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Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
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Item 5 (b) of the provisional agenda*

Inclusion of chemicals in Annex III of the Rotterdam Convention: review of notifications of final regulatory actions to ban or severely restrict a chemical: Mirex

Mirex: supporting documentation provided by Canada

Note by the secretariat

The annex to the present note contains the supporting documentation provided by Canada in support of its final regulatory action on mirex.

* UNEP/FAO/RC/CRC.2/1.

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Annex

List of supporting documentation on Mirex from Canada

- Focused summary
- Scientific Justification for Mirex (Environment Canada, 20 pages)
- Contaminants Profiles (3 pages)

NOTE: In view of the fact that the following documentation is very voluminous it will be made available to the full Committee at the meeting.

- Mirex, Environmental Health Criteria Document, Health and welfare Canada, Health Protection Branch 77-EHD-12, September 1977, 168 p.
- Mirex in Canada, A report of the task force on Mirex, April 1 1977 to the Environmental Contaminants Committee of Fisheries and Environment Canada and Health and Welfare Canada, Technical Report 77-1, 153 p

FOCUSSED SUMMARY FOR MIREX

BY CANADA

Introduction

Overview of Canada's regulatory system

Canadian Environmental Protection Act

The *Canadian Environmental Protection Act, 1999* (CEPA 1999) is an important part of Canada's federal environmental legislation aimed at preventing pollution and protecting the environment and human health. A key aspect of CEPA 1999 is the prevention and management of risks posed by toxic and other harmful substances. CEPA 1999 emphasizes the integral role of science and traditional aboriginal knowledge (where available) in decision-making and that social, economic and technical issues are to be considered in the risk management process.

CEPA 1999 requires the virtual elimination of releases of substances that are persistent (take a long time to break down), bioaccumulative (collect in living organisms and end up in the food chain), toxic (according to the meaning under CEPA) and primarily the result of human activities. Virtual elimination is the reduction of releases to the environment of a substance to a level below which its release cannot be accurately measured.

Toxic Substances Management Policy

In 1995, the federal government introduced the Toxic Substances Management Policy (TSMP). The TSMP puts forward a preventive and precautionary approach to deal with substances that enter the environment and could harm the environment or human health. The TSMP guides federal regulatory and non-regulatory programs by defining the ultimate management objective for a substance:

- virtual elimination from the environment of toxic substances that result predominantly from human activity and that are persistent and bioaccumulative (referred to in the policy as Track 1 substances); and
- management of other toxic substances and substances of concern, throughout their entire life cycles, to prevent or minimize their release into the environment (referred to in the policy as Track 2 substances).

Events that led to the regulatory action in Canada

A Task Force was jointly established by Environment Canada and Health Canada in August 1976 to determine whether mirex is entering or will enter the environment to cause a significant danger to human health or to the environment. The Mirex Task Force Report[1] included an extensive review of the literature and addressed all aspects

[1] Mirex in Canada, A report of the task force on mirex, April 1, 1977, to the Environmental Contaminants Committee of Fisheries & Environment Canada and Health & Welfare Canada, Technical Report 77-1, 153 p.

of the mirex problem in a comprehensive fashion. Further to its investigation of the mirex problem in Canada, the Task Force made recommendations on measures to control the use of mirex and products containing mirex, and the manufacturing and disposal practices to prevent the releases of mirex to the environment. The Task Force considered there were no uses for which mirex was indispensable in Canada.

In parallel, Health Canada produced a second document[2] on mirex. The purpose of this document was to provide a critical review of the available scientific literature concerning mirex to enable an objective and scientific assessment of whether the presence of mirex in the Canadian environment is, or is likely to constitute, a public health hazard requiring that a mirex standard be set for drinking water. All aspects of mirex were searched, including its chemistry, analytical methods, uses, environmental occurrence, persistence, metabolism and toxicity to animals and man.

Further to the recommendations of the Mirex Task Force, all uses of mirex have been banned in Canada since 1978 when the *Mirex Regulations* under the *Environmental Contaminants Act* (ECA) were implemented. In the late 1980s, the ECA was replaced by the *Canadian Environmental Protection Act* (CEPA). These regulations were transferred under the authority of CEPA as the *Mirex Regulations, 1989*. At the same time, Mirex was placed on the *List of Toxic Substances* (Schedule I) of CEPA.

In 1997, mirex was assessed against the criteria for track 1 substances under the TSMP. Further to this assessment, it was concluded that mirex meets all the criteria for Track 1 substances under the TSMP and that it should be virtually eliminated from the environment. However, no new action was taken as it was considered to be already adequately regulated.

During the Regulatory Review process of the Department of the Environment, it was suggested that it would be simpler and more effective administratively to develop a generic banned substances regulation to which substances would be scheduled rather than having separate regulations, as it was the case for mirex, polychlorinated terphenyls and polybrominated biphenyls. The *Prohibition of Certain Toxic Substances Regulations* under CEPA put into one set of regulations all of the toxic substances for which it has been determined that their use in Canada should be totally banned for reasons of environmental or health protection.

Significance of the regulatory action

The *Prohibition of Certain Toxic Substances Regulations* put into one set of regulations all of the toxic substances for which it has been determined that their use should be totally banned for reasons of environmental or health protection.

At the time of the Task Force investigation, mirex was probably no longer marketed in Canada nor stockpiled. Therefore its use could be prohibited, as a preventive measure, without major economic or social disruption and without increasing the risk of fire hazard to the public from products that require fire retardant additives (for more information on uses, see below). This regulatory action will ensure that human and environmental exposure and associated risks are reduced by eliminating Canadian sources of mirex.

[2] Mirex, Environmental Health Criteria Document, Health and Welfare Canada, Health Protection Branch, 77-EHD-12, September 1977, 168 p.

Scope of the regulatory action

Subsequent to Canada's notification of final regulatory action on mirex in 2000, the regulations have been substantially amended. The 2005 Regulations prohibit the manufacture, use, sale, offer for sale and import of the toxic substances listed in Schedules 1 and 2 to the Regulations. Dodecachloropentacyclo [5.3.0.$0^{2,6}$.$0^{3,9}$.$0^{4,8}$] decane (Mirex) is listed in Schedule 1 to the 2005 Regulations.

Schedule 1 lists prohibited toxic substances subject to total prohibition, with the exception of incidental presence. Schedule 2 includes toxic substances that are subject to prohibitions related to concentration or use. The original Regulations (which were the subject of Canada's notification) included only one schedule that subjected all listed toxic substances to the same regulatory requirements.

The 2005 Regulations prohibit the manufacture, use, sell, offer for sale or import of mirex or a mixture or product containing mirex unless the substance is incidentally present. The 2005 Regulations do not apply to the use of mirex in laboratories for scientific research purposes or analytical standards. The 2005 Regulations do not apply when mirex is:

(*a*) contained in a hazardous waste, hazardous recyclable material or non-hazardous waste;
(*b*) contained in a pesticide[3]; or
(*c*) present as a contaminant in a chemical feedstock used in a process from which there are no releases of the toxic substance and provided that mirex is destroyed or completely converted in that process to a substance that is not a toxic substance set out in either Schedule 1 or 2 to the Regulations.

The 2005 Regulations do not apply to mirex or to any mixture or product containing mirex that is for use:
(*a*) in a laboratory for analysis;
(*b*) in scientific research; or
(*c*) as a laboratory analytical standard.

The 2005 Regulations introduce a notification requirement for the use of mirex in a laboratory setting or for the purposes of scientific research if the quantity will exceed 10 g in any calendar year.

The Regulations also establish a permit system that provides a mechanism for temporarily exempting certain applications of mirex. A permit may be granted only if the Minister of the Environment is satisfied that there is no technically or economically feasible alternative or substitute available for mirex. In addition, the Minister must be satisfied that measures have been taken to minimize or eliminate any harmful effects mirex on the environment and human health. Finally, the applicant must provide an

[3] Although the use of mirex contained in a pesticide is exempt from the Regulations, mirex is not registered for pest control use in Canada. Unless registered, pesticides cannot be imported, sold or used in Canada.

implementation plan that identifies specific timelines for eliminating mirex. Each permit lasts for 12 months, and can be renewed only twice[4].

Risk Evaluation

Main conclusions from the 1997 report of the Mirex Task Force:

1. Mirex contaminates several ecosystems in Canada.

2. Mirex is not known to occur in the environment as a natural product.

3. The main sources of mirex in Canada are located in New York State (US) in the Niagara River and the Oswego River where chemical manufacturing and fire retardant plants were located.

4. The transboundary movement of mirex in the Lake Ontario ecosystem has resulted in the contamination of fish and fish feeding birds in Canada.

5. Human dietary exposure to mirex is generally very low in Canada with the possible exception of a critical subpopulation partly or wholly dependent on a diet of fish or fish-feeding birds from Lake Ontario and the St. Lawrence River.

6. Mirex is biologically active, accumulates in food chains, is extremely persistent and dispersed in the environment.

Additional information on the risks from Mirex can be found in additional supporting documents that were produced after the 1978 Regulations.

Risk Reduction and relevance to other States

Uses

Mirex has been used worldwide against fire ants, termites and other insect pests. However, mirex was never registered for use as an agricultural pesticide in Canada. It has mainly been used as a fire retardant agent in plastics, rubber, paint paper and electrical goods. It has also been used as a pyrotechnic for generating white smoke.

Production, Importation and exportation

There were three manufacturers that received large quantities of mirex in the 1960s (a peak of 46,000 kg in 1965). In addition there were other companies that imported small quantities into Canada. These smaller quantities were probably for research purposes and were not used in commercial production.

The Department of National Defence (DND) undertook a study of the use of mirex as a pyrotechnic for the generation of smoke for military exercises and imported about 225 kg for this purpose. The Task Force compiled imports from the DND until 1976.

Stockholm Convention on POPs

[4] Mirex is subject to a prohibition since 1978, and it is unlikely that these newly introduced permit provisions would be used for mirex.

The Stockholm Convention, which entered in force in May 2004, is a global treaty to protect human health and the environment from persistent organic pollutants (POPs). Currently, the convention targets 12 POPs for reduction and eventual elimination, including mirex.

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Toxic Substances Management Policy

Scientific Justification

MIREX

Candidate Substance for Management under Track 1
of the Toxic Substances Management Policy

Environment Canada
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Mirex

Synopsis

Mirex was assessed against the criteria for selection of Track 1 substances under the federal Toxic Substances Management Policy (TSMP). This policy provides a framework based on two key objectives for managing toxic substances: virtual elimination from the environment of toxic substances that are persistent, bioaccumulative and result primarily from human activity (Track 1); and life-cycle management of other toxic substances and substances of concern to prevent or minimize their release into the environment (Track 2).

Mirex was never registered for use as a pesticide in Canada. It has entered Canada through long range atmospheric transport and via water and sediments in the Niagara River where it was manufactured until 1976, and via loadings from the Oswego River where it was used as a flame retardant.

The information reviewed for this assessment indicates that mirex occurs in the Canadian environment exclusively as a result of human activity, is bioaccumulative and persistent. Mirex is specified on the List of Toxic Substances in Schedule I to the Canadian Environmental Protection Act.

It is concluded that mirex meets all the criteria for Track 1 substances under the federal Toxic Substances Management Policy and that it should be virtually eliminated from the environment.

Any person may file a submission presenting scientific evidence objecting to or supporting whether the criteria for management under Track 1 of the policy are satisfied. All such submissions must be sent to the Director, Commercial Chemicals Evaluation Branch, Department of the Environment, Ottawa, Ontario, K1A 0H3 within 60 days of publication of the notice in the Canada Gazette, Part 1, announcing the availability of this report.

1 Introduction

The Toxic Substances Management Policy (TSMP) outlines the federal government's approach to the management of toxic substances (Government of Canada, 1995a). The policy presents a management framework based on two key objectives: virtual elimination from the environment of toxic substances that are persistent, bioaccumulative, and primarily the result of human activity (Track 1); and life-cycle management of other toxic substances and substances of concern to prevent or minimize their release into the environment (Track 2).

In developing the criteria for the TSMP, the federal government considered data for substances whose environmental or health risks had been previously assessed, including those under the *Canadian Environmental Protection Act* [CEPA] Schedule I, the CEPA Priority Substances List [PSL] toxic substances, the Accelerated Reduction / Elimination of Toxics [ARET] List A, the International Joint Commission Critical Pollutants List, and the Ontario Ministry of the Environment and Energy Primary List for Bans and Phase Outs) (Government of Canada, 1995b).

The analysis presented in this report is based on the information summarized in recent reviews and the primary scientific literature. The synopsis summarizes the findings of the assessment. A brief background on mirex is presented in Section 2. The assessment of whether mirex meets the criteria for management under Track 1 is in Section 3. Expert judgement was used to analyze the scientific and technical evidence available for this substance, and a conclusion was drawn using the accumulated weight of evidence to establish whether the criteria of the TSMP have been met. In releasing this report, the federal government is offering interested parties the opportunity to comment on the analysis conducted and the conclusions presented herein.

2 Background Information

Reviews. Several reviews have been written on mirex in the last few years, including those of ATSDR (1995), IPCS (1995) and WHO (1984).

Identity and Physical and Chemical Properties. Mirex (Chemical Abstract Service Number 2385-85-5) is a white, crystalline, odourless solid with a molecular weight of 545.5 and a melting point of 485°C. It is soluble in several organic solvents but is practically insoluble in water. Mirex has a log octanol/water partition coefficient (log K_{ow}) of 6.89 (Veith *et al.,* 1979), an organic carbon distribution coefficient (log K_{oc}) of 6.42 (Comba *et al.,* 1993), a vapor pressure of $3x10^{-7}$ mm Hg at 25 °C (IARC 1979), and a Henry's Law constant of 5.16×10^{-4} atm • m^3 mol^{-1} at 22 °C (Yin and Hassett, 1986).

Production and Uses. Technical mirex contains approximately 95% mirex and 2.5 % chlordecone (IPCS, 1995). Although mirex was never registered for use as an agricultural pesticide in Canada it has been used world wide against fire ants, termites and other insect pests. Mirex has also been used as a fire retardant agent in plastics, rubber, paint, paper and electrical goods (Kaiser, 1978; Merck, 1989). The main sources of mirex in Canada are located in New York State in the Niagara River and the Oswego River where chemical manufacturing and fire retardant production plants were located (Lewis and Makarewicz, 1988; U.S. EPA, 1978; Kaiser, 1978; Kaiser, 1974). Mirex already present in soil and sediment can be released to other media or taken up by organisms.

3 Assessment Against the Criteria for Track 1 Substances

The TSMP presents four criteria to be used in identifying substances for management under Track 1 (Appendix). The following analysis documents the evidence considered and whether the criteria are satisfied for mirex.

3.1 Predominantly Anthropogenic

For a substance to be "predominantly anthropogenic", its concentration in the environment has to result largely from human activity. Since quantitative data describing the relative importance of anthropogenic and natural sources of a given substance are not always available, the assessment for this criterion is not based on a predetermined numerical parameter but on expert judgement using the weight of available evidence.

Mirex is not known to occur in the environment as a natural product (IARC, 1979; Waters *et al.*, 1977). Although the generation of mirex by natural processes can not be excluded, such a contribution to the levels existing in the environment is considered negligible.

Another line of evidence that can be used to ascertain whether a substance is predominantly from an anthropogenic source is the analysis of core sediment samples. Durham and Oliver (1983) analyzed such samples and their results clearly indicate that the concentrations of mirex in sediment from Lake Ontario are correlated with known production and usage patterns of the substance.

Conclusion

On the basis of the available information, it is concluded that the concentration of mirex in the environment is due largely to the quantities of this substance used or released as a result of human activity.

3.2 Persistence

To be managed under Track 1, a substance must be determined to be persistent in at least one environmental medium. In assessing if a substance is persistent in the environment, only transformation processes are taken into account; dilution or transportation to other media are not considered.

Soil. The results of a laboratory experiment using radio-labeled mirex revealed no evidence of aerobic or anaerobic degradation after 56 days in hydro soils (Huckins *et al.*, 1982).

Sediment. Durham and Oliver (1983) analyzed core sediment samples collected in Lake Ontario and reported that the concentrations of mirex in the sediments closely followed the production and use of the substance. Specifically, the results showed that mirex deposited in the 1960s and

1970s is still measurable in that medium.

In their review of the environmental fate of mirex, ATSDR (1995) and WHO (1984) referred to a number of studies published in the 1970s that present qualitative evidence of the persistence of the substance in the environment (Metcalf *et al.,* 1973; Andrade and Wheeler, 1974; Andrade *et al.*, 1975; Baker and Applegate, 1974; Carlson *et al.*, 1976; Jones and Hodges, 1974; U.S. NRC, 1978). While the information presented in these studies does not allow for the estimation of half-lives, the results clearly indicate that the half-life of mirex in lake sediments is above one year.

Evidence from monitoring studies in remote areas clearly indicates that mirex is subject to long-range transport (Lockhart *et al.*, 1992; Thomas *et al.*, 1992).

Conclusion

Quantitative information describing the persistence of mirex is limited. However, the available information consistently indicates that the substance is persistent in the environment. Specifically, mirex is recognized to be subject to long-range transport and has been demonstrated to persist in sediment. On the basis of the available information, it is concluded that mirex is persistent in the environment.

3.3 Bioaccumulation

To be managed under Track 1 of the TSMP a substance must either have a bioaccumulation or a bioconcentration factor higher than 5000, or a log K_{ow} (octanol/water partition coefficient) $\geq$ 5.0. Bioaccumulation refers to the uptake of a given substance directly from water or through the consumption of food containing the substance, while bioconcentration refers only to uptake from water. Bioaccumulation and bioconcentration factors are a ratio of the concentrations observed in biota with respect to concentrations in the exposure medium. For further detail on these terms, refer to Government of Canada (1995b).

Oliver and Nimii (1985) reported a bioaccumulation factor of 15 000 for mirex in lake trout captured in Lake Ontario. The same authors also reported a bioconcentration factor of 1200 for rainbow trout exposed under laboratory conditions.

Hollister *et al.,* (1975) reported BCFs ranging between 3200 and 7300. In their review of the microbial bioconcentration of organic pollutants, Baughman and Paris (1981) reported a BCF of 400 000 in bacteria.

Using radio-labeled mirex, Huckins *et al.* (1982) reported BCFs of 51 000, 12 400 and

3 700 in whole body fathead minnows exposed for 56 days to 0.37, 3.8 and 33 ug/L, respectively. The examination of residues did not reveal the presence of derivatives or metabolites of mirex.

A comparison of concentrations of mirex in lake trout, a predator species, with those in smelt, a prey species, gives a ratio of 1.26, indicating that biomagnification is occurring (Thomann, 1989). The observed biomagnification factor of 10^8 for mirex between its concentration in water of Lake Ontario and the St. Lawrence River and in beluga whale oil is among the highest reported (Comba *et al.*, 1993).

Conclusion

On the basis of the available information, it is concluded that mirex is a bioaccumulative substance.

3.4 CEPA-toxic or equivalent

Federal Actions. Mirex (under the name dodecapentachloropentacyclo [5.3.0.$0^{2.6}$.$0^{3.9}$.$0^{4.8}$0 decane]) is specified on the List of Toxic Substances in Schedule I to the *Canadian Environmental Protection Act*. Regulations prohibiting the manufacture, use, process, sale or import of mirex for any commercial, manufacturing, or processing purpose were published in the Canada Gazette, Part II, 1990.

Under CEPA, mirex is, under the grouping of "Organohalogen compounds ", a prohibited substance for ocean dumping (CEPA, Schedule III, Part I).

International Actions. In response to the increasing international awareness concerning the environmental and human health risks associated with certain persistent organic pollutants (POPs) mirex has been identified as one of the priority substances for consideration in the negotiation of a Protocol for POPs under the United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution (UN ECE, 1996).

Due to the increasing concern about the risks to human health and the environment posed by persistent organic pollutants, the United Nation Environment Programme (UNEP) has initiated a process to evaluate the need to develop a global legally-binding instrument for managing these substances. At the invitation of the UNEP Governing Council the Intergovernmental Forum for Chemical Safety (IFCS) submitted a report to the Governing Council for consideration in 1997. The report concludes that there is sufficient scientific knowledge to warrant immediate international action to protect human health and the environment and to develop a global legally binding instrument to that effect. Mirex is one of the initial 12 substances to be considered under this initiative (IFCS, 1996).

Conclusion

Mirex is on the List of Toxic Substances in Schedule I to the *Canadian Environmental Protection Act*, it is therefore CEPA-toxic.

4. Overall Conclusion

On the basis of the information reviewed, it is concluded that mirex is predominantly anthropogenic, persistent, bioaccumulative, and CEPA-toxic. Mirex satisfies all four criteria for the selection of Track 1 substances under the federal Toxic Substances Management Policy.

Mirex

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Mirex

Appendix Criteria for the Selection of Substances for Track 1 Under the Toxic Substances Management Policy

Persistence [1]		Bioaccumulation [3]	Toxicity [4]	Predominantly anthropogenic [5]
Medium	Half-life			
Air	≥ 2 days [2]	BAF ≥ 5 000 or BCF ≥ 5 000 or log K_{OW} ≥ 5.0	CEPA-toxic or CEPA-toxic equivalent	Concentration in environment largely resulting from human activity
Water	≥ 6 months			
Sediment	≥ 1 year			
Soil	≥ 6 months			

[1]A substance is considered persistent when the criterion is met in any one medium.

[2]A substance may be considered as persistent in air if it is shown to be subject to atmospheric transport to remote regions such as the Arctic.

[3]Whole-body, wet weight basis. Bioaccumulation factors (BAF) are preferred over bioconcentration factors (BCF); in the absence of BAF or BCF data, the octanol/water partition coefficient (log K_{OW}) may be used.

[4]A substance is considered toxic if it meets or is equivalent to the definition of "toxic" found in Section 11 of the *Canadian Environmental Protection Act*, as determined through a systematic, risk-based assessment. Section 11 states: "a substance is toxic if it is entering or may enter the environment in a quantity or concentration or under conditions (a) having or that may have an immediate or long-term harmful effect on the environment; (b) constituting or that may constitute a danger to the environment on which human life depends; or (c) constituting or that may constitute a danger in Canada to human life or health."

[5]Based on expert judgment, the concentration of the substance in any environmental medium is due largely to the quantities of the substance used or released as a result of human activity relative to contributions from natural sources. Elements and naturally-occurring inorganic compounds are not candidates for virtual elimination from the environment.

Mirex

Mirex

Origin and Uses

Mirex does not occur naturally in the environment. It was first manufactured in 1946, primarily for use as an insecticide to control fire ants. Mirex was also used as a stable fire retardant additive in thermoplastics and resins, and as an additive in paper, paint, rubber, electrical adhesive and textile applications. It was sold under the trade names Dechlorane and Ferriamicide. Although use of mirex in Canadian agriculture was never permitted, it has been imported into Canada for other uses, and has been used extensively in the southeastern United States. Approximately 75 percent of the mirex used in the United States was for non-agricultural applications.

All uses of mirex have been banned in Canada since 1978, and its use as an insecticide was banned in the United States in the same year. Patents for mirex use exist in several countries including Belgium, France, Germany, Japan, the Netherlands, and the United Kingdom but little use information is available.

Persistence and Movement in the Environment

Mirex is extremely stable and highly persistent in the environment. Mirex is not soluble in water and is essentially non-volatile, thus it is not usually present in water or air. Slow partial photodegradation does occur, and mirex is degraded to photomirex (8 monohydromirex), a compound containing one less chlorine atom. Mirex is very resistant to degradation by soil bacteria, and is only dechlorinated to photomirex by anaerobic microbial action. Mirex is highly persistent in sediment and soil for extended periods of time, where it is bioaccumulated by biota. Mirex is biomagnified in aquatic and terrestrial food chains, including humans.

Exposure

In humans, mirex is stored mainly in fat tissue, where it is not broken down. Mirex that is not stored is excreted primarily in the feces, and a very small amount in the urine.

The primary route of exposure for mirex is through food, mostly the consumption of contaminated fish. The highest concentrations were found in fish from Lake Ontario, the St. Lawrence River, and the southeastern United States. It is unlikely that current levels in Great Lakes fish are a risk to human health, if fish consumption advisories are followed. For example, in 1988 a person who consumed Lake Ontario fish (114 g fish/meal/week) containing a concentration of 0.10 mg/kg of mirex would ingest 5.7 µg of mirex/person/week (or 0.022 µg/kg•bw/day). This is below the Canadian provisional tolerable daily intake (PTDI) of 0.07 µg/kg•bw/day. Mirex levels in breast milk are above average for communities consuming high amounts of fish, marine-bird eggs, or sea mammals (Dewailly et al. 1991; Davies and Mes 1987).

Releases from waste disposal sites continue to add mirex to the environment. Thus, populations living near hazardous waste sites storing mirex might be exposed through dermal contact (although it is not known if mirex can enter the body through dermal contact) or through ingestion of contaminated soil or indigenous wildlife. Higher levels of mirex in human adipose tissue have been correlated with areas of mirex usage, manufacture, or disposal at waste sites in the southeastern United States (Burse et al. 1989; Kutz et al. 1974), New York (Bush et al. 1983), and Ontario (Williams et al. 1988).

Mirex is rarely found in drinking water and air. It was detected in only five out of 1147 samples taken of Ontario drinking water in 1987, the highest concentration was 5 ng/L. Mirex was measured at very low levels, ranging from 4–1000 ppq in ambient air samples taken from southern Ontario.

Reducing Exposure

Contaminated fish, marine-bird eggs, or sea mammals may present a risk when consumed at levels in excess of advisory recommendations. Follow fish consumption advisories.

Human Health Considerations

Data on the human health effects of mirex are not available. For this reason, the primary organs affected by mirex in experimental animals have been included. They are the liver, kidneys, eyes, and thyroid.

Acute and intermediate duration: diarrhea (due to hemorrhagic intestines); increase in hematocrit; hepatic effects (adaptive and toxic effects); dermal/ocular effects (hair loss, production of cataracts in very young, mild epidermal proliferation; in mice); toxic effects to the thyroid; adrenal gland hypertrophies and releases increased levels of corticosterone; decreases in serum glucose levels; decreases in body weight or body weight gain greater than 10 percent; abnormal behaviour (lethargy, weakness, hyper-excitability, tremors, convulsions); reproductive and developmental effects in female and male rats.

Chronic exposure: renal effects; decreases in body weight or body weight gain greater than 10 percent, non-precancerous lesions of the liver; cancer (an increased incidence of hepatocellular adenomas have been noted, but only in animals having hepatotoxicity). In 1992, it was concluded that only weak evidence exists for the hepatocarcinogenicity of mirex (Sauer 1992).

The International Agency for Research on Cancer (IARC) has classified mirex as possibly carcinogenic to humans, based on sufficient evidence in animals, but inadequate evidence of carcinogenicity in humans.

Table 1

PTDI AND OTHER VALUES FOR MIREX

Agency	Focus	Level	Comments
Health Canada	Drinking water	no guideline	
Health Canada	Fish	0.1 µg/g	
Health Canada	All sources	0.07 µg/kg•bw/day	PTDI
OMOEE	Fish flesh	> 0.1 µg/g consumed occasionally < 0.1 µg/g unrestricted consumption (excluding women of childbearing age and children)	

PTDI: Provisional tolerable daily intake
OMOEE: Ontario Ministry of Environment and Energy

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