental contact with the treatment chemical occurs. Wash contaminated clothing separately from other clothing. • Wear impermeable footwear in all working areas. Creosote solutions may penetrate shoes and leather.

TABLE 4.2 SAFETY PRECAUTIONS FOR PERSONNEL WORKING WITH CREOSOTE SOLUTIONS (CONT'D)

Specific Precautions During Creosote Treatment	
Objective: To outline safe workplace practices for each activity during the treatment process.	
Activity	Recommendations
Unloading or handling creosote	• Wear protective apparel including chemical goggles or face shields, impermeable gauntlets, coveralls, impermeable aprons, and impermeable shoes or boots. (Resistance rating of materials: Excellent - Viton, Neoprene, Butyl Rubber; Good - Nitrile, Polyvinyl chloride (PVC); Fair - Polyvinyl alcohol, Polyethylene) • Do not wear contact lenses. • Work in well ventilated areas. • Approved respirators should be readily available. Wear respirators in accordance to NIOSH guidelines whenever airborne contaminant concentrations are unknown or in excess of TLVs. • Provide self-contained breathing apparatus with full facepiece operated in pressure-demand or other positive pressure mode. • Provide combination respirator that includes Type C supplied-air respirator and full facepiece operated in pressure-demand or other positive pressure or continuous-flow mode and auxiliary self-contained breathing apparatus operated in pressure-demand or other positive pressure mode. • Provide an emergency eyewash and shower in the immediate unloading or handling areas. • Provide adequate equipment for safe, controlled transfer of creosote as required in Section 4 of the National Fire Code of Canada and as appropriate for the specific facility. • Immediately clean creosote spills. • Thoroughly clean protective equipment after use.
Sampling Procedures	• Wear eye protection and gloves impermeable to creosote when sampling creosote solutions, i.e., from a pipe tap. Other non-routine sampling efforts such as through cover ports may require more stringent precautions. • Wear impermeable gloves when taking borings from freshly-treated wood. • Clean gloves, and goggles as soon possible after completing sampling. • Clean the outside of sample containers after sampling solutions. • Wash hands thoroughly after all sampling operations.
Cleaning cylinders or tanks	• Follow all standard precautions for vessel entry (as per provincial health and safety regulations). • Flush vessels as required to establish safe entry conditions, or use an approved self-contained breathing apparatus prior to entry. • Wear NIOSH approved respirators (or breathing apparatus as above), creosote-impermeable gauntlets, outer clothing and boots during all vessel entries. • Always have a standby attendant present and provision for continuous outside communications. • Collect and store contaminated waste material in sealed and labeled drums. • Wash all protective equipment immediately after use. • Shower after cleaning retorts or tanks.
Removing treated charges from cylinders	• Wear eye protection and creosote-impermeable gauntlets and coveralls or apron during door openings and when moving loads of freshly-treated wood. • Avoid breathing preservative mists. Wear an approved respirator if airborne concentrations are unknown or, at or above TLVs*.
Handling treated lumber	• Wear impermeable** gloves, apron and boots if handling treated wood manually. • Wear a respirator if treated wood is handled in enclosed areas (e.g., boxcars). • Change coveralls daily.

TABLE 4.2 SAFETY PRECAUTIONS FOR PERSONNEL WORKING WITH CREOSOTE SOLUTIONS (CONT'D)

Specific Precautions During Creosote Treatment (Cont'd)	
Activity	Recommendations
Handling and maintaining contaminated equipment	• Thoroughly steam-clean or flush contaminated equipment with solvent (e.g., Varsol or equivalent) prior to handling. (Contain all solvent washings). • Change coveralls daily. • Wear impermeable apron, glove and boots.
Welding	Welding can produce toxic fumes In addition to the precautions for handling and maintaining contaminated equipment: • Obtain the specific approval from the plant supervisor before welding. • Block or disconnect lines from tanks before initiating welding operations. • Completely drain and thoroughly rinse tanks or lines prior to welding operations. • Ensure that equipment is completely dry and free of cleaning solvent residues. • Wear a respirator or provide effective, local exhaust ventilation during welding to prevent potential exposure to toxic fumes. • Assure good general ventilation of the work area. Ensure that creosote volatiles have been purged from enclosures (tanks, cylinders) prior to welding. • Comply with all additional provincial workplace safety requirements (Appendix A). • Prevent distribution of sparks to other contaminated areas or to areas where volatiles of creosote may be deposited.

* An initial workplace monitoring program as suggested in Table 8.3 will have determined the need for respirators. The results of the program are assumed to be indicative of conditions in subsequent facility operations, unless procedural or design changes have occurred.

** As described under "Unloading or handling creosote" on previous page.

(ACGIH). Creosote per se is not addressed by the ACGIH. The ACGIH suggests the use of benzene soluble fractions of coal tar pitch volatiles as a measure of exposure (49). Table 4.3 reviews the ACGIH recommended limits and provides recommendations designed to specifically define acceptable levels of worker exposure to creosote in the wood preservation workplace.

The ACGIH recommended threshold limit value - time weighted average (TLV-TWA) for creosote represents a time-weighted average concentration "for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect." The recommended TLV-TWA value for benzene soluble fractions of coal tar pitch volatiles is 0.2 mg/m^3. Recently, the ACGIH has suggested augmentation of TLV workplace evaluations by use of "biological exposure indices (which) may be useful as a guide to safe exposure" (49).

The ACGIH TLV-TWA's for chemicals are defined with the following provisos:

- "The limits are intended for use in the practice of industrial hygiene as guidelines for good practices or recommendations in the control of potential health hazards and for no other use" (e.g., not for proof or disproof of the cause of an existing disease or physical condition).
- "The limits are not fine lines between safe and dangerous concentrations."
- "In spite of the fact that serious injury is not believed likely as a result of exposure to the Threshold Limit concentrations, the best practice is to maintain concentrations of all atmospheric contaminants as low as is practical."
- "When two or more hazardous substances, which act upon the same organ system are present, their combined effect, rather than that of either individually, should be given primary consideration."

Skin and Eye Contact. A wide range of dermal exposures to creosote can potentially be encountered in the workplace, from "pure" creosote to creosote liquids to waters containing a few parts per million creosote. A minimal level of protection and hygiene, e.g., impermeable gloves and regular clothing changes, should be required for all facility workers who could have dermal exposure to creosote, oil and aqueous solutions of creosote or freshly treated wood. The level of protection should increase with increasing potential for exposure.

Inhalation. The ACGIH TLV-TWA values for coal tar pitch volatiles discussed previously are applicable as maximum allowable values for inhalation. Adequate design

TABLE 4.3 LEVELS OF CONCERN FOR CREOSOTE EXPOSURE IN THE WORKPLACE

Route of Entry	Basis for Recommendation	Recommendations/Comments
Skin and eye contact	• Creosote is a skin irritant and a potential skin carcinogen.	• Use protective measures for workers in contact with creosote (Table 4.2). • Avoid direct contact of skin and eyes with creosote solutions or sludges. • Sensitive individuals (as defined in Section 3.4.2) should take special care to avoid exposure. • Current material safety data sheets should always be readily available to workers.
Inhalation	ACGIH Threshold Limit Value 8-Hour Time Weighted Average (TLV - TWA). Cyclohexane Soluble Coal Tar Pitch Volatiles: 0.2 mg/m^3 air (Potential contributions to overall exposure can occur through the cutaneous route including mucous membranes and eye, either by airborne, or more particularly, by direct contact with the substance.)	• Ensure good ventilation and protective measures as suggested in Table 4.2. • Use self-contained breathing apparatus for fire-fighting activities where creosote is present. • The permissible concentration of creosote refers to vapours and aerosols.
Ingestion	The reported lethal dose of creosote for adults ranges from seven (7) grams to 50 grams (21,52,53).	• Prevent the ingestion of any quantity of creosote.

and operational procedures will minimize worker exposure to vapours, i.e., adequate local ventilation and use of respiratory equipment where necessary. Other potential sources of inhaled coal tar volatiles include: vapours in the vicinity of charge removal areas and in the vicinity of freshly treated wood; and, aerosols at improperly maintained facilities (e.g., from leaking seals) or at inadequately designed facilities (e.g., from vacuum pump discharges to work area).

Ingestion. Oral intake of creosote must be avoided. Ingestion of creosote or creosote containing liquids is unlikely if workers follow elementary rules of good hygiene. Acceptable limits of ingestion are not prescribed by regulation since there is no valid reason for any such intake to occur. The single dose level of creosote suggested to be fatal is in the order of 0.1 g creosote per kilogram of body weight (21).

4.3 Biological Monitoring of Exposed Workers

Periodic medical examinations, particularly for skin and respiratory lesions and including appropriate laboratory tests, are the only suggested means of biological monitoring of workers exposed to creosote. Procedures such as periodic monitoring PAHs in body fluids have not been adequate indicators of exposure (19, 50).

5 SITE SELECTION

5.1 Purpose

Preliminary assessment of an industrial site involves both an evaluation of technical site characteristics (e.g., hydrogeology, topography and soils) and socio-geographic factors (e.g., land use and availability, and proximity to transportation routes). This section highlights site features that contribute to the control of any potential creosote releases from wood preservation facilities.

In many cases, natural site characteristics may impose constraints on technical features of a creosote facility. Early recognition of less desirable site features will enable the development of a compensating facility design, and subsequently facilitate site approval.

Criteria for site assessment discussed in this section may also indicate the aspects of existing treatment plant facilities that need to be modified or changed to assure protection of the environment and worker health.

5.2 Assessment Factors

Use of creosote at a plant site introduces the potential for contamination of groundwaters and surface waters. The extent of potential contamination by released creosote is, in turn, dependent on the chemical, physical and biological properties of the creosote, plant design and operating practices as well as site-specific characteristics including: soil type, geology, hydrology, climate, topography and drainage.

This section describes environmentally important site characteristics and how those characteristics can affect the eventual impact of a chemical release. These characteristics are important in designing features of a wood preservation plant that:

a) minimize the possibility of off-site contamination via groundwater and surface waters;
b) minimize chronic on-site contamination to protect worker health during operation; and
c) facilitate decommissioning of the plant in the event of partial or complete closure.

The assessment factors for preliminary site evaluation rely on readily available information. Table 5.1 (at the end of this section) lists the site features that must be considered in an environmental impact assessment.

5.2.1 **Regional Geology.** Geologic information about many areas of Canada may be obtained from federal and provincial surveys. Information that should be obtained includes:

- Texture of unconsolidated material - Fine-grained material is more likely to retain chemical contaminants than coarse material.
- Depth to bedrock - Shallow soils imply a limited ability to retain spilled chemicals.
- Aquifer recharge and discharge zones - Potential for hydraulic connections to regional groundwater aquifers and subsequent discharge to sensitive surface waterbodies should be considered.
- Discontinuities such as faults, fissures, joints, fractures - Discontinuities may cause "short-circuiting" of a contaminated plume.

5.2.2 **Soils.** Soil properties should be assessed to evaluate the potential for leaching of treatment chemical constituents. Physical characteristics of soil to consider are: depth, permeability, texture, water holding capacity and shrink-swell potential. Chemical properties to consider include cation exchange capacity (CEC), anion exchange capacity (AEC), organic carbon content, and iron and aluminum oxide content (58). Soils with high anion exchange capacities will provide greater retention of dissociated phenols. Soils with high cation exchange capacities will enable greater retention of organic bases. Soil depth and soil types are routinely indicated on soil maps (and often on geology maps). Although the available maps may not indicate the exact soil composition of a small site (e.g., two hectares), they can be used for preliminary assessment purposes.

5.2.3 **Geotechnical Description (including subsurface hydrology and water table data).** Published maps and reports on regional geology and soils are adequate references with which to infer subsurface hydrogeology at the preliminary site assessment stage. However, site-specific hydrologic data will be required if one or more of the following conditions is identified during preconstruction assessment:

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

The additional information required will have to be defined in consultation with the appropriate regulatory agency.

5.2.4 Topography. Topographical information is easily obtained from published government maps. In general, steep sites should be avoided due to runoff problems and erosion. However, topography is a site selection parameter that can be modified by facility design. Slope gradients between 1-10% should present few problems. Upland flat and terraced landforms are desirable locations for treatment facilities. Floodplains are acceptable if they lie above the 100-year flood level; otherwise special design provisions must be implemented.

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

5.2.6 Proximity to Sensitive Uses. Sites located adjacent to waterbodies (e.g., lakes, rivers, marine waters) or above aquifers used for drinking or irrigation water supplies, food manufacturing plants and beverage processing plants, should be considered cautiously by the wood preservation industry. If such a site is selected, then exceptional design requirements and operational and monitoring procedures will be required. Desirable minimum distances between creosote facilities and sensitive waterbodies are dependent upon previously discussed factors such as soil type, regional geology, topography and climate. If a selected site is adjacent to waterbodies used by migratory fish, then the intended plans will have to be reviewed by both Environment Canada, and Fisheries and Oceans Canada.

5.3 Selection Procedures

After compiling the data for various potential sites, the developer of a facility is then faced with a decision-making process for site selection. The process integrates environmental protection with economic considerations. On the basis of economic factors alone, a less environmentally acceptable site might be most desirable. However, since the less acceptable environmental features in the design and operation of the wood preserva-

tion facility will add to the cost of adapting the facility to the site, environmental protection must be interpreted as a real cost of locating a facility at such a site.

All factors previously described should be considered. Techniques that may be used to select a site on the basis of environmental acceptability include criteria ranking, matrices, decision trees, or mathematical modelling. Since assessment techniques among regulatory agencies may vary considerably, local and provincial regulatory agencies must be consulted (as well as federal agencies where necessary).

Table 5.1 provides examples of site characteristics requiring very little environmental mitigation as well as those requiring significant environmental mitigation. Deviations from the most desirable characteristics, suggest varying degrees of mitigating and design operational measures:

- Slight mitigating design/operational measures are necessary for those site features that are well suited to the location of a treatment facility. The site will require only low cost maintenance and monitoring to assure environmental protection.
- Moderate mitigating design/operational measures present more of a problem, but in general sites requiring such measures are acceptable.
- Severe mitigating design/operational measures such as special innovative designs may partially overcome the constraints of a marginally suitable site. Design costs are likely to be high. Extensive monitoring efforts will be required, adding to the cost of locating a treatment facility at such a site.
- Very severe mitigating/operational measures pose such a threat to environmental protection that the site may be economically impractical.

Site features and the mitigating design/operational measures shown in Table 5.1 are based on siting criteria suggested by various investigators (59,60).

TABLE 5.1 SITE FEATURES AFFECTING THE DESIGN OF A CREOSOTE PRESSURE TREATMENT FACILITY

	Suggested Degree of Mitigating Design/Operational Measures	
Site Features	Slight	Severe
Soil Texture	loam, silt loam, silty clay loam, clay loam, sandy clay	gravel
Permeability (cm/h)	<0.5	>50
Topography (% slope)	0-9	>30
Soil Depth to Bedrock (cm)	>200	<60
Depth to Groundwater (cm)	>200	<60
Flooding	None	Frequent (>once/20 years)
Drainage	Moderate	Very rapid
Distance to surface waterbody (lake or river)	Depends on interaction with other site features (e.g., permeability of soil).	Directly adjacent

6 DESIGN

This section suggests approaches for the design of wood preservation facilities in order to protect workers and the environment from harmful exposure to creosote. The recommendations are based on "best practices" currently in use. The design aspects are intended to achieve the following general objectives:

a) to prevent or reduce direct contact of personnel with creosote or components of creosote;
b) to reduce releases of creosote to the environment to the greatest degree possible by providing secure containment and control; and
c) to enable prompt response and effective corrective measures to assure worker safety and environmental protection after abnormal events (e.g., tank rupture).

Means of achieving the above design objectives at creosote wood preservation facilities are presented in Tables 6.1 to 6.7. The recommended design features in these tables may not be the sole options available to attain the stated objectives. Alternative approaches may exist which would be equally effective or more suitable to site-specific conditions. If a more suitable alternative approach can be demonstrated to be equally effective in attaining the desired objective, an appropriate design feature that has not been included in the recommendations could be used at a specific facility.

Figure 6.1 presents an overview of the subject areas covered by the design recommendations in Tables 6.1 to 6.7. The figure is based on the handling and use of creosote at wood preservation facilities, and is cross-referenced to indicate the appropriate table for each process step. It is intended that all new wood preservation facilities be designed to achieve the specific objectives listed in Tables 6.1 to 6.7.

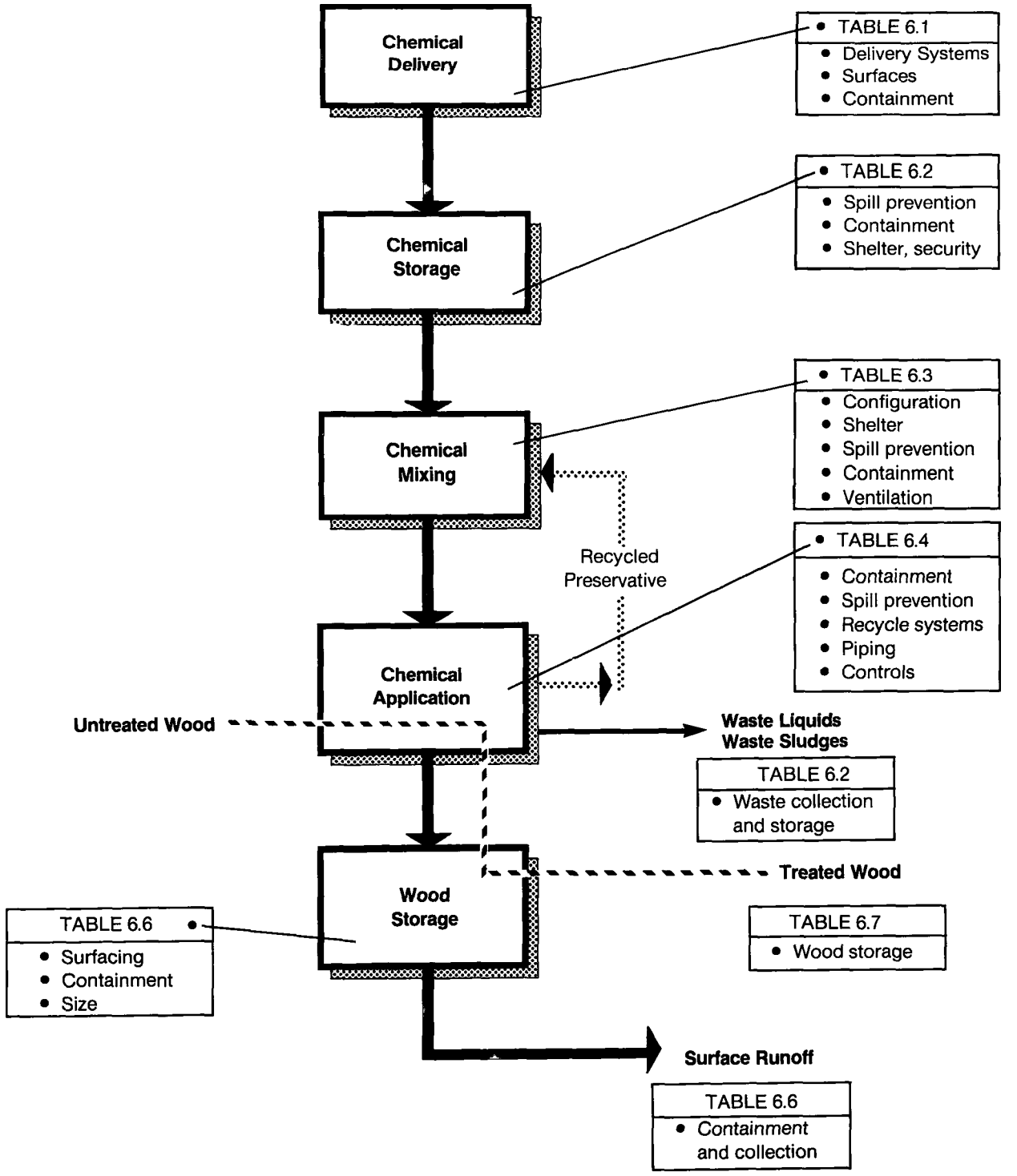

FIGURE 6.1 OVERVIEW OF DESIGN RECOMMENDATIONS FOR CREOSOTE FACILITIES

TABLE 6.1 RECOMMENDED DESIGN FEATURES FOR CHEMICAL DELIVERY AREAS

Delivery Format	Design Feature	Recommendation
Bulk Liquid ° Creosote ° Petroleum oil (CSA 080.201-83) (Delivered by Truck, Ship, or Rail Tanker)	**Objective:** To provide an off-loading area that enhances spill prevention and containment and complies with Section 4 of the National Fire Code of Canada (NFCC).	
	Off-loading pad	• Provide a graded loading site or sloped floor (preferably an impervious pad) to divert spills, or provide noncombustible sills, curbs or dikes; drain to a containment area in accordance with NFCC Sections 4.1.6.1 and 4.1.6.2. • Design to prevent settling or cracking of the pad.
	Drip control	• Design, install and maintain system to prevent leakage and spillage as per NFCC 4.6.6. • Provide for wash down of minor drips or spills with recovery of wash water (or infiltrating precipitation) for treatment.
	Access	• Attempt to locate off-loading area away from high yard traffic routes. • Restrict access during delivery.
	Delivery system piping	• Install piping and piping systems in accordance with specifications outlined in Section 4.4 of the NFCC, i.e., materials, corrosion protection, identification, joints, location and arrangement of pipes, valves, heating, methods of transfer and operating procedures. • Install permanent delivery systems with rigid, accessible and visible delivery lines (lines should not be buried). • Protect delivery systems if there is potential for vehicular impact or physical damage (NFCC 4.4.7.1(1), 4.4.7.2(1), 4.11.7.1). • Provide mechanically secure connections between the tanker and delivery hookup point. • Clearly identify all delivery lines (NFCC 4.4.4). • Use top delivery to bulk storage tanks.
	Backflow prevention	• Install backflow preventors on delivery lines (NFCC 4.4.10.8).
	Security	• Install locking valves on delivery lines, restrict access.

TABLE 6.1 RECOMMENDED DESIGN FEATURES FOR CHEMICAL DELIVERY AREAS (CONT'D)

Delivery Format	Design Feature	Recommendation
Bulk Liquid (Cont'd) ° Creosote ° Petroleum oil	**Overflow prevention**	• Provide maximum visibility of the delivery system from the point of off-loading. • If visibility is limited, use audible alarms to detect tank overflow during delivery.
	Static protection	• Provide acceptable provisions for electric bonding as per NFCC 4.6.6.5 to 4.6.6.8, and 4.11.6.
	Emergency response	• Provide accessible storage for spill response equipment, absorbant and personnel protection equipment. • Install a phone or manual alarm switch near the off-loading area.

TABLE 6.2 RECOMMENDED DESIGN FEATURES FOR CHEMICAL STORAGE AREAS

Storage Format	Design Feature	Recommendation
Bulk Liquids ° Creosote ° Petroleum oil ° Creosote/petroleum oil working solutions ° Contaminated surface runoff ° Drip return	**Objectives:**	• To provide positive spill prevention features. • To conform to Section 4.3 of the NFCC, where applicable.
	Tanks	• Engineer materials of construction and dimensions in accordance with ASME, CAN and API standards as defined in 4.3.1 of the NFCC. • Provide tanks in sound physical condition, with no rust or serious physical damage. • Mount tanks on containment pad surfaces within a dyked area (subsurface storage tanks are strongly discouraged). • Mount tanks in stable position and anchor securely (NFCC 4.3.3). • Locate tanks in accordance with 4.3.2 of NFCC (i.e., minimum distances from buildings and other tanks). • Evaluate means of controlling contaminated surface waters (e.g., roofing of tanks, runoff water treatment). • Test for leakage prior to backfilling as per NFCC 4.3.16. • Provide means for detecting leaks in insulated tanks (e.g., identify inspection points, undertake regular leakage tests). • Vent interior tanks to the exterior (never vent to the workplace); protect vents against release of entrained liquids or overflow (e.g., provide direct overflow piping to sumps or containment areas). • Provide grounding for tanks as per 4.6.6 of NFCC. • Provide vent piping for vapour control as per 4.3.4 and 4.3.5 of NFCC.
	Spill containment	• Install, impervious, structurally sound floors. • Provide structurally sound and impermeable dykes as per 4.3.7.4 of NFCC. • Provide a dyked containment volume equivalent to 150% of the largest storage tank or vessel within the dyked area or equivalent to 100% plus 150 mm additional containing wall for single tanks in isolated containment. • Engineer containment for long-term integrity (leak-proof for infiltration and exfiltration). • Consider means of detecting subsurface leakage from containment systems (where warranted by site-specific conditions, e.g., where the site over-lays sensitive groundwater systems). • Provide for directing all spills, washes and infiltrating water to tankage as per 4.1.6.2 and 4.3.7.9 of NFCC. (Contaminated liquids must be treated to applicable limit before discharge.) • Provide effective capability for transferring spilled liquids from containment areas to secure storage. • Provide surface drainage to prevent pooling of minor spills and washdowns as per 4.3.7.9 of NFCC. • Design to minimize tracking of fluids from containment surfaces.

TABLE 6.2 RECOMMENDED DESIGN FEATURES FOR CHEMICAL STORAGE AREAS (CONT'D)

Storage Format	Design Feature	Recommendation
Bulk Liquids (Cont'd) ° Creosote ° Petroleum oil ° Creosote/petroleum oil working solutions ° Contaminated surface runoff ° Drip return	**Piping and valves**	• Design according to applicable codes (e.g., Sections 4.4 and 4.6.6 of NFCC). • Use rigid, permanent piping throughout. • Provide visible, accessible piping with a simple layout (to facilitate early leak detection and easy repair). • Maximize the use of above-floor piping and/or open containment channels for subgrade piping (avoid use of buried piping). • Properly engineer piping systems for intended use and materials. • Identify piping systems and valves (e.g., by labelling and/or color coding). • Provide mechanical impact protection for vulnerable, exposed piping. • Provide freezing protection for piping (as required, and as per 4.4.9 of NFCC if heat is applied).
	Drip containment	• Provide local collection/containment (isolated from larger containment areas) at drip points (e.g., under pumps, valves, flanges).
	Spill prevention/ detection	• Install reliable, accurate level indicators on all tanks. • Provide mechanical impact protection on glass sight gauges (provide means to stop and contain releases from broken gauge tubes). • Install shut-off valves on all rupturable lines and tank gauges. • Install permanent overflow piping from tanks directly to a sump or containment area. • Install devices to prevent overflow from tanks as per A-4.3.14.4 of NFCC, preferrably reliable, independent high level alarms on tanks (i.e., audible alarm). • Interlock high-level alarms to tank feed pumps (auto shut-off). • At sites with inadequate containment areas (e.g., in terms of volume, lack of pavement) installation of 24-hour monitoring alarms (with remote) is suggested for immediate detection of tank or pipe rupture. • Install means of emergency communication (e.g., telephone, walkie talkie, etc.) manual alarm buttons (call for help) at potential major spill points.
	Backflow prevention	• Design to protect against inadvertant transfers to/from interconnected tanks.

TABLE 6.2 RECOMMENDED DESIGN FEATURES FOR CHEMICAL STORAGE AREAS (CONT'D)

Storage Format	Design Feature	Recommendation
Bulk Liquids (Cont'd) ° Creosote ° Petroleum oil ° Creosote/petroleum oil working solutions ° Contaminated surface runoff ° Drip return	**Location**	• The preferred location for oil tankage (all solutions) is in an exterior centralized tank farm area which is arranged in accordance with Subsection 4.3.2 of the NFCC.
	Security	• Provide security precautions to prevent vandalism or access to tanks by unauthorized persons (4.6.2.5 of the NFCC requires a firmly anchored fence surrounding bulk storage tanks if their aqggregate capacity exceeds 564 000 L).
	Emergency response	• Provide accessible storage for spill response equipment, absorbants and personnel protection equipment. • Install a phone and manual alarm switch near the storage area. • Provide appropriate measures for rapid, effective fire control with containment of liquid fire-fighting residues and treatment to required limits before discharge.
Drummed Wastes ° Sludges ° Contaminated debris	**Shelter/containment**	• Provide a paved curbed area for storing all drummed wastes pending removal for approved disposal (Section 8.1). • Label waste drums and contents. • Provide a covered area or tarps for drummed wastes.
Bulk Sludges	**Location/shelter**	• Locate storage in an exterior or well-ventilated location.
	Containment	• Provide closed tanks in sound condition. • Install tanks in a containment area with impermeable, cleanable floors. • Provide adequate containment capacity for the worst-event spill. • Block any drains in the containment area; Design to collect infiltrating precipitation for treatment to applicable limits prior to discharge (if contaminated).
	Handling	• Provide transfer equipment for clean, safe sludge handling with minimum worker exposure.
	Security	• Provide effective security against unauthorized access and/or release of tank contents.

TABLE 6.3 RECOMMENDED DESIGN FEATURES FOR CHEMICAL MIXING SYSTEMS

Chemical Format	Design Feature	Recommendation
Creosote Petroleum Oil	**Objectives:***	• To provide a mixing system with effective spill prevention features. • To provide a mixing system which minimizes worker contact with creosote.
	Configuration	• Use permanent, closed mixing systems (rigidly piped, tank to tank).
	Spill Prevention	• Install high-level alarms and controls to prevent mixing tank overflow.
	Spill Containment	• Provide all applicable features for "spill containment of bulk liquids" (Table 6.2).
	Drip Containment	• Provide local drip collection at all potential drip points.
	Splash Protection	• Discourage open transfer operations. If unavoidable, provide reliable splash protection.
	Emergency Response	• Provide features described in "Emergency Response" (Table 6.1).

* Separate mixing vessels may not be used (e.g., mixing generally occurs in storage/work tanks). However, these precautions apply to any mixing process in use.

TABLE 6.4 RECOMMENDED DESIGN FEATURES FOR TREATMENT PROCESS SYSTEMS: GENERAL REQUIREMENTS

Design Feature	Recommendation
Objectives:	• To minimize and contain all releases of creosote and creosote/oil solutions. • To recover and recycle releases that do occur.
Spill Containment	• Provide spill containment capability for 150% of the largest on-site bulk storage tank or cylinder (in multiple vessel containment areas) or 100% plus 150 mm additional containing wall for single vessels in isolated containment. • Locate treatment cylinders and process tanks in an area with: - continuous, structurally sound paved floors or, slabs or sections with sealed joints, - sealed surfaces for cleanability and impermeability, - reinforced dyke walls and sealed joints, - graded surfaces for ready drainage of wetted surfaces, - walkway grates (or alternative design) to minimize worker exposure and prevent tracking of chemicals from containment areas. • Engineer containment for long-term integrity (leak proof for infiltration and exfiltration). • Provide permanent, isolated drainage/transfer systems to direct all spills, washes and infiltrating water to tankage. Treat contaminated liquids to applicable limits before discharge. • Isolate control and transfer equipment to avoid damage from spilled liquids in containment areas.
Process Control Area	• Segregate the operator control area from retort and tank spill containment areas. • Locate the process control area for maximum visibility of treatment systems.
Process Emissions to Air	• Provide control equipment for any air emissions vented to the interior and any emissions subject to environmental controls. - Prevent worker exposure to vacuum pump exhausts. - Install traps on tank vents (to remove entrained liquids). - Install additional control equipment (e.g., activated carbon filters where odour problems exist) as required to comply with applicable air emission limits (see Section 8.1.4). • Assess level of workplace air contaminants. Provide ventilation in areas where excessive levels may occur.
Fire Controls	• Provide fire controls as decided on site-specific basis in consultation with the local fire department. • Provide containment for contaminated runoff waters and residues generated by firefighting activities (e.g. blockage of storm drains, adjacent ditches).
Weather Protection (winter operations)	• Protect equipment from freezing temperatures, particularly where water is or may be present (e.g., water may build up in bottom valves of oil transfer system). • Winterize process control area.

TABLE 6.5 RECOMMENDED DESIGN FEATURES FOR TREATMENT PROCESS SYSTEMS

Design Feature	Recommendation
Objectives:	• To provide fail-safe operation of the treatment system. • To minimize the potential for creosote and creosote/oil spills.
Treating Cylinder	• Treating cylinders and pressurized components must meet all pressure vessel certifications required by the provincial ministry responsible for such certification. • Install an effective protection device to prevent door openings when the cylinder is pressurized or filled with preservative. - Install independent indication/alarm/interlocks between the cylinder door and the control point (where the door is not visible from the control point). • Design to facilitate drainage of excess preservative.
Piping and Recycle Systems	• Design an overall system that is effective for containing and recycling all chemicals with minimum potential for release and dispersal and minimum infiltration of water. • Select and install piping as per Table 6.2.
Sumps	• Provide leakproof design (e.g. impermeable surfaces, sealed joints). • Provide overflow protection if sump not in containment area (e.g., install independent high-level alarms).
Process Controls	• Design for simple, unambiguous operation (regardless of the degree of automation). • Establish a clear relationship betweeen process controls and process functions in order to minimize operator error.

TABLE 6.6 RECOMMENDED DESIGN FEATURES FOR DRIP AREAS FOR FRESHLY-TREATED WOOD

Design Feature	Recommendation
Objective*:	• To minimize losses of preservative chemicals from treated wood by: - providing proper conditions for containing drips from freshly treated wood, and - controlling the generation and disposal of contaminated runoff waters.
General Design	• Integrate design requirements for: - Efficient drip and runoff collection and containment (runoff can also be minimized by sheltering) - Surface drainage and return of fluids to process with minimum dispersal from tracking by personnel and vehicles
Drip Time**	• Provide for sufficient storage area to hold all freshly-treated wood until dripping is complete.
Containment	• Immediate drip areas should be: - impermeable (i.e., concrete or other surfaces resistant to attack by oils), - curbed, - with provision for collecting and storing all runoff and infiltrating precipitation (for treatment and controlled discharge under terms of existing regulatory standards). Where storage of runoff waters would be difficult, roofing should be considered.

* A facility should operate so that after-bleeding is minimal (e.g., good conditioning, expansion bath, final vacuum).

** The nature and magnitude of drippage losses depend strongly on oil and wood types, and on process-specific factors.

TABLE 6.7 RECOMMENDED DESIGN FEATURES FOR STORAGE AREAS FOR TREATED WOOD

Design Feature	Recommendation
Objective:	To minimize and control releases of contaminated surface waters from treated wood storage areas.
Storage Areas	• Evaluate options for storage area surfaces on the basis of factors such as ground water usage, probability of bleeding and expected levels of precipitation. (Large paved areas will result in large quantities of runoff waters but paved areas may be necessary if groundwater is consumed domestically in the area and/or if a high probability of preservative bleeding from the wood exists.) • Locate unsurfaced ground storage areas away from surface waterbodies. • Routinely monitor contaminant levels in storage area runoff. Contaminant levels of concern to regulatory agencies may require collection and treatment of storm runoff waters. • Store wood as per subsection 3.2.2 of the NFCC, i.e., - "storage site shall be level, solid ground, paved or surfaced with material such as cinders, gravel or crushed stone" - "yard storage areas shall be separated from mill operations and other structures by an acceptable clear space permanently available for fire fighting operations" - "storage site shall be maintained free of combustible ground vegetation including grass and weeds for at least 4.5 m from the stored material and at least 30 m from bush or forested area" - "lumber treated with combustible liquids shall be stored in piles separated from other stored material, ...not less than 4.5 m" - "at least two fire department access routes shall be provided"

7 OPERATION

In addition to the design objectives described in Section 6, a creosote facility should develop operating procedures to protect both workers and the environment from potentially harmful exposure to creosote solutions. The operating procedures would:

a) minimize direct contact of personnel with wood preserving chemicals;
b) minimize releases of wood preserving chemicals to the environment; and
c) facilitate clear and accurate definition of responsibility for routine operations.

Recommended operating practices are presented in Tables 7.1 to 7.4 and include:

- General practices (Table 7.1)
- Procedures for handling and storing creosote (Table 7.2)
- Practices for operating process systems (Table 7.3)
- Practices for maintenance, cleanout and shutdown of preservation systems (Table 7.4)

The recommendations provided in these tables may not be the sole options available to attain the objectives. Alternative approaches may be equally effective or more suitable in view of site-specific conditions. When programs are developed for a particular facility, the recommendations may be modified if it can be demonstrated that an alternative approach, more suitable to plant specific conditions, would be equally effective in attaining the desired objective.

Consistent with the stated intent of this document, it is recommended that all existing and new wood preservation facilities meet the specific objectives outlined within Tables 7.1 to 7.4 by implementating the recommended practices or their equivalents. Detailed operating procedures for each facility should be incorporated into a written operations manual that is available to all personnel who may have contact with creosote and/or responsibilities for any decisions involving the management and use of creosote. Responsibility and accountability for implementing procedures should be clearly assigned to supervisory personnel and to workers.

TABLE 7.1 RECOMMENDED GENERAL PRACTICES FOR OPERATING CREOSOTE TREATMENT FACILITIES

Operation	Recommendation
Personnel	**Objective:** To enhance worker protection by providing education and medical surveillance.
	• Train all foremen, on-scene supervisors, operators, and handlers in good work practices.
	• Provide pre-employment medical check-up and annual on-going medical surveillance (see Section 4).
	• Provide periodic review and update of education and training.
Procedures	**Objective:** To assure that worker responsibilities are well understood, and that site-specific procedures are available in hardcopy for reference.
	• Prepare (and have readily available) explicit written instructions for all aspects of chemical use, facility operation, maintenance and emergency response.
	• Identify and communicate precautions for all other on-site handlers of treated wood (including quality control personnel, sorters, and transporters).
Signing	**Objective:** To assure clear and accurate signing in all wood preservation use areas.
	• Identify the contents of all tanks (e.g., "creosote tank", "creosote/petroleum oil work solution").
	• Identify the function of each tank (e.g., "storage tank", "mix tank").
	• Prominently display personnel safety precautions and first aid procedures.
	• Prominently display emergency response procedures.
	• Prominently display emergency telephone numbers for medical aid, facility management, local environmental control agencies.
Personal Hygiene and Safety Precautions	• Follow precautions outlined in Section 4 (Table 4.2).
Housekeeping	**Objective:** To maintain a clean, orderly site.
	• Define and practice regular housekeeping standards (suggest daily), - contain all contaminated debris, and - minimize generation of waste.
	• Visually inspect for, record and report leaks at least daily as per subsection 4.4.11.8 of the National Fire Code of Canada (NFCC).
	• Contain and repair all leaks.
Spill Response	**Objective:** To maintain a state of readiness in case of a chemical spill.
	• Develop a spill contingency plan with consideration of NFCC Subsections 4.1.6, 4.1.9 and 4.4.11, and in consultation with regulatory agency and local municipality and authority.

TABLE 7.1 RECOMMENDED GENERAL PRACTICES FOR OPERATING CREOSOTE TREATMENT FACILITIES (CONT'D)

Operation	Recommendation
Record Keeping	**Objectives:** • To provide a secondary level of control for chemical losses. • To enable a rapid assessment of potential hazards, in the event of a catastrophic incident (e.g., tank rupture, fire, etc.).
	• Maintain accurate daily records for: - chemical delivery, use and inventory, and - equipment condition and maintenance. • Record and compare bulk tank volumes before and after facility shutdowns in excess of two days (NFCC Subsection 4.3.17 requires weekly measurements and gain or loss computation records for 2 years for examination by jurisdictional authority). - If changes in volume are apparent, check for tank leaks and/or irregular practices. • It is a practice at some facilities to compare actual versus estimated chemical retention by wood. (If actual greatly exceeds estimated quantities, efforts are made to determine if leaks or poor operating practices exist.)
Fire Fighting	**Objective:** To maintain a state of readiness in case of fire emergency.
	• Establish a fire contingency plan (Section 10) as required in Subsection 4.1.5.7 of the NFCC and undertake all necessary action to maintain a state of readiness to implement the plan in case of emergency (provide ready access to appropriate fire-response equipment (e.g., foam extinguishing capability), carry out routine checks of the proper functioning of firefighting equipment, and undertake drills with all affected personnel). • Liaise with the local fire department, with regard to chemicals in storage and use, and emergency procedures. • When a fire alarm call is made, notify firefighters of chemical quantities in stock and verify storage locations. • Require self-contained breathing apparatus for all personnel exposed to smoke (only trained fire-fighting personnel should be allowed at the fire scene). • Make advance preparation to contain and properly dispose of contaminated fire residues. - Fire sites should be assessed for the presence of toxic residues before undertaking cleanup activities. This assessment should consider both environmental safety and worker protection. - Runoff water from fires in creosote storage areas are presumed to be contaminated and should be contained. - Dispose of firefighting waters as "contaminated runoff" (Table 8.1). - Dispose of non-salvageable solid, treated wood fire residues as "contaminated solid wastes" (Table 8.1).

TABLE 7.2 RECOMMENDED OPERATING PRACTICES FOR CHEMICAL HANDLING AND STORAGE

Operation	Recommendation
Unloading Chemicals • Creosote • Petroleum Oil	**Objective:** To assure that unloading of treatment chemicals occurs in a safe manner (as per Section 4 of the National Fire Code of Canada (NFCC)). • Assure that the delivery of preservation chemicals is undertaken by personnel who are trained in emergency response procedures (as required by Federal Transport of Dangerous Goods Regulations (TDGR). • Assure that personnel engaged in transfer of petroleum oil and creosote are trained as per Subsection 4.4.11 of the NFCC, i.e., emergency procedures, constant attendance during unloading, operation of fire protection equipment and emergency shutoff valves. • Consult with Section 4 of the NFCC regarding transfer operations of combustible materials via different modes of transport, e.g., rail, truck, ship unloading procedures, grounding, etc. • Assure that ready access to emergency advice and aid is available during all chemical unloading periods, i.e. train employees in standard procedures for normal operations as well as for emergencies and post procedures in printed form for reference (4.4.11 of NFCC and Section 9.7 of the TDGR). • Restrict access to the unloading area during chemical transfer operations.
Handling of Wood Preservation Solutions	**Objective:** To assure worker safety during handling of creosote solutions. • Follow the personnel safety precautions for all procedures (Table 4.2). • Avoid inhalation, ingestion and skin or eye contact with creosote solutions.
Storage of Wood Preservation Chemicals • Creosote • Petroleum Oil	**Objective:** To assure that all creosote solutions are safely stored. • Assign responsibility for storage areas to trained personnel. • Label storage areas and tanks with the identity of contents by chemical name, type of solution, and concentration (e.g., creosote, creosote/oil work solutions). • Place chemical identity placards, fire or spill emergency response procedures, personnel safety precautions and first aid procedures at storage room entrances and/or at storage areas. • Implement visual inspection routine at least once each shift for prompt detection of abnormal conditions (as per NFCC 4.4.11.7). • Frequently inspect and test all safety shutoff valves and other fire safety devices (as per NFCC 4.4.11.9). • Check and maintain the integrity of storage tanks and storage containers. - Clean up all leaks or spills and implement remedial actions (suggest immediately). - Check liquid levels in storage tanks weekly. Compare measurements with meter readings. Compute gains or losses of liquid, as per NFCC 4.3.17.

TABLE 7.3 RECOMMENDED OPERATING PRACTICES FOR PROCESS SYSTEMS

Operation	Recommendation
Pre-charging Checks	**Objectives:** • To define procedural practices to enhance environmental protection and worker safety. • To operate the facility in compliance with the National Fire Code of Canada (NFCC).
Worker Safety	• Follow all precautions listed in Table 4.2.
Work Solutions	• Regularly check and record quantities of treating solution in storage as per NFCC 4.3.17.
All Process Components	• Visually check the complete system for leaks as per NFCC 4.4.11.7. - Take immediate action to stop leaks. • Check sludge levels in retorts. - Clean out as required, in accordance with facility policy. - Observe personnel safety precautions (See Table 4.2).
Tank Vents	• Inspect tank vents regularly for blockage (suggest once/month).
Charges	• Secure loads to avoid uncontrolled floating. • Stack loads to allow good drainage of preservative from all wood surfaces after treatment.
Treating Cylinder	• Check door seals for damage. - Replace door seals at regular intervals or as required if damaged. • Check cylinder doors for proper seal after loading charges. - Ensure that all bolts on doors are securely fastened or that the hydraulic collar has moved to its regular endpoint.
Trams	• Use tram design which will facilitate drippage during "drain" step in the pressure cylinder. • Clean soil and debris from trams to prevent contamination of the preservative. • Thoroughly clean trams before different preservative treatments are used.
Checks During Treating	**Objective:** To monitor the treatment system for quick identification of potential/ actual problems.
System Integrity	• Closely monitor process systems for leaks during initial stages of treatment. • Check for leaks or abnormal conditions throughout pressurized systems at least once per shift or once per charge (whichever is most frequent), (as per NFCC 4.4.11.7 and 4.4.11.8). • Compare instrument readings with indicating gauges and thermometers. • Note malfunctions of recording devices, thermometers, gauges (including level floats) and arrange for prompt repairs. • Carefully observe pressures during treatment to make certain that maximum limits are not exceeded (maintain records of treatment cycles, tank gauge readings and chemical consumption). • Provide written instructions for operator responses to abnormal events (e.g., response to equipment breakdown).

TABLE 7.3 RECOMMENDED OPERATING PRACTICES FOR PROCESS SYSTEMS (CONT'D)

Operation	Recommendation
Post-treating Checks	**Objective:** To prevent worker contact with treatment solution and with freshly charged loads.
Retort Opening	• Ensure that retorts cannot be opened when liquid and/or pressure remains. • Avoid preservative mists. If airborne concentrations are unknown or, at or above TLV's, wear an approved respirator. • Wear goggles during retort door openings.
Charge Removal	• Wear impermeable gauntlets during handling of freshly treated charges. • Pull charges only when the superficial excess preservative has sufficiently drained. • Avoid exposure to vapours by working upwind of charge and/or by wearing an approved respirator.
Load Jams	• Follow standard regulatory safety procedures for tank entry. • Do not enter retorts until purged with fresh air (until the retort is cooled). - If retort airborne coal tar pitch volatiles levels exceed regulatory TLV values or if airborne levels are not known, then the attendant must wear a self-contained full-face respirator mask, impermeable coveralls, boots and gauntlets. - If airborne coal tar pitch volatiles are less than regulatory TLV limits, wear NIOSH-approved respirator, impermeable coverall, boots and gauntlets. • Assure presence and constant communication with a standby attendant. • Shower immediately after tank entry.

TABLE 7.4 RECOMMENDED OPERATING PRACTICES FOR MAINTENANCE, CLEANOUT AND SHUTDOWN OF TREATMENT SYSTEMS

Operation	Recommendation
Equipment Maintenance	**Objective:** To assure that equipment is maintained in a manner which will minimize releases of creosote and minimize worker exposure to creosote.
	• Maintain all equipment in good operating condition. • Prepare explicit written maintenance procedures with assigned responsibility and accountability. • Follow all personnel safety precautions during maintenance procedures (Table 4.2). • Drain and/or clean wood preservation chemicals from equipment prior to maintenance (e.g., steam clean). - If applicable, dispose of steam cleaning waters as contaminated liquids. • Comply with NFCC 4.4.11 recommendations for maintenance. • Carry out welding and cutting operations in accordance with section 5.17 of the NFCC. - Thoroughly clean surfaces to be welded (residues and components of creosote are flammable) - Wear an approved respirator when welding surfaces which have contacted creosote - Provide good ventilation in the work area - Contain all sparks and remove flammable materials from the vicinity of the repair area
Cleanout	**Objectives:** • To prevent accumulation of creosote solutions and sludges within the treatment system • To assure worker safety during clean out operations
	• Observe personnel safety precautions during all procedures (Table 4.2). • Clean or scrape drip pads at regular intervals to prevent accumulation of creosote residues. Cleanout frequency should be determined by site-specific factors including the probability of worker exposure, vehicle traffic, and washdown by rain. - If possible, recover and reuse drainage from drip pads (or provide appropriate disposal). - Provide appropriate treatment for wash waters (if applicable). • Routinely inspect sludge levels in storage tanks and clean out if required. Determine and specify sludge levels requiring removal. - During cleanup, inspect gauge floats or similar equipment within tanks. • Routinely inspect treating cylinders for sludge accumulation and clean out if required. - Purge cylinders with fresh air sufficiently to permit entry. - If airborne concentrations of pollutants are unknown, at, or above TLV's, wear approved respirators and impermeable gloves, boots, and coveralls. - Provide a constant standby attendant and continuous outside communication. - Follow standard safety procedures for entry of confined spaces. - Prevent skin contact with sludges. - Remove sludges with equipment used only for cleanut purposes. - Collect, drain, and store contaminated material in sealed drums pending disposal (Table 8.1). - The attendant should shower immediately after cleaning retorts or tanks.
Alarms	• Test all alarms and safety devices at regular intervals (or as specified by the manufacturer).

TABLE 7.4 RECOMMENDED OPERATING PRACTICES FOR MAINTENANCE, CLEANOUT AND SHUTDOWN OF TREATMENT SYSTEMS (CONT'D)

Operation	Recommendation
Long-term Shutdown	**Objective:** To assure orderly shutdown prior to long-term closure.
	• Thoroughly drain and clean all equipment which has been in contact with preservatives. • Where applicable, collect all solvents and wash-waters generated by cleanup operations (e.g., steam cleaning) (Table 8.1). • Hold solutions in closed tanks for prolonged shutdown. - Drain all open tanks or sumps to closed storage tanks. - Provide adequate freezing protection for all piping and vessels containing or potentially containing water (as applicable; e.g., assure that condensed or trapped water cannot freeze and rupture piping). • In case of permanent shutdown, reuse of treatment solutions at another facility is preferred to disposal.

8 PROCESS EMISSIONS

8.1 Control, Treatment and Disposal

The creosote pressure treatment process generates liquid and solid wastes, and emissions to air. Numerous approaches are used or can be used by the industry to control, treat and/or dispose of the process wastes and emissions. Potential sources of chemical releases from creosote pressure treatment facilities were described in Section 2.2 and Figure 2.3. Table 8.1 identifies the main categories of process wastes or emissions that can be generated at creosote facilities, and summarizes recommended control, treatment and/or disposal methods.

8.1.1 Waste Liquids Containing Creosote

Liquid Process Wastes. Leaks and drips of oil solutions are contained and reused in the treatment process. Liquids such as condensates, wash waters and infiltrating waters, which cannot be reused, are treated to remove creosote and petroleum oil prior to discharge (1,2,3). The treatment techniques include one or a combination of:

- oil/water API separation,
- gravity separation in settling tanks,
- activated sludge treatment,
- activated carbon treatment,
- physical-chemical treatment (e.g., flocculation), and/or
- evaporation.

A regulatory discharge permit must be obtained for disposal of the treated wastewaters.

Contaminated Storm Runoff. Because creosote wood preservation facility sites are generally large, considerable volumes of storm runoff occur from these sites. Precautions should be taken to avoid contamination of storm runoff water, particularly in the vicinity of creosote storage sites, and charging and treatment areas. It is common practice in the industry to roof the process areas, including the pressure cylinder and associated equipment, and this practice reduces contaminated storm runoff. Charging areas are often paved, with provisions for collection of surface runoff. A possibility of creosote-contaminated runoff from treated wood storage areas must be acknowledged and surface runoff from the storage areas should be monitored for creosote and oil. If contamination is evident, and if the runoff is directed to a waterbody or a storm sewer, the need for control of the discharge will have to be determined in consultation with the appropriate regulatory agency.

TABLE 8.1 RECOMMENDED DISPOSAL PRACTICES FOR CREOSOTE-CONTAMINATED WASTES

Waste Category	Examples	Recommendation
Liquid Creosote or Creosote/Oil Solutions	• Preservative work solutions • Material skimmed from oil separators	• Collect and reuse. (standard practice at creosote/oil plants)
	• Drips from freshly-treated lumber	• Recover and reuse. (successfully demonstrated at some oil-borne plants)
Liquid Creosote-Water Solutions	• Condensates • Wash waters • Infiltrating waters	• Treat to remove oil and creosote to within regulatory limits • Reuse retrieved oil and creosote, e.g., from gravity separation • Dispose of treated waters as per regulatory requirements
Contaminated Solid Wastes	• Debris and bottom sludge from storage tanks, sumps and pressure cylinders • Soils contaminated by spills • Clean-up absorbents • Sludges from wastewater treatment processes	• Drain and/or drum, store and dispose in accordance with provincial regulatory requirements (high-temperature thermal destruction appears to be the most feasible disposal option).
Miscellaneous Solid Wastes	• Scraps, cuttings and shavings from creosote-treated lumber	• Dispose of in sanitary landfills. (subject to approval by the provincial regulatory agency)
Contaminated Storm Runoff	• Any storm runoff or contaminated liquid discharge which is determined to be toxic to fish at the point of discharge (toxicity is determined by bioassay tests of specific discharges)	• Prevent or minimize contamination of storm runoff to the greatest possible extent. • Monitor surface water discharges (in consultation with the provincial regulatory agency) to assess contaminant concentrations and to determine the need for control.
Fire-fighting Water Runoff	• As above (contaminated storm runoff)	• Consider containment provisions in areas where creosote and creosote-oil solutions are present. • Consult with the provincial regulatory agency to determine acceptable disposal practices.

Control Requirements. Control specifications will depend upon factors such as the volume and frequency of the discharge and the sensitivity of the receiving environment. Appendix A reviews existing Canadian regulatory limits which would be applicable to discharges of creosote and petroleum based oils. The discharge of creosote-contaminated emissions into waters inhabited by fish is subject to the provisions of Section 33(2) of the Federal Fisheries Act. Because of the differences in bioassay results for creosote, as noted in Table 3.4, and due to the varying composition of creosote, it is suggested that regulatory limits be defined on a site-specific basis.

8.1.2 Solids With Potentially High Creosote Concentrations. For the purposes of this document, solids with "potentially high levels of creosote" are defined as:

- sludges from sumps, work solution tanks and pressure cylinders;
- sludges from wastewater treatment processes (e.g., flocculated material); and,
- "spent" activated carbon.

Activated carbon contaminated with creosote can be regenerated and should not be considered a "waste".

While awaiting disposal the contaminated solids should be stored in leakproof containers in a specially designed area which is curbed and lined with impermeable material. The area should be roofed or covered by a plastic leakproof tarpaulin to protect the wastes from precipitation. Any seepage or leachate generated at the site should be contained.

The wood preservation industry in Canada has the following options for handling and disposal of creosote-contaminated solids:

- on-site storage until hazardous waste disposal facilities have been constructed and are operating in Canada;
- shipment to the United States where, until August 1988, land disposal of creosote-contaminated wastes is allowed (high temperature incineration of such wastes subsequently will be required (61)); or
- incineration of the wastes following approval by the appropriate provincial regulatory agency.

At the moment, incineration of creosote-contaminanted wastes has not been reviewed by Environment Canada to determine whether guidelines are required.

8.1.3 Miscellaneous Solid Wastes. Miscellaneous solid wastes (creosote-treated wood and containers used to store creosote) from creosote wood preservation plants may be disposed of at sanitary landfills designated by the provincial regulatory agency. Containers must be steam-cleaned prior to disposal.

8.1.4 Air Emissions. Air emissions at creosote pressure treatment facilities are generally localized; effects, if any, would be restricted to workers at the facilities. Such emissions include:

- vapours from tank vents,
- vapours from opening of retort cylinder doors,
- vapours from freshly treated charges, and
- vapours from vacuum system outlets.

Analyses of air emissions from creosote facilities indicate that the components are mostly low molecular weight organic compounds (23).

Design and procedural recommendations for control of localized emissions are suggested in Sections 6 and 7. Two potential sources of air emissions at the facilities could result in more widespread dispersal of contaminants:

- Evaporation units used for wastewater disposal - Although evaporation as a wastewater disposal technique is decreasing in Canada, its continued use implies the need for proper assessment of emissions associated with the practice (1,2,3). Efforts to evaluate evaporation tank emissions from creosote facilities are limited to qualitative data (10).
- Open burning of contaminated solids - If this still occurs, the practice should be stopped.

8.2 Emission and Site Monitoring

Site monitoring and assessment is required at creosote facilities to verify that the wood preservative chemical is being properly managed (in accordance with the design and operating objectives described in this document). Archiving of the assessment records will also provide an orderly evaluation of site decommissioning activities if plant shut-down occurs.

Environmental monitoring for creosote facilities would normally be developed in consultation with the appropriate provincial environmental regulatory agency. Additional consultation would be required with Environment Canada if the facilities have

a potential to affect federally managed resources (e.g., facilities located on or adjacent to Indian lands, or facilities located adjacent to waters used by anadromous fish such as salmon). Worker health monitoring requirements would be developed in consultation with a Provincial Workers' Compensation Board and/or Department of Labour.

The level of detail and scope of these monitoring activities depends on site characteristics, facility design, and the requirements of the regulatory agencies. Tables 8.2 and 8.3 suggest components of a site environmental and worker health monitoring program.

Analytical methodologies proposed for use must be approved by the regulatory agencies. Constituents (analytes) to be identified and quantified should include some indicators of petroleum oil contamination, e.g., oil and grease analyses using methods 503 B or 503 E in Standard Methods (62) and selected components of creosote. Components of creosote selected by other investigators for monitoring have included: naphthalene and, 1-methyl and 2-methyl naphthalene (17); 2,4-dimethyl phenol and 3,5-dimethyl phenol (16); and phenol (11). Fluorescence spectroscopy (63) has been successfully used for field assessment of creosote in soils and waters (64). All analytical data requires documentation which will: 1) trace the sample from the field to the final results, 2) describe the methodology used, 3) describe the confirmatory evidence, 4) support statements about detectability, 5) describe the quality assurance program and demonstrate adherence to it, and 6) support confidence statements for the data (65).

TABLE 8.2 SUGGESTED ROUTINE ENVIRONMENTAL MONITORING

Item	Recommendation
Authority/Reporting	• Develop a site-specific monitoring plan in consultation with the appropriate regulatory agency. • Define reporting requirements. • Re-evaluate the plan if the facility expands or changes design or operating practices.
Soils	• Consider implementing a soil monitoring program (with emphasis on unsurfaced grounds) including: - all areas where preservative chemical is routinely stored, processed or handled, - all freshly-treated lumber storage areas, - all treated wood storage areas, - drainage ditches or areas exposed to surface runoff (including overflow from drip pads and paved areas). • Define sampling frequency (e.g., annual), sample type (e.g., surface, core), and required analyses (e.g., constituents, detection levels, quality control) in consultation with the regulatory agency.
Surface Waters	• Consider implementing a monitoring program for adjacent water bodies. - Define monitoring frequencies and required analyses (e.g., constituents, detection level, quality control) in consultation with the regulatory agency. - Define concentrations of concern.
Groundwaters	• Consider implementing a groundwater monitoring program using permanent monitoring points down-gradient of unpaved process areas and treated lumber storage areas. - Define well construction. - Define sampling frequencies and required analyses (e.g., constituents, detection levels, quality control). • Give special attention to on-site wells used for drinking water.
Air Emissions	• Identify air emission sources by use of data provided in workplace exposure study (Table 8.3), and include areas in the vicinity of: - freshly drawn charges, - vacuum pump discharge pipes, - retort door on opening, - tank vents, and - wastewater evaporation tank emissions. • Monitor air emission as required by local air emission permits.
Liquid Waste Streams	• Identify liquid waste discharges (including stormwater runoff) and determine: - concentrations of selected indicators of creosote and/or petroleum oil, and - estimated total mass rates of emissions. • Monitor as required for all discharges governed by permits.
Solid Wastes, Sludges	• Maintain current, complete records for all solid wastes stored on-site (pending disposal). • Undertake all reporting and disposal activities required by applicable regulations.

TABLE 8.3 SUGGESTED ROUTINE WORKPLACE MONITORING

Item	Recommendation
Authority/Reporting	• Develop a facility-specific plan in consultation with the regional Workers' Compensation Board office. • Define reporting requirements.
Contact Exposure	• Identify existing and potential sources of skin exposure by periodic walk-through inspections.
Inhalation Exposure	• In consultation with the regulatory agency responsible for worker safety, define the design of an initial monitoring program (e.g. sampling techniques, frequency of sampling, etc.). • For the purpose of defining worker health protection measures, provide an initial evaluation of peak and average levels of indicators of creosote and/or petroleum oil in air at significant points of worker exposure including: - retort doors (openings), - receiving areas for all vents/exhausts which discharge to areas frequented by personnel (including interior spaces receiving drift from exterior emission sources), - all enclosed preservative process areas, and - areas adjacent to freshly-treated wood storage. • Make personnel samplers available for spot monitoring (as required) if high emission levels are suspected.
Biological Monitoring	• Conduct initial screening physical exams to identify sensitive individuals (Section 4). • In consultation with the regulatory agency, define a schedule for medical exams for symptoms of exposure to preservative constituents.

9 TRANSPORTATION OF CREOSOTE SOLUTIONS AND WASTES

The transportation of creosote and creosote wastes generated in wastewater treatment processes is regulated under the Federal Transportation of Dangerous Goods Regulations (TDGR). However, the TDGR do not apply to the transportation of lumber and forestry products treated with preservatives (66).

Creosote is listed in the TDG regulations and is cross-referenced to wood preservatives, which are classified as flammable liquids (Class 3, Divisions 2 and 3). Proposed Schedule 8 of the TDGR is intended to regulate flammable liquids with a flash point of up to 61°C. Schedule 8 also proposes to cross reference creosote to poisonous liquids not otherwise specified (currently classified as Division 6.1), and to update the classification to include a subsidiary classification to reflect U.S. regulations. Users should refer to the TDGR (67), and the guides prepared by Environment Canada for classification and manifest (68).

Regulatory requirements for shipping, documentation, placarding and personnel training were published on February 6, 1985, in Part II of the Canada Gazette (67). Table 9.1 provides a brief overview of the regulatory aspects of shipment of dangerous goods. The regulations themselves must be consulted to ensure that all conditions of transport have been addressed. The regulation of intra-provincial movement of dangerous goods by road is a provincial responsibility.

Table 9.2 suggests more specific transportation procedures for creosote which are based on good operating practice and which complement the 1985 TDGR. It is the intent of these control measures to minimize the potential for accidental release in transit and to provide an effective mechanism for safely managing spills if they do occur.

TABLE 9.1 TRANSPORT OF DANGEROUS GOODS REGULATIONS APPLICABLE TO CREOSOTE

TDGA Reference*	Subject	Brief Description
4.4, 4.8	**Shipping Documentation**	Shipping document to indicate (inpart): primary classification number; special instructions for safe handling, transportation, and storage; 24-hour telephone number for information concerning damaged or defective containers; placard requirements.
4.9	**Identification of Active Constituents**	Where dangerous goods are a systemic poison, the technical name of the active constituents shall be included.
4.15 - 4.18	**Shipments of Wastes**	A manifest is required for the shipment of more than 5 kg of solid wastes or more than 5 L of liquid wastes.
4.19	**Empty Containers/Vessels**	Cleaning and purifying of residues from containers and vessels is required until "no hazard exists", containers and vessels to be signed as "empty - last contained creosote".
4.22	**Rail Transport**	Railway crews to be notified of the position within the train of vehicles containing dangerous goods.
4.23	**Location of Documentation during transport**	Documents to be in cab door of truck.
4.24. - 4.26	**Delivery of Dangerous Goods**	Provision of consignee with documentation.
4.27	**Retention of documentation**	Document to be retained for two years.
5.2	**U.S. - Canada shipments**	Compliance with all aspects of the TDGA is required.
5.5 - 5.15	**Labels**	Label requirements are specified.
5.16 - 5.3	**Placards**	Placard requirements are specified.
7.4	**Incompatibility**	Shipment with incompatible goods is not allowed.
7.14	**Transborder consignment of wastes**	Imports and exports require notice in writing to the Director General, Transport Canada TDGD.
9.2 - 9.3	**Personnel Training**	Handling, transport only by trained personnel.
9.8	**Registration**	Each importer of dangerous goods must register with the Director General, Transport Canada TDGD.
9.13 - 9.14	**Dangerous Occurrence Reporting**	Dangerous occurrences (e.g. spills) involving more than 5 kg or 5 L of specified solids, solutions or wastes must be reported immediately (see Appendix for reporting authority).

* Transport of Dangerous Goods Act Section No. (6 February, 1985).

TABLE 9.2 RECOMMENDED TRANSPORTATION PRACTICES FOR CREOSOTE-CONTAINING SOLUTIONS OR WASTES

Feature	Recommendation
Container Specifications	• Container for transporting creosote must be: - free of mechanical defects; and - filled and closed in the manner prescribed for Wood Preservatives by the "Regulations for the Transportation of Dangerous Commodities by Rail", 1986, as amended, published by the Canadian Transport Commission.
Container Labelling	• Comply with Transportation of Dangerous Goods Act label requirements. • Affix the proper labels to each container. • Label each container on at least two sides.
Vehicle Placarding	• Affix the proper placards to vehicles carrying 500 kg or more of any material (solutions or wastes) containing creosote.
Securing Vehicle Loads (i.e., drummed wastes)	• Strap drums vertically to pallets. • Strap drums horizontally to each other. • Brace or tie down loads to prevent shifting (do not rely on the vehicle floor or sides to prevent shifting). • Ensure a stable load consistent with the vehicle floor strength. • Secure other load items to prevent drum punctures.
Responsibilities of Truck Driver, Ship Captain or Railroad Crew	• Know the nature of the load. • Carry suitable emergency equipment and be trained in its proper use. • Know and follow correct procedures for the reporting of accidents or spills. - Immediately telephone the 24-hour contact identified in the shipping manifest. - If more than 5 kilograms is spilled, also telephone the emergency contact identified in the Appendix. - Know and comply with any other requirements of the shipper/manufacturer. • Immediately replace lost or damaged placards or labels (carry spares). • Notify the receiver of goods that creosote materials are in transit. (Note: Some provinces allow only licensed carriers to transport hazardous wastes).
Loading Procedures	• Ensure that personnel have the means and ability to transfer bulk materials safely. • Assure that all procedures involving transfer of creosote and petroleum oil solutions are in accordance with Section 4.11 of the National Fire Code of Canada. • Set vehicle handbrakes securely and place wheel blocks prior to unloading. • Require the presence of a person who knows the hazards of creosote and who is trained and prepared to respond to spills and other emergencies. • If leakage or spillage occurs, decontaminate the vehicle prior to returning it to service. • Dispose of absorbants and spill cleanup materials as per Table 8.1.
Manifest Requirements	• Transport of Dangerous Goods Regulations require a manifest. See Table 9.1 and the 06 February 1985 Canada Gazette for specific details.

10 SPILL AND FIRE CONTINGENCY PLANNING

It is recommended that facilities using creosote prepare a detailed contingency plan to ensure that response to spills and fires is safe and effective. Although details of a contingency plan would be facility-specific, the following sections outline the provisions that should be found in a typical spill contingency plan. It is recommended that the individual facility plan be filed with the authority having jurisdiction and/or municipality.

10.1 Spill Contingency Planning

10.1.1 General Requirements. A contingency plan should:

1. Have policy, purpose and organizational structure.
2. Be geared to the most probable spill size.
3. Address the following phases of spill response:
   - discovery and notification;
   - evaluation and initiation of action;
   - containment and countermeasures;
   - cleanup, mitigation and disposal;
   - documentation and cost accounting.
4. Clearly assign duties and roles to responsible personnel and organizations.
5. Outline equipment requirements for spill control.
6. Include procedures for updating the plan on a scheduled basis.
7. Outline training requirements for plant personnel in prevention and response.
8. Co-ordinate with other chemical spill prevention plans and procedures if appropriate.
9. Be submitted to chemical suppliers and the cleanup consultant or contractor for review.
10. Subsequently be submitted to appropriate government agencies including the local fire department for review.

10.1.2 Implementation Capability. A contingency plan should:

1. Describe location, capability and limitations of cleanup and containment equipment.
2. Pre-arrange for use of the best available cleanup and containment equipment.
3. Identify detailed response options and strategies.

4. Provide for training programs and regular practice sessions.
5. Identify communication requirements with police, fire departments and regulatory agencies.
6. Describe how communications will be maintained among all parties during response operations.
7. Describe steps to be taken as a routine precaution against spills.
8. Address human safety issues.
9. Assign selected personnel to respond to public and media calls.
10. Provide for sampling and data collection of runoff waters.

10.1.3 Environmental Protection and Other Liability Risks. A contingency plan should:

1. Identify high-risk areas and operations.
2. Discuss expected chemical and physical behaviour of spill materials.
3. Identify and priorize sensitive environments for protection.
4. Detail specific actions planned for minimizing damage to resources.
5. Define explicit standards for the components of and extent of effective cleanup.
6. Include provisions for responding to spills under all anticipated weather conditions.
7. Pre-arrange all response capability needed for the estimated worst-case spill.

10.1.4 Examples of Action Steps. Safety of people is a prime concern. If a spill of occurs:

1. Stop the flow of creosote or any liquids containing creosote
    - use common sense;
    - act quickly;
    - shut off pumps, close valves, etc. if can be done without risk; and
    - if applicable, shut down mechanical production systems first (for example, lumber movement) to prevent injury.
2. Warn people in the immediate vicinity
    - do not allow unauthorized personnel to enter the area;
    - provide proper protective equipment for on-site personnel; and
    - avoid any contact with skin, eyes, clothing or shoes.
3. Contain the spill
    - act promptly;

- block off drains, culverts and ditches;
- surround spilled material with earth, peat, straw, sand, booms, or commercial sorbents; and
- use liquid recovery type vacuum cleaner (or use of empty cylinder and vacuum pump) for recovery of pools.

4. Obtain required assistance from

   - company personnel (advise at earliest opportunity);
   - chemical suppliers; and
   - fire/police/public works/highways department/contractors (as required).

5. Notify applicable government agencies

   - prompt notification is especially important for spills which have entered or may enter receiving waters;
   - spills to marine waters require contact with Environment Canada;
   - spills to water bodies with anadromous fish, or spills on or adjacent to Indian lands require contact with Environment Canada and provincial emergency program office; and
   - for all other spills, contact provincial emergency program office.

6. Commence recovery, cleanup, restoration action

   - recover pools using vacuum systems and contain recovered liquid for re-use;
   - use an inert absorbent to complete clean-up; and
   - carry out clean-up and disposal in consultation with provincial and federal regulatory personnel.

10.2 Fire Contingency Planning

Creosote is a flammable liquid. An irritating heavy black smoke forms with a creosote fire. Although water is ineffective as an extinquisher, it should be used to cool fire-exposed containers. Proper fire extinguishing agents are dry chemical, foam or carbon dioxide.

10.2.1 General Requirements. A fire contingency plan should:

1. Be prepared in consultation with local fire authorities.
2. Describe policy, purpose and organizational structure.

3. Assure that creosote and petroleum oil are stored as per the National Fire Code of Canada.
4. Be geared to the most probably affected area.
5. Address the following phases of fire response:
    - discovery and notification;
    - evaluation and initiation of action;
    - clean-up, mitigation and disposal; and
    - documentation.
5. Clearly assign duties and roles to responsible personnel and organizations.
6. Include procedures for updating the plan on a scheduled basis.
7. Co-ordinate with other fire prevention plans and programs as appropriate.
8. Be submitted to local fire department for review.

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

1. Water only is used to cool fire-exposed containers.
2. Foam, dry chemical or carbon dioxide is used for oil fires.
3. Fire-fighters are protected from smoke emissions by use of respirators.
4. An evacuation plan is prepared for populations with potential exposure to smoke plume.
5. Contaminated runoff waters are contained.
6. The provincial emergency program is notified if runoff waters could have entered receiving waters.

REFERENCES

1. Henning, F.A. and D.E. Konasewich. Characterization and the Assessment of Wood Preservation Facilities in British Columbia. Environmental Protection Service, Environment Canada, Pacific and Yukon Region, West Vancouver, British Columbia, 1984.

2. Henning, F.A. and D.E. Konasewich. Description and Assessment of Four Eastern Canadian Wood Preservation Facilities. Environmental Protection Service, Environment Canada, Ottawa, Ontario, 1984.

3. Henning, F.A. and D.E. Konasewich. Overview Assessment of Selected Canadian Wood Preservation Facilities. Environmental Protection Service, Environment Canada, Ottawa, Ontario, 1984.

4. Wallis-Taylor, A.J. The Preservation of Wood. William Rider and Son Ltd., London, England, 1925.

5. Broese van Groenov, H., H.W.L. Rischen, and J. van der Berge. Wood Preservation During the Past 50 Years. A.W. Sijthoff's Vitgeversmaatschappij, Leiden, Holland, 1951.

6. Hunt, G.M., and G.A. Garratt. Wood Preservation. McGraw Hill Book Co., N.Y., N.Y., 1967.

7. Wilkinson, J.G. Industrial Timber Preservation. Associated Business Press. London, England, 1981.

8. Hartford, W.H. Letter to the Editor. Chemical and Engineering News, Vol. 61 (31), August 01, 1983. American Chemical Society, Washington, D.C, 1983.

9. Canadian Standards Association. Wood Preservation CSA Standard 080M-1983. Canadian Standards Association, Rexdale, Ontario, 1983.

10. Environment Canada, Environmental Protection Service-Ontario. Emission survey of evaporation tank-January 20, 1982. Manuscript report by EPS Ontario Region, Toronto Ontario, 1985.

11. Konasewich, D.E. and G. Gough. Spill Incidents and Consequences at Kopper's facility. Presentation at an EPS Chemical Management Workshop on "Control of Chemical Releases from Wood Treating Facilities". Sponsored by Envirochem Services and Environment Canada. Held in Burnaby, British Columbia, March 27-28, 1985.

12. Thompson, G.E., H. Husain, J. Parry and P.J. Gilbride. Hydrogeological control and cleanup of soil and groundwater contaminants at Northern Wood Preservers Ltd. Presented at: Ontario Industrial Waste Conference, Toronto, Ontario, June 18-21, 1978.

13. The Clean Environment Commission. Report on the review of the plan for the rehabilitation of the site of the Domtar Inc. former wood preserving plant, Transcona, Manitoba. The Clean Environment Commission, Winnipeg, Manitoba, 1984.

14. Berard, M.F. and T. Tseng. Survey of Northern Wood Preservers Inc., Thunder Bay, Ontario, October 1984. Conservation and Protection, Environment Canada, Toronto, Ontario, 1986.

15. Michel, J., D.D. Domeracki and W.J. Sexton. Site evaluation methodology and results, American Creosote Plant Site, Louisiana. In: Proceedings of the 1982 Hazardous Materials Spill Conference, 1982.

16. Goerlitz, D.F., D.E. Troutman, E.M. Godsy and B.J. Franks. Migration of wood-preserving chemicals in contaminated groundwater in a sand aquifer at Pensacola, Florida. Environ. Sci. Technol. 19(10): 955-961, 1985.

17. Bedient, P.B., A.C. Rodgers, T.C. Bouvette, M.B. Tomson and T.H. Wang. Ground-water quality at a creosote waste site. Ground Water 22(3):318-329, 1984.

18. Johnson, E.L. Notice of rebuttable presumption against registration of pesticide products containing coal tar, creosote and coal tar neutral oil. Fed. Reg. 43(202): 48154-48266, 1978.

19. Todd, A.S. and C.Y. Timbie. Industrial Hygiene Surveys of Occupational Exposure to Wood Preservation Chemicals. U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, Cincinnati, Ohio, 1983.

20. American Wood Preservers Association. AWPA Book of Standards. Am. Wood Preservers Assoc,, Bethesda, Md, 1977.

21. International Labor Organization. Encyclopedia of Occupational Health and Safety. ILO, Geneva, Switzerland, 1983.

22. Hartford, W.H. Report of preservatives committees. Proc. Am. Wood Preservers Assoc. 63:106-137, 1967.

23. Brudermann, G.E. Creosote - A position on why designation is neither needed nor warranted. Submission to Ontario Ministry of Environment. Domtar Inc., Montreal, Quebec, 1984.

24. Sax, N.I. Dangerous properties of industrial materials. Van Nostrand Reinhold Co., N.Y., N.Y, 1979.

25. Windholz, M. The Merck Index - An Encyclopedia of Chemicals, Drugs, and Biologicals. Merck and Co., Inc., Rahway, New Jersey, 1983.

26. Hawley, G.G. The Condensed Chemical Dictionary. Van Nostrand Reinhold Co., New York, New York, 1977.

27. National Fire Protection Association, Inc. Fire hazard properties of flammable liquids, gases, volatile solids. National Fire Protection Asscociation, Inc., Quicy, MA, 1977.

28. Ingram, L.L. Jr., G.D. McGinnis, L.R. Gjovik and G. Roberson. Migration of creosote and its components from treated piling sections in a marine environment. Am. Wood Preserv. Assoc. pp. 120-128, 1982.

29. Aquatic Ecosystem Objectives Committee. Annual Report to the Great Lakes Science Advisory Board of the International Joint Commission. IJC Regional Office, Windsor, Ontario, 1983.

30. Peters, J.A., D.G. DeAngelis and T.W. Hughes. An environmental assessment of POM emissions from residential wood-fired stoves and fireplaces. In: Proc. 5th symp. on polynuclear aromatic hydrocarbons: Chemistry, analysis and biological fate: Polynuclear Aromatic Hydrocarbons, M. Corke and A.J. Dennis (eds.), Battelle Press, Columbus, Ohio. pp 571-581, 1981.

31. Webb, D.A. Some environmental aspects of creosote. Proc. Am. Wood Preserv. Assoc. 71: 176-181, 1975.

32. Domtar Inc. The LC_{50} of creosote for trout. Reported in the Canadian Institute of Treated Wood comments on the EPS draft report "Recommendations for the Design and Operation of Wood Preservation Facilities", 1985.

33. McLeese, D.W. and C.D. Metcalfe. Toxicity of creosote to larval and adult lobster and crangon and its accumulation in lobster hepatopancreas. Bull. Environ. Contam. Toxicol. 22, 796-799, 1979.

34. Sanborn, H.R. and D.C. Malins. Toxicity and metabolism of naphthalene: A study with marine larval invertebrates. In: Proceedings of the Society for Experimental Biology and Medicine, 154: 151-155, 1977.

35. U.S. Environmental Protection Agency. Water Quality Criteria-Naphthalene. U.S. Environmental Protection Agency, Washington, D.C., 1980.

36. Buikema, A.L. Jr., M.J. McGinniss and J. Cairns Jr. Phenolics in aquatic ecosystems: A selected review of recent literature. Marine Environ. Res., 2: 87-181, 1979.

37. NRC Associate Committee on Scientific Criteria for Environmental Quality. Polycyclic aromatic hydrocarbons in the aquatic environment: formation, sources, fate and effects in aquatic biota. National Research Council Canada, Ottawa, Ontario, 1983.

38. Malins, D.C., B.B. McCain, D.W. Brown, A.K. Sparks, and H.O. Hodges. Chemical contaminants and biological abnormalities in Central and Southern Puget Sound. NOAA Technical Memorandum OPMA-2. 295 pp, 1980.

39. Gibson, D.T. Microbial degradation of carcinogenic hydrocarbons and related compounds. In: Proceedings of the Symposium on the Sources, Effects, and Sinks of Hydrocarbons in the Aquatic Environment, August 9-11, Washington, D.C, 1976.

40. Varanasi, U., D.J. Gmur and P.A. Treseler. Influence of time and mode of exposure on biotransformation of naphthalene by juvenile starry flounder (Platichthys stellatus) and rock sole (Lepidopsetta bilineata). Arch. Env. Contam. Toxicol., 8: 673-692, 1979.

41. Lauglin, R.B., Jr. and J.M. Neff. Interactive effects of salinity, temperature and polycylic aromatic hydrocarbons on the survival and development rate of larva of the mud crab (Rhithropanopeus harrisii). Marine Biol. 53:281-291, 1979.

42. Great Lakes Science Advisory Board. Annual report to the International Joint Commission. IJC Regional Office, Windsor, Ontario, 1983.

43. Konasewich, D.E., P.M. Chapman, E. Gerencher, G. Vigers and N. Treloar. Effects, pathways, processes and transformations of Puget Sound contaminants of concern. NOAA Technical Memorandum OMPA-20. United States Department of Commerce, National Oceanic and Atmospheric Administration, Boulder, Colorado. 357 pp, 1982.

44. Health and Welfare Canada. Guidelines for Canadian Drinking Water Quality-Supporting Documentation. Minister of National Health and Welfare, Ottawa, Ontario. 739 pp, 1978.

45. World Health Organization. Quoted in reference 29.

46. International Joint Commission. New and Revised Great Lakes Water Quality Objectives- An I.J.C. Report to the Governments of the United States and Canada. International Joint Commission, Ottawa and Washington D.C, 1977.

47. Canadian Council of Resource and Environment Ministers. Canadian Water Quality Guidelines, Inland Waters Directorate, Environment Canada, Ottawa, 1987.

48. World Health Organization International Agency for Research on Cancer (IARC), IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: polynuclear aromatic compounds, part 4, bitumens, coal-tars and derived products, shale-oils and soots. IARC, Lyon, France, 1985.

49. American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values. Fourth Edition. ACGIH, Cincinati, Ohio, 1986.

50. National Institute for Occupational Safety and Health, (NIOSH). Criteria for a recommended standard-occupational exposure to coal tar products. DHEW Pub. No. (NIOSH) 78-107. Department of Health and Human Services, NIOSH, Cincinnati, Ohio, 1977.

51. United States Department of Agriculture. The Biologic and Economic Assessment of Pentachlorophenol, Inorganic Arsenicals, Creosote, Submitted to the Environmental Protection Agency, Nov. 04, 1980, USDA Technical Bulletin 1658-1, 1980.

52. Dreisbach, R.H. Handbook of Poisoning. Lange Medical Publications, Los Altos, California, 1983.

53. United States Department of Health, Education and Welfare/United States Environmental Protection Agency. Registry of Toxic Effects of Chemical Substances, U.S. HEW, Washington, D.C., 1980.

54. Alscher, A. and G. Lohnert. Creosote - New aspects of technical developments and environmental requirements. Record of the 1985 Annual Convention of the British Wood Preserving Association. pp. 55-63, 1985.

55. FIFRA Scientific Advisory Panel. Review of FIFRA Section 6(b)(1) Action on pentachlorophenol, inorganic arsenicals and creosotes (wood preservatives). Memorandum to U.S. EPA Deputy Assistant Administrator for Pesticide Programs, U.S. Environmental Protection Agency, Washington, D.C, 1981.

56. Flickinger, C.W. and A.W. Lawrence. Occupational health experience in the wood preserving industry. Proc. Amer. Wood Preser. Assoc., pp. 11-30, 1982.

57. Reidel, D. Response to CITW comments re: first drafts of EPS technical recommendations documents, 1983.

58. McCall, P.J., D.A. Laskowski, R.L. Swann and H.J. Dishburger. Measurement of sorption coefficients of organic chemicals and their use in environmental fate analysis. In: Test Protocols for Environmental Fate and Movement of Toxicants. Proceedings of a Symposium. Assoc. Off. Anal. Chem. 94th Annual Meeting, Oct 21-22, 1980. Washington, D.C., pp 89-109, 1980.

59. Brown, K.W., G.B. Evans, Jr., and B.D. Frentup. Hazardous Waste Land Treatment. Butterworth Publishers, Boston, MA, 1984.

60. Monenco Consultants Ltd., Guide to the Environmental Aspects of Decommissioning Industrial Sites, for Environment Canada, Ottawa, 1985 (unpublished).

61. Personal communication with U.S. Environmental Protection Agency Region X, Seattle and W. Tilsbury, of A.A. Anderson Waste Disposal Services, Delta, B.C., 1987.

62. American Public Health Association, American Water Works Association and Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater. 16th Edition. American Public Health Association, Washington, D.C, 1985.

63. Keizer, P.D. and D.C. Gordon Jr. Detection of trace amounts of oil in sea water by fluorescence spectroscopy. J. Fish. Res. Board Canada 30(8): 1039, 1973.

64. Gerencher, E. and D.E. Konasewich. Studies on creosote levels at the Koppers International Burnaby Plant Site and on the potential migration of creosote in groundwaters. Report to Koppers International by E.V.S. Consultants Ltd., North Vancouver, B.C., 1981.

65. American Chemical Society Committee for Environmental Improvement. Principles of environmental analyses. Anal. Chem. 55: 2210-2218, 1983.

66. Transport Canada. Regulations-Treated Wood. Dangerous Goods Newsletter 5(3), Sept. 1985, p. 13, 1985.

67. Minister of Transport. Regulations Respecting the Handling, Offering for Transport and Transport of Dangerous Goods. Canada Gazette Part II, February 06, 1985.

68. Environment Canada, Industrial Programs Branch, User's Guide to Hazardous Waste Classification (TDGR) and User's Guide for the Hazardous Waste Manifest (TDGR), Waste Management Division, Ottawa, 1986.

APPENDIX - LEGISLATIVE SUMMARY

The following principal federal and provincial legislation (acts and regulations) address the use, transportation, and disposal of creosote.

Federal Acts

1) Fisheries Act
2) Environmental Contaminants Act
3) Pest Control Products Act
4) Ocean Dumping Control Act
5) Transportation of Dangerous Goods Act
6) Clean Air Act

Provincial Acts

Alberta	1) Clean Water Act
	2) Clean Air Act
	3) Hazardous Chemicals Act
British Columbia	1) Waste Management Act
	2) Pesticide Control Act
	3) Workers' Compensation Act
	4) Environmental Management Act
Manitoba	1) Dangerous Good Handling and Transportation Act
	2) Clean Environment Act
	3) Workplace Safety and Health Act
New Brunswick	Clean Environment Act
Newfoundland	Department of Environment Act
Nova Scotia	1) Environmental Protection Act, SNS, 1973
	2) Dangerous Goods and Hazardous Wastes Management Act, SNS, 1986
Ontario	1) Dangerous Goods Transportation Act
	2) Environmental Protection Act
	3) Health Protection and Promotion Act
	4) Lakes and Rivers Improvement Act
	5) Ontario Water Resources Act

6) Pesticides Act
7) Occupational Health and Safety Act

Quebec

1) Loi sur la qualité de l'environnement (Environmental Protection Act)
2) Loi sur la santé et la sécurité du travail (Occupational Health and Safety Act)
3) Code de la sécurité routière (Road Safety Code)

Saskatchewan

The province has no legislation specific to the use and disposal of chemicals used in the wood preservation industry. The uncontrolled release of preservative chemicals is reportable under the Environmental Spill Control Regulations, 1981, and disposal in municipal landfills is prohibited by the Municipal Refuse Management Regulations, 1986. Creosote treated products are regulated on provincial highways by the Dangerous Goods Transportation Regulations, 1986. Hazardous Substances and Industrial and Hazardous Waste Management Regulations which will address the storage, treatment and disposal of these wastes by industry are in preparation. These regulations should be in place by 1988.

Figure A.1 provides a schematic overview of regulatory agencies and their responsibilities with respect to creosote wood preservation facilities. Table A.1 presents a brief review of the pertinent sections of the acts and any regulations that have been promulgated under the acts. Table A.2 provides emergency contacts in case of contraventions of the above Acts; additional contacts to provide clarification of requirements are provided in Table A.3.

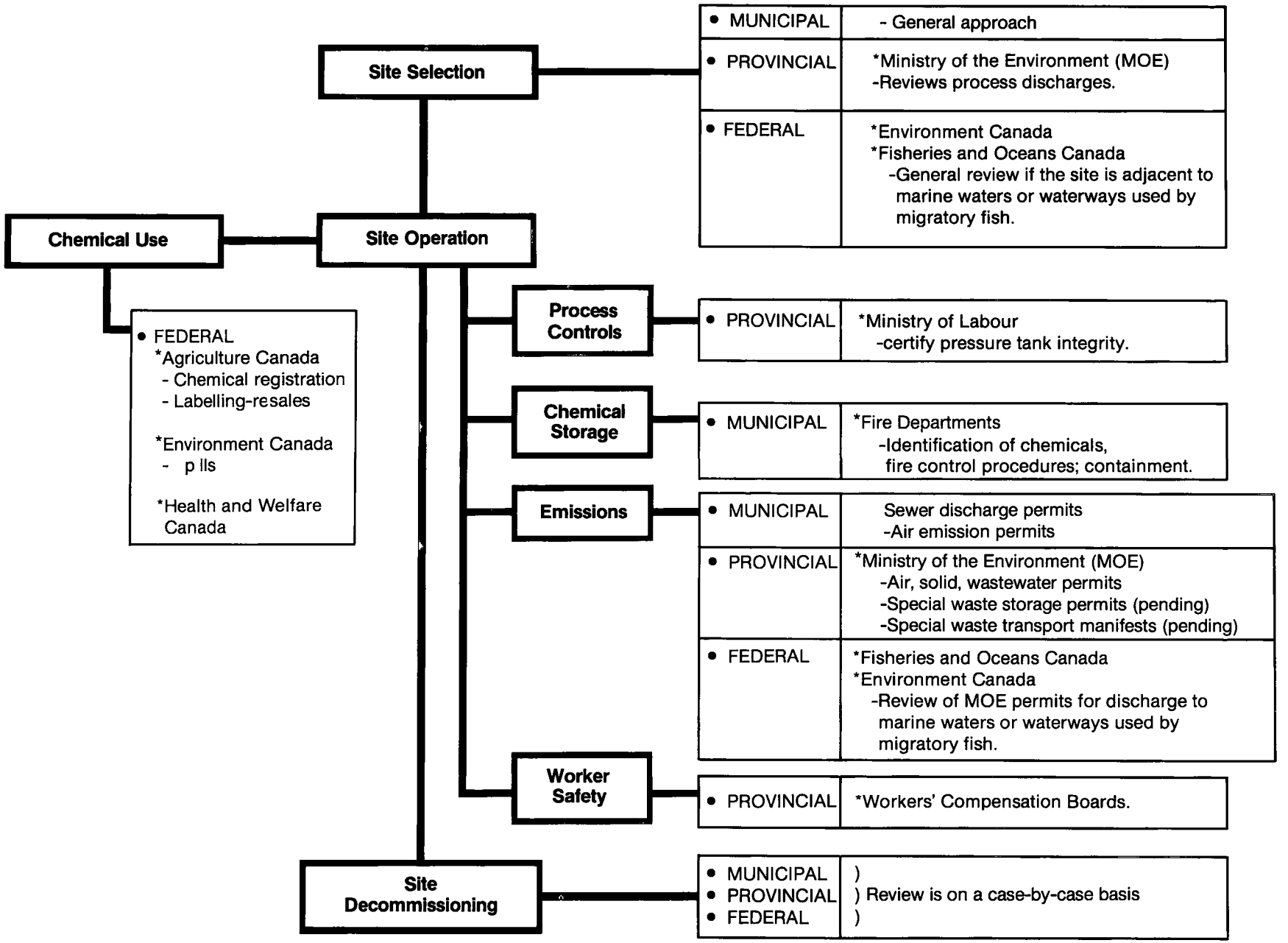

FIGURE A.1 OVERVIEW OF AGENCY MANDATES FOR REGULATING WOOD PRESERVATION FACILITIES

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE

Legislative Act (Responsible Agency)		Relevant Sections	Comments
1.	**Federal**		
1.1	Fisheries Act (Environment Canada and Fisheries and Oceans Canada)	Section 33(1)	If a proposed facility could affect federally managed resources, then Environment Canada (EC) has the authority to review plans for operations and works, to recommend modifications and, if necessary, to prohibit construction.
		Section 33(2)	This Section focuses on the protection of certain fish fish species in marine and fresh waters. It is used by EC and DFO for the prohibition of the discharge of deleterious substances into waterways frequented by fish. Creosote is deleterious to fish and their habitat. Other subsections of the Act may have application if regulations are developed or if specific information is requested.
1.2	Environmental Contaminants Act (Environment Canada, Health and Welfare Canada)	Section 4(1)	The Act gives the federal government authority to investigate and collect information on commercial chemicals pertaining to all facts of production, use, and release into the environment. Polycyclic aromatic hydrocarbon compounds are currently being investigated to determine the nature and extent of the danger that they pose to human health and the environment.
		Section 8	Pursuant to Section 8 the federal government may develop regulations prescribing the maximum quantity of a substance which may be released and the conditions under which the substance may not be imported, manufactured, processed, offered for sale or used.
1.3	Pest Control Products Act and Pest Control Regulations (Agriculture Canada)	Section 5	The Act regulates products used for the control of pests and organic functions of plants and animals. Examples of products are insecticides, fungicides, mulluscides and herbicides. The Act requires that an importer exporter, manufacturer and distributor of a controlled product must register that product with Agriculture Canada. The Regulations prescribe the registration procedures, the information required to be submitted with an application and they define restrictions on the formulation and composition of the products, packing and labelling, product distribution and product use.
1.4	Ocean Dumping Control Act Ocean Dumping Regulations	The Act Section 5	The Act provides the federal government the authority to restrict the dumping of scheduled substances into Ocean waters.
	(Environment Canada)	The Regulations Section 5	Chlorophenols would be included under the category of "Restricted Substances" (pesticides and their by-products not included in Schedule 1). Such substances are considered to be potentially harmful and require special care when dumped into the marine environment.

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)		Relevant Sections	Comments
1.5	Transportation of Dangerous Goods Act and Regulations (Transport Canada)	Section 4 Section 5 Section 26	The Act was proclaimed in 1980 in order to promote public safety in the transport of dangerous goods, such as explosives, flammable materials and toxic chemicals. Sections 4 and 5 define the offences under the Act, and Section 26 provides the federal government the authority to develop regulations and standards. Regulations published in 1985 identify specific requirements for documentation (manifests and waybills), packaging and labelling for nine classes of dangerous goods and wastes.
1.6	Clean Air Act (Environment Canada)	Section 7(1) Section 31	An Act relating to ambient air quality and the control of air pollution.
2.	**Alberta**		
2.1	Clean Water Act (Alberta Environment)		Act provides the legislative basis for the protection of surface and fresh groundwater.
2.2	Clean Air Act (Alberta Environment)		Legislative basis for the protection of ambient air quality and control of air pollution.
2.3	Hazardous Chemicals Act Hazardous Waste Regulations (Alberta Environment)		The disposal of hazardous waste is controlled under this Act and Regulations.
3.	**British Columbia**		
3.1	Waste Management Act (Waste Management Branch of the B.C. Ministry of Environment)	The Act	The Act provides the Waste Management Branch with the legislative basis for overall management of industrial wastes for the protection of the environment. The Act was passed in 1982; however, as of 1987 no regulations had been promulgated.
		Section 3	A permit or approval from the Waste Management Branch is required to discharge a waste into the environment (applies to liquid effluent discharges, air emissions and solid wastes).
		Section 4	Storage of "special wastes" in excess of specified quantities must be authorized by a permit.
		Section 5	The generator or owner of a waste must complete a manifest form and meet other requirements before transporting special wastes.
		Section 10 Section 22	All industries that handle hazardous materials may be required to prepare a contingency plan. The Waste Management Branch can issue an "order" for a company to investigate the risk to the environment posed by its handling of a polluting substance or the environmental effects of a spill, or to conduct remedial and abatement measures.

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)	Relevant Sections	Comments
3.2 Environmental Management Act - B.C.	The Act Section 5 Section 6	Declaration of environmental emergency. Recovery of costs associated with environmental emergency.
3.3 Pesticide Control Act and Regulations (Pesticide Control Branch of the B.C. Ministry of Environment)	The Act	The Act and Regulations are designed to ensure that pesticides are sold and used safely according to label directions in a manner that will not produce an unreasonable adverse effect to the environment.
	The Regulations Section 4	The application of a pesticide on public land must be conducted by a certified pesticide applicator. A certified pesticide applicator has successfully completed a course and examination in a speciality field conducted by the Pesticide Control Branch.
3.4 Workers' Compensation Act Industrial Health and Safety Regulations - B.C. (Workers' Compensation Board (WCB))	The Act	The Act designates the WCB as responsible for the prevention of injuries and industrial diseases to workers at their place of employment. The Act empowers the WCB to make regulations that may apply to employers, workers and all persons working in or contributing to the production of any industry within the scope of the Act.
	8.18*	Adequate direction and instruction of workers.
	8.20	Supervisors are responsible for the proper instruction of workers under their direction and must ensure the work is performed without undue risk to the worker.
	12.01	Signs indicating the presence of hazardous chemicals at facilities.
	12.03	Storage of hazardous chemicals and design and labelling of containers.
	12.05	Emergency wash facilities.
	13.01	Exposure to airborne polycyclic aromatic hydrocarbons and measures to mitigate excessive exposure.
	13.05, 13.07	Tests to determine unsafe conditions.
	13.09	Protective measures where workers are in a confined space with unsafe atmosphere.
	13.07	Ventilation and testing for confined areas.
	13.37	Design of ventilation systems.
	13.43	Location of exhaust ventilation systems.

* Only certain regulations are highlighted. Many other regulations are applicable, including 8.02, 8.04, 8.22, 8.32, 8.52, 8.58, 8.72, 8.74, 8.84, 12.11, 13.41, 13.57, 14.01, 17.03, 17.05.

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)		Relevant Sections	Comments
3.4	Workers' Compensation Act Industrial Health and Safety Regulations, cont'd	13.47, 13.49	Restrictions on the recirculation of contaminated exhaust air.
		14.16, 14.18, 14.21	Protective equipment for workers handling treatment chemicals or treated lumber.
		14.23	Provisions for respiratory protection equipment for workers.
		68.46	Special procedures for dealing with fires involving creosote.
		76.29	Chemical spills shall be cleaned up under the supervision of persons who are knowledgeable of the hazards of such spills and the precautions to be taken.
4.	**Manitoba**		
4.1	Dangerous Goods Handling and Transportation Act and Regulations (Environment and Workplace Safety and Health)	Section 8 Section 9 Section 12 Section 31 Section 32	The Act was proclaimed August 1984 and provides the legislative basis covering all aspects of handling dangerous goods including their manufacture, use, storage, transportation and disposal. Sections 31 and 32 cover penalty provisions and offences. Section 40 provides provincial government the authority to develop regulations.
4.2	Clean Environment Act and Regulations - Environment and Workplace Safety and Health	Section 14	A proposal must be filed with the department for the establishment of any operation that will release contaminants into the air, water or soil. Subsequently, the operation will receive a Clean Environment Commission order setting out limits, terms and conditions for the process. In the absence of a central hazardous waste management system and facility, such an order will be required for the operation of a wood preservation facility in Manitoba. NOTE: This legislation is in the process of change - but approval will still be required.
5.	**Ontario**		
5.1	Dangerous Goods Transportation Act (Ministry of Transportation and Communications)		The Act permits the Ministry to enact regulations to supplement those promulgated under the Federal Transportation of Dangerous Goods Act.

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)	Relevant Sections	Comments
5.2 Environmental Protection Act (Ministry of the Environment)		The Act provides the legislative basis for the protection of the environment.
	Sections 12 and 14	The Ministry of the Environment must be notified if a discharge is greater than the permitted level, or is likely to harm the environment.
	Sections 80 and 81	Spills likely to harm the environment must be reported to the Ministry, the municipality and company management. Remedial action must be taken.
	Section 84	Disposal of spilled material may be regulated by the Ministry.
	Section 136(1)	The Ministry may regulate the discharge of a contaminant or the modification of waste treatment facilities.
	Section 136(7)	Any occurrence in compliance with the Ontario Water Resources Act or the Pesticides Act is not a "spill".
Air Pollution (Control) Regulations	Section 9	The Ministry must be consulted if a process upset results in excessive emissions.
	Section 10 Also Section 6	The use of treated wood wastes in a boiler is legally questionable.
Spills Regulations		Sets out procedures for compensation of persons affected by a spill; but only if the Pesticides Act and other applicable federal, provincial and municipal legislation has not been complied with.
Waste Management General Regulation	Section 15	Generators of waste must be registered with the Ministry.
	Section 16, 20-23	Waste must be properly disposed of, and all prescribed manifests kept.
	Schedules 1 and 2	Sludge from the effluent treatment plant is a hazardous industrial waste.
Guidelines for Environmental Protection Measures at Chemical Storage Facilities		*Code of good practice for storage tanks.*
5.3 Health Protection and Promotion Act (Ministry of Health)		The medical officer of health may inspect, receive complaints and issue orders or directions in case of a health hazard.
5.4 Lakes and Rivers Improvement Act (Ministry of Natural Resources)		The Act provides for the protection of water bodies and for their equitable public and private use.
	Sections 37 and 38	The Ministry of Natural Resources may order a mill not to discharge any refuse, sawdust, chemical, etc.
	Also Section 39	

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)	Relevant Sections	Comments
5.5 Ontario Water Resources Act (Ministry of the Environment)		The Act provides for the preservation of water purity, and governs the operation of water and sewage works.
	Sections 14-16	Discharge of any substance that may impair water quality is prohibited, and an ex parte injunction may be obtained against it.
	Section 18	The Minister may order the maintenance of equipment or chemicals necessary to alleviate impairment of water quality.
5.6 Pesticides Act (Ministry of the Environment)		The Act regulates the elimination of pests, and all use and handling of pesticides.
	Section 4	The use of a pesticide such that excessive harm is caused to the environment is prohibited.
	Section 28	Provides for the enactment of regulations governing the transportation, handling, storage and use of pesticides, the type, labelling and disposal of containers, and decontamination.
	Also Sections 20, 21 and 23	
Pesticides (General) Regulations	Section 24	A pesticide must be kept in the proper container, which must be properly labelled.
	Sections 25 and 26	Empty pesticide containers must be properly disposed of, damaged containers must be replaced or disposed of and spillage cleaned up.
	Section 27	If a pesticide is involved in a fire, theft or other unusual occurrence, the Director (Pesticides, MOE) must be notified.
	Section 98	Pesticides must be kept away from human or animal food.
	Section 99	Pesticides on schedules 1, 2 and 5 must be stored in a room which is vented to the outside, with doors marked "Chemical Storage - Authorized Persons Only" and which is accessible only to authorized persons.
	Also Sections 105 and 106	

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)	Relevant Sections	Comments
5.7 Occupational Health and Safety Act (Ministry of Labour)		The Act governs protection of health and safety in the work place.
	Sections 14-17	Employer shall provide necessary equipment, educate workers, disclose all hazards, maintain occupational health service, keep records of chemicals used, including exposure records. The use of new chemicals must be reported, the levels of chemicals must be monitored and kept below a prescribed level. Supervisor must ensure that workers comply with health and safety procedures. Workers must use protective equipment provided, and inform the employer of any unsafe situations.
	Section 20	The Ministry may regulate the use of, and exposure to any toxic substances.
	Section 41 (1) and (2)	Provides for the specific regulation of exposure to chemicals.
	Also Sections 23, 24, and 28-33	
Industrial Establishments Regulations	Section 66 (1)	Piping containing a hazardous substance shall be labelled at valves, fittings, etc.
	Sections 83, 85 and 88	Workers must be provided with equipment protecting them from skin and eye injury, and be trained in its use.
	Setions 128 and 129	Eyewash fountains and deluge showers must be provided.
	Sections 131 and 132	Work place must be adequately ventilated.
	Sections 134 and 135	Workers shall be trained in the use of chemicals, use of protective equipment and emergency procedures. Food, drink and tobacco not permitted near poisonous substances.
	Section 145	All measures necessary to prevent exposure to toxic substances shall be taken.
	Also Sections 14, 15, 26, 27, 71-74, 139, 141(b), and 142	
Regulations Concerning Exposure to Chemical and Biological Agents		

TABLE A.1 SUMMARY OF LEGISLATION REGULATING THE USE OF CREOSOTE (Cont'd)

Legislative Act (Responsible Agency)		Relevant Sections	Comments
6.	**Quebec**		
6.1	Loi sur la qualité de l'environnement (Environmental Protection Act) (Ministry of Environment)	Article 1	Contaminants are defined in the following manner: a solid liquid or gas, or any combination of these that could alter in some manner the quality of the environment.
		Article 20	This article states that no person may emit, dispose of, release or discharge, or permit the emission, disposal, release or discharge, into the environment of a contaminant that could affect human life, health, safety, security, welfare or comfort, or cause damage or otherwise compromise the quality of soil, vegetation, wildlife or property.
		Article 21	The Deputy Minister of the Environment must be notified immediately of any incident that causes the presence of a contaminant in the environment.
		Hazardous Wastes Regulation (A.C. 1000-85)	This regulation defines bottom sediment sludges from the treatment of wastewaters from wood preserving processes that use creosote, pentachlorophenol or inorganic components containing arsenic, as being a category of hazardous wastes.
		Solid Waste Regulations (R.R.Q. 1981, C.Q. - 2, r.14)	Any leachate containing contaminants (chromium, copper, phenolic compounds) above the standards prescribed must not be discharged into the hydrographic surface network or into a storm water sewer.
6.2	Loi sur la santé et la sécurité du travail (Occupational Health and Safety Commission) (L.R.Q., chap. S-2.1)		This act establishes mechanisms to permit the participation of workers and employers in the elimination of causes of accidents and occupational illnesses. The act gives to workers the right to take leave if exposure to a contaminant poses a danger to them, as evidenced by signs of health effects.
		Industrial and Commercial Establishments Regulation (R.R.Q. 1981, chap. S-2.1 r.9)	This regulation prescribes general standards of health and safety for industrial and commercial premises. The scope of application includes the state of workplaces, working conditions such as ventilation, lighting, noise and vibration, control of hazardous substances and radiation, equipment and individual protection.
		Regulation on the Quality of the Workplace (R.R.Q. 1981, chap. S-2.1, r.15)	This regulation applies to the presence of dust, gases, fumes and vapours, lighting, temperature, noise, ventilation, etc.
6.3	Code de la sécurité (Highway Safety Code) (Ministry of Transport)	Transport of Dangerous Substances Regulation (C-24.1, r.19.01)	This regulation protects the public during the transport of dangerous goods. Documentation, packing, and signing for dangerous goods are specified.

TABLE A.2 EMERGENCY CONTACTS (Creosote Treatment Facilities)

Emergency Incident	Emergency Contact
Spills to marine waters	Environment Canada - Local office
Spills to freshwaters containing anadromous fish (e.g., salmon) or Spills on federal or Indian lands	Environment Canada - Local office and Provincial Emergency Program - Local office
Spills to land during transport (More than 5 kilograms or 5 litres of creosote or creosote wastes)	Provincial Emergency Program - Local office
Ingestion of creosote or exposure to high concentrations of creosote	Local Hospital and Poison Control Center (additional information)
Fire	Local Fire Department
Emergency response information	Allied Chemical Corporation (313) 358-3750 Domtar Chemicals Ltd. (416) 624-5700 Koppers Co. Inc. (412) 227-2457 USS Chemicals (412) 433-7578

TABLE A.3 GENERAL INFORMATION CONTACTS (Creosote Treatment Facilities)

Subject	Contact
Compliance with Federal Environmental Legislation	Environment Canada - Local office
Transport of Dangerous Goods Act (Questions of consignors, manufacturers, consignees, warehousers, freight forwarders, brokers, etc.)	Local Regional Inspector Transport of Dangerous Goods Transport Canada
Railway Transport	Local Dangerous Goods Coordinator and Chief, Operations Railway Transport Committee
Transport of Dangerous Goods Road Transport	Local Director, Administrator and Road Safety Motor Vehicle Department