DIOXINS IN CANADA:

THE FEDERAL APPROACH

Interdepartmental Committee on Toxic Chemicals

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Dioxins are a group of 75 chemicals identified by the number and position of their chlorine atoms. The simultaneous use of dioxin(s) to mean both the specific chemical 2,3,7,8-tetrachlorodibenzo-p-dioxin, one of 22 tetrachlorodibenzo-p-dioxins, as well as all 75 polychlorinated dibenzo-p-dioxins has led to some confusion. Therefore, in this document, the abbreviation used for 2,3,7,8-tetrachlorodibenzo-p-dioxin is 2,3,7,8-TCDD. The term dioxin(s) is used to refer generally to all 75 polychlorinated dibenzo-p-dioxins.

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EXECUTIVE SUMMARY

The Federal Approach to dioxins attempts to set out, in an orderly fashion, the magnitude of the potential problems in Canada with dioxins and develop, within this context, actions to be taken by the federal government, often in collaboration with provincial agencies, to reduce these problems. This approach can be readily applied to a co-contaminant, the polychlorinated dibenzofurans (furans). Although far less is known about furans, they are likely to have "similar" toxic properties to dioxins. Action to control release of dioxins will also control furans.

Background

In December 1981, the National Research Council published a report "Polychlorinated dibenzo-p-dioxins: Criteria for their effects on man and his environment" which reviewed and assessed the scientific knowledge of the sources, amounts, pathways, persistence and fate of dioxins in the environment, and evaluated the parameters available for assessing the toxicity of dioxins.

At the same time, the former Minister of the Environment, the Honourable John Roberts, and the Minister of National Health and Welfare, the Honourable Monique Bégin, established the Ministers' Expert Advisory Committee on Dioxins under the Environmental Contaminants Act. This committee was charged with providing advice on the sources of dioxins, the pathways into and through the environment, the potential and actual exposures of human and non-human populations to dioxins, the toxicity of the dioxin congeners, the risks to humans and non-humans from dioxins, and to recommend any appropriate controls.

A number of federal departments, primarily Environment Canada, Agriculture Canada, National Health and Welfare, and Fisheries and Oceans, which were working on aspects of the dioxin issue, had recognized the need for a more formal integrated collaborative effort. This led to the formation of a working group under the Interdepartmental Committee on Toxic Chemicals to review and recommend the most appropriate actions that could be taken with regard to dioxins in Canada. The rationale for immediate action to control major known sources of dioxins was that this would be more cost-effective than any further refinement in the assessment of the risks of dioxins. It has already taken 10 years of intensive world-wide research, at a cost of $100 million, to document the hazard of 2,3,7,8-TCDD. To repeat this for other dioxins (theoretically 74 other congeners could exist) could cost $1 billion and could take at least another 10 years. While this would provide important information about the effects and environmental pathways of dioxins, it would, by itself, do nothing to alleviate any problems that may exist.

Federal Approach to Dioxins

The Federal Approach to Dioxins is based on the premise that to reduce or eliminate the major sources of dioxins into the Canadian environment is pragmatically and economically more effective than continued rigorous assessment of the risks of dioxins. At the same time, it does recognize that additional investigations are necessary to provide information, to refine actions now being taken and to identify other areas requiring control or remedial measures. Monitoring and research programs that are currently in place will be improved to ensure continued sensing of the quality of the environment, human exposure to these chemicals and provide information on the need for further control.

The Federal Approach to Dioxins has two major thrusts. The first is directed towards controlling dioxins by controlling the life cycle of the dioxin-containing chemicals including past disposal practices of industrial wastes, and the second is assessing the potential for dioxin formation directly from specific combustion sources.

With respect to controlling dioxins through the dioxin-containing chemicals themselves, an identification of the potential release pathways for dioxins during the life cycle of dioxin-containing chemicals has been made. These include, an examination of the historic manufacturing processes and sites for disposal of manufacturing wastes, formulation of compounds, importation of compounds, transportation and storage of compounds, registration and use of compounds. By using this approach, the major problem areas are readily identifiable. The major compound of international concern in relation to industrial accidents and inadequate waste disposal - 2,4,5-trichlorophenol[1] - has never been manufactured in Canada. Other dioxin-containing chemicals, pentachlorophenol, tetrachlorophenol, 2,4-D and 2,4,5-T[1], have been manufactured but at only four known sites. Inadequate disposal of manufacturing wastes is a severe problem in the U.S. and is already recognized as a source of contamination in the Canadian Great Lakes environment. There are four potential problem sites in Canada in various stages of investigation. The adequacy of this information is being researched; as well the Federal/Provincial Abandoned Waste Site Program is being used to double check for any other possible dioxin-related hot spots.

The major potential problems with the dioxin-containing chemicals result from their use. The compounds in question have already had their uses highly restricted. The dioxin content of 2,4-D and 2,4,5-T is regulated, and the aim of the federal government is to apply the concept of purification to regulate all dioxin-containing chemicals as a prudent course of action. The major area where there is still concern is the use of pentachlorophenol and tetrachlorophenol in wood preservation and protection. Codes of Good Practice for these industries will aid immeasurably in containing any human and environmental exposure.

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[1] 2,4,5-trichlorophenol (sometimes abbreviated as TCP) is not to be confused with its phenoxy herbicide derivative 2,4,5-T (2,4,5-trichlorophenoxy acetic acid).

Combustion remains perhaps the least understood of all dioxin sources. Of particular relevance is the magnitude of natural disasters such as forest fires when compared to other anthropogenic sources such as cigarette smoking or garbage incineration. Such comparisons are underway including characterization of various Canadian sources for their dioxin emissions. There is, however, no reason to add to the environmental burden coming from natural sources through human activities that are amenable to control. Options on emission control and disposal practices for combustion wastes, especially fly-ash, are underway.

In conclusion, the major concerns in Canada are the potential impacts of dioxins on human health, wildlife and commercial and recreational fisheries. The areas to be addressed to control these concerns are the use of dioxin-containing chemicals and the waste disposal associated with their manufacture; and combustion sources of dioxins. Of particular note are the use of chlorophenols in the wood preservation industry and the waste disposal practices of U.S. manufacturers in the Niagara River area that affect the Canadian environment. Even though levels in the Great Lakes have declined in the past decade, there are still concerns about the environmental pathways by which the public is exposed to dioxins.

DIOXINS IN CANADA: THE FEDERAL APPROACH

1. Origin and Nature of Public Interest

The history of dioxins has no real starting point. In one instance, it can be traced back to chick edema disease which caused deaths of U.S. chicken flocks in the late 1950s. The deaths were a result of contamination of chicken feed but the identification of hexachlorodibenzo-p-dioxin as the contaminant responsible for chick edema disease did not occur until the late 1960s. By 1969, there was concern over the contamination of the phenoxy herbicide 2,4,5-T with 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). Links were also made to 2,4,5-trichlorophenol[1] and its use as an intermediate for 2,4,5-T and hexachlorophene production. In the late 1940s, workers involved in industrial accidents in the production of 2,4,5-trichlorophenol developed a skin condition called chloracne (a boil-like acne). Chloracne was also reported in some PCB workers. By the early 1970s, the similarity of action of 2,3,7,8-TCDD, other dioxins, PCBs and their contaminants - the polychlorinated dibenzofurans (furans) - was well established.

The phenoxy herbicides 2,4-D and 2,4,5-T have been used since the 1940s because of their effectiveness in simulating plant hormones, leading to accelerated growth and eventual death of broad-leafed plants. In the 1960s, the phenoxys, in specific mixtures such as Agent Orange, were used as defoliants in Vietnam. The use of defoliants was cause for protest during this period, and many of the public perceptions today are a reflection of moral judgments made in that era. The fact that a highly toxic contaminant, 2,3,7,8-TCDD, was present in significant amounts (parts per million) combined with the fact that the phenoxy herbicides were used in the U.S. on rangelands, rice paddies and forests, prompted further public concern and debate. The debate over the use of phenoxy herbicides still continues. In Canada, restrictions on the uses and 2,3,7,8-TCDD content of 2,4,5-T, together with regulation of the dioxin content of 2,4-D, have resulted in much cleaner products for use today. Provincial restrictions have further reduced the amount of 2,4,5-T used in Canada.

Environmental residues of 2,3,7,8-TCDD were for many years very difficult to detect. In the early 1970s, detection limits for toxic substances were usually in the parts per million range. 2,3,7,8-TCDD was, however, rarely found at these levels and so there were few data that caused any concern. In the mid-1970s, there was a series of questionable results reporting 2,3,7,8-TCDD in the environment. These reports caused so much debate among scientists as to their validity, their meaning and the potential effects that they led to considerable confusion. More sophisticated analytical equipment was developed that brought detection limits in the parts per billion range (ppb) into common usage. Later, detection limits for 2,3,7,8-TCDD reached parts per trillion (ppt) and subsequently parts per quadrillion (ppq) in 1983. The quest for accurate identification of dioxins, particularly 2,3,7,8-TCDD, has done more to advance the field of analytical chemistry than has research of any other chemical; however, in late 1970s, when valid dioxin results became available, the confusion and concern resulting from the earlier problems still existed, as indeed it does today.

Three specific incidents highlight the confusion and debate of the mid-1970s. The first was a citizen's survey of miscarriages in Oregon which implicated 2,4,5-T from forest spraying. Even though the survey was later discounted, the public concern was considerable. The use of 2,4,5-T was discontinued, temporarily, in the U.S. The press coverage had an impact on Canada because of our own use of 2,4,5-T in forests. Ontario, British Columbia, New Brunswick and Saskatchewan have stopped the use of 2,4,5-T. The same debate resulted in Quebec stopping spraying for the 1983 season. The court judgment on spraying in Nova Scotia found no evidence to substantiate the alleged risks.

The second incident was a major industrial accident at Seveso, Italy, involving 2,4,5-trichlorophenol production. Considerable areas of the surrounding town and countryside were contaminated, resulting in large

losses of many animals. Some of the townspeople, specifically the children, developed chloracne and some neurological disorders. Although other such incidents had occurred in Europe and the U.S., the connection between 2,4,5-trichlorophenol, 2,4,5-T, hexachlorophene and 2,3,7,8-TCDD had not been previously made clear to the general public even though it had been known in scientific circles for at least 10 years.

The third incident involved the Love Canal waste disposal site in Niagara Falls, N.Y. Subsequently another waste dump - Hyde Park - was identified in the same area. Much of the early concern was raised by a group of Love Canal residents concerned about their families' health. There was again an epidemilogical study that was later discounted, that led to considerable debate over the levels of contaminants. The residents were eventually moved but the debate continued. Canada's attention was directed towards the Niagara problem in the late 1970s - early 1980s by the ability to detect 2,3,7,8-TCDD at very low levels. Environment Canada's results for 2,3,7,8-TCDD in herring gulls eggs focussed Canadians' attention on the 2,3,7,8-TCDD problem as being not just simply a waste dump problem, but a problem of extensive widespread contamination of their own environment. Again, the problem was 2,4,5-trichlorophenol through the inadequate disposal of still-bottoms, the wastes left after the manufacture of the product.

These three incidents were important in focussing the public's attention on 2,3,7,8-TCDD but did not represent the end of the problem in the U.S. In 1982, Times Beach, Missouri became renowned. This incident was also linked to 2,4,5-trichlorophenol still-bottoms which had been mixed with PCBs and waste oils and used in the early 1970s as a spray to keep down dust. The beginnings of the problem have been known for many years as the "horse-arena" incident because several horses died and children became sick after an arena was sprayed with this mixture in the early 1970s. Winter flooding in late 1982 spread 2,3,7,8-TCDD contaminated soil over a residential area, Times Beach, that eventually led to the U.S. government relocating the population. Times Beach was only one of the areas that had been sprayed and the full extent of the problem may take many years to surface.

Very recently (June '83) concerns were raised in New Jersey over the same issue - 2,4,5-trichlorophenol wastes. In the future, we are likely to see an increasing number of such reports as all U.S. manufacturers' waste sites are examined and the problems become public. The only related incidents pertinent to Canada would be related to the manufacture of 2,4,5-T. 2,4,5-trichlorophenol, which has been consistently identified as the major international manufacturing and waste problem, was never produced in Canada.

Attention on manufacturers has, historically and currently, centred on Dow Chemical at Midland, Michigan. The most recent studies show that Dow effluents from Midland do indeed contain minute quantities of dioxins including 2,3,7,8-TCDD. A 1976 study on bioaccumulation in fish indicated this to be the case. Dow, however, used the counter arguments that it has used deep-well injection for its wastes and now uses a U.S. Environmental Protection Agency approved chemical incinerator. Dow maintains that it was the combustion of organic materials that produced the dioxins. To enforce this argument, Dow published its "Trace Chemistries of Fire". In essence this theory concluded that, given organic carbon, chlorine, oxygen and a flame, traces of dioxins are formed. There is still considerable scientific controversy over several academic points but the data now available support the theory. The significance of combustion as a source of dioxins has yet to be fully determined.

The "Trace Chemistries of Fire" broadened public perception of the dioxin issue by highlighting the fact that there were indeed dioxins other than 2,3,7,8-TCDD. This was added to by Agriculture Canada's announcement of dioxins in 2,4-D (Oct. 81). These dioxins were not 2,3,7,8-TCDD and are considered much less toxic than 2,3,7,8-TCDD. However, the data on the toxicity of these other dioxins were rudimentary and not conclusive. The historic relationship between 2,4-D and 2,4,5-T and Agent Orange further clouded the issue and, as a consequence, dioxins in 2,4-D continue to resurface as an issue, even though the dioxins content of 2,4-D is regulated by Agriculture Canada under the Pest Control Products Act.

At the same time as the 2,4-D announcement, NH&W reported the finding of dioxins in the livers of chickens housed on pentachlorophenol-contaminated wood-shavings. The dioxins in pentachlorophenol - a wood preservative - have been known since the late 1960s when, as already mentioned, they were identified as the causative agent of chick edema disease.

2. Basic Facts

Major Sources

Dioxins are a group of 75 compounds (congeners). Specific dioxins are identified by the total number of chlorines (one to eight) and the numerical position of the chlorine atoms in the compound. Dioxins are not chemicals that we intentionally manufacture or for which we have any use. They are by-products formed during production of other organic chemicals, or during the general combustion of organic materials.

Chemicals Containing Dioxins:

Pentachlorophenol and tetrachlorophenol were manufactured in Canada and are used as wood preservatives (about 3 million kg per year). They are contaminated with hexa, hepta, and octachlorodibenzo-p-dioxins at the parts per million level.

2,4,5-trichlorophenol contains 2,3,7,8-TCDD. Although registered for use in Canada, there is now no Canadian supplier. It was never manufactured in Canada but was used as the starting product to manufacture 2,4,5-T. It was also used as a disinfectant.

2,4,5-T is a herbicide containing 2,3,7,8-TCDD. It is registered for specific forestry uses in Canada but only about 500kg are used annually. It is restricted to use in forestry applications and used under provincial authority.

2,4-D is a herbicide used extensively in the prairie provinces (about 4.5 million kg per year). It contains various dioxins, including some tetrachlorodibenzo-p-dioxins, but not 2,3,7,8-TCDD.

Other chemicals, such as Triclosan and Hexachlorophene, are known to contain dioxins. Other pesticides, such as Dicamba and MCPA, are closely related to dioxin-containing chemicals and are scheduled for investigation.

Waste Dumps

These can be sources of dioxins, particularly those associated with disposal of wastes from 2,4,5-trichlorophenol manufacture. The only confirmed Canadian area of concern is the Great Lakes region with the current emphasis on the Niagara River which is affected by U.S. landfills. Some concern has been raised and investigations are underway at landfills at Elmira, Ontario where Uniroyal produced 2,4,5-T and 2,4-D in the past, and where dioxins were found in groundwater of one of several test wells at the site. Other potential problem areas include the Detroit River, St. Clair River and Saginaw Bay in Lake Huron.

Combustion

Incineration, particularly of municipal garbage and chlorinated industrial waste, produces trace quantities of dioxins if the combustion temperature is not high enough. The large portion of the dioxins are adsorbed into fly ash and are removed by electrostatic precipitators, but some are emitted, adsorbed to particles or as gases. The majority are the higher chlorinated dioxins [less than 1% is 2,3,7,8-TCDD]. There are many other potential combustion sources, including natural sources such as forest fires and human activities such as smoking. This raises the probability that a detectable background level of dioxins exists in industrialized nations today.

Quantities entering Canadian Environment

The quantitative assessment of input from the various sources is in only a rudimentary stage of development and open to considerable refinement. In 1981, the NRC estimated 9.2 kg of dioxins from 2,4-D, 1500kg from pentachlorophenol (including tetrachlorophenol) and 13.4kg from municipal incinerators. On the basis of current compliance to regulations, 2,4-D (with a use pattern of 4500 tonnes and 3 dioxins at 10ppb) gives at total environmental input of 0.14kg (a 98% reduction). The contribution of 2,3,7,8-TCDD from 2,4,5-T (with a use pattern of 500kg and manufacturers levels of 10ppb) gives a total environmental input of 5mg ($5X10^{-6}$kg). By comparison, 2,3,7,8-TCDD contained in the Niagara waste dumps is estimated as 45 kg in Love Canal and 2.23 tonnes in Hyde Park. The S-area and 102nd Street dumps contain similar quantities of 2,4,5-trichlorophenol wastes but of unknown 2,3,7,8-TCDD content.

The total potential load from penta/tetrachlorophenol remains largely the same as estimated at 1500kg. This does, however, require some clarification. First a large portion of that total is octachlorodibenzo-p-dioxin, which is not considered very toxic. The more problematic hexa- and heptadibenzo-p-dioxins isomers contribute 430 kgs of the total. The fraction of this total that actually contaminates the environment or contributes to human exposure is unknown. Certainly a large portion would be expected to remain in the treated wood. As a result of an intensive wood preservation plant study, planned for 1984, the various contributions and losses of dioxins will become clearer.

Combustion represents a much more complex assessment because of the various possible sources and wide variety of fragmentary values available. NRC has estimated the contribution from municipal incinerators as 6.7 kg precipitated as fly ash and an equal amount emitted. On the basis of preliminary Environment Canada results (to be available later), the NRC estimates for emitted dioxins appear high. However, within the range of total data available, dioxins contained on emitted fly ash could contribute anywhere from less than 1 up to 50 kg total dioxins per year. Such variation can also be expected for precipitated fly ash which is

usually disposed of in land-fill. How much dioxin escapes from these land-fills by leaching and enters the environment is unknown. It is not readily bioavailable in the form of fly-ash.

Other incineration sources are under investigation for their contributions to this total, both as solid wastes and as emitted particles. Of these sources, sewage incinerators would appear to be a source with a potential of 4-13 kg emitted per year on the basis of the limited data available. Forest fires have perhaps the largest potential of natural sources. Using limited data on wood burning, an estimate of possible inputs from forest fires is 160 kg per year. Even though forest fires would seem to represent a significant natural source, an equal quantity of dioxin could come from urban-related incineration and combustion process.

Environmental Concerns

2,3,7,8-TCDD is relatively persistent and evidence now exists that in soils the half-life may exceed 10 years. Data for other dioxins do not exist but it has been predicted that dioxins with less chlorine will have a shorter half-life whereas dioxins containing more chlorine will have much longer half-lives. Dioxins have very low water solubilities but a much higher affinity for fats and proteins. Consequently, they bioaccumulate and are much more easily detected in biological samples than in water. Dioxins have been detected in some samples of fish, some raw water from the Great Lakes, human tissue, bird eggs across Canada, and soils and sediments around wood preservation plants.

There is no evidence of recurring problems from the low environmental levels of dioxins encountered at present in the Canadian environment. The reproductive failure of several fish-eating bird colonies on the Great Lakes in the early 1970s has been attributed to 2,3,7,8-TCDD, but these problems are not encountered today.

Fishery Concerns

Dioxins are readily bioaccumulated and, as a consequence, 2,3,7,8-TCDD has been reported in several species of commercial and sport fish. As a result of the significance of fish as a human food source, both in Canada and as an export commodity, environmental contamination with dioxins has threatened the viability of the commercial and sport fishery of the Great Lakes as witnessed by the incorrect assumption by Japanese importers that Lake Erie smelt were contaminated with dioxins.

In addition, there is some evidence that 2,3,7,8-TCDD, at relatively high water concentrations (100 times the levels so far detected), can affect the survival and growth of the early stage of certain species. Whether this has an impact on the stocks of fish in Canada is unknown at present.

Health Concerns

Health concerns over dioxins stem from laboratory animal studies that indicate several dioxins have extreme, acute toxicity and that some have effects at very low levels when exposure is lengthy. Long-term, low-level exposures in animal studies have resulted in reproductive dysfunction and carcinogenic effects.

In man, the major health concern is over continuous or intermittent, low-level exposure. Acute lethality is not a major concern as environmental levels in fish, water and air are one million to 100 million times lower than acutely lethal effect levels in laboratory animal species tested. The only confirmed effects in humans are chloracne and some biochemical and neurological disorders.

Effects such as reproductive failure, birth defects and increased cancer rates have been claimed in connection with events such as the Seveso, Italy, explosion, spraying of Agent Orange in Vietnam and

communities sprayed with 2,4,5-T in the U.S. These reported effects remain, however, unsubstantiated at the present time. Numerous confounding factors and, in some cases, small numbers of exposed subjects made meaningful scientific interpretation of these cases impossible.

2,3,7,8-TCDD is considered to be the most toxic of the dioxin congeners. Estimates of the toxicity of the other dioxins have been made, based on the structure, i.e. the number and position of chlorine atoms on the molecule, and the relative activities of some of these other dioxins in enzyme induction and toxicity trials. Predictions of toxicity for those dioxins available for testing have been reasonably accurate. As predicted, 1,2,3,7,8-pentachlorodibenzo-p-dioxin and two hexachlorodibenzo-p-dioxin congeners have the highest acute toxicity after 2,3,7,8-TCDD. Octachlorodibenzo-p-dioxin is far less toxic than both 2,3,7,8-TCDD and hexachlorodibenzo-p-dioxin. These structure-activity relationships may also be useful in predicting carcinogenicity. The mixtures of hexachlorodibenzo-p-dioxin congeners tested proved to be carcinogenic at concentrations 10 times higher than those determined for 2,3,7,8-TCDD.

More than 800 workers have been exposed to dioxins in industrial accidents. Chloracne and some neurological disorders (which disappear after a few years) have been observed in many of these exposed workers. Because of the long latent periods often associated with cancer, it is difficult to draw definite conclusions. The earliest well-documented case of human exposure resulted from an accident in 1949 in which 250 workers were exposed and 122 cases of chloracne were reported; so far, 32 deaths (versus 46.4 expected) have occurred in this group with no apparent increase in deaths from malignant neoplasms. In other studies, an increase in soft tissue sarcomas (3 out of 105 workers, 2.86%, versus 0.07% in the general population) has been reported. These studies neither prove nor disprove the carcinogenicity of dioxins for man.

Risk Assessment

The assessment of the risks from dioxins is scientifically complex and publicly a very sensitive issue. Some of the problems encountered when assessing the risk of exposure to dioxins in the environment, and with toxic chemicals in general, are the low concentrations (often below traditional detection limits), the long latency periods for effects to appear, the limited manifestations of effects which are similar for many compounds, unknown pathways through the environment, and unknown transformations of compounds within the environment.

The term "risk" is associated with many human activities and is commonly used to express the likelihood of many kinds of harm, including financial. In the case of health, risk is defined as the product of the magnitude of the hazard (adverse health outcome) and the probability of its occurrence. In dealing with toxic chemicals, the hazard itself depends on exposure and susceptibility of the host and, therefore, the aim is to reduce exposure to levels where the risk becomes insignificant.

The three major routes of dioxin exposure to human populations are oral, dermal and respiratory: the first being of prime significance to the general population as a result of environmental exposure, and the others to those occupationally exposed. The highest risk is in the workplace; the greatest exposure would be to those working in the manufacture or formulation of chemicals containing dioxins. Second line exposure would include those using these chemicals directly, for example during pest control spraying operations or at wood treatment facilities. The tertiary exposure groups could include workers handling contaminated products such as sawmill workers, lumber suppliers, or persons working in contaminated areas. There may also be high risk groups within the general population depending upon their proximity to a source or their eating habits.

Guidelines may be set on the basis of two different approaches. A safety factor approach takes the "No Observable Effect Level (NOEL)" for carcinogenicity and/or adverse reproduction in laboratory animals and reduces it by an appropriate safety factor. Alternatively, a mathematical analysis of the carcinogenic data is extrapolated to an "acceptable risk". Both methods are used and often result in similar Maximum Acceptable Concentrations (MACs) being set for the protection of human health.

Current Canadian Guidelines

Under the Food and Drugs Act, no food may be sold if contaminated with detectable levels of dioxins. Fish are listed as a special commodity based on their consumption rate by Canadians, and because some species in Lake Ontario have accumulated dioxins. The acceptable level of 2,3,7,8-TCDD in fish is 20 parts per trillion at a consumption rate of 113 g (_ lb) per week. (In New York State, the acceptable level is 10 ppt, but the suggested consumption rate may be up to twice that used in Canada.) This is based on the safety factor approach where the safety factor is 218; in other words, the guideline has been set to ensure public exposure is 218 times less than the NOEL determined in long-term animal studies.

Ontario Ministry of the Environment has announced a provisional air guideline for total dioxins of 30 picograms per cubic metre, annual average. The guideline is based on 2,3,7,8-TCDD carcinogenicity data for laboratory animals with a safety factor of 100. Since it is based on the most toxic congener but applied to all equally, there is a relatively wide safety margin in this guideline.

Regulations under the Pest Control Products Act require 2,4,5-T to contain less than 100 ppb of 2,3,7,8-TCDD (although analyses usually show less than 10 ppb), and 2,4-D to contain less than 10 ppb of any dioxin congener. Ideally the regulated levels of dioxins would be based on toxicological data as related to the hazards encountered by the most exposed individual such as a pesticide sprayer. In this scientific basis, prudence and technological feasibility have been employed.

3. The Need to Manage Chemicals Better

The preceding account documents that most of the problems in Canada with dioxins stem from two major sources: a) dioxin-containing chemicals and the poor waste management practices associated with their manufacture and use; and b) the combustion of organic materials. Thus, the observed chemical contamination of the environment appears to be only a symptom of the real problem - the past, current and potential future mismanagement of chemicals. The solution to the problem would appear to be better management of chemical activities.

In the long term, the better management of chemicals must be founded on societal recognition and understanding: of the benefits and risks of chemical use; of the choices available; of the responsibilities of various sectors of society; of environmental quality goals particularly with respect to economic policies; and of the difficulties and cost of identifying and assessing existing and potential toxic chemical hazards, and developing and implementing effective solutions. Based on this understanding, government programs will not just address the problems by providing remedial solutions, but will become much more preventative ensuring that the past mistakes are not repeated.

With respect to the manufacturing of dioxin-containing chemicals, the federal government's approach has been to examine the life-cycle of these chemicals, predict the potential entry pathways for dioxins into the environment and to take effective action to control these entry sites. The steps in the life-cycle that are important to examine are manufacture, importation, formulation, transportation, product storage, product use and registration. Table 1 outlines these steps for the dioxin-containing chemicals in use in Canada - 2,4,5-trichlorophenol, 2,4,5-T, 2,4-D, tetrachlorophenol, pentachlorophenol, triclosan and hexachlorophene. An examination of Table 1 shows those areas where potential dioxin problems could occur in Canada. Table 2 is an expansion of this information combined with the actions the federal government is taking or has taken to reduce the potential problem. For example, Table 1 shows that 2,4-D:

a) is not currently manufactured in Canada and thus no problems with the manufacturing process or industrial accidents are expected.

b) was manufactured at 4 plants in Canada, no accidents occurred during manufacture, and waste disposal was by deep-well injection.

c) is imported from foreign sources and formulated in Canada.

d) is registered for use in Canada under the Pest Control Products Act but the dioxin content is regulated to not more than 10ppb of any dioxin congener.

e) is listed under the Transportation of Dangerous Goods Act.

f) is used as a herbicide in agriculture and forestry in Canada (4500 tonnes).

g) contains dioxins that are not of very high toxicity.

From this, the potential problems would appear to be:

a) the adequacy of waste disposal by deep-well injection.
b) high usage in agriculture and forestry.

The federal government actions (Table 2) are:

a) to encourage with the provinces an investigation of the adequacy of deep-well injection of wastes.
b) to encourage the proper use of the herbicide 2,4-D, and examine alternatives to herbicide use, especially in urban areas.

Information for each of the dioxin-containing compounds and combustion sources can be obtained in the same manner from Tables 1 and 2.

4. Summary of Canadian Concerns and Actions

Tables 1 and 2 summarize the investigations undertaken into the life cycles of the dioxin-containing chemicals and highlight those areas where actions are required as well as areas where actions are not required. Because of the level of public awareness with respect to dioxins in other countries, particularly the U.S., it is important to outline the activities that are a concern in Canada.

The major concerns in Canada are the potential impacts on human health, wildlife, and commercial and recreational fisheries. The areas to be addressed to control these concerns include the manufacture and use of dioxins-containing chemicals and the waste disposal associated with that manufacture; the waste disposal practices of U.S. manufacturers in the Niagara River area that affect the Canadian environment; the use of chlorophenols in the wood preservation industry; and combustion sources of dioxins. In addition, there are concerns about the environmental pathways by which the public is exposed to dioxins.

These concerns and the actions being taken in Canada in relation to them are discussed in the following sections.

Manufacture: In terms of the world-wide chemical industry, Canada is only a small manufacturer. Of the dioxin-containing chemicals, only 2,4,5-T, 2,4-D, tetrachlorophenol and pentachlorophenol are known to have been manufactured in Canada. The major manufacturing concern in other countries is the manufacture of 2,4,5-trichlorophenol; however, to the best of our knowledge, this compound has not been manufactured in Canada. As a precaution, federal agencies are actively investigating, with the chemical industry, whether there was any previously unknown historical manufacturing of 2,4,5-trichlorophenol.

The Environmental Contaminants Act (EC Act), administered jointly by Environment Canada and National Health and Welfare, has the power to compel companies to disclose information concerning commercial chemicals, to undertake systematic investigations to determine the environmental fate of commercial chemicals, and to impose controls generally on the use of chemicals.

The EC Act will be used initially to collect information from industry, especially with respect to the historical manufacture of the dioxin-containing chemicals. In addition, the EC Act will be used to monitor the use pattern of the dioxin-containing chemicals so that a current inventory is available.

Since the closing of Uniroyal at Clover Bar, Alberta where pentachlorophenol, tetrachlorophenol and 2,4-D were manufactured, there is no manufacture of any of the dioxin-containing chemicals in Canada. No industrial accidents are known to have occurred at the sites of past manufacturers and the manufacture of the dioxin-containing chemicals per se is not a concern in Canada.

Waste Disposal: The historical disposal of manufacturing wastes is of concern. In the case of the four dioxin-containing chemicals (2,4,5-T, 2,4-D, tetrachlorophenol and pentachlorophenol), the plants involved in Alberta (Clover Bar, Fort Saskatchewan), Saskatchewan (Saskatoon) and Ontario (Elmira) were licensed to use deep-well injection for disposal of manufacturing wastes. This practice, while considered adequate at the time, is being re-examined at each site by provincial agencies to ensure that problems are not occurring. If current or potential problems are found, then remedial measures will be instituted.

Activities are underway to develop more appropriate methods for waste disposal than deep-well injection, such as high temperature incineration, that can be adopted by provincial agencies and industry to ensure problems do not occur in the future from chemical wastes.

Investigations are also under way in the Federal/Provincial Abandoned Waste Site Program to determine the extent to which toxic chemicals have been disposed in either active or abandoned waste dumps. This program is a joint venture between the federal government and most of the provinces (Ontario and Quebec have their own independent programs). In excess of 4500 existing waste sites have been identified under this program to date. These sites are being assessed for items dumped and which sites will require remedial action. This program is being modified with specific focus on dioxin-containing wastes.

The possibility that wastes from the U.S. manufacture of dioxin-containing chemicals could have been disposed of in Canada will be checked by the provinces by means of their way-bill process. This may not be totally adequate in terms of the historical records, so industry and public alike are also being encouraged to supply any background information they may have.

Niagara River: The disposal of wastes from the manufacture of 2,4,5-trichlorophenol in the United States poses a problem for Canada in the Niagara River area. The inadequate disposal of still bottoms in the Niagara region has caused 2,3,7,8-TCDD contamination of Lake Ontario. Federal and Ontario government efforts will continue with the U.S. government to ensure adequate containment of the wastes. In addition, in conjunction with the Ontario Government, the possibility of drinking water contamination will continue to be investigated and preventative measures implemented, such as the Pilot Trace Chemical Filtration system, using activated charcoal, in Niagara Falls, Ontario. Measures will be undertaken to put into perspective public understanding of the real versus the perceived danger, the alternatives and the costs. It is not yet clear from a scientific viewpoint whether the levels of 2,3,7,8-TCDD that currently exist in the environment pose a significant health problem. However, there are a variety of alternatives available to the public to lower their exposure to dioxins. In the final analysis, it will be the public that identifies the level of protection it wants and the additional cost it is willing to bear to lower the risks. A public consultation and participation forum is being planned for 1984 to discuss this aspect of the problem.

Transportation: There have been no recorded accidents during the transportation of the dioxin-containing chemicals. There is a single instance in Canada associated with a poorly cleaned boxcar that had carried pentachlorophenol and resulted in the contamination of cattle feed.

There now exists some protection against transportation accidents. The Transportation of Dangerous Goods Act (TDG Act), administered by Transport Canada, promotes the safe transportation of dangerous goods through the communication of information respecting the nature of the products being transported, and by ensuring that reasonable safety standards are established for packaging, handling and transporting the products. The dioxin-containing chemicals are already listed under the TDG Act as either acute toxic substances in Class 6.1 or as environmentally hazardous substances in Class 9.2. In addition, any compound or substance for which the owner/generator has no further use (such as distressed compounds, still bottoms, proscribed dangerous goods, hazardous waste streams), and which is to be discarded, is subject to additional documentation requirements such as the waste manifest. The waste manifest ensures that the correct type and quantity of waste arrives at the intended destination, which has also been authorized by the appropriate authority to receive those wastes.

Registration and Use: All of the dioxin-containing chemicals are registered for use in Canada under either the Pest Control Products Act and/or the Food and Drug Act. The Pest Control Products Act (PCP Act) administered by Agriculture Canada, regulates pesticides in Canada (Section 3(1)). Regulations (Section 5(g)) can be promulgated prescribing standards for such chemicals. For example, Regulations under the PCP Act describe the dioxin standards for 2,4,5-T and 2,4,-D. The approach taken by Agriculture Canada in establishing dioxin regulations has been to request purification as a prudent course of action. The actual use of pesticides is a provincial responsibility where pesticides are licensed for use according to provincial specifications. Limitations to the use of 2,4,5-T have occurred in Ontario, British Columbia, Saskatchewan, New Brunswick and Quebec.

2,4-D is an important herbicide in agriculture and to a lesser extent in forestry and the use contributes significantly to the productivity of these industries. Since regulations were promulgated to limit the levels of dioxins in 2,4-D, the contribution made by this herbicide to dioxin contamination of the environment has decreased nearly 100 fold. 2,4,5-T has a very limited but important use in the forest industry and restrictions on both its use and 2,3,7,8-TCDD content have resulted in a very small input. Monitoring of dioxin content and usage patterns of 2,4-D and 2,4,5-T will continue to ensure that the dioxin contribution from these compounds remains at its present lowered level. Effective alternatives to pesticide use, especially in urban areas where their use is often considered unwarranted by the public, will continue to receive a high priority by federal agencies. The Forest Pest Management Institute is examining alternatives to both pesticide use and current forest management practices, including an integrated pest management scheme. Public education programs on the correct use of pesticides are being expanded.

Tetrachlorophenol and pentachlorophenol are registered pesticides under the PCP Act, and regulations for dioxin content of each are still being investigated. Tetrachlorophenol is used predominantly in the surface treatment of wood by dipping - termed Wood Protection. Pentachlorophenol is used predominantly for impregnation of wood by pressure treatment - termed Wood Preservation. The use of tetrachlorophenol is mainly limited to British Columbia whereas pentachlorophenol is used nation-wide. In high use areas local contamination may exist. Because of Canada's large forest and lumber industry, considerable amounts of these chemicals are used; however, where industries operate on an environmentally sound basis, impacts to the environment and human health are minimized. In cooperation with industry, labour and the provinces, the federal government has initiated the development of Codes of Good Practice for both the Wood Protection and Wood Preservation industries. This exercise has started in British Columbia where there is the largest industrial use of chlorophenols, and will expand nationally in the next few years.

Pentachlorophenol has a variety of other uses. In Canada, many agricultural uses, such as in barns or food containers, have already been discontinued, as has its use in leather and textiles where close human contact would occur. Programs are being established to monitor imported textiles and leather goods for pentachlorophenol residues to determine whether restrictions should be implemented. However, a recurring problem is the use of pentachlorophenol preserved wood shavings contaminated with pentachlorophenol residues as bedding for farm animals, especially those that are later sold as food. A concerted educational program for farmers and the lumber industry on the potential problem of using treated wood shavings as bedding will be developed. Adequate disposal of treated wood wastes, especially by burning, poses a particular problem, since it is related to the generation of dioxins by combustion. Such concerns are being addressed in the Codes of Good Practice.

In addition to being registered under the PCP Act, hexachlorophene and triclosan may also fall under the provisions of the Food and Drugs Act. There is authority in the Act [paragraph 25(1)(c)] to make regulations limiting the dioxin content of drugs and cosmetics sold in Canada.

Hexachlorophene is a derivative of 2,4,5-trichlorophenol. Its use today is highly restricted in comparison to what it used to be. Products containing hexachlorophene in a concentration greater than 0.75% of the total substance may be sold on prescription only. Hexachlorophene constitutes a very small percentage of a drug product, thereby giving an exceptionally low concentration of any dioxin that may be present.

Triclosan is in some ways more problematic. NH&W has recently declared that triclosan has an inadequate data base for registration as a pesticide as a result of the IBT toxicity testing. Replacement studies are being considered by the manufacturers. The dioxin content is in the ppm range and purification of the product may be necessary.

Combustion: Combustion is a source of dioxins to the environment. The significance of this source is still unclear because the quantities of the various dioxin congeners produced from many sources are still under investigation.

Investigations into whether dioxins are emitted as gaseous forms, bound to emitted particulates or to precipitated fly ash are underway both in Canada and internationally. There are many natural combustion sources which may produce dioxins, particularly forest fires, which require investigations to determine the extent to which they contribute dioxins to the Canadian environment.

At present, an initial assessment of the magnitude of natural, human activity and industrial combustion sources in Canada is nearing completion. This is based on very limited data and the characterization of some of the potential sources remains a high priority. Various incinerator types, power-generators and wood-burning sources are being investigated which will further refine the assessment of combustion sources. The federal government, in collaboration with provincial agencies, especially in Ontario, is examining controls that might be useful. Solutions may involve changes in design, operating conditions or fuel enrichment, and are being actively investigated.

The national criteria for air emissions are under consideration under the Clean Air Act. The Clean Air Act, administered by Environment Canada, is designed to protect the health of the Canadian public from air pollution, and to promote a uniform approach across Canada to air pollution control. Standards under the CA Act could be developed to limit the emissions of dioxins from combustion sources following an assessment of their applicability and feasibility. Ontario has already issued a provisional air guideline for dioxins.

Monitoring Activities: Current and planned monitoring activities in Health and Welfare Canada on dioxins and furans include surveys of commercial fish from the Great Lakes and other sources in Canada (in collaboration with Fisheries & Oceans) commercial poultry and swine tissues at retail level; human adipose tissue from various geographical locations in Canada; and drinking water in Ontario (in collaboration with Ontario Ministry of the Environment).

Other current and planned activities include the development of rapid screening methods for dioxins and furans and the organization and conduct of appropriate national and international studies on quality assurance in laboratories testing dioxins.

Monitoring by the Department of Fisheries and Oceans will continue to measure the level of 2,3,7,8-TCDD in fish and other biota from areas impacted by dioxin contamination to assess baseline levels and to monitor trends in dioxin levels over time. Monitoring of fish flesh will encompass both whole fish and edible portions where appropriate. Fisheries and Oceans will continue to investigate the pathways by which this contaminant enters biota, and will also be investigating the toxic effects of dioxins on the fishery resource. New analytical facilities in Burlington, Ontario and St. Andrews, New Brunswick will play an integral part in these studies.

Environment Canada has been using birds eggs to monitor organochlorines for a number of years. In 1979, attention was turned to 2,3,7,8-TCDD and positive results were found in the Great Lakes. In 1982, residues of other dioxins in addition to 2,3,7,8-TCDD, were found in birds eggs from across Canada. Polar bears from the far north are being examined to determine if there is a background level of dioxins found throughout the country. Herring gull eggs have shown a significant drop in residue levels in Lake Ontario during the period 1970-1980. It is this type of long-term evaluation of environmental levels in indicator species to which monitoring efforts will be devoted. More detailed investigations of dioxins in localised area of suspected or known contamination, such as the Niagara River, Detroit River, St. Clair River, including analysis of water and sediment, are proceeding.

Research Activities: There is an enormous international research effort into dioxins. For example, in the U.S., there are at least 65 federally supported programs, expected to cost more than $100 million, to study dioxins and to help answer the questions surrounding its health implications. In the next 2 to 3 years, many of the results of this international effort will be available and a better picture of the dioxins issue will emerge. There is no doubt that Canada can augment this knowledge-base, but research projects must be chosen with care so that significant additions are made to the knowledge-base in areas of uncertainty that are of significance in Canada. In Canada, the current federal dioxins program exceeds $1 million.

One such research project is to define the chemical properties of the higher chlorinated dioxins that define the bioaccummulation and persistence potential of these compounds. When the predictions are tested against model ecosystems, this type of study will be important in defining both our ability to predict accurately the environmental behaviour of chemicals from simply obtained data, as well as the length of time levels in the environment will be sustained.

As previously mentioned much of our knowledge on the toxicity of dioxins, other than 2,3,7,8-TCDD, comes from predictions based on simple enzyme tests. Some support for the ability of these tests to predict toxicity comes from acute toxicity tests and a single carcinogenic study. However, there is no guarantee that those dioxins predicted as inactive are indeed inactive, particularly as this pertains to their carcinogenic potential. A carcinogenic study on a predicted inactive dioxin, such as the 1,3,6,8-TCDD from 2,4-D, would, if negative, add considerable weight to the application of enzyme tests to the prediction of the toxicity of many dioxin congeners. This is particularly relevant to complex mixtures of dioxins, such as result from combustion sources.

TABLE 1

Summary: Dioxin-containing-chemicals - Canadian relevance

Chemical	2,4,5-Trichlorophenol	Tetrachlorophenol	Pentachlorophenol
Dioxins present	2,3,7,8-TCDD	hexa-, hepta-, octadioxins	hexa-, hepta-, octadioxins
Current usage	1 tonne	800 tonnes	2500 tonnes
Manufacture			
Current	none in Canada	none in Canada	none in Canada
Historic	none known in Canada	Fort Saskatchewan, Alberta Clover Bar, Alberta	Fort Saskatchewan, Alberta Clover Bar, Alberta
Process	-	closed system	closed system
Accidents	international only	none known	none known
Waste type	-	still bottoms	still bottoms
Disposal	-	deepwell injection	deepwell injection
Importation			
Current	1 tonne	800	2500 tonnes
Formulation	none	yes: at point of use	yes: at point of use
Transportation	listed TDG Act[1]	listed TDG Act	listed TDG Act
Accidents	none known	none known	boxcars
Storage Accidents	none known	none known	storage tank fire (1982)
Product Use	intermediate for 2,4,5-T and hexachlorophene	wood protection, mainly in BC	wood preservation (95%) accidental spills - several many historic uses discontinued imported Consumer Goods are not regulated
Registration	PCP Act[2]	PCP Act	PCP Act
Dioxin regulations	none	none	none
Significant Points	Most toxic dioxin	Highly toxic dioxins in ppm concentrations	Highly toxic dioxins in ppm concentrations
	No manufacture Little use Waste disposal in Niagara U.S. dumps	Manufacture Relatively high use Known accidents at point of use	Manufacture Very high use Known accidents at point of use Broad use pattern

Note: "-" means not applicable

1. Transportation of Dangerous Goods Act
2. Pest Control Products Act
3. Food and Drug Act

TABLE 1 (Cont'd)

Chemical	2,4,-D	2,4,5-T	Hexachlorophene	Triclosan
Dioxins present	Some di-, tri-, & tetra-dioxins (not 2,3,7,8-TCDD)	2,3,7,8-TCDD	2,3,7,8-TCDD	Some di-,tri-, and tetradioxins
Current usage	4500 tonnes	0.5 tonne	15 tonnes	
Manufacture				
Current	none in Canada	none in Canada	none in Canada	none in Canada
Historic	Clover Bar & Fort Saskatchewan Elmira, Ontario Saskatoon, Saskatchewan	Saskatoon, Saskatchewan Elmira, Ontario	none known in Canada	none known in Canada
Process	closed system or condensation	condensation	-	-
Accidents	none known	international only	international only	none known
Waste type	still bottoms or concentrated washings	concentrated washings	-	-
Disposal	deep-well injection	deep-well injection	-	-
Importation				
Current	4500 tonnes	0.5 tonne	15 tonnes	unknown
Formulation	formulated for specific brand name herbicide	formulated for specific brand name herbicide	associated with consumer products	associated with consumer products
Transportation	listed TDGA	listed TDGA	listed TDGA International	-
Accidents	none known	none known	none known	none known
Storage Accidents	none known	none known	none known	none known
Product Use	herbicide in agriculture & forestry. many consumer products eg. Tomato set	herbicide with very restricted forestry use	health care products, dog collars, etc. many uses have been discontinued	health care products replacement for hexachlorophene
Registration	PCP Act	PCP Act	F&D Act[3]	F&D Act PCP Act
Dioxin regulations	10 ppb of any dioxin	100 ppb - 2,3,7,8-TCDD	none	none
Significant Points	Low toxicity dioxins	Most toxic dioxin	Most toxic dioxin (suspected to be present)	Moderate to low toxicity dioxins suspected (data incomplete)
	Past manufacture Very high use 2,4-D usage controversial Essential to agriculture and forestry	No manufacture Little use Forest spray	No manufacture Moderate use Health care products	No manufacture Unknown use volume products

TABLE 2

2,4,5-trichlorophenol

Is a high profile compound because of a) a number of industrial accidents (explosions) in U.S. and Europe (eg. Seveso)
b) the disposal of manufacturing wastes (still bottoms) particularly in U.S. (eg. Love Canal, Hyde Park, Times Beach)
c) the starting compound for the herbicide 2,4,5,-T and the biocide hexachlorophene
d) its 2,3,7,8-TCDD content

Canadian Relevance	Tactic	Actions
Manufacture		
- none known	- request industry to report on any historical involvement	- request information from industry
Waste Disposal		
- no problems anticipated from manufacture in Canada		
- transboundary contamination of the Great Lakes from U.S. wastes	- Niagara River Strategy to reduce risks posed by drinking water to health of Canadians	- meetings on drinking water and investigations on alternative treatment processes.
	- stop continuing input of contaminants including 2,3,7,8-TCDD to Great Lakes	- public information - continued consultation with U.S. government agencies regarding landfill areas on Niagara River
	- identify other potential sources	- investigate Detroit River, St. Clair River and Georgian Bay, Lake Huron
- historical transboundary waste shipment (unknown but possible)	- request industry and public information	- request provinces to review way-billing historic waste problems
Registration and Use		
- 1981 figure suggest 1.0 tonne/year use pattern	- track current use patterns	- notice under EC Act
- registered under PCP Act as biocide but single registered supplier (Dow) no longer manufacturing product		- none required
- registered under F&D Act and was historically a common household disinfectant but no longer in use		- none required
Transportation		
- no known accidents	- listed under TDG Act	- improved tracking/manifest systems for international and inter-provincial waste shipments

Tetrachlorophenol

Is important in British Columbia because a) it is used for wood protection (dipping treatment) largely in B.C. and there is high potential for environmental and worker contamination
b) wood exportation is of high economic importance
c) it contains hexa-, hepta- and octachlorodioxins

Canadian Relevance	Tactic	Actions
Manufacture		
- known historic manufacture at 2 plants Clover Bar, Alberta	- request province to assess past involvement	- discussions with provinces - some effluent sampling complete
- Fort Saskatchewan, Alberta	- encourage Fort Saskatchewan Industrial Association to investigate their environmental impact	- plans under review by province and federal government
Waste Disposal		
- manufacturing wastes disposed by deep-well injection	- request provinces to delineate magnitude of any waste disposal problems, review licences and check injection strata	- discussions with province
	- advocate the discontinuance of this practice and encourage use of better alternatives such as high temperature incineration	- request provinces to withdraw support from this practice
Registration and Use		
- registered under PCP Act (no dioxin regulations currently in force)	- assessment of Canadian situation	- hazard assessment documents and recommendations under EC Act
	- investigate dioxin content and need for purification	- develop regulations if necessary
- major use in the surface treatment of wood by dipping called Wood Protection which largely uses tetrachlorophenol and predominantly occurs in B.C. The areas of concern are: - occupational exposure - accidental spills - effluent and waste disposal including contaminated wood wastes	- develop Code of Good Practice for B.C. in cooperation with industry, labor, provincial and federal governments	- The industrial survey and Code development are complete and the Draft Code is being finalized. - many companies are already modifying their facilities - national inventory of wood protection for application of the Code nation-wide.
- 800 tonnes per year used	- track current use pattern	- notice under EC Act
Transportation		
- no known problem	- listed under TDG Act	- improved tracking/manifest systems for international and inter-provincial waste shipment

TABLE 2 (Cont'd)

Pentachlorophenol

Is important because a) it contains hexa- and hepta- and octachlorodioxins at significant (ppm) levels
b) it is a compound of scientific, government and industrial concern
c) it is in widespread use and frequent identification in monitoring surveys
d) there have been several accidental spills

Canadian Relevance	Tactic	Actions
Manufacture		
- known historic manufacture at 2 plants Clover Bar, Alberta	- request province to assess past involvement	- discussions with provinces - some effluent sampling completed
- Fort Saskatchewan, Alberta	- encourage Fort Saskatchewan Industrial Association to investigate their environmental impact	- plans under review by province and federal governments
Waste Disposal		
- manufacturing wastes disposal by deep-well injection	- encourage province to delineate the magnitude of any waste disposal problems, review licences and check injection strata	- discussions with province
	- advocate the discontinuation of this practice and encourage use of better alternatives such as high temperature incineration	- request provinces to withdraw support from this practice
Registration and Use		
- registered under PCP Act (no dioxin regulations currently in force)	- assessment of Canadian situation	- hazard assessment documents and recommendations under EC Act
	- investigate dioxins content and need for purification	- Interdepartmental Chlorophenol Risk/ Benefit group considering PCP as case study for Risk/Benefit Analysis
- major use in for the pentetrating treatment of wood by pressure called Wood Preservation	- develop Code of Good Practice in cooperation with industry, labor, provincial and federal government	- industrial survey in B.C. complete - national inventory of wood preservation plant to commence - development of Code to commence - implementation in B.C. and national acceptance to follow
- 2500 tonnes per year	- track current use patterns	- notice under EC Act

TABLE 2 (Cont'd)

Pentachlorophenol (continued)

- areas of concern in wood preservation are: - occupational exposure		- additional actions underway which are in support of Code of Good Practice
- accidental spills and fires		- analyze Montreal fire as a case-history
- plant-site contamination		- cooperative industry/government investigation into plant site and effluent controls - develop guidelines for use, regeneration and disposal of activated charcoal
- effluent and waste disposal		- some effluent sampling complete - examination of wood wastes where dioxin contamination is a result of burning (see also combustion)
- secondary use of pentachlorophenol preserved wood shavings as agricultural litter has caused food contamination	- determine control options	- analysis of poultry and pork
- other use of pentachlorophenol	- assessment of Canadian situation	- hazard assessment documents, with recommendations under EC Act
- imported consumer products not covered by Canadian use-pattern restrictions	- assess potential problem	- assessment underway
Transportation		
- historical accidental contamination during transportation	- listed under TDG Act	- improved tracking/manifest systems for international and inter-provincial waste shipments

2,4-D (dichlorophenoxyacetic acid)

Is not considered a dioxin problem but became a high profile compound because:
a) its historic relation to Agent Orange (2,4-D/2,4,5-T mixture)
b) its documented dioxin content although not 2,3,7,8-TCDD
c) its wide agricultural, forestry and urban use.

Canadian Relevance	Tactic	Actions
Manufacture		
- no current manufacture		- none required
- four historical manufacture sites Elmira, Ontario Clover Bar, Alberta Fort Saskatchewan, Alberta Saskatoon, Saskatchewan	- request provinces assess past involvement	- discussions with provinces on historical manufacture sites
Waste Disposal		
- manufacturing wastes disposed by deep-well injection	- request provinces to delineate the magnitude of any waste disposal problems, review licences and check injection strata	- discussions with provinces - provincial investigations under development
	- advocate the discontinuance of this practice and encourage use of better alternatives such as high temperature incineration	- request provinces to withdraw support from this practice
Registration and Use		
- dioxins restricted to 10ppb		- compliance with regulations
- dioxins present considered of low potency	- define predicted activity, test scientific hypotheses, and review hazards	- structure-activity relationship for theoretical inaction of dioxins present; - 1,3,6,8-TCDD carcinogenic study - dioxin-containing chemicals being reinvestigated for its toxicity - major international review in final stages of completion for WHO
- about 4500 tonnes/year, mainly as herbicide in prairie provinces - also used in forestry (conifer release) and on highways, rights of way and in urban situations for weed control	- agriculturally important - forestry important	- encourage proper usage - public information on correct use, costs, health implications and alternatives
Transportation		
- no known problems	- listed under TDG Act	- improved tracking/manifest systems for international and interprovincial waste shipments

TABLE 2 (Cont'd)

2,4,5-T (trichlorophenoxyacetic acid)

Became an issue because a) it contains 2,3,7,8-TCDD
b) of its historic relation to Agent Orange (2,4-D/2,4,5-T mixture) and its use in Vietnam
c) it was used on forests in U.S. and Canada which has given rise to public concern, leading to current court action in Nova Scotia.

Canadian Relevance	Tactic	Actions
Manufacture		
- known to have been manufactured in the past at: Elmira, Ontario and possibly in Saskatoon, Saskatchewan	- request provinces to assess past involvement	- discussions with the provinces on historical manufacture
- no other known manufacture	- request industry to report on any other historical involvement	- request information from industry
Waste Disposal		
- problems may be associated with landfills or deep-well injection from past manufacture and use	- request provinces to delineate magnitude of any waste disposal problem	- discussions with provinces
- Elmira, Ontario	- Ontario Waste Site Program	- already under investigation
- Saskatoon, Saskatchewan	- Abandoned Waste Site Program	- joint federal/provincial action plan under development
- no other known sites	- Abandoned Waste Site Program	- detailed assessments of high priority waste disposal sites
Registration and Use		
- registered under PCP Act for forestry use (conifer release) under specified conditions, and other purposes	- urge development of alternatives	- Forest Pest Management Institute establishing herbicide group to examine alternatives
- used under provincial authority		
- 2,3,7,8-TCDD content regulated to 100ppb (compliance at about 10 ppb)	- reduce allowable content of 2,3,7,8-TCDD to voluntary compliance level	- under consideration
- usage very low at 0.5 tonne/year	- track current use patterns	- notice under EC Act
Transportation		
- international movement as distressed compound	- listed under TDG Act	- improved tracking/manifest systems for international and inter-provincial waste shipments

TABLE 2 (Cont'd)

Hexachlorophene (2,2'-methylene bis (3,4,6-trichlorophenol))

Is of interest because of a) its involvement with infant deaths in hospitals several years ago
b) 2,4,5-trichlorophenol is the raw material
c) its 2,3,7,8-TCDD content
d) its wide historic use as a disinfectant in toothpastes, mouthwashes, etc.

Canadian Relevance	Tactic	Actions
Manufacture		
- none		- none required
Waste Disposal		
- none		- none required
Registration and Use		
- registered under F&D Act for restricted use in some health care products	- determine required product purity for continued use under Food & Drug Act and Pest Control Products Act	- determine 2,3,7,8-TCDD content - define advisability for use
- registered under PCP Act for limited disinfectant and germicidal use		
- about 15 tonnes/year but historically much greater amounts used	- track current use patterns	- notice under EC Act (voluntarily reported at present)
Transportation		
- no known problems	- Listed under TDG Act International Schedule	- improved tracking/manifest systems for international and inter-provincial waste shipments

TABLE 2 (Cont'd)

Triclosan (5-chloro-2-(2,4-dichlorophenoxyl) phenol)

Is of interest because it a) contains dioxins of relatively low potency (not 2,3,7,8-TCDD)
b) has widespread use in some health care products as hexachlorophene replacement

Canadian Relevance	Tactic	Actions
Manufacture		
- none		- none required
Waste Disposal		
- none		- none required
Registration and Use		
- registered under F&D Act for wide variety of medicated health care products and under PCP Act for limited number of products	- IBT - Inadequate Pivotal Data Base - Category A2	- replacement studies under discussion
	- determine required product purity for continued use under F&D Act and PCP Act	- determine the dioxin congeners present - define the advisability of its current use-pattern
- quantity used in Canada is unknown	- track current use patterns	- notice under EC Act

Related Compounds

The following list includes compounds related to those known to contain dioxins:
a) Dicamba (3,6-dichloro-2-methoxy benzoic acid)
b) MCPA (4-chloro, 2-methyl phenoxyacetic acid)

Canadian Relevance	Tactic	Actions
Dicamba		
- registered under PCP Act - used as herbicide in crop production about 1800 tonnes per year	- investigate potential for dioxin content - purify if necessary	- determine amount and type of dioxin present - industrial negotiation
MCPA		
- registered under PCP Act - used as herbicide in crop production about 2200 tonnes per year	- investigate potential for dioxin content - purify if necessary	- determine amount and type of dioxin present - industrial negotiation

Combustion

Is important because a) any burning of organic carbon when chlorine and oxygen are present may produce dioxins, including very small amounts of 2,3,7,8-TCDD, if combustion temperature is not high enough
b) there are numerous possible urban incineration sources
c) there are numerous possible natural sources and human activities that may contribute to both quantity and exposure
d) there is the possibility of a natural background

Canadian Relevance	Tactic	Actions
Sources		
- there are several documented sources in Canada. Many sources are suspect as a result of world-wide investigations into sources.	- identify and characterize combustion sources	- characterization of municipal incinerators, hospital incinerators, coal-fired electrical generators, coal preparation plants - characterization of dioxins produced by wood waste burning such as open pit disposal, old railroad ties - assess significance of contribution to dioxins in environment of man-made and various natural sources, such as forest fires, and activities such as smoking, wood stove use, automotive exhausts
Control		
- there are a variety of control options for emissions to ambient air depending on source, type or practice. These may be electrostatic precipitators, absorbers, elimination of certain feedstocks, changing the temperature or the residence time the gas generated stays in the combustion zone	- examine emission control options by source	- pre- and post-control examination of Montreal municipal incinerator, sampling complete - examination of different practices of wood waste burning such as open pit and power boilers - examine Enerdemo (Ottawa-Carleton district heating project - energy from waste) for demonstration of built-in controls.
Waste disposal		
- precipitators result in ash residues containing dioxins that are then disposed in landfill	- encourage provinces to examine waste disposal procedures for fly ash	- discussions with provinces
Guidelines		
- Ontario Ministry of Environment has issued a provisional guideline.	- consideration of Clean Air Act as a legislative tool for a dioxin emission standard	- assessment of applicability and feasibility of standard development

Further Reading

Report of the Joint Health & Welfare Canada/Environment Canada Expert Advisory Committee on Dioxins, 1983.

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