Mercury .... A Global Toxin

Perspectives on Initiatives and Programs on Coal-Fired Power Plants and Mercury Emissions

Prepared for Environment Canada

by

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Acknowledgments

Mercury – A Global Toxin: Perspectives on Initiatives and Programs on Coal-Fired Power Plants and Mercury Emissions, was written for Environment Canada to offer perspectives from the environmental communities on this topic.

The opinions expressed in this document are those of the author. They are given as advice to Environment Canada for consideration and as such, do not represent federal government policy.

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Anna Tilman

Mercury – A Global Toxin

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Executive Summary

Mercury is one of the most toxic pervasive substances known. Its harmful effects on human health and the environment, along with the three-fold increase in global levels since industrialization, have made it a high priority case on a national and international scale.

In attempts to counteract this disturbing increase in the level of mercury in the environment, various programs and initiatives have been developed to examine the numerous sources of release of this metal that are a direct result of human activity. Not surprisingly, the deeper one probes into this, the more one discovers how difficult it is to try to "control" an element as ubiquitous as mercury without considering the root causes that perpetuate its use and its release into the environment.

Of the many anthropogenic sources of mercury, the one that is currently the focus of much attention is the electric power generating sector, in particular, coal-fired power plants. The enormous interest in this topic stems mainly from the high degree of toxicity of mercury and the global concern about the prevalence of this substance; the role that coal-fired power plants play as currently the most significant source of anthropogenic atmospheric mercury emissions; and the lack of standards or regulations on mercury emissions from these facilities.

Furthermore, the growing demand for energy, and particularly from coal, is yet another complex dynamic that weighs heavily into any discussion or debate on this topic.

To address the growing concern about what has been basically an unregulated source of mercury emissions, the United States has been engaged in developing policies to regulate coal-fired power plants at a federal level as well as in individual states. Canada is also in the process of developing a "Canada-wide Standard" for mercury for these facilities. As with many of our domestic activities and policies, the actions taken in United States tend to have a profound effect on Canada.

Much of this report is specifically designed to examine the many issues pertaining to current policy discussions in the United States on coal-fired power plants and their mercury emissions with particular attention to their potential implications for Canada as it is engaged in its own standards development exercise.

The task of writing on this subject has proven to be very challenging, not only because of the nature of the electricity generating industry and the substance itself, but also because of the political climate that exerts a strong influence on policy, especially with regard to energy sources.

A number of the chapters deal with specialized material related to coal-fired plants and related policy issues. At the same time, this work strives to place these issues within the framework of a larger picture, which is essential when dealing with a global pollutant such as mercury. Consequently, similar themes emerge and resonate intentionally throughout each section of the document. While the reader may choose to focus on those areas of particular interest, the underlying message is always there that significant steps must be taken now to reduce mercury emissions from these facilities and from other sources.

The views and opinions expressed in this work are those of the author, and are reflective of those generally held by the environmental community in the United States and Canada. This document is intended to articulate these views to Environment Canada, and to a broader public audience. It is a follow-up to my previous document "Mercury…A Public Concern" (March 2002) which was prepared for Environment Canada and designed to heighten public awareness on the significance of coal-fired power plants with respect to mercury emissions in Canada.

I trust that the material and the advice may be found useful in many respects to a broad audience that includes the public, environmental and health organizations, governments, industry and politicians.

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1 Introduction

1.1 Scope and Context

This report is designed to provide Environment Canada with the perspectives of the environmental communities in both Canada and the United States on issues and policies specifically related to mercury emissions from coal-fired power plants including proposed regulatory actions, national standards, and trading of mercury emissions. These facilities have come under scrutiny in both the United States and Canada as a major source of anthropogenic mercury emissions that is as yet unregulated.

The preparation of this document has entailed research into numerous mercury-related topics, including international policies and commitments on mercury. As well, some of the material emanated from attending and participating in a number of conferences in the U.S. on mercury and coal-fired power plants. These conferences offered a first-hand view of policy debates as well as research initiatives on mercury measurement and control. They also provided the opportunity to have one-on-one discussions with other participants, including government representatives, members of environmental non-government organizations (ENGOs), and industry representatives.

The information garnered from many members of the environmental community in Canada and the U.S. through informal discussions, conferences and surveys has been very valuable in the preparation of specific sections of this report, especially the ones on the trading of mercury emissions and U.S. policy.

The report includes a synopsis of the issue at hand, which covers health and environmental concerns about mercury; a description of coal-fired facilities and their role pertaining to mercury emissions; a summary to date of government initiatives and programs on mercury in Canada, in particular Canada-wide Standards (CWS) for mercury; and an overview of current strategies and control technology related to mercury. It then moves into the U.S. policy arena with a discussion of trading of mercury emissions; a summary of the U.S. regulatory action on mercury and coal-fired plants and ENGO opinions thereon. To round out this work, highlights of international programs on mercury are presented, with emphasis on the United Nations Environment Program (UNEP) Global Mercury Assessment. Recommendations and conclusions follow.

The three appendices include a description of state initiatives in the U.S. on coal-fired power plants and mercury, focusing on activities in Massachusetts; the complete report on ENGO perspectives on emissions trading of mercury for Environment Canada; and an extensive list of acronyms and abbreviations for reference.

This report seeks to enhance the contribution and influence of the public interest groups towards setting appropriate mercury emissions standards for this sector that will result in major reductions in emissions of mercury by ensuring that energy is generated in a way that addresses the larger issue of pollution prevention and protection of human health and the environment in a local and global context.

1.2 Mercury - A Global Poison

Of all toxic substances, mercury, the shiny, silvery liquid metal, is perhaps the most familiar and fascinating in the world. This metal has influenced many disciplines and practices for centuries - from mythology, folklore, alchemy, and gold-mining to medicine, science and "modern" technology. Its unique properties have lent themselves to many diverse applications from cosmetics, jewellery, hats and paints to thermometers, thermostats, fluorescent tubes, lamps, batteries and electrical switches to disinfectants, insecticides, fungicides, dental amalgam and vaccines. As well, mercury has been and continues to be used in numerous industrial and chemical processes.

Mercury, a natural element buried deep in the earth's crust, is indestructible and highly volatile, has no biological value, and is one of the most potent persistent bioaccumulative toxins known, capable of inflicting serious and irreversible neurological and developmental damage to humans and wildlife worldwide, as epitomized by Minamata disease in Japan[1].

Through natural phenomena such as volcanoes, erosion, forest fires and evaporation, mercury escapes from the earth's surface into the atmosphere and begins its wanton travels around the globe, taking on different forms, cycling back and forth between air, water, sediments, soil and biota, eventually returning to earth in rain or snow, contaminating lakes and rivers near and far from its source. Like the genie in the bottle, once set loose, mercury eludes capture - there is no getting it back.

When mercury enters water, it is transformed by bacteria into methylmercury, its most toxic form. Having gained access to the aquatic food chain, methylmercury concentrates in fish tissue, becoming increasingly more concentrated as it moves up each step of the aquatic food chain to the point where toxic levels in top predatory fish and fish-eating mammals can be over a million times greater than that found in surrounding waters.

While the mercury cycle has continued for eons, the global pool of mercury has more than tripled in just over 100 years as a result of human (anthropogenic) activity, primarily from industrial combustion sources such as coal-fired electricity generators, incinerators, smelters, chlor-alkali facilities, and cement manufacturers. The use and disposal of mercury-containing products further contribute to releases of mercury. Every year, the global pool of mercury increases as these activities continue to increase worldwide.

[1] "Minamata Disease" is synonymous with the large-scale methylmercury poisoning in Minamata, Japan in the 1950's, caused by discharge of methylmercury from an acetaldehyde manufacturing plant into Minamata Bay[1]. The most widely publicized epidemic poisoning in history, "Minamata Disease" demonstrates the worst possible effects that extensive exposure that methylmercury can have on human health and the environment.

1.3 Forms of Mercury

Mercury can occur in three chemical forms: elemental, inorganic, and organic. ***Elemental mercury*** refers to the metallic element (Hg^0), also known as quicksilver or metallic mercury. In this form, mercury can exist as a shiny silver liquid or a colourless, odourless gas vapour at room temperature, and it is insoluble in water. ***Inorganic mercury*** (Hg^{1+} and Hg^{2+}) refers to mercury in combination with other elements such as sulphur, chlorine, and oxygen). ***Organic mercury*** refers to mercury compounds that include carbon, such as methylmercury (CH_3-Hg)[2]. Each of these forms exhibits unique chemical and biological characteristics and has a different degree of toxicity.

Anthropogenic activities such as combustion sources, mining and smelting, and incineration primarily generate elemental mercury and to a lesser extent, inorganic mercury. Most of the mercury present in the atmosphere is elemental mercury, an extremely volatile form that can reside in the atmosphere as a gas anywhere from three months to two years. Approximately 60% of atmospheric mercury emissions, in particular elemental mercury, tend to be transported far beyond their sources, resulting in elevated levels throughout North America at locations far from the source, such as the Arctic.

Some of the elemental mercury will react with oxidants in the atmosphere and be transformed into inorganic mercury, a highly soluble form of mercury that, unlike the elemental form, has a tendency to be deposited closer to its source onto the soil, lakes and rivers. Once in water, bacterial action transforms the inorganic mercury into methylmercury which is subsequently absorbed by plankton. As larger aquatic organisms feed on the plankton, methylmercury concentrates in their tissues and bioaccumulates up the aquatic food web by millions to predatory fish[3].

1.4 Mercury Toxicity –Health and Environmental Impacts

Exposure to mercury can cause serious neurological and developmental damage to humans that range from subtle but permanent nerve damage, losses of sensory or cognitive ability (e.g. walking, talking), tremors, multiple sclerosis, birth defects, learning disabilities, and death. As well, it can lead to alterations to the immune system, liver degeneration, kidney toxicity and cardiovascular disease.

In addition to the level of mercury to which one is exposed, other major factors that affect an individual's susceptibility to the toxicity of mercury include one's immune reactivity, exposure to other toxins and potentially synergistic effects, and the detoxification ability of an individual. Such susceptibility factors can be particularly significant for a population exposed to mercury at extremely low levels over a long period.

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[2] Other organic forms include dimethylmercury, ethylmercury, and phenylmercury.

[3] Bioaccumulation or biomagnification describes the process by which lower organisms take up and store toxins such as mercury from their surroundings. Their predators collect and retain the toxins in their tissues, building up higher concentrations, and so on throughout the food chain, resulting in the highest members of the food chain having levels of methylmercury millions of times of that found in the surrounding waters.

The insidious symptoms of mercury poisoning may not readily manifest themselves, and may often be undetected or misdiagnosed especially in cases of exposure at low doses. As a result, these symptoms are often attributed to other diseases such as rheumatism, senile dementia, emotional instability and psychosis.

While all forms of mercury are dangerous if inhaled or ingested, organic mercury and in particular, methylmercury, the most common organic form of mercury and ***the most toxic form to living organisms***, is a potent neurotoxin and fetotoxin, easily absorbed orally and in turn easily enters the brain and fetus.

Consumption of mercury-contaminated fish is the predominant path of exposure to methylmercury for humans as well as fish-eating birds and mammals. Human exposure can also occur through inhalation and contact with mercury in the workplace, homes (breakage and use of mercury-containing products) and through use of dental amalgam and inoculation of some vaccines that contain mercury.

At present global mercury loading rates, less than $1/50^{th}$ of a teaspoon of mercury per 20 acre lake surface is enough to make fish unfit for human consumption. Concentrations of methylmercury have now reached levels where consumption of fish can pose threats to human health, particularly top predator species such as salmon, lake trout, or walleye; the most popular fish to eat and the most heavily contaminated with mercury.

Mercury is the most prevalent toxin found in large game fish in the Great Lakes. Most Canadian provinces and 45 states in the U.S. now issue fish consumption advisories due to mercury. Trimming or skinning fish is of no avail as mercury is bound to muscle tissue.

Those populations at greatest risk are women of child-bearing age, young children, the fetus, and communities reliant on fish and wildlife in their traditional diets. When ingested by pregnant women, methylmercury readily crosses the placenta and targets the developing fetal brain and central nervous system. Infants can also be exposed to high levels of methylmercury during breast-feeding.

While there is no scientific dispute about the hazards of high levels of mercury exposure, concern is emerging that even smaller exposures may cause subtle and irreversible damage to the brain and central nervous system, particularly among children and during fetal development.

In a study conducted on the toxicological effects of methylmercury in 2001, the Centers for Disease Control and Prevention (CDC) estimated that as many as 375 000 U.S. babies being born each year at risk for developmental disorders[4]. However, based on an analysis of new data and measurements of mercury levels in newborns, the U.S. Environmental

[4] National Health and Nutritional Survey (NHANES) Study published by the Centers for Disease Control and Prevention (CDC) March 21 2001

Protection Agency (EPA) has now found that more than 630 000 babies out of 4 million born each year may have dangerous levels of the toxin in their bodies[5].

These latest figures are an alarming increase over initial studies by the National Academy of Sciences just four years ago that found approximately 60 000 babies were at such risk[6]. While these updated figures will likely stir controversy, the more refined the data becomes with a greater understanding of the transference of methylmercury to the fetus, the need for taking appropriately strong measures to reduce mercury emissions is all the more paramount.

1.5 Mercury in the Arctic

Mercury is a particularly troublesome substance of major concern for Canada. While Canada's own anthropogenic emissions may pale compared to those of other countries, the climate in Canada, particularly the Polar Regions, makes those areas highly susceptible to mercury contamination of the traditional foods of the aboriginal people.

The Arctic is the receptor of many contaminants, such as mercury, and dioxins and furans, PCBs (polychlorinated biphenyls) and pesticides that originate from industrial sources thousands of kilometres away[7]. Given a sufficient amount of solar energy, these toxic substances evaporate at warmer temperatures, and become transported on air and ocean currents from southern agricultural and industrial sources to cooler regions in the Arctic where there is insufficient energy to re-vaporize or re-mobilize these substances. This pattern of transport is commonly referred to as the "grasshopper effect".

Upon reaching the northern Polar area, these long distance "travelling pollutants" condense and settle to the surface resulting in elevated concentrations of these pollutants in water, soil, sediments, snow, rain, ice for the most part as well as linger in the air.

As for mercury, when it reaches the Arctic, it undergoes a transformation that causes the mercury to deposit onto the snow at the start of the Arctic sunrise. This phenomenon is known as the Mercury Depletion Effect (MDE). Thus, at this particular period, a significant amount of mercury readily enters the food web while some of the mercury re-enters the atmosphere[8]. As few as six steps in the food chain stand between methylmercury ingestion by microorganisms and consumption by human beings in the Arctic.

A recent study of Inuit babies in the Nunavik region of Northern Quebec has detected subtle nervous system and behavioural changes that appear to be due to mercury and PCB

[5] Kathryn Mahaffey, EPA scientist (study completed February 2004): The study reported that mercury levels in the umbilical cord of the fetus are 70% higher than in the mother's blood, not the same as was previously thought. Reference: www.reuters.co.uk/newsArticle Feb.6, 2004, Maggie Fox, reporter.
[6] Toxicological Effects of Methylmercury, National Research Council (NRC) of NAS, July 2000.
[7] Long-range contamination of the Arctic became a concern after PCBs and dioxins were found in the blood and breast milk of Inuit mothers in the mid 1980s.
[8] Canadian Artic Contaminants Assessment Report II, March 2003 Highlights – Indian and Northern Affairs, Canada

contamination, contaminants whose presence in the Arctic is a result of long-range transportation of these pollutants[9]. This study is believed to be the first scientific evidence that long-range air pollution is affecting human health in the Arctic. The Inuit are especially vulnerable because such pollutants tend to build up in the fat of fish and game animals, on which much of their diet is based.

Global warming is now modifying the atmosphere and currents in a manner expected to further increase the levels of mercury and other heavy metals in the Arctic Ocean and enhance their mobilization to travel further to even cooler regions in the Arctic. And even though the levels of some contaminants are slowly declining across the circumpolar Arctic, this is not the case for mercury.

1.6 Pattern of Industrial Emissions of Mercury

Mercury emissions from some industrial sectors have decreased mainly through regulation, technological modifications and changes that have led to the replacement of the use of mercury, as well as closures of such facilities. Consequently, the pattern of source attribution of anthropogenic emissions of mercury today has shifted in many parts of the world from major sources of the past, such as chlor-alkali plants, smelting and mining, to other industrial sources, notably, coal-fired electric power generating facilities.

To cite examples illustrating the degree to which this sector has replaced others as a major emitter of mercury, coal-fired electric power plants are the number one source of atmospheric mercury emissions in North America, with some 91 tonnes emitted annually[10]. In the Great Lakes area, coal combustion is the single largest unregulated source of mercury air deposition[11].

In the present political climate, the growing demand for electricity is too often translated into a growing demand for coal-fired plants. The consequences of the expansion of this source of energy in terms of mercury and numerous other pollutants and climate change are alarming. This is particularly so, in light of inadequate legislative protection to significantly rein in and reduce the emissions from these facilities, lack of appropriate state-of-the-art control equipment, and, even more to the point, a dearth of energy policies that speak to the need for energy conservation and renewable energy sources to lessen the reliance on fossil fuels.

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[9] Muckle et al, Laval University: Prenatal exposure of Quebec Inuit infants to environmental contaminants. *Envir Health Perspect* 2001, 109, 1291-9

[10] The North American Commission for Environmental Cooperation (NACEC) Spring Issue, #9, TRIO Newsletter www.cec.org/trio

[11] Priorities 2001-2003, September 2003; Report to the International Joint Commission (IJC), p.17

2 Coal-Fired Power Plants and Mercury

2.1 An Overview of Coal as an Energy Source

Coal is a complex combination of organic matter and inorganic minerals formed over eons by the partial decomposition of successive layers of vegetative matter. As the coal ages and morphs over time, its characteristics are altered. The various stages of transition are typically divided into four types or ranks according to age, from lignite (the youngest), sub-bituminous, bituminous, to anthracite.

These different coal types vary in properties such as hardness and dryness, carbon content, volatile matter and heating value. Lignite is soft, brown to black with visible original plant material. Sub-bituminous coal is banded and black but still soft, with traces of woody layers. Bituminous coal, the most common of coals, is black and hard, while anthracite**,** the oldest and deepest buried, is a glassy textured dense carbon-rich rock. Lignite, sub-bituminous and bituminous coals are used in coal-fired power plants.

The composition and vast abundance of coal have made it a very popular relatively cheap, accessible source of electricity in the world. In fact, coal-fired power plants are the primary source of electricity production in many parts of the world today, despite their relatively low efficiency in generating electricity. In the United States, over half of the electric power generation is dominated by coal-fired power generation, while in Canada, as much as 21 percent of its total electrical energy is supplied by coal[12].

Rich in carbon and hydrogen, coal releases energy in the form of heat when burned or combusted. This heat is subsequently used to produce power and drive other processes. Coal also contains a host of other substances, such as sulphur and nitrogen as well as heavy metals and minerals. Many of these substances are toxic. When these fuels are burned at high temperature, not only do they yield heat energy from their carbon and hydrogen, they also release numerous toxic substances into the environment.

Coal-fired generating plants are a major source of miniscule particles that lead to respiratory problems and premature mortality. Their emissions are the primary components of acid rain and smog and a major contributing factor to climate change. They emit numerous hazardous pollutants some of which are neurotoxic and fetotoxic, in particular, mercury, while others, such as arsenic and cadmium, are known carcinogens.

The degree and nature of substances that are emitted from the combustion of coal depend on many factors – the type of coal, its composition, the generating and operational capacity of the plant, the state of the equipment, firing conditions and the control technologies employed. But of this there is no doubt - the combustion of coal causes emissions of particles and gases into the atmosphere that are harmful to human health and the environment and contribute to the diminishing capacity of a number of water bodies to sustain the qualities with which they are attributed.

[12] Electric Power Generation, Transmission and Distribution, 2001, Statistics Canada

2.2 Mercury and Coal-Fired Plants – The Toll

The focus on mercury and coal-fired plants stems from their significant and increasing role as a major contributor to anthropogenic releases of mercury to the atmosphere. Coal, the fossil fuel most utilized for generation of electricity, contains the highest amount of mercury of all fossil fuels. And of all toxic substances known, mercury is the most elusive, highly volatile and difficult to capture by pollution control devices.

When coal is combusted in the boiler units of these facilities at elevated temperatures, a number of chemical reactions occur, including the formation of gases that exit the boiler along with the release of numerous substances including trace metals trapped in coal. Some substances, including the non-combustible components in the coal, remain behind as coal residue, commonly called ash.

Depending on a number of parameters, some of the coal ash, usually larger particles, tends to settle out in the boiler (bottom ash) while some of the ash, mainly the finer particles, will be entrained in the flue gas (fly ash). The bottom ash is typically collected from the boiler and sent to landfill. On the other hand, the fly ash is carried along with the combustion gases and may be 'captured" in the pollution control equipment or travel up the stack and be released into the atmosphere.

The fate of the trace metals depends on a number of factors related to properties of the particular metal as well as specifications and composition of the coal. Some of these metals may be in the bottom ash and/or the fly ash. However, since mercury is a highly volatile element, it will be vaporized and emitted from the combustion area as a gas along with the numerous other combustion gases. No mercury is found in the bottom ash[13].

As the combustion gases pass through the air pollution control system, small amounts of mercury-containing compounds may adsorb on the surface of fine particles (particulate mercury) or become oxidized and combine with other elements, such as chlorine. Much of the mercury will remain in a gaseous phase as a vapour. While some of the oxidized mercury and particulate mercury may be captured by these control devices, most will not, and along with the gaseous mercury, will be emitted into the atmosphere.

While the amount and form of mercury emitted varies, the amount of mercury in coal prior to combustion must equal the amount of mercury released into the environment after combustion – whether it is in air, deposited in landfill or incorporated in some way.

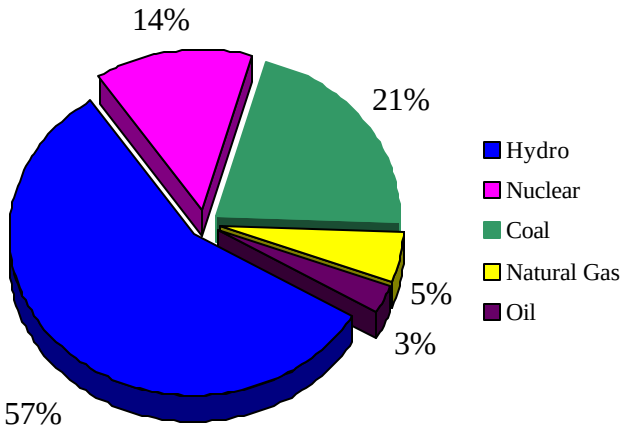
Even if it may not be possible to trace the path that mercury follows from its specific source, such as a coal-fired power plant, to a specific destination, once emitted into the atmosphere, mercury will eventually be deposited on land and in water bodies and enter the aquatic food chain, be it within 100 kilometres from a power plant, 1000 kilometres, or beyond[14].

[13] Environment Canada: A Primer on Electricity Generation 2000: Draft
[14] Estimated by the Electric Power Research Institute, U.S. (EPRI)

The heavy burden that such facilities exert on the ecosystem may not be easily quantified, but with all things considered, the reliance on fossil fuels as an energy source poses serious problems as it continues into the 21st century. While the price of coal may be cheap, its true cost to human health and environment is an ever-diminishing return.

2.3 The Role of Coal-Fired Electric Generation in Canada

Figure 2.1 Electricity Generation in Canada, 2001



The degree to which coal is utilized in Canada for the generation of electricity is often surprising to many Canadians. Hydroelectric facilities are the predominant source of electricity overall, while coal-fired plants are the second most prevalent source nationally. Renewable energy sources (wind, solar, biomass) are so insignificant that they are not represented on the adjacent pie-chart.

Each of the jurisdictions in Canada has their unique blend of energy sources. On a relative scale, coal-fired power plants are the dominant source of electricity in Nova Scotia, Alberta, Saskatchewan, followed by Ontario and New Brunswick. (Manitoba derives about 1% from coal, and along with the other jurisdictions, relies on hydroelectricity as the major source of energy). In terms of actual generation, Alberta followed by Ontario represents about 75% of all the coal generation in Canada.

Electric Energy Generation – 2001[15]

Province	Coal (GWh)	Total (GWh)	%Coal to Total
Nova Scotia	9800	11552	85
New Brunswick	3830	18750	20
Ontario	38689	148452	26
Saskatchewan	12113	16598	73
Alberta*	45315	55674	81
Total (5 provinces)	109747	251026	36

* Note: The Alberta Clean Air Strategic Alliance (CASA) Electricity Framework Report (November 2003) states that the generation from coal is about 66% of all energy sources for the year 2002 (total generation is 64,280 GWh)

[15] Electric Power Generation, Transmission and Distribution, 2001, Statistics Canada.

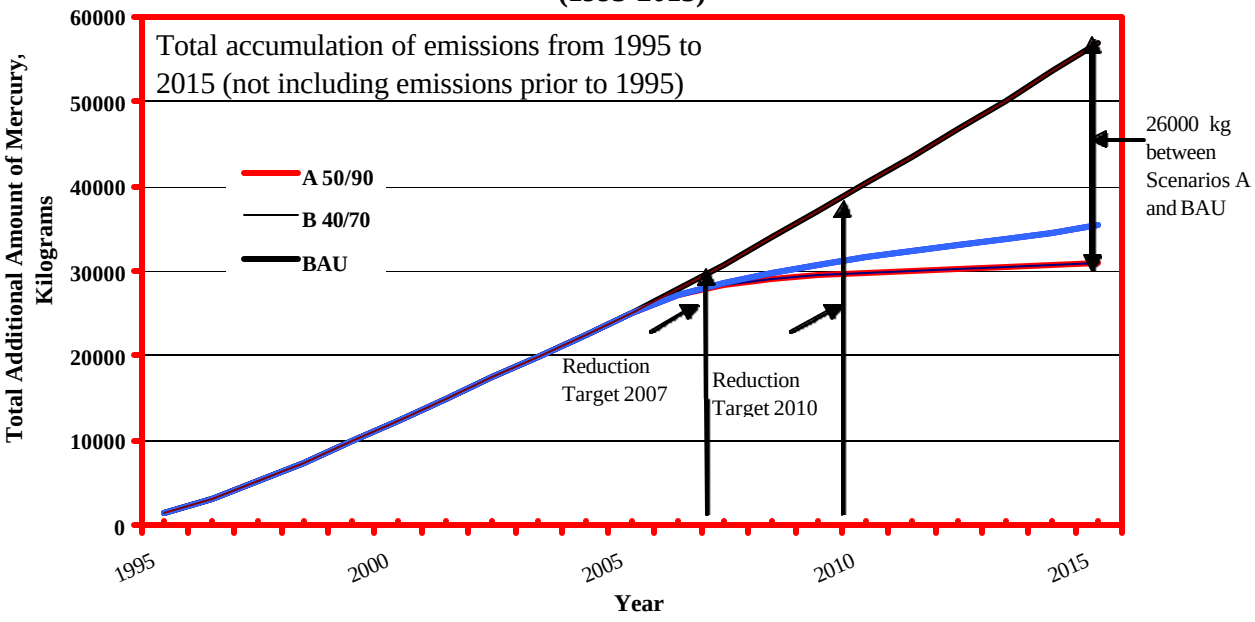
2.4 Cumulative Emissions

The annual atmospheric mercury emissions from coal-fired plants in Canada are estimated at about 2450 kilograms. Relative to other major sectors of mercury emitters, coal-fired plants account for approximately 39 per cent of Canada's total atmospheric mercury emissions, the largest contributor of atmospheric mercury in Canada[16].

Focusing strictly on yearly emissions masks a highly significant property of mercury – its persistency. A more realistic depiction of the loading of mercury into the environment would result if one were to account for the cumulative emissions of mercury from these facilities over a period of time, such as a 20 year span or even more realistic, the lifetime of their operation. For example, if the accumulation of emissions is aggregated over a twenty-year period, the total amount of mercury emitted is in the order of 50-60 tonnes. Considering that some of these facilities that are operating today have been on line for close to 50 years, their lifetime legacy of mercury emissions is very substantial.

The following graph gives an indication of the extent of the total accumulated amount of mercury emitted in Canada from coal-fired plants projected over a 20-year span from 1995-2015 under three scenarios: BAU - Business As Usual, that is, no reductions; "50/90" scenario, emission reductions of 50% by 2007 and 90% by 2010 (1999 base year); and "40/70" scenario, representing a 40% reduction by 2007 and 70% by 2010.

Figure 2.2 **Cumulative Emissions of Mercury from Coal-fired Plants in Canada (1995-2015)**



While all three curves show the **increase** in the accumulated amount of mercury in the environment, only when attempts are made to reduce annual emissions (as in scenarios A

[16] "Mercury..A Public Concern" A. Tilman March 2002 Refer to Chapters 4 and 5.

and B) in the year 2007 and 2010 does the rate at which the total amount of mercury accumulates begin to decrease. The crucial factors affecting the rate are the dates at which reductions of annual emissions commence and the actual amount of the reductions.

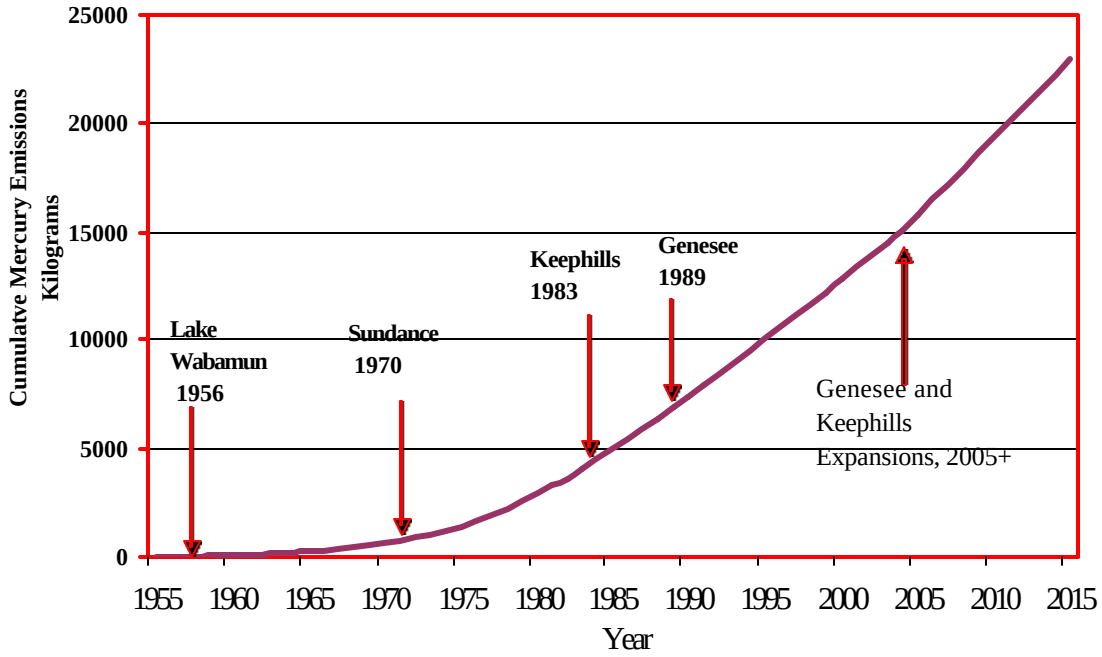
The graph makes it all the more evident that the longer it takes to implement a standard that would significantly reduce mercury emissions, the more problematic the mercury loading factor will be both locally and long-range. It underscores the importance of early action in setting stringent mercury emissions standards if the increase in cumulative emissions is to be abated in any significant manner.

2.5 Cumulative Emissions - Alberta

One example to illustrate the cumulative emissions of mercury in a region is the Lake Wabamun area, the location of four coal-fired power plants, namely, Lake Wabamun, Sundance, Keephills and Genesee.

The following graph illustrates the accumulation of mercury emissions from the four coal plants from their start-up dates to 2015, under the assumption that there will be no specific mercury controls added for that period and that planned expansions at two of the facilities (Genesee and Keephills) are to proceed (Genesee 3 is to be on line in 2005).

Figure 2.3 Cumulative Emissions: Lake Wabamun Area (1995-2015)



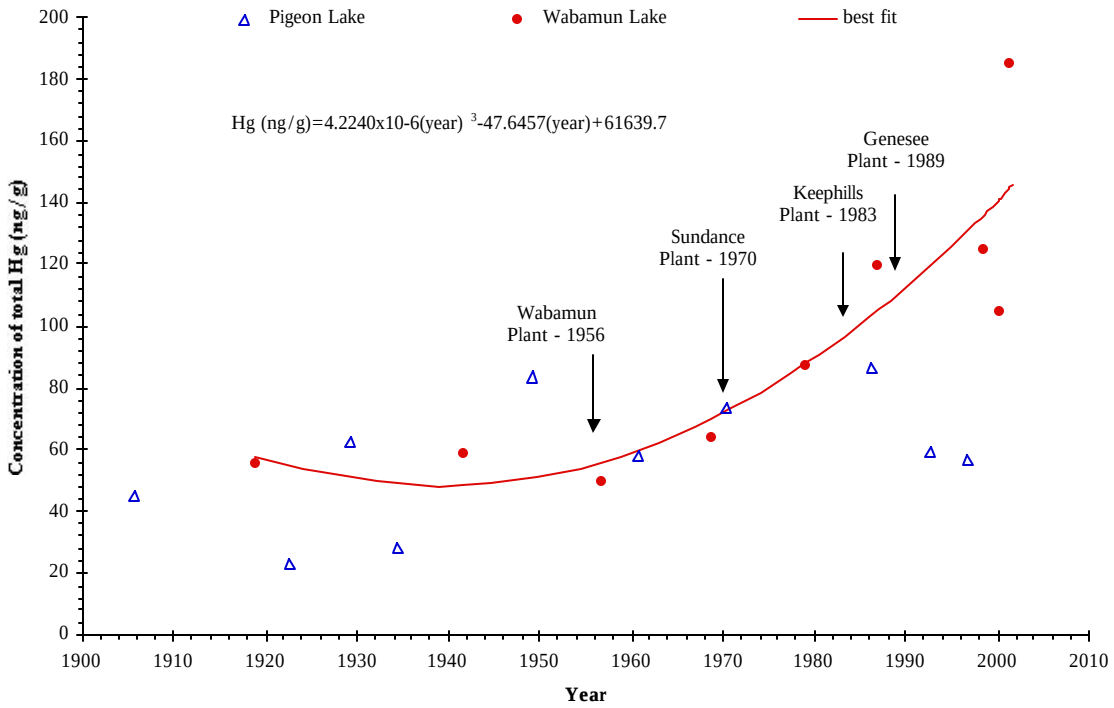
2.6 Lake Wabamun Sediment Studies[17]

A study of sediments and fish tissues was initiated in June 2002 by the University of Alberta in response to concerns expressed by the Lake Wabamun Enhancement and Protection Association on impacts of regional coal-burning power plants on metals accumulation in Wabamun Lake. This concern was heightened by the occurrence of a large and extended fish-kill in Wabamun Lake during the winter of 2001-2002.

The goal of the study was to determine whether and how the accumulation of metals in Lake Wabamun has changed through time, whether metals toxicity may have played a role in the fish kill, and whether regional coal-burning power plants have resulted in increased contaminant delivery to Lake Wabamun.

The following graph illustrates the concentration of mercury in sediments of Lake Wabamun and Pigeon Lake[18] over a period of approximately 80 years (1920-2000).

Figure 2.4 Concentration of Mercury in Sediments –Wabamun and Pigeon Lakes



[17] "An assessment of impacts of regional coal-burning power plants on metals accumulation in Lake Wabamun" prepared for the Lake Wabamun Enhancement and Protection Association by William F. Donahue, Ph. D, Department of Biological Sciences University of Alberta, September 2002.
[18] Pigeon Lake is located approximately 70 km south of Lake Wabamun.

The study pointed out a close coincidence of increases in mercury deposition within Lake Wabamun with the construction and operation of the four coal-burning power plants in the local area compared to Pigeon Lake where there are no such facilities. This observation suggests a causal relationship between coal-related industry in the area and increased mercury deposition. It also may rule out both atmospheric mercury from global sources and local natural geologic sources as proximal causes for relatively recent increases in mercury deposition in sediments of Lake Wabamun.

The author remarked that future expansions of coal-related industry in the area without adoption of effective mercury emission control technology may likely result in continued increases in mercury deposition and accumulation within Lake Wabamun, and, as a result, mercury concentrations within biota will likely rise, and especially in top predators like pike or fish-eating birds and animals.

While the results of this study are preliminary, it is worth comparing the results of the historic cumulative atmospheric emissions in the Lake Wabamun area with the sediment studies and the similarity in pattern between the graphs (figures 2.3 and 2.4).

3 Canada-wide Standards for Mercury - Electric Power Generating Sector

3.1 Canada-wide Standards - Background

Under the Harmonization Accord on the Environment and the Standards Sub-Agreement (January 1998), the Canadian Council of Ministers of the Environment (CCME) committed to developing and implementing Canada-wide Standards (CWS) for a number of substances that are of national concern to human health and the environment. Mercury is one of the priority substances for the development of such standards.

"Development Committees" composed of government representatives were established to guide this process and develop recommendations for standards. Stakeholder consultation and participation from non-government organizations (NGOs) and industry representatives are an integral component of the standards development process.

The CWSs are intended to be achievable targets based on science, social and economic impacts and technical feasibility. They have no legal force and represent but one route for developing "standards", or perhaps more appropriately, "guidelines". Each jurisdictional government is responsible for the implementation of the standards in their respective jurisdiction and for the mechanism chosen to do so.

3.2 Canada-wide Standards for Mercury - Update

The CWS for mercury has focused on atmospheric releases from designated sectors that account for most of such releases. These sectors include base metal smelters, waste incinerators (medical, municipal solid waste and hazardous waste), coal-fired electrical power generating facilities (EPG) as well as some of the mercury-containing products.

To date, CWSs have been endorsed for base metal smelters, incinerators, mercury-containing lamps and dental amalgam waste[19]. However, after a rather contentious five year period and several meetings of the Multi-stakeholder Advisory Group (MAG), at this stage, a mercury-CWS for the EPG sector is still in-waiting.

One could cite several factors for the lack of progress in this regard – strong reluctance on the part of industry at the onset to move forward on the issue, watching and waiting for U.S. regulatory action on mercury standards for coal-fired plants before proceeding with a "Canadian" solution, lack of information available on these facilities to best inform a CWS, and a two-year hiatus in engaging stakeholder meetings of the MAG on the CWS[20]. All of these factors and many more, whether justifiable or not, contributed to an inordinate delay in the development of a CWS.

[19] CCME website – www.ccme.ca Canada-wide standards for mercury gives background, endorsements and jurisdictional plans

[20] The EPG Multi-Stakeholder Group (MAG) met regularly at the beginning of the process until November, 2001, but did not reconvene for a face-to-face meeting until October, 2003.

Despite these factors, there has been some recent movement in the standard exercise - a work-plan has been developed and a national data collection and testing program has been initiated. Some provinces have been taking direct action to set mercury standards for their coal-fired power plants, in particular, Alberta.

Furthermore, on June 9 2003 the CCME issued a statement announcing its commitment to develop a CWS by 2005 to reduce mercury emissions from the coal-fired electric power generating sector by 2010[21]. The CCME acknowledged this sector to be the largest single remaining anthropogenic source of atmospheric mercury emissions in Canada (approximately 2450 kg in 1999 and similar levels in subsequent years).

In its announcement, the CCME indicated that it was exploring a national capture of mercury from coal burned in the range of 60-90%, and seeking alignment with the expected US standards of mercury. The capture of mercury would include all efforts to reduce mercury releases and may be achieved through a continuum of actions, from pollution prevention through emissions control.

The CWS is to apply to existing and new plants. CCME expects coal-fired electric power generation (EPG) to take early actions to reduce mercury emissions in Canada and will consider recognition for "early action." In addition, the application of the national target or standard by individual provinces could vary, with some provinces doing more or less, depending on the control technologies for the different coal types (especially lignite).

This statement is the first sign in years that there is a commitment to set a standard. It also requires clarification and details in terms of the form and level of a standard, the use of "capture rate" as a measure of reducing emissions of mercury, "early actions", and the variance in application of a standard in the different provinces.

In seeking alignment with the US, Canada is referring to proposed regulatory actions for this sector in the U.S. that were due to be announced December 2003 and in place the following year. "With the growing integration of the continental energy market, it is in Canada's best interests to develop a CWS for the EPG sector that takes the U.S. actions into account."

Having heard the outcome of the proposed US draft mercury rule on December 15, 2003, it remains to be seen whether the rationale for alignment is even possible in light of the nature of the U.S. proposed regulation. That being the case, the question remains as to whether and what action will be taken by provinces and the federal government, and what is the fate of the CWS itself.

No doubt, the challenges of setting a standard for this sector are daunting. Nonetheless, the government parties involved are expected to demonstrate their commitment to a fair process and to the establishment and implementation of a CWS in a timely manner that would lead to significant reductions of mercury emissions from coal-fired plants.

[21] Refer to the June 9, 2003 posting on the CCME website " CWS for Mercury Emissions from Coal-fired Power Plants"

Since the June 2003 announcement from the CCME, the MAG for EPG has met in October, 2003 with a revised draft terms of reference and expanded membership that now includes the Aboriginal Partners Advisory Group (APAG). This meeting provided the opportunity for an update on a number of issues – in particular, the proposed work-plan for the group, the data collection program and activities in the affected jurisdictions.

3.3 Jurisdictional Updates on Mercury Programs, 2003[22]

The following chart summarizes current actions in the various jurisdictions on coal-fired power plants.

Province	Actions/Research/Standards to Reduce Mercury Emissions
Manitoba	• **Selkirk** - converted to natural gas • **Brandon** - station to be assessed
New Brunswick	• **Grand Lake** – equipped with CS-ESPs, • to cease burning sub-bituminous indigenous coal prior to 2010 • **Belledune** – equipped with desulphurization system, CS-ESPs, and low NOx burners; ceased burning sub-bituminous indigenous coal January 2002
Nova Scotia	• **NS Power** – switched to solid fuels with lower mercury content, expect 30% reduction in mercury emissions by 2005
Ontario	• **Nanticoke and Lambton** – SCR units being installed • OPG is funding mercury switch-out program (no credit) • Re-starting nuclear facilities to reduce reliance on coal • Lakeview – to stop burning coal by 2005
Saskatchewan	• **Boundary Dam –** ESPs installed • **Poplar River –** demonstration project for mercury removal from flue gas at station • Proposal for mercury switch program between SaskPower and IPSCO (steel company)[23]
Alberta[24]	• **Clean Air Strategic Alliance (CASA),** a multi-stakeholder group, has developed an emission management framework for the Alberta electricity sector recommended for implementation by January 2006. The framework consists of a multi-pollutant strategy focusing on 5 priority substances including mercury. The specific recommendations pertaining to mercury emissions from coal-fired plants are expected to realize a 50% reduction in mercury emissions by the end of 2009 based on the application of Best Available Technology Economically Achievable (BATEA).

[22] Jurisdictional Updates were presented at the MAG meeting October 2 2003. For details, refer to CCME website www.ccme.ca. The information on Alberta has been updated since that meeting. (Note ref #24).
[23] Refer to p.19-22 for more information on mercury switches and cross-sectorial implications.
[24] Refer to the CASA website: http://www.casahome.org/electricity "An Emission Management Framework for the Alberta Electricity Sector Report to Stakeholders", November 2003. This report and its recommendations were approved by the CASA board November 27 2003. **Editorial update**: The Framework was adopted and endorsed by the Alberta Government on March 4 2004.

3.4 Uniform Data Collection Program (UDCP) - Canada

Throughout the long-drawn efforts to develop a CWS for mercury for coal-fired plants, the lack of appropriate data was often cited as a barrier to moving forward on the development of a standard. In response to this barrier, in 2002, the CCME initiated an information collection program (UDCP) with the objective of gathering "nationally consistent, comparable and compatible information upon which to base future standards development"[25]. The collection of data itself commenced August 2002.

The data collection program was prepared under the guidance of the Mercury Development Committee (i.e., representatives of jurisdictions) in collaboration with National Resources Canada (NRCAN) with the intention of compiling national inventories for mercury in coals, residues and flue gases, developing correlations between these levels of mercury for mass balance purposes and predicting the reductions to be expected from the various control technologies. The information obtained is being collected by jurisdictions and is to be compiled in a national report through the CCME that is to be publicly available.

While the U.S. EPA conducted its Information Collection Request (ICR) in 1999 to gather information on its coal-fired utilities to inform setting its mercury rule, the UDCP is a much more extensive data collection and reporting program, using standard testing protocols and reporting requirements[26]. Upon its completion and analysis, detailed information for each and every facility in Canada, including a mercury mass-balance calculation will be available and is expected to provide a reliable data base for the development of a mercury standard.

The UDCP program itself consists of three parts: general plant information, coal, ash and residues sampling; and an air emissions monitoring program:

Part1 requires individual facilities to submit plant-specific information to their jurisdictional representatives and update that information upon any modifications made that may impact on mercury emissions.

Part 2 details the collection of weekly coal, ash and residues sampling/analysis programs from every electrical generating unit in Canada. Prior to sampling, each utility was to submit a site-specific test plan according to proscribed methodologies (Appendix B, UDCP Guidance Document). The samples collected are to be analyzed for content of mercury, chlorine, inherent moisture and sulphur. The coal samples are also to be analyzed for heat value and the ash for unburned carbon. It is also recommended (but not required) that utilities sample for other substances, such as halides (bromine and

[25] CCME website "The Canadian Uniform Data Collection Program for Mercury (UDCP) from Coal-fired Electric Power Generation – Guidance Document", January 2003.

[26] On April 9, 1998 the US EPA published notice in the Federal Register of its intent to obtain additional information on mercury emissions from coal-fired power plants. The final draft of "Electricity Utility Steam Generating Unit Mercury Emissions Information Collection Effort" (ICR) was approved by the Office of Management and Budget (OMB) November 17, 1998.

fluorine). The sampling program is to run for 24 months. Utilities are required to submit their data quarterly to their jurisdictional representative.

Part 3 consists of the development of "quality-assured" speciated mercury emission data for every electricity-generating unit. Facilities are to determine mass-balance relationships, predict the fate of mercury for each facility, the annual mercury emissions and the reductions in these emissions that may be expected from different control technologies. All stack testing is to be completed by June 2004.

While the testing programs required are to be conducted according to jurisdictional – specific agreements (between utilities and their provincial governments), certain conditions may preclude the use of some recommended sampling procedures and thus allow for the use of alternatives to the testing protocol to yield equivalent information. In other words, the program allows for the use of equivalency, or "proxy" status, meaning that specific testing may not be required in cases where there are units equivalent in nature, provided there is detailed justification for the use of "proxies". Also, where stack-testing has been completed prior to the introduction of the UDCP, these tests may already satisfy the conditions required under the UDCP and not require further testing.

The UDCP is not necessarily intended to be a "gold standard" of a collection program – that is, it requests a certain amount of information but is not exhaustive. Furthermore, the UDCP has been modified or adapted through negotiations with the Canadian Electricity Association (CEA), the utilities and their respective jurisdictions, and is considered to represent a "reference method" or "template" for the collection of data.

However, as long as the required information is collected through a program aligned with the UDCP as reference, once that information is assessed and validated by outside experts, the UDCP or its equivalent counterparts would serve its function as a national inventory of data that has never been available for these facilities.

Because of the scope of the program and requirements for testing and frequency of submission of data, reporting, particularly in parts 2 and 3, the analysis of the information collected is being carried out by outside experts under the auspices of the CCME[27].

This analysis should be able to indicate deficiencies, shortfalls or discrepancies in information, what additional information would be useful, as well as whether proxies are appropriate where used and other relevant matters. A summary report on the data collection and the analyses is to be made available to the public on the CCME website. The most important element of this program relates to its fundamental purpose, that is, the setting of a defensible national standard, i.e., the CWS.

[27] The data for each utility is available through the Canadian Electricity Association (CEA) website at www.ceamercuryprogram.ca.

3.5 Mercury Switches – CCME Canada-wide Standards

In furthering the existing efforts to reduce anthropogenic emissions of mercury to the environment, in 2002, the CCME began a process to explore possible mechanisms to address a significant "reservoir" of mercury in vehicles and appliances that contain mercury switches under the existing framework of the mercury CWS.

While mercury switches were once commonplace, their use has diminished, particularly in appliances. Automobile manufacturers in North America have recently begun to phase out the use of mercury switches from their fleet.

The essential problem with these switches revolves around avoiding releases of mercury from this "reservoir" to the environment as these vehicles and appliances reach their "end-of-life" and are scrapped, shredded in the numerous scrap yards and "recycled" as a feed source in the production of steel in Electric Arc Furnaces (EAFs).

The interest of this particular endeavour to that of the mercury-CWS for the EPG sector is the potential cross-sectorial link of these two industrial sectors in trading or off-setting mercury emissions as a mechanism to manage and reduce mercury emissions.

3.5.1 Background – Mercury in Automobiles

Mercury is an excellent conductor of electricity, a property that has led to its widespread use in the manufacture of electrical switches. In the automobile industry, electrical switches containing mercury in capsules are commonly used to operate convenience hood and trunk lighting, antilock braking systems (ABS), back-lit instrument panels and mercury vapour headlamps. Overall, these mercury switches account for most of the mercury (about 99%) used in automobiles.

The typical car manufactured in North America contains an average of 1.06 switches, each of which contains about 0.7 to 1 gram of mercury, an amount that can contaminate a small lake of about 8 hectares surface area. With a fleet size of approximately 235 million vehicles in North America, the total inventory of mercury switches in cars could amount to 250 million. While removal of mercury switches from convenience lighting applications is a fairly simple procedure, very little known recovery actually occurs. Even less likely is recovery of ABS mercury switches.

The automotive industry has indicated that it is in the process of phasing out the primary uses of mercury such as convenience lighting (or other applications) in most models by 2004[28]. However it is not clear whether all types of vehicles or models will be "mercury-free" in lighting switches and ABS systems. Other applications of mercury such as high intensity discharge headlamps, navigational displays, and family entertainment systems are expected to continue and rise, although the amount of mercury in such uses is significantly less than that used in electrical switches.

[28] Canadian Vehicle Manufacturers' Association (CVMA) Poster on "Mercury Switch Removal", 2002.

Each year, approximately 12 million cars in North America are retired from useful life and typically end up in vehicle recycling and disposal[29]. Once salvageable parts are removed, vehicle hulks are sent to shredder facilities to recover metals or directly to electric arc furnaces (EAFs) where they are melted to make new steel products[30].

Scrap material from end-of-life vehicles constitutes a major source of feedstock for EAFs. (Other items in the scrap that may contain mercury switches include major household appliances, viz., white goods such as chest freezers and washing machines. Many of these products no longer contain mercury switches.) However, since most mercury switches, in particular from automobiles, are unlikely to have been removed prior to shredding, virtually all mercury from these products will be released as air emissions when they are recycled in EAFs.

As a result, electric arc furnaces are potentially a major source of atmospheric mercury emissions and perhaps the most significant of all potential sources of mercury emissions in terms of the steel manufacturing sector[31]. According to national U.S. emissions estimates, EAFs emit 15.6 tonnes of mercury per year, and constitute the largest **manufacturing** source of mercury air emissions, larger than all other manufacturing sources combined. Mercury from automobiles is presumed to be the single largest contributing source.

There are approximately 10,000 to 14,000 auto scrap yards in the United States and Canada, many of which have been designated as environmental contamination sites (some with known mercury contamination). The vast majority of EAFs, shredders and scrap yards in North America are neither monitored nor regulated for mercury pollution. As a result, unless appropriate measures are in place, the mercury from switches in end-of-life vehicles and appliances is also being released to soil when these products are dismantled, crushed, or shredded by auto shredder facilities and scrap yards.

3.5.2 Actions on Mercury Switches

The European Union (EU) has recently taken a major step in this direction by adopting the End-of-Life Vehicle (ELV) Directive, which requires the phase-out of most applications of mercury and other heavy metals. The Directive also gives automakers financial responsibility and sets recycling targets for ELVs. European-sold automobiles have not contained mercury switches since 1993, when mercury use was banned in Sweden. This suggests that proactive government policies may be the more effective approach to achieving clean production ends.

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[29] Toxics by Design, "The Automobile Industry's Continued Use of Mercury, Dean M.Menke, Pollution Prevention Alliance, January 2001

[30] In Canada, this could translate to as much as 1000 kg of mercury annually.

[31] Operations in steel mills that release mercury include cokemaking, iron sintering, (coal, coke, limestone, sludges), electric arc furnaces (scrap steel), basic oxygen furnace (scrap steel, limestone/lime) and blast furnace operations (iron ore, coke, limestone/lime). The amount of mercury released to the atmosphere from steel manufacturing in Canada is roughly estimated to be about 600 kg to 1000 kg or more.

Some states in the U.S. are now requiring the labeling of mercury-added products (including automobile components) or restricted mercury-containing products from entering the waste stream and are considering comprehensive mercury legislation, which would restrict sales, ban disposal, and provide a collection scheme for mercury-added products[32]. In particular, in July 2002, the State of Maine enacted legislation to prevent mercury emissions upon recycling and disposing of motor vehicles. The Act prohibits the sale of new motor vehicles with mercury switches and the replacement of mercury switches. In addition, it places responsibility on the manufacturers for the collection and removal of such switches.[33]

3.5.3 The Canadian Scene on Mercury Switches

Specific to Canada, there are currently 12 EAFs operating in Canada (Alberta, Saskatchewan, Manitoba, Ontario and Quebec) that recycle scrap steel and numerous automotive recycling and some shredding facilities. There is no national or provincially legislated program dealing with the issue of mercury switches – collection, use, recycling or disposal. Since mercury switches are unlikely to be removed prior to shredding automobiles, the electric arc furnaces (and basic oxygen furnaces) are considerable contributors to the release of mercury from EAFs into the atmosphere.

Vehicles in Canada could contain as much as 13 to 15 tonnes of mercury. In the absence of any Canada-wide control strategy, much of this mercury reservoir will be released to the environment over the next 10 to 15 years as end-of-life vehicles (and other scrap such as appliances) are dismantled, crushed, shredded, or recycled in EAFs.

The CCME multi-stakeholder committee, "Mercury Switch Life-Cycle Management Initiative", established in 2002, initiated discussions and proposal on various approaches regarding life-cycle management of mercury switches to reduce and avoid the emissions and release of mercury from these switches. Discussions ranged from actions and regulations underway in various regions and proposals for collection and disposal of mercury switches and producer responsibility.

Amongst many items that were brought forward to the table, was a proposition by the province of Saskatchewan to further explore an industry-driven proposal to recycle the mercury from mercury switches that involves the electric arc furnace (EAF) and the electric power generation (EPG) sectors. Specifically, the EPG sector would initiate actions for the recycling of the mercury from switches, and receive "recognition for early actions" since the mercury would no longer be in the scrap[34].

[32] For example, states with mercury switch programs include Vermont, Maine, Michigan, Washington and Minnesota.
[33] Public Laws of Maine, Chapter 656, "An Act to Prevent Mercury Emissions when Recycling and Disposing of Motor Vehicles"
[34] This proposal may be considered in the management of any future requirements through the establishment of a Canada-wide Standard for Mercury in the Electric Power Generation (EPG) Sector.

The Environmental Non-Government Organizations (ENGO) stakeholders of the committee in general expressed concern about the cross-sectorial aspects of the "Saskatchewan" proposal and its likely ramifications. ENGOs typically expect each sector to reduce their own mercury emissions and are concerned about cross-sectorial transfers of this nature as a means of meeting obligations under the CWS for mercury, in particular, for the EPG sector, once such a standard is developed.

Upon reviewing the work of this committee, the Development Committee (DC) of the mercury CWS decided that "jurisdiction-based mercury switch management programs, with or without recognition of early action, would be the most effective, flexible and timely approach and that a CWS in this case was not feasible". With no resolutions forthcoming, and lack of cooperation on some parties, in particular the auto industry representatives, on July 3, 2003, the stakeholder committee was officially terminated and the issue of developing any national program fell to ashes.

While acknowledging the useful information brought forward by many members of the committee, resolution or consensus amongst participants in the discussions was difficult if not impossible. It must also be stated the Canadian Vehicle Manufacturing Association (CVMA) has not accepted responsibility (financial) in the collection of switches and in commitments to eliminate the use of mercury altogether.

Despite examples of innovative programs and model legislation that could be adapted to the Canadian scene, no national program is foreseeable. It is now in the hands of jurisdictions to implement any mercury switch program – on a voluntary basis. The lack of resolution emerging from these consultations and the decision to sunset this committee is disturbing, particularly when there seemed to be a clear path forward that would result in a reduction of a substantive reservoir of mercury emissions as the millions of cars that contain mercury switches reach their end-of-life.

Clearly, efforts from all responsible parties are needed to eliminate mercury from scrap and feedstock, and to phase out its use altogether. Automakers in particular must accept responsibility for hazards posed by their products at the end of their useful lives through various initiative and programs such as product take-backs and by providing funding for a separate mercury collection and recovery system.

4 Strategies and Control Technologies for Reducing Mercury Emissions

4.1 Emission Reduction Options

This chapter explores some of the existing and emerging technologies relevant to coal-fired power plants and mercury emissions. At the same time, it must be recognized that pollution control technologies represent one of a number of avenues to consider in pursing a goal of reducing and eliminating anthropogenic emissions of mercury. Moreover, there are limits to what such technologies can achieve as well as new problems that emerge in their application.

In that respect, it is important to consider various other options beyond control technologies in developing an overall long-term strategy to reduce mercury emissions. For example, potential strategies may include any one or a combination of the following:

1) Optimization of conventional existing control technologies for PM, NOx, and SO_2 to increase mercury removal;
2) Development and installation of mercury-specific technologies;
3) Application of pre-combustion controls such as fuel switching, natural gas co-firing, coal-switching and coal cleaning; and
4) Avoidance of emissions - pollution prevention, energy conservation, demand-side management and renewable energy portfolios.

4.2 The Speciation of Mercury – Impacts on its Capture

The three main forms or species of mercury emitted from coal-fired plants are; elemental mercury (Hg^0), oxidized mercury (Hg^{2+}) and particle-bound mercury (Hg_p). The concentration of these forms, i.e., speciation, depends on a number of factors, primarily the composition and type of coal, fly ash characteristics, combustion conditions as well as the type of pollution control devices being utilized in the unit.

During combustion, elemental mercury (Hg^0) is liberated from coal. Upon exiting the boiler, a portion of the elemental mercury will be oxidized in the post-combustion environment. Some of the oxidized mercury will be associated with the fly ash particles (Hg_p) as well as existing in the cooled flue gas downstream[35].

The speciation of mercury in coal-fired flue gas greatly influences its removal across the flue gas path and can be an important factor in determining potential control options and operating parameters. For example, flue gas temperature can affect the ability of fly ash to adsorb mercury from flue gas while oxidized forms of mercury are effectively removed across most wet absorbers. Hence, both Hg^{2+} and Hg_p are more effectively captured relative to Hg^0 in conventional pollution control systems, such as flue gas desulphurization systems (FGD); fabric filters (FF) and electrostatic precipitators (ESPs).

[35] The nature by which mercury is oxidized is not clear, but coal type and chloride content in coal are thought to play a role.

The feasibility of the capture and removal of the two forms of mercury over elemental mercury from the flue gas is instrumental for identifying controls for other pollutants, such as NOx reduction controls that will oxidize Hg^0 to the other forms.

The type of coal is very significant in the effectiveness of mercury capture in particular with reference to the type of control devices. While there is moderate to good capture of bituminous coal, sub-bituminous coals and lignite represent the greatest challenge and to date exhibit poor capture.

4.3 Existing Control Technologies (for PM, SO_2 and NOx)[36]

Mercury emissions reductions are currently being achieved as a result of the effectiveness of SO_2, NOx and PM controls in their ability to capture mercury, not on dedicated mercury controls. For example, in the US, approximately 43% of mercury is being "captured" on a national scene, although the actual variation in capture can be anywhere from 0% (essentially no capture) to 90% or more[37].

The following chart provides a general guide of the relative effectiveness of existing controls on their ability to remove or capture mercury as determined by the capability of the specific existing control technology to transform elemental mercury to forms of mercury - oxidized or particulate, that are more readily captured.

Control Technology	Effect - Oxidized Mercury	Effect - Elemental Mercury	Effect - Particulate Mercury
Electrostatic Precipitators (ESP)	Little, if any	Little, if any	Efficient removal
Fabric Filter (FF)	Adsorption on fly ash (western fuel) Decrease due to oxidation in some instances	Adsorption on fly ash with high amount of unburned carbon Decrease due to oxidation in some instances	Efficient removal
Flue Gas Desulphurization (FGD)	Efficient removal	Little if any removal Increase due to reduction of adsorbed oxidized mercury in some cases	No effect
Selective Catalytic Reduction (SCR)	Increase due to oxidation	Decrease due to oxidation	Increase in some cases
Selective Non-Catalytic Reduction (SNCR)	Unknown	Unknown	Unknown

[36] Table from presentation – Praveen Amar, NESCAUM, CWS Mercury Meeting, Edmonton, June 2001
[37] Out of about an annual amount of 75 tons/yr of mercury in coal, 43 tons are being emitted to the atmosphere, while 32 tons are "captured" or "removed" by pollution control devices.

The effectiveness of these existing control systems is highly variable[38]. For example,

- Mercury capture associated with Particulate Matter (PM) controls ranked from best to worst: Fabric Filters (FF), Electrostatic Precipitators (ESP), PM scrubber and mechanical collector.
- Wet (Flue Gas Desulphurization) FGD Units are capable of 90% removal of ionic mercury. Wet FGD ranged from 33% for sub-bituminous coal to 96% removal for bituminous coal.
- NOx controls may enhance the ability to capture mercury. Ammonia used in SCR and SNCR oxidizes elemental mercury and converts it to ionic form.
- SNCR+CS-ESP (Selective Non-Catalytic Reduction with Cold-Side Electrostatic Precipitator) and SCR+SDA-FF (Selective Catalytic Reduction with Spray Dry Absorber and Fabric Filter) exhibited 91% and 97% reductions for bituminous coal.
- FGD and SNCR are capable of 95% removal (long-term).
- Dry scrubbers ranged from 3% to 98% removal for sub-bituminous to bituminous coals.

4.4 Continuous Emission Monitors (CEMs)[39]

The current methods of mercury emissions measurement are limited. They do not provide real-time data. Nor do they provide long-term results necessary to show variation in mercury emissions. Consequently, emission factors are frequently relied upon for estimates of mercury. To address these limitations, automated on-line continuous mercury monitors are being developed to provide real or near real-time results and a direct measure of mercury emissions including temporal variation.

Reliable and accurate techniques to measure ***speciated*** forms of mercury emitted from these facilities on a continual basis is essential to achieve and assure compliance to pending regulation. Furthermore, these monitoring techniques are likely to vastly improve the understanding of the behaviour of mercury in flue gases and the ability to assess the performance of and options for control systems[40].

At the present stage, CEMs have limited capabilities to operate consistently unattended or produce near real-time data over a relatively long time period with the prerequisite accuracy and reliability[41]. However, with further efforts underway to improve the feasibility of continuous mercury monitors, the plausibility that such instrumentation would become operational and reliable is promising and expected in the next few years.

[38] These observations summarize those from the U.S. Information Collection Request Effort undertaken in the U.S. in 1999 on a number of coal-fired power plants.
[39] Laudal, Thompson and Pavlish, EERC; Brickett, US NETL; Chu (EPRI) ; Continuous Emission Monitors (CEMs) for Mercury Emissions from Coal-Fired Utilities
[40] EPA has not determined what type of monitoring or testing may be included in the upcoming regulation.
[41] CEMs are also referred to as Continuous mercury Monitors (CMMs).

4.5 Lignite Coal and Mercury Control[42]

Power plants in the U.S. and Canada (e.g., Saskatchewan) that burn lignite coal emit greater portions of elemental mercury (Hg^0) relative to gaseous oxidized mercury (Hg^{2+}) than plants burning sub-bituminous or bituminous coals.

Lignite coals in general contain comparable concentrations of mercury to other coals, but have lower chlorine concentrations and higher calcium concentrations. The different compositions affect both the quantity and form of mercury emitted from the boiler and the type of control equipment that may be needed to remove mercury. Coals with higher chlorine content tend to produce a flue gas in which Hg^{2+} is the dominant form whereas Hg^0 is dominant for low-chlorine coals such as lignite. Elemental mercury is substantially more difficult to remove from flue gas than Hg^{2+}.

A combined US-Canada study is being carried out to develop and demonstrate mercury control technologies for facilities that burn lignite coal. Specifically the goals of the study are to develop a better scientific understanding of mercury interactions with flue gas components; test sorbent-based technology options that target oxidation and removal of Hg^0; and select the most promising technology for demonstration and quantification of effectiveness, performance and cost at a power plant.

Preliminary tests on sorbents indicate that carbon sorbent activated at higher temperatures over baseline temperatures may be more effective than other sorbents tested (e.g., calcium) in removing elemental mercury from the flue gas and converting it to the oxidized form. The injection of the sorbent between ESP and fabric filter was found most effective for mercury removal.

4.6 Specific Mercury Control Technologies

The expectation of mercury regulation in the U.S. has given further impetus into investigating methods to control and reduce mercury emissions and to look for opportunities to reduce mercury emissions in conjunction with other pollution controls[43]. Following is a brief summary of some of the research and technology at various stages of development that is directed not only to mercury capture, but also, to deliver co-benefits in capturing other pollutants. This material is derived from numerous papers on this topic presented at international conferences. At this stage it is difficult to judge the merits and weaknesses of some of this technology. Evidently, no one type of control technology will be needed to address the variability in these facilities.

[42] Pavlish, Homes, Benson et al, Mercury Control Technologies for Utilities Burning Lignite Coal, University of North Dakota, EERC.

[43] Laudal, Thompson and Pavlish; Evaluation of Mercury Speciation at Power Plants using SCR and SNCR NOx Control Technologies

4.6.1 Effect of NOx Controls on Mercury Speciation[44]

While the most common NOx reduction strategy to date has been the installation of low-NOx burners (capable of 40-60% reduction of NOx emissions), there is increased regulatory pressure to improve the performance of these burners[45].

NOx controls in coal-fired utilities are generally installed upstream of other controls and may effect mercury reactions across downstream control devices. For example, SCR (and SNCR) processes involve gas phase oxidation-reduction reactions. While these systems are effective at achieving nitrogen oxide reduction, each may impact mercury speciation differently.

Selective catalytic reduction (SCR) technology is becoming favoured for NOx control as it is capable of reducing NOx emissions by 70% to more than 90% in some cases and the costs are continuing to decrease as the knowledge base expands for these systems. Within the next few years, 80-90 U.S. utilities are projected to install SCR units.

SCR systems achieve lower NOx emissions by injecting ammonia or other compounds into the flue gas in the presence of a catalyst to reduce NOx to elemental nitrogen and water[46]. These units are operated at about 340^o – 400^o C. The catalysts generally used in the SCR process are metal oxide catalysts such as titanium/vanadium oxide (Ti/V) catalysts[47]. These catalysts have been shown to promote the conversion of Hg^0 to Hg^{2+} and/or Hg_p in relatively simple flue gas mixtures[48].

Thus, an SCR unit could potentially improve the mercury removal efficiency of **existing** pollution control equipment by promoting the conversion of elemental mercury to the other forms resulting in additional removal of mercury across downstream scrubbers or wet absorbers. Possible mechanisms that could impact mercury speciation and the catalytic oxidation of mercury include alteration of flue gas chemistry along with a subsequent change in fly ash chemical composition, and residence time.

Some of the current research in SCRs is directed to gain insight into reactions between flue gas mercury and NOx control processes under various conditions using a variety of coals. The tests to date indicate that while SCR assists in conversion of elemental mercury to the oxidized form, the effect is coal-specific and possibly dependent on the

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[44] Richardon, Machalek, Miller, URS Corporation, Dene and Chang, EPRI, Effect of NOx Control Processes on Mercury Speciation

[45] These regulations are concerned with $PM_{2.5}$, regional haze and ozone formation.

[46] SNCR systems also use ammonia as the reactant to reduce NOx without catalyst. A higher boiler temperature (about 700^oC) is required along with a longer residence time in the boiler to reduce NOx.

[47] Chemical configuration for the catalyst is titanium oxide (TiO_2)-supported vanadium pentoxide (V_2O_5) catalysts. These catalysts have been shown to have greater oxidation effects than other metal catalysts in reducing NOx.

[48] Measurements of mercury speciation at European coal-fired plants equipped with SCR units confirm that SCR catalysts promote the formation of Hg^{2+}.

catalysts. As expected, a high percentage of Hg^{2+} has been found to be removed by the FGD system and similarly a high percentage of the Hg_p is removed by the ESP.

Studies of this nature could lead to the ability to predict the expected effect of downstream controls on mercury removal and to consider the possibility that SCR and SNCR systems could be considered multi-pollutant technologies.

There are possible downsides of SCR systems, such as catalytic poisoning and an excess of ammonia released. There is also the possibility of reduction of the oxidized mercury occurring in the scrubber that would lead to re-volatilization of mercury in elemental form. In that case, scrubber capture efficiencies for oxidized mercury may be overstating overall mercury removal efficiencies. Further problems arise in situations where there may be no downstream absorber which would result in an increase in emissions of oxidized mercury, with the potential of creating a localized mercury deposition problem that may not otherwise have been considered.

4.6.2 Flue Gas Desulphurization (FGD) Systems

In the U.S., wet FGD systems are currently installed on about 25% of the coal-fired utility generating capacity representing about 50% of the total number of coal-fired units. Wet FGD (scrubbers) has evolved from a typical 90% SO_2 removal capability in the 1970s to more reliable and lower cost systems capable of achieving 95-98% in systems being installed today. These scrubbers are also able to remove oxidized mercury by more than 90%, with limited and highly variable success of anywhere from 0 to about 70% in the removal of elemental mercury.

Improvements to the performance of wet scrubbers on the capture of mercury primarily depend on methods to increase the oxidation of elemental mercury, such as the injection of an appropriate oxidizing agent or the installation of fixed oxidizing catalysts upstream of the scrubber to promote the oxidation of elemental mercury. Wet FGD systems may be able to provide a cost-effective, near-term mercury emissions option for boilers already equipped with such devices if the improvements indicated are capable of improving their mercury removal performance in the order of 90% with little or no impact on operation and SO_2 removal performance.

The mercury catalytic oxidation process under development uses catalytic material (in a honeycomb form) to promote the oxidation of elemental mercury in the flue gas from coal-fired plants with wet lime or limestone FGD systems. Preliminary estimates indicate that these catalysts installed in the above manner should to be able to achieve 90% or greater oxidation of elemental mercury in the flue gas.

The catalyst material is inserted into the flue gas path upstream of the wet FGD system at the outlet of the particulate control device (ESP). The oxidized mercury would be removed in the wet FGD absorbers and typically co-precipitate with other by-products from the FGD system.

Based on information from the U.S. Information Collection Request (ICR), technology for catalytic oxidation of Hg^0 would appear to have its greatest effect on the flue gas from sub-bituminous or lignite coals, where most of the mercury is in elemental form. In the U.S., currently, over 30 000 MW of scrubbed capacity use these fuels, with more similar systems planned.

A test plan has been designed for two sites with similar configurations, each firing relatively low-sulphur, low chloride coals, with similar mercury concentrations, one being (North Dakota) lignite and the other (PRB) sub-bituminous coal[49].

A thorough characterization of the flue gas is to be conducted that will include mercury concentrations and speciation (using the OH method) as well as other pollutants[50]. This will allow for a mercury balance to be calculated across the host sites and in turn verify the fate of mercury absorbed in the FGD system.

An aspect to the employment of wet FGD systems that needs to be addressed is the large quantities of waste, i.e., spent slurry, generated by these systems (scrubbers). This "waste" is typically disposed by ponding the slurry (without dewatering) or land-filled (after dewatering or mixing the sulphite sludge with fly ash and lime). As another means of disposal, by-products in the form of concentrated gypsum from the slurry are used in the manufacturing of wallboard or cement [51].

In that the spent material contains mercury, these disposal practices need to be examined for possible re-releases of mercury. This project will be addressing these issues and evaluating FGD by-products for mercury stability as well as investigating the leaching of mercury into groundwater and the volatilization of mercury into air from the by-products.

4.6.3 Sorbent Injection[52]

Sorbent injection, such as activated carbon injection (ACI) is an emerging technology that holds promise as a means of controlling mercury emissions from coal-fired power plants. Of all the emerging technologies on mercury control, it is the most mature and closest to commercialization.

The injection of sorbents such as powdered activated carbon (PAC) into the flue gas upstream of particulate control equipment has been shown to be effective in removing both elemental and oxidized species of vapour phase mercury from bituminous and sub-bituminous coals. This has been demonstrated in field tests on equipment at a scale comparable to power plants.

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[49] The Cold Creek Station site fires North Dakota lignite and uses a cold-side ESP for particulate control. The Spruce Plant (San Antonio) site fires PRB coal with fabric filter for particulate control.
[50] Tests will be done on sulphuric acid, chlorine, hydrogen fluoride and fluorine and trace metals.
[51] The Cold Creek Station FGD system produces a calcium sulphite by-product that is landfilled while the Spruce FGD system produces a gypsum byproduct that is sold for wallboard or cement production.
[52] Bustard et al, Full-Scale Evaluation of Sorbent Injection for Mercury Control in Coal-Fired Power Plants.

In comparison to wet FGD units alone, the sorbent injection approach is far more advantageous with respect to overall mercury capture. Wet scrubbers are only able to capture oxidized mercury and cannot remove elemental mercury. They are further limited in that they are only effective for mercury removal with certain bituminous coals.

The principal behind the use of ACI is the feasibility of interaction of the sorbent with mercury. The gas-phase mercury in the flue gas contacts the sorbent and attaches to its surface. The sorbent mixes with the flue gas and flows downstream to the particulate control equipment which then collects the sorbent with the mercury attached along with the fly ash. Thus, the mercury makes contact with the sorbent twice, increasing the potential for capture. The type of particulate control equipment used is a key parameter that determines the amount of sorbent required, residence time for interaction between mercury and the sorbent and thus the degree to which mercury can be removed.

The type of particulate control equipment used is a key parameter to determining the amount of sorbent required and the degree to which mercury can be removed. Of the two main types of particulate control, electrostatic precipitators (ESPs) and fabric filters (FF), (baghouses), fabric filters offer the greater opportunity for good interaction between the flue gas and the sorbent. Consequently, facilities that use fabric filters (e.g., COHPAC baghouses) have much greater potential to achieve higher mercury removal rates with much lower feed rates of the sorbent than ESPs[53].

Test results have indicated that mercury removal levels to be capable of exceeding 90% with the use of fabric filters, whereas, the removal level for ESPs is at the very maximum around 70% and that rate is only achievable by using a much higher feed rate of the sorbent. (Note that the mercury removal rates include both oxidized and elemental forms of mercury.) The COHPAC baghouse has been shown to be particularly amenable to carbon injection.

As with other control technologies, ACI has limitations. For one, the composition of coal and the different coal types may affect the amount of carbon required to effectively remove mercury. Further, the increased amount of carbon in the ash as a result of carbon injection is problematic with respect to the use of fly ash in the manufacturing of concrete, as even the presence of trace amounts of carbon in the ash rendered the ash unacceptable and thus unmarketable for use in concrete[54].

This particular problem could be ameliorated by adding a COHPAC baghouse downstream of the existing ESP. The ash would be collected upstream of the carbon injection by the existing ESP while the downstream baghouse would act as the primary mercury collector.

[53] Compact Hybrid Particulate Collector (COHPAC) is an EPRI-patented concept that places a high air-to-cloth baghouse downstream of an existing ESP to improve overall collection efficiency.

[54] Initial testing of fly ash at the Pleasant Prairie Power Plant test site in Wisconsin where the PRB ash is a valuable by-product showed that fly ash samples with low carbon concentrations were discoloured and failed to meet testing on freeze-thaw requirements.

Another issue is the increased cleaning frequency of the bags required as a result of carbon injection and the subsequent impact on bag life and particulate emission levels.

Injecting activated carbon between an ESP and a COHPAC fabric filter, a configuration referred to as TOXECON, can produce up to 90% reduction in mercury emissions at relatively low carbon feed rates without contaminating the bulk of the ash[55]*. This technique represents one of the most cost-effective approaches of reducing mercury emissions from coal-fired boilers.*

4.6.4 Electro-Catalytic Oxidation (ECO) [56]

The Electro-Catalytic Oxidation (ECO) technology is a 3-stage multi-pollutant removal process with capabilities of removing mercury and other heavy metals, fine particulate matter ($PM_{2.5}$), nitrogen oxides (NOx) and sulphur dioxides (SO_2) simultaneously from the exhaust gas of coal-fired power plants.

The ECO system is installed downstream of a power plant's ESP or fabric filter. Pollutants in the gas stream are initially oxidized by electro-chemical reduction in a gas reactor[57]. Following the oxidation, an ammonia scrubber removes unconverted sulphur dioxide and nitrogen dioxide. A wet ESP collects the resulting oxidized mercury along with particulate matter and aerosols produced by the gas reactor and scrubber.

The effluent from the wet ESP and scrubber contains ammonia sulphate and nitrate salts, fine particulate matter and dissolved metals such as mercury. A by-product recovery system removes ash by filtration and mercury by activated carbon adsorption. The treated stream can then be processed for use in products, typically fertilizers and wallboard.

On the basis of preliminary pilot tests, the ECO system seems to have the ability to significantly reduce the emission of pollutants in an integrated fashion while producing commercially saleable by-products avoiding landfill disposal of waste[58]. Further, ECO equipment minimizes the amount of retrofitting required with a single installation and reduces capital investment in other pollution control equipment. At this stage, while ECO appears to be a promising emerging technology, full-scale testing is needed to support these purported advantages.

4.7 Coal Utilization By-Products[59]

The potential re-release of mercury (and other metals) into the environment from coal combustion residues (CCRs) and by-products of fly ash are a major concern and interest in the U.S. and needs to be further explored in Canada. At present, most of the CCRs are

[55] Chu et al, Update on Mercury Control Technologies: Ramsay Chang, EPRI, Dick Johnson WE Energies
[56] McLaren, Powerspan Corp., Mercury Removal in a Multi-Pollutant Control Technology – for Utility Boilers. The technology has been developed by Powerspan Corporation
[57] ECO uses a dielelectric barrier discharge to convert elemental mercury to mercuric oxide.
[58] The ECO pilot system is constructed at FirstEnergy's R.E. Burger Plant in Ohio.
[59] Brickett, National Energy Technology Laboratory (NETL), Thorneloe, EPA, DOE/EPA Perspectives; Hassett et al, Potential for Mercury Release from Coal Combustion By-Products

land-filled. In the U.S. alone, the amount of mercury in landfill is about 21 tons[60]. If the projected increase in the use of coal is realized, the EPA has estimated the amount of this mercury to be in the order of 31 tons.

The U.S. has a strong market in manufacturing by-products from ash, with current production estimated to be over one million tons annually[61]. For instance, in the year 2000, 32% of fly ash was utilized primarily in cement and concrete while 19% of FGD material was used primarily as gypsum for wallboard manufacturing.

The question for this section is whether or how these new technologies may affect the usability of fly ash in by-products. For example, at present, activated carbon injection is viewed as a promising means of reducing mercury emissions. However, the application of such technology could lead to increased carbon and mercury concentrations in ash (see section 4.6.3). The stability of mercury in high temperature reuse processes such as cement manufacturing, along with the increased amounts of carbon could exert detrimental effects on by-products and their marketability.

4.8 Summary on the Impact of Technology

The properties of mercury make its capture or removal by pollution control devices a challenge indeed. No one of these technologies is the panacea. They all have their limitations. Then again, some of the facilities operating in both the U.S. and Canada have been doing so with very limited or little control devices for decades. In such cases, installation of up-to-date control technologies would be beneficial if these facilities intend to continue to operate. Otherwise, they should close down.

The research into coal utilization by-products as briefly described above shows the importance of life-cycle analysis of mercury and how it is complementary to exploring technologies to reduce emissions of mercury from coal-fired plants. For what may seem a promising mercury control technology may create problems that can have bearing on the overall benefits of the effectiveness of the technology.

This is why it is so important to go beyond the technological fix to the current problems so vividly illustrated by mercury. The direction we need to follow is the one that shifts away from mending out-dated systems and policies of meeting energy demands at any cost to the environment to one which calls for renewable sources of energy and conservation at the core. And when applied to that goal, technological innovation will be much more fruitful than adaptation to the present situation.

"We can't solve problems by using the same kind of thinking we used when we created them." Albert Einstein

[60] 70% of coal combustion residues (CCRs) are land disposed in 600 facilities representing 74 million tons of residue material, of which 21 tons are mercury (1999 data). With projected growth in the use of coal, these numbers are expected to increase to 53 million tons CCR and 31 tons mercury by 2010.

[61] Total fly ash production is approximately 64 million tons/yr while FGD yields 26 million tons/yr. The utilities alone contribute about 20 million tons of fly ash and 4 million of FGD.

5 Mercury-Emissions Trading

This is an abridged version of the report to Environment Canada, "Mercury-Emissions trading and Coal-Fired Plants, Perspectives from Environmental Non-Government Organizations", December 2003. The complete report is found in Appendix B. While it was written prior to the U.S. mercury proposal with respect to coal-fired plants, which is discussed in chapter 6, the content and opinions expressed on the topic of mercury emissions trading remain unaltered.

5.1 Preface

The intention of this paper was to offer Environment Canada perspectives primarily from the environmental community in Canada and the United States on the topic of trading of mercury emissions pertaining to coal-fired power plants. I trust that Environment Canada will consider these views very carefully in shaping and enacting policy in this regard.

As a means of soliciting the various views and positions on this topic, environmental organizations were canvassed by a survey as well as in informal discussions. In addition to canvassing these organizations, opinions on this topic were sought from individuals from academia, consulting firms and industry associations. The feedback from all these avenues has been thought-provoking and extremely valuable in formulating the essence of this work.

This topic elicits very strong sentiments. In many cases, lengthy discussions on this topic delved into moral, ethical and environmental justice issues as well as the nature of the toxin itself. In order to do justice to these comments, they have been included in the full report, in some cases, verbatim. Viewpoints expressed by industry groups and others who support emissions trading of mercury as well as their reservations have also been incorporated as a means of illustrating the scope of the debate on this matter.

In light of the importance of this issue on a national and international scale, the trading of mercury emissions is framed within a larger picture, one that discusses fundamental issues not only on the ethical and human rights aspect of emissions trading, but also on questioning the approach taken by governments in how they address toxic substances (or management thereof) in particular, mercury.

5.2 Background: The U.S. Policy Scene

The concept of emissions trading of mercury, in particular with respect to coal-fired power plants, has been advanced in the U.S over the past few years and has moved into the spotlight of current policy discussions regarding regulation of mercury emissions from these facilities. It gained prominence through the introduction of the Clear Skies Act 2003, a bill proposed by the Bush Administration to regulate emissions from coal-fired plants. "Clear Skies", a 3-pollutant bill (SO_2, NOx and mercury) that lays out a two-phased reduction plan premised on a cap-and-trade mechanism for all three pollutants.

The "Clear Skies" proposal has called for a 69% reduction in mercury emissions from the base year 2000, that is, from 48 tons to 15 tons by 2015, and a first phase target of 26 tons by the year 2010, equivalent to a 46% reduction in mercury emissions[62].

While other multi-pollutant bills pertaining to regulating and limiting emissions from coal-fired power plants have been introduced into the U.S. Congress over the past two years, "Clear Skies" has been at the forefront and focus of much polarized debate.

Prior to the introduction of "Clear Skies", on December 2000, the U.S. Environmental Protection Agency (EPA) had announced its decision to regulate emissions of mercury and other air toxics from coal- and oil-fired electric power plants, based on the findings of two major studies which identified mercury as the Hazardous Air Pollutant (HAP) of greatest concern to human health and cited coal-fired plants to be the single largest source of mercury air emissions in the U.S.[63]

In accordance with the existing air toxics section of the Clean Air Act (CAAA 1990, Section 112), the EPA was obligated to embark on a rule-making process to develop a mercury standard that would require all U.S. coal-fired power plants to install Maximum Achievable Control Technology (MACT) within specified timelines[64]. The MACT standard is expected to yield reductions of atmospheric mercury emissions from the 464 coal-fired plants in the U.S. by at least 90% from current levels (that is from 48 tons to approximately 5 tons) by the year 2008. Trading in mercury emissions is not a component of the MACT rule.

The draft "MACT" standard, due December 15, 2003, is to be finalized the following year with full compliance by December 2007.

If "Clear Skies" is enacted into legislation, it would amend the Clean Air Act and obviate the mercury MACT standard. Thus, while the regulatory train may have left the station for coal-fired plants in the U.S, two very different policy tracks regarding mercury and coal-fired plants have been laid out, Clear Skies and MACT. These tracks are really incomparable and incompatible, not only in terms of schedules and goals, but also in how these goals are to be attained.

Based on the present political climate in the U.S., it would have seemed a safe bet that the MACT draft rule would be first out of the gate, as it must, while Clear Skies takes a temporary reprieve, undoubtedly maintaining its strong influence in the corridors of power.

However, in the wake of its December 15 deadline, the outcome and nature of the draft MACT rule became uncertain as efforts to unravel MACT unfolded. In particular, the EPA under the present administration is considering adopting a new legal interpretation

[62] Under a cap-and-trade mechanism, the EPA has projected that mercury emissions will actually be approximately 18 tons by 2020. See page 40 for further details on Clear Skies.

[63] The reports are (i) EPA "Mercury Study Report to Congress" (December 1997), and (ii) the Utility Air Toxic "Final Report to Congress" (February 1998).

[64] The "MACT standard" requires that controls for existing facilities be at least as stringent as the limit achieved by the best performing 12 % of all the sources For new facilities, MACT requirements are to be at least as stringent as the emissions limit achieved by the best-controlled existing source. The process by which the mercury standard is set is referred to as the MACT rule.

of the Clean Air Act that would rescind the MACT rule-making process and standard for mercury and replace it with a much more "flexible" and far less stringent mechanism (Section 111 under the CAA) that would allow for the trading of mercury emissions.

To add more "fuel to the fire", the reductions of mercury emissions specified in the first phase of Clear Skies has been modified from the reduction goal of 26 tons by 2010 (46%) to 34 tons (a mere 30%). This reduction level is the one that the electric power industry has continued to rally around for the past few years as it makes its case that reduction in mercury emissions is to be derived only as a co-benefit of reductions of NOx and SO_2, not by any mercury-specific controls.

These potential changes really put the U.S. regulatory situation in a state of confusion as to the kind of standard the EPA will produce and whether the potential re-jigging of the Clean Air Act will be played out. Regardless of the outcome, any change that would derail the MACT track will lead to contention and litigation and result in further delays in dealing with the mercury emissions from these coal-fired plants, the single largest source of mercury emissions in the U.S.

Since Canada is so heavily influenced by the U.S. scene to inform its own policies and standards, particularly as regards coal-fired plants and mercury, the outcome of MACT and the future of Clear Skies is critical and of great interest to Canada.

5.3 Views on U. S. Policy – Clear Skies

To no surprise, the environmental community, by and large, in both the U.S. and Canada are opposed to "Clear Skies" for a number of reasons - its timelines are long-drawn, the reductions specified are inadequate, it does not include CO_2 emissions, it rolls back safeguards to protect local air quality and weakens public health protection of the existing Clean Air Act and does not address older "grandfathered" plants. And despite the fact that caps have been set for each pollutant, the actual emissions of the three pollutants will be higher than the caps set in "Clear Skies" since facilities that reduce emissions early can earn allowances for those actions and use those allowances at a later date (i.e. under banking provisions).

Furthermore, environmentalists find its proposal on mercury and the trading of mercury emissions likely to perpetuate and increase risks of mercury exposure to mercury from the major source of such emissions in the U.S, namely power plants, and lead to mercury "hotspots". ENGOs in general support the process of setting the mercury standard via a MACT ruling, if it will result in reductions in mercury emissions from coal-fired plants in the order of 90%. They are wary about the impact that Clear Skies may have on MACT.

Those who support the Clear Skies Act and hence subscribe to trading in mercury, regard trading as an economic incentive that can result in earlier reductions and do not feel the need to treat mercury differently from other the other pollutants under consideration. While they may acknowledge that there are present limitations to the feasibility in trading in mercury emissions, they hold to the view that, given the appropriate technology and time, such barriers will be overcome to allow for trading in mercury emissions.

Support for "Clear Skies" emanates primarily the electrical industrial sector, in particular, the coal-fired generation sector, as well as many who actively participate in market

mechanisms that involve emissions trading. These same supporters are vehemently opposed to the "MACT" rule for mercury. They see it as a command-and-control program that would stifle innovation, lead to higher compliance costs and electricity costs and would be more expensive than a cap-and-trade program. At the same time, some industry feel that the mercury targets specified in Clear Skies are too optimistic as they expect that reductions in mercury will be realized as co-benefits as a result of reductions in other pollutants, such as NOx.

5.4 International/Domestic Actions and Policies[65]

While the domestic federal "regulatory" actions on mercury in the U.S. are of major importance in Canada and the international community, in many theatres around the world, at regional, national and international levels, discussions are ongoing in efforts to come to grips with one of the most toxic substances known in the environment. These activities speak to the level of concern about this element, its ever-increasing global levels and long-lasting harmful effects on the ecosystem. None of them mention or even explore emissions trading of mercury.

The last decade alone has witnessed the continuance and intensification of numerous studies and programs that delve into many facets of mercury that range from the science, atmospheric transport, environmental and health effects, anthropogenic sources of emissions, and means to control and reduce mercury emissions that include technology and measurement to legislative efforts and international initiatives and agreements. Overall, the message that emerges is the need to take action sooner rather than later.

On the international front, in February 2003, the Governing Council of UNEP stated that there was "sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment and that national, regional and global actions, both intermediate and long-term, should be initiated as soon as possible." Further, the Governing Council urged that "all countries adopt goals and take national actions, as appropriate, with the objective of identifying exposed populations and ecosystems and reducing anthropogenic mercury releases that impact health and the environment."[66]

Other relevant programs include:

- The 1997 Great Lakes Binational Toxics Strategy (BNS), an agreement between United States and Canada, that seeks virtual elimination of specific persistent bioaccumulative toxic substances, including mercury, from the Great Lakes Basin[67];
- The North American Commission for Environmental Cooperation Regional Action Plan (NARAP) for mercury whose goal is the reduction of mercury to approach natural levels and fluxes in certain environmental media and a 50% reduction in mercury emissions by 2006; and

[65] Refer to chapter 7 of this document for an in-depth description of these actions.
[66] Comments are based on the "Global Assessment of Mercury" report initiated by the United Nations Environmental Programme (UNEP) in 2001. A full review of this report is in Chapter 7.
[67] The U.S. sought a 50% reduction in mercury emissions by 2005, while Canada specified a 90% reduction by 2000.

- The Mercury Action Plan adopted by the Eastern Canadian Provinces and New England Governors whose ultimate goal is the virtual elimination of anthropogenic mercury in the region.

In the Arctic, the Northern Contaminants Program has established mercury as a serious health concern. In Canada specifically, the Canadian Environmental Protection Act, 1999 (CEPA '99), pollution prevention is indicated as being priority for the management of toxic substances[68]. Mercury, one of the "CEPA-toxic" substances, is designated as a track II substance and is slated for "life-cycle management".

Of particular significance to core matters in this document, coal-fired plants have been singled out as a major and growing contributor to atmospheric mercury emissions. In the U.S., these sources account for approximately 40% of its domestic atmospheric mercury emissions and up until this time of writing this document, this industrial sector is the single largest unregulated source of mercury emissions in the U.S. Many states, alarmed with growing evidence of the local impact of mercury, are developing legislative tools to reign in mercury emissions from these plants.

Emissions of mercury from these sources in Canada have also become the number one source of anthropogenic mercury emissions in this country. For the past five years, Canada and its jurisdictions have been engaged in the process of developing "Canada-wide Standards" for mercury emissions from coal-fired power plants and are expected to come up with a standard by 2005.

Keeping an eye on all this activity is a daunting task, but an important one and even more so, if trading of mercury emissions becomes enshrined in U.S. policy and regulation, as this would send signals to other countries and jurisdictions that have not entertained this notion and may possibly have ramifications on the interpretation of existing agreements and future ones.

5.5 ENGO Perspectives on Mercury Emissions Trading

The positions of non-governmental environmental organizations (ENGOs) and "environmentalists" on the general concept of emissions trading vary, from cautious support, reluctant acceptance to total rejection. While a number of ENGOs see potential benefits in emissions trading in the case of certain pollutants such as CO_2, SO_2 and NOx, their support or acceptance of trading is premised on there being appropriate safeguards and principles in place.

Those who see some benefits to emissions trading are of the opinion that it has been a positive influence, an incentive, that has contributed to and in fact accelerated reductions of SO_2 emissions (under the U.S. Clean Air Act Amendments) and can work for NOx under certain circumstances. Trading in global pollutants such as CO_2 generally receives wider acceptance than the other pollutants, but again not without reservations and limitations.

[68] Mercury is listed as a toxic substance on Schedule I, Track 2 of CEPA. Such substances are slated for life-cycle management to prevent or minimize their release into the environment.

On the other hand, these sentiments are not universally held by the environmental community at large. Rather, emissions trading is often viewed with uncertainty and skepticism. Many are wary about the principle of employing a trading scheme as a means of reducing emissions rather than a regulated emissions reduction mechanism with emphasis on pollution prevention at source. The most contentious issue is the concern that emissions trading can result in potential environmental "hotspots" and environmental justice issues.

Regardless of the various opinions on emissions trading, the views of environmentalists converge when the issue of trading in mercury emissions arises.

The reaction of ENGOs and others (including academics and some industry representatives) to the concept of trading in mercury emissions is swift and definitive in the negative, as witnessed by comments expressed in the survey or in discussions. In many cases, the response was that of shock, outrage and the very absurdity of employing such an idea[69]. The monetary assignment of emission permits, selling and banking of credits, difficulties in the accuracy in the measurement of mercury emissions, along with societal costs and benefits, environmental justice issues and nature of mercury were all cited as obstacles to trading.

One aspect of trading put forward via the survey pertained to the possible use of "offsets", where in the absence of present technological solutions, industries are permitted to "offset" their current mercury emissions through arrangements or partnerships regarding mercury recycling or recovery efforts where abatement technologies are not presently available. However, in order for offsets to be effective in achieving early reductions, the mechanisms of administering offsets must be part of a larger package of a mercury reduction strategy and not be substituted for technological advancements.

At this stage, it is evident that there is no ENGO support in the U.S. or Canada for trading in mercury emissions. It is viewed as a very dangerous route – as precedent-setting in allowing trading in persistent bioaccumulative toxins and one that should not even be opened for discussion. It goes against the grain of national and binational commitments and international programs that are geared to achieve specific percent reductions or the "virtual elimination" of anthropogenic releases of mercury in general and for specified regions such as the Great Lakes.

Further to the point, the trading of mercury emissions is a parting of the seas, in that it represents a major ideological shift away from adopting strategies that prevent anthropogenic emissions of mercury in the first place. For that matter, the concept is contrary to the "precautionary principle" in that it cannot be shown to not raise threats of harm to human health and the environment.

Rather than pursing a cap-and-trade program for coal-fired power plants, ENGOs deem regulatory instruments, i.e., "command-and-control" measures appropriate.

[69] Dr. Donald McKay, Professor Emeritus, Trent University and University of Toronto – keynote speaker at the IJC conference, February 2003

5.6 Concluding Remarks

Clearly, the trading of mercury emissions is a highly controversial and challenging issue with divergent views from a number of quarters. It brings to the forefront the ethical and moral question of engaging in "market strategies" as a mechanism to address the "management" of toxic substances, in this case one of the most pervasive toxic substances known. It has been compared to a "traveller without a passport that spreads around the world in air and water" causing damage in its wake for years to come, adding to the global pool, eluding capture[70].

How does one even begin to attribute a "social" cost to this substance? In granting permits to emit mercury to facilities, does the cost of the permits reflect the costs and damage for present and future generations? If the price of the permits are set sufficiently high to reflect the nature and impact of the substance, then what trades will ensue? And what then, becomes the incentive to reduce emissions or retire old (grandfathered) plants?

When it comes to mercury, an indestructible element, do we have a "moral" or "ethical" right to inflict and continue to inflict this toxin on vulnerable innocent communities and on the ecosystem? Can we disregard the impact of emissions of toxic substances from an industrial setting in regions such as the Arctic? And as I write this paper, arguments prevail as to a "safe level" of exposure to mercury in attempts by some parties to derail the U.S. EPA cautionary reference dose and lower the bar of protection for the most sensitive populations, thereby lessening potential requirements to reduce mercury emissions. This is most disturbing.

International agreements and assessments of mercury sound the alarm of the sheer magnitude of the increasing presence of mercury in the environment since industrialization and speak to the need to reduce anthropogenic emissions of mercury significantly, in some cases, to virtually eliminate anthropogenic releases of mercury. While these agreements and commitments are silent on emissions trading of mercury, it may be that the very concept did not enter into discussion. One may very well question whether the very nature of this topic is in direct conflict with the intent and essence of these agreements and commitments.

For Canada, what is the consequence of mercury emissions trading if initiated in the U.S.? Will Canada be obligated to embrace emissions trading of mercury if Clear Skies or some form of a mercury-trading regulation? Are we not more affected by such trading mechanisms, considering our Arctic lands, for example? How will Canada reassure its residents, native communities, and women of childbearing age that they will not be harmed, that their communities will not become a haven for mercury pollution? These very same questions apply on a global scale as well.

Taking it to another level, one needs to look at the potential fallout resulting from increased exposure to methylmercury (the most toxic and most common form of human exposure to mercury) on the family, the care and nurturing required, loss of livelihood, the community, habitat, local food sources for many, many years. Perhaps that is the question to first ask and decide whether the path of emissions trading is on a collision

[70] Quote from Dr. Klaus Toepler, Executive Director of UNEP, March 2003

course with the need for reduction in and prevention of anthropogenic mercury emissions as has been so often stated and re-stated around the world. Then the question of trading in mercury emissions is truly moot.

In conclusion, the mere consideration of the possibility of trading a toxin such as mercury is akin to embarking on a journey into the unknown, where the path is riddled with obstacles and the outcome "shrouded" in uncertainty. It may well be akin to striking a Faustian bargain.

For all the complexities and issues raised, from practical to ethical matters, the environmental community has no appetite for and cannot support trading in mercury emissions and strongly advices Canada to not go down that road.

5.7 Addendum: Clear Skies 2003

This section provides the reader with the specific goals and targets specified by the Clear Skies Proposal.

Clear Skies Act 2002/3, an initiative proposed by the Bush administration establishes a mandatory new cap-and-trade program requiring reductions of sulphur dioxide, nitrogen oxides, and mercury emissions from all fossil fuel electric generators > 25 MW[71]. Mercury requirements are applicable only to coal-fired facilities. The following table lays out the caps and targets.

Clear Skies, 2002/3

Pollutant	Actual Emissions 2000 - tons	Phase 1 Caps – tons	Phase 2 Caps - tons	Reduction from 2000 %	EPA Projected Emissions 2020 –tons
SO_2	11.2 million	4.5 million in 2010	3 million in 2018	73	3.9 million
NOx	5.1 million	2.1 million in 2008	1.7 million in 2018	67	1.7 million
Mercury	48	26 in 2010**	15 in 2018	69	18

* This column reflects EPA's projections of actual emissions that are expected to exceed the caps due to the mechanics of emissions trading and banking of credits.
** As of November 2003, the 26 ton cap has been increased to 34 tons.

[71] Clear Skies was first introduced into Congress by Senator Smith, February 2002. It was re-introduced February 2003. Clear Skies amends Title IV also amends Title 1 of the Clean Air Act by providing an alternative regulatory classification for units subject to cap-and-trade programs. Refer to http://www.epa.gov/air/clearskies/fact2003.html

6 United States Regulatory Action on Mercury and Coal-Fired Power Plants

6.1 Update on Mercury Ruling of December 15, 2003

6.1.1 Overview

On December 14, 2000, the U.S. Environmental Protection Agency (EPA) announced its decision to regulate emissions of mercury and other air toxics (specifically nickel) from coal- and oil-fired electric utility steam generating units (power plants)[72]. Draft mercury regulations for coal-fired plants were due by December 15, 2003, final regulation by December 15, 2004 with full compliance by December 2007.

Following this historic announcement, the EPA established a multi-stakeholder working group to develop a mercury standard that would require all 464 of the nation's coal-fired power plants to use maximum achievable technology (MACT) to reduce their mercury emissions, an approach anticipated to result in a 90% reduction of mercury emissions to air from these facilities by the compliance date.

Coal-fired power plants are the single largest industrial unregulated source of airborne mercury in the U.S. In the year 2000 alone, these facilities emitted approximately 48 tons (44 tonnes) of mercury, about 40% of all annual U.S. anthropogenic emissions to air for that year.

The historical basis for the decision to regulate mercury emissions from coal-fired plants is rooted in the U.S. Clean Air Act Amendments of 1990 and comes a full decade after the U.S. Congress first directed the EPA to begin its analysis of mercury emissions in the U.S. in 1990. It is of particularly significant in that these facilities were exempted from regulation to address emissions of mercury and other air toxics under the 1990 U.S. Clean Air Act Amendments of (CAAA 1990).

Two major reports were instrumental in forming the EPA decision to regulate mercury from coal-fired plants; the EPA "Mercury Study Report to Congress" (December 1997) which determined that coal-fired plants are the single largest source of mercury air emissions in the U.S. and the Utility Air Toxic "Final Report to Congress" (February 1998) which identified mercury as the Hazardous Air Pollutant (HAP) of greatest concern to human health. Subsequent analyses and other available information further substantiated the need for regulation.

The announcement on the long-awaited mercury draft rule came on December 15, 2003 and with that, a highly perplexing scenario, with the EPA presenting two options for comment, both of which run against the thread of legal requirements under the CAAA as to the mechanism on how air toxics such as mercury need to be regulated. Neither of these options represents the essence of the December 2000 decision by the EPA that it was necessary and appropriate to regulate mercury emissions from coal-fired plants.

[72] "Electric utility steam generating unit" means "any fossil fuel fired combustion unit of more than 25 MW that serves as a generator for electricity for sale" (Section 112 (a) (8) of the Act).

While it is too early and far too complex to delve into the various complications and legal ramifications of the draft proposal at this stage, it is nevertheless worth recalling elements of the process leading up to the determination to regulate mercury, present a brief summary of these proposals and providing some critical analysis into the tableau of events that have unfolded that have undoubtedly influenced the outcome of the December 15, 2003 proposal.

6.1.2 Utility Air Toxics Regulatory Determination – Historical Context

i) Requirements under the Clean Air Act:

Under the 1990 Amendments of the Clean Air Act (CAAA, section 112n), the electric utility sector was given differential treatment from other major sources of hazardous air pollutants (HAPs) such as mercury and nickel in that they were granted exemption from regulation. As a result, what is now the largest source air emissions of mercury in the U.S., namely coal-fired power plants, has remained the last major unregulated source of mercury emissions.

In passing the Clean Air Act Amendments (CAAA) in 1990, the US Congress directed the EPA to further the reduction of air pollution from various industrial sectors and categorize and regulate all major sources of HAPs, which included mercury[73].

Accordingly, the EPA was mandated to carry out studies on the exposures, hazards and risks to public health that are "reasonably anticipated to occur as a result of HAP emissions from coal- and oil-fired electric utility steam generating units (power plants)". The EPA was also required to study the risk associated with mercury emissions from coal-fired power plants and to determine whether it was necessary and appropriate to regulate mercury emissions from this source category[74].

[Section 112(n)(1)(A) of the Act requires the EPA Administrator to regulate HAP emissions from electric utility steam generating units if such regulation is found to be "appropriate and necessary" after considering the results of the study. The quoted language is considered to play a principle, but not exclusive role in the decision on regulation. The EPA Administrator is also authorized to collect and evaluate any other applicable and appropriate information that would be needed to make an informed decision.]

The analysis for mercury was primarily based on the Mercury Study Report to Congress, December 1997 which provided an assessment of the magnitude of U.S. emissions of mercury by source, the health and environmental implications of these emissions, the availability and cost of control technologies and identified areas where further research is

[73] Section 112 (n) (1)(A) of the CAAA sets requirements for study in addition to need for regulatory action. Section 112(c) lists source categories, Section 112(b) contains the list of 188 HAP including mercury.
[74] The reports are (i) EPA "Mercury Study Report to Congress" (December 1997), and (ii) the Utility Air Toxic "Final Report to Congress" (February 1998).

needed. **The report found that coal-fired plants were the largest source of mercury air emissions in the U.S.**

In its comprehensive Final Report to Congress (known as the utility RTC), February 1998[75], based on its assessment of exposures, hazards and risks, the EPA concluded that out of 67 air toxics emitted from coal-fired power plants, **mercury was the hazardous air pollutant of greatest potential concern.** Some of the concerns cited related to the nature of mercury itself, its toxicity, its multi-media presence, the levels of anthropogenic emissions, and its effect on human health and the environment.

The EPA also concluded that on balance, mercury emissions from these utilities were of sufficient concern for public health to merit further research and monitoring. As a result, the EPA began a process to gather additional relevant information on mercury and coal-fired plants (Information Collection Request, ICR) along with analyses on costs and control options. This information would also be useful to assist in determining whether regulation would be deemed appropriate (under section 112 CAAA) and thus in developing an applicable mercury emissions standard.

The findings of these in-depth studies and the information gathered led the US EPA to its announcement of December 2000 in which it found it "appropriate and necessary" to regulate mercury (and other HAPs) from coal-fired power plants under the existing air toxics section of the Clean Air Act Amendments of 1990 (CAAA 1990).

In accordance with of the Clean Air Act (CAAA 1990, Section 112), the EPA was obligated to embark on a rule-making process to develop a mercury standard that would require all U.S. coal-fired power plants to install Maximum Achievable Control Technology (MACT).

The EPA was required to issue a draft "MACT" standard within three years of the determinations that is, by December 15, 2003, and following a public comment period, promulgate final regulations to by December 15 2004. Thus full compliance is required by December 2007.

ii) The MACT Rule and Process

At the very minimum, (known as the MACT floor), a MACT standard is to be no less stringent than the top 12% (best performers) in the particular source category. MACT can be more stringent than the "floor"[76]. Other significant factors apply in establishing a MACT standard under section 112 of the CAAA; in particular, a trading regime for mercury is not permissible. Furthermore, "cost" does not need to be a factor in the determination of a standard.

Sources are commonly given a 3-year period to comply with emissions reduction requirements under the MACT provisions. All such units in the source category are

[75] "Study of Hazardous Air Pollutant Emissions from Electricity Utility Steam Generating Units – Final Report to Congress" February 24, 1998

[76] For new facilities, MACT requirements are to be at least as stringent as the emissions limit achieved by the best-controlled existing source.

affected. [While a MACT standard would typically be rate-based, reductions are typically translated into national percent reductions.]

In accordance with requirements of CAAA, a multi-stakeholder working group consisting of representatives of environmental organizations, industry and government was formed to discuss and consult on the nature and level of reductions of a MACT standard. Amongst the diverse working group members, proposals for reductions of mercury emissions from the current level of 48 tons tended to range from 2 to 30 tons with a mid-point range of 5 tons to 15 tons[77]. In December 2001, the EPA itself had indicated that MACT standards could reduce atmospheric mercury emissions from the 464 coal-fired plants (1149 units) in the U.S by about 90%, that is, from 48 tons to 5 tons by 2008.

While the MACT process was underway, in February 2002, the Bush administration introduced the Clear Skies Act into Congress to regulate emissions of SO_2, NOx and mercury from coal-fired plants[78]. Clear Skies is a 3-pollutant bill premised on two-phase cap-and-trade mechanism for all 3 pollutants. Reductions specified in mercury emissions from the 2000 level of 48 tons were 26 tons for 2010 and 15 tons for 2018. The proposed Act would effectively amend the CAAA, particularly with respect to mercury and the MACT ruling.

In November 2003, the lead sponsor of the Clear Skies Plan[79] changed the first round of mercury reductions specified in Clear Skies from 26 to 34 tons, with the rationale that utilities would be unable to meet the more stringent cap because of limits on pollution control technology. The 34-ton target is the low end of an estimate of the level of reductions in mercury emissions that could be achieved based solely on the installation of controls for SO_2 and NOx, that is, mercury reductions are realized as a co-benefit of reductions of NOx and SO_2 and thus mercury-specific controls are not required.

This modified reduction scenario is the one that the electric power industry has rallied around for the past few years as they vehemently oppose mercury-specific regulations, in particular, MACT, and have continuously argued that mercury-specific controls are not readily available the cost for such controls would be prohibitive and that more time was required to develop mercury-specific controls.

While other multi-pollutant bills pertaining to regulating emissions from coal-fired power plants have been introduced into the U.S. Congress over the past two years, the essential elements and tenets of Clear Skies remain at the forefront exerting a powerful influence on the outcome of the EPA's Mercury ruling of December 2003.

However, with lawmakers and politicians focusing attention on other matters in the U.S., it became foreseeable that Clear Skies plan would not go forward into legislation for 2003 nor in 2004, an election year. Since EPA was obliged to come out with its mercury

[77] "Moderate" reduction scenarios were in the order of 75% reduction (12 tons), while most industry representatives did not exceed 30 tons.

[78] "Clear Skies 2003" was re-introduced February 2003. Clear Skies amends titles of the Clean Air Act by providing an alternative regulatory mechanism for units subject to cap-and-trade mechanisms. Refer to http://www.epa.gov/air/clearskies/fact2003.html

[79] The U.S. Senate lead sponsor is Chairman of the Environment and Public Works Committee, James Inhofe (R-Okla).

ruling by December 15 2003, the industry, adamant in their opposition to MACT, intensified lobbying efforts in the months preceding the deadline, urging the EPA to come out with a broad interpretation of the Clean Air Act that would allow for a risk-base flexible approach to mercury regulations – and not MACT.

In anticipation of the December 15 announcement, one could only surmise the unfolding events that would ensue if the EPA proposal would entertain re-jigging the Clean Air Act and derail MACT. However, any attempt to obfuscate MACT and impinge on legal requirements under CAAA would clearly lead to contention and litigation only to lead to further delays in dealing with the mercury emissions from these coal-fired plants, the single largest source of mercury emissions in the U.S.

6.2 EPA Proposed Ruling for Mercury – December 15, 2003

As the December deadline drew nearer, information obtained from leaked documents indicated that the EPA was abandoning its plan to adopt a MACT standard and come out with a radically different proposal that would replace it with a far less stringent standard under a "cap-and-trade" program that would mirror Clear Skies.

On December 15, 2003, the EPA announced its long-awaited "Utility Mercury Reduction Rule". In spite of speculation as to the nature of the rule, it was even more surprising than anticipated. Rather than coming out with a proposed "standard" – MACT or otherwise, the proposed federal regulation has put forward 2 options for public comment:

1) Require utilities to install MACT (under the CAAA section 112), resulting in a 29% nationwide reduction in mercury emissions (from 48 to 34 tons) by the end of 2007, OR

2) Rescind the formal EPA determination of December 2000 to regulate emissions from coal-fired power plants and, in its stead, put in place a cap-and-trade regime under section 111 CAAA that would set a mandatory two-phased cap on mercury emissions. In the first phase, due 2010, mercury emissions would be reduced to 34 tons by co-benefit controls (that is, reducing emissions of SO_2 and NOx). The second phase, due 2018, would require reductions to 15 tons.

Neither of these options appears to fit into the current requirements of the CAAA for air toxics. One option would require re-interpretation of the CAA and "MACT" while the other would require a rescission of the EPA determination that it was necessary and appropriate to regulate mercury emissions from coal-fired plants under MACT.

The EPA has clearly indicated its preference for the second option, stating that a "the cap-and-trade" approach would deliver far greater benefits than a "command-and-control" alternative and would be less costly and give industry flexibility and financial incentives to improve pollution control equipment[80]. In further rationalization of its preference for this option, the EPA finds that it fits well with new proposed regulations

[80] The trading mechanism proposed for mercury is based on the trading of SO_2 under the current Acid Rain Program.

on NOx and SO_2 emissions from these utilities in that it would take advantage of reductions specified for these pollutants[81].

At the same time, the EPA was critical of the application of MACT for requiring controls in a short time period of time that may not have been shown to be effective and for restricting options and incentives for power plants to achieve low-cost reductions (i.e., no trading permitted under section 112 CAAA).

Either of the proposed routes is a radical departure from EPA's decision announced 3 years ago that it was necessary and appropriate to regulate utility mercury emissions under MACT. The first option specifies a very low reduction under MACT that flies in the face of the range of reductions achievable under MACT. The second proposal would rescind MACT and replace it by a far less stringent new source performance standard (NSPS) under Section 111 under the CAA and allow for unconstrained emissions trading in mercury – that is, no specific units would be required to reduce mercury emissions[82].

Both options are complicated, confusing and highly litigious. In reversing and abandoning the path required by the EPA determination in 2000, these options subvert the process and intent of Section 112 of the Clean Air Act. Clearly, legal challenges will likely delay any action for this sector for at least three years and serve to maintain the industry's often-stated preferential position of not having to make any mercury-specific modifications or regulation.

The proposed "mercury rule" is a huge disappointment for those who awaited the ruling in the hopes that finally, this largest source of mercury emissions in the U.S. would be regulated in a meaningful way. The lobbying efforts of the electric utility sector and their supporters to reverse and undermine the EPA decision of 2000 and the MACT rule have "paid off"- at least for the time being, for those who stand in intentional denial of the extremely toxic nature of mercury and their continuing contribution to its increasing levels in the environment.

The implications of the rule have cast a dark shadow on the potential for realizing meaningful regulation of this source of mercury for years to come. The delay is unconscionable.

6.3 Consequences of Proposed Mercury Ruling

6.3.1 Potential Legal Issues

While there has been little time to assess the ramifications of the proposals, one can expect legal challenges pertaining to the proposal's interpretation of MACT under section 112 of the CAA. For example,

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[81] Interstate Air Quality Rule – EPA's proposal to reduce SO_2 and NOx emissions in the Eastern U.S, introduced December 2003.

[82] NSPS limits are technology-based standards, that unlike MACT requirements, can take cost and energy impacts into account in determining the appropriate level of reductions and allow for emissions trading in lieu of outright reductions. While NSPS generally applies to new construction, the EPA plans to include existing sources in its proposed mercury rule. In some cases, the EPA has not updated NSPS regulations in decades and there is currently no NSPS for mercury.

- The best-performers criteria under MACT have not been met.
- Trading is not permissible
- De-listing criteria of formally rescinding regulation under 112 has not been met.
- The legality of regulating mercury under section 111 of CAAA is not clear.
- The EPA needs to revise its December 2000 finding – how is this to be done?

Individual states who have initiated their own programs on mercury regulation of coal-fired plants may consider legal action, especially when reduction levels and dates for compliance differ widely from the EPA proposal and where there is or is not any trading of mercury emissions.
For example, reductions proposed for the following states are:
Wisconsin 40% by 2010, 80% by 2015 (in discussion)
Massachusetts – 85% 2006, 95% 2012, capture
New Jersey 90% by 2007

In light of the patchwork nature of state actions, a trading scheme in which the individual states would be allocated allowances for mercury for trading is difficult to envision.

All of these considerations and many more, make it ever so more difficult to anticipate the outcome of the federal proposed regulation. But it does appear that the proposal is on shaky legal ground and that its passage in an election year is questionable. The legal challenges by many quarters will keep the situation on the front burner for quite a while.

6.3.2 Consequences for Research

The December 2000 announcement of the intent to regulate mercury emissions from coal-fired power plants using MACT had no doubt given considerable impetus to exploring various approaches to reduce mercury emissions from coal-fired power plants. While acknowledging the "difficulties" in capturing mercury, research efforts were promising and indeed, there were indications that a 90% reduction in mercury emissions was possible through the application of various techniques specific to the parameters of a facility.

The question is – what are the consequences of the proposed ruling of December 2003 on the current level of research efforts on mercury and coal-fired plants? It has long been held that regulation is the driver of innovation – as witnessed, in particular, in the case for mercury regulation for incinerators in the U.S.

By not requiring specific mercury controls in the first phase of the proposed ruling, investment and incentive on furthering the development of mercury control technologies may be substantially reduced. Likewise many other related research efforts, such as continuous emissions monitoring for mercury, treatment of coal - gasification, and so on may also be adversely affected in view of the cloak of ambiguity and more than likely legal challenges to incur and delays. In protecting the "interests" of the industry, the U.S. EPA may have placed themselves in a legal logjam – that may prove more far costly than had it stayed the course.

6.3.3 Consequences for Canada

The Canadian Council of Ministers of the Environment (CCME) has made a number of commitments in striving to develop a Canada-wide Standard (CWS) for mercury emissions from its coal-fired power plants. The CCME has committed to have a standard in place by 2005 to reduce mercury emissions from the coal-fired electric power generating sector by 2010, to explore the national capture of mercury from coal burned in the range of 60-90%, and to align with the US standards of mercury.

Since the CCME has indicated that it is seeking alignment with the U.S., Canada is in a particular predicament as to whether it will follow its own agenda or enter into the quagmire stirred up by the December 15 announcement of the U.S. EPA. It is highly questionable as to whether "alignment" is the appropriate term.

6.4 Reaction to U.S. Mercury Policy

The following is an abridged version of an article that appeared in the San Francisco Chronicle, Dec. 31, 2003 describing some of the initial reaction to the EPA announcement of its proposed mercury ruling[83].

For nearly 21 months, a government task force steadily moved toward recommending rules that within three years would force every coal-fired power plant in the country to reduce emissions of mercury.

The Environmental Protection Agency-sponsored working group had a well-regarded mix of utility industry representatives, state air quality officials and environmentalists. Without settling on specific emission reductions, the panel agreed that all 1,100 of the nation's coal- and oil-fired power plant units must use the "maximum achievable control technology" (MACT) to reduce mercury and other hazardous pollutants.

In April, the EPA abruptly dismantled the panel with no explanation -- that is, until late last month, when the Bush administration revealed it was taking an entirely different approach, using a more flexible portion of the Clean Air Act.

The new approach would still cost the industry billions of dollars to meet long-term goals. But it was far cheaper and less onerous than the MACT approach that most experts had assumed the EPA was developing to meet a court- imposed deadline of Dec. 15.

The administration's alternative plan would technically downgrade the danger of mercury pollution; grant utility companies 10 more years to develop and install new anti-pollution equipment; and launch a cap-and-trade system that would allow utilities to buy emissions "credits" from lesser-polluting companies to meet an overall industry target, or cap, without having to install new scrubbers or anti-pollution equipment on every plant.

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[83] The article "Inside the mercurial Bush policy on mercury pollution - Nearly 2 years of work by EPA panel dumped" was written by Eric Pianin of the Washington Post, December 31, 2003.

The proposed rule mirrored President Bush's "Clear Skies" legislation, which was stalled in Congress, and would regulate mercury pollution along with two less-toxic air pollutants, sulfur dioxide and nitrogen oxide. Mike Leavitt, the new EPA administrator, said the approach would provide "the largest air pollution reductions of any kind not specifically mandated by the Congress."

But some task force members were shocked and angered. "Just when we think we have a process in action to control mercury from every power plant, they walk away from it" said John Paul, co-chair of the working group and supervisor of Ohio's Regional Air Pollution Control Agency.

"It was a huge decision that demonstrated that (the EPA's) desire wasn't to regulate mercury in the way that Congress and a federal advisory committee and other stakeholders had anticipated," added panel member S. William Becker, executive director of a bipartisan association of state air quality officials.

EPA and White House officials defend their approach as being actually "greener" than the one prescribed by Congress and considered by the working group. In the long run, they say, it will encourage development of mercury-removal technologies beyond existing techniques envisioned under MACT; offer utilities economic incentives to continuously reduce mercury emissions; and cover emissions from plants to be built, although new facilities are likely to use clean-burning natural gas, not coal.

Critics, on the other hand, accuse the White House and its allies in the utility industry of subverting a process involving one of the most toxic chemicals known. John Stanton of the National Environmental Trust, a member of the working group, said the administration's decision marks "really a fundamental shift in the recognition of the threat posed by mercury to the very most susceptible," including the fetuses of pregnant women who eat mercury-tainted fish.

Stanton and other environmentalists charge that by shifting the regulations from the rigorous Section 112 of the Clean Air Act, crafted by Congress to deal with the most hazardous pollutants, to the more permissive Section 111, the administration will excuse the utility industry from controlling more than 60 other toxins associated with the burning of coal and allow power plants to continue polluting for another decade.

7 Global Initiatives on Mercury

For several years, mercury pollution has been widely recognized as a growing global threat in all regions of the world. The element itself has been compared to a "traveller without a passport that spreads around the world in air and water"[84]. The unique nature of mercury means that no one country can be immune to its effects. It also means that no single country can resolve the issues related to mercury without international cooperation.

In acknowledging the concerns over the ever-increasing levels of mercury in the environment and the deleterious impact on human health and the environment, numerous initiatives have emerged at regional, national and international levels that seek to reduce the use and anthropogenic releases to the environment. The scope of these initiatives vary considerably in terms of long-term objectives, specific goals, the particular sectors addressed, instruments to arrive at the goals, and measures of compliance or conformance.

This section examines these various initiatives, and in particular, the United Nations Environment Programme's "Global Mercury Assessment", which is the most recent and most inclusive of all mercury initiatives to date. It also includes a summary of comments and recommendations for action on mercury by the Ban-Mercury Work Group, an international coalition of public interest non-governmental organizations.

7.1 United Nations Environment Programme (UNEP)

7.1.1 Global Mercury Assessment - Synopsis

i) Background and Mandate

In response to the request made by the Governing Council (GC) of UNEP at its 21st session (February 5-9) 2001, UNEP agreed to undertake a global assessment of mercury and its compounds to be presented to the GC for consideration at its 22nd session in 2003. This request is referred to as GC decision 21/5. The GC outlined a number of elements that were to be included in the assessment including options for international action[85].

In pronouncing its decision, the GC referenced a number of influential factors, such as – scientific studies which established the global cycling of mercury; the precautionary approach as articulated in the Rio Declaration of 1992, underlying the need for preventative action to protect human health and the environment; the decision under the Convention on Long-range Transboundary Air Pollution (November-December 2000), to invite UNEP to initiate an assessment of mercury and to consider future action; and the Barrow Declaration taken by the Artic Council, October 2000, that also called upon UNEP to initiate a global assessment of mercury that could form the basis for appropriate international action in which the Arctic States would participate actively.

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[84] Comment by Dr. Klaus Toepfer, Executive Director, United Nations Environment Programme (UNEP).
[85] The 21st GC session was held February 5-9, 2001. This request is referred to as GC decision 21/5. The text of the decisions is found at http://www.unep.org/gc_21st/.

As part of implementing the GC decision, UNEP established a Working Group consisting of representatives from government, intergovernmental and non-governmental organizations and the private sector to contribute to the preparation and review of the Global Mercury Assessment Report. In addition, The Working Group identified key findings of importance and finalized the assessment report for submission to the GC[86].

Based on the key findings identified, the Working Group concluded that, in its view, there was sufficient evidence of significant global adverse impacts to warrant international action to reduce the risks of mercury to human health and the environment. The Group also agreed on an outline of possible options to address these adverse impacts at the global, regional, national and local levels and on a need to submit to the GC a range of possible immediate actions in light of their findings of the impacts of mercury.

Over 80 countries (out of 192 countries) from all regions in the world as well as 10 intergovernmental and 12 non-government organizations submitted information for or comments on the report.

Accordingly, the assessment, its findings and recommendations of the Working Group were presented to the Governing Council at its 22nd session, February 2003 in Nairobi for their consideration.

ii) Global Mercury Assessment Report, December 2002

The final Global Mercury Assessment Report is a comprehensive and informative document on various aspects of mercury on a global scale. Topics include the transformation, transport and deposition of mercury in the environment, its chemistry, health and environmental impacts, natural and anthropogenic sources, current global production and use of mercury, prevention and control technologies and the use of suitable substitutes, and regional, national and international initiatives to reduce and/or eliminate the use, release and exposure to mercury.

The Report also outlines options to address the adverse impact of mercury by reducing and/or eliminating the use, emissions, discharges and losses of mercury and its compounds; improving international cooperation and enhancing risk communication and identifies data and information gaps that need to be addressed. It also presents the "key findings" and conclusions of the Working Group that speak to the many reasons why the global adverse impacts of mercury in the environment are of such concern.

The Report itself does not judge or analyze the information presented. Rather, it offers the reader a compilation of information gleaned from the existing base of knowledge of the health and scientific community, national governments and other organizations pertaining to mercury. As such, the Global Mercury Assessment Report is objective, highly informative, educational and an excellent reference source.

[86] The Global Mercury Assessment Report is available at http:/www.chem.unep.ch/

At the same time, the report illustrates just how pervasive mercury is in the environment, its deleterious effects on human health and the ecosystem and the extent to which governments around the world may or may not be addressing these matters. Each section in its own right gives the reader cause to question why we continue to allow this toxic trespass to persist and magnify. Taken as a whole, the report is an affirmation of a call for action on this toxic substance without delay. It remains to be seen what impact or influence the work of UNEP will have in initiating such action.

iii) Key Findings of the Report - Highlights

The following is an abridged summary of the "key findings" of the Report. These findings form the basis of the decision of the Governing Council of UNEP to accept the findings and what further action to take to address the concerns raised[87].

- Environmental mercury levels have increased considerably since the on-set of the industrial age.

- Mercury is released from various sources to air, water and land, but most significantly to air. Once released, mercury is persistent in the environment and cycles globally, is deposited on land and water and re-mobilized.

- Mercury takes on different forms depending on sources and atmospheric chemistry and can be deposited locally and far from source. Once deposited, mercury can change to methylmercury by micro-organisms which then bioaccumulates in organisms and concentrates up the food chain, especially the aquatic food chain. Nearly all the mercury in fish is methylmercury, the form of greatest concern[88].

- Fish are highly nutritious – mercury is a major threat to this food supply. Contaminated fish has serious economic and health repercussions on communities dependent on fisheries.

- Elevated mercury levels are found in fresh-water and marine species throughout the world. The highest levels are in large predatory fish and fish-consuming mammals.

- Some populations are especially susceptible to mercury exposure – notably, the fetus, the newborn, young children, indigenous populations subsistent on fish, and workers exposed to mercury, particularly, small-scale gold and silver mining.

- Mercury has caused a variety of documented, significant adverse impacts on human health and the environment worldwide. It is highly toxic, especially to the developing nervous system as it readily passes the placental and blood-brain barriers. It can produce subtle to severe adverse neurological effects in children.

[87] Global Mercury Assessment Report – Key findings pp. iii-viii

[88] The term bioaccumulation refers to the net accumulation in time of metals within an organism from both biotic (other organisms) and abiotic (soil, air and water) sources.

- Human exposure to mercury can result from consumption of mercury-contaminated fish, the most common route, as well as dental amalgam, vaccines and pharmaceuticals containing mercury as a preservative (thimerosal), occupational exposure in working environments that use mercury in processes and manufacture products that contain mercury, mining, living on or near mercury-contaminated or hazardous waste sites, household, personal (cosmetic) and cultural (ritualistic) uses.

- Numerous wildlife species (e.g., top predators such as otter, mink, eagles, osprey and raptors) that rely on fish as a large part of their diet have elevated levels of mercury that are a threat to reproduction.

- Mercury levels in Arctic ringed-seals and beluga whales have increased 2-4 times over the past 25 years in some areas in the Canadian Arctic and Greenland.

- Intervention through programs that are directed to reduce and/or eliminate anthropogenic emissions of mercury is effective (e.g., Sweden).

- Mercury is a global problem – local/regional action by itself is not sufficient.

- Regions with no anthropogenic sources of mercury, such as the Arctic, are adversely affected due to transcontinental and global transport of mercury.

- Mercury is more problematic in less-developed regions or nations – lack of regulation, awareness.

- Mercury continues to be used in numerous products and processes all over the world – elemental mercury is used in small-scale mining, chlor-alkali production, manometers, thermometers, electrical switches, fluorescent lamps, dental amalgam fillings. Mercury compounds are used in batteries, biocides, pharmaceuticals, paints, herbicides and fungicides (on seed grain); and as laboratory agents and industrial catalysts (calomel).

- Mercury is an international commodity with significant on-going trade in mercury and mercury-containing products some of which is un-regulated, illegal and uncontrolled.

- The supply of mercury comes from a number of sources: mining of mercury either as a main product or by-product in mining and metal-refining operations (gold, zinc); private and government stocks (reserves, chlor-alkali plants), recycled mercury from spent products and industrial wastes.

- Many uses and shipments of mercury and mercury-containing products can lead to releases.

- Large amounts of mercury remain in mine tailings, landfills and sediments as well as stockpiles – presenting an ever-present threat of future release.

- Primary sources of mercury releases are: natural sources – volcanoes, weathering of rocks; current anthropogenic activities that mobilize mercury from rocks and impurities in raw material (fossil fuels – coal in particular, mining etc.); current releases from the intentional use of mercury in products and processes; and re-mobilization of historic anthropogenic releases in soils, sediments, water bodies, landfills and waste/tailing piles.

- A large portion of mercury in the atmosphere today is a result of many years of anthropogenic releases which have increased the levels of mercury in the atmosphere by about a factor of 3 and deposition near industrial sites by anywhere from 2-10.

- Highly contaminated industrial sites and abandoned mining operations continue to release mercury as well as forest and agricultural practices.

- The most significant anthropogenic sources of mercury releases include coal-fired power (electricity and heat generation), smelting, cement production, mining, iron and steel making, chlor-alkali production, incineration of products containing mercury, landfills, sewage sludge, and cremation.

- Specific methods to reduce or eliminate mercury releases require controlling releases from mercury-contaminated raw materials and feedstocks as well as reducing or eliminating the use of mercury in processes and products, that is, preventative and control measures.

- Preventative measures are viable in many cases through substitution of other substances in products and processes and reducing consumption of raw materials. Controlling mercury releases through end-of-pipe technology may be appropriate for processing raw materials with trace amounts of mercury by adopting a multi-pollutant approach using existing technologies as well as mercury-specific technologies (in various stages of development). However, while these technologies may mitigate the problem of atmospheric mercury pollution, they still lead to mercury wastes that are potential sources of future emissions.

- Reducing and/or limiting and preventing uses, releases and exposures of mercury by nations through adopting actions and regulations that control mercury releases into the environment, such as:

  product control for mercury-containing products, environmental quality standards that specify maximum mercury concentrations for different media and food such as fish; standards, programs and actions such as regulations on mercury exposures in the workplace, reporting requirements, fish consumption advisories and consumer safety measures; development and introduction of safer alternatives and cleaner technology, encourage substitution, voluntary agreements with industry, and awareness raising.

- Because of the long-range cycling and persistence of mercury in the environment, co-ordinated action at regional and internationals levels is essential (many such actions are already in existence).

- Despite data gaps, sufficient understanding has been developed that international action should not be delayed.

iv) Conclusions of Working Group

Based on key findings of the Report, the Working Group concluded that, in its view, there was sufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment. At the same time, the Working Group emphasized that it was not necessary to have full consensus of complete evidence in order to take action and therefore potentially significant global adverse impacts should also be addressed.

Furthermore, the Group also agreed on an outline of options for recommendations on measures to address global adverse impact of mercury at the global, regional, national and international level and agreed to submit to the Governing Council a range of possible immediate actions in light of their findings on the impacts of mercury.

v) Decisions adopted by the Governing Council

At its 22nd session, February 3-7, 2003, the Governing Council were in agreement with the conclusions of the Working Group and in accepting the key findings of the Global Mercury Assessment, decided that national, regional and global actions, both immediate and long-term, should be initiated as soon as possible to protect human health and the environment through measures that will reduce or eliminate releases of mercury and its compounds to the environment and urged all countries to adopt goals and take national actions, as appropriate with the objective of identifying exposed populations and ecosystems, and reducing anthropogenic mercury releases that impact human health and the environment.

In addition, the GC requested UNEP to facilitate and conduct technical assistance and capacity-building activities to support efforts of countries to take action on mercury pollution in cooperation and consultation with other organizations.

7.1.2 New UNEP Mercury Programme

As a result of the decision at the 22nd session, the GC initiated a new programme in May 2003. The long-term objective of the programme is to facilitate national, regional and global actions to reduce or eliminate as far as possible anthropogenic uses and releases of mercury and mercury compounds, thereby significantly reducing the global adverse impacts on health and the environment from these compounds. The immediate objective is to encourage all countries to adopt goals and take national actions, as appropriate, with

the objective of identifying exposed populations and ecosystems, and reducing anthropogenic mercury releases that impact human health and the environment.

This programme is to focus on the following activities:

Awareness raising workshops, (2004): These workshops are aimed at assisting developing countries and countries whose economies are in transition to understand mercury problems in their country, develop tools and strategies to mitigate the problems, increase awareness and promotion of mercury-free products or responsible use of mercury, where appropriate and develop strategies for enhanced communication with at-risk populations. Likely locations are Africa, Asia, South and Central America, Eastern Europe and Commonwealth of Independent States.

Generation of Guidance materials: Topics could include developing inventories, identifying and evaluating populations at risk, communication and outreach to these at-risk communities, increasing awareness and promotion of mercury-free products and processes, pollution prevention and control techniques for reducing releases, based on needs identified by countries and other partners.

Development of a Clearinghouse: to collect and facilitate the exchange of and access to relevant information among Governments and other partners.

UNEP is to consult and coordinate with other international government and non-government organizations in proceeding with the designated programme activities of this programme and to report on progress made in addressing mercury in February 2005at the 23rd session of the GC. As well, further measures to address global mercury pollution, such as a legally binding instrument, a non-legally binding instrument or other actions will be presented for consideration along with further action that might be taken with regard to other metals, e.g., cadmium and lead, at that same session.

7.1.3 Commentary on the UNEP Programme

As has been mentioned, the Global Mercury Assessment Report is a valuable resource on the status of mercury in the world. It remains to be seen whether the very limited resources applied to the efforts of the new programme will translate into meaningful and measurable results. Clearly, unless the developed countries take a leadership role and invest considerable efforts and resources in domestic and international programmes and assist developing countries, the expectations of achieving significant reductions in the global anthropogenic use and release of mercury to the environment are limited.

Multinational corporations who run operations such as mining in many of these countries do not have a good track record as to following environmentally-sound practices. Often, they choose to locate in remote areas where there is either non-existent or a modicum of labour and/or environmental standards or enforcement. These are some of the richest companies in the world whose negligence and rapacious behaviour turn profits on the backs of the most disadvantaged.

Dangerous operations such as small-scale gold mining are proliferating in the developing world as communities strive for their very survival. Contaminated and abandoned sites leave a legacy of toxic metals that threatens the health and well-being of nearby communities. While some countries are implementing measures to phase out mercury-containing products and practices that use mercury at the domestic front, some of these same countries export these products or their companies produce them in other countries.

Some industrial sectors have reduced their use of mercury and mercury emissions, others have not. In particular, coal-fired electric generating facilities have become major emitters of atmospheric mercury. To meet the seemingly insatiable appetite for electricity, these facilities are expanding and doing so, in many cases, without consideration for the consequences of burning fossil fuels and releases of the numerous toxic substances, including mercury. The expansion in off-shore drilling and exploration activities for oil and gas is yet a further example of a growing source of mercury being released into the marine ecosystem.

7.2 Status on International Agreements and Initiatives on Mercury

7.2.1 Conventions and Protocols

There are a number of international agreements and instruments, known as "conventions" that contain provisions to manage and control releases and to limit use and exposures to mercury. These "conventions" may be global in coverage or apply to specific regions and countries. They require ratification by a specified number of countries (Parties) to come into force, that is, be binding on those Parties. They can define reduction goals or require specific measures to be implemented at a national level for the participating countries.

These instruments are useful insofar as they set a platform for international action and can influence domestic initiatives. Three of the most relevant instruments related to mercury are briefly described[89]:

The 1998 Aarhus Protocol on Heavy Metals is a legally-binding agreement that targets three metals – mercury, lead and cadmium[90]. Canada is required to reduce releases of mercury by 50% of base year 1990 from specific industrial sources eight years from entry into force. As well, the Protocol provides recommendations for product substitution for use of mercury in chlor-alkali plants and a number of mercury-containing products. The UN ECE Region covers Central and Eastern European countries, Canada and the U.S. The Protocol has been ratified by 21 countries, including Canada and the U.S., and entered into force December 29, 2003.

[89] Two other conventions apply to the Baltic Sea, the North-east Atlantic, the North Sea and address mercury and mercury compounds in releases, products and wastes.

[90] The Aarhus Protocol is one of 8 protocols extended under the Convention of Long-Range Transboundary Air Pollution (LRTAP) which entered force in March 1983. The Convention and its protocols are open to member States of the United Nations Economic Commission for Europe (UNECE) which has 55 member states from Central and Eastern Europe as well as Canada and the U.S.

The Basel Convention, adopted March 1989 and entered into force in 1992, is a global convention that regulates the transboundary movements of hazardous wastes and establishes obligation for its Parties to ensure that such wastes are managed and disposed of in an environmentally sensitive manner. Any waste containing or contaminated with mercury and its compounds is covered by this convention. The Convention imposes restrictions on the transboundary movement of such wastes that include the prohibition of the shipment to non-parties as well as a ban of exports of hazardous wastes from specific countries to other non-member countries for final disposal, recovery or recycling[91].

The Rotterdam Convention includes provisions that cover mercury compounds used as pesticides. The Convention ensures that international trade does not take place if an importing party decides to prohibit use of these compounds as pesticides however it does not make any specific recommendations to reduce or eliminate the use of mercury compounds as pesticides. The Convention, adopted September 1998, is open to all States but has not entered into force.

7.2.2 North American Regional Initiatives

Concern regarding the large increase in mercury levels globally and its implications on human health and the environment have led to a number of initiatives and programs at the continental level. Canada has assumed obligations and commitments to reduce mercury emissions in the following agreements:

- The 1997 Great Lakes Binational Toxics Strategy (BNS), an agreement between Canada and United States[92], establishes a process to work toward ***virtual elimination*** of specific persistent bioaccumulative toxic substances, including mercury, from the Great Lakes Basin[93]. The Canadian goal was to seek a 90% reduction in the use, generation, or release of mercury by the year 2000 in the Great Lakes Basin. The US goal sought a 50% reduction by the year 2006 for all land-use based sources.

- The Mercury Action Plan**,** adopted in 1998 by the Eastern Canadian Provinces and New England Governors, established a long-term regional goal of virtual elimination of anthropogenic mercury emissions that initially called for an interim goal of a 50% reduction in regional emissions by 2003 from specified sources which was subsequently revised in 2001 to an overall reduction in emissions of 75% or greater by 2010. Specifically, a 60-90% reduction is being sought from coal-fired plants by 2010. In addition, the plan incorporates monitoring, research, reporting, education and recycling programs.

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[91] The ban, an amendment to the Basel Convention, adopted in 1995 applies to countries listed in "Annex VII", that is, members of the European Union (EU), Liechtenstein and the Organization for Economic Development (OECD) to "non-Annex VII" countries.

[92] The Strategy is in keeping with the objectives of the 1987 Great Lakes Water Quality Agreement (GLWQA).

[93] **Virtual elimination** refers to **use, generation and release** of such substances by encouraging and implementing strategies consistent with the philosophy of zero discharge (International Joint Commission).

- The Commission for Environmental Cooperation North American Regional Action Plan (NARAP) for Mercury was signed by Canada June 2000. It has established as its goal the reduction of mercury to approach natural levels and fluxes in certain environmental media, seeking a 50% reduction in mercury emissions by 2006.

- The Arctic Council, composed of 8 circumpolar nations, has established the Arctic Monitoring and Assessment Programme (AMAP) to provide information on the status of and threats to the Arctic environment and to provide scientific advice on preventative and remedial actions relating to contaminants of special concern for the Arctic – including mercury. The Council has called for international co-operative action to reduce risks of exposure to identified pollutants[94]. It has also established the Arctic Council Action Plan to Eliminate Pollution in the Arctic (ACAP) in which a number of pollutants of special concern for the Arctic region, including mercury, have been prioritized for action. Planned activities include identification and quantification of major point sources of mercury in all member nations with the aim of implementing concrete emission reduction projects as examples of effective mercury reduction initiatives.

7.3 Northern Contaminants Program (NCP) - Canada

The transboundary contamination in the Canadian north in the 1980s led to the establishment of the Northern Contaminants Program (NCP) in 1991 to co-ordinate Canada's action on the issue of northern contaminants nationally and provides research necessary to take action internationally. The NCP is managed co-operatively by several First Nation groups and federal and territorial agencies The NCP addresses concerns about exposure to elevated levels of contaminants in fish and wildlife species that are an integral part to traditional diets of northern Aboriginal people.

The aim of the NCP is to continue to work on international agreements; raise the profile of mercury contamination in the north; work towards reducing and eliminating contaminants in traditional foods and assist communities in making informed decisions about their food use through improved communication.

The NCP has been instrumental in the development of two major reports that provide a comprehensive assessment of contaminants in the Canadian Arctic; The Canadian Arctic Contaminants Assessment Report (CACAR) of 1997 and the recently released report, CACAR II that is a critical component in establishing a long-term strategy to safeguard the northern environment and general health of the North[95].

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[94] In October 2000, the Arctic Council issued the Barrow Declaration which "noted with concern that releases of mercury have harmful effects on human health and may damage ecosystems of environmental and economic importance". The Declaration called upon the United Nations Environment Programme to initiate a global assessment of mercury that could form the basis for appropriate international action in which the Arctic States would participate actively.

[95] The CACAR II Report, published under the authority of the Minister of Indian Affairs and Northern Development, Ottawa 2003, consists of 5 volumes: www.ainc-inac.gc.ca

With respect to mercury, the CACAR II noted increasing levels of mercury in lake sediments in Nunavut – possibly due to transport from the south and climate change; species that continue to be affected by mercury contamination include beluga whales, walrus, ringed seals and Arctic cod; mercury levels have been increasing in Arctic seabirds, in some cases to double the levels in 1975; and the highest mercury levels are found in the Baffin and Nunavik regions - nearly 80% of Nunavik mothers and 68% Baffin mothers have mercury levels exceeding US EPA reference dose.

The CACRII report makes a number of recommendations pertaining to the need for further monitoring and research, as well as continuing and enhancing support for education, training, capacity building and communication and for effective support for national and international policy and commitment activities related to contaminants of the Canadian north to ensure the safety of traditional aboriginal foods.

With respect to mercury, CACAR II noted increasing levels of mercury in lake sediments in Nunavut – possibly due to transport from the south and climate change; species that continue to be affected by mercury contamination include beluga whales, walrus, ringed seals and Arctic cod; mercury levels have been increasing in Arctic seabirds, in some cases to double the levels in 1975; and the highest mercury levels are found in the Baffin and Nunavik regions - nearly 80% of Nunavik mothers and 68% Baffin mothers have mercury levels exceeding US EPA reference dose.

7.4 Ban Mercury Working Group (Ban-Hg-Wg)

The Ban-Hg-Wg is an international coalition of public interest non-governmental environmental and health organizations and individuals who are concerned about mercury pollution worldwide. It was formed at the time of the UNEP Working Group to promote the negotiation of a legally-binding international instrument to phase-out the use, trade and emissions of mercury globally. Members of the group track and exchange up-to-date information on events related to mercury.

In preparation for the 22nd UNEP GC meeting in Nairobi, February 2003, the Ban-Hg-Wg issued its report, "Mercury Exposure: The World's Toxic Time Bomb"[96]. This report is more than a document of information. Insofar that it highlights the primary sources of human exposure to mercury; its toxicology, fish consumption; occupational exposure including small-scale mining; dental amalgam; thimerosal-laden vaccines and domestic uses of mercury, the report is also a call for action.

In highlighting the nature and degree of the growing ecological and health crisis as a result of the tripling of mercury levels in the global environment from industrial, occupational, medicinal and domestic uses, the report articulates the environmental injustices faced by developing countries experiencing a disproportional mercury pollution burden from industrialized nations that are increasing the risks of neurological and developmental effects to their children from exposure to mercury. It urges the development of legally-binding international instruments as the only route that can

[96] The full report is on line at www.mercury/policy.org (or www.ban.org/Ban-Hg-Wg)

"require equal responsibility to all state-actors and prevent the unjust transfer of mercury from the developed to the developing world. Voluntary and aspirational international targets are insufficient."

"No single country can resolve the mercury problem on its own – there are alternatives to mercury, but there is no alternative to international cooperation." [97]

The report points out that while mercury emissions in North America and Europe may have decreased since 1990 as a result of regulations, closures, etc. affecting certain industries and practices, the expanding global use of coal to generate electricity is further adding to and creating unprecedented mercury pollution levels and have become the major source of atmospheric mercury emissions in a number of countries and regions - the U.S., China and India, eastern Africa and Eastern Europe. Unless effective control strategies and/or an increase in emphasis on renewable energy, conservation and efficiency are employed, the world is facing further dramatic increases in mercury emissions from the proliferation of coal consumption.

Recommendations for Action - Highlights

The following is a summary of recommendations made by the Ban-Hg-Wg in its report to the Governing Council for their consideration at the 22nd UNEP meeting, February 2003.

- Adopt as its goal the virtual elimination for all uses and releases of human-induced mercury pollution, including the development and implementation of national and regional action plans and agreements that aim to reduce or eliminate all mercury release to all media, to the maximum extent possible, within a specific time.

- Convene an open-ended ad hoc working group whose mandate is to propose international action to consider all measures to reduce or eliminate releases of mercury to the environment.

- Develop and promote the creation of an international inventory to account for and monitor mercury emissions, sources, uses, imports and exports.

- Develop and international binding agreement that includes the following:
  a) Strict control measures on the global trade of mercury, mercury wastes and technologies, and prevention of mercury trafficking from developed to developing countries
  b) Permanent retirement of all existing civil and military stockpiles (including chlor-alkali-plants and the Defence stocks)
  c) Promote mercury-free alternatives in the small-scale mining sector
  d) Return of mercury to countries of origin for storage

[97] Statement by Michael Bender, Mercury Policy Project director and the Ban-Mercury Group representative at the 22nd GC meeting, February 2003.

e) Funding mechanism for the rehabilitation of communities and environments negatively affected by industrial processes knowingly transferred from developed to developing countries
f) End of government subsidies for primary mining of mercury, and an effective strategy for managing by-product mercury produced in the metals mining industry (including gold mining).

The report concludes: "To avert a global mercury catastrophe, concrete and binding international action must be developed to coordinate and harmonize action at the local national and regional levels in order to protect children and future generations from mercury exposure – the world's toxic time bomb".

As a member of the Ban-Hg–Wg, I naturally concur with their report and recommendations. But I am also concerned that international action requires a level of cooperation and commitment that many countries are unable or unwilling to offer. That is why it is even more important for countries such as Canada, the EU countries and the U.S. to take definitive steps on the domestic front and be cognizant of the operations of their respective companies in operations abroad, particular, in developing countries.

7.5 Commentary on International Actions

With the myriad of mercury-related programs and activities in North America and worldwide, it would be expected that there would be some progress in addressing domestic and global mercury issues. However, commitments made to these programs at the onset do not necessarily translate into realization of the anticipated goals, with little if any consequence to parties for failing to meet such commitments, which leads one to question the effectiveness of these various programs.

In operating on a global scale, the well-being of the global community is often at odds with the ethos of individual nation states. The disparity between the industrialized, developed countries and developing countries often leads to diluted and moderated efforts. Since extremely limited funding is made available to institute such programs and activities, these funds, inadequate as they may be, are directed to countries in economic transitions.

All too often, some of the richest nations tend to point their fingers to other countries as the main source of or contributor to global pollutants such as mercury, while, in comparison, their own country is seen as contributing very little to the global pool. This parochial attitude is often used to rationalize themselves out of action on the domestic front, let alone the international stage. Delays in action in the most prosperous regions of the world on a substance as toxic, persistent, and bioaccumulative as mercury only lead to delays worldwide and serve no interest.

However, at the same time that efforts are being directed to tackle the existing sources of anthropogenic mercury, further increases in mercury emissions are projected. These increases are likely to come from the energy sector worldwide – namely, coal-fired power

plants, to meet an insatiable energy demand with the cheapest, most abundant fossil fuel. A global increase in gold-mining operations is another area which is anticipated to lead to an increase in the availability of mercury.

The continuing use of mercury-containing products only ensures a market for recycled mercury, thus perpetuating its use and further release to the environment. This speaks to the need to continue efforts to seek binding agreements on the use and intentional release of mercury worldwide.

Global commitments and instruments represent one necessary avenue to address mercury, but the problem lies in the length of time required to develop agreements and any binding actions. Ultimately, the responsibility lies with governments to show leadership and commitment at the domestic front and institute appropriate measures that can be extrapolated beyond their borders to address the essence of the problem.

On a special note regarding our own country, while Canada is an emitter of mercury through its anthropogenic sources – coal-fired plants, smelters, mining operations, incineration, etc., it is also a receptor of mercury, particularly in its Arctic regions. That makes it all the more important for Canada to take an active interest and role in international programmes and conventions. Having a credible role in international negotiations also requires entering these negotiations with "clean hands", that is, with demonstrated action in implementing strong measures at the home front. Thus, international agreements have the potential to influence domestic action.

8 Summary

8.1 Canada-wide Standards - Recommendations

The setting of national standards for mercury emissions for this sector in Canada has been a rather thorny task, considering the widely divergent positions held by the various stakeholders, from industry to government jurisdictions, to ENGOs. As well, the contribution and role of coal-fired power plants in generating electricity at each jurisdictional level makes comparability between jurisdictions, their priorities, and mandates very difficult.

For example, Ontario has pledged to phase out coal-fired power plants by 2007, although it is uncertain how that goal is to be met. Alberta, in which coal is the dominant source of electricity generation, has endorsed a framework to manage emissions of mercury and other pollutants from its coal-fired power plants. Saskatchewan is researching efforts to reduce emissions from their lignite. Achieving convergence on a level of reduction that will satisfy all stakeholders is a great challenge indeed.

While the CCME was seeking alignment of the CWS with the U.S. regulatory actions on mercury emissions from coal-fired power plants, this is unlikely to happen because the recently proposed regulatory path in the U.S. is not readily applicable to Canada.

It remains to be seen just what level of reduction of mercury emissions will be sought on a national scale in what timeframe, and how it will be achieved. An information collection program is currently underway that will inform the setting of a mercury standard. The CCME expects to have the CWS set by 2005 for implementation in 2010[98].

ENGOs have continued to support a consistent national standard and have advocated reduction levels of the order of 90% over a 10-12 year time frame. A stringent mercury standard would likely reduce other pollutants as well, and promote innovative approaches in control and preventative techniques. Certain elements that ENGOs have recommended as key for inclusion in the CWS are pollution prevention measures, renewable energy strategies, energy efficiency and conservation, and stricter standards for new facilities to account for and counterbalance the potential growth in this sector in some regions[99].

Emissions trading of mercury, off-site exchanges, and cross-sectorial trading are strategies not supported by the environment community. These strategies are seen to detract from the goal of achieving significant reductions of anthropogenic mercury emissions from these facilities.

Resolution of the CWS is expected in the next two years and the outcome will surely invite further discussion from all concerned parties.

[98] These dates were announced by the CCME in its statement on the CWS issued June 2003.
[99] Refer to "Mercury…A Public Concern" A. Tilman March 2002, for a CWS that was proposed and supported by ENGOs at that time.

8.2 Concluding Remarks

Over the last 50 years or so, large-scale epidemics of mercury exposure have dramatically demonstrated its devastating and long-lasting impacts on human health and the environment. But it is the ever-increasing levels of mercury in the world since industrialization that is also making its mark in the most pernicious way. It has been compared to a "traveller without a passport that spreads around the world in air and water"[100].

The impact of mercury exposure, particularly on the fetus and young children, in the form of neurological and developmental disorders, is testimony to its insidious nature. The worldwide contamination of fish with mercury is perhaps the best-known litmus test of the damage done by this toxin to the ecosystem.

The use and release mercury into the environment have impacted the most vulnerable, compromised and least powerful communities in the world. For example, many communities in the Arctic suffer a disproportionate and unfair burden of pollutants such as mercury and PCBs - pollutants whose presence in the Arctic is mainly due to their long-range transport from industrial sources thousands of kilometres away.

International and national commitments, agreements and initiatives have arisen in response to concerns over exposure to mercury and in an attempt to reduce the continuing usages and increasing emissions of mercury globally, regionally and locally.

While mercury emissions from some industrial sectors have decreased due to regulation, technological modifications or shut downs, other industrial sources, in particular, coal-fired electric power plants, have taken over as the most significant sources of anthropogenic atmospheric mercury emissions in the world today. Coal is projected to play an even greater role in the future to meet the growing worldwide demand for electricity. The consequences of expanding this source of energy are alarming.

In the U.S., where coal-fired power plants are the single largest source of atmospheric mercury emissions, trading in mercury emissions has been proposed as an "incentive" to reduce these emissions – a highly controversial move adamantly opposed by environmentalists and many others[101].

The longer and the more extensive the anthropogenic use and emissions of mercury continue, the greater the global loading and cumulative impact of mercury will be. The simple reality is that we are unleashing a highly toxic element into the environment that we cannot not capture, contain or destroy.

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[100] Dr. Klaus Toepfer, Executive Director, UNEP

[101] Great Lakes United, an ENGO, has a policy on mercury emissions trading that equivocates its opposition to any form of trading of mercury emissions and that re-affirms its position on virtual elimination of anthropogenic emissions of mercury.

Sadly, the existing global pool of mercury cannot be altered. The best that can be done is to prevent further anthropogenic releases and strive for the virtual elimination of these releases of mercury to the environment.

Technological solutions through pollution controls may provide some reprieve, but they are not a panacea. On the contrary, they may serve to perpetuate the use of coal under the assumption that the controls will remedy the problem. Unfortunately, with a substance like mercury, it is not that simple. As the history and legacy of mercury pollution has shown, to continue in the present direction is to perpetuate a circle of poison and risk courting irreversible ecological destruction.

Concrete and binding commitments to achieve reductions in mercury emissions within a specified timeframe must be sought at all levels – local, national and international – commitments whose ultimate goal is the virtual elimination of all releases of human-induced mercury pollution.

Clearly, at the same time, an alternate path must be developed that reduces our reliance on fossil fuels while promoting renewable energy sources and conservation. The on-going use of mercury in products and processes must be eliminated and replaced with mercury-free products and processes.

To put us on this path requires a major shift in the current mindset in shaping policy on energy. The supply of coal may be able to keep the lights on for a while, but the cost to our health and that of future generations, and the harm to the environment, far outweigh the benefits derived from burning this fossil fuel.

If the present usage of coal for the generation of electricity in Canada were replaced by renewable resources, more than twenty per cent of our energy sources would be "clean". That would have a profound effect on Canada's contribution to mercury emissions. It is a goal worth pursuing.

Appendix A

Mercury Regulatory Plans - State Level

Several U. S. States have issued or are entertaining proposals for regulating mercury from coal-fired power plants, notably Massachusetts, Wisconsin, Minnesota, New Jersey, New Hampshire, Connecticut and others. Of the various proposals to date, the multi-pollutant bill for power plants in the state of Massachusetts is one of the most advanced in terms of multi-pollutant legislation, and, as such, an interesting one to examine. A number of elements of the proposal may be useful for further consideration by certain jurisdictions in Canada and in the development of the mercury CWS for coal-fired plants[102].

The Massachusetts regulatory proposal specifically for mercury requires an amendment to the existing multi-pollutant bill in that state. The proposal has merits for a number of reasons: its succinctness; process, a well-laid out background and rationale, its multi-pollutant nature, and the nature and level of the proposed standards to achieve significant reductions of mercury emissions within a concise timeframe. There are also sections that are controversial, mainly its alternate off-site pollution reduction plan, that require further work and may be adjusted as a result of feedback during the public comment period and hearings. The final rule is expected in the spring of 2004.

A.1 Massachusetts Proposed Mercury Regulation

The Massachusetts bill (310 CMR 7.29), promulgated by the Department of Environmental Protection (DEP), April 2001, addresses emissions of the three pollutants, SO_2, NOx and CO_2 from the six power plants in the state. It also caps mercury emissions from the four coal-fired plants (8 units in total), all of which combust bituminous coal, by limiting annual mercury emissions to the average annual emissions calculated based on stack tests required by the regulation. The overall cap is set at 185 pounds with specific caps for each of the four facilities.

The bill also provides a framework for establishing mercury emission standards for the affected coal-fired facilities by requiring the DEP to undertake a complete evaluation of the technological and economic feasibility of controlling and eliminating mercury emissions from the combustion of fossil fuels in the state and to propose mercury emission standards within 6 months of this evaluation, that is, by December 2002.

The resulting report, referred to as the "Mercury Feasibility Report"[103], concluded that the removal of 85-90+% of mercury in flue gas are feasible at the present time from both a technological and economical aspect. Subsequently, the DEP proposed amendments to its regulation (310 CMR 7.29) to establish mercury standards for the affected power plant units along with requirements for compliance with the standards.

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[102] Regulation 310CMR 7.29 Emission Standards for Power Plants
http://www.state.ma.us/dep/bwp/daqc/files/regs/729final.doc

[103] Department of Environmental Protection (DEP) "Mercury Feasibility Report", December 2002
http://www.state.ma.us/dep/bwp/daqc/files/mercfeas.doc

A1.2 Rationale and Background –Amendment to bill 310 CMR 7.29

This section includes the health and environmental effects from mercury emissions in the state; the role of utility emissions in the overall state mercury inventory; and reference to existing work by the EPA and other states applied in establishing the proposed mercury standards. In setting out all these pieces, the state wove together a strong rationale for its proposal that it could substantiate with examples and tests carried out in the state and elsewhere in the U.S. on these facilities. Highlights of these elements are as follows:

a) Health and Environmental Effects

- The levels of mercury across the state are considered high – over 60% of Massachusetts lakes and ponds have fish that are considered unsafe for pregnant women and children due to mercury with almost 40% of these waterbodies testing unsafe for all humans.

- The extreme toxicity of the metal at minute amounts is noted in several instances;
  - The Massachusetts Department of Health fish advisory recommending that pregnant women and children not eat fish containing 0.5 ppm of mercury (less than 1/100,000 of an ounce of mercury per pound);
  - A study in Minnesota which stressed that fish can be contaminated to unsafe levels by the annual deposition of only about 1 gram of mercury (the amount in a fever thermometer) per 20 acres[104]; and
  - Data from the US Centers for Disease Control (CDC) indicating that about 8% of women of childbearing age are exposed to mercury at a level above that recommended by the US EPA and National Academy of Sciences[105].

- The acidification of surface waters increases the bioavailability of mercury to fish.

- Coal combustion is a significant anthropogenic source of mercury emissions.

b) Mercury State Inventory

The three main sources of atmospheric mercury emissions in the state are Municipal Waste Combustors (MWC), Sewage Sludge Incinerators (SSI) and coal-fired plants. In the year 2002, these sectors emitted 560, 260 and 167 pounds of mercury respectively. The first two sources are being controlled through regulation (MWC) and pollution prevention strategies (SSI).[106]

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[104] Study was done in Minnesota but similar air deposition rates are found in the New England -.Swain, E.B. et al., 1992 "Increasing Rates of Atmospheric Mercury Deposition in Mid-continental North America" Science, 257: 784-7.

[105] This figure has been recently updated by the EPA to 15%.

[106] The MWC sector is the largest point source of mercury emissions in Massachusetts - the largest of such units are regulated and have reduced their emissions by [106]over 90% over the past 5 years. Further significant reductions are expected to result in emissions less than 100 pounds in the future.

However, emissions from coal-fired utilities have remained unregulated except for the current requirements under 310 CMR 7.29 for the three pollutants. Furthermore, mercury emissions from these utilities have not been reduced in five years since the New England Governors and Eastern Canadian Premier' Mercury Action Plan was adopted in 1998, calling for a 50% reduction in mercury emissions by 2003. In the absence of mercury regulations, such as those being proposed, this sector has become an increasingly larger part of the mercury inventory as other sectors have come under control.

While the controls for SO_2 and NOx currently being installed at the units may result in some co-benefits as to reduction in mercury, these potential benefits may not be accrued or maximized in the absence of mercury emission regulations. Without a standard, facilities have no incentive to optimize SO_2 and NOx controls for mercury removal.

c) Other Regulatory Action on Mercury in the U.S.

In light of the present uncertainty of the U.S. federal requirements, the Massachusetts DEP decided to move forward on mercury regulation. The state has utilized the work of the EPA in its initial determination of setting a mercury standard under MACT for assessing available control technologies and the data obtained from the EPA's Information Collection Request to demonstrate the feasibility of mercury control to the levels of the proposed standard[107].

Several other states are studying, measuring or regulating mercury emissions from electric generating units. For example, Connecticut (May 5, 2003) approved a law that requires coal-fired plants to achieve a minimum of 90% mercury removal (or maximum 0.6 pounds per GWh) by a compliance date of July 1 2008 and required its DEP to seek a more stringent standard by 2012. The Wisconsin Natural Resources Board has considered requiring a 40% reduction from 2002-2004 levels by January 1, 2010 and an 80% reduction by January 2015 (however, this is up for reconsideration).

A1.3 Description of Proposed Standards

The draft proposed regulation is in two phases. It also allows for an alternative reduction plan for off-site mercury reductions to offer initial flexibility to the affected units during the time that they will be testing and optimizing new SO_2 and NOx controls.

Phase 1: 85% mercury removal efficiency OR mercury emission limit of 0.0075 lb/GWh – equivalent to 3.4 mg/MWH , effective October 1, 2006, with the first annual average calculated from October 1, 2006 to September 30, 2007 period.

Phase 2: 95% mercury removal efficiency OR mercury emission limit of 0.0025 lb/GWh – equivalent to 1.14 mg/MWH, effective October 1, 2012, with the first annual average calculated from October 1, 2012 to September 30, 2013 period.

[107] EPA's Mercury Information Collection Request – Control of Mercury Emissions from Coal-Fired Electric Utility Boilers refer to www.epa.gov/ORD/NRMRL/Pubs/600R01109/600R01109.htm

The proposed standards provide a choice for each affected utility. Either choice is expected to yield a similar reduction in mercury emissions. It is important to realize that the percentages refer to "capture rates". The actual mercury emission reductions expected are in the order of 52-54% for phase 1 and 85% for phase 2 based on a total mercury cap of 185 pounds established by regulation 310 CMR 7.29, with specific caps determined for each facility.

A1.4 Justification of Feasibility of Mercury Controls

Technological:
The Department used the EPA's ICR data from pulverized coal boilers which are the ones employed in Massachusetts along with the type of emission controls installed. The results indicate that, 98% removal of mercury is achievable from bituminous coal through application of specific control devices currently available.

The test data conducted by the state in 2001-2 indicated that half of the eight coal-fired units are already achieving mercury removal approaching 90% due to existing controls and operating conditions.

Preliminary results from field test data of mercury-specific control technology using sorbent-injected mercury control systems have demonstrated the feasibility of achieving at least 90% mercury removal, further substantiated with the use of fabric filter technology (in particular, the COHPAC baghouse system).

Economic:
An analysis of present costs for SO_2 and NOx controls and mercury-specific technology (activated carbon) along with the expected decline in costs that accompany the commercialization of the technology have supported the economic feasibility of controls.

A1.5 Other Items

Ash Re-burn: The proposed regulation requires facilities to include mercury from coal ash that is re-burned in Massachusetts when reporting the facility's total emissions of mercury. The ash could be re-burned on-site or off-site (e.g., cement kilns, asphalt batching plants) resulting in re-volatilization of mercury.

Requirements for Monitoring for Compliance: Mercury Continuous Emission Monitors (CEMs) are required to be installed by January 1, 2008 at all coal-fired units. Where these units do not measure particulate-bound mercury, then the levels of particulate-bound mercury found in the most recent stack tests must be added to the CEM readings to determine total mercury emissions.

Stack Testing Frequency: The proposed regulation calls for facilities to test for mercury each calendar quarter. After a two-year period of compliance, the frequency is reduced to testing in four out of five calendar quarters.

A1.6 Alternative Reduction Plan

The proposed regulation includes an interim provision for affected facilities to apply for an alternative reduction plan to implementing the standards. The alternative plan would be offered until December 31, 2009 to allow time for facilities to optimize their SO_2 and NOx controls for mercury removal. Of all elements in the proposed regulations, this particular one is the least crystallized and raises the most questions and concerns.

The two alternatives proposed are:

- Facilities to seek opportunities to reduce mercury air emissions from other Massachusetts facilities; OR
- Facilities reduce potential air emissions in the state by collecting and recycling mercury from schools or dentists offices at a 2 for 1 credit – that is, one pound mercury credited for every two pounds reduced. A facility wishing to use alternative reductions toward compliance would indicate such in the required annual report.

The use of an alternative option as described above could allow for credits toward compliance with the cap. However, the proposed mercury regulations, in keeping with the current regulation, do not allow alternative reductions to be used to comply with a facility's mercury cap; i.e., actual site emissions must not exceed the cap.

The use of such options was put forward in the proposal to solicit further comment, specifically on the following as to:

- Whether an alternative reduction option should be offered
- Whether those reductions that occur through collection and recycling of mercury be credited at a 2 to 1 ratio or some other ratio
- Whether an alternative option be extended to the second phase in 2012 or beyond
- Whether alternative reductions should be credited toward compliance with a facility's mercury emissions cap and, if so, in a case where a facility meets neither the emission standards nor the mercury cap, whether a single pound of alternative reduction be credited toward compliance with both requirements (standard and cap).

Another consideration put forward in the alternative options related to the permanent storage of mercury and if such a mechanism were to be available, would the DEP encourage permanent storage by crediting collection and storage on a one pound for pound stored basis.

A1.7 Commentary

As initially stated, much of the proposal on regulations is well-though out and, in many instances exemplary. Of course, Massachusetts is dealing with four relatively small facilities, all of which use the same type of coal. This makes certain aspects such as technological feasibility an easier case than in those areas where coal types are variable. However, even that the state emits a relatively smaller amount of mercury than many other jurisdictions, the fact that they are moving ahead with a multi-pollutant bill that includes mercury is worthy of notice.

One must also be careful to correctly interpret the actual reductions of mercury emissions to result from the proposed standard which is expressed in terms of mercury removal or capture as well as emission rate at the outlet. In fact, the current facilities are presently capturing in the order of about 30% overall, with the largest facility (Brayton Point) capturing about 38% of the mercury. Since four out of eight units are already on track of being able to remove 90% of the mercury, the goal in phase 1 and 2 seem quite realistic and plausible. However, the phase 1 proposed standard translates to just over a 50% reduction. It is only in approaching the phase 2 standard in 2002, will reductions in the order of 85% will be realized.

Regarding the issue of ash re-burn, I have no idea how much of this activity will occur, but it would be advisable to have information that project likely scenarios in such cases.

The "alternative reduction plan" is likely to invite some interesting public comments and is the most controversial element of the proposal. It appears as though the DEP wanted to institute an incentive to realize early reductions where such may not have been feasible for some units within the first phase.

However, it may have been wiser to limit the suggestions for the options in the alternative reduction plan to a tight timeframe, such as 2009 as suggested, rather than bring in the question of a time extension to 2012 and even beyond. The rationale for the 2 to 1 ratio for assigning credits for collecting and recycling mercury (one pound credited for every two pounds reduced) does not appear to be well determined, making it difficult to judge whether the ratio is appropriate and, if not, what should the ratio be?

Further, to even consider whether a facility should be allowed to exceed both requirements (standard and cap) through credits may create a complicated scenario that raises more problems than it solves, and finally, it is premature to consider storage of mercury at this stage as this may not become a reality for some time to come.

In light of the stalling on federal action and even in some of the states on mercury regulation, this proposal at least addresses some important issues and does regulate mercury emissions from these facilities in a timely manner. It will be interesting to see what changes are made prior to promulgation in the spring of 2004.

A.2 Mercury Initiatives in Other States

i) New Jersey

In December 2003, New Jersey released a proposal to regulate mercury from incinerators, smelters, and coal-fired boilers. For coal-fired boilers, sources would have to comply with the regulation by December 15, 2007 through either one of the provisions below:

- The emissions of mercury from any coal-fired boiler shall not exceed 3.00 mg/MW- hr, based on an annual weighted average of all valid stack emission tests performed for four consecutive quarters weighted by megawatt hours produced each quarter; or
- The reduction efficiency for control of mercury emissions of the air pollution control apparatus for control of mercury of any coal-fired boiler shall be at least 90 percent, based on the annual weighted average of all valid stack emission tests performed for four consecutive quarters weighted by megawatt hours produced each quarter.

The New Jersey rule would allow sources to delay compliance to 2012 if the owner or operator of a boiler has:

- entered into an enforceable agreement with DEP by December 15, 2007 to meet specified NOx, SO_2, and PM standards by December 15, 2012, and
- if compliance with the 3.00 mg/MW-hr limit is achieved by December 15, 2007 for approximately 50 percent of the total coal-fired capacity of the company.

In addition, the December 15, 2007 deadline for compliance is not applicable to an owner or operator of a coal-fired boiler who has entered into an enforceable agreement by December 15, 2007 to shut down the boiler by December 15, 2012.

Sources can apply to the DEP for an averaging plan for two or more units at the same facility. A public hearing is scheduled for March 4, 2004 and the comment deadline is March 5, 2004.

ii) Wisconsin

The Wisconsin Department of Natural Resources has postponed its decision on a response to objections raised by the state legislature with respect to the Department's proposed rule to reduce mercury emissions from the state's coal-fired power plants.

The following are provisions from the proposal adopted by the Natural Resources Board in June 2003. However, it is still unclear what will eventually emerge from the process. Under the June version of the proposal, major electric utilities (emitting more than 100 pounds of mercury per year) would be required to achieve the following reductions in

mercury from baseline emissions (baseline emissions are defined as uncontrolled mercury emissions from calendar years 2002, 2003 and 2004):

- January 1, 2008 –imposes a cap based on performance tests conducted no later than October 1, 2005 (the cap would be determined by multiplying the baseline emissions by the control efficiency of any control equipment or mercury emission reduction activity at the unit).
- January 1, 2010 - 40% reduction
- January 1, 2015 - 80% reduction

Companies would be able to comply by averaging emissions across their entire system. They also would be able to purchase excess reductions generated by other utilities. Companies could also obtain relief from the initial reduction requirement (the 40 percent requirement) if they obtained approval of a multi-pollutant reduction proposal. In addition, new and modified major stationary sources would be subject to Best Available Control Technology (BACT).

iii) Connecticut

In March 2003, PSEG Power Connecticut, Clean Water Action, the Connecticut Coalition for Clean Air and the Clean Air Task Force issued a joint recommendation to the Connecticut General Assembly calling for legislation establishing stringent mercury emission standards for the state's coal-fired power plants. The legislation implementing the proposal passed both houses of the legislature in May 2003 and was signed by the Governor in June 2003.

The legislation requires Connecticut electric generators that combust coal as greater than ten percent of their heat input to achieve either an emissions standard of 0.6 lbs per trillion btu or a 90 percent reduction from the measured inlet conditions by July 2008. (If a unit properly installs and operates control technology designed to achieve the mercury emissions rate requirement, and the technology fails to achieve the rate, an alternative emissions limit can be established for the unit.) The legislation also directs the Connecticut Department of Environmental Protection to consider new emissions standards in 2012.

iv) New Hampshire

On May 9, 2002, the governor signed into law a multi-pollutant policy for fossil fuel-fired power plants. The law requires the Department of Environmental Services to recommend a cap for mercury emissions to the legislature by March 31, 2004. The timing was intended to allow the state to consider the proposed federal MACT standard. The Department has not yet set a cap, but will likely have a proposal to the legislature by February 2004.

v) North Carolina

On June 20, 2002, the governor signed the "Clean Smokestacks" bill, a multi-pollutant bill that covers the state's coal-fired electric generators. The law requires the Division of Air Quality of the Department of Environment and Natural Resources to study mercury from coal-fired generating units, evaluate available control technologies, and estimate costs and benefits of alternative control strategies.

The Division must report annually to the Environmental Management Commission and the Environmental Review Commission beginning in September 2003, with final recommendations due September 2005. The Division issued a report in September 2003 that outlines the state of science. The report notes that controls installed to comply with the NOx and SO_2 provisions of the Clean Smokestacks Act are expected to reduce mercury emissions from these units by approximately 55 percent.

vi) Illinois

Legislation signed by the governor in August 2001 calls for a report by the Illinois EPA concerning a reduction in mercury (among other pollutants) emissions from fossil fuel-fired electric generating plants. Illinois EPA must report to the House and Senate Committees on Environment and Energy before September 30, 2004

vii) Iowa

Based on a determination by the Iowa Department of Natural Resources, in June 2003 the MidAmerican Energy Company took an enforceable permit condition on a new 790 MW coal-fired utility boiler burning western sub-bituminous coal. The pre-construction permit requires a mercury reduction of 83 percent, based on the use of activated carbon injection.

Appendix B

Mercury - Emissions Trading
And
Coal-Fired Plants

Report on

Perspectives from Environmental Non-Governmental Organizations (ENGOs)

Prepared by

Anna Tilman

December 2003

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Preface

This paper is intended to provide Environment Canada with perspectives on trading of mercury emissions pertaining to coal-fired power plants primarily from the environmental community in Canada and the United States. As a means of soliciting the various views and positions on this topic, environmental organizations were canvassed by a survey as well as in informal discussions. In addition to canvassing these organizations, opinions on this topic were sought from individuals from academia, consulting firms and industry associations. The feedback from all these avenues has been thought-provoking and extremely valuable in formulating the essence of this work.

This topic is one that elicits very strong sentiments. In many cases, lengthy discussions were held on emissions trading that delved into moral, ethical and environmental justice issues as well as the nature of the toxin itself. In order to do justice to these comments, they have been included in this report, in some cases, verbatim. Viewpoints expressed by industry groups and others who support emissions trading of mercury as well as their reservations have also been incorporated as a means of illustrating the scope of the debate on this matter.

In order to provide the reader with some context and historical background to this topic, this document provides a brief description of initiatives and policy on mercury that are of relevance to this issue as well as a discussion on basic features of emissions trading.

In light of the importance of this issue on a national and international scale, I have chosen to frame the topic of emissions trading of mercury within a larger picture, one that discusses fundamental issues not only on the ethical and human rights aspect of emissions trading, but also on questioning the approach taken by governments in how they address toxic substances (or management thereof) in particular, mercury.

I trust that Environment Canada will find this paper informative and consider these views very carefully in shaping and enacting policy related to mercury, and in particular, regarding emissions of mercury from coal-fired plants.

Anna Tilman

December 2003

ACRONYMS, UNITS and ABBREVIATIONS

BNS	-	Binational Toxics Strategy (Great Lakes)
CAA	-	Clean Air Act (U.S.)
CAAA	-	Clean Air Act Amendments (1990)
CEMs	-	Continuous Emissions Monitoring System
CEPA 99	-	Canadian Environmental Protection Act, 1999
CO_2	-	Carbon Dioxide
DNR	-	Department of Natural Resources (Wisconsin)
EEI	-	Edison Electric Institute
ENGO	-	Environmental Non-Government Organization
EPA	-	Environmental Protection Agency (United States)
g	-	gram
GLU	-	Great Lakes United (Environmental Organization in U.S. and Canada)
GHGs	-	Greenhouse Gases
HAP(s)	-	Hazardous Air Pollutant(s)
Hg	-	mercury
ICF	-	Consulting firm
kg	-	kilogram (1000 grams)
lb	-	pound (0.454 kg)
MACT	-	Maximum Achievable Control Technology
mg	-	milligram (one thousandth or 10^{-3} gram)
MW	-	Megawatts
g	-	microgram (one-millionth or 10^{-6} gram)
NACEC	-	North American Commissions on Environmental Cooperation
NGO	-	Non-Government Organization
NO_x	-	Nitrogen Oxides
NRDC	-	Natural Resource Defence Council (U.S. Environmental Organization)
SO_2	-	sulphur dioxide
ton	-	2000 lb (0.908 tonnes)
tonne	-	1000 kg (1.10 ton)
UNEP	-	United Nations Environment Programme
US (U.S.)	-	United States
WE	-	Wisconsin Electric Power Company

A. Background

a) The U.S. Policy Scene The Mercury Rule and Clear Skies

The concept of emissions trading of mercury, in particular with respect to coal-fired power plants, has been advanced in the U.S over the past few years and has moved into the spotlight of current policy discussions regarding regulation of mercury emissions from these facilities. It gained prominence through the introduction of the Clear Skies Act 2003, a bill proposed by the Bush Administration to regulate emissions from coal-fired plants. 鼎lear Skies , a 3-pollutant bill (SO_2, NOx and mercury) that lays out a two-phased reduction plan premised on a cap-and-trade mechanism for all 3 pollutants[108]. While other multi-pollutant bills pertaining to regulating and limiting emissions from coal-fired power plants have been introduced into the U.S. Congress over the past two years, 鼎lear Skies has been at the forefront and focus of much polarized debate.

Prior to the introduction of 鼎lear Skies on December 2000, the U.S. Environmental Protection Agency (EPA) announced its decision to regulate emissions of mercury and other air toxics from coal- and oil-fired electric power plants. This decision was based on the findings of two major studies, one of which identified mercury as the Hazardous Air Pollutant (HAP) of greatest concern to human health and the other cited coal-fired plants to be the single largest source of mercury air emissions in the U.S.[109] Subsequent analyses further substantiated the need for regulation.

In accordance with the existing air toxics section of the Clean Air Act (CAAA 1990, Section 112), the EPA was obligated to embark on a rule-making process to develop a mercury standard that would require all U.S. coal-fired power plants to install Maximum Achievable Control Technology (MACT) within specified timelines[110]. The application of the MACT standard is expected to yield reductions of atmospheric mercury emissions from the 464 coal-fired plants in the U.S. by at least 90% from current levels (that is from 48 tons to approximately 5 tons) by the year 2008. Trading in mercury emissions is not a component of the MACT rule.

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[108] Refer to Appendix C, p.24.

[109] The reports are (i) EPA "Mercury Study Report to Congress" (December 1997), and (ii) the Utility Air Toxic "Final Report to Congress" (February 1998). Furthermore, in 1995, the EPA determined an exposure reference dose (0.1ìg mercury per kg body weight per day) that was scientifically justified to protect against harmful neurological effects during fetal development and early childhood. This is the most cautionary threshold in the world.

[110] The "MACT standard" requires that controls for existing facilities be at least as stringent as the limit achieved by the best performing 12 % of all the sources For new facilities, MACT requirements are to be at least as stringent as the emissions limit achieved by the best-controlled existing source. The process by which the mercury standard is set is referred to as the MACT rule.

The draft 溺ACT standard is to be issued by December 15, 2003. Following a public comment period, the final 溺ACT rule is due December 2004 with full compliance by December 2007.

If 鼎lear Skies is enacted into legislation, it would amend the Clean Air Act and obviate the mercury MACT standard. Thus, while the regulatory train may have left the station for coal-fired plants in the U.S, two very different policy tracks regarding mercury and coal-fired plants have been laid out, Clear Skies and MACT. These tracks are really incomparable and incompatible, not only in terms of schedules and goals, but also in how these goals are to be attained.

Based on the present political climate in the U.S., it may have seemed a safe bet that the MACT draft rule would be first out of the gate, as it must, while Clear Skies takes a temporary reprieve, undoubtedly maintaining its strong influence in the corridors of power. However, in the wake of its December 15 deadline, the outcome and nature of the draft MACT rule has become uncertain as efforts to unravel MACT are unfolding. In particular, the Bush administration is considering adopting a new legal interpretation of the Clean Air Act that would rescind the MACT rule-making process and standard for mercury and replace it with a much more 吐lexible and far less stringent mechanism (Section 111 under the CAA) that would allow for the trading of mercury emissions.

To add more 吐uel to the fire work is on hand to 杜odify the reductions of mercury emissions specified in the first phase of Clear Skies by altering the 46 % reduction goal by 2010 as currently specified (from 48 tons to 26 tons) to a mere 30% (34 tons). This reduction level is the one that the electric power industry has continued to rally around for the past few years as it makes its case that reduction in mercury emissions is to be derived only as a co-benefit of reductions of NOx and SO_2, not by any mercury-specific controls.

These potential changes really put the U.S. regulatory situation in a state of confusion as to what kind of standard the EPA will bring forth on December 15, 2003 and whether the potential re-jigging of the Clean Air Act will be played out. Regardless of the outcome, any change that would derail the MACT track will lead to contention and litigation and result in further delays in dealing with the mercury emissions from these coal-fired plants, the single largest source of mercury emissions in the U.S.

Since Canada is so heavily influenced by the U.S. scene to inform its own policies and standards, particularly as regards coal-fired plants and mercury, the outcome of MACT and the future of Clear Skies is critical and of great interest to Canada.

b) Views on U. S. Policy

To no surprise, the environmental community, by and large, in both the U.S. and Canada are opposed to 鼎lear Skies for a number of reasons - its timelines are long-drawn, the reductions specified are inadequate, it does not include CO_2 emissions, it rolls back safeguards to protect local air quality and weakens public health protection of the existing Clean Air Act and does not address older 堵randfathered plants. And despite the fact that caps have been set for each pollutant, the actual emissions of the three pollutants will be higher than the caps that have been since facilities that reduce emissions early can earn allowances for those actions and use those allowances at a later date (i.e. banking).

Furthermore, environmentalists find its proposal on mercury and the trading of mercury emissions likely to perpetuate and increase risks of mercury exposure to mercury from the major source of such emissions in the U.S, namely power plants, and lead to mercury 塗otspots ENGOs in general support the process of setting the mercury standard via a MACT ruling, if it will result in reductions in mercury emissions from coal-fired plants in the order of 90%. They are wary about the impact that Clear Skies may have on MACT.

Those who support the Clear Skies Act and hence subscribe to trading in mercury, regard trading as an economic incentive that can result in earlier reductions and do not feel the need to treat mercury differently from other the other pollutants under consideration. While they may acknowledge that there are present limitations to the feasibility in trading in mercury emissions, they hold to the view that, given the appropriate technology and time, such barriers will be overcome to allow for trading in mercury emissions.

Support for 鼎lear Skies emanates primarily the electrical industrial sector, in particular, the coal-fired generation sector, as well as many who actively participate in market mechanisms that involve emissions trading. These same supporters are vehemently opposed to the 溺ACT rule for mercury. They see it as a command-and-control program that would stifle innovation, lead to higher compliance costs and electricity costs and would be more expensive than a cap-and-trade program. At the same time, some industry feel that the mercury targets specified in Clear Skies are too optimistic as they expect that reductions in mercury will be realized as co-benefits as a result of reductions in other pollutants, such as NOx.

c) International/Domestic Actions and Policies

While the domestic federal 途egulatory actions on mercury in t he U.S. are of major importance in Canada and the international community, this is not the only arena of policy related to mercury. In many theatres around the world, at regional, national and international levels, discussions are ongoing in efforts to come to grips with one of the most toxic substances known in the environment. These activities speak to the level of concern about this element, its ever-increasing global levels and long-lasting harmful effects on the ecosystem.

The last decade alone has witnessed the continuance and intensification of numerous studies and programs that delve into many facets of mercury that range from the science, atmospheric transport, environmental and health effects, anthropogenic sources of emissions, and means to control and reduce mercury emissions that include technology and measurement to legislative efforts and international initiatives and agreements. Overall, the message that emerges is the need to take action sooner rather than later.

On the international front, in February 2003, based on the Global Assessment of Mercury report initiated by the United Nations Environmental Programme (UNEP) in 2001, the Governing Council of UNEP stated that there was 都ufficient evidence of significant global adverse impacts from mercury and its compounds to warrant further international action to reduce the risks to human health and the environment and that national, regional and global actions, both intermediate and long-term, should be initiated as soon as possible. Further, the Governing Council urged that all countries adopt goals and take national actions, as appropriate, with the objective of identifying exposed populations and ecosystems and reducing anthropogenic mercury releases that impact health and the environment.

Other attempts to wrestle with the problem of mercury have led to a number of programmes of various scales. The 1997 Great Lakes Binational Toxics Strategy (BNS), an agreement between United States and Canada, has established a process to work toward virtual elimination of specific persistent bioaccumulative toxic substances, including mercury, from the Great Lakes Basin[111]. The North American Commission for Environmental Cooperation (NACEC) has in place a Regional Action Plan for mercury whose goal is the reduction of mercury to approach natural levels and fluxes in certain environmental media and a 50% reduction in mercury emissions by 2006. In the Arctic, where sources of anthropogenic mercury are typically far removed, the Northern

[111] The U.S. sought a 50% reduction in mercury emissions by 2005, while Canada specified a 90% reduction by 2000.

Contaminants Program has established mercury as a serious health concern. The Mercury Action Plan adopted by the Eastern Canadian Provinces and New England Governors states as its goal the virtual elimination of anthropogenic mercury in the region.

In Canada specifically, the Canadian Environmental Protection Act, 1999 (CEPA 9), pollution prevention is indicated as being priority for the management of toxic substances[112]. Mercury, one of the 鼎EPA -toxic substances, is designated as a track II substance and is slated for 斗ife-cycle management

Of particular significance to core matters in this document, coal-fired plants have been singled out as a major and growing contributor to atmospheric mercury emissions. In the U.S., these sources account for approximately 40% of its domestic atmospheric mercury emissions and up until this time of writing this document, this industrial sector is the single largest unregulated source of mercury emissions in the U.S. Many states, alarmed with growing evidence of the local impact of mercury, are developing legislative tools to reign in mercury emissions from these plants. Emissions of mercury from these sources in Canada have also become the number one source of anthropogenic mercury emissions in this country. For the past 5 years, Canada and its jurisdictions have been engaged in the process of developing 鼎anada -wide Standards for mercury emissions from coal-fired power plants and are expected to come up with a standard by 2005.

Keeping an eye on all this activity is a daunting task, but an important one and even more so, if trading of mercury emissions becomes enshrined in U.S. regulation, as this would send signals to other countries and jurisdictions that have not entertained this notion and may possibly have ramifications on the interpretation of existing agreements and future ones.

B. Emission Reduction Mechanisms

This section is designed to give the reader background into concepts of emissions trading in general as reference to the issues being discussed in this document.

Two fundamental approaches are generally advanced as mechanisms to reduce the emissions of specific pollutants namely, 田ommand -and-control and market mechanisms, viz., 兎missions trading These approaches are central to the policy debate on the achievement of reductions in mercury emissions from coal-fired plants.

[112] Mercury is listed as a toxic substance on Schedule I, Track 2 of CEPA. Such substances are slated for life-cycle management to prevent or minimize their release into the environment.

a) Command-and-Control Systems

Under command-and-control systems, a regulator specifies the pollutant emission level/rate or reduction level for each plant/unit base on a combination of criteria that may include such parameters as boiler type and age, fuel type, and location. Each such plant/unit must comply with its regulatory agent痴 specified emission level/rate or reduction level. These systems can vary in terms of flexibility, for example, some systems may specify specific technology to be installed, or a cap on emissions with no trading allowed between different plants. These regulatory systems are seen considered (by some) to be drivers in technical innovation provided that they set sufficiently robust levels of reduction and establish a credible compliance and enforcement regimen and offer certainty to the public.

b) Market-based Mechanisms

i) Cap-and-Trade

Under a cap-and-trade system, or 田losed market a regulatory agency establishes the t otal cap on emissions of a given air pollutant for a regulated industry/sector (e.g., power plants) in a common air-shed. Key emitters/participants are identified and only these emitters can participate in trading allowances (田redits . The regulatory age ncy divides the total cap into emission allowances which is then allocated by auction or assignment to emitters (regulated sources), on the basis of historic or permitted emissions (grandfathered or other means). In turn, participants are required to surrender an allowance for each unit of pollutant emitted.

Thus, under this system, the total units of emissions for the specified sector are capped or constrained to be no more than the allowances distributed by the regulatory agency. Any reductions *under* the cap can be traded (bought or sold) by participants. Participants in this system can choose whether to purchase allowances (田redits to cover its emissions from other plants that have emissions below the required limit or to reduce emissions by installing pollution control retrofits, switching fuels, or reducing their capacity. These systems are considered (by some) to be appropriate for pollutants that disperse over long distances and are of regional/global concern[113].

[113] While an "open market" system another mechanism advanced for emissions trading is, it has not come into serious discussion at this juncture.

ii) Allocation of Trading Permits

Permits are allocated by auction or grandfathering, and hybrids of these schemes. Auctioning of emissions permits is a method by which permits for emissions may be allocated among emitters and firms in a domestic emissions trading regime based upon willingness to pay for these permits. Supporters of this method of emissions trading assert that the advantage of auctioning is that it would provide governments with revenue and provide price signals to the new and developing market for permits. Critics contend that its disadvantage is that it may be less politically acceptable to those entities that would stand to gain from grandfathering of permits.

Grandfathering of emissions permits is a method by which permits for emissions may be allocated among emitters and firms in a domestic emissions trading regime according to their historical emissions. Supporters of 堵randfathering assert that this would be administratively simple. Some critics argue that this method favours the older, more polluting facilities by rewarding firms with high historical emissions. Grandfathering is also criticized in that it unfairly complicates the entry of new less-polluting facilities entry into markets.

c) Rationale for Emissions Trading In General

The following section looks at the rationale for the application of market mechanisms such as emissions trading in general from both an industry and ENGO point of view.

(i) Industry Viewpoint

Emissions Trading is favoured by industry in that it allows industry to integrate emission reduction strategies with their 田orporate priorities; to buy credits when capital is limited; invest in technology to meet requirements; and to achieve reductions in Hg emissions through financial incentives earlier and, faster than command-and-control methods. It is also seen as complimenting and/or supplementing regulatory mechanisms. By over-investing in technology, surplus reductions for trading- revenue are generated for future use.

While trading does not, in itself, reduce emissions, it increases an industry痴 flexibility to optimize emission control investment decisions and to make earlier or further reductions than otherwise would be realized under a strict regulatory mechanism.

(ii) Natural Resources Defence Council (NRDC)[114]

The views from the NRDC are generally aligned with those ENGOs who see benefits for a market mechanism such as emissions trading as a potentially effective tool in reducing emissions of specific pollutants provided safeguards are in place. These views do not apply in the case of mercury.

Market-based approaches create incentives and rewards for early action or over-compliance hold potential to achieve reductions earlier than might not be otherwise obtained. For example, reductions in SO_2 emissions that have been realized through the U.S. Acid Rain Program have been achieved at lower costs than have been achieved through traditional command-and-control options.

Emissions trading may enable greater sector-wide reductions at a faster rate than possible by reliance on command-and-control approaches, usually limited by ability of lowest common denominator. It can facilitate control technology innovation if well designed, and may lower compliance costs and permit additional reductions.

Market-based options can range from disclosure that empowers consumer choice, to tax benefits, offsets, innovative trading schemes. Those options that include disclosure and best technology approaches are favoured over options that are used to excuse the use of best technology.

C. Perspectives on Mercury Emissions Trading

a) The Two Solitudes [115]

i) ENGO View - Natural Resources Defence Council (NRDC)[116]

NRDC does not believe that any emissions trading mechanism can be devised that will allow coal-fired plants to comply with a national emissions cap for mercury emissions without unacceptable risks remaining for populations and sensitive ecosystems downwind of such facilities. The major issues of concern are technical uncertainties, reliability in tracking emissions and verifying

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114 NRDC is a U.S. Environmental Organization based in Washington D.C.

115 These views were debated at the International Air Quality Conference held in Washington D.C., September 2002. In addition comments were taken from the NRDC briefing paper presented at Emissions Marketing Association 6th Annual Spring Meeting, New Orleans, May, 2002.

116 Comments are extracted from of the NRDC briefing paper by Patricio Silva presented at Emissions Marketing Association 6th Annual Spring Meeting, New Orleans, May, 2002

reductions, health effects and behaviour of mercury once released into the environment. Following is a description of the rationale for the position of NRDC on emissions trading (of mercury).

Mercury is a volatile hazardous air pollutant that behaves differently from sulphur dioxide and nitrogen oxides that undergo limited oxidizing reactions and conversion into sulphuric and nitric acids and are then deposited in a well characterized mechanism several hundred kilometres downwind of emission sources. On the other hand, mercury is more complicated. It can be emitted in different forms particulate, oxidized, elemental phases, each with significantly different deposition patterns. Some ecosystem receptors respond with different sensitivities to exposure to mercury emissions. The present knowledge about transport fate and deposition (atmospheric chemistry and transformations) are not adequate to ensure integrity, accuracy and protectiveness if reliance is placed on market based mechanisms to reduce mercury.

Stack emissions of mercury species are highly variable, dependent on fuel type, operational characteristics, pollution controls, etc. Improvements are needed in Continuous Emission Monitor systems (CEMs) and real time measurement to track mercury emissions effectively and accurately and allow for reasonable level of predictability.

While NRDC does see benefits for market-based approaches to reduce emissions of some pollutants, they stipulate principles and conditions that would apply in determining the acceptability of emissions trading, such as:

1. When dealing with toxics with local impacts, regulatory initiatives must not tolerate adverse local impacts. Therefore, NRDC does not endorse any market mechanisms, in particular, cap-and-trade regimes, that tolerate increased risk and/or inequitable distribution of risk compared to a sole reliance on traditional approaches.
2. No source of mercury emissions should be excused from compliance with technology-based performance standards.
3. Trading programs should only be pursued to the extent that they augment the reductions that are achievable through traditional regulatory approached.
4. Uncertainty in measurement and environmental impact must be interpreted conservatively to endure the health protectiveness of any resulting standard.

In summary, while market-based mechanisms may result in lower compliance to reduce mercury emissions from coal-fired plants, the extension of emissions trading mechanisms to mercury is inappropriate and the concept is rejected (by NRDC) [117].

ii) Industry View - Edison Electric Institute (EEI)

The EEI is an influential association of electric companies that supports Clear Skies. However, it is calling for a revision of the 2010 mercury cap to levels achievable with control technologies for sulphur dioxide and nitrogen oxides[118]. Their line of argument in defense of trading of mercury emissions to counter objections raised by environmentalists is as follows[119]:

- Power generation sources contribute up to about 10% of total from all man-made and natural sources; a 50% reduction would result in 5% contribution.
- Most of the power plant emissions of mercury become elemental mercury soon after release. Elemental mercury tends not to get deposited nearby and may remain in the global pool for months to years before being deposited to the earth.
- If < 5% of mercury comes from power plants as a result of a 杜odest (50%) mercury emission reduction program and a large portion of that mercury is elemental and not deposited locally, then the hot spot issue is an unrealistic concern.
- SO_2 trading did not create 塗otspots (as shown by the EPA and Environmental Law Institute and Resources for the Future)
- Trading can result in a substantial reduction in emissions, in that no areas would be without controls. The largest plants are controlled first due to economics.
- Restriction (or prohibition) of mercury trading will result in lost economy efficiency with no environmental benefit. Eliminating trading would eliminate the opportunity to save as much as $5 billion during 2004-2020 (in 1999 dollars).
- Further, adverse health effects of mercury due to environmental exposures related to electric power emissions are speculative.

However, it is worth noting that these views are not held by all industry or consultants on the topic of trading. In fact, it has been suggested that due to possible concerns for the impact of mercury

[117] Analysis of Emission Reduction Options for the Electric Power Industry, Office of Air and Radiation, U.S. EPA (March 1999)
[118] EEI News Release, Feb. 27, 2003.
[119] This viewpoint by industry has been expressed and presented by Michael Rossler of EEI at the Air Quality III Conference, Washington, September 9-12, 2002

emissions on communities near the emission source, some policy proposals would specify a command-and-control system for mercury rather than cap-and-trade[120]

b) A Challenge for Emissions Trading

*The following is an **abridged version** of an article by Donna Danihel, senior environmental specialist, Wisconsin Electric Power Company (WE), Milwaukee, Wisconsin, and Dave Michaud, principal environmental scientist at WE [121]. The opinions are those of the authors, not necessarily the opinions of the Emissions Marketing Association, its members or member companies or that of the author of this paper.*

Emissions trading has quickly evolved from an economic theory into a proven business tool that achieves environmental results. Its efficient application has demonstrated advantages in environmental policy cost savings, resource allocation, innovation and environmental protection for both government and industry. This success invites speculation as to whether emissions trading could work for emerging environmental concerns such as mercury. The presence of this metal in the environment has received increased attention in recent years, but its sources and impacts are only beginning to be understood. Its unique and complex characteristics need to be considered in determining the best approach to mitigating mercury emissions.

Emissions trading markets for sulphur dioxide (SO_2) and nitrogen oxides (NOx) have proven successful to date. Under the US Acid Rain Program, created under the 1990 Clean Air Act Amendments, SO_2 sources were allowed to determine which emission reduction solutions (e.g., fuel switching, control technology, or emissions trading) were most economical for each facility. This flexibility resulted in greater environmental benefit at lower cost than otherwise would have occurred. The newer, evolving, NOx market has also reduced emissions, although prices have been more volatile.

The greenhouse gas (GHG) market that is developing in response to concerns about climate change will be more complicated than single-emission markets in order to accommodate multiple gases, hundreds of types of emission sources and millions of potential participants, while being influenced by significant scientific, regulatory and political uncertainties. Since GHG reductions provide global rather than local or regional benefit, the geographical location of reductions is less

[120] (ICF Consulting, Air Quality IV Conference, Washington, September 2002.
[121] *The article was published in the journal "* Emissions Marketing Association (Publication - Market View", (Dec – Jan 2001)

relevant than for SO_2 and NOx, environmentally if not politically. Despite the complexity, many are convinced that an effective GHG trading regime can be designed and implemented.

Challenges and Obstacles for trading in mercury emissions

- Not all mercury emissions are created equal. Elemental mercury can be emitted by both natural processes and human activity; the oxidized form is produced primarily by combustion sources. These forms face different environmental fates. For example, oxidized mercury is quite soluble in water and can be washed out of the atmosphere closer to its source than elemental mercury. Elemental mercury, however, is virtually insoluble in water. This suggests that sources of oxidized mercury may have more local or regional impacts on aquatic systems (only oxidized mercury can be converted by microbes to the more dangerous methylmercury form in the environment). On the other hand, elemental mercury emissions are only very slowly oxidized in the atmosphere and are thought to contribute to the global atmospheric pool of mercury.

- The geographic distribution of sensitive ecological receptors is another complicating factor. Unlike 創Jonattainment areas defined around metropolitan areas, some ecosystems are more sensitive to mercury emissions than others, making the identification and measurement of the effects of mercury deposition and its control much more difficult.

- There has been little or no detailed measurement of mercury emissions, characterization of sources by amounts and chemical form of emissions. While mercury measurement in power plants (the most studied source) is improving, accurate baseline emission estimates necessary to develop a trading market still do not exist for these or any sources.

- Actual amounts emitted per source are thought to be quite small, generally tens or hundreds of pounds per year. In contrast, the SO_2 and NOx markets comprise tens of millions of tons annually. The small size of annual emissions increases the importance of accurate baselines and measurement methods.

- Due to the limited potential size of a mercury emissions trading market, it seems unlikely that a separate market would develop unless the unit cost to control mercury is substantial. The US Department of Energy (DOE) recently estimated control costs at between $20,000 and $70,000 a pound.

D. ENGO Perspectives on Mercury Emissions Trading

a) Overview

The positions of non-governmental environmental organizations (ENGOs) and 兎nvironmentalists per se on the concept of emissions trading in general vary, from cautious support, reluctant acceptance to total rejection. While a number of ENGOs see potential benefits in emissions trading in the case of certain pollutants such as CO_2, SO_2 and NOx, their support or acceptance of trading is premised on there being appropriate safeguards and principles in place.

Those who see some benefits to emissions trading are of the opinion that it has been a positive influence, an incentive, that has contributed to and in fact accelerated reductions of SO_2 emissions (under the U.S. Clean Air Act Amendments) and can work for NOx under certain circumstances. Trading in global pollutants such as CO_2 generally receives wider acceptance than the other pollutants, but again not without reservations and limitations.

On the other hand, these sentiments are not universally held by the environmental community at large. Rather, emissions trading is often viewed with uncertainty and skepticism. Many are wary about the principle of employing a trading scheme as a means of reducing emissions rather than a regulated emissions reduction mechanism with emphasis on pollution prevention at source. The most contentious issue is the concern that emissions trading can result in potential environmental 塗otspots and environmental justice issues.

Regardless of the various opinions on emissions trading, the views of environmentalists converge when the issue of trading in mercury emissions arises.

The reaction of ENGOs and others (including academics and some industry representatives) to the concept of trading in mercury emissions is swift and definitive in the negative, as witnessed by comments expressed in the survey or in discussions. In many cases, the response was that of shock, outrage and the very absurdity of employing such an idea [122]. The monetary assignment of emission permits, selling and banking of credits, difficulties in the accuracy in the measurement of mercury emissions, along with societal costs and benefits, environmental justice issues and nature of mercury were all cited as obstacles to trading.

One aspect of trading put forward via the survey pertained to the possible use of 登ffsets where in the absence of present technological solutions, industries are permitted to 登ffset their

[122] Dr. Donald McKay, Professor Emeritus, Trent University and University of Toronto – keynote speaker at the IJC conference, February 2003

current mercury emissions through arrangements or partnerships regarding mercury recycling or recovery efforts where abatement technologies are not presently available. However, in order for offsets to be effective in achieving early reductions, the mechanisms of administering offsets must be part of a larger package of a mercury reduction strategy and not be substituted for technological advancements.

At this stage, it is evident that there is no ENGO support in the U.S. or Canada for trading in mercury emissions. It is viewed as a very dangerous route as precedent-setting in allowing trading in persistent bioaccumulative toxins and one that should not even be opened for discussion. It goes against the grain of national and binational commitments and international programs that are geared to achieve specific percent reductions or the 砺irtual elimination of anthropogenic releases of mercury in general and for specified regions such as the Great Lakes.

Further to the point, emissions trading of mercury is a parting of the seas, in that it represents a major ideological shift away from adopting strategies that prevent anthropogenic emissions of mercury in the first place. For that matter, the concept is contrary to the 莵recautionary principle in that it cannot be shown to not raise threats of harm to human health and the environment.

Rather than pursing a cap-and-trade program for coal-fired power plants, ENGOs deem regulatory instruments, i.e., 田ommand -and-control measures appropriate.

b) Highlights of Responses

i) The following list highlights key points identified by respondents canvassed as to their opinion on emissions trading particularly with respect to mercury.

Nature of mercury:

- Persistent Bioaccumulative Toxin (PBT), indestructible, volatile
- Exists in different forms hard to track
- Complex behaviour once emitted in the atmosphere
- Deposition, remobilization and transformation into different forms

Health and environmental impacts:

- Local and long-range transport and deposition issues
- Environmental justice issues creation or perpetuation of hotspots, (pollution havens, deterioration of air/water quality, demonstration of no net harm)

- Short and long-term health impacts difficult to characterize
- Different sensitivity of receptors
- Current exposure thresholds level of protection to the most sensitive

Technological - Measurement and monitoring (specific to Coal Plants):

- Uncertainties related to mercury speciation
- Reliability of continuous emission monitors (CEMs) still in experimental stage
- Relationship to coal type variable
- Difficulties in available mercury-specific capture and control mechanisms

Issues with Respect to Emissions Trading Mechanisms:

- Who regulates the system and sets the value of permits?
- How is the true 田osts of permits assessed and what factors are considered?
- Allocation of permits (Grand-fathering, Auctioning) - potential impacts
- Banking and retiring allowances-mechanism
- Potential for Inter-year trading[123] ?
- Exceedance of cap impact on timelines to meet reduction targets
- Confined to one sector or cross-sectorial?
- Purchasers of allowances how to ensure prevention of environmental degradation
- Potential disincentive for installation of improved technology to decrease mercury emissions, particularly older facilities

Other Concerns:

- Potential conflicts with national, international agreements/commitments that specify percent reductions in specific regions, goal of 砺 irtual elimination
- Not comparable to f other pollutants/substances 鍍raded (e.g., SO_2, NOx, CO_2)
- Not amenable to trading within one nation - If elemental mercury is considered as global pollutant, international agreements would be required for trading
- The U.S. MACT rule does not account for trading mercury
- Impact of increase in capacity (generation of electricity by coal
- Will the trading in SO_2 and NOx be adversely impacted by **not** having trading in mercury emissions[124] ?

[123] Refers to time constraints between the year a credit is created and bought or used at a later time.

ii) Specific Responses of Note

Below are two responses from the ENGO community that are unique in the nature and scope. Other responses and comments are found in Appendix B.

i) Ecology Action Centre, Nova Scotia - Jim White , Economist

Emission permit trading schemes have been held in theory to provide flexibility to industry in reaching toward achieving reductions of emissions to some level set by a regulatory authority. Such schemes are held out as reducing the economic cost of compliance with regulated levels. However, a great many important questions and considerations arise in moving from the theoretical economic idea to an operational regime for a particular pollutant or industry, such as: how regulated levels of pollution are set and then monitored for compliance; and how permits are initially distributed (for example, allocated on historical patterns, auctioned in an open market or closed market). Overall, the central questions surround whether a permit scheme is seen as sanctioning pollution, actually reduces pollution and provides incentives to prevent pollution and reduce pollution (further). The devil is in the details.

Depending on the specific details of the scheme, it may act merely to shift pollution from one area to another with the attendant questions of equity and distribution of income (environmental amenities). In some instances, the effect of the scheme could be to prolong use of and extend the life of a highly polluting facility and equipment to the benefit of its owners and shareholders at the detriment of the rest of society and the environment. Permit trading may well delay introduction of abatement and/or retirement of old plants.

In the case of a highly toxic substance such as mercury, a tradeable permit scheme would seem to sanction the emissions of the poison. The health effects upon human and animal species are severe and well known and while assignment of a monetary value to damage will likely remain controversial and unknown, it cannot be used in any calculus in calculating the benefits, in monetary terms, of the more certain costs of abatement of mercury emissions from anthropogenic sources. An auction of rights to permit mercury emissions will result in a market price of permits which reflects the value to would-be emitters of their emissions and the costs to them of reducing such emissions. The price of the permit would not reflect the cost to human health or to the health of other animal species.

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[124] For example, if a facility generates credits through a reduction in a tradeable pollutant (e.g., SO_2, NOx), the facility that purchase these allowances will likely increase mercury emissions (depending on it coal type, existing controls, etc.)

The benefits from being permitted to emit mercury are concentrated while the costs are highly diffused (e.g., effect upon wild food sources used by northern First Nations and Inuit). To eliminate anthropogenic sources of mercury emissions through a permit scheme would require a permit price high enough for there to be no benefit to a would-be polluter. The ratchetting down of the quantity of permits for a set amount of emissions is an action by the regulating authority and so amounts to a command and control approach.

Given the toxic nature of mercury, the precautionary principle should be invoked and a command and control approach sought in dealing with mercury (anthropogenic sources) in accordance with agreements requiring virtual elimination of anthropogenic sources of mercury emissions and with the principles of CEPA.

ii) Great Lakes United (GLU) - Resolution on Mercury Emissions Trading

Great lakes United (GLU) is a non-profit non-government coalition consisting of over 170 organizations from United States and Canada in the Great Lakes Basin[125]. By virtue of a resolution, GLU has adopted as policy with respect to emissions trading of mercury that states the following: 典herefore be it resolved that Great Lakes United opposes the trading of any mercury emissions and reaffirms its support for the virtual elimination of the human use, generation and release of anthropogenic sources of mercury to the environment [126]. This policy is binding on all its membership groups. The full text of the resolution is in Appendix B.

[125] The membership of GLU is diverse and includes environmental organizations, First Nations and Tribes, Labour and Conservations Groups as well as individuals.

[126] The resolution was adopted at the GLU Annual General Meeting held June 8, 2003.

E. Concluding Remarks

Clearly, the trading of mercury emissions is a highly controversial and challenging issue with divergent views from a number of quarters. It brings to the forefront the ethical and moral question of engaging in 杜arket strategies as a mechanism to address the 杜anagement of toxic substances, in this case one of the most pervasive toxic substances known. It has been compared to a traveller without a passport that spreads around the world in air and water [127] causing damage in its wake for years to come, adding to the global pool, eluding capture.

How does one even begin to attribute a 都ocial cost to this substance? In granting permits to emit mercury to facilities, does the cost of the permits reflect the costs and damage for present and future generations? If the price of the permits are set sufficiently high to reflect the nature and impact of the substance, then what trades will ensue? And what then, becomes the incentive to reduce emissions or retire old (grandfathered) plants?

When it comes to mercury, an indestructible element, do we have a 杜oral or 兎thical right to inflict and continue to inflict this toxin on vulnerable innocent communities and on the ecosystem? Can we disregard the impact of emissions of toxic substances from an industrial setting in regions such as the Arctic? And as I write this paper, arguments prevail as to a 都afe level of exposure to mercury in attempts by some parties to derail the U.S. EPA cautionary reference dose and lower the bar of protection for the most sensitive populations, thereby lessening potential requirements to reduce mercury emissions. This is most disturbing.

International agreements and assessments of mercury sound the alarm of the sheer magnitude of the increasing presence of mercury in the environment since industrialization and speak to the need to reduce anthropogenic emissions of mercury significantly, in some cases, to virtually eliminate anthropogenic releases of mercury. While these agreements and commitments are silent on emissions trading of mercury, it may be that the very concept did not enter into discussion. One may very well question whether the very nature of this topic is in direct conflict with the intent and essence of these agreements and commitments.

For Canada, what is the consequence of mercury emissions trading if initiated in the U.S.? Will Canada be obligated to embrace emissions trading of mercury if Clear Skies or some form of a mercury-trading regulation? Are we not more affected by such trading mechanisms, considering our Arctic lands, for example? How will Canada reassure its residents, native communities, and

[127] Quote from Dr. Klaus Toepler, Executive Director of UNEP, March 2003

women of childbearing age that they will not be harmed, that their communities will not become a haven for mercury pollution[128]? These very same questions apply on a global scale as well.

Taking it to another level, one needs to look at the potential fallout resulting from increased exposure to methylmercury (the most toxic and most common form of human exposure to mercury) on the family, the care and nurturing required, loss of livelihood, the community, habitat, local food sources for many, many years. Perhaps that is the question to first ask and decide whether the path of emissions trading is on a collision course with the need for reduction in and prevention of anthropogenic mercury emissions as has been so often stated and re-stated around the world. Then the question of trading in mercury emissions is truly moot.

In conclusion, the mere consideration of the possibility of trading a toxin such as mercury is akin to embarking on a journey into the unknown, where the path is riddled with obstacles and the outcome 都hrouded in uncertainty. It may well be akin to striking a Faustian bargain.

For all the complexities and issues raised, from practical to ethical matters, the environmental community has no appetite for and cannot support trading in mercury emissions and strongly advices Canada to not go down that road.

[128] Canada has yet to finalize a cautionary (other than a provisional) "safe-level" of exposure to mercury for the most vulnerable. It has not adopted the U.S. reference dose (Canada's provisional level is twice that of the U.S. for the most vulnerable).

Appendices

A. Survey Mercury Emissions Trading

Note: The following questionnaire has been circulated for the past year in Canada and the U.S. (since September 2002) to a number of ENGOs and others (academics) to solicit views and engage in discussion on the topic of emissions trading of mercury.

Introduction

A very controversial issue has emerged with respect to mercury and coal-fired plants namely, the creation of an emissions trading scheme for mercury as an incentive to reduce mercury emissions, in particular from coal-fired plants. The 鼎lear Skies Initiative an Act initially proposed in 2002 by the Bush administration to reduce emissions of SO_2, NOx and mercury from coal-fired plants, has been re-introduced into both the House of Representatives and the Senate in February 2003. Clear Skies is a cap-and-trade 3-pollutant bill that incorporates emissions trading for all three pollutants, including mercury as its main tenet. The potential for Clear skies passing into legislation has become more likely now with the Senate Republican majority, making the prospect of trading in mercury emissions more of a reality. There is a fair amount of activity on this topic in the U.S., particularly from marketers, consultants, and governments. Clear Skies has ramifications for Canada as well.

The following survey is designed to solicit opinions on emissions trading of mercury from coal-fired plants from individuals and environmental organizations across Canada and the US. The responses and comments will be compiled in preparation of a position paper on this topic. Your response would be greatly appreciated.

Please indicate the following:

1) What is your view on emissions trading of mercury emissions?

a) Support b) Support with caveats c) Interested in exploring the possibilities

d) Have concerns about the concept e) Do not support trading mercury emissions

f) Don't know anything about the topic g) Other

2) Provide any comments, reasons, opinions, suggestions on this matter.

Name Organization

3) Are you representing your own view or that of your organization or both?

Please return this "questionnaire" within two weeks if possible. You may send this to me directly or to the list-serve. Confidentiality of views is respected if so requested.
Thanks so much and looking forward to hearing from you,

Anna Tilman

B. Comments from Survey (Appendix A)[129]

Great Lakes United (GLU) - Resolution on Mercury Emissions Trading

Whereas mercury in its various forms is a Persistent Bioaccumulative Toxin (PBT), exhibiting neurotoxicity and fetotoxicity, posing risks to susceptible populations, in particular the developing fetus, children, women of child-bearing age, native populations, in addition to plants, fish and wildlife, and

Whereas the contamination of fish from methylmercury, the most toxic form of mercury, have deprived wildlife, communities, and the public-at-large from a valuable, nutritious, readily-available food source and is the cause of 95% of the fish advisories in the Great Lakes Basin, and

Whereas Canada and United States are participants in international and bi national agreements that seek to address significant reductions and elimination of anthropogenic sources of mercury, and

Whereas the Parties to the Great Lakes Water Quality Agreement (GLWQA) in cooperation with the Great Lakes states and provincial jurisdictions have committed to virtual eliminate [130] the input of persistent toxic substances, including mercury, to the Great Lakes system in order to protect human health and to ensure the continued health and productivity of living aquatic resources and human use, and

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[129] Refer to section D p.12-18 for additional comments. *Names of individuals are given upon permission.*

[130] **Virtual elimination** as articulated by the International Joint Commission refers to **use, generation and release** of such substances by encouraging and implementing strategies consistent with the philosophy of zero discharge.

Whereas the 1997 Great Lakes Binational Toxics Strategy (BNS) [131] establishes a process to work toward the virtual elimination of specific persistent bioaccumulative toxic substances, including mercury, from the Great Lakes Basin, and

Whereas pollution prevention is considered the cornerstone to achieving reduction in anthropogenic mercury, and

Whereas the Bush Administration has proposed the Clear Skies Act 2003 which initiates a cap-and-trade system for mercury emissions from coal-fired plants,

Therefore be it resolved that Great Lakes United opposes the trading of any mercury emissions and reaffirms its support for the virtual elimination of the human use, generation and release of anthropogenic sources of mercury to the environment.

Mewassin Community Action Council, Alberta: 泥oes not support trading mercury emissions gives the appearance of taking action or addressing the problem. It would offer the industry the lowest cost option for the short term while delaying government regulatory action as long as possible. This approach does no good for people living near power plants or in surrounding areas, not to mention local watershed impacts and overall global impacts.

CleanNewfoundland, (Linda Whalen)**:** No support (view of individual and organization)

Emissions trading in general does not improve conditions in the local environment. As well, it permits industry to pay its way out of serious pollution prevention requirements by purchasing credits to continue to pollute rather than investing in phase-outs, mitigation or clean-up. Even if government has decided to go the route of emissions trading, it is not acceptable in the case of mercury, as the objective here, given the extreme toxicity of the substance and its grasshopper effect on the northern environment should be virtual elimination.

Citizen痴 Waste Council, Ontario (John Jackson):

Does not support emission trading.

忍missions trading means that we do not maximize reductions. It means that the areas where pollution is currently worst tend to continue to be the ones where improvements are not made because they are the out of date plants and the expensive ones to upgrade. It fosters the idea that money can be exchanged for the right to pollute. This is wrong.

[131] The Strategy is in keeping with the objectives of the 1987 Great Lakes Water Quality Agreement (GLWQA).

Dr. Donald McKay, (Professor Emeritus Trent University and University of Toronto keynote speaker at the IJC conference, February 2003);
摘missions trading of mercury is obscene. Mercury must be considered as a whole its behaviour and transformation into different species belies a simple approach.

Nova Scotia Allergy and Environmental Health Association Advisory Board, (Sheila Cole)
Does not support trading: 溺ercury emissions need to be controlled at source and diminished by all mitigating means to the point of elimination since there are no safe levels of mercury. Trading, in my opinion, would encourage continuing pollution.

Ecology Action Centre, Nova Scotia, (Jim White)
Does not support emissions trading (see, p. 16, 17 for response)

National Environmental Trust (U.S.), (Tom Natan)**:**
填nder t he Clean Air act Trading in toxics is prohibited. This prohibition should be maintained.

Environment Hamilton, (Lynda Lukasik)**:**
Does not support emissions trading: 渡eed for concerns re geographical disparities, commitments to ratcheting down emissions via trading (trading approach no guarantees)

National Wildlife Federation, Minnesota (Jane Reyer): Does not support trading.
Trading will never eliminate (anthropogenic) mercury emissions completely (view of organization)

Other (private, confidential)
Interested in exploring the possibilities and have concerns about the concept.
擢or sectors where viable alternatives or technological controls are not yet available I am interested in exploring the opportunity of these sectors funding mercury recovery efforts to offset their current emissions, until such time as there are viable alternatives or technological controls available. At this time mercury products are a significant source of mercury pollution but collection programs are non existent and poorly funded. As mercury products are phased out and collected over the next one to two decades we will see a natural sun setting of this source of offsets.

Prairie Acid Rain Coalition, Alberta: Have concerns about the concept

Elliott Energy Services (Ontario): Does not support trading

Clean North, Ontario: (Cecilia Fernandez): Does not support emissions trading.

World Wildlife Fund (Susan Sang): Does not support trading

Sierra Club Canada: Totally opposed to mercury trading (October, 2002)

Sierra Club U.S. has adopted a **no trading position** that extends to non-toxic emissions.

C. Clear Skies 2003 - Details

Clear Skies Act 2002/3, an initiative proposed by the Bush administration establishes a mandatory new cap-and-trade program requiring reductions of sulphur dioxide, nitrogen oxides, and mercury emissions from all fossil fuel electric generators > 25 MW[132]. Mercury requirements are applicable only to coal-fired facilities. The following table lays out the caps and targets.

Clear Skies, 2002/3[133]

Pollutant	Actual Emissions 2000 - tons	Phase 1 Caps - tons	Phase 2 Caps - tons	Reduction from 2000 %	EPA Projected Emissions* 2020 –tons
SO_2	11.2 million	4.5 million - 2010	3 million in 2018	73	3.9 million
NOx	5.1 million	2.1 million - 2008	1.7 million in 2018	67	1.7 million
Mercury	48	26 in 2010**	15 in 2018	69	18

* This column reflects EPA痴 projections of actual emissions that are expected to exceed the caps due to the mechanics of emissions trading and banking of credits.

** As of November 2003, the 26 ton cap has been increased to 34 tons.

New allocation procedures for allowances for SO_2 and NOx (and mercury) emissions are to be implemented in 2010 and 2008 respectively, in transition to an auctioning mechanism. Compliance to hold allowances covering emissions of all 3 pollutants are determined on a facility-wide basis.

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[132] Clear Skies was first introduced into Congress by Senator Smith, February 2002. It was re-introduced February 2003. Clear Skies amends Title IV also amends Title 1 of the Clean Air Act by providing an alternative regulatory classification for units subject to cap-and-trade programs. Refer to http://www.epa.gov/air/clearskies/fact2003.html

[133] The information presented here reflects EPA's modeling of the Clear Skies Act of 2002. The Agency is in the process of updating this information to reflect modifications included in the Clear Skies Act of 2003.

Appendix C - ACRONYMS, UNITS and ABBREVIATIONS

Note: This list is more extensive than the abbreviations contained in this report

ACI	-	Activated Carbon Injection
APCD	-	Air Pollution Control Device
BACT	-	Best Available Control Technology (US)
BAT	-	Best Available Techniques
BATEA	-	Best Available Technology Economically Achievable
BNS	-	Binational Toxics Strategy (Great Lakes)
Btu/hr	-	British thermal unit per hour (equivalent to 0.293 watts)
^{o}C	-	degrees Celsius
CAA	-	Clean Air Act (U.S.)
CAAA	-	Clean Air Act Amendments (1990)
CAC	-	Criteria Air Contaminants
CCME	-	Canadian Council of Ministers of the Environment
CASA	-	Clean Air Strategic Alliance (CASA)
CCR(s)	-	Coal Combustion Residue(s)
CCS	-	Cold Creek Station (power plant)
CDC	-	Centers for Disease Control and Prevention (US)
CEMs	-	Continuous Emissions Monitoring System
CEPA 99	-	Canadian Environmental Protection Act, 1999
CH_3-Hg	-	Methylmercury
CMMs	-	Continuous Mercury Monitors
COHPAC	-	Compact Hybrid Particulate Collector
CO	-	Carbon Monoxide
CO_2	-	Carbon Dioxide
CS-ESP	-	Cold-Side ESP
CSI	-	Clear Skies Initiative (act proposed by the Bush Administration)
CWS	-	Canada-wide Standards
DC	-	Development Committee of the CWS
DNR	-	Department of Natural Resources (Wisconsin)
DOE	-	Department of Energy (United States)
DSI	-	Dry Sorbent Injection
EC	-	Environment Canada
ECO	-	Electro-Catalytic Oxidation
EEI	-	Edison Electric Institute
EERC	-	Energy and Environmental Research Center
ENGO	-	Environmental Non-Government Organization
EPA	-	Environmental Protection Agency (United States)

EPG	-	Electric Power Generation (Generating)
EPRI	-	Electric Power Research Institute
ESP	-	Electrostatic Precipitator
^{o}F	-	degrees Fahrenheit
FBC	-	Fluidized Bed Combustion
FF	-	Fabric Filter
FGD	-	Flue Gas Desulphurization
FSW	-	Fuel-Switching (to natural gas)
g	-	gram
GC	-	Governing Council, United Nations Environmental Programme
GHGs	-	Greenhouse Gases
GLU	-	Great Lakes United (Canada-US ENGO)
GLWQA	-	Great Lakes Water Quality Agreement
GWh	-	Gigawatt-hour (1000 MWh)
HAP(s)	-	Hazardous Air Pollutant(s)
Hg	-	mercury
Hg^{0}	-	gaseous elemental or metallic mercury,
Hg_2^{1+}	-	mercurous ion (monovalent mercury)
Hg^{2+} or Hg^{++}	-	mercury II (mercuric ion, divalent mercury, oxidized/ionic form)
Hg_p	-	particle-bound mercury
Hg_T	-	total mercury
HS-ESP	-	Hot-Side ESP
ICR	-	Information Collection Request
kg	-	kilogram (1000 grams)
kWh	-	kilowatt-hour
lb	-	pound (0.454 kg)
lb/Btu	-	pounds per British Thermal Units (emission rate)
LSD	-	Lime Spray Drying
LSFO	-	Limestone Forced Oxidation (wet scrubbing)
MACT	-	Maximum Achievable Control Technology
MAG	-	Multi-stakeholder Advisory Group
MBtu	-	Million British Thermal Units (293 MWh)
mg	-	milligram (one-thousandth or 10^{-3} grams)
ìg	-	microgram (or 10^{-6} grams)
MW	-	Megawatt (million Watts)
MWh	-	Megawatt-hour
NAAQS	-	National Ambient Air Quality Standard
NACEC	-	North American Commission for Environmental Cooperation
NARAP	-	North American Regional Action Plan
NAFTA	-	North American Free Trade Agreement

NAS	-	National Academy of Sciences
N.B.	-	New Brunswick
NEG/ECP	-	New England Governors/Eastern Canadian Premiers
NESCAUM	-	NorthEast States for Coordinated Air Use Management
NETL	-	National Energy Technology Laboratory (DOE)
NGO	-	Non-Government Organization
NH_3	-	Ammonia
NO_x	-	Nitrogen Oxides
NPRI	-	National Pollutant Release Inventory
NRDC	-	Natural Resource Defence Council (U.S ENGO organization)
NRC	-	National Research Council (US)
NSPI	-	Nova Scotia Power Incorporated
NSPS	-	New Source Performance Standards (US)
NSR	-	New Source Review (US)
N.S.	-	Nova Scotia
NY	-	New York
OECD	-	Organization for Economic Cooperation and Development
OH	-	Ontario Hydro
OMB	-	Office of Management and Budget (US)
OPG	-	Ontario Power Generation
PAC	-	Powdered activated carbon
PC	-	Pulverized coal
PCBs	-	Polychlorinated biphenyls
pg	-	picogram (10^{-12} gram)
PJFF	-	Pulse-Jet Fabric Filter
PM	-	Particulate Matter
PM_{10}	-	Particulate Matter less than 10 microns in diameter
$PM_{2.5}$	-	Particulate Matter less than 2.5 microns in diameter
POP(s)	-	Persistent Organic Pollutants
ppb	-	parts per billion
ppm	-	parts per million
PRB	-	Powder River Basin coal
PS	-	particulate scrubber
RfD	-	Reference Dose (US)
RTC	-	Report to Congress
SC	-	spray cooling
SCR	-	Selective Catalytic Reduction
SD	-	Spray Dryer
SDA	-	Spray Dry Absorber
SDS	-	Spray Dry Scrubbing

SNCR	-	Selective Non-Catalytic Reduction
SO_2	-	Sulphur dioxide
TDI	-	Tolerable Daily Intake (Canada)
TiO_2	-	Titanium oxide
Ti/V	-	Titanium/vanadium oxides (catalysts)
ton	-	2000 lb (0.908 tonnes)
tonne	-	1000 kg (1.10 ton)
TRI	-	Toxics Release Inventory (US)
UNEP	-	United Nations Environment Programme
US (U.S.)	-	United States
US EPA	-	US Environmental Protection Agency
V_2O_5	-	Vanadium pentoxide
WE	-	Wisconsin Electric Power Company
WFGD	-	Wet FGD (also called LSFO)
WHO	-	World Health Organization