ENVIRONMENTAL MANAGEMENT OF TIMBER PRESERVATION PLANTS TREATING WITH CCA WATERBORNE PRESERVATIVES.

MARC SALMON

1991 GOTTSTEIN FELLOWSHIP REPORT

JOSEPH WILLIAM GOTTSTEIN MEMORIAL TRUST FUND

The Joseph William Gottstein Memorial Trust Fund was established in 1971 as a national educational Trust for the benefit of Australia's forest products industries. The purpose of the fund is *"to create opportunities for selected persons to acquire knowledge which will promote the interests of Australian industries which use forest products for the production of sawn timber, plywood, composite wood, pulp and paper and similar derived products."*

Bill Gottstein was an outstanding forest products research scientist working with the Division of Forest Products of the Commonwealth Scientific Industrial Research Organization (CSIRO) when tragically he was killed in 1971 photographing a tree-felling operation in New Guinea. He was held in such high esteem by the industry that he had assisted for many years that substantial financial support to establish an Educational Trust Fund to perpetuate his name was promptly forthcoming.

The Trust's major forms of activity are,

1. Fellowships - each year applications are invited from eligible candidates to submit a study programme in an area considered to be of benefit to the Australian forestry and forest industries. Study tours undertaken by Fellows have usually been to overseas countries but several have been within Australia. Fellows are obliged to submit reports on completion of their programme. These are then distributed to industry if appropriate.

2. Seminars - the information gained by Fellows is often best disseminated by seminars as well as through the written reports.

3. Wood Science Courses - at approximately two yearly intervals the Trust organises a week-long intensive course in wood science for executives and consultants in the Australian forest industries.

4. Study Tours - industry group study tours are arranged periodically and have been well supported.

Further information may be obtained by writing to,

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J.W. Gottstein Memorial Trust Fund,
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Marc Salmon is an Environmental Scientist with Aquatech Pty. Ltd., Environmental and Water Management Consultants. Since completing his Bachelor of Environmental Science Degree at Wollongong University, Marc has been involved with the forest products industry, initially as an environmental scientist with R. L. Newman and Partners, and then on various projects through Aquatech. He is currently studying sampling strategies for the analysis of soil contamination at timber preservation sites as part of a Post-Graduate Diploma in Forestry Science at the Australian National University.

The purpose of his 1991 Gottstein Fellowship was to examine the environmental management of timber preservation plants which treat with CCA-waterborne preservatives in North America and New Zealand.

ACKNOWLEDGMENTS

This study tour was undertaken with the financial support and the encouragement of the J.W. Gottstein Memorial Trust Fund. I would like to offer my sincere thanks to the trustees of the Fund for awarding me this Fellowship, and making the tour and this report possible.

I would also like to thank Aquatech Pty Ltd for both the time to undertake this Fellowship and the encouragement throughout.

In undertaking this Fellowship there were countless people who gave freely of their time and expertise, both here in Australia and in the countries which I visited. To all of those people involved, thank-you. This report is dedicated to all of you, with my sincere hope that it may be of benefit to the forest products industry .

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CHAPTER SYNOPSIS & RECOMMENDATIONS

REGULATORY DEVELOPMENTS IN THE UNITED STATES, CANADA AND NEW ZEALAND.

Examines and compares legislation in the United States, Canada and New Zealand in order to determine useful strategies which may be developed by the Australian preservation industry. Industry in these countries is being forced to operate under increasingly stringent environmental legislation, and this trend will continue in Australia.

The preservation industry in the United States is heavily regulated, and although this places considerable costs upon the industry, it has resulted in an excellent standard of environmental management. Components of this regulation should be examined by the Australian industry and incorporated into treatment plant design and management. The Canadian and New Zealand industries are less heavily regulated, though recent legislation in New Zealand is attempting to rationalise and improve environmental management. Self-regulation and voluntary compliance by the preservation industries in New Zealand and Canada has been developed to varying degrees.

The Australian preservation industry should strive to achieve the standards of environmental management exhibited in the United States, through mechanisms of self-regulation and voluntary compliance similar to those adopted in Canada and New Zealand.

INDUSTRY INITIATIVES.

Reviews initiatives being undertaken by the preservation industries in the United States, Canada and New Zealand, to improve the public's knowledge of the safety and benefits of treated timber products. The initiatives reviewed are: the Canadian Institute of Treated Wood's "Treated Wood Saves Trees" campaign, an educational campaign which was initiated after a survey of consumers; the Consumer Awareness Program in the United States, which was established as part of an agreement between the industry and the EPA, to inform all consumers of the proper use and handling of treated products; and, the establishment of training seminars for regulatory officers by the Timber Industry Training Council in New Zealand.

The Australian preservation industry should implement an educational campaign and a consumer awareness program on a national level, and establish training seminars for regulatory officers at the state level.

TREATMENT PLANT DESIGN.

Design features from plants in North America and New Zealand are examined. The advantages of considering environmental management and incorporating possible future regulated controls during the design phase are discussed. Aspects examined include overseas design requirements, site selection, restricted access, process equipment, operator control areas, elevated tramways, washing systems, drip pads, asphalt buffer zones, waste storage areas, changing rooms, stormwater control and soil conservation.

Design criteria in regards to environmental management, for both the upgrading of existing sites and the establishment of new plants, should be carefully considered on a site specific basis. Designs should be adopted which facilitate environmental management, with special attention being paid to containment and waste minimisation.

DRIP PAD DESIGN AND MAINTENANCE.

New regulations in the United States specify secondary containment on the drip pad and the regular maintenance of drip pads. These regulations have been established as contamination has occurred at sites with drip pads. This chapter reviews those regulations and details design criteria for secondary containment and drip pad maintenance. Secondary containment for new drip pads consists of liners and test wells, and for established drip pads, the application of sealants.

The Australian preservation industry should adopt secondary containment, and treatment plant managers should regularly inspect and maintain drip pads to prevent the discharge of chemicals.

PLANT OPERATING PROCEDURES.

Operating procedures which facilitate good environmental management are reviewed, with aspects considered including housekeeping, waste minimisation, waste management, contingency planning and staff training.

Detailed and site specific environmental objectives should be established. Detailed operating procedures should be developed to meet these objectives, and incorporated into a written operations manual.

ENVIRONMENTAL MANAGEMENT AND IMPROVED FIXATION.

Because of the potential for reducing chemical discharge, accelerated fixation techniques are being examined by both industry and regulatory agencies. This chapter reviews the fixation process and a method for determining the degree of fixation, before examining accelerated fixation techniques. These include the MSU process, steam fixation, kiln and warm chamber fixation and drying, and catalytic fixation.

Preservation plants should adopt accelerated fixation technology as soon as possible. In the interim, plants should be designed such that accelerated fixation technology may be incorporated when available.

WASTE DISPOSAL AND SITE REMEDIATION.

Increasing attention to waste management and site remediation will be accompanied by more stringent regulations and increased costs. Although solidification and stabilisation prior to landfill represents the Best Available Technology (BAT), other options include resource recovery and on-site treatment. The development of chemical extraction technology and in-situ remediation are examined. The Toxicity Characteristic Leaching Procedure (TCLP) being adopted by Australian regulatory agencies, and methods for determining soil criteria are reviewed.

The Australian preservation industry should examine the option of chemical extraction of CCA chemicals prior to landfill. Approval to stockpile waste material pending the commercial development of an extraction technology should be sought.

1. INTRODUCTION

The timber treatment industry depends upon the use of chemicals which are toxic to living organisms. The continued growth of the industry is dependant upon the industry managing these chemicals in a manner which protects the community and the natural environment from contamination by these chemicals. This report, by the amalgamation of information and ideas from the United States, Canada and New Zealand, is intended to provide information to the Australian preservation industry which may be incorporated into the environmental management of timber preservation plants.

While CCA treated timber is also produced in European countries, the similarities between North America and New Zealand and the Australian situation are more readily comparable. Similar aspects include species treated and climate (except Canada), market share, and environmental management of treatment plants. The European trend is towards banning, compared to the philosophy of better control in North America and New Zealand. As the objective of this report is to encourage improved control of treatment facilities, the developments in North America and New Zealand were examined. The itinerary of the study tour is shown in Appendix I.

It is important to separate the antics of the more extreme elements of the environmental movement and some of the political decisions which have been made - supposedly on environmental grounds - from the community's desire for a general improvement in environmental standards and from the regulations demanding more stringent environmental controls. While the former command more media attention, and require monitoring by the industry, it is the latter which this report primarily addresses.

These extreme elements reflect the community's concern with environmental issues. Consequently, there exists a world-wide trend of regulators attempting to translate the ecological and ethical concerns of the community into laws which will both control and protect the activities of the community, whilst being realistic and achievable. This process has resulted in such concepts as "polluter pays" and "from the cradle to the grave", as industry is being made to be responsible and accountable for its activities. This idea has been manifested in the laws of most countries over recent years through a significant increase in fines and penalties which are applicable to environmental offences. Liability is increasingly being assigned to individuals, as shown by this extract from the Environmental Reporter (1991) in the United States.

RCRA Sentence Of Company President Upheld

The U.S. Court of Appeals for the Fourth Circuit upheld the sentence imposed under the Resource Conservation and Recovery Act on the president of a West Virginia wood treating company in a decision issued Sept. 12 (*U.S. v. Jude*, CA 4, No. 90-6504, 9-12-90). The appeals court said the district court, which ordered Harrison Jude to pay a $75,000 fine and placed him on probation for three years, acted within its discretion in fining Jude (*U.S. v. Jude*, DC SWVa, No. 3:88-00226; 20 ER 831). Jude, who pleaded guilty to one count of transporting hazardous wastes without a manifest, could have been fined $250,000, the appeals court observed.

Similar legislation has been enacted in Australia, such as the NSW Environmental Offences and Penalties Act (1989) which carries fines of up to $ 250,000 and imprisonment of up to 7 years for wilful or negligent damage. Whilst this legislation has not been used against a member of the preservation industry to date, a successful prosecution and a fine of $ 20,000 has recently been awarded against a machinery operator for releasing water from a leachate dam into a creek in the Blue Mountains.

Whatever reasons may be put forward to encourage the proper environmental management of timber preservation sites, the fact remains that it is illegal to manage a site, either wilfully or negligently, in a manner which degrades the environment. And the regulatory enforcement agencies, both in Australia and abroad, have shown that they are prepared to prosecute persons who manage a site in such a manner.

There are also good financial reasons for implementing improved environmental practices now rather than later. A study by the Environmental Protection Agency in the United States on the impact of environmental regulations on small business (EPA, 1988) found that the costs associated for sites without contamination was on average around $ 200,000, while sites which required remediation were facing a cost of between $ 400,000 and $ 2.2 million over a similar period.

Recommendations have been made to the preservation industry for at least the last ten years to improve the level of environmental management and control at preservation sites. Duignan (1982) in his address to the New Zealand Wood Preservers Association identified inadequate bunding, misuse of drip pads, housekeeping and the unsafe disposal of wastes as environmental concerns which needed addressing. These problems are still apparent today, and it seems unlikely that regulatory authorities will give the industry another ten years. Therefore it must be a priority of the industry to instigate good environmental practices.

An objective of the industry should be to be as self-regulating as possible. Even the heavily regulated US industry endeavours to achieve voluntary compliance wherever possible, and this has been attributed as part of the reason the industry has enjoyed such substantial growth. Self-regulation limits the amount of external regulation required, thereby allowing a balanced view of important and practical considerations.

In order for the preservation industry here in Australia to develop controls which are in accordance with any possible future imposed regulations, it is necessary that developments in international environmental legislation are examined. This will allow not only the installation of appropriate controls by the industry , but the forestalling of possible regulations which could be economically damaging to the industry, and which do not offer any greater protection to the environment. The population pressures and the economic size of North America has generated an earlier, and to some extent more intense, adoption of environmental controls and regulations. Australian industry and legislators are therefore in a position to adopt those regulations and controls which would enable industry to operate successfully and protect the environment. Chapter 2 of this report examines the regulatory developments in the United States, Canada and New Zealand, and offers some comments on these developments.

Equally important, industry should make the community aware of its good environmental practices and its environmentally safe product. The environmental concerns of the community are often expressed in the market place. By instigating an awareness campaign to inform the community of the benefits of treated products the industry will be in a position to take advantage of a growth in demand. If, however, industry waits to address community concerns in a retroactive fashion it may never capitalise on the potential growth.

The treatment industries in the United States, Canada and New Zealand are conscious of the need - as is the Australian industry - to initiate programs which will alleviate the environmental concerns of the community. While many industry initiatives are being undertaken in these countries, Chapter 3 details three initiatives which could be applied by the Australian industry.

This report also addresses the practical aspects of the management of timber preservation sites, both design and operational procedures are reviewed and recommendations for the Australian industry are given. Because of the developing and competitive nature of the industry, proprietary products and techniques are at times discussed. For these reasons, details are at times brief, though where appropriate company and product names have been detailed, although this is not necessarily an endorsement of those products.

Chapter 4 examines general design considerations for both the upgrading of plants and the design of new plants. While it has long been recognised that an impervious, bunded drip pad is the best method for preventing environmental contamination, little attention has been paid to the details of design or to the maintenance. In view of recent changes to legislation in the United States concerning drip pad design and maintenance, Chapter 5 examines drip pad design and maintenance in more detail.

Chapter 6 reviews operational procedures in North America and New Zealand which are applicable to the Australian industry. These include general house keeping, waste minimisation and management, and contingency planning.

Accelerated fixation techniques as a part of the treatment process are expected to become mandatory over the next 3-5 years in North America, and presumably in Australasia sometime after that. The development of accelerated fixation techniques is examined in Chapter 7, after briefly reviewing the fixation process and a method for the determination of the degree of fixation.

More stringent controls regarding the disposal of wastes generated during the treatment process and enforced remediation of sites will be enacted in Australia, forcing treaters to clean up past mismanagement and to better control future management. This can be expected to follow overseas experiences, and accordingly Chapter 8 examines waste disposal and site remediation.

Recommendations are made throughout this report, and reiterated in the concluding chapter. Although these recommendations will not be applicable to every site or style of management, they should be carefully considered and adopted if applicable. In the most part they are intended to be technically simple and cost effective, and to present practical options for achieving the necessary environmental objectives. However, guidelines and recommendations should never preclude site specific solutions.

Accordingly, the solution to most environmental problems simply requires that past attitudes be replaced, and environmental management be given the attention which it warrants.

2. REGULATORY DEVELOPMENTS IN THE UNITED STATES, CANADA AND NEW ZEALAND.

The enactment of legislation shows world wide trends overtime, such as the development of the US Federal Pollution Control Act in 1972, the New Zealand Water & Soil Conservation Act in 1967 and the New South Wales Clean Waters Act in 1970. The increasing environmental pressure on both the chemical industry in general and the timber preservation industry will be translated into more stringent legislation in Australia, as has occurred overseas. By examining some of the legislation and regulations being developed in the United States, Canada and New Zealand, useful strategies may be developed for application by the Australian preservation industry.

2.1 The United States.

The legislative controls governing the timber preservation industry, and industry in general, are detailed and complex, characterised by a large number of statutes and operating within an adversarial legal system. The use of the courts to establish requirements and definitions is commonplace, with interest groups and private companies suing the enforcement agencies and the agencies in turn suing private companies and individuals. Of primary interest are the control of the preservation industry under the Federal Insecticide, Fungicide and Rodendicide Act (FIFRA) through a labelling program; the Clean Waters Act (CWA) and amendments requiring discharge permits; recent amendments to the Resource Conservation and Recovery Act (RCRA) listing CCA drippage as hazardous waste and mandating secondary containment on the drip pad; and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) which dictates the control and remediation of contaminants. Other relevant Acts and regulations which affect the timber preservation industry are discussed where appropriate in this report.

The administration and enforcement of legislation relating to environmental management in the United States is carried out by the Environmental Protection Agency (EPA). In contrast to Canada and New Zealand, there exists no specific document detailing operational and design guidelines relating to timber preservation plants. Rather, through various powers under different Federal and State Acts, the EPA, generally through state offices, is able to control the operating procedures at plants and limit the discharge of chemicals to the environment.

The preservative application process is regulated under FIFRA. In 1986 the EPA conducted a special review of the preservation industry which determined that the benefits to the community of the continued use of timber preservatives outweighed the hazard posed. An outcome of this review was the reclassification of the major timber preservatives as restricted use pesticides, and the establishment of comprehensive labelling requirements for in-plant application, including provisions for worker safety and environmental protection. Under these requirements the label must detail toxicology and environmental hazard information, instructions on the application, storage, disposal, spill response and the monitoring of workers. Use of a timber preservative in a manner inconsistent with its labelling would be a violation of FIFRA, and subject to prosecution.

Discharge of wastewaters containing arsenic and chromium from timber preservation plants in the United States is regulated under the Clean Waters Act. The Act dictates that any person responsible for the discharge of a pollutant into any waters from any point source must obtain a permit specifying conditions of discharge which must be complied with. Guidelines have been established detailing effluent limitations for direct discharges into navigable waters and pretreatment standards for indirect discharges into publicly owned treatment works, including the prescribed levels of arsenic and chromium that wood treating wastewater discharges may contain.

The EPA requires that CWA permit holders monitor, record and report on their facilities discharges. Provisions exist under the Act for EPA enforcement officers to enter, inspect and monitor facilities, and to copy records and sample effluents. Where EPA discovers violations options available under the Act include the issue of administrative orders, Civil actions in district courts and the bringing of criminal actions against persons who wilfully or negligently violate the Act. The permit may also be revoked if the conditions of the permit are not met.

The Clean Waters Act regulations also require timber preserving facilities which use arsenic or chromium to obtain a National Pollution Discharge Elimination System (NPDES) permit for stormwater discharge. Although amended by the US Congress in 1987 to require the establishment of phased requirements for stormwater discharge permits, it was not until 1991 that the deadline for the applications was eventually set. Application could be either by an individual application or a group application. Applications must contain details of stormwater management practices to control, minimise and treat stormwater, certification that each outfall has been evaluated for non-stormwater discharge and analytical data from each discharge point.

Monitoring requirements by the EPA are likely to necessitate a minimum annual sampling of each discharge point. The plant operator would be required to maintain the results of the program, but would not be required to submit the information unless requested by the conditions of the permit or by the EPA.

Under the Resource Conservation and Recovery Act a waste may de defined as hazardous by either being listed by the EPA or by exhibiting one or more of the characteristics of a toxic waste, including toxicity, corrositivity, explosivity or flammability. Wastes identified as hazardous under either of these criteria must be managed as detailed in the RCRA hazardous waste management program.

Recent amendments to RCRA have changed the status of CCA wastes from a characteristic waste to a listed waste; "wastewaters, process residuals, preservative drippage and spent formulations from wood preserving processes generated at plants that use inorganic preservatives containing arsenic or chromium". Accordingly any of these materials are considered as hazardous wastes, regardless of the concentration of arsenic or chromium, and are subject to the hazardous waste regulations in RCRA, including an inspection by the EPA every two years for facilities which generate hazardous wastes.

This ruling also establishes design and management standards for drip pads, as detailed in Chapter 5 of this report.

The newly listed wastes are also designated as hazardous substances under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). Under CERCLA if quantities of these wastes exceeding the Reportable Quantities (RQs) are released to the environment (one pound in this case) the Federal, state and local emergency response centres must be notified. Where the EPA believes that there may be a release or a threatened release of hazardous substances, it may enter and inspect the facility and determine if removal or remedial action is necessary. Where there is a release or threatened release the person responsible for such release is held liable for the response costs and natural resource damage.

2.2 Canada.

Regulation of industry to protect the environment in Canada is achieved on both federal and provincial levels. Federal responsibility includes chemical use, emission standards, site selection and decommissioning and the protection of federal resources, such as waterways and lakes, although overlap with provincial agencies occurs on many of these issues. The Canadian Environmental Protection Act (1988) is the primary mechanism used for protecting the environment, with Environment Canada being vested with the following relevant authority under this Act:

* to obtain information and require testing of both new substances and substances already existing in Canadian commerce;

* to control all aspects of the life cycle of toxic substances from their development, manufacture or importation, transport, distribution, storage and use, their release into the environment as emissions and their ultimate disposal as waste;

* to create guidelines and codes for environmentally sound practices as well as objectives setting desirable levels of environmental quality.

In 1984, Environment Canada established a Wood Preservation Industry Technical Steering Committee to develop technical recommendations for wood preservation facility design and operational measures. Included on the steering committee were representatives of Federal and provincial government agencies, timber preservation companies, forest industry labour unions and workers compensation boards. This steering committee reviewed the technical recommendations document, which was subsequently published as Environment Canada "Chromated Copper Arsenate (CCA) Wood Preservation Facilities: Recommendations for Design and Operation" in 1988 (henceforth referred to as the Canadian Technical Recommendations).

The Technical Recommendations are a voluntary compliance document which reflects the intent of the Federal Environmental Protection Act and the Federal Fisheries Act. It is Environment Canada's intention to conduct a survey of timber preservation plants sometime in 1994/95 to determine the levels of compliance which has been achieved with the Technical Recommendations. If the result of such a survey indicate that compliance has been poor the Technical Recommendations will be incorporated into legislation under the Canadian Environment Protection Act.

To date provincial surveys have been carried out in British Columbia and Ontario by the provincial agencies. These have shown that compliance has generally been good, although problems exist in monitoring of emissions, and that past practices have resulted in contamination at preservation sites.

Sections of the Federal Fisheries Act focus on the protection of aquatic species and the discharge into waterways of contaminants can be controlled under this legislation. The remediation of sites can be specified if the discharge of emissions from a site exceeds the permissible limits. Proposed development which may impact on fish habitats under Federal control are subject to review by Environment Canada, and recommendations to modify the design or operation may be issued, or if necessary the development prohibited. Recommendations are issued if a timber preservation plant or the proposed operations do not meet those specified in the technical recommendations.

Provincial environmental agencies are primarily responsible for the control of emissions of air, stormwater, wastewaters and solid wastes. While the acceptable level of contaminants varies between provinces, they must, as a minimum requirement, meet the national standard as set by Environment Canada. Because of the past problems of the monitoring of emissions, many of the provincial agencies are proposing to enforce monitoring programs at timber preservation sites. The development of these programs will be site specific and administered by the Regional offices of the provincial agencies.

Environment Canada has attempted to work in conjunction with industry to achieve appropriate levels of operation which protect the natural environment. Strict legislation of the CCA preservation industry has been avoided to a large degree by the voluntary compliance with the Technical Recommendations. If Environment Canada becomes dissatisfied with the progress towards achieving compliance throughout the industry, it will make the Technical Recommendations mandatory, thereby increasing the regulation of the industry. The provincial agencies will undoubtedly follow suit in increasing their monitoring and control.

2.3 New Zealand.

Prior to the enactment of the Resource Management Act in July 1991 timber preservation plants in New Zealand had been regulated via numerous statutes and enforcement agencies. The primary mechanism used has been the Ministry of Labour's (1979) "Occupational Safety and Health Guidelines for the Safe Use of Timber Preservatives", administered by the Regional Councils and City or District Councils. However, as the environmental legislation which existed was considered out-dated (some relevant statutes being up to 40 years old), too complex, legislative and overlapping it was considered essential that the New Zealand resource management laws be revised. The resulting Resource Management Act, while still in a transitional period, has given the regulatory authorities more control on site management and pollution control while establishing more streamline and sensible procedures for industry. The new Act and its implications for the preservation industry are reviewed after examining the Ministry of Labour's Guidelines and the previous legislative controls.

In 1990 the Ministry of Labour began to develop new OSAH Guidelines, "Occupational Safety and Health Guidelines for the Safe Use of Timber Preservatives" (henceforth referred to as the OSAH Guidelines), to replace the those developed in 1979. While it was considered that the preservation process and the associated hazards were adequately covered by the original OSAH Guidelines, most of the provisions were recommendations which could not be easily enforced. The new OSAH Guidelines were to more fully address environmental management concerns and to take account of technology changes since 1979. Legally enforceable provisions were also deemed necessary, and consequently included. The purpose of the OSAH Guidelines (Ministry of Labour, 1990), is to establish:

a. safe work practices that will reduce the potential for exposure and contamination of personnel engaged in the operation of timber preservation plants;

b. the design and operation of the plant and treatment site that will either prevent or minimise the potential damage to the environment.

As required by the Factory and Commercial Premises Act, draft copies of the OSAH Guidelines were circulated amongst industry for comment and those comments taken into consideration in the final preparation. This has resulted in several rewrites of the draft guidelines, with the final guidelines expected to be enacted in 1992, and titled "A Code of Practices for Preservative and Antisapstains Treatment".

The occupational health and safety aspects of the OSAH Guidelines are administered by the Occupational Safety and Health Service of the Department of Labour, and by compliance with the mandatory sections, treatment plant operators are able to meet their principle safety, health and welfare obligations of the Factories and Commercial Premises Act (1981).

Enforcement of the environmental provisions of the OSAH Guidelines is by means of local Bylaws established under the Resource Management Act and administered by regional councils. Regional councils may either incorporate the appropriate sections of the OSAH Guidelines into local Bylaws using the provisions of the Resource Management Act, or use them as guidelines to control the discharge of effluent.

The OSHA Guidelines contain mandatory instructions, indicated by "shall" and "must", with recommendations to be adopted where practical as indicated by "should" and "may". Direct quotes from the OSAH Guidelines in this report confirm with these interpretations or are indicated as being mandatory where appropriate. Under the OSHA Guidelines occupiers have three years from the date of enactment to comply with all matters covered by the OSAH Guidelines, although dispensations may be granted in certain circumstances.

Previously regional councils had limited ability to apply controls to timber preservation plants and therefore reduce the risk of contamination. The controls which councils could apply consisted of water rights granted for stormwater discharge, the offences section of the Water and Soil Conservation Act (1967)(WSCA), the Bylaw provisions of the 1973 amendment to the Water and Soil Conservation Act, and by submissions or objections to planning applications, District and Regional Scheme changes and reviews and to Draft Regional Schemes.

Water rights were granted generally for stormwater discharges via artificial drainage systems to surface waters. Control over contaminants was via conditions applied to discharge water quality. The offences section of the Water and Soil Conservation Act (WSCA) prohibited the discharge of wastes or natural waters containing wastes into any natural waters and the discharge of wastes or natural waters containing wastes onto land. Under the Bylaw provisions of the 1973 amendments to the WSCA Bylaws could be made by local councils to control the placing or discharge onto or into land any substance which would be liable to affect detrimentally the purity of underground water.

While these mechanisms could generally be used to control the discharge of contaminants, there existed limited ability to control practices on site, and little scope other than prosecution for enforcement.

In order to develop a legislative mechanism for the integrated management of the environment and to remove the inadequacies of the existing laws, the Resource Law Reform Project was initiated. The resultant Resource Management Act (1991) (RMA) replaces more than 20 major statutes, including the Town & Country Planning Act (1977) and the Water and Soil Conservation Act (1967) and amendments. The Act creates planning, consent, discharge and enforcement procedures that are common to most resource users, including timber preservers. A central philosophy of the Act is that decision making will focus on the results of a development rather than on the regulation of the resource use. For example, rather than preclude the establishment of a treatment plant on a particular site, the emphasis will be placed on achieving acceptable standards for noise level and waste management at that site.

The RMA outlines the functions of regional councils and territorial authorities, including the controls on the use of land for the purpose of preventing or mitigating any adverse effects of the storage, use, disposal and transport of hazardous substances. It also establishes an independent central governmental body, the Hazardous Control Commission (HCC). The HCC will be responsible for controlling the importation, production, use and disposal of hazardous substances through the licensing of Hazardous substances. As part of this licensing process the bioaccumulation, persistence and toxicity to the ecosystem will be assessed.

Regional councils play a pivotal role in the new resource management administration, including a responsibility for a mandatory regional policy statement, which will set out the objectives for managing all resources of the region in an integrated manner. Statements will draw together land, air and water management so that a more consistent approach to issues such as pollution and waste management can be provided. Through these regional policy statements councils will control the discharge of contaminants into or onto land, air or water, and the discharges of water into waters.

Under the RMA resource consents are granted to engage in activities, including land use consent and discharge consents. Only upon the granting of a resource consent by the regional council will it be possible to develop land in a manner that contravenes a regional plan. The consent procedure involves public participation and impact assessment, and is an essential part of the consent granting and planning procedure. The discharge of contaminants into the environment is prohibited unless the discharge is expressly allowed by a rule of a regional plan, a resource consent or regulations. Discharge permits relate to plant operations and site conditions, and set conditions on all significant discharges from sites. For example, the Northern Regional Council as part of the conditions required for the granting of discharge consent to timber preservation plants, requires a bunded and roofed drip pad and sets the discharge levels of contaminates in stormwater at 6.5 mg/m^3 for copper, 190 mg/m^3 for arsenic and 130 mg/m^3 for total chromium. The discharge permits will be the principal mechanism available to regional councils to set consistent industry performance standards.

Under the new Act those who discharge wastes or emissions will have a responsibility to adopt the "Best Practical Option" (BPO) for preventing and controlling pollution. Included in these responsibilities, waste generators are required to examine recycling and waste minimisation. In setting discharge permits for timber preservation plants regional councils will have due regard to the BPO for the industry, and may specify standards which are more stringent than those that may be specified as national minimums (Ellis, 1989).

Compliance with policies and rules under the Act can take the form of abatement notices, enforcement orders or prosecution. The offences provisions provide for strict liability with fines of up to $ 200,000, community service sentences and possible imprisonment.

2.4 Comparative Analysis

The effectiveness of any environmental legislation may be determined by the level of environmental protection gained and the ability of the regulated industry to continue to operate effectively. Whilst trade-offs between the two may exist, the objectives of any legislation should be to maximise both components simultaneously. The attitudes of those operating under any legislation are also important in achieving those objectives, and in judging the effectiveness of any such legislation.

From this review it can be seen that a ranking of the level of regulation would place the United States as the most regulated and Canada as the least, with New Zealand being in a transitional phase towards a greater level of regulation than previously experienced there.

While the preservation industry in the United States appears to be over regulated, the large number of Superfund sites which where formerly preservation sites necessitated considerably more stringent regulation. This situation is somewhat confused by the fact that a large number of these sites were contaminated by organic preservatives, through the use of unlined impoundments which were at one time specified by the EPA. The recent enactment of even more stringent guidelines was partially justified by the EPA because of the number of contaminated sites, a problem which was originally compounded by the EPA.

Recent amendments to the Resource Conservation and Recovery Act which classify CCA wastes as listed wastes instead of characteristic wastes have further increased this level of regulation, with no apparent gains in environmental protection. These amendments have brought considerable opposition by the preservation industry, and while this opposition somewhat softened the affect of these amendments, the industry has had unnecessary constraints placed upon it. Prior to these amendments, extensive inspection, monitoring and reporting requirements existed under the RCRA, CERCLA and CWA regulations for hazardous wastes. These amendments have placed considerable costs on the industry by duplicating existing controls, and these costs are considered to far exceed any possible benefits in environmental protection.

Extensive costs are already placed on the American preservation industry through the complicated and detailed administration and recording requirements of the regulations. These costs have been furthered by the RCRA amendments.

The result of the extensive regulation of the preservation industry in the United States does however have one distinct advantage; the environmental management of treatment facilities is in general excellent. The extensive regulation and the adversarial legal system have combined to give a system of environmental management which is second to none. It is apparent however that once a system of heavy regulation is adopted, that knowing when to stop is not always clear. The recent amendments to RCRA would have been appropriate if they had detailed new standards for drip pads (see chapter 5), but the listing of all CCA wastes as hazardous wastes is an unnecessary and costly addition to the list of regulations.

The most striking feature of the American preservation industry is the attitude of those involved in the industry towards environmental management. A complete acceptance of the need to manage their facilities in a manner which controlled discharges and wastes, has removed what is perhaps the greatest barrier to environmental management in Canada, New Zealand and Australia. The challenge for the preservation industry in these countries is to obtain a comparable attitude, without the "big stick" which hangs over the Americans.

The development of environmental legislation in Canada has been partly an attempt to avoid what is perceived as the over regulation of American industry. This has resulted in the Federal Government encouraging voluntary compliance by industry where-ever possible. The success of this policy is however debateable, and provincial agencies are suggesting that a greater level of enforcement is required.

Because of this attitude by the provincial agencies and a level of compliance with the Canadian Technical Recommendations which is generally below standard, it is likely that the Technical Recommendations will be incorporated into legislation under the Canadian Environmental Protection Act. If the Canadian preservation industry is to avoid stricter regulation it is necessary that the level of compliance increases over the next two to three years, at a accelerated rate to that exhibited in complying with the Technical Recommendations since their original release.

However it must be said that the Canadian preservation industry faces considerable disadvantages: the northern softwood species are considerably denser than the southern yellow pine treated in the States, resulting in poor penetration; the Canadian market is almost exclusively price driven, restricting the amount of environmental marketing; and, they are forced to compete with the bullish American industry.

The release of the Canadian Technical Recommendations in 1988 was one of the first attempts by the preservation industry, working in co-operation with a regulatory agency, to develop self-regulation and to set standards. While the motivation and achievement of this is enviable, and well ahead of the Australian industry, the document itself is open to criticism. The inclusion of excess information and its repetitive and confusing lay-out make it less effective than it should be.

The environmental legislation and regulations in New Zealand appear to have reached a good balance between regulation of the industry and self-regulation, although, as has been noted, the Resource Management Act is in somewhat of a transitional phase. The Resource Management Act was designed to address inconsistencies in the management of the environment by New Zealand industry in general. This obviously presumes an unsatisfactory level of protection of the environment by most of New Zealand industry, including sections of the preservation industry.

The amendment of the 1979 OSAH Guidelines to include more easily enforceable provisions indicates specifically a need for the NZ preservation industry to address aspects of environmental management. For the most part this is being done admirably, with detailed and consistent input by industry in the formulation of the new OSAH Guidelines.

The New Zealand Ministry of the Environment has given a clear signal to the preservation industry that it is willing to work together in achieving pragmatic solutions which both protect the environment and allow the continuation of the industry in a competitive environment. However, it has also clearly stated that if industry fails to exhibit significant improvement, it will use its new powers under the Resource Management Act to force industry compliance (Ellis, 1989).

It is recommended that the Australian preservation industry strive to achieve the standards of environmental management exhibited in the United States, through mechanism of self-regulation similar to the New Zealand and Canadian industries, in order to avoid the extensive regulation of the industry in the United States.

3. INDUSTRY INITIATIVES

While improved environmental management at timber preservation sites will reduce potential contamination and associated environmental problems, if the products or the process are perceived to be dangerous, on either occupational health and saftey or environmental grounds, any improvements will be for nought. The industry should therefore seriously consider some form of pro-active campaign to increase the image of CCA treated products in the market place. A plethora of information exists within the industry on the benefits of the products, the safety of the process and the products and the action that the industry is undertaking to improve all of these aspects. If this information is not effectively disseminated, the real possibility exists that misinformation will instead be accepted by the general public and the regulators.

An incident which occurred in North America in 1989 illustrates this point. A study by a masters student at Guelph University in Canada (Warner et.al, 1989) found that CCA- treated timber exhibits high leaching of metals under an acid rain scenario. The study cited that a 50 metre long fence constructed of CCA treated timber could leach approximately 0.5 kg of copper, 0.3 kg of chromium and 0.5 kg of arsenic over a period of forty days. Although the North American industry was quick to respond to these figures and to show serious experimental design faults, it was not before the press in Canada and the United States had printed various articles quoting these figures, such as this article from the Atlanta Journal.

Acid Rain May Leach Metals From Pressure-Treated Timber

Acid rain may leach toxic metals out of the pressure-treated timber used in fences, decks, docks, foundations and other outdoor applications, Canadian researchers have reported.

Lumber treated with one common wood preservative, chromated copper arsenate (CCA), lost 91 percent of the copper, 12 percent of the chromium and 30 percent of the arsenate after 40 days of exposure soaking in slightly acidic lake water, scientists at the University of Guelph said. All three chemicals are toxic and known to accumulate in the environment.

Canadian scientists say although pressure-treated wood contains relatively low levels of the toxic chemicals, direct contact with the wood could pose a potential hazard if it had been soaked by acid rain. Manufacturers of CCA-treated wood advise people working with their product to avoid skin contact and to avoid inhaling sawdust. They also say treated wood should never be burned because of the toxic emissions produced in combustion.

3.1 Information Dissemination and Image Improvement.

While most trade associations and many companies make literature available concerning environmental issues, a comprehensive approach has been adopted in Canada. The Canadian Institute of Treated Wood (CITW), in response to this and other incidents, commissioned a study to evaluate the public's attitude to treated timber products and the process. The survey found people to be generally ambivalent about the product, with no strong feelings either way, though the feeling of CITW was that people were impressionable on the subject. Consequently, the CITW decided that there existed an opportunity to convince the general public of the benefits of CCA treated timber, before any significant negative mindset had developed.

The industry therefore commenced the "Treated Wood Saves Trees" campaign to enforce a positive response to treated timber. The campaign consisted of several components:

A "Treated Wood Saves Trees" poster, to be displayed at retail outlets (inside cover page of this report);

"Treated Wood Saves Trees" bumper stickers, to be given out from retail outlets; and

"Treated Wood Saves Trees" leaflets, again to be made available at retail outlets, and reproduced on pages 19 to 21.

The retail handout requests that interested parties contact the CITW for more information. The CITW makes available to these parties an Environmental Statement endorsed by the Institute members, a nine page document addressing common questions about pressure treated timber and the chemicals and processes used, and a reference list on environmental and health and safety aspects of pressure treated timber. This package is reproduced in appendix II.

This two layered approach is designed such that interested persons who see the poster and read the brochure are able to continue exploring the subject of treated timber. The question & answer sheets address the issues in a straight forward and honest manner, with the scientific literature reference list providing those who wish to further explore the matter a good introduction to the literature.

It was felt by the CITW that the public is far more sophisticated today regarding to environmental matters, and that it is more interested in information than slogans and blanket statements. Therefore, a range of options is available. From a evocative forest scene which establishes the attention of the public and an initial awareness, through to the extensive scientific literature available on the subject. A person may, by progressing through the stages of poster, brochure, mailout and reference list, learn as much as they desire in order to develop an informed personal opinion.

Canadian Institute of Treated Wood brochure as part of the "Treated Wood Saves Trees" campaign.

TREATED WOOD SAVES TREES

CITW

It's a fact. Pressure treated wood saves trees.

There are precious few substitutes for wood, one of our most valued, versatile building materials. Wood is economical and plentiful, prized for its warmth, its beauty, strength and workability.

Wood will remain a vital, renewable resource only if our forests are soundly managed. The wood we harvest must be wisely used. And it must be made to last. Today, every tree must count.

Extending the life of the wood we use means we'll cut down fewer trees.

Wood has natural enemies. Preyed upon by fungi, insects and millions of microorganisms, wood is susceptible to rot and decay. It's especially true wherever wood comes in contact with the ground or water.

But modern technology has developed ways of protecting wood from its natural predators, injecting it with preservatives which are retained in the wood cells. The process, known as pressure treatment, renders wood useless as food for fungi and insects, ensuring wood's structural soundness and extending its useful service life.

Pressure treated lumber will last many times longer than untreated lumber.

During the pressure treating process, chemical preservatives are forced into the wood cells. By depositing the preservatives into the cellular structure of the wood, the useful service life is significantly increased over that of untreated wood. These preservatives are highly leach-resistant.

The pressure treatment process does not alter wood's essential characteristics. Treated lumber will not shrink, swell, check, split or warp to any greater degree than will the same species left untreated. It simply lasts longer and remains stronger, an ideal construction material.

Pressure treated wood not only helps conserve our forests - each year it saves consumers millions of dollars.

Pressure treated wood is used primarily outdoors and has dozens of industrial applications, from docks and marinas to railway ties, utility poles, piling, bridges, highway guardrail posts and even roller coasters. It's used in landscape architecture and for erosion control of beaches.

Around the home, treated wood is used for decks, fences, gazebos, playground equipment and outdoor lighting fixtures. It may also be used for certain indoor applications where building codes require treated wood.

It takes approximately three 45 year old trees to build a backyard deck.

You'd like to build a backyard deck. That calls for lumber from two or three trees, each at least 45 years old. Working with untreated lumber, you'll probably need to replace all or part of your deck every few years. But if you build with pressure treated lumber, your deck will be strong and attractive for up to 50 years. You'll save thousands of dollars on upkeep, leave many trees uncut–and enjoy your deck that much more.

Pressure treated wood is safe to use.

At a time of growing environmental awareness, we must have the facts to be able to make informed decisions. It's misleading to talk about safe and unsafe chemicals. There are no safe chemicals - only safe ways of using them.

Pressure treated wood is safe when used properly. It shouldn't be used for kitchen counter tops, for example. With the exception of incidental contact such as docks and bridges, it shouldn't come in contact with drinking water, food or animal feed. All pressure treated wood should be disposed of by ordinary trash collection or burial rather than burned. Detailed information regarding the wise use and handling of pressure treated wood is readily available through the Canadian Institute of Treated Wood.

If the chemicals used for pressure treating wood were not toxic, the process wouldn't work.

But pressure treated wood is not hazardous to people and animals under its intended conditions of use. Wood preservatives used in Canada meet all the requirements and standards of the Pest Control Products Act administered by Agriculture Canada.

The two most widely used preservatives in the Canadian pressure treating industry are chromated copper arsenate (CCA) and pentachlorophenol (penta). Two other preservatives in commercial use are ammoniacal copper arsenate (ACA) and creosote. Each has its own specific uses and benefits.

Ammoniacal Copper Arsenate (ACA) is an industrial preservative particularly well suited for treatment of our Canadian wood species. It is highly resistant to leaching and will not evaporate. Most ACA-treated wood is destined for industrial uses such as construction lumber and marine timbers and pilings.

Creosote, the oldest industrial wood treating preservative, is used mainly for railway ties, marine structures, piling and highway construction. Its oily nature improves the dimensional stability of wood and reduces checking and splitting.

Chromated copper arsenate (CCA) is the most commonly used wood preservative for residential applications.

CCA-treated wood is light green in colour and weathers to a driftwood grey. It is suitable for decks, gazebos, playground equipment and agricultural stakes, but is also used for utility poles, marinas and wood foundation lumber and plywood.

One of the primary active ingredients in CCA is inorganic pentavalent arsenic, a naturally-occurring trace element which is present in soil, water, air, plants and in the tissues of most living creatures - including humans. It's the same type of arsenic found in the food we eat and should not be confused with trivalent arsenic which is more toxic and never used in the wood treating process.

Research has proven CCA treated wood is safe when used properly.

Studies conducted in several nations around the world have found no evidence of harmful health effects to people from the installation or use of pressure treated wood structures.

Further studies have shown environmental risks from CCA-treated wood are also negligible. The active ingredients of CCA are deposited into wood cells and permanently fixed there, virtually immune to leaching. Indeed, properly impregnated wood retains the preservative in virtually undiminished quantities for decades. That's why pressure treated wood lasts so long.

Pentachlorophenol (penta) has been safely used in North America for almost half a century.

Penta is widely used for the treatment of utility poles, railway ties. bridge timbers and in fresh water piling.

Though much media attention has been given to dioxins, it must be stressed there are many different kinds (75 dioxins in all) with a wide range of toxicity. The compound usually referred to by the media as 'dioxin' is in fact a specific substance called 2,3,7,8 TCDD, which has never been found in pentachlorophenol used for heavy duty wood preservation in Canada.

There are many common sources of dioxins including municipal incinerators, coal-fired utility boilers, forest fires, and motor vehicle exhausts. Dioxins do not render penta-treated wood dangerous for use.

As a slight amount of the oil carrier used may evaporate, penta treated wood should not be used for interior applications.

Are there alternatives to pressure treated wood?

Steel, aluminum, concrete and plastic could be substituted for certain applications, but this would mean higher costs, far greater energy consumption in the manufacture of these materials, and increased air and water pollution. Often, substitute materials won't even be appropriate - steel, for example, may corrode and concrete may deteriorate in saltwater.

It's vital we maintain the integrity of our environment. There will always be trade-offs, but pressure treated wood is still the best option, ecologically and financially.

We must act responsibly.

Environment Canada and other regulatory bodies have developed a series of recommendation documents in conjunction with the CITW relating to the design and operation of wood preserving facilities. Members of the CITW are committed to producing quality products which preserve and protect our environment.

We owe it to ourselves. And to future generations.

For more information regarding the use and handling of pressure treated wood, contact:

Canadian Institute of Treated Wood
506 - 75 Albert Street
Ottawa, Ontario
K1P 5E7

Tel.: 613-234-9456
Fax: 613-234-1228

3.2 Consumer Awareness Program.

Since 1986 the American treatment industry has been engaged in a Consumer Awareness Program (CAP) to ensure that the continued use of timber preservatives does not present unacceptable risks to the users of treated products or to the environment. The timber preserving trade associations agreed to implement the CAP as a result of an agreement between themselves and the Environmental Protection Agency, as part of the Agency's special review of timber preservatives. The program was designed to meet the EPA's goal of implementing a program to inform all consumers of the proper use and handling of pressure treated products.

The central mechanism to the CAP is the distribution of Consumer Information Sheets (CISs) through a dissemination network of treaters, retailers, wholesalers distributors, trade associations and preservative manufacturers. Although the primary responsibility for the programs success rests with the treaters, under the EPA agreement each of the participants has certain responsibilities. The responsibilities of the parties involved include:

* Treaters: Attach Consumer Information Sheets to each bundle or batch of pressure treated timber leaving the plant. Attach one CIS to each sales invoice containing treated products. Provide adequate quantities of CISs and signs or placards to wholesalers, retailers and other distributors.

* Wholesale Distributors and Retailers: Display CISs at sales counters. Give a CIS to each purchaser of pressure treated timber. Prominently display signs or placards in sales area to inform consumers of availability of CIS. Cooperate with the treater associations in annual surveys to satisfy EPA requirements for compliance with the program.

* Preservative Manufacturers: Assure participation by treaters in the program.

* Treater Associations: Encourage all treaters to fully participate in the program. Ensure that their members participate in providing CISs to treated timber buyers. Initially furnish members with a limited number of CISs and signs or placards. Have CIS available for purchase by both members and non-members. Provide environmental standard plaques or certificates indicating participation in the program to be displayed in members' sales area or office.

Encourage members to advertise their participation in the program and the availability of CISs.

As part of the agreement reached with the EPA a standardised format was agreed upon for the Consumer Information Sheets, shown on page 24. Companies are permitted to embellish the CIS with their name and logo as well as marketing and promotional information providing certain conditions are met; primarily that the words agreed upon in conjunction with the EPA are not altered.

The logo under consideration by the American Wood Preservers Institute's Communications Committee for adoption by the industry.

We Support
Consumer Awareness
Of Pressure Treated Wood

Ask for the EPA approved
consumer information sheet.

Another component of the 1986 agreement was the verification of distribution of the CISs to wholesalers, distributors and retailers by the treaters and chemical manufacturers through an annual audit, conducted by the treater associations. Subsequently the EPA requested that wholesalers, distributors and retailers be surveyed to determine if the sheets were being passed on to the consumer. In 1990 the EPA dropped the requirement to survey treaters and chemical manufacturers because of a compliance rate of nearly 100% over the life of the program.

Additional responsibilities of the treater associations include the provision of an annual report on industry's compliance to the EPA, the notification of non-complying members, followed by a 90 day review to determine if the treater is complying and the subsequent notification to the EPA of the extent of compliance.

While compliance with the program represents additional concerns to the industry, there are benefits to be gained by the incorporation of the program into the treaters marketing strategy. By the embellishment of the CIS with a company name and logo and product information, a company gains distinct advertising advantages in the market place. By the inclusion of information detailing the safety of the product when used correctly, the CISs can both contribute to alleviating the public's concern regarding environmental issues and act as an educational tool. The CISs also offer partial protection against lawsuits based on the misuse of the product, a concern which is very real in the United States.

EPA Approved Consumer Information Sheet used by the United States preservation industry as part of the Consumer Awareness Program.

Consumer Information Sheet

INORGANIC ARSENICAL PRESSURE-TREATED WOOD

(Including: CCA, ACA, and ACZA)

CONSUMER INFORMATION

This wood has been preserved by pressure-treatment with an EPA-registered pesticide containing inorganic arsenic to protect it from insect attack and decay. Wood treated with inorganic arsenic should be used only where such protection is important.

Inorganic arsenic penetrates deeply into and remains in the pressure-treated wood for a long time. Exposure to inorganic arsenic may present certain hazards. Therefore, the following precautions should be taken both when handling the treated wood and in determining where to use or dispose of the treated wood.

USE SITE PRECAUTIONS

Wood pressure-treated with waterborne arsenical preservatives may be used inside residences as long as all sawdust and construction debris are cleaned up and disposed of after construction.

Do not use treated wood under circumstances where the preservative may become a component of food or animal feed. Examples of such sites would be structures or containers for storing silage or food.

Do not use treated wood for cutting-boards or countertops.

Only treated wood that is visibly clean and free of surface residue should be used for patios, decks and walkways.

Do not use treated wood for construction of those portions of beehives which may come into contact with the honey.

Treated wood should not be used where it may come into direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges.

HANDLING PRECAUTIONS

Dispose of treated wood by ordinary trash collection or burial. Treated wood should not be burned in open fires or in stoves, fireplaces, or residential boilers because toxic chemicals may be produced as part of the smoke and ashes. Treated wood from commercial or industrial use (e.g., construction sites) may be burned only in commercial or industrial incinerators or boilers in accordance with state and Federal regulations.

Avoid frequent or prolonged inhalation of sawdust from treated wood. When sawing and machining treated wood, wear a dust mask. Whenever possible, these operations should be performed outdoors to avoid indoor accumulations of airborne sawdust from treated wood.

When power-sawing and machining, wear goggles to protect eyes from flying particles.

After working with the wood, and before eating, drinking, and use of tobacco products, wash exposed areas thoroughly.

If preservatives or sawdust accumulate on clothes, launder before reuse. Wash work clothes separately from other household clothing.

Approved by the U.S. Environmental Protection Agency

9/85

3.3 Training Seminars for Regulatory Officers.

An initiative being undertaken in New Zealand by the Timber Industry Training Centre (TITC) which warrants close examination by the Australian Industry is the proposed running of preservation appreciation seminars for Regional Council/District Council Staff. The aim of these seminars will be to inform Council staff who will be responsible for the administration and enforcement of the "Code of Practices for the Safe Use of Timber Preservatives" about the preservation industry, the processes and chemicals used and the operation of treatment plants.

Located in Rotorua, the Timber Industry Training Centre, together with the Forestry Training Centre, comprises the Waiariki Polytechnics School of Forestry and Timber Processing. In conjunction with Koppers-Hickson, the Centre has installed treatment facilities on site, primarily for industry training. In response to a recognised need to educate those council staff on the limitations of the treatment industry and to encourage a more sympathetic view on the operation of treatment plants, the TITC has written to regional and district councils requesting their response to the idea of the proposed seminars. Encouragingly, the Ministries for the Environment and Occupational Safety & Health have indicated their support for seminars of this nature.

A proposed format for such courses included:

- An overview of the New Zealand Preservation industry;

- Processes and chemicals used;

- Responsibilities of treatment plant operators;

- Demonstrations of plant operation;

- Practical problems facing plant operators;

- Discussions of the Code of Practices, including interpretation and correct application.

3.4 Australian Applications.

Whilst not a comprehensive discussion of the initiatives being undertaken internationally, the CITW campaign, the Consumer Appreciation Program in the United States and the TITC administrator education seminars should all be closely considered by the Australian treatment industry. The experiences of the Australian hardwood industry have shown that the money required to retroactively fight a challenge far exceeds that required for proactive initiatives. While extra costs are having to be borne to meet current and impending environmental requirements, an additional investment now will undoubtedly save much larger costs in the future.

Only by establishing a good public profile for their product will treaters fully enjoy the expected growth in the consumption of treated timber. The more extreme elements of the environmental movement have shown an ability, when they target particular sections of industry, to seriously reduce the operational viability of that industry. By educating the community with a reasonable level of objective information, and by working with regulators to improve their understanding of the treatment industry, it will be possible to inject a robust quality into the industry which should weather any attacks.

The large growth in the treated wood market in the United States has been attributed partially to the aggressive self-regulation of the sale and distribution of treated products. This is an area where the Australian industry needs to analyse its past performance and decide what target could be reached and to that end what strategies should be adopted. Although a large component of this would need to be quality control, a consumer awareness program and a safety and benefits of treated products educational campaign should also be incorporated.

The vehicle for achieving such an information campaign should be the Timber Preservers' Association of Australia. It would be desirable for a survey to be conducted prior to any information campaign to determine the strategy necessary for such a campaign and to establish the questions most commonly asked and the publics' current perceptions. Training seminars for regulators should be considered through the state bodies, such that legislation relevant to particular states may be addressed. Any initial expense by the industry in establishing a more understanding and receptive attitude within the regulatory bodies will be undoubtedly recouped both individually and collectively.

4. TREATMENT PLANT DESIGN.

Whether designing new plants or the upgrading of existing plants, careful attention to the layout of the plant in regard to environmental matters is essential to future good management practices. The treatment process, chemical storage, chemical delivery and operator work areas should be designed such that plant operation is as carefree as possible. Any procedures which can be shortened invariably will be, so plants should be designed such that the quickest and easiest procedures are also the correct procedures. Good design which takes into consideration operational procedures and objectives will enable the most efficient plant operation and encourage good house-keeping practices.

Plant design should be undertaken so that the operation of a plant from environmental management perspective occurs in conjunction with the overall efficient management of a site. By integrating the environmental management with the operational management, substantial financial savings will be made through the conservation of chemicals, more efficient use of man-power due to good housekeeping practices, reduced waste disposal and remediation costs, and from a general reduction of management involvement in responding to environmental "spot fires".

If through poor design, environmental objectives are in conflict with operational objectives, the environmental objectives will be sacrificed. While this may be satisfactory in the short term, it can only lead to unnecessary expense such as site remediation and prosecution.

Plant design should not only take into account current requirements, but future possible regulatory specifications should be examined, and incorporated into the design if applicable. Given the current focus on the environment it can be expected that the operational life of a plant will exceed the period between amendments to environmental legislation and regulations. Additional design features which anticipate regulatory requirements, whilst representing an initial cost increase, will save money when new regulations are implemented.

A new drip pad installed at Universal Forest Products in Union City, Georgia illustrates this point. Although predating the propagation of parts of Resource Conservation and Recovery ACT (RCRA) which required liners and test wells, the new pad at the Union City site was designed and built with these components incorporated. While other treatment plants are now facing the additional cost of drip pad upgrade or replacement under RCRA, Universal Forest Products are able to more fully concentrate on production concerns.

The New Zealand OSAH Guidelines and the Canadian Technical Recommendations both contain instructions which should be taken into consideration during the design of timber preservation plants. These are detailed below. While no specific guidelines have been established for treatment plant design in the United States, design aspects are regulated under various Federal and State Acts, such as RCRA and FICRA. Details of drip pad requirements under recent amendments to RCRA are described in Chapter 5.

Under the NZ OSAH Guidelines it is mandatory that new and existing sites be designed to prevent the loss of any treatment chemicals into the environment. The guidelines state that "*all plants shall be laid out so that any spillage or dripping of preservatives cannot enter the soil, surface water or ground water systems, or in the case of dry material, from blowing away*" (Ministry of Labour, 1990).

The Canadian Technical Recommendations suggest design aspects which are intended to:

> "* *prevent or reduce direct contact of personnel with CCA wood preservative chemicals;*
> * *reduce releases of CCA to the environment to the greatest degree possible by providing secure containment of CCA solutions; and*
> * *to enable prompt response and effective corrective measures to assure worker safety and environmental protection after abnormal events, such as tank rupture*" (Konasewich & Henning, 1988).

Both of these documents also state that alternatives to those suggested may be used, providing that a similar level of environmental protection is provided. It should be stressed that there exists no right or wrong way to solve an environmental problem, as long as the problem is solved. Accordingly, site specific factors will often determine design criteria, and while guidelines will be invaluable, plant managers should look for innovative solutions which will suite their situation.

4.1 Site Selection

Historically site selection has been controlled primarily by economic considerations, such as distance to raw materials and markets, and the availability of land and suitable workforce. It is now however necessary that consideration is given to environmental parameters, such as soil type, proximity of water courses, topography and flood interval. Attention to environmental matters should now also be considered as an economic factor. Location of a site in an environmentally sensitive area, or near sensitive sections of the community may cause considerable delays during the Environmental Impact Assessment process. In the worst case scenario this may lead to a site being rejected, after time in the Land & Environment Court, and the accompanying costs.

Therefore, before a site is chosen, environmental parameters should be considered. Sites which meet few or none of the favourable environmental characteristics should be rejected, as not only will plant design need to be modified to guarantee environmental protection, but increased operating and monitoring costs will also be incurred.

The NZ OSAH Guidelines and the Canadian Technical Recommendations both suggest environmental factors which should be taken into consideration when planning the siting of a CCA timber preservation plant.

4.2 Plant Design

4.2.1 Bunded Areas: The process area, chemical storage area and the drip pad should be surrounded by continuous, impervious structurally sound bunds to prevent the movement of chemicals from these areas. Conversely, they prevent storm water from entering these areas.

Layout of the plant should consider access points onto bunded areas so that only essential traffic crosses such areas. The NZ Guidelines make it mandatory for personnel working with treatment chemicals and processes to enter and leave the work area via the changing room.

In order to reduce sludge generation the recycling system should contain a settling tank or sump to separate the solids from the preservatives. A properly designed filtering system should be installed to remove coarse particles, with the filters located so that it is easily accessible for cleaning.

4.2.2 Chemical Delivery Area: Although a routine occurrence at treatment plants, there exists the possibility of a large scale spill during the delivery of CCA concentrate. More common is small scale drippage during the unloading of the concentrate. It is necessary therefore that the unloading of CCA concentrate occurs within a bunded area which allows the collection of any chemical. Ideally this area should be separate from the drip pad, primarily to minimise tracking of chemical. If for reasons of reduced cost the delivery area is incorporated within the drip pad, procedures should be implemented to guarantee that chemical residuals do not leave the drip pad on truck tyres. These should include cleaning the delivery area before delivery and hosing down the truck tyres as it exits.

4.2.3 Treatment Process and Chemical Storage Areas: One practice being used at some plants in North America is to paint the storage tanks and cylinders white. This means that any drips or leaks are more easily noticed, and therefore should be immediately cleaned up. Another important benefit of this practice is that visitors to the site perceive the process and storage area to be very clean, with the white tanks imparting the impression of a "laboratory" like environment. A favourable first impression is consequently formed, and generally only if something is drastically amiss will this impression be lost. This obviously relies upon the area being kept clean.

In regards to the operator control area, the option exists either for this area to be segregated from the chemical storage areas and the rest of the treatment process area; or to be incorporated within the bunded area. While there are advantages to be gained from both options, on environmental grounds a segregated operator control area is preferred.

If the operator control area is incorporated within the bunded area as in Plate 4.1, the operator is more fully aware of the different stages of the treatment cycle as they progress. However, for occupational health and safety reasons, for better response to any spills and to minimise the tracking of chemicals if a spill occurs, a segregated control area is preferred. The design objective for optimum results would be a operator control area which was located outside of the bunded areas and adjacent to the treatment process area, chemical storage area and the drip pad. In this manner the operator is assured of good visibility of all aspects of the process.

The operator control area should be connected to the plant office, as a minimum, by a telephone or two-way system. In this manner, communication between the two does not require excessive access to the treatment area. The operator control area should also contain any analytical equipment required for normal operations, protective clothing for the operators and visitors, a first aid kit, fire extinguisher and alarm.

4.2.4 Drip Pads: If elevated tramways, with loading/unloading operations by winch are used, the drip pad is isolated from the rest of the facilities. All access to the drip pad can therefore be controlled through one point, and the tracking of chemical off the pad is minimised. Examples of this design feature are shown in Plates 4.2 and 4.3. The height of the rails does not matter, aslong as traffic across the rails is prohibited. The cylinder entrance may be either by a draw bridge, or by staggered rails as shown in Plate 4.4.

Although a dedicated forklift is an ideal method for eliminating the movement of chemicals off the drip pad this may not always be practical. If forklifts are moved on and off a drip pad strict wheel washing procedures should be followed.

One access point for forklifts and chemical delivery trucks should be demarcated at the design stage. At this point the kerb of the bund is replaced by a berm. An automated wheel washing system should be examined, with high pressure nozzles being operated by pressure pads.

Overhead cranes are utilised in some plants in North America. These are ideal from an environmental perspective, although increased time for the loading and unloading of the carriages may make them impractical from an operational perspective. It is however worthwhile to investigate the specifications and costs of these during the design stage to determine if it would be suitable for a particular situation.

Roofing of the drip pad is mandated by some regional councils in New Zealand as a condition of granting discharge permits. The recent amendments to RCRA in the United States stipulate that a drip pad must be roofed or provision be made for the collection of the rainfall from the 25 year 24 hour storm.

The complete enclosure of the drip pad area, as in the colder parts of New Zealand and North America (as shown in Plate 4.5) should be considered. Although expensive, it offers advantages during the operation of a site, including reduced access, thereby lowering the amount of tracking which occurs, protection from dust and rain thereby reducing waste materials and increasing security.

If left open, a buffer zone of several metres of asphalt to reduce dust generation around the drip pad and on the clean side of the rails should be considered. Asphalt should slope away from the drip pad, with drainage being directed into spoon drains which discharge into the storm water system.

A secure area for the storage of waste material drums should be incorporated on the drip pad. This area should be large enough to accommodate the projected requirements for six months, and should be protected from the elements, as shown in Plate 4.6. No other chemicals or fuels should be stored in this area.

4.2.5 Spill Equipment Storage Room: In the event of a spill it is important that the necessary response equipment is quickly accessible. To facilitate this dedicated area for the storage of spill response equipment should be dedicated, as shown in Plate 4.7. Ideally the storage area should be located so that it is outside of the bunded area and readily accessible from the operator control area and the chemical unloading area. The door to the storage room should be sealed such that it may be easily forced during an emergency, but not easily accessible for the use of equipment during day to day operations.

Equipment to be stored should include:

- an approved half-face respirator with the appropriate filter cartridges;
- personnel protective equipment, that is multiple copies of rubber boots, rubber gloves, goggles or helmets with splash shields and rabbit suits;
- spill control equipment such as shovels, brooms, drums and manual pumps;
- absorbent and neutralising materials such as oil dry or absorbent clay, lime, cement, or sodium bisulphate.

4.2.6 Changing Rooms: Plants should be laid out such that changing rooms which incorporate a clean and dirty section are adjacent to the treatment process area and entry and exit to the process area should be through the clean/dirty entrance. Existing plants should be modified if at all practical. Under the OSAH Guidelines the provision of changing rooms to enter and exit the process area is mandatory for new plants. An emergency exit must also be included in the design.

4.3 Stormwater and Soil Conservation.

The design of treatment plant sites should include measures for storm water management and soil conservation. The separation of process waters and stormwater should be controlled by the bunding of the drip pad and process area such that runoff from a site may be discharged directly to the stormwater system. It is important however that runoff controls are designed to prevent soil erosion, particularly from existing sites.

As the CCA chemicals are strongly fixed in the surface soil the movement of sediment offsite will result in discharges above acceptable standards. The key element to soil conservation is the protection of the soil, by vegetation, concrete, asphalt or gravel. Areas within treatment sites which experience minimal traffic, such as road verges and boundaries, should be vegetated. This will both protect the soil and increase the general ambience of the site. The use of trees for wind breaks will both reduce the level of dust generation on site, and likewise increase the ambience of the site. Areas with high usage should be asphalted if practical or be laid down with gravel.

Stormwater directed away from the process area should be discharged through sediment traps, as prescribed by the New Zealand OSAH Guidelines (1992); "*All stormwater discharge outlets from the treatment plant site shall be provided with a silt trap/sump with a capacity not less than 1000 litres to allow the Regional Council to monitor site discharge water and sediment*".

The addition of a sediment basin and emergency retention basin, as shown in Plate 4.8, should be considered. This not only removes sediment by settling, but in an emergency situation the basin may be isolated to prevent discharge. Even when runoff water does not come into contact with CCA chemicals, clean waters regulations specify limits to suspended solids in discharged water, so the control of sediment is a legal obligation.

Plate 4.1: Operator area located within containment area and white process equipment.

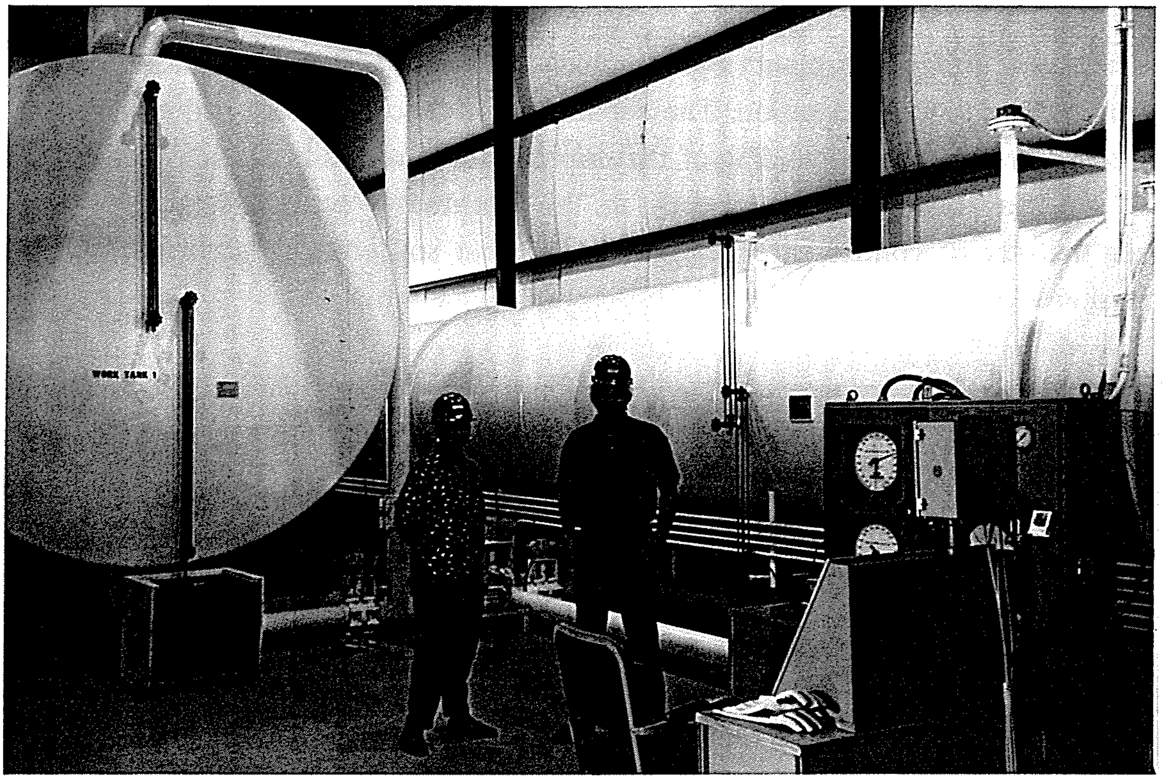


Plate 4.2: Elevated tramway seperating drip pad from loading yard.

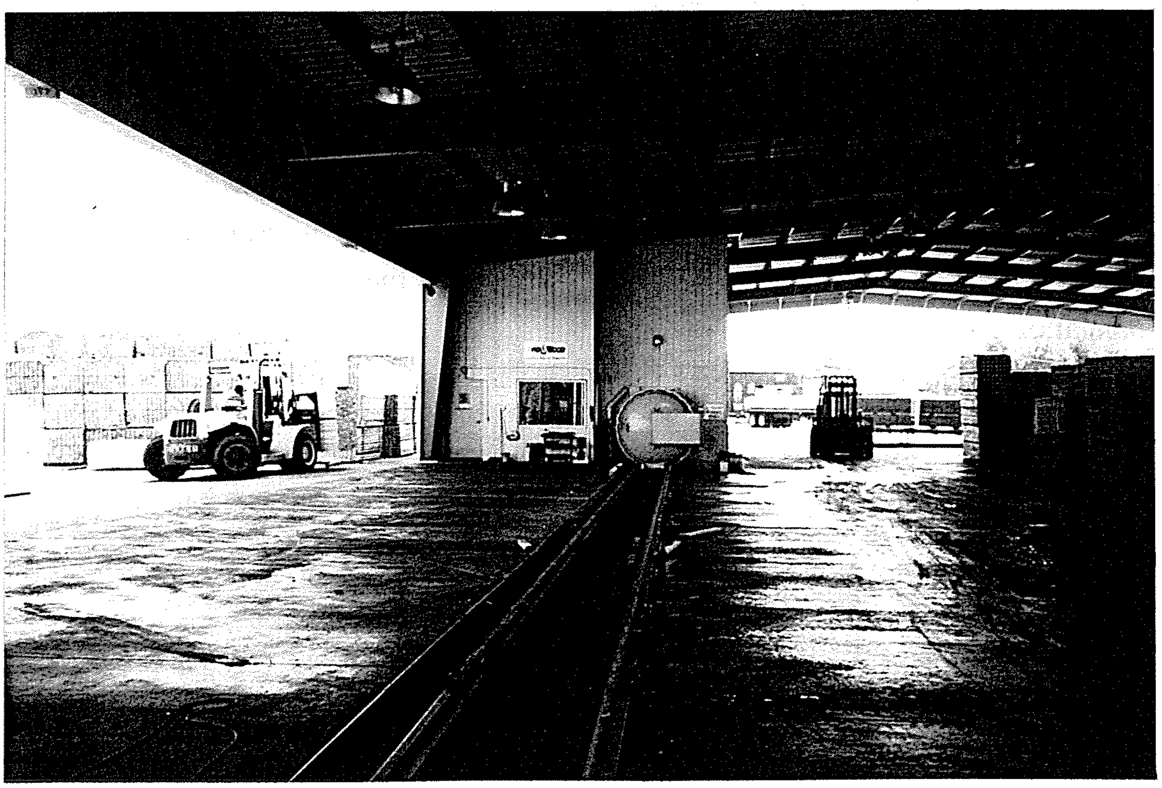


Plate 4.3: Charge being loaded onto an elevated tramway.

Plate 4.4: Staggered entry to cylinder from elevated tramway.

Plate 4.5: Fully enclosed treatment facility in Canada.

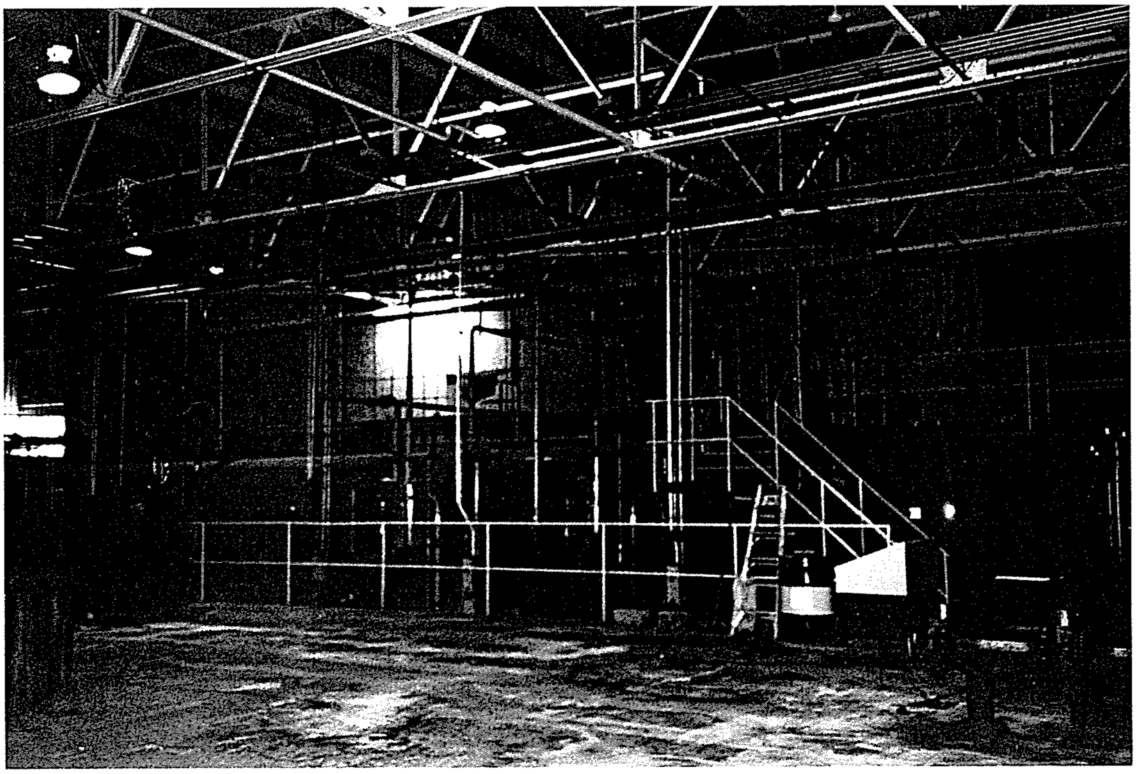


Plate 4.6:
Hazardous waste storage area on drip pad

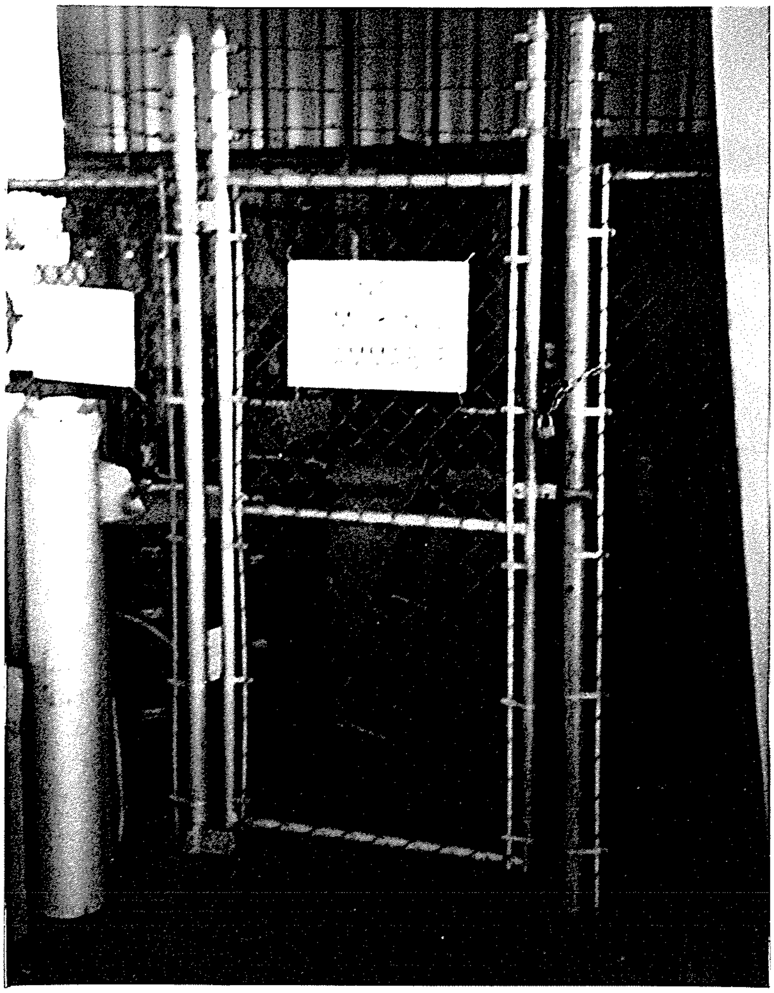


Plate 4.7:
Spill response equipment
storage room

Plate 4.8: Stormwater discharge basin with isolating drain outlet.

5. DRIP PAD DESIGN AND MAINTENANCE.

One of the most valuable pieces of 'equipment' for preventing discharge of chemicals to the environment is a sound drip pad. This fact has been recognised in the various guidelines which describe the design and operation of treatment plants. There has however been insufficient emphasis placed on the need to maintain the drip pads, nor have these guidelines been specific in their details of design.

It is to the plant operator's advantage to think of their drip pad as a piece of equipment which should be maintained, just as for pumps, forklifts and other items of machinery. While CCA chemicals will not permeate through sound concrete of sufficient depth, any cracks will negate the expense of a drip pad and lead to contamination.

Recent amendments to the United States Resource Conservation and Recovery Act have been made because of past contamination from preservation sites. A component of the new regulations is the establishment of drip pads as a new type of hazardous waste management unit. As part of these amendments, the EPA defines a drip pad as " an engineered structure consisting of a curbed, free-draining base, constructed of non-earthen materials and designed to convey preservative kick-back or drippage from treated wood, precipitation, and surface water run-on to an associated collection system at wood preserving plants".

Under the new RCRA regulations the design requirements for drip pads are that:

* Drip pads must consist of a base that is constructed of non-earthen materials, excluding wood and non-structurally supported asphalt;

* Drip pads must have a collection area or device/system designed to collect drippage, leakage and storm water;

* Drip pads must have a run-on and run-off control to prevent contamination of surface water, unless the pads are covered or enclosed in a structure;

* Drip pads must be sloped to free drain treated wood drippage and any other waste that falls onto the pad to the collection system, and must have a curb or berm around the perimeter;

* The drip pads must be strong and thick enough to prevent failure due to physical contact, climatic conditions, the stress of installation, and the stress of daily operations;

* The surface of the drip pads must be sealed, coated, or covered with an impermeable material so that it can contain drippage and precipitation and prevent leakage to the underlying soil as the waste is conveyed to the collection system;

* New pads must be underlaid with leak detection systems, and the pad and leak detection system must be underlaid with a chemical-resistant liner.

The EPA will allow existing drip pads to continue operating without liners and leak detection systems for up to 15 years, depending upon the age and condition of the drip pad, provided that owners/operators obtain from an independent, qualified registered professional engineer a certification of compliance with all other design standards. New pads with liners and test wells are not required to be sealed.

Although the majority of these requirements conform with the existing notion of a drip pad, they also introduce the concept of secondary containment. New drip pads and the required leak detection system must be underlaid by an impermeable, chemically resistant liner, which acts as a secondary containment layer below the primary concrete layer. In this way any chemical which may escape through the concrete will be contained by the liner. Existing drip pads are modified by the addition of an impermeable surface coating, which then acts as a primary containment layer, with the concrete becoming the secondary layer. When a drip pad is constructed with a leak detection system and liner, a surface sealer is not required.

5.1 Secondary Containment Systems.

5.1.1 Drip Pad Liners and Test Wells: The suggested material for the secondary liner is high density polyethylene (HDPE). Reef Industries of Houston Texas manufacture HDPE liners under the name of Permalon in one piece up to an acre in size, at approximately (US) $ 3.00 per square metre. They will accept collect calls from outside of the US on 1 713 484 6892. While this is not a specific endorsement of this product, the specifications are shown in appendix III, and any liner used should be comparable to these specs.

The recommended design for liner installation is shown in Figure 5.1 (Annessi, 1991). A continuous 18ml HDPE containment liner is placed over a layer of 12 oz geotextile fabric. The liner should be in one piece if possible, or joined together with sufficient overlap. A cellular plastic composite drainage system (tex-net) is lain over the liner to promote the free flow of any liquids to the test well.

The test well is located at the lowest point and should consist of a 8" HDPE pipe embedded in aggregate, such as 1/2 " well rounded river rock. The geotextile fabric and HDPE liner should be continuous under the test well, and geotextile fabric should overlay the liner to protect the liner from the aggregate around the bottom of the test well. The bottom 12 " of the test well pipe should be perforated and wrapped with geotextile fabric. It may also be advantageous to include a flush well, using a similar design, through the slab at the highest point.

The three layered lining system of geotextile fabric, HDPE liner and cellular plastic composite drainage system, is then joined to the side of the slab by an extrusion weld. This is shown in Figure 5.2.

Figure 5.1: Design of drip pad liner showing geotextile fabric, HDPE liner and composite drainage system (Annessi, 1991).

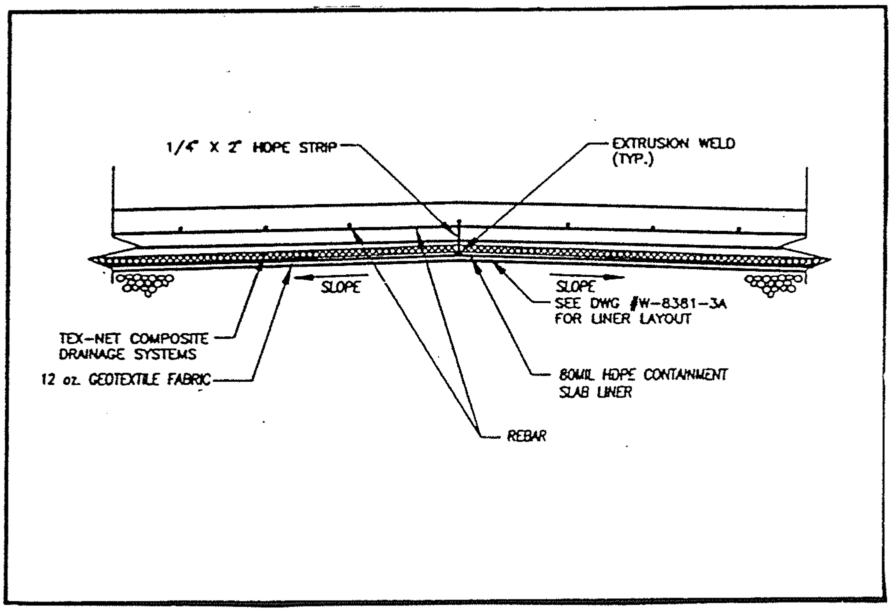
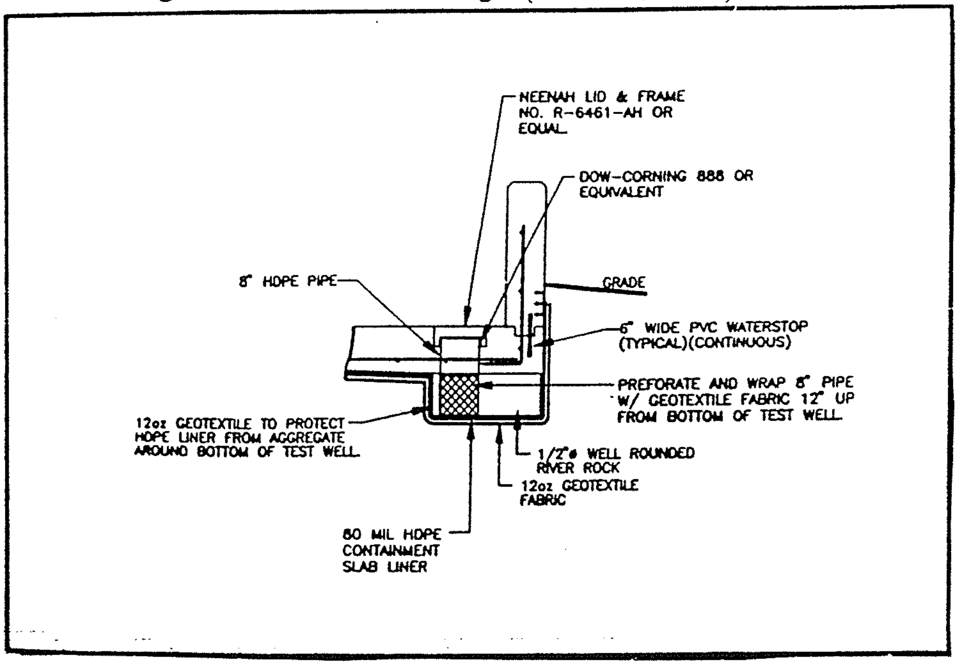


Figure 5.2: Test well design (Annessi, 1991).



5.1.2 Drip Pad Sealant: While the addition of a liner into the design for drip pads yet to be constructed is recommended, removing existing drip pads to replace with lined drip pads would be impractical because of the costs involved. Consequently the new RCRA regulations require the surface of existing drip pads to be sealed, coated or covered with an impermeable material. Several penetrating sealers (polysiloxane) have been recommended by the chemical supplier companies in the United States: Sikaguard 70, from Sika Corporation; Enviro Seal 40, from Hydrozo; and SL100 from Prosol Company. It should be noted that although chemical compatibility tests with CCA chemicals are being conducted, these are yet to be confirmed. The cost is approximately (US) $ 8.00 per square metre.

The preparation and condition of the concrete is critical to the success and life of the coating (Keen, 1991). Any repairs to cracks, spalls or joints should be completed and cured prior to sealing. All loose concrete, dirt, tyre rubber, grease, oil and CCA must be removed. This should be achieved by steam cleaning, sand blasting or blast tracing the concrete. Steam cleaning is the least expensive and the water can be reused in the preservation process. However, if steam cleaning does not give satisfactory results, one of the other methods should be used. If steam cleaning is used sufficient time must be allowed for the pad to dry, usually two days. Two coats of the sealant should be applied, with sufficient time being allowed between coats for the sealant to dry. The sealant should then be allowed to cure for several days after the final coat such that it becomes locked in.

5.2 Drip Pad Maintenance and Repair.

The recent amendments to RCRA also specify certain operating requirements for drip pads. Some of these requirements are good housekeeping procedures which should already be applied during the normal operating procedures of a treatment plant. These are further discussed in Chapter 6. Others of these requirements relate specifically to the maintenance and repair of drip pads, and are detailed below. It should be stressed that operating requirements for drip pads, and the plant in general, should be considered during the design phase. This will enable a more efficient operation of the plant as well as allowing any operational requirements to be more easily met.

Under the new RCRA regulations the operating requirements for drip pads are:

* Drip pads must be maintained free of cracks, corrosion or deterioration that could lead to leakage;

* Drip pads and collection systems must be operated to collect drippage or precipitation that falls onto the pad;

* Drippage and precipitation must be removed from the collection system as necessary to prevent overflow onto the drip pad. Collection systems must be emptied immediately following storms;

* Drip pads must be operated and maintained to minimise tracking of hazardous waste fro the pad that may result from the activities of personnel and equipment;

* Drip pad surfaces must be thoroughly cleaned at least once every seven days to remove any accumulated residues (but not permanent stains);

* Drip pads must be inspected at least every seven days during operation and after storms to detect evidence of any conditions that could lead to failure;

* Owners/operators must document operating and waste management practices in the facility operating log;

* Drip pads discovered to be leaking or in danger of leaking must be repaired

or removed from service;

* Drip pads without liners and leak detection systems must be assessed annually by an independent qualified registered professional engineer;

* Releases must be documented and the EPA regional administrator notified within 24 hours of a leak detection. The plan and schedule for repair of a leaking drip pad must be submitted to the regional administrator within 10 days of detection. Certification of repairs and cleanup must be submitted to the regional administrator upon completion of repairs and cleanup.

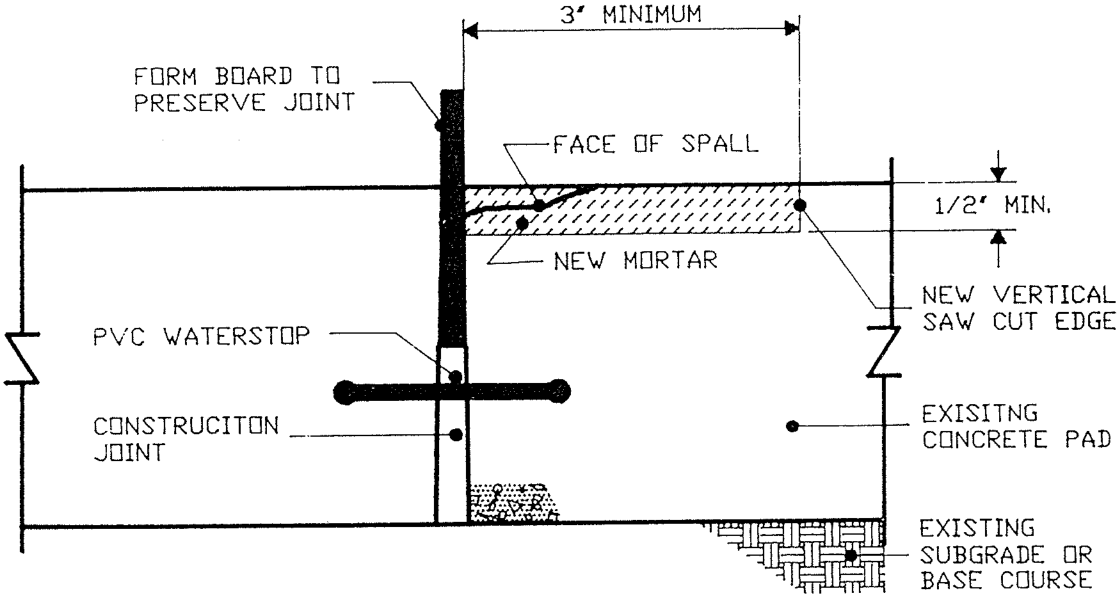
5.2.1 Drip Pad Repairs: All repairs to spalls, joints and cracks should be completed and cured before any surface sealants are applied. Material collected such as old concrete, old sealant and debris during repair operations will probably be contaminated and should be treated as such.

These procedures should not be used for structural failures, in which case the affected area will need to be replaced.

"*Spalling Repair: Spalls should be repaired before joints or cracks are sealed. Vertical saw cuts should be made around the spall at least to 1/2 inch in depth and 3 x 3 " in area. A thin plank should be installed in the joint to protect the joint area if the spalling is on a joint. The concrete should be routed out until all structurally poor material is removed and sound concrete is reached. The depth should be a minimum of 1/2 " and the width a minimum of 3 ". This minimum width and depth must be attained to allow for a sound repair, even though sound concrete may be found before these limits.*

The spall should be blown clean using oil-free air. Apply either a bonding agent (such as Sika's Armitech 110) or epoxy mortar (Sikatop 122) such that the area is flush with the existing concrete. If the depth of the spall is greater than one inch, pea gravel should be added to the mix. Damp burlap should be placed over the area for three days and the area left undisturbed. If on a joint the form board may be removed after this time and the joint resealed." (Keen, 1991).

Figure 5.3: Repair of a Spall on a Construction Joint (Keen, 1991).

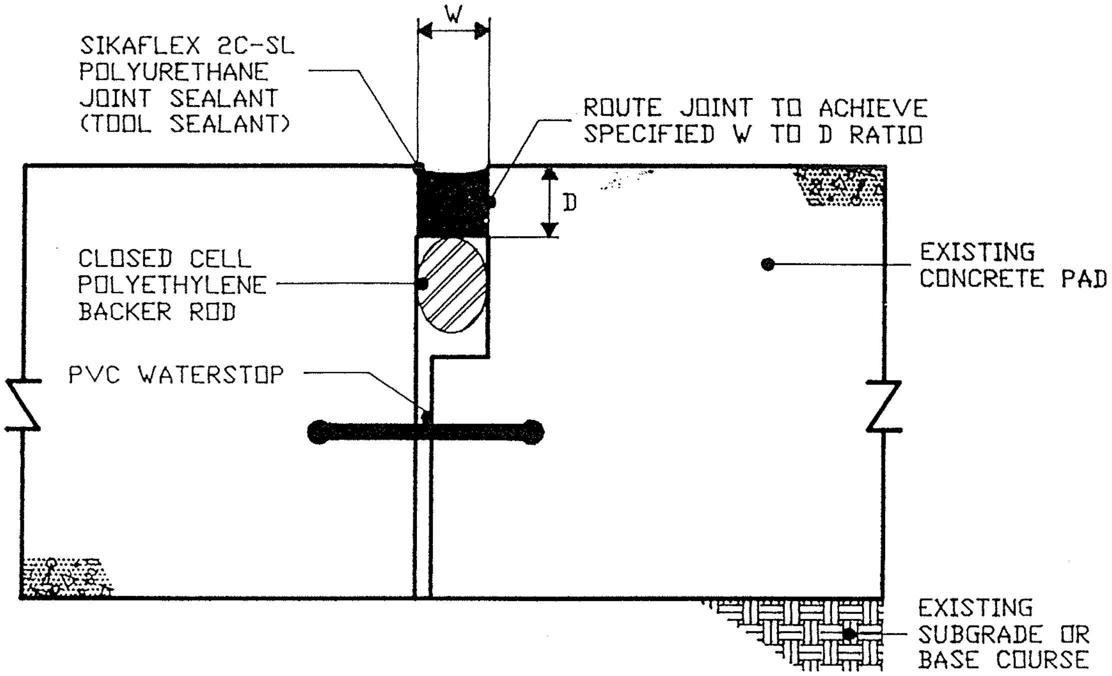


"*Construction Joint or Crack Repair: Construction joints and cracks require the same basic repair techniques* (as shown in Figures 5.4 and 5.5). *The joint or sawcut is routed out until all unsound concrete and old joint sealant compound is removed. The width and depth of the joint or sawcut must be at least 1/4 of an inch. The width and depth should be the same up to 1/2 an inch, with the depth being at least 1/2 an inch if the width is greater than 1/2 an inch. Sand blasting of the joint or sawcut may be required. Blow the sand and other debris from the area with oil-free air.*

Insert a closed cell polyethene backer rod into the join or sawcut. The rod should be slightly wider than the joint. The backer rod prevents the joint sealer from adhering to the bottom of the joint or crack. For cracks with small depths bond breaker tape may be used instead of the backer rod.

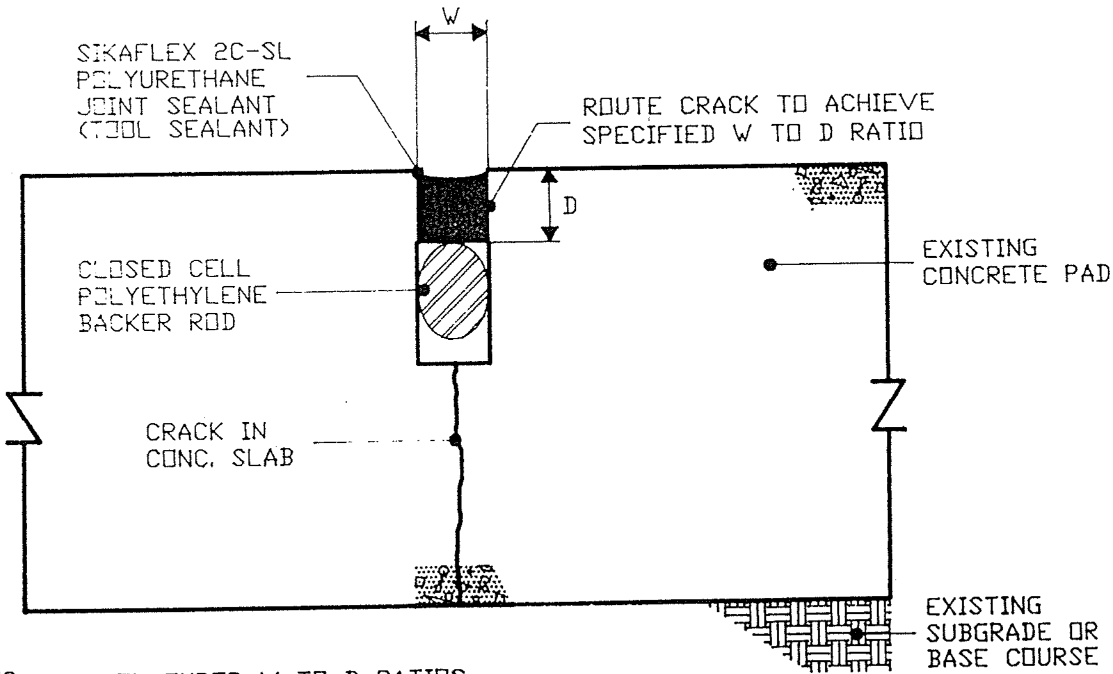
A polyurethane sealant (such as Sika Flex 2C-SL) is poured into the join or sawcut, with any access being removed from the concrete. The sealant should be forced into the joint and a depression created in the sealant by running a spatula or spoon along the joint. If forklifts using the pad have hard wheels a semirigid epoxy, not polyurethane, sealant should be used. The sealant should be cured for two to three days, with all traffic and liquids being kept clear of the repair area." (Keen, 1991).

Figure 5.4: Resealing Joints (Keen, 1991).



NOTES: 1) DEPTH (D) OF SEALANT DEPENDENT ON WIDTH (W) OF JOINT
a) MIN. W=D=1/4"
b) FOR W=1/4" TO 1/2", W=D
c) FOR W>1/2", D=1/2"
2) RESEALING OF SAWCUT JOINTS SIMILAR

Figure 5.5: Crack Repair (Keen, 1991).



NOTES: RECOMMENDED W TO D RATIOS
a) MIN. W=D=1/4"
b) FOR W=1/4" TO 1/2", W=D
c) FOR W>1/2", D=1/2"

6. PLANT OPERATING PROCEDURES.

The operating procedures at timber preservation plants should be designed in such a manner that production objectives and environmental objectives can be met simultaneously. The first step to achieving this aim is to clearly define the environmental objectives of a site. These are often generally defined, as for example by the Canadian Technical Recommendations (Konasewich & Henning, 1988) as:

"* *minimise direct contact of personnel with timber preserving chemicals;*

* *minimise release of timber preserving chemicals to the environment; and*

* *facilitate clear and accurate definition of responsibility and action when emergency response is required*".

Nevertheless, each treatment plant should develop detailed and site specific environmental objectives. These may comprise such elements as the elimination of chemical movement from the containment areas, waste minimisation, control of storm-water and soil conservation, training of staff to an acceptable level, maintenance of protective clothing and emergency response equipment, the development and updating of contingency plans, and the annual auditing of the plant's performance in meeting the various components of the environmental objectives plan.

Detailed operating procedures developed to meet these objectives should be incorporated into a written operations manual which is available to all members of staff concerned. It is important that responsibility and accountability for implementing procedures are clearly assigned to supervisors and employees.

6.1 Process Area and Drip Pad.

6.1.1 Housekeeping: One of the most important components of achieving environmental objectives is the implementation of a good house keeping program. This should begin with the untreated timber, which should be kept clean and free of dirt and dust. Contact with the ground should be avoided by using bearers or skids. The use of a compressor to air blow material from the timber before treatment should be considered.

Regular cleaning of the treatment process area and drip pad is essential. The requirements for the frequency of cleaning vary between the United States, Canada and New Zealand. The New Zealand Ministry of Labour guidelines (1990) state that " *all drip pads and other area subject to the buildup of chemical deposits must be kept clean by regular hosing down with water into collection sumps for reuse or appropriate treatment and disposal. The practice of dry sweeping is not permitted*".

The Environment Canada Technical Recommendations suggest the daily implementation of housekeeping practices. In the United States under the RCRA amendments, it is required that cleaning of the drip pad occurs every seven days. It is not necessary under these requirements that this is done by hosing, only that the drip pad is clean enough for an inspection of the drip pad to determine that no cracks or faults have developed.

By the sensible amalgamation of these requirements, a satisfactory schedule of housekeeping can be defined. For example, a daily cleanout of the process area and a weekly cleaning of the drip pad. The weekly cleaning should could be considered the end of the week task and include an inspection of the drip pad for cracks or faults, the emptying of the sump and the cleaning of the cartridge filter. Ideally the drip pad should be dry swept to collect as much material as practical and then hosed down to avoid the build up of chemical deposits and to better determine the condition of the drip pad. The area adjacent to the drip pad should also be cleaned at this time.

Material collected during a dry sweep should be placed in specially allocated washing trays on the drip pad, as shown in Plate 6.1. These consist of a free draining based frame, with a filter cloth lining, which allows water leached chemical to be returned to the treatment process. After each sweep the trays should be thoroughly rinsed with clean water. This is an inexpensive method for reducing the chemical level in waste, which also recovers chemical for the treatment process.

From the wash trays material should be placed in specially allocated drums on the drip pad, which have been clearly marked as such. All material which has come into contact with CCA chemical should be placed in these drums. It is important that they are equipped with lids (as shown in Plate 6.1) so that they are not used as general purpose garbage bins. When full, the drums should be sealed and kept in a designated, secure area on the drip pad until disposal.

6.1.2 Waste Minimisation: It is important to assure that as little material as possible comes into contact with CCA chemicals. By following good housekeeping practices waste generation will be minimised. Untreated wood scraps, clean dirt, banding and refuse should not be placed in drums with CCA sludge or contaminated material. These should be disposed of through normal garbage disposal or burial.

An ideal method of reducing the generation of CCA contaminated waste is the dedication of a forklift to the drip pad area. This would tremendously reduce the amount of dirt, gravel and other debris that is normally tracked onto the pad and becomes contaminated with treatment solution. While it is unlikely that a dedicated forklift will become mandatory in the United States, Canada or New Zealand, primarily because of the difficulty of policing such a regulation, it is to the treater's advantage to implement this policy. The disposal of contaminated material costs money, and these costs will increase. If at all possible, dedicate a forklift!

In order to reduce the tracking of dirt and gravel onto the pad and the tracking off of CCA chemicals, access to the drip pad should be limited to the plant operators, maintenance personnel and supervisory staff. The entry and exit of the necessary personnel should be through one defined point, and procedures should be implemented to eliminate the movement of materials through this point. Ideally this would be through changing rooms attached to the treatment plant, divided into clean and dirty sections. Existing plants should designate the most convenient point if the construction of changing rooms is impractical.

To facilitate restricted access, a communication system between the office and treatment process area should be installed and used as a part of normal procedures. By the installation of a two-way radio system operators may communicate with loader drivers, steamer operators, etc.

While restriction of access may generally be limited to these personnel, other personnel and visitors to the site will require access at certain times. A convenient and inexpensive method for controlling the movement of materials in these instances is the provision of paper booties, as shown in Plate 6.2. These can be stored in the clean section of the changing rooms and deposited in a CCA contaminated material drum upon exit.

6.2 Waste Management.

In the United States the management of hazardous waste is regulated through the RCRA. The individual plant requirements under this Act vary depending upon the amount of hazardous waste generated at the facility per month. Facilities which generate between 100 and 1000 kg/month (equivalent to between 1/2 and 3 44 gallon drums per month), as at most treatment plants, are considered Small Quantity Generators. If a plant generates more than 1000 kg per month it is classified as a Large Quantity Generator and additional regulations apply. The Act requires that certain provisions be met, including waste minimisation, correct disposal of wastes, storage methods, accumulation time, personnel training, the development of contingency plans and routine inspection. Of relevance to the Australian preservation industry are the procedures used for storage, routine inspection, personnel training and the development of contingency plans for emergency situations.

Storage recommendations include location of the storage area in a section which is safe from damage. Spilled or leaked waste must be removed and the storage area should be fenced, locked and posted. A container holding hazardous waste must always be closed during storage, except when it is necessary to add waste, and it must not be opened, handled or stored in a manner which may rupture the container or cause it to leak. At least weekly, a designated environmental officer or co-ordinator must inspect areas where containers are stored for leaks, deterioration of containers, proper labelling, approved containers, etc. These routine inspections should be recorded in a "Hazardous Waste Inspection" log, which includes the date, what was found and any action taken.

6.3 Contingency Planning.

It is important that plant staff are able to respond correctly when an emergency situation occurs. To facilitate this response it is imperative that a contingency plan is developed for each site and that staff are well versed in the implementation of these plans. The development of a contingency plan will protect both life and property, and prevent hazardous spills leaving the site and contaminate surrounding land or groundwater. A contingency plan should set out the procedures that are to be followed to respond to various types of emergencies that may occur at a plant. The contingency plan should include:

* Designation of personnel to take responsibility for the co-ordination of an emergency response;

* Assignment of emergency tasks to specific personnel;

* Emergency conditions requiring evacuation and evacuation procedures;

* Types of protective clothing and safety equipment required;

* A plant layout map noting the location of chemicals, flammable liquids, first aid, emergency equipment;

* Identification of all materials considered hazardous and details of these substances;

* Contacts for local fire departments, police, hospital, doctor and state emergency service, and co-ordination procedures for these bodies;

* Detailed procedures for responding to emergency situations.

For example, spill procedures should include (CSI, 1989):

"*1. Immediately contain the spill by the construction of earthen dykes or other barriers with shovels, rakes or loaders as appropriate;*

2. Recover the spilled waste. Shovel into drums for disposal. Soak up liquids with absorbent;

3. If spilled on soil, treat chromium waste with sodium bisulphate and add lime to stabilise the pH".

In the United States facility contingency plans are required by law for proper response to a hazardous waste, chemical or oil spill, under Title III of the Superfund Amendments and Reauthorization Act, the Federal Water Pollution Control Act and the OSHA Hazard Communications Program.

The Environment Canadian Technical Recommendations recommend the development of contingency planning for response to both spills and fires, and that the plan be filed with the relevant authorities. Detailed in the Canadian Technical Recommendations are sections covering Implementation Capacity and Environmental Protection & Liability Risks, which state that a contingency plan should;

> "*Describe location, capability and limitations of cleanup and containment equipment. Pre-arrange for use of the best available cleanup and containment equipment. Identify detailed response options and strategies. Provide for training programs and regular practice sessions. Detail how communications will be maintained among all parties during response operations. Consider its degree of implementation as a normal prevention procedure . Address human safety issues. Assign selected personnel to respond to public and media calls.*
>
> *Identify high risk areas and operations. Discuss expected behaviour of spill materials. Identify critical environments for protection and place in order of priority. Detail specific actions planned for minimising damage to resources. Have explicit standards spelling out what constitutes effective clean-up. Have provisions for responding to spills under all anticipated weather conditions. Pre-arrange all response capability needed for the estimated "worst-case" spill*" (Konasewich & Henning, 1988).

In New Zealand the regional councils require that in the event of a spill that may extend beyond the site perimeter that the council, the fire service and the downstream landowners are notified immediately. Procedures for responding to spills are mandatory, as set out in the OSAH Guidelines:

> "*1. isolate the source of the spillage and ensure no further discharge occurs;*
>
> *2. contain the spill with soil or sand, and mop with sawdust or other absorbent material;*
>
> *3. if substantial quantities are present, e.g. over 50 litres, an attempt must be made to recover the liquid by pumping into a storage tank or other container. Smaller quantities shall be absorbed completely and placed in a drum or similar container and clearly labelled.*" (Ministry of Labour, 1990).

6.4 Personnel Training.

Essential to the proper operation of a treatment plant, and to the response to emergencies, is the adequate training of all personnel. As it is necessary to train personnel to meet production objectives, only by satisfactory training can the discharge of chemicals or the contamination of the site or groundwater be prevented.

In the United States additional to the Occupational Safety and Health requirements for staff training through the Hazard Communications Program, operators of treatment plants have responsibilities to assure a minimum level of training under the Resources Conservation and Recovery Act (RCRA). The level of RCRA employee training is determined by the extent to which employees work with and around hazardous wastes. Management and supervisors are required to have broad training so that they are familiar with all aspects of hazardous waste management. The training program requirements detailed by the Act include the management and handling of hazardous waste, the hazardous waste contingency plan, response to fires, explosions, groundwater contamination and operations shut downs.

The Canadian Technical Recommendations are unusually reserved on this subject, suggesting that all foreman, on-scene supervisors, operators and handlers are trained in good work practice.

In New Zealand, the Ministry of Labour requires that the training of workers in the safe use of timber preservatives be undertaken by every employer before any worker undertakes any work, unless supervised by experienced personnel.

Plate 6.1: Washing tray with free draining base and filter cloth lining.

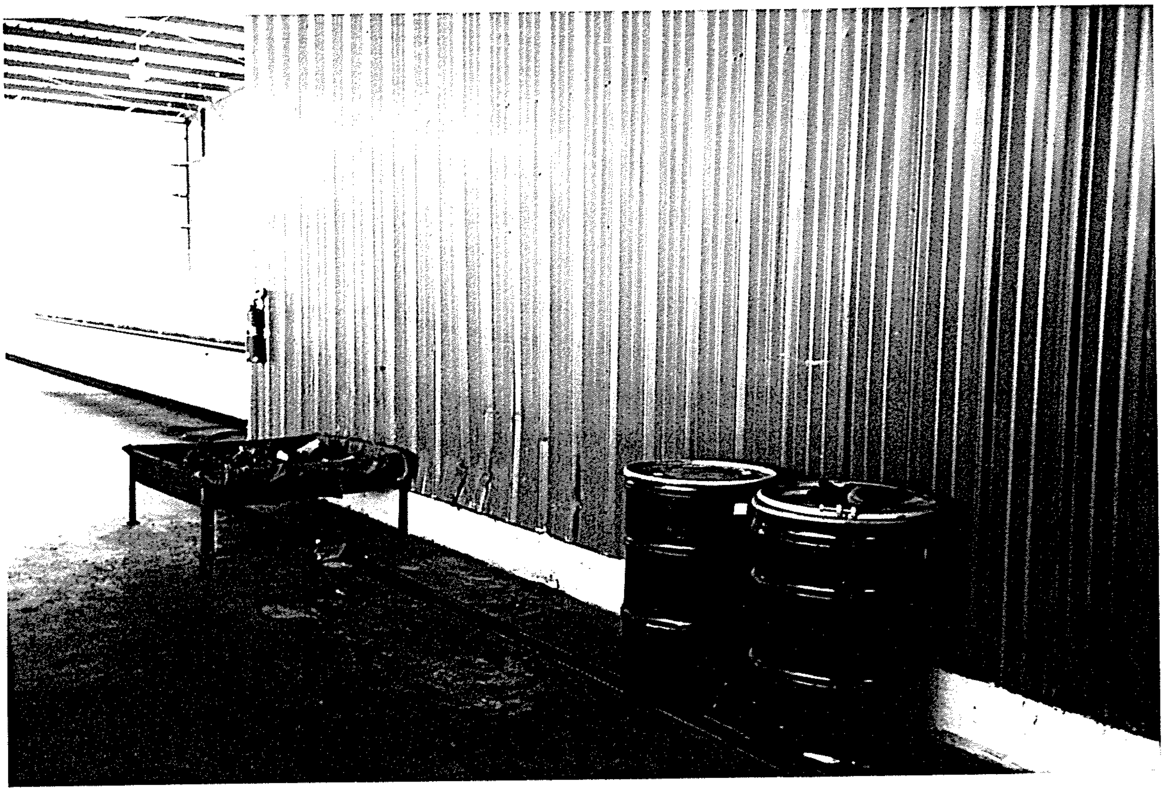


Plate 6.2: Visitors wearing paper booties to prevent tracking of wastes.

7. ENVIRONMENTAL MANAGEMENT AND IMPROVED FIXATION.

One aspect of the timber preservation process which easily lends itself to improved environmental management is the reduction of drippage from treated timber. This is reflected in industry action both in Australia and abroad. To achieve this objective two techniques are being investigated and developed: modification of the treatment process via the addition of a final vacuum and the development of accelerated rates of fixation.

Modifications to the treatment schedules developed by the preservative suppliers has enabled the application of a final vacuum within the treatment cycle. This, whilst reducing the potential for on-site contamination, also reduces the holding times for timber on the drip pad and gives greater control over chemical usage. Information on this process, marketed under various names such as Tanalith Dry, should be obtained from the appropriate supplier. The New Zealand Occupational Safety and Health Guidelines recommend techniques for the reduction of drip from pressure treated timber. These include the application of a final vacuum of at least minus 85 kPa for not less than 15 minutes and the tilting of timber using bolsters to help excess solution run off.

The fixation of the preservative chemicals within the timber is potentially the most controversial aspect of the preservation process. An exact definition as to when the fixation process has been completed, and a method for readily determining when this has occurred, remains elusive. Timber which may be dry, and therefore generally presumed to be "fixed", may begin dripping again under the right climatic conditions. Past work practices of leaving incompletely fixed timber upon unprotected surfaces has lead to contamination of sites, and much of the attention now focused upon the industry is a direct result of this occurring. There is also evidence to indicate that the rate of leaching from timber in service is increased when treated timber is dried rather than fixed, compounding the environmental problems facing the industry. Furthermore, timber which is dripping whilst being transported, which has certainly occurred in the past, presents the worst face of the industry to the public - which is also the enduser.

Due to the difficulty in defining when the fixation process has been completed, regulatory agencies have generally avoided to attempt a definition. Rather they have opted for specifying a minium requirement for the holding of the treated timber upon an impervious drip-pad. Under the recent amendments to the United States Resource Conservation and Recovery Act, treated timber must be held on the drip pad until drippage has ceased. The Environment Canada Technical Recommendations state that drip pads must be designed to provide sufficient storage area to hold all freshly treated wood for a minimum of 48 hours under cover or 96 hours in specially designated uncovered area, with assured recovery of dripped material and precipitation. The NZ Occupational Safety and Health Guidelines recommend that all freshly treated timber which may drip shall be stored in a holding area for 48 hours or until the surface is touch dry, whichever is the shorter.

As the regulatory agencies require that the treated timber must be stored on impervious structures during this fixation period, any technique used to reduce the amount of post-treatment drippage and to speed up the fixation process will impart advantages in the operation of a treatment plant. While the drip pad at a site should eliminate post-treatment contamination of a site, accelerated fixation will reduce the extent of the required drip-pad, imparting considerable savings on expensive civil works. The potential for contamination from treated timber held within the drip pad, as well as contamination from rainwater run-off from treated timber held within the yard would be reduced to almost be non-existent. By employing accelerated fixation techniques, the storage time required to hold stock would be reduced, and worker safety would be improved as precautions for handling the fixed timber would be identical to untreated timber.

An important consideration, given the ability of accelerated fixation techniques to reduce the potential for environmental contamination, is that of regulation of this aspect of the process. The feeling within the industry in New Zealand, the United States and Canada is that legislation concerning fixation will be enacted within the next two to five years, if the lack of accelerated fixation techniques can be identified as a significant cause of contamination. In addition to environmental pressures, it is thought that occupational health and safety considerations will further increase the pressure for this type of legislation.

Market forces within Canada and the United States may however dictate accelerated fixation ahead of legislation. Large customers, such as utility companies using treated poles, are beginning to specify that the supplied products be fixed before delivery. The motivation of these customers is both that of OHS, and a desire to portray an "environmentally friendly" image, whilst avoiding any entanglements with environmental groups.

In response to the problem of excess drippage and inadequate fixation, several techniques for accelerating and improving fixation have been developed or are being investigated. These include steam fixation such as the MSU process and the Koppers-Hickson HiFix method, kiln fixation and drying and the use of elevated temperatures with a catalytic process. These will be examined after briefly reviewing the fixation process.

7.1 The Fixation Process.

Much has been written on the fixation process, notably by Dahlgren (1972), which should be consulted for a detailed review. Essentially the process involves the formation of precipitates, through ion-exchange and adsorption reaction, within the wood which results in the reduction of the active elements. The rate and path of fixation is dependant upon temperature, moisture content, species of timber and the composition and concentration of the solution. Although more complex in reality, a three stage reaction process has been proposed (Dahlgren, 1972), which involves an initial instant reaction when the preservative comes into contact with the wood, a main precipitation fixation period and a final reaction period.

Initial instant ion-exchange and adsorption reactions between the wood and the preservative solution involve the ion-exchange fixation of copper, the temporary ion-exchange consumption of hydrogen ions and the adsorption of the chromic acid. During this phase there is a substantial increase in the pH.

The main precipitation fixation period is characterised by the release of protons and adsorbed chromic acid from the wood fibre and the formation of precipitation compounds. The pH continues to increase towards a maximum during this phase, with the maximum coinciding with the complete precipitation of chromium, which indicates the end of the main precipitation period. The chromium is thereby reduced from a hexavalent to a trivalent state, with the copper and arsenic being precipitated considerably before the end of the chromium precipitation.

As some of the newly formed compounds are not stable at the now higher pHs, slow conversion reactions via dissolution lead to the formation of more stable compounds. The final equilibrium fixation products include ion-exchange fixation of copper to the wood, copper arsenate ($Cu_2(OH)AsO_4$), chromium hydroxide ($Cr(OH)_3$) and chromium arsenate ($CrAs_4$).

The rate of fixation is highly dependent upon many factors, including temperature, moisture content of the wood, wood species, RH, the CCA formulation being used and its concentration. For any given situation, temperature and moisture content are the variable factors, with the other factors being determined by other objectives. Accordingly, techniques for accelerating fixation use the manipulation of these two variables.

Temperature exerts the greatest influence on the rate of fixation by acting as a catalyst for the reactions involved. The approximate time to completion of the fixation process as a function of temperature, as determined by a number of studies, is shown in Figure 7.1. Moisture content of the wood is also important, as full moisture saturation of the wood cell walls promotes better mass transfer of the chemical involved in the process. This may also be related to the low solubility of the precipitates formed during the main precipitation period, such that with increased moisture content the conversion reactions occur at an increased rate and consequently the time to the final reactions reduced.

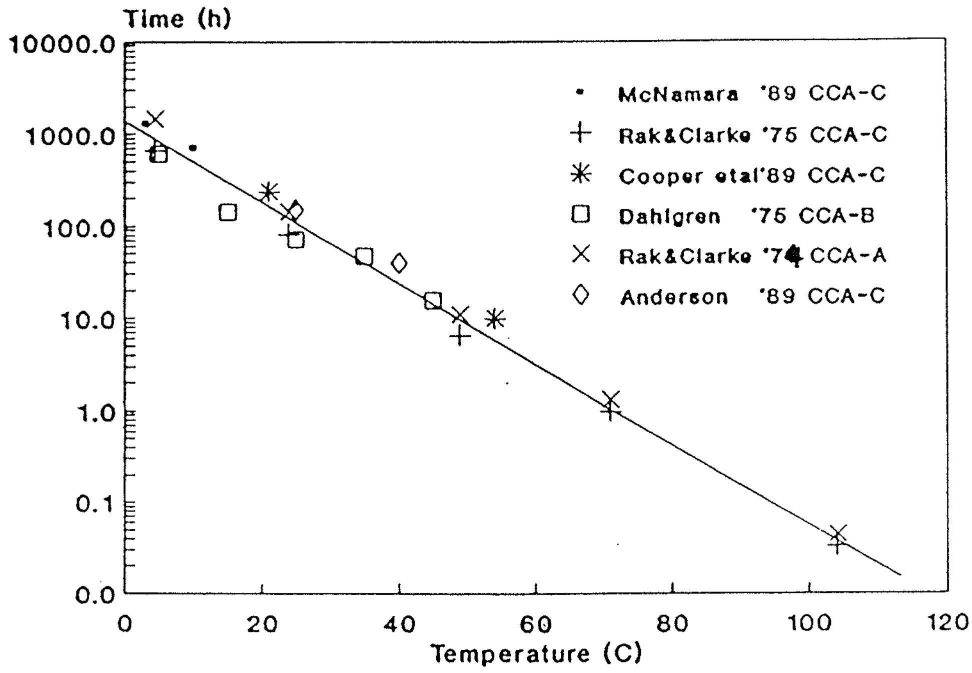


Figure 7.1: Relationship between temperature and time to fixation as determined by various studies. (Cooper, 1990).

7.2 Determination of the Degree of Fixation.

Fixation studies have shown that hexavalent chromium is the CCA component which takes the longest time to be immobilised through its reduction to trivalent chromium. As hexavalent chromium complexes with chromotropic acid - resulting in the formation of a pink/purple colour - but not with trivalent chromium, it is possible to determine the degree of fixation by the presence of the coloured chromotropic acid complex.

A method for this determination has been proposed to the AWPA by the United States Department of Agriculture's Forest Products Laboratory (Foster, 1988):

"Half a gram of chromotropic acid or its di-sodium salt is dissolved in 100 ml of 1 molar sulphuric acid. This solution should have a shelf life of at least 2 months.

Samples of freshly treated timber should be hand bored and then split. The bit should be thoroughly rinsed in water between borings. The split sample should be allowed to come to room temperature before proceeding.

The test sample should be placed on a white plotter paper surface, such as filter paper or a white index card. Using a medicine dropper several drops of the chromotropic acid solution are applied to the sample. Usually 5 to 7 drops per one-inch length of core is sufficient for a core still wet from treatment. If the core is dry it is helpful to apply 2 or 3 drops of the solution and allow the surface of the core to become saturated before applying the remaining drops.

Allow the reaction to continue for at least 10 minutes, then remove the wood sample and observe the coloured complex that has leached onto the blotter. If the blotter is not wet insufficient solution was applied and the test should be repeated. Any pink to purple colour on the blotter indicate the incomplete conversion of chromium VI to chromium III".

This method has the advantage of being a quick and inexpensive technique for determining an approximation of the degree of fixation which has taken place. The only limitation to this technique is that a minimum detection limit of 15 ppm chromium VI exists. It is however a useful comparative technique which offers an indication of the degree of fixation.

Using this negative chromotropic acid test variations in fixation times depending upon CCA concentrations have been approximated (Passick and Osborne, 1991) as;

$$\text{time in days} = 3.2\ (\%\ \text{CCA}\ ) + 6.2$$

This relationship, shown in Figure 7.2, was determined using Southern Yellow Pine treated by a full cell process under summer conditions. By using this approximation it is possible to determine when timber treated at varying concentrations is completely fixed, thereby giving the treater improved control of site emissions.

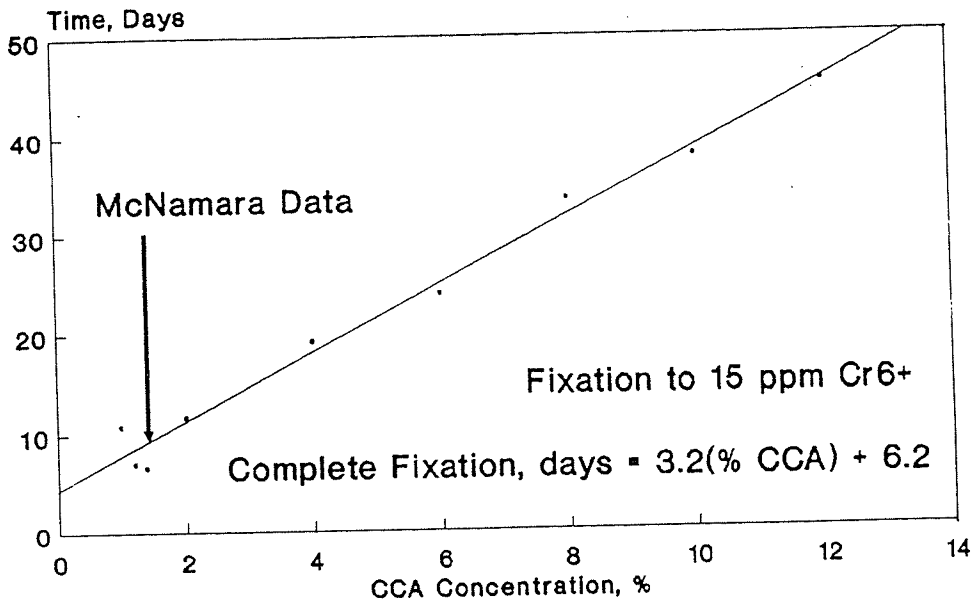


Figure 7.2: Fixation time versus CCA concentrations, full cell process treating southern yellow pine at ambient summer temperatures (Passick & Osbourne, 1991).

7.3 Accelerated Fixation Techniques.

7.3.1 The MSU Process: One of the earliest techniques developed for accelerating the fixation of CCA preservatives was developed at the Mississippi State University (MSU) during the late '70s. Following the publication of test data in 1980 changes were made in the Standards of the American Wood Preservers' Association to allow for the use of the process. The main advantage of this process include (Barnes, 1988):

* all CCA chemicals are precipitated or fixed prior to the removal of the timber from the retort;

* as a final vacuum is used after the fixation period, the excess preservative is drawn off and the timber is dry upon removal;
* the resultant weight increase of the timber is less than one-third of that obtained by the full cell process, thus reducing or eliminating post-treatment drying of the timber;
* plant efficiency is improved by reducing the mechanical handling of the timber; and
* the desirable characteristics of an empty cell treatment are maintained while achieving a full cell preservative gradient.

Essentially the MSU process involves a heating period following the addition of the preservative while the timber is still held within the retort. Either steam or hot water may be used as the heating medium. Water gives a better mass transport within the wood as it is a better conductor of heat, although by using steam less dirty water is generated. Since the preservative is fixed within the timber an empty cell process can be used, as well as a final vacuum.

An example of a treating schedule utilising the MSU process is as follows (Wood et.al., 1980): a 10 minute initial air pressure of 10 psi is followed by treatment to refusal with CCA at 150 psi. The CCA is then removed while maintaining the pressure at 150 psi. Steam coils within the retort are then covered with water and the temperature is raised to between 210 and 220 °F, while the pressure is decreased to 35 psi. These temperature and pressure conditions are maintained for three hours, then a one hour final vacuum of 26 to 27 inches of mercury is applied following the heating period. This type of schedule is shown in Figure 7.3.

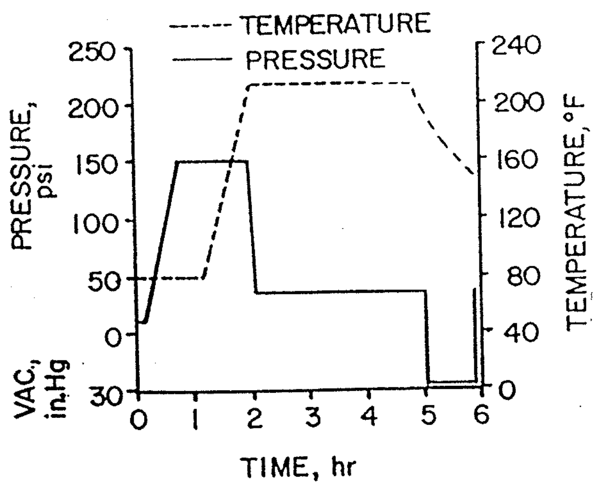


Figure 7.3: Treating cycle used to treat southern yellow pine pole sections with CCA by the MSU process-modified Rueping process (Wood et.al, 1980).

Although obvious advantages are obtainable using the MSU Process, commercial utilisation has been very limited. This can be explained by the extended retention time of the charge within the cylinder - four hours in the above example. In a competitive market, where turn around time between charges can dictate the success of an operation, it is necessary that any accelerated fixation process does not involve a reduction in the efficiency of the treating cylinder. Problems can also arise using this process if the amount of heating water used exceeds that required for the treating process, necessitating the treatment of contaminated water.

7.3.2 Hifix Steam Fixation: In an attempt to avoid the draw backs of the MSU Process Koppers-Hickson have developed a method of controlled fixation which also utilises heating of the treated timber by steam, termed Hifix Steam Fixation. This system, developed in New Zealand for use with radiata pine, utilises a steaming vessel in addition to the treating cylinder, thereby freeing the main treating cylinder for the commencement of the next charge. The extent of surface drying varies, depending upon steaming temperatures and the species involved. Using the Hifix system, process schedules are developed which enable the treater to pre-determine the speed and degree of fixation most appropriate for their needs. The process schedules are variable depending upon the species and timber sizes, the configuration of the timber pack and its stickering and the required surface appearance (Koppers-Hickson, 1991).

Fixation can be used by one of two means using this system. Either the CCA chemicals are fixed within the steaming vessel during the steaming process, which allows the timber to be dispatched almost immediately from site, or the timber may be steamed to a specific temperature and then withdrawn to stand for a further period on the drip-pad. The latent heat within the pack completes the fixation process, thereby reducing the amount of time a pack is held within the steaming vessel.

7.3.3 Kiln and Warm Chamber Fixation and Drying: In the colder regions of North America the need for raising temperatures above the ambient temperature is essential to allow the completion of the treatment cycle. An example of this is shown in Plates 7.1 and 7.2, where Total Forest Industries employ a post-treatment kiln at their Hagersville treatment site in Canada. This technique may also be used in warmer climates to accelerate the rate of fixation. The methods used to achieve this are obviously variable, and should be chosen according to the specific site conditions. Factors may include if kiln or boiler facilities exist on a site, can timber off-cuts be used as a fuel source or what other heat source is most readily and economically available, the rate of production through the treating cylinder/s, space requirements and availability, etc.

Whatever method of elevating temperature is utilised, it is imperative that accelerated fixation is not confused with drying of the timber, as the fixation process is impaired by the drying of samples before fixation. Not only is the diffusion of the CCA chemicals within the cell walls impeded if the moisture content is too low, but better heat transfer into the interior of the wood is obtained with a higher moisture content. Consequently any attempt to accelerate fixation using kilns or warm chambers should employ moderate temperatures of between 50 to 60 °C and high humidity, as the wet bulb temperature is more important than the absolute temperature.

7.3.4 Catalytic Fixation: It is possible to achieve accelerated fixation by the use of a chemical catalyst in addition to heat catalyst. CSI in the United States employ a second retort in addition to the main treatment cylinder. After treatment with the CCA preservative solution the charge is placed into the second cylinder using a rail transfer, and the chemicals are added whilst the temperature is elevated. This process, whilst raising the temperature and keeping the moisture content of the cell walls up, has the added advantage of aiding fixation through the catalytical action of the chemicals.

This technique is still in a commercial development stage, with full operation expected in 1992/93.

7.4 Australian Applications.

While it is not currently required for accelerated fixation techniques to be applied within Australia, designed operational life of a plant will exceed political and regulatory time frames. If the predictions from North America and New Zealand are proven correct and accelerated fixation becomes legislated, it is reasonable that Australian regulators will at some stage follow suit. The design of treatment facilities in Australia should take this into account. Although it may not be possible to design plants which initially employ this technology, plants should be designed such that accelerated fixation can be incorporated at a future date. Attention should be given to such aspects as: spatial requirements for the appropriate fixation technology; location of this technology such that optimal operating practices will occur, including the movement of timber to and from this technology; and, cost of the system in the future. Design of extensions or remodelling at existing sites should also take into account the future incorporation of fixation technology.

However, considering the benefits obtainable with the use of fixation technology - environmental, operational and financial - consideration should be given to the installation of such technology ahead of any regulatory requirements, at both planned and existing plants. Environmental benefits include:

* reduced potential for contamination both on the drip-pad and in the storage yard;

* reduced area required for covered, impervious drip-pad;

* reduced production of type two sludge;

* reduced clean up costs for contaminated soils;

* reduced leaching of products in service;

* elimination of drippage off-site;

* reduced OHS problems; and

* an improved image of product in the market place.

An additional consideration for proposed treatment plants would be the impact of incorporated fixation technology on the Environmental Impact Assessment procedure. If the details of the improved fixation technology are well presented to the public and the regulators during the assessment procedure, then not only will the project appear more favourable, but expensive delays may be avoided.

Plate 7.1: Pre-kiln holding area at a Canadian treatment Plant.

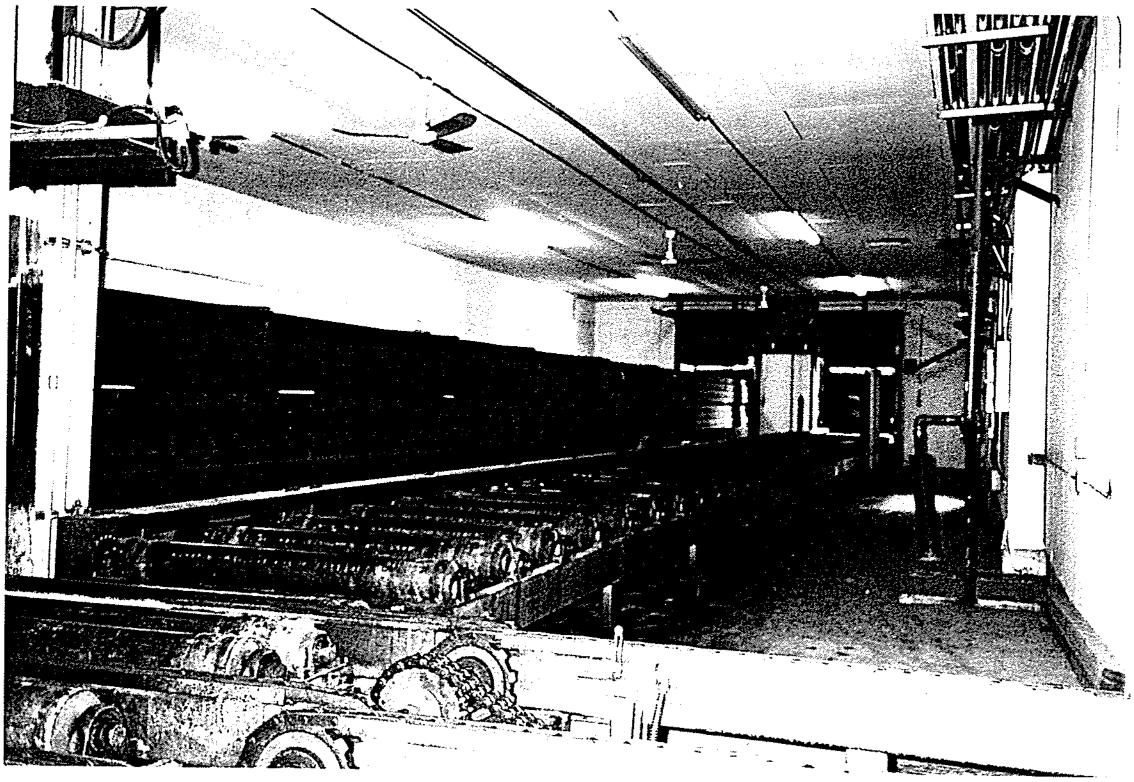
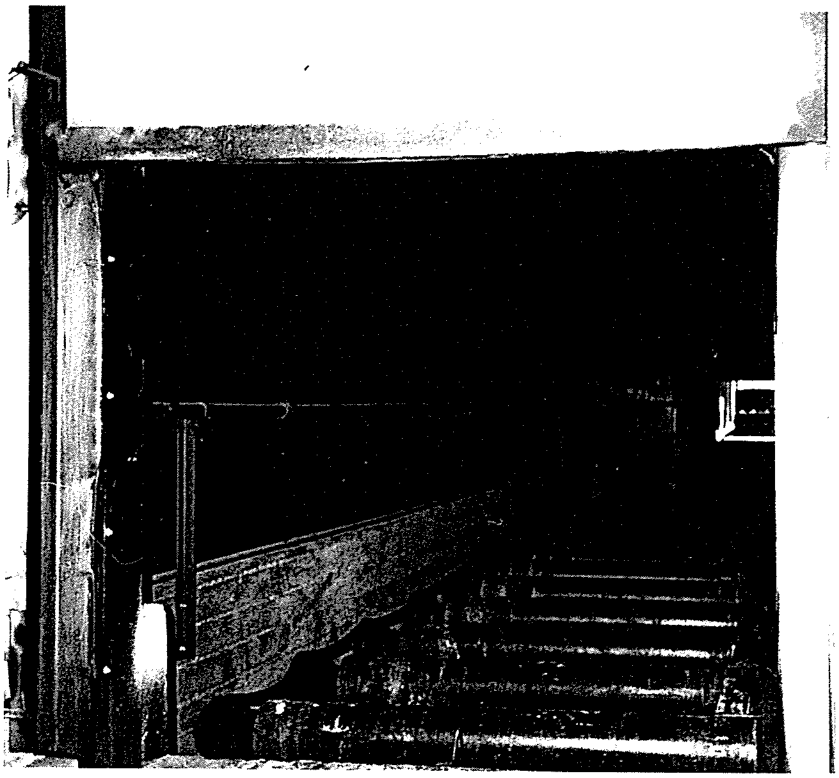


Plate 7.2: Kiln used for accelerated fixation.



8. WASTE DISPOSAL AND SITE REMEDIATION.

The primary solution for the disposal of hazardous inorganic wastes has been the off-site transportation and landfill disposal. In situations where sites have been contaminated by the uncontrolled release of preservative chemicals, these disposal procedures have generally been followed after the contaminated material has been excavated. While this technique satisfactorily removes the contaminated material from site, there are distinct disadvantages; The waste generator is faced with an additional and increasing cost and the material is for all intents and purposes, once landfilled, un-recoverable. Consequently there is increasing emphasis to force generators to utilise resource recovery and on-site treatment wherever possible.

Currently the Best Available Technology (BAT) to generators of CCA wastes is the solidification/stabilisation treatment of the wastes and the subsequent disposal of these wastes in authorised landfills. However, other options available include the extraction of the chemicals from wastes or soils and the in-situ remediation by the use of geochemical fixation or vitrification.

In the USA RCRA required the EPA to develop a system for classifying wastes which are hazardous and to develop a system for tracking the wastes from the point of generation to the point of ultimate disposal. Under this system long term liability issues have arisen wherein waste generators are held totally responsible for their hazardous waste from the "cradle to the grave". Cases exist where waste generators have been forced to pay for the re-excavation and disposal of wastes which were presumed to be no-longer their responsibility. Under RCRA severe penalties exist for the incorrect disposal of hazardous wastes.

Prior to the enactment of the Sub-Part W amendments to RCRA, the disposal of wastes from timber preservation plants was dependent upon the concentration of chromium and arsenic. Wastes which had concentrations above 5.0 mg/L were characterised as hazardous wastes. The leaching procedure used for determining the concentration was the Toxicity Characteristic Leaching Procedure (TCLP), and this is now being adopted by regulatory authorities in Australia.

The TCLP uses an rotating agitation apparatus, which rotates at a fixed speed and for a set time period. The TCLP is designed to determine the mobility of contaminants by simulating the leaching action that occurs in municipal landfills. An attenuation rate of

100 is used to simulate movement through the environment, and if the concentration of the extract exceeds the drinking water standard by 100 times, the waste is considered hazardous.

The New Zealand OSAH Guidelines defines waste from treatment plants which must be disposed of outside of normal refuse disposal. Department of Labour, (1990);

> *"Final disposal of the sludge from any treatment plants, all silt collected in stormwater sumps, and any contaminants captured by filters or scrubbers shall be arranged to the satisfaction of the regional council".*

The Canadaian Technical Recommendations also define wastes needing special disposal and suggests solidification/landfill. Also suggested is the recovery of the components, though it is noted that it is "not commercially feasible in Canada at this time" (Environment Canada, 1988).

> *"Solids with high CCA concentrations are defined as those which include sludges from sumps and cylinders, and disposable cartridge filters which are used to filter recycled waters. ....The preferred means of disposal for CCA contaminated material is solidification and burial in an approved, secure (hydrogeologically isolated) chemical landfill. It is the responsibility of the waste generator to obtain and comply with approvals required by the jurisdiction in which the disposal facility is located."* Environment Canada, (1988).

The development of guidelines to determine cleanup criteria is a relatively recent undertaking for regulatory agencies worldwide, and the techniques used for defining criteria have varied between regulatory agencies. Two approaches have been attempted: The establishment of numerical criteria for regional or national application; or the development of procedures which use risk assessment to determine site specific criteria. Numerical criteria have the advantage that they are easy to use, though they are insensitive to site specific conditions. Conversely, the use of site specific determinations is often complicated.

In the United States the Federal Environmental Protection Agency uses site-specific information to estimate doses that site users could receive via various pathways. Preliminary remediation goals are then identified as the concentrations of a contaminant that will not exceed an assumed risk. This technique, while attentive to site specific conditions does rely on assumptions, and has been at times criticised as being to conservative.

Several Canadian provinces have attempted to develop numerical criteria, such as the Onatario Ministry of the Environment and the Ministere de l'Environnment du Quebec. At a national level the Canadian Council of Ministers of the Environment is attempting to develop remediation criteria, and has to date established interim numerical criteria. These will probably be replaced by site specific procedures.

In principle, remedial action will be required whenever contaminants are present at concentrations above ambient background levels (MOE, 1989). Ambient background levels should be determined by a local sampling program. Clean-up criteria above background levels may be developed providing that they are developed such that human health and the environment is protected. The proposed landuse after remediation needs also to be considered, with cleanup criteria for residential and agricultural land requiring more stringent guidelines, an example of which is shown in Table 8.1 (MOE, 1989).

Table 8.1: Clean-up Criteria for Soils (MOE,1989).

Parameter	Agricultural / Residential / Parkland		Commercial / Industrial	
	medium & fine textured soils	course textured soils [1]	medium & fine textured soils	course textured soils
Arsenic	25	20	50	40
Chromium VI	10	8	10	8
Chromium Total	1000	750	1000	750
Copper	200	150	300	225

* all units in ppm (ug/g) dry weight

1 greater than 70% sand & less than 17% organics

The disposal of CCA contaminated wastes in North America is generally handled by the chemical supply companies, except in the case of site remediation where the services of specialty environmental firms are engaged. The chemical supply companies will collect drums of waste generated during normal operations, provided that all EPA requirements are met. Plate 8.1 shows a Hicksons bulk supply tanker modified to pick-up during delivery.

8.1 Treatment Techniques.

8.1.1 Stabilisation/Solidification: This technique involves the binding of the waste material with a binding material, such as fly ash, portland cement or potassium silicate, to "fix" the chemicals to the binding material. This process is normally carried out at the hazardous waste landfill prior to disposal in lined pits. Studies show that this is an effective method for immobilising the contaminants, as shown in Table 8.2 (EPA, 1990).

Table 8.2: Fixation studies on binding material (EPA, 1990).

Element	EP Toxicity (mg/l)		Binder
	raw	treated	
Chromium	90	0.5	potassium silicate
	90	4.1	portland cement
Arsenic	1.8	0.01	potassium silicate

8.1.2 Encapsulation: An EPA approved technology developed by KMG Services of Houston, Texas obtains satisfactory compression strengths which allows the cement encapsulated waste to be used on-site for construction purposes. The Hazcon process involves the blending of soil/sludge waste with portland cement, a polymer additive called chloranan and water to form concrete. Depending on application requirements the strength of the Hazcon treated material may be developed for landfilling (approx 500 psi) or for load bearing applications (3,500 psi). The process is capable of immobilising contaminants so that the TCLP leachate of treated material reflects less than the limits imposed by the US EPA, as shown in Table 8.3 (Mitchell, 1990).

Table 8.3: Leachate Results of Hazcom encapsulation.

Element	Before Treatment PPM	After Treatment PPM
Arsenic	4100	0.242
Chromium	7700	0.138
Copper	1700	0.074

8.2 In-Situ Treatments.

Two techniques exist for the in-situ treatment of soils contaminated with CCA: vitrification and geochemical fixation. These techniques have advantages over disposal in that the cost of transportation and landfill is removed, although these are replaced by other, generally less expensive costs. However if in-situ treatments are used the material is not recoverable.

8.2.1 Vitrification: This technique involves the solidifying of silicates in the soil by the application of an electric current to the ground, thereby locking up contaminants in the soil. While this technique is very effective at locking up metals, volatiles such as hydrocarbons are given off. This technique, while effective at preventing the migration of metals, is only considered a temporary measure.

8.2.2 Geochemical Fixation: By the addition of chemical reagents to contaminated soils containing free elements, reactions occur which can immobilise the contaminants in the soil. The fixation of copper and arsenic can be achieved by the modification of the pH regime, as long as other conditions such as redox conditions are maintained within an appropriate range. In some cases it may be necessary to form a co-precipitate of iron hydrous-oxide and iron arsenate, where the natural subsurface materials do not have adequate geochemical sorbtive capacity (Pyrih and Bond, 1990).

If the soil properties are appropriate for the geochemical remediation of chromium, this can be achieved by the addition of a reagent to reduce the hexavalent chromium to the trivalent form which in turn is immobilised by geochemical interactions with the aquifer material. If the chemical constituents of a soil are suitable, geochemical remediation may be utilised to immobilise the contaminants within the soil, thereby eliminating the off-site movement of contaminants.

8.3 Extraction Technology.

Extraction technologies can be used to separate contaminants from the host matrix. These systems commonly utilise an extractant and through a separation phase produce a more concentrated waste and a less contaminated residual. In a bench scale study designed to extract chromium from a contaminated mining soil, 64 % of the total chromium and 93 % of the hexavalent chromium were extracted utilising an acid extractant (EPA, 1990).

Hicksons research laboratories in the USA, in conjunction with Lewis Environmental Services are currently developing an extraction technology utilising acid leaching and carbon absorption. This technology, which is proprietary, will enable the reclaiming of copper, chromium and arsenic from contaminated soils and materials, with the reclaimed chemicals being incorporated back into the production stream. A pilot plant is envisioned for 1992.

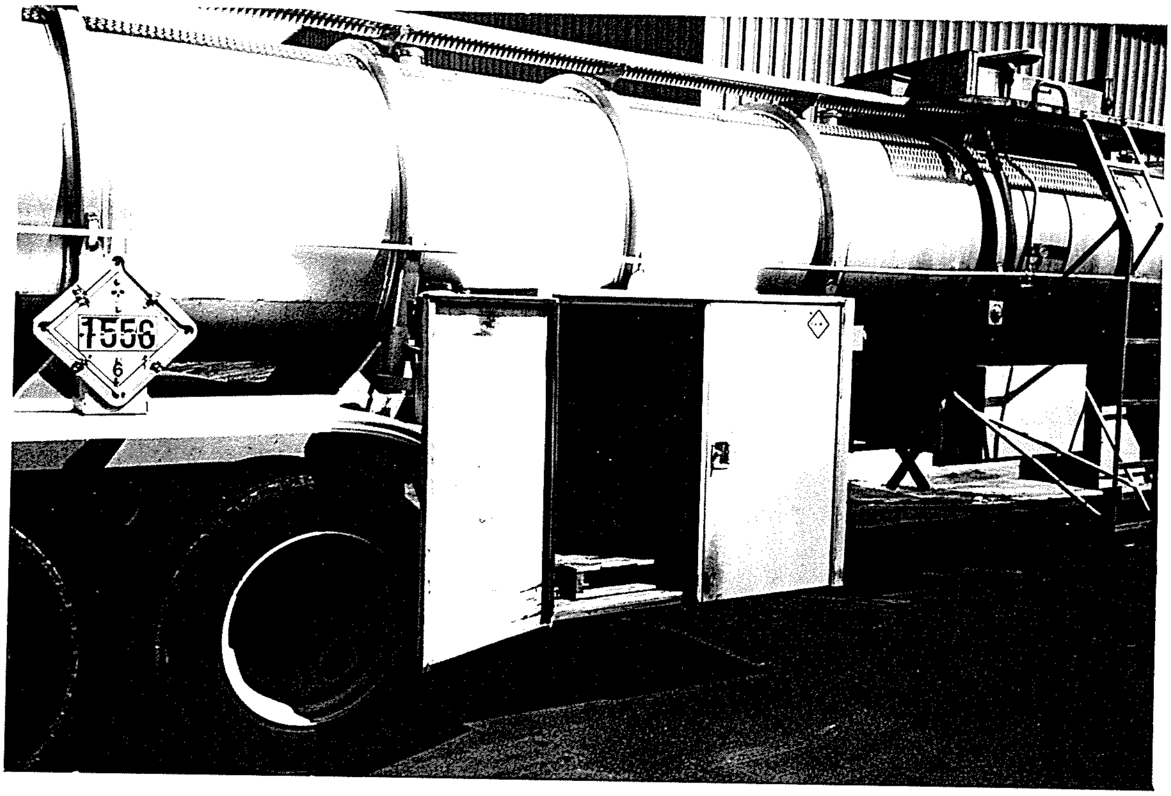
8.4 Australian Applications.

While the technology for digging up and dumping contaminated material currently exists, the immobility of the CCA chemicals in the soil should be considered when developing a remediation strategy for the industry. The interests of the treaters and the environment may be better served if CCA contaminated materials are stockpiled on-site pending the commercial development of an extraction technology.

If material was retained on site in a manner which guaranteed that no migration of chemicals occurred, future options would be the extraction of chemicals, or if necessary, disposal in an appropriate landfill site. If the material is landfilled, no future options can exist for recovery. On-site retention of the material could be in-situ if a sampling program indicated that migration was minimal, or held in lined holding pits if in-situ migration existed. Options would need to be examined on a case-by case basis and regulatory authority approval sought.

The preservation industry should examine the possible option of chemical extraction. While it may prove inappropriate after due consideration, it would be to the advantage of every treater to determine if this technology could be applied to their site within a realistic time frame.

Plate 8.1: Bulk tanker equipped for hazardous waste transportation



9. CONCLUSION AND RECOMMENDATIONS.

The timber preservation industries in North America and New Zealand are focusing more attention on environmental management now then at any other time during the history of timber preservation. This has arisen because of an increased awareness of the need to mitigate their impact on the environment, in response to a market more concerned with environment issues, and through increasingly stringent regulation of industry.

For the most, the preservation industries in these countries have met, and are continuing to meet, the challenge to improve environmental management admirably. Generally this has not necessitated the development of new technology, but rather a improvement in general site management, and the modification and improvement of existing technology. Technological developments have been directed primarily towards improving treatment techniques and accelerated fixation. The industry has also benefited from improvements in waste management and site remediation techniques; fields which have improved greatly in recent years for all applications.

Improved environmental management standards have been reached in the United States, Canada and New Zealand by varying methods, with these methods often being more a reflection of the country in question than of the industry of timber preservation.

The American industry is heavily regulated, with extensive and complicated procedures governing most aspects of operation. This has produced an industry with a high standard of environmental management. Recent amendments to the environmental legislation however have placed an undue burden on the industry, whilst providing no greater environmental protection.

Canada enjoys considerably less regulation then their neighbours, partially because the Federal Government has attempted to encourage voluntary compliance and self-regulation wherever possible. The preservation industry in Canada participated with the Environment Canada to produce technical recommendations for the safe use of timber preservatives, and these have been used by the Canadian industry, and others, as a guideline for the design and operation of treatment facilities. While opinion is varied, it appears that these recommendations will be incorporated into legislation over the next two to five years, to improve the level of compliance.

In New Zealand, industry has co-operated with the regulatory agencies in the formation of a new set of guidelines for the use of timber preservatives. These guidelines, which are expected to be released in June of this year in their final format, have been formulated such that they are more readily enforceable. This and the recent Resource Management Act will see the level of environmental management improve greatly over the next three years, thereby correcting some of the problems of the past.

In all three countries the preservation industries recognise the need to facilitate a better knowledge of the safety and benefits of treated products, and accordingly they have adopted programs to improve their industry's image. These various initiatives will undoubtedly pay dividends, and contribute to the expected growth of the respective markets.

The Australian preservation industry is currently approaching a crossroads. More stringent legislation governing the industry will be enacted over the coming years if a need is recognised by the community and the regulatory agencies. Furthermore, the size of the future domestic market will be decided to a degree by the community's perceptions of the product and the level of environmental management exhibited by the industry.

Self-regulation and voluntary compliance would enable the industry to develop the controls which are most applicable for achieving effective environmental management, while not unnecessarily constraining operations or growth. Improvements need to be made on a collective basis and with the environmental management of individual sites. It is hoped that this report will contribute to this process. Accordingly, the following recommendations are made:

* The Australian preservation industry should strive to achieve the standards of environmental management exhibited in the United States, through mechanisms of self-regulation and voluntary compliance similar to those adopted in Canada and New Zealand.

* The Australian preservation industry should implement an educational campaign and a consumer awareness program on a national level, and establish training seminars for regulatory officers at the state level.

* Design criteria in regards to environmental management, for both the upgrading of existing sites and the establishment of new plants, should be carefully considered on a site specific basis. Designs should be adopted which facilitate environmental management, with special attention being paid to containment and waste minimisation.

* The Australian preservation industry should adopt secondary containment, and treatment plant managers should regularly inspect and maintain drip pads to prevent the discharge of chemicals.

* Detailed and site specific environmental objectives should be established. Detailed operating procedures should be developed to meet these objectives, and incorporated into a written operations manual.

* Preservation plants should adopt accelerated fixation technology as soon as possible. In the interim, plants should be designed such that accelerated fixation technology may be incorporated when available.

* The Australian preservation industry should examine the option of chemical extraction of CCA chemicals from wastes prior to landfill. Approval to stockpile waste material pending the commercial development of an extraction technology should be sought.

The process of improving the environmental management of timber preservation sites has of course already begun in Australia. Recent years have seen the meeting of industry to discuss environmental issues and to examine solutions. The Timber Preservers' Association of Australia is currently developing guidelines for the safe use of timber preservatives, and some state groups have already established such guidelines. This process will continue as the industry becomes more experienced in environmental management.

For undoubtedly, environmental management is now a requirement of operation in today's business environment, and the Australian preservation industry will need to become more experienced. The initial step which needs to be taken is that of recognition and acceptance.

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APPENDIX I

Hazardous Waste Facilities
Chemical Waste Management Inc
Kettleman Hills, California

Biology Department
Faculty of Social Ecology
University of California
Irvine, California

Mississippi Forest Products Laboratory
Mississippi State University
Starkville, Mississippi

Hickson Research Laboratory
Hickson Corporation
Conley, Georgia

Treatment Facility
Universal Forest Products
Union City, Georgia

Osmose Technical centre
Osmose Wood Preserving Division
Griffin, Georgia

CSI Technical Centre
Chemical Specialties Inc.
Charlotte, North Carolina

Treatment Facility
Mellco
Rock Hill, South Carolina

Office of Solid Waste
Environmental Protection Agency
Washington, D.C.

American Wood preservers Institute
Vienna, Virginia

National Technical Information Service
Washington, D.C.

Canadian Institute of Treated Wood
Ottawa, Ontario

Ontario Ministry of the Environment
Ottawa, Ontario

Treatment Facilities
Total Forest Industries
Hagersville, Ontario

Environment Canada
Hull, Quebec

Wood Science & Forest Products
University of Toronto
Toronto Canada

Faculty of Forestry
University of British Columbia
Vancouver, British Columbia

NZ Timber Preservers Council
Auckland, NZ

Koppers-Hickson Technical Centre
Koppers-Hickson Timber protection (NZ) Ltd
Auckland, NZ

Treatment Facility
Carter Holt Harvey Timber Limited
Kumen, NZ

Carter Holt Harvey Timber Group
Auckland, NZ

Treatment Facility
Carter Holt Harvey Timber Group
Kopu, NZ

Treatment Facility
Tauranga Treatments
Tauranga, NZ

Timber Industry Training Centre
Waiariki Polytechnics
Roturua, NZ

Forest Research Institute
Roturua, NZ

Treatment Facility
Pinex Round Wood
Kinleitch, NZ

APPENDIX II

Canadian Institute of Treated Wood
Institut Canadien des Bois Traités
506-75 Albert St. • Ottawa • Ont. • K1P 5E7 • Tel 613-234-9456 • Fax 613-234-1228

Environmental Statement

Members of the Canadian Institute of Treated Wood share with all Canadians the responsibility of maintaining the integrity of our environment now and for the future. Responsible stewardship of our resources, be they related to air, land or water, is supported by members of the Institute. In the spirit of environmental responsibility and sustainable development, Institute members have endorsed the following set of principles to govern their attitude and action in environmental matters:

- CITW members will endeavour to produce quality products which when used correctly have no adverse effects on health and safety of the public or the environment.
- CITW members will assess, plan, construct, and operate facilities in compliance with all applicable regulations.
- Sound management and production practices will be applied by CITW members to advance environmental protection in the absence of regulatory statutes.
- Research and development of new products and processes which further minimize environmental impact will be encouraged.
- Environmental awareness and responsibilities will be promoted amongst employees of member firms and the public.
- CITW will work with all levels of government in the development of regulations and product standards based on sound, economically achievable technologies, and determination of environmental impact.

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Canadian Institute of Treated Wood
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QUESTIONS & ANSWERS ABOUT PRESSURE TREATED WOOD

Pressure treated wood helps conserve our Canadian forests.

Today, every tree must count. Our forests are being called upon to produce ever-increasing volumes of products in response to our needs.

Here in Canada, if wood is to be a vital, renewable resource for future generations, our forests must be soundly managed. There are, after all, very few substitutes for wood, one of man's most versatile building materials. It is economical, plentiful and prized for its warmth, beauty, strength and workability.

One of the best and most effective ways to help conserve Canadian forests is to use the wood we harvest wisely - and to make sure it lasts. Extending the service life of wood by pressure treating means fewer trees will have to be cut down.

Why should wood be preserved?

Wood has natural enemies. It is preyed upon by fungi, insects and millions of microorganisms which cause rot and decay. This is especially true in hot and humid climates or wherever wood comes in contact with the ground or water.

As a fungus feeds on wood fibres, the wood is broken down and loses strength. Termites and other wood-eating insects subsist on the cellulose content of wood. Wood preservatives render wood useless as food for fungi and insects. This ensures wood's structural soundness and dramatically extends its useful service life.

Although some species are more naturally durable than others, timber is never completely immune to decay in most environments. Generally, the heartwood from dense, impermeable timber tends to be more resistant than light, porous timber, but no wood is indestructible.

Untreated wood may rot or decay within a few years. Studies have shown that wood preservation increases the service lifetime of wood by a factor of five to fifteen depending on the wood species, use and efficacy of treatment. Annually, that saves millions of dollars and hundreds of thousands of trees.

Estimates in the United States show that if untreated wood was used for applications now employing preservative-treated wood, the added annual cost to the transportation, utility, and construction industries would be over 15 billion dollars. Substitutes like plastic and concrete are energy intensive and would require an equivalent of 19 to 32 million barrels of petroleum per year if used in pressure treated woods stead.

It has been estimated that if wood preservative chemicals were not used, timber requirements would increase three- to six-fold.

What is pressure treated wood?

It is a versatile, multipurpose building material. During the pressure treating process, stable preservative chemicals are pressure-impregnated in the wood cells. They react with wood sugars and are highly resistant to leaching. This process of positive protection results in lumber and plywood of enduring structural integrity.

There are three categories of chemical wood preservatives - creosote solutions, waterborne preservatives and oilborne preservatives. The specific treatment used is dictated by the species of wood, its end use and moisture content.

The application of chemical preservatives takes place in a hermetically-sealed chamber or cylinder, restricting the opportunity for contact and vapour inhalation. The preservatives are applied through a series of pressure and vacuum cycles. Any excess is returned to the working tanks for subsequent loads. The specific treatment times and pressures are dictated by the species of wood, the type of wood product (E.G., lumber or plywood) and the moisture content of the wood.

The required properties of preservatives for wood treatment are specified in CSA Standard 080, "Wood Preservation".

Design and operation of pressure treating facilities are closely monitored by Environment Canada and the provincial ministries. Provincial authorities regulate occupational, health and safety, and environmental aspects of treatment plants.

What are the characteristics of pressure-treated wood?

The pressure treatment process does not alter wood's essential characteristics. Treated lumber will not shrink, swell, check, split or warp to any greater degree than will the same species left untreated. It simply lasts longer and remains stronger, an ideal construction material.

Waterborne treatments introduce water, which means the wood swells slightly during treatment, but returns to its original size upon subsequent drying.

Who needs pressure treated wood?

Carefully selected wood, pressure-treated with a preservative after it is cut and before it is used, has a useful life many times greater than untreated wood. Its relative low cost and ready availability make it ideal for dozens of industrial and domestic applications, from poles and piling to agricultural stakes and backyard decks. We all need pressure treated wood.

Pressure-treated wood is used primarily outdoors wherever wood building components come in contact with the ground or water. It may also be used for certain indoor applications where building codes require treated wood.

Pressure-treated wood is used industrially for docks and marinas, railway ties, piling, utility poles, bridges, roller coasters and playground equipment. It is widely used in landscape architecture and for erosion control of beaches.

Pressure treated wood is used domestically for such applications as decks and fences, gazebos, railings and outdoor lighting fixtures. It is also used for permanent wood foundations.

What chemicals are used in the manufacture of pressure treated wood?

The two most widely used preservatives in the Canadian pressure treating industry are chromated copper arsenate (CCA) and pentachlorophenol (penta). Two other commonly used preservatives in commercial use are ammoniacal copper arsenate (ACA) and creosote.

Each preservative has its specific benefits and appropriate applications to provide protection against wood's natural enemies. Careful note should always be made of the product's end use to determine the most appropriate treatment.

Chromated copper arsenate (CCA) and **Ammoniacal copper arsenate (ACA)** are waterborne preservatives used for the long-term protection of wood from fungi, insects and marine borers.

CCA is the most commonly used preservative for residential applications, including decks, gazebos, agricultural stakes and playground equipment. It is also used for lumber and timbers, utility and construction poles, marine timbers and piling, fence posts, wood foundation lumber and plywood.

ACA is used primarily in industry for the pressure treatment of construction lumber and timbers, utility and construction poles, marine timbers and piling and fence posts. Because ACA has superior penetrating characteristics when compared with other waterborne preservatives, it is particularly well-suited for Canadian wood species, most of which are difficult to treat.

The base ingredients from which CCA treating solutions are made are hexavalent chromium, cupric oxide, arsenic pentoxide and water; the base ingredients from which ACA treating solutions are made are copper oxide powder (cuprous oxide), arsenic acid (arsenate), concentrated ammonium hydroxide and water. Treatment solution concentrations usually range from 2% to 4% by weight depending on the species of wood to be treated and the product's end use.

It is important to note there are significant differences in the chemistry and toxicity of arsenic compounds. Inorganic pentavalent arsenate, one of the primary active ingredients in CCA and ACA, is a naturally-occuring trace element which is present in soil, water, air, plants and in the tissues of most living creatures – including humans. It should not be confused with trivalent arsenic compounds which are generally more toxic than pentavalent compounds and never used in the pressure treating process.

The pentavalent arsenate found in wood preservatives is also the most prevalent arsenic compound in nature. It is rapidly excreted by the kidneys and does not accumulate. Again, it is important to note that chronic inorganic arsenic intoxication is associated with trivalent arsenic, which is not present in CCA and ACA solutions.

The chemical reactions which fix the CCA and ACA components in the wood are complex. For example, in general terms, the pressure-injected chemicals in CCA are reduced to their metallic state and become bonded to the cellular structure of the wood. These highly insoluble precipitates are virtually immune to leaching (seeping from the wood) and will not vaporize or evaporate under normal conditions.

Many of the allegations about wood preservatives in current use are anecdotal and groundless. To date, all evidence collected on the toxicity of CCA and ACA treated wood shows no health hazard, even by very exaggerated contact to treated wood. (The oral lethal dose of treated wood for a 70 kg human would be more than half a kg. Even then it might not prove fatal, because the digestive system would likely be unable to liberate all the arsenic from the wood.)

Studies show that properly impregnated wood retains its CCA and ACA preservatives in virtually undiminished quantities for decades. Environmental risks from CCA and ACA treated wood are negligible.

CCA treated wood is light green in colour, while ACA treated wood is olive to bluish-green. Both weather to a driftwood grey over time. Seasoning after treatment leaves the wood dry, paintable, odourless and clean. This is preferred for applications where there is close human or animal contact.

Pentachlorophenol (penta) is the most common oilborne preservative used industrially for the long-term protection of wood against attack and destruction by fungi and insects. It has been used in Canada for almost half a century.

Oilborne penta is used extensively for the treatment of utility poles. It is also used for railway ties, foundation piling, timbers in highway construction, construction timbers and poles, and fence posts.

Pure pentachlorophenol is a white, crystalline, aromatic compound. It is produced by reacting phenol with chlorine. Technical penta used in wood preservation usually contains about 10% related chlorophenols such as tetrachlorophenol and some trichlorophenol. It also contains some impurities such as octa-, hepta, and hexachlorodibenzo-p-dioxins and chlorodibenzofurans at levels of parts per million. It is important to note that the highly toxic tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), which has received much attention in the media, has NOT been found in penta.

Pentachlorophenol manufacturers comply with all the requirements of the U.S. Environmental Protection Agency and impurities are below stated limits.

For wood preservation treatments, pentachlorophenol is dissolved in petroleum oil conforming to CSA 080.201 "Standard for Hydrocarbon Solvents for Preservatives". Penta treating solution concentrations range from 3% to 7% by weight, depending on the wood products and species to be treated.

If, through accidental exposure, pentachlorophenol is absorbed, inhaled or ingested, it does not accumulate in the body (the half-life is about 36 hours). Thus, after exposure, penta is released from the body relatively quickly in the urine. Studies carried out on treatment plant workers exposed to penta for up to 20 years show no long-term adverse health effects. Basic, common sense measures make penta safe for use.

While pentachlorophenol treated wood is safe for many uses, plants in direct contact with penta treated wood could be adversely affected. Therefore, it should not be used in greenhouses or next to house and food plants. Nor should it be used in home interiors or salt water applications.

However, pressure-impregnated penta does not evaporate or exude from wood to an appreciable extent. According to several studies, this is true not only for wood in ground contact, but also for properly treated piling and timbers in fresh water applications. It is also important to note that low concentrations of penta are biodegradable and subject to photodecomposition.

Penta treated wood is light to dark brown in colour, depending on the oil used and the species treated, and usually weathers to a silvery grey over time. It is also somewhat water repellant. This improves the wood's dimensional stability and reduces checking and splitting. The wood is also more resistant to mechanical wear. The oil lubricates the wood, facilitating spur penetration when climbing poles.

Oilborne penta also slows corrosion of metal fasteners. It is resistant to a variety of corrosive chemicals and is a suitable treatment for several types of chemical storage and conduit structures.

Creosote is the oldest and one of the most effective industrial preservatives for protecting wood from deterioration and decay caused by fungi, insects and marine organisms. It is virtually insoluble in water.

Creosote has been applied to a large variety of wood products for more than 150 years. It is used primarily for railway ties (where it is often blended with a heavy petroleum oil), utility poles, marine piling and timbers and highway construction.

Creosote is derived from coal tar which is formed during high temperature carbonization of bituminous coal. This carbonization process takes place during the making of coke by the steel industry. The coal tar is then distilled to produce creosote and other products.

Many factors affect the character and composition of creosote, including the characteristics of the coal which is used, the method of coal tar distillation and the temperature range in which the creosote fractions are collected. Over 150 chemical compounds have been identified.

Common sense dictates that the creosote preservative must be handled with care. Studies conducted on human workers exposed to creosote indicate there is no increased incidence of cancer or cancer-related deaths. Further studies corroborate that exposure to creosote fumes is not associated with any observed significant adverse health effects, including cancer.

Pressure-injected creosote does not exude or move out of the wood in a liquid form to any appreciable extent. According to several studies, this is true not only for wood in land use but also for properly treated piling and timbers in the marine environment. Furthermore, creosote in small concentrations is biodegradable. Tests indicate that creosote is low in toxicity to birds and moderately toxic to fish.

Initially, creosote treated wood is dark brown to black in colour and weathers to a light brown. It has distinct odours which diminish with age. Because creosote is oily, the treated wood is somewhat water repellant. This improves the wood's dimensional stability and reduces checking and splitting. Creosote treated wood is also more resistant to mechanical wear, which is of vital importance for such applications as railway ties and bridge decking.

Is pressure treated wood safe?

Pressure treated wood has been safely used for decades. At a time of growing environmental awareness, it is misleading to talk about safe and unsafe chemicals. There are no safe chemicals - only safe ways of using them.

The greatest environmental concerns with regard to wood preservatives are related to potential accidental spills during transport and plant use. There is a much lesser concern with the use of the finished product, treated wood.

When handled wisely and used correctly, pressure treated wood poses no threat, but certain precautions should be taken. Guidelines are available from the Canadian Institute of Treated Wood in Ottawa.

Treated wood should not be used where it may come in direct or indirect contact with public drinking water, except for uses involving incidental contact such as docks and bridges. Treated wood should not be used where the preservative may become a component of food or animal feed. For example, it should not be used for kitchen countertops or cutting boards.

Are wood preservatives regulated?

Wood preservatives used in Canada meet all the requirements and standards of the Pesticide Control Products Act administered by Agriculture Canada. Members of the Canadian Institute of Treated Wood also cooperate in the preparation of standards published by nationally recognized bodies and review and consider industry standards which are not necessarily covered by Canadian Standards Association standards.

Development and adoption of new technologies occur on a continual basis. CITW members are committed to producing safe, quality products in an environmentally sound and progressive manner.

How can wood preservatives be safe if they are toxic?

If the chemicals used for the pressure treatment of wood weren't toxic, the process wouldn't be effective. But treated wood is not toxic to humans and animals under its intended conditions of use.

For example, arsenic in the pentavalent form occurs naturally in our environment and most living organisms. It's the same type of arsenic found in the food we eat, such as shrimp, tomatoes, potatoes, rice and mushrooms, and should not be confused with trivalent arsenic which is more toxic and NOT used in the wood treating process. Furthermore, the pressure-injected active ingredients in CCA are highly resistant to leaching and will not seep from the wood.

Studies conducted in several nations around the world confirm no evidence of harmful health effects to people from the installation or use of pressure treated wood structures.

Further studies have shown environmental risks from treated wood are also negligible. The active ingredients are deposited deep into wood cells and fixed there, virtually immune to leaching. Properly impregnated wood retains the preservative in virtually undiminished quantities for decades.

What about dioxins in pentachlorophenol?

Dioxins found in penta are strictly regulated and do not render wood hazardous for use when proper care is exercised in handling and application. The U.S. Environmental Protection Agency has set acceptable limits for dioxin content.

Dioxin is a name used to identify a group of 75 different chlorinated congeners which have a wide range of toxicity. During the Viet Nam war, a great deal of media attention was given to tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), a component of Agent Orange. This dioxin has NOT been found in penta.

Will wood preservatives migrate from the wood?

A unique process occurs within wood during and after the pressure-treating and curing process which deposits the chemical preservative in the wood cells, rendering its components virtually insoluble. Leaching is negligible and poses no threat to people, pets, or the environment at large.

How should you dispose of pressure treated wood?

Dispose of treated wood by ordinary trash collection or burial. It should not be burned because toxic chemicals may be produced as part of the smoke and ashes.

Is all treated wood pressure treated?

Usually, but not always. One non-pressure treatment is known as thermal treatment. Brush-on or spray wood preservatives are also used, often as consumer applied products. The latter methods are generally not as effective in protecting the wood and will likely leach.

What are the alternatives to treated wood?

Steel, aluminum, concrete and plastic could be substituted for certain applications, but this would mean significantly higher costs in applications where treated wood is now used. It would also require far greater energy consumption in the processing of these substitute materials and may add to air and water pollution and/or environmental protection costs.

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Often, substitute materials won't be appropriate where treated wood is now used. Steel may corrode or concrete may deteriorate in salt water.

It is vital that we maintain the integrity of our environment, but there will always be trade-offs. Pressure treated wood, properly applied, is still the best option, ecologically and financially.

Because wood is a renewable resource, modern forest managers can assure a continuous and plentiful supply. Wood preservation reduces the demand on the nation's forests for solid wood products.

How does pressure treated wood help conserve our forests?

A typical small backyard deck calls for lumber from two or three trees each at least 45 years old. If it is built with untreated lumber, all or part of the deck would probably need replacing every few years. With treated lumber, the deck will remain strong and attractive for up to 50 years. The net result is a savings of thousands of dollars on upkeep, and many hectares of uncut forest.

Where can I find out more about pressure treated wood?

The Canadian Institute of Treated Wood (CITW) is a trade association which represents the treated wood industry in Canada. CITW members cooperate in the preparation of standards published by nationally recognized bodies and review and consider industry standards not necessarily covered by Canadian Standards Association specifications.

The CITW operates under Federal Charter and serves as a forum for those concerned with all phases of the pressure treated wood industry, including research, production, handling and use and the environment.

For any additional information, contact:
Canadian Institute of Treated Wood
506-75 Albert Street
Ottawa, Ontario
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Tel: 613-234-9456
Fax: 613-234-1228

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APPENDIX III

Permalon®

High Strength Specialty Films

Reef Industries, Inc. P.O. Box 750245 Houston, Texas 77275-0245

PERMALON GROUP
SALES SPECIFICATIONS

Permalon products are composite laminates of tri-layer coextruded film. Various colors are available, depending on grade. Basic properties and typical test values for each grade are provided below. Also provided for reference are some typical values for PVC.

Property	ASTM Method	Units	X-80	X-100	X-150	X-210	PVC	PVC
Standard Weight	D-2103	lb/msf	13.8	19.5	31.0	69.0	135.0	203.0
Thickness	D-2103	mils	5.1	6.0	9.0	18.0	20.0	30.0
1" Tensile - MD	D-0882	lb	15	20	25	55	46	69
		psi	2950	3300	3400	3000	2300	2300
1" Elongation - MD	D-0882	%	550	450	575	650	375	375
Cold Crack	D-1709	°F	-10	-60	-60	-60	-20	-20

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PERMALON PLY X 210 SPECIFICATIONS

Permalon Ply X-210 is a four layer composite laminate of three layer co-extruded polyolifin film. The material is composed of 12 distinct layers and is oriented in the machine direction, the transverse direction and at a 45 degree angle to both. The polymer is compounded with copolymer impact modifiers and copolymers to improve the impact resistance along with typical properties.

Burial Properties

Physical Property	Initial Result	Post Burial Result	% Change
3" Tensile	128 pounds	126 pounds	-1.5%
3" Elongation	714%	730%	+2.2%
100% Modulus	86 pounds	87 pounds	+1.2%

The differences in the test results fall within the expected machine error for these test methods.

Permeability

The water vapor transmission specifications for the Ply X-210 are as follows:

Less than 0.04 perms.
Less than 0.0035 perm-inches
less than 10 to the -7th power cm/sec.

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Standard Weight	D-2103	lb/msf	13.8	19.5	31.0	69.0	135.0	203.0
Thickness	D-2103	mils	5.1	6.0	9.0	18.0	20.0	30.0
1" Tensile - MD	D-0882	lb	15	20	25	55	46	69
		psi	2950	3300	3400	3000	2300	2300
1" Elongation - MD	D-0882	%	550	450	575	650	375	375
Cold Crack	D-1709	°F	-10	-60	-60	-60	-20	-20

PERM-PVC.WK1
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DGD

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