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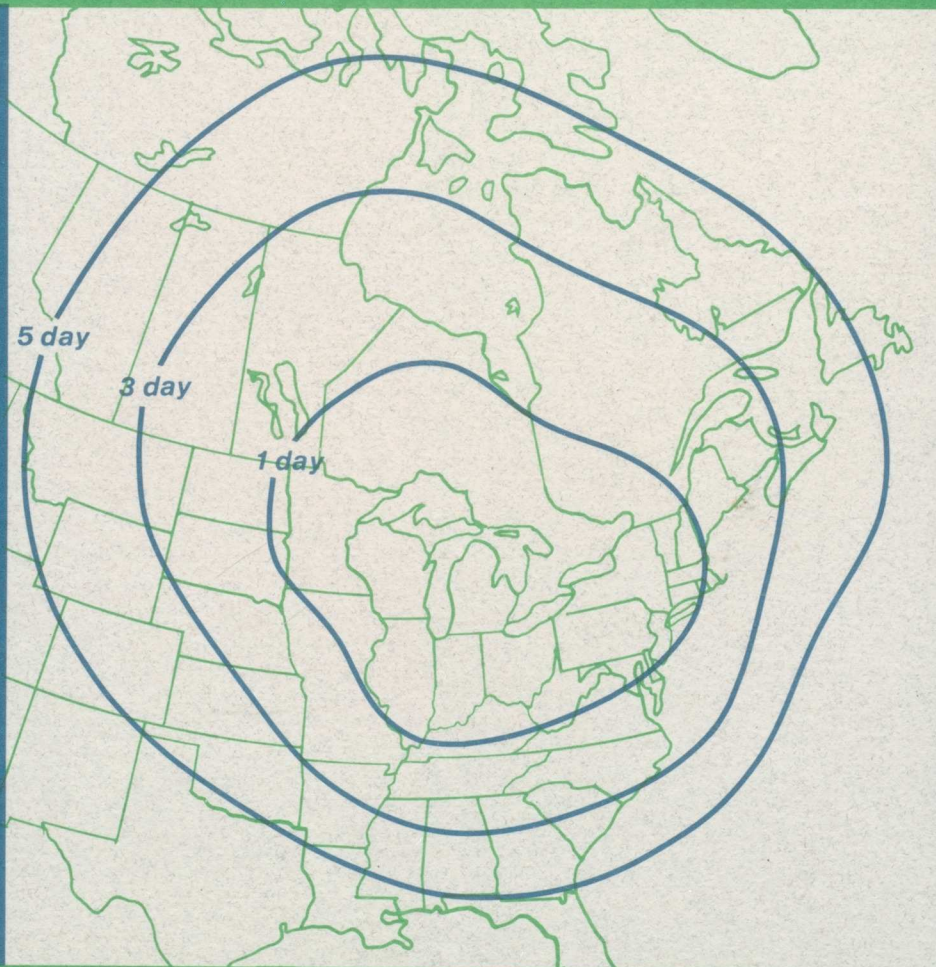


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# International Air Quality Advisory Board

## Progress Report 25 to the International Joint Commission



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April 2000



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## 1.0 EXECUTIVE SUMMARY

### 1.1 Introduction

Over the past several years, the International Air Quality Advisory Board (IAQAB) has been concerned with all aspects of air pollution on both sides of the US-Canada border that have an impact on transboundary pollution transfer. Topics considered include the control of ozone and fine particulate (PM<sub>2.5</sub>) formation; acid rain emissions and deposition; mobile source emissions from vehicles of all types; emissions of persistent toxic substances and the possible impact of global climate change. The evolution of air pollution standards in both countries has also been traced by the Board .

This report emphasizes the complexity of many of the air pollution issues that exist on both sides of the border, and the continuing adjustments and changes that will be required if the transboundary transfer of air pollutants is to be reduced. Several recommendations are put forward by the Board for consideration by the International Joint Commission.

The Board has also completed more detailed work on the emissions, transport and deposition of dioxin to the Great Lakes basin, while cataloguing emissions and control efforts applied to other persistent toxic substances under Annex 15 of the Great Lakes Water Quality Agreement. This work can be viewed on the IAQAB website at <http://www.ijc.org/boards/iaqab/index.htm>. A printed report, describing the transport and deposition modeling effort as one of the 1997/99 Great Lakes Priority activities, can be obtained from the IJC Great Lakes Regional Office.

### 1.2 Synopsis of Board Comments and Recommendations on Recent Significant Developments

#### 1.2.1 Ozone and Particulate Matter

Among the significant developments since Progress Report 24 is the beginning of *negotiations on an Ozone Annex under the Canada/United States Air Quality Agreement*. At a recent first meeting, representatives of the United States and Canada agreed to work toward a signed agreement by the end of the year. The Board will track subsequent negotiations over the next several months and advise the Commission as appropriate.

The development of *Canada-wide Standards for ozone and fine particulate* by the federal and provincial environment ministers, scheduled for completion by June of 2000, is reviewed and the Board recommends the Commission **encourage the Canadian Council of Ministers of the Environment (CCME) to adopt, during this year, a Canada-wide Standard for ozone of 65 ppb, 8 hour average, to be attained no later than the year 2010.**



An update on the evolving issues of comparability of fine particulate measurements taken using the US Federal Reference Method and those obtained by the different prevailing Canadian protocol is also provided.

Developments with regard to *revised standards for ozone and fine particulate in the United States* are also described, particularly the impact of recent Federal Court decisions remanding these standards. In view of the court action, the United States Environmental Protection Agency (USEPA) has proposed reinstatement of the 1 hour ozone standard in nearly 3,000 counties. The agency will also be requesting that 10 major urban centers revise their smog reduction plans.

### 1.2.2 Acid Gas Emissions (SO<sub>2</sub> and NO<sub>x</sub>)

*Commitments by both countries to reduce acid rain emissions are reviewed.* With respect to stationary sources, the focus is on emissions from utilities. The USEPA action, supported by some states and the Province of Ontario, against 'grandfathered' coal fired utilities excluded from upgrades in emission control systems in the Clean Air Act Amendments of 1970 and 1977 is reviewed, as is the status of the USEPA NO<sub>x</sub> State Implementation Plan call, which recently withstood a challenge in Federal court by a number of states. The Agency response to petitions under Section 126 of the US Clean Air Act from downwind (largely New England) states against acid gas emissions in several upwind states is also summarized.

**Table 1: Ontario Strategic Attack on Air Pollution**

<b>Emission Caps</b>			
<b>Pollutant</b>	<b>Current Cap</b>	<b>Proposed Cap</b>	
Nitrogen Oxide (NO)	38 kt/yr NO (58 kt/yr NO <sub>2</sub> )	36 kt/yr NO (55 kt/yr NO <sub>2</sub> )	
Sulphur Dioxide (SO <sub>2</sub> )	175 kt/yr	157.5 kt/yr	

<b>Emission Performance Standards</b>			
<b>Pollutant</b>	<b>Ontario</b>	<b>Conversion to lbs/mmBTU</b>	<b>U.S. EPA Benchmark</b>
Nitrogen Oxide (NO)	1.3 kg/MWh	1.3 kg/MWh - 0.266 lbs/mmBTU	-
Nitrogen Oxide (NO <sub>2</sub> )	2.0 kg/MWh	2.0 kg/MWh - 0.41 lbs/mmBTU	0.15 lbs/mmBTU

Note: The conversion factor found in the U.S. EPA's NSPS, for both utility and industrial steam generating units, is stated as 0.15 lbs NO<sub>x</sub>/mmBTU input, equivalent to 1.6 lbs NO<sub>x</sub>/MWh gross output (Source: Coal Boiler Mercury Control Technology Options and Reductions Targets, Joint Coal Boiler Workgroup New England Governors/Eastern Canadian Premiers Conference).



The Ontario *Strategic Attack on Air Pollution* is also reviewed, and summarized in Table 1. The Province is proposing to cap NO (not NO<sub>x</sub>) emissions from oil and coal fired utilities at 36 kilotonnes per year by 2001 (from the current cap of 38 kt/year) and an SO<sub>2</sub> emissions cap at 157.5 kt/yr by the year 2001 (from 175 kt/year currently). Emissions Performance Standards (in kg per megawatt for NO and SO<sub>2</sub>) are proposed for individual oil and coal fired facilities. Those for nitrogen species do not appear as aggressive as the benchmark used by the USEPA for such facilities. An emissions trading system for these gases is also proposed.

**With respect to the Ontario Strategic Attack on Air Pollution, the Commission should recommend:**

- i. the inclusion of gas fired units within any nitrogen oxides cap for Ontario electrical generation facilities;**
- ii. rather than the current cap of 36 kt/year on NO emissions, a commitment to a lower cap of 21.6 kilotonnes/year from all combustion electrical generation facilities consistent with application of the USEPA NO<sub>2</sub> performance benchmark for such facilities of 0.15 lb of NO<sub>2</sub>/mmBTU (0.65 kg/MWh);**
- iii. an acceleration of the province-wide, multi-sectoral programs for SO<sub>2</sub>, NO<sub>x</sub>, and VOCs to an attainment year of not later than 2010, with ongoing and careful review to determine if reduction actions are adequate to meet air quality objectives; and,**
- iv. that the use of emissions trading not allow total SO<sub>2</sub> and NO<sub>x</sub> emissions to exceed the province-wide targets established by Ontario. The Commission should encourage that any emissions trading system for SO<sub>2</sub> and NO<sub>x</sub> deployed by any government, including Ontario, include limits on the distance and direction of sources traded with and, with regards to NO<sub>x</sub> emissions, additional actions outside the trading processes to deal with seasonal variability and the amelioration of short term episodes.**

The new US Tier 2 *mobile source standards*, including reductions in sulfur in gasoline and emissions of SO<sub>2</sub>, NO<sub>x</sub> and particulate matter are reviewed. The projected impact of NO<sub>x</sub> controls on mobile sources over the next several years is shown in Table 2. The Canadian government will promulgate comparable standards within the same timeframe with attainment in 2007. The US sulphur in gasoline standard is comparable to the current Canadian regulation.



**Table 2: Reductions from US Tier 2 Mobile Sources Regulations**

NO <sub>x</sub> Category	Base Case (annual emissions)			Control Case			
	1996	2007	2030	2007	% Red.	2030	% Red.
Stationary and Area	11,768,720	8,690,766	8,765,165	8,690,766	–	875,165	–
Non-road Vehicles	6,215,200	5,950,291	5,675,190	5,950,291	–	5,675,190	–
HD & MC Highway	2,372,476	1,484,071	1,286,233	1,452,562	–	1,251,626	–
LD Highway	3,908,147	3,095,698	3,704,747	2,239,227	27,667	909,196	75,459
Total Highway	6,280,624	4,578,769	4,990,979	3,691,688	–	2,160,821	–
Total Inventory	24,264,544	19,220,826	19,431,355	18,322,746	4,620	16,601,177	14,565

Source: EPA - Notice of Final Tier 2 Rulemaking, December 21, 1999.  
Forty-seven state non-attainment area, FRM Inventory, annualized season tons.

Note: HD - heavy-duty, MC-medium class, and LD = light-duty

The Board draws particular attention to the human health effects of *fine particulate emissions from diesel engines*, especially the issue of carcinogen risk. It notes that improved particulate emission control technology will require reductions in sulphur fuel content, similar to those recently required in gasoline, and concludes that **the Commission should recommend that the governments of the United States and Canada move to adopt standards limiting the sulphur content of diesel fuel, so as to enable the introduction of advanced, reliable and durable high level control systems for NO<sub>x</sub> and particulate matter on diesel engines. These sulphur standards will likely lead to a diesel fuel with an estimated 5 ppm sulphur content. The infrastructure to produce and deliver this fuel must be place in the year 2006 to support emission standards applicable to the 2007 model year vehicles.**

### 1.2.3 Climate Change

Further detail on measured phenomena and possible impacts of *climate change* are examined in some detail, along with a few possible mechanisms for various countries to meet their commitments to green house gas reductions under the Kyoto Protocol. The emergence of a market for trading in greenhouse gas emissions and the involvement of the World Bank in such efforts are also described.



#### 1.2.4 Toxic and Persistent Toxic Substances

The Board also considers the issue of *toxic and persistent toxic emissions and releases*. It notes that the newly enacted requirement for US utilities to report on toxic emissions under the Toxics Reduction Inventory (TRI) will make that sector the most significant source of total toxic substances released. *Emissions of mercury*, a persistent toxic substance, from sources in United States and Canada are reviewed in some detail. Regarding US sources, consistent with the Board's earlier concern about the effect of deregulation on the utility sector, the focus is on mercury emissions from the coal fired portion of that sector. The Board notes that a multi-pollutant control strategy for mercury, acid gases, fine particulate, and perhaps greenhouse gases, is appropriate for these coal-fired utilities. The activities of the New England Governors/Eastern Canadian Premiers and the recommendations of the Commission for Environmental Cooperation for further control of mercury emissions from utilities are both reviewed.

The Canadian commitment to a *proposed Canada-wide Standard for Mercury* is noted; objectives for metal smelting and municipal, medical, hazardous waste and sewage sludge incineration are reviewed. A Canada-wide Standard (CWS) for coal fired utilities is being held in abeyance until at least mid 2000. The Board states that **the Commission should recommend to the Canadian Council of Ministers of the Environment that data on mercury emissions from individual facilities be made available to the public through the CCME website and other means. If absolutely necessary, provisions could be made for the exclusion of process (not emissions) details from this information due to confidentiality agreements; the rationale for doing so should be described.**

The Board also reviews *sources of benzene* in the United States and Canada, considers the level of this compound in gasoline (typically 1 to 1.5%) and describes the proposed action on benzene under the CWS process.

Data indicating that the *uncontrolled residual burning of refuse is a significant source of dioxin and furan and other hazardous contaminants* is examined. The Board recommends that **the Commission should recommend governments recognize the significant contribution of the backyard open burning of trash to the total burden of dioxin on the Great Lakes system, and ensure that the curtailing of this activity will be integrated into plans and strategies to eliminate loadings of dioxin to the Great Lakes.**

Finally, the *status of Methyl Tertiary Butyl Ether (MTBE)*, an additive used in reformulated gasoline to reduce air pollution, which has been implicated in the fouling of water supplies in several states (Progress Report 24), is discussed. The recent announcement by the USEPA of an intention to 'significantly reduce or eliminate' MTBE use in gasoline is also noted.



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## 2.0 SUMMARY OF RECOMMENDATIONS

### Ambient Standards for Particulate Matter and Ozone

1. The Commission encourage the Canadian Council of Ministers of the Environment (CCME) to adopt, during this year, a Canada-wide Standard for ozone of 65 ppb, 8 hour average, to be attained no later than the year 2010.

### Status of Smog and Acid Rain Management Programs

With respect to the Ontario Strategic Attack on Air Pollution, the Commission should recommend:

- i. the inclusion of gas fired units within any nitrogen oxides cap for Ontario electrical generation facilities;
- ii. rather than the current cap of 36 kt/year on NO emissions, a commitment to a lower cap of 21.6 kilotonnes/year from all combustion electrical generation facilities consistent with application of the USEPA NO<sub>2</sub> performance benchmark for such facilities of 0.15 lb of NO<sub>2</sub>/mmBTU (0.65 kg/MWh);
- iii. an acceleration of the province-wide, multi-sectoral programs for SO<sub>2</sub>, NO<sub>x</sub>, and VOCs to an attainment year of not later than 2010, with ongoing and careful review to determine if reduction actions are adequate to meet air quality objectives; and,
- iv. that the use of emissions trading not allow total SO<sub>2</sub> and NO<sub>x</sub> emissions to exceed the province-wide targets established by Ontario. The Commission should encourage that any emissions trading system for SO<sub>2</sub> and NO<sub>x</sub> deployed by any government, including Ontario, include limits on the distance and direction of sources traded with and, with regards to NO<sub>x</sub> emissions, additional actions outside the trading processes to deal with seasonal variability and the amelioration of short term episodes.

### Mobile Sources: Diesel Emissions

1. The Commission should recommend that the governments of the United States and Canada move to adopt standards limiting the sulphur content of diesel fuel, so as to enable the introduction of advanced, reliable, and durable high level control systems for NO<sub>x</sub> and particulate matter on diesel engines. These sulphur standards will likely lead to a diesel fuel with an estimated 5 ppm sulphur content. The infrastructure to produce and deliver this fuel must be place in the year 2006 to support emission standards applicable to the 2007 model year vehicles.



## Toxics and Persistent Toxics

### Mercury

1. The Commission should recommend to the Canadian Council of Ministers of the Environment that data on mercury emissions from individual facilities be made available to the public through the CCME website and other means. If absolutely necessary, provisions could be made for the exclusion of process (not emissions) details from this information due to confidentiality agreements; the rationale for doing so should be described.

### Dioxin

1. The Commission should recommend the governments recognize the significant contribution of the backyard open burning of trash to the total burden of dioxin on the Great Lakes system, and ensure that the curtailing of this activity will be integrated into plans and strategies to eliminate loadings of dioxin to the Great Lakes.



### 3.0 INTRODUCTION STATES AIR QUALITY AGREEMENT ACTIVITY

The International Air Quality Advisory Board (IAQAB) was established by the International Joint Commission (IJC) in 1966 in response to a request to the IJC from the Canadian and United States governments to observe air quality along the boundary between these two countries. Since that time, the Board has provided advice on transboundary air issues by various means, including the preparation of progress reports.

In this, its 25<sup>th</sup> progress report, the Board continues to inform and advise the International Joint Commission on transboundary air quality issues pertaining to the Criteria or common air pollutants - particulate matter, ozone, sulphur dioxide, and nitrogen oxides. Given the Commission's focus on climate change in its report "The IJC in the 21<sup>st</sup> Century," the Board also considers the most recent evidence of warming of the earth's surface and possible associated effects of this phenomenon.

The Board also continues its reporting on the control, transport and deposition of persistent toxic substances with regard to the Great Lakes basin. Its most recent summary on this subject can be found on the Board's website at <http://www.ijc.org/boards/iaqab>. A written summary of transport and deposition aspects of this work is part of the 1997/99 Report on Great Lakes Priorities which is available on the Commission website ([www.ijc.org](http://www.ijc.org)) as well as in printed form through the IJC Great Lakes Regional Office. The Board's Special Report, issued in November of 1998 and also available on the IAQAB website, brought these two themes together as part of its survey of issues of particular interest in specific regions along the boundary.

In this report, the Board reviews and advises on current developments, including consideration of an Ozone Annex by the Canada-United States Air Quality Committee, the evolution of Canada-wide standards (CWS) for particulate matter, ozone, mercury and benzene, the Ontario Strategic Attack on Air Pollution, principally sulphur dioxide and nitrogen oxide control and associated emissions trading provisions, United States Environmental Protection Agency (USEPA) actions on NO<sub>x</sub> emissions, particularly from coal-fired utilities and the status of the NO<sub>x</sub> State Implementation Plan (SIP) call affecting several states, further restrictions on vehicle emissions, including fuel content regulation, consideration of particulate emissions from diesel engines, and discussion of sources of mercury (coal-fired utilities) and dioxin (open residential burning of refuse). As mentioned, climate change indicators and possible effects are also reviewed.



# INTRODUCTION

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## 4.0 CANADA-UNITED STATES AIR QUALITY AGREEMENT ACTIVITY

### 4.1 Update on Ozone Negotiations

On February 16, 2000, Canada and the United States met for their first negotiating session on an Ozone Annex to the 1991 Canada/US Air Quality Agreement, which is intended to reduce the transboundary flow of ozone and ozone precursor pollutants.

The meeting led to an agreement on several issues concerning the Annex, including:

- Timing: obtain a signed agreement by the end of the year 2000;
- Scope: the Annex will target emission source regions in each country that contribute significantly to transboundary air pollution;
- Pollutants: the Ozone Annex would focus on nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOCs) as the major pollutants responsible for the creation of air pollution;
- Elements: the Annex will set emissions targets and implementation schedules including provisions for reporting on relevant emissions and air quality to ensure continued progress towards meeting the goals of protecting human health and the environment.

The Parties will next meet on this Annex in Washington in mid-June.



THE CANADIAN MILITARY AIR QUALITY AGREEMENTS

1.1. The Parties to the Agreement

The Parties to the Agreement are the Government of Canada and the Government of the Province of Ontario, hereinafter referred to as the Parties.

The Parties have entered into this Agreement for the purpose of...

1.2. The Parties have agreed to the following terms and conditions:

1.3. The Parties have agreed to the following terms and conditions:

1.4. The Parties have agreed to the following terms and conditions:

1.5. The Parties have agreed to the following terms and conditions:

1.6. The Parties have agreed to the following terms and conditions:



## 5.0 AMBIENT STANDARDS FOR PARTICULATE MATTER AND OZONE

### 5.1 Canadian Update

At present, Canadians are protected by National Air Quality Objectives, which have served as a basis for development of air quality management plans and international agreements. Use of the objectives by provincial and municipal government has been at their discretion, with some adopting the air quality objectives either as guidelines or as legally enforceable standards.

The existing Canadian government ambient air quality objectives for particulate matter are currently in transition. The National Ambient Air Quality Objectives are still in place for Total Suspended Particulate (TSP), however, as there is no size differentiation, they do not reflect the current scientific understanding of the health effects of particles. Some provinces already have provincial objectives or standards in place for fine particulate (PM<sub>2.5</sub>) and the more coarse fraction (PM<sub>10</sub>) based on observed health effects. Unlike the new Canada-wide Standard, none of these has a specific timeline for achievement or formal reporting or accountability requirements. Prevailing particulate standards in Canada are summarized in Table 3.

**Table 3:** Particulate Standards for Canada

Pollutant	Averaging Time	Permissible Pollutant Concentrations (µg/m <sup>3</sup> )			
		Canadian Objectives	Some Provincial Standards		
		Acceptable Level	Newfoundland	British Columbia	Ontario
Total Suspended Particulate (TSP)	24-Hour	120	120	120	
	Annual	70	-	70	-
PM <sub>10</sub>	24-Hour	-	50	50	50
PM <sub>2.5</sub>	24-Hour	-	25	-	-

Source: Environment Canada, National Ambient Air Quality Standards on PM and Ozone, 1997.

The current air quality objective for ozone was established in 1976 under the Canadian Clean Air Act (CAA), as summarized in Table 4.



**Table 4:** Ozone Standards in Canada

Pollutant	Averaging Time	Permissible Pollutant Concentrations ( $\mu\text{g}/\text{m}^3$ )		
		Acceptable Level	Canadian Objectives	
			Newfoundland	British Columbia
Ozone	1-Hour	82	82	82
	8-Hour	-	-	-

Source: Environment Canada, National Ambient Air Quality Standards on PM and Ozone, 1997.

### 5.1.1 Canada-wide Standards

In January of 1998, the Canadian Council of Ministers of the Environment signed the Canada-wide Harmonization Accord, committing the provincial, territorial and federal governments to the implementation of harmonized programs to address a number of environmental issues.

As one outcome, Canada-wide standards are to be developed for mercury, dioxins and furans, benzene, particulate matter, total petroleum hydrocarbons in soil, and ground level ozone.

### 5.1.2 CWS for Ozone and Particulate Matter (PM)

The Canada-wide Standard (CWS) process considered PM and ozone together because they share common origins and both contribute to the formation of smog. The proposed standards represent a balance between human health and environmental protection and the feasibility and costs of reducing emissions.

Particulate matter and ozone are air pollutants associated with adverse health effects for a significant portion of the Canadian population. Research suggests PM and ozone are non-threshold toxins, that is, there is no concentration or level which can be considered absolutely safe for humans. Other adverse environmental effects include reduced visibility due to PM in the atmosphere and vegetation damage due to abnormal levels of ozone.

Ground-level ozone is a secondary pollutant produced by the chemical reaction of two precursor pollutants: nitrogen oxides ( $\text{NO}_x$ ) and volatile organic compounds (VOC's). Particulate matter can be both a primary and secondary pollutant. Primary particles are emitted directly into the



atmosphere, while secondary particles are formed through chemical reactions involving VOCs, NO<sub>x</sub>s, sulphates, and ammonia.

Ozone is a particular concern in the summer because the sun encourages its formation through reactions of the precursors. While PM is a year-round concern, maximum concentrations in the atmosphere of the finer fractions (PM<sub>2.5</sub>) can also be episodic. These two pollutants and their precursors can be transported considerable distances in the atmosphere; therefore, quantities measured at a given site are frequently a mixture of emissions from local and distant sources.

In November of 1999, the Canadian Environment Ministers accepted, in principle, a number of proposed standards, including standards for particulate matter and ozone. The proposed Canada-wide standard for particulate matter is focused on the fine particulate fraction of PM, smaller than 2.5 microns aerodynamic diameter, known as PM<sub>2.5</sub>.

- the recommended CWS for PM<sub>2.5</sub> is 30 µg/m<sup>3</sup> averaged over 24 hours, and is to be achieved by the year 2010. Achievement is based on the 98<sup>th</sup> percentile ambient measurement annually, averaged over three consecutive years.

The Ministers are also considering two options for the regulation of coarse (PM<sub>10</sub>) Particulate Matter. Option A is a standard of 60 µg/m<sup>3</sup>, averaged over 24 hours, to be achieved by the year 2010. Option B is a standard of 50 µg/m<sup>3</sup>, 24 hour average time, to be achieved by the year 2010.

Individual jurisdictions can continue to apply their existing air quality guidelines for the coarser fraction of PM to guide management actions.

- the recommended CWS for ozone is 65 ppb, averaged over 8 hours and based on the 4<sup>th</sup> highest annual measurement averaged over three years, to be achieved by the year 2015.

The Ministers are also considering two options with regard to the ozone standard of 65 µg/m<sup>3</sup>, 8 hour averaged time; Option A, achievement by the year 2012 or Option B, introduction of the standard in 2010.

As part of the implementation strategy for these two contaminants, the governments will strive to maintain air quality through use of best available economically feasible technologies on new sources and upgrades to existing sources in those areas currently below the proposed standards. The governments will also aggressively pursue further reductions in the transboundary flow into Canada of PM and ozone and their precursor pollutants.

For those areas where continuous excessive concentrations are primarily due to transboundary flow of PM and ozone or their precursor pollutants from the United States or from another province or territory, given that "best efforts" have been made to reduce the contribution of sources within the jurisdiction, these areas will be identified as "transboundary influence



communities," unable to achieve the standards until further reductions in transboundary flow occur. *In particular, for the Province of Ontario, a 45 per cent reduction in NO<sub>x</sub> and VOC emissions from 1990 levels by the year 2015 will be considered the province's appropriate level of effort toward achieving the standard, and any remaining ambient ozone levels above the standard will be considered a product of transboundary flow from the US of ozone and its precursor pollutants.*

By the end of the year 2005, additional scientific, technical, and economic analyses are to be completed and available for possible establishment, revision or supplementing of the PM and ozone standard for the year 2015, as appropriate. Any need for revision to the standards is to be determined by the end of the year 2010. The Ministers are also considering a shortened review period to either the end of the year 2004 or the year 2003.

Reporting under the standards is to begin with comprehensive reports at five year intervals beginning in the year 2006, with annual reports to commence in the year 2011. The annual reports will be limited in scope, containing summary information on PM and ozone and identifying communities where ambient levels are exceeding or approaching the CWS levels.

Five year reports will be comprehensive, including assessment of ambient levels and trends in communities and identifying those where levels are exceeding or approaching the standards, information on PM and Ozone precursor emissions and trends, description of smog management efforts, progress with implementing established plans, and actions to maintain 'clean' areas.

Achievement of the standards will be based on *community oriented monitoring sites*, that is, sites where people live, work and play, rather than at the expected maximum impact point for specific emission sources.

The final determination on these standards is expected to occur at the next meeting of the CCME in June, 2000.

## **Recommendation**

**The Commission encourage the Canadian Council of Ministers of the Environment (CCME) to adopt, during this year, a Canada-wide Standard for ozone of 65 ppb, 8 hour average, to be attained no later than the year 2010.**

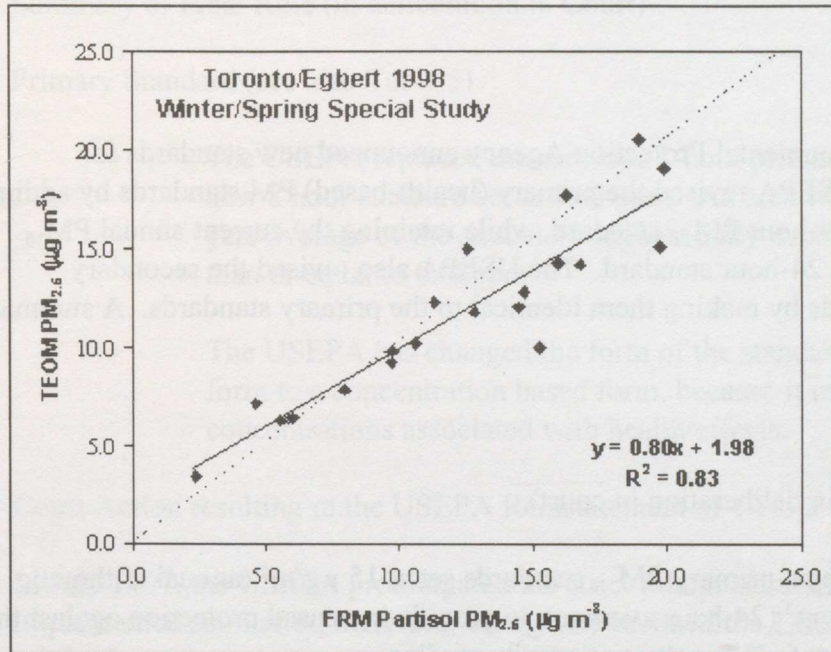
### 5.1.3 Comparison of US and Canadian PM<sub>2.5</sub> Measurement Methods

In reviewing the evolution of the fine particulate (PM<sub>2.5</sub>) regulations in the United States, the Board noted in previous reports that the United States Environmental Protection Agency (USEPA), through its Federal Reference Method (FRM) for the measurement of fine particulate concentrations, established instrumentation distinctly different from that used for such measurements in Canada - the TEOM or Tapered Element Oscillating Balance Monitor. The



issue of comparability or correlation between measurements derived from these two techniques was seen as of continuing import in the coming years as environmental agencies attempt to compare fine particulate data from sites adjacent to the international boundary or within the influence of the other country.

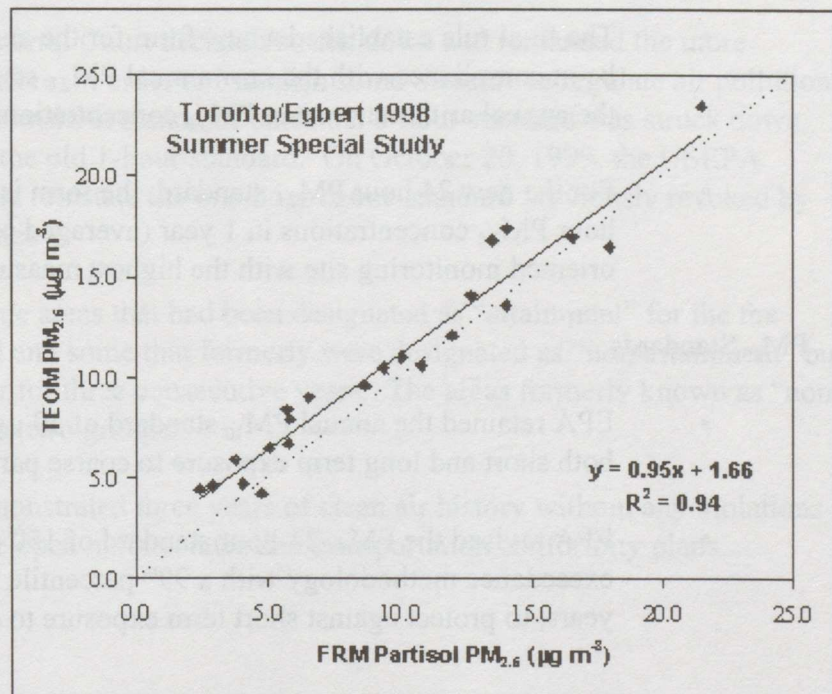
**Figure 1:** Toronto/Egbert 1998 Winter/Spring Special Study



While US/Canada co-operative studies are proceeding at sites in the Canadian Maritimes and Saskatchewan, it is worth noting that the Canadian agencies use a number of instruments for this measurement - the TEOMs, as mentioned - but also manual instruments that are generally equivalent to those described in the FRM protocol. Data are available from a location where these two types of instruments (the TEOM and the FRM Partisol sampler)

have been measuring fine particulate, and, as the graphs indicate, in the Toronto/Egbert Winter/Spring 1998 Study (Figure 1) and Spring/Summer 1998 study (Figure 2), comparison between the two methodologies was reasonably good.

**Figure 2:** Toronto/Egbert 1998 Summer Special Study





Preliminary indications are that, while no simple correlations can be applied to the two measurement processes, as relationships could prove to be day and site specific, on a larger scale, the possibility of relatively good agreement exists. The output of the Maritimes and Saskatchewan studies should define this relationship further. Environment Canada also has requested funding for deployment of FRM samplers at a number of locations in the border areas of all provinces and is awaiting a response.

## 5.2 United States Update

### 5.2.1 PM Standards

On July 17, 1997, the US Environmental Protection Agency announced new standards for particulate matter (PM). The USEPA revised the primary (health-based) PM standards by adding a new annual  $PM_{2.5}$  and a new 24-hour  $PM_{2.5}$  standard, while retaining the current annual  $PM_{10}$  standard and adjusting the  $PM_{10}$  24-hour standard. The USEPA also revised the secondary (general welfare-based) standards by making them identical to the primary standards. A summary is given below and in Table 5.

#### Summary of Final Rule

##### $PM_{2.5}$ Standards (currently still in deliberation in court)

- EPA added two new primary  $PM_{2.5}$  standards set at  $15 \mu\text{g}/\text{m}^3$  (annual arithmetic mean) and  $65 \mu\text{g}/\text{m}^3$  (24-hour average), to provide increased protection against the PM-related effects found in the community studies.
- The final rule established a new form for the annual  $PM_{2.5}$  standard. Areas would be in compliance with the new annual  $PM_{2.5}$  standard when the 3 year average of the annual arithmetic mean  $PM_{2.5}$  concentrations is less than or equal to  $15 \mu\text{g}/\text{m}^3$ .
- For the new 24 hour  $PM_{2.5}$  standard, the form is based on the 98<sup>th</sup> percentile of 24-hour  $PM_{2.5}$  concentrations in 1 year (averaged over 3 years), at the population-oriented monitoring site with the highest measured values in an area.

##### $PM_{10}$ Standards

- EPA retained the annual  $PM_{10}$  standard of  $50 \mu\text{g}/\text{m}^3$  to protect against effects from both short and long term exposure to coarse particles.
- EPA revised the  $PM_{10}$  24-hour standard of  $150 \mu\text{g}/\text{m}^3$  by replacing the 1-expected-exceedance methodology with a 99<sup>th</sup> percentile methodology, averaged over 3 years, to protect against short term exposure to coarse particles.



The Clean Air Act provides that ambient air quality standards be reviewed every five years. Along with the implementation of new PM<sub>2.5</sub> and PM<sub>10</sub> standards, the USEPA is considering the need to address the coarse fraction of particles within PM<sub>10</sub>, known as PM<sub>10-2.5</sub>. This review entails the writing of a new Criteria document.

### 5.2.2 Ozone Standards

#### Summary of Final Rule (in deliberation in Court)

##### Primary Standard (see also Table 5)

- The USEPA replaced the previous 1-hour primary standard of 0.12 ppm with a new 8 hour standard set at 0.08 ppm. An area will attain the standard when the 3 year average of the annual 4<sup>th</sup>-highest daily maximum 8 hour concentrations is less than or equal to 0.08ppm.
- The USEPA has changed the form of the standard from an expected-exceedance form to a concentration based form, because it more directly relates to ozone concentrations associated with health effects.

#### Court Action resulting in the USEPA Reinstatement of 1-Hour Ozone Standard

In July 1997, the USEPA promulgated the strict 8-hour standard and expected it to be implemented soon after, therefore, the agency revoked the 1-hour standard in areas that had, at a minimum, shown three consistent years of clean air.

However, on May 14, 1999, a Federal Court decision struck down and remanded the more stringent 8-hour standard. Therefore, in order to establish some measure to regulate air pollution in areas of the US that have been without standards since the 8-hour standard was struck down, the USEPA decided to reinstate the old 1-hour standard. On October 20, 1999, the USEPA proposed a rulemaking that would reinstate the one-hour ozone standard previously revoked by the agency in nearly 3,000 counties.

The reinstatement will affect some areas that had been designated as "attainment" for the the USEPA's 1-hour ozone standard and some that formerly were designated as "non-attainment" but where monitors showed clean air for three consecutive years. The areas formerly known as "non-attainment" were categorized into two groups:

- Group 1, had demonstrated three years of clean air history without any violations and also had developed maintenance and transportation conformity plans.



- Group 2, has shown three years of clean air data, but did not have any plans developed for maintenance and transportation conformity when the standard was revoked.

**Table 5:** Summary of US Current and Proposed Standards for PM and Ozone

Pollutant	Current Primary Standards		Proposed Standards (revised)	
<i>Ozone</i>	1-Hour 0.12 ppm	To attain this standard, the daily maximum 1-hour average concentration measured by a continuous ambient air monitor must not exceed 0.12 ppm more than once per year, averaged over 3 consecutive years	8-Hour 0.08 ppm	To attain this standard, the 3-year average of the fourth-highest daily maximum 8-hour average of continuous ambient air monitoring data over each year must not exceed 0.08 ppm
<i>PM<sub>10</sub></i>	Annual 50 µg/m <sup>3</sup>	To attain this standard, the arithmetic average of the 24-hour samples for a period of 1 year, averaged over 3 consecutive years, must not exceed 50 µg/m <sup>3</sup>	Annual 50 µg/m <sup>3</sup>	Same as existing standard for PM <sub>10</sub>
	24-Hour 150 µg/m <sup>3</sup>	To attain this standard, the concentration of samples taken for 24-hour periods at each monitor within an area must not exceed 150 µg/m <sup>3</sup> , more than once per year, averaged over 3 years	24-Hour 150 µg/m <sup>3</sup>	To attain this standard, the 99th percentile of the distribution of the 24-hour concentrations for a period of 1 year, averaged over 3 years, must not exceed 150µg/m <sup>3</sup> at each monitor within an area.
<i>PM<sub>2.5</sub></i>		No Current Standard	Annual 15 µg/m <sup>3</sup>	To attain this standard, the 3-year average of the annual arithmetic mean of the 24-hour concentrations from single or multiple population oriented monitors must not exceed 15.0 µg/m <sup>3</sup>
		No Current Standard	24-Hour 65 µg/m <sup>3</sup>	To attain this standard, the 98th percentile of the distribution of the 24-hour concentrations for a period of 1 year, averaged over 3 years, must not exceed 65 µg/m <sup>3</sup> at each monitor within an area

Source: EPA - Final Revisions to the Ozone and PM Air Quality Standards, August, 1999.

Affected areas will have to continue monitoring for ozone, and some areas will be subject to requirements intended to limit ozone formulation. These requirements include implementation of maintenance plans, transportation conformation and new source review requirements.



## Tougher Smog Reduction Plans

The USEPA has requested that some of the most heavily polluted metropolitan areas submit more complete plans to reduce urban smog. Of the ten major areas that must complete detailed plans for reducing smog under the 1990 Clean Air Act, only one – Springfield Massachusetts – has fully met the USEPA's requirements. However, all other areas have made substantial progress, and the USEPA has indicated a willingness to lift sanctions under the Act if areas make good-faith efforts to comply with the standards. Data on ozone exceedance days in some of these communities are given in Table 6.

The metropolitan areas cited by the USEPA include: Baltimore, Washington D.C., Philadelphia, New York, Milwaukee, Houston, Hartford, Chicago and Atlanta. Of the metropolitan areas that did not meet the USEPA standards, four – including Washington – have already sent targets to the agency but have not submitted a final transportation emissions budget. The other areas fell short of the USEPA's emissions targets for reducing both VOC's and NO<sub>x</sub>'s, components which contribute to smog. Officials from Baltimore and Washington have set a target date of 2005 to meet federal smog regulations. However, their plans heavily depend on anticipated pollution reductions in the west from power plants and other sources. To meet the standards, in 2004, the Baltimore-Washington region would only be allowed one smog violation day per summer, compared to the 11 that occurred last summer. The Washington D.C. area's plan has not been considered complete because it is not considered to include adequate projection of pollution levels from cars, trucks and other vehicles.

**Table 6:** Location Days Exceeding Ozone Standard (1999)

Location	Days Exceeding Standard
Houston/Galveston	50
Atlanta	23
New York	13
Baltimore	11
Philadelphia	11
Hartford	10
Washington D.C.	7
Chicago/Gary, Ind.	1

Source: *The Washington Post*, December, 1999.



### 5.3 Other International Action on Ozone

#### 5.3.1 European Proposal on Reducing Ozone

A European proposal on reducing ozone is currently under consideration after the European Commission released a report citing numerous days of unhealthy levels of ozone in a number of cities over the summer of 1999. The annual report on ground-level ozone indicated that the ozone concentration at more than 1000 stations was above the threshold value set by the European Union's (EU) directive.

The current health protection threshold of  $110 \mu\text{g}/\text{m}^3$  (55 ppb) was exceeded on between 20 and 60 days in the Mediterranean countries of the EU, and between 10 and 35 days in the central countries, with some individual areas recording 80 days of exceedances. Violations of the health threshold are frequent, and even the information threshold of  $180 \mu\text{g}/\text{m}^3$  (90 ppb) of ozone was violated in most countries. Currently, the EU is reviewing a proposed ground-level ozone threshold of  $120 \mu\text{g}/\text{m}^3$  (60 ppb) (8-hour average); however, it faces considerable opposition particularly from the Mediterranean countries.

#### 5.3.2 European Union $\text{PM}_{10}$ Standard

In the European Council Directive 1999/30/EC of April 22, 1999, limit values for sulphur dioxide, nitrogen oxide, particulates and lead in ambient air, were established. The limit values for  $\text{PM}_{10}$  are listed in Table 7, and occur in two stages. The first stage has a target date of 2005, while stage 2 has a target of year 2010.

The member countries agree not to exceed the  $\text{PM}_{10}$  limit values in ambient air, however, there are exceptions allowed due to natural events and resuspension of particulates following the winter sanding of roads. The standards will be reviewed every five years, similar to US PM standards, to determine if changes in the limit value or conditions are needed.



**Table 7: Limit Values for Particulate Matter (PM<sub>10</sub>): European Union**

	Averaging Period	Limit Value	Margin of Tolerance	Date of Which Limit Value is to be Met
<i>STAGE 1</i>				
1. 24-hour limit	24 hours	50 µg/m <sup>3</sup> PM <sub>10</sub> , limit of <36 exceedances per calendar year	50% at the start of enforcement on Jan. 1, 2001, and then reduced every year to 0%, by Jan. 2005	January 1, 2005
2. Annual limit	Calendar Year	40 µg/m <sup>3</sup>	20% at the start of enforcement on Jan. 1, 2001, reduced to 0% by 2005	January 1, 2005
<i>STAGE 2</i>				
1. 24-hour limit	24 hours	50 µg/m <sup>3</sup> PM <sub>10</sub> , limit of <8 exceedances per calendar year	Identical to Stage 1 tolerance	January 10, 2010
2. Annual limit	Calendar Year	20 µg/m <sup>3</sup> PM <sub>10</sub>	Identical to Stage 1 tolerance	January 10, 2010

Source: Official Journal of the European Communities, Annex III. June 1999.



Year	Value	Percentage	Notes
1990	100	100%	Baseline
1991	105	105%	5% increase
1992	110	110%	10% increase
1993	115	115%	15% increase
1994	120	120%	20% increase
1995	125	125%	25% increase
1996	130	130%	30% increase
1997	135	135%	35% increase
1998	140	140%	40% increase
1999	145	145%	45% increase
2000	150	150%	50% increase
2001	155	155%	55% increase
2002	160	160%	60% increase
2003	165	165%	65% increase
2004	170	170%	70% increase
2005	175	175%	75% increase
2006	180	180%	80% increase
2007	185	185%	85% increase
2008	190	190%	90% increase
2009	195	195%	95% increase
2010	200	200%	100% increase

The data shows a steady increase in value over the period from 1990 to 2010, reaching a total of 200% by the end of the study. This represents a doubling of the initial value over the 20-year period.



## 6.0 STATUS OF SMOG (NO<sub>x</sub>) AND ACID RAIN MANAGEMENT PROGRAMS

### 6.1 Stationary Sources

#### 6.1.1 Utility Emissions Overview

Power generation across North America has been linked to the creation of acid rain, smog, possible climate change and other environmental effects, through the release of sulphur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), carbon dioxide (CO<sub>2</sub>) and various particulates. One of the main sources of NO<sub>x</sub> and SO<sub>2</sub>, in both Canada and the US, as seen in Figure 3, is the utility sector. Regulations have substantially decreased overall emission from utilities; however, further reductions will be necessary if negative environmental impacts are to be ameliorated.

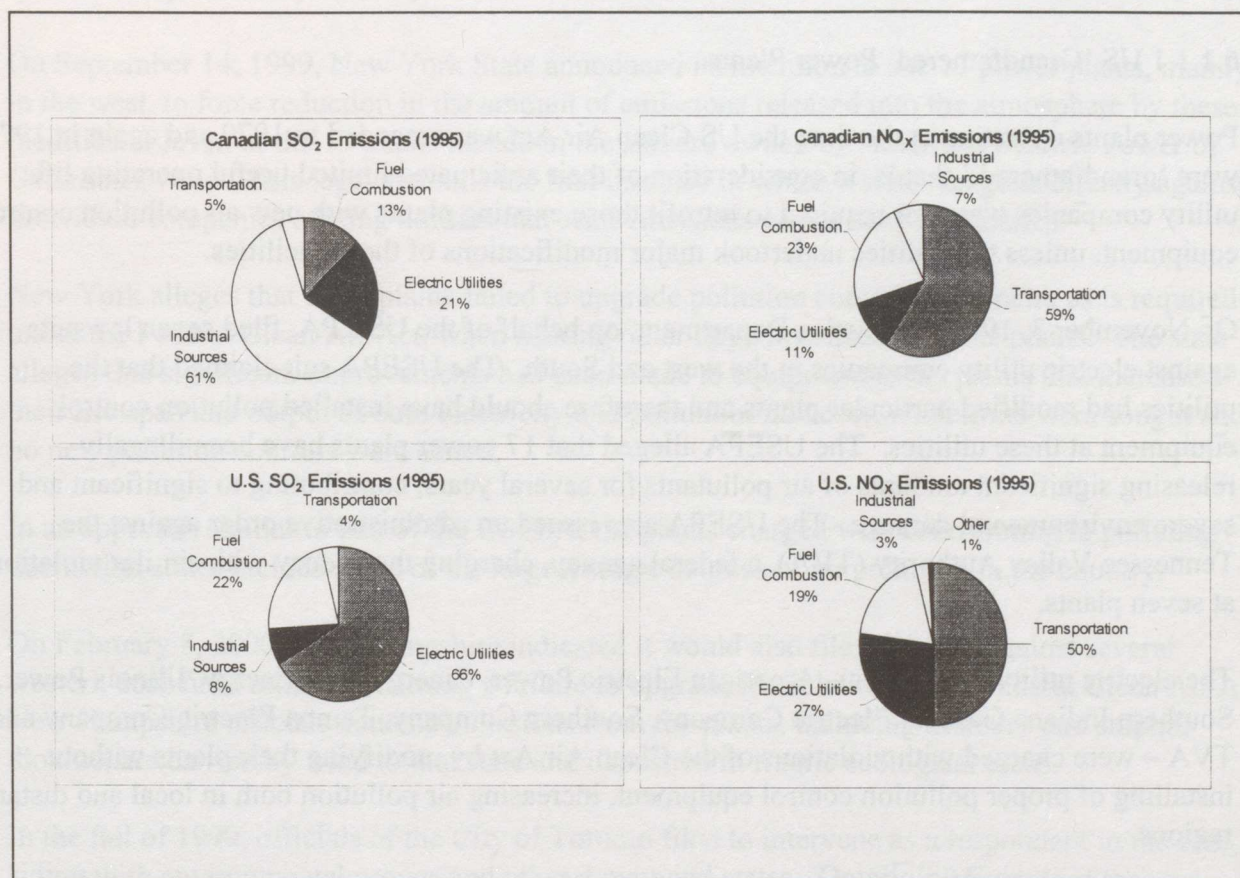


Figure 3: US/Canadian Acid Gas Emissions (1995)



## 6.2.1 US 'Grandfathered' Power Plants

### 6.2.1.1 USEPA Action

Power plants operating at the time the US Clean Air Act was amended in 1972 were 'grandfathered,' that is, in consideration of their anticipated limited useful operating life, utility companies were not required to retrofit those existing plants with new air pollution control equipment, unless the utilities undertook major modifications of those facilities.

On November 3, 1999, the Justice Department, on behalf of the US EPA, filed seven lawsuits against electric utility companies in the Midwest and South. The USEPA suit alleged that the utilities had modified particular plants and therefore should have installed pollution control equipment at these utilities. The USEPA alleged that 17 power plants have been illegally

### 6.1.1.1 US 'Grandfathered' Power Plants

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On November 3, 1999, the Justice Department, on behalf of the US EPA, filed seven lawsuits against electric utility companies in the west and South. The USEPA suit claimed that the utilities had modified particular plants and therefore should have installed pollution control equipment at these utilities. The USEPA alleged that 17 power plants have been illegally releasing significant amounts of air pollutants for several years, contributing to significant and severe environmental damage. The USEPA also issued an administrative order against the Tennessee Valley Authority (TVA), a federal agency, charging the agency with similar violations at seven plants.

The electric utility companies – American Electric Power, Cinergy, FirstEnergy, Illinois Power, Southern Indiana Gas and Electric Company, Southern Company, Tampa Electric Company and TVA – were charged with violations of the Clean Air Act by modifying their plants without installing of proper pollution control equipment, increasing air pollution both in local and distant regions.

In addition to the lawsuits and administrative orders, the USEPA also issued notices of violation to the utilities, and named an additional eight plants where similar violations have occurred. The 32 plants targeted are located in Alabama, Florida, Georgia, Illinois, Indiana, Kentucky, Mississippi, Ohio, Tennessee, and West Virginia. The USEPA aims to reduce the amount of SO<sub>2</sub>, NO<sub>x</sub> and PM that electric utility plants release to the atmosphere through installation of current air pollution technology.



In early March, 12 more plants were added to the suit, five American Electric Power (AEP) plants in Ohio, West Virginia and Virginia, two Cinergy plants in Indiana, and five Southern Company affiliates in Georgia, Mississippi, Florida and Alabama. A settlement with Tampa Electric Co. of Florida was also announced, under which that facility would reduce emissions by burning natural gas rather than coal at some facilities, while installing new pollution control equipment and operating existing equipment more efficiently at other units. The utility also agreed to pay a \$3.5 million fine. A similar settlement is being considered by the Tennessee Valley Authority (TVA).

The United States government continues to seek significant civil penalties from the other violators. The Clean Air Act authorizes civil penalties of up to \$25,000 for each day of violation at each plant prior to January 30, 1997 and \$27,500 for each day thereafter.

#### 6.1.1.2 Complementary Activity

On September 14, 1999, New York State announced its intention to sue 17 power plants, mainly in the west, to force reduction in the amount of emissions released into the atmosphere by these facilities. Eleven of the 17 plants named in the suit are owned by American Electric Power of Columbus, Ohio. This legal action is the first instance in which a state has gone directly against individual companies owning utilities that send emissions across state boundaries.

New York alleges that these plants failed to upgrade pollution control equipment, as is required under the Federal Clean Air Act, when making other large investments in the plants. The state alleges that significant improvements had been made to equipment at the plants that increased their life span and output of both electricity and pollution; however, no permits were sought and no new pollution controls were added.

In an approach similar to that of the USEPA, the plants charged with contributing to polluting downwind states include some of the largest single sources of air pollution in the country.

On February 8, 2000, New Hampshire indicated it would also file a lawsuit against several western coal-fired utilities, claiming a failure to upgrade in violation of the Federal Clean Air Act. New Hampshire officials contend emissions from the plants, including mercury and sulphur dioxide, are carried by wind to that state and deposited in fragile ecological areas.

In the fall of 1999, officials of the City of Toronto filed to intervene as a respondent in the case, siding with environmental groups and other downwind states. Ontario's Ministry of the Environment estimates that half of the sulphur dioxide and NO<sub>x</sub> pollution in the province originates in the United States. A significant portion of this pollution comes from coal-fired power plants in the -west United States.



## 6.1.2 Evolution of United States E-GRID Database

The Emissions & Generation Resource Integrated Database (E-GRID) is a comprehensive source of information on the environmental characteristics of all electric power generated in the United States. It integrates 12 different databases from 3 federal agencies: EIA (Electrical Industry Association), the USEPA and the Federal Energy Regulatory Commission (FERC). It covers approximately 4800 plants and 2100 generating companies. E-GRID provides data on pollutant emissions and resource mix for individual power generating plants and also from non-utilities, such as cogenerators. It allows for direct comparison of attributes between plants, companies, states and regions in the country.

From various studies performed by environmental groups, it was established that power generating plants are responsible for:

- 26 per cent of all emissions of nitrous oxides (NO<sub>x</sub>)
- 64 per cent of all emissions of sulphur dioxides (SO<sub>2</sub>)
- 40 per cent of man-made emissions of carbon dioxide (CO<sub>2</sub>)

Many consumers of electricity may wish to be informed about how their power is generated and related environmental impacts. This information could become very important as consumers become free to choose their electricity suppliers. Approximately 20 states have determined that consumers have the right to know about emissions and the generating method associated with the electricity they use.

### *What E-GRID Provides*

- For every power plant and generating company, information is available on:
  - emissions of three major pollutants - NO<sub>x</sub>, SO<sub>2</sub> and CO<sub>2</sub> in lbs/MMBTU and lbs/MWh
  - generation resource mix
  - identification and locational information
- It can assist States in the development of mechanisms for electricity labeling and verification of green power marketing claims.
- It can assist States that are adopting approaches to regulating emissions based on product output (emissions per kWh).
- It could allow environmental regulators to identify regional differences in emission rates that could affect air quality in a competitive electricity market.

E-GRID97 can be downloaded from the Website <http://www.epa.gov/acidrain/egrid/egrid.html>. Downloading all E-GRID97 files could take up to a few hours depending on Internet connection. The USEPA plans to make E-GRID97 available on CD-ROM in early 2000.



### 6.1.3 US NO<sub>x</sub> State Implementation Plans (SIPs)

#### Background

- NO<sub>x</sub> and associated ozone can travel hundreds of miles across State and International boundaries to affect the health of the public and the environment. Thus, cities or areas where clean air objectives are being met may be contributing to a downwind city's ozone problem.
- The US Clean Air Act requires that a State Implementation Plan contain provisions to prevent a State's facilities or sources from contributing significantly to air pollution 'downwind,' specifically in those areas that fail to meet the national air quality standards.
- In June of 1997, the Ozone Transport Assessment Group (OTAG) States (largely those east of the Mississippi River) voted to reduce NO<sub>x</sub> emissions from utilities and other major sources. Reductions ranged from those currently required by the Clean Air Act, up to an 85 per cent reduction in emissions rate from the year 1990 electric utility levels (or to a level of 0.15 lb/mmBTU in the input fuel) in a number of states in the OTAG region.
- On November 7, 1997, building on the OTAG recommendations, the USEPA proposed to require 22 states and the District of Columbia to submit State Implementation Plans that address the regional transport of ground-level ozone. The USEPA proposed to require NO<sub>x</sub> emission reductions by September 2002 to eliminate the significant contribution of emissions from upwind states, and set statewide NO<sub>x</sub> emissions budgets reflecting those reductions.

In the fall of 1998, the USEPA announced three actions meant to address the regional transport of ground-level ozone, focused on NO<sub>x</sub> emissions from all sources. They included:

- (1) As of October 1998, the EPA mandated a rule requiring 22 States and the District of Columbia to submit modified State Implementation Plans (SIP's) to address the regional transport of ground-level ozone through reductions in emissions of nitrogen oxides (NO<sub>x</sub>'s).

The rule requires emission reduction measures to be in place by May 1, 2003, and would have a significant impact on both utilities and large non-utility point sources (such as coal-fired industrial generators and combustors).

The final rule includes a model NO<sub>x</sub> emissions trading program that would allow States to achieve over 90 per cent of the required reductions in a highly cost-effective way. The goal is reduction in total summertime emissions of nitrous oxides by about 28 per cent (1.2 million tons) beginning in the year 2003 in the affected 22 States and the District of Columbia.



For the 1998 SIP Rule, the USEPA considered what levels of NO<sub>x</sub> reductions could be obtained by applying proven pollution control technologies to various source sectors in a reasonably cost-effective and feasible manner. For utilities, the USEPA chose emissions reductions that are equivalent to an emission limit of 0.15 lb/mm BTU of input fuel heat value.

For electrical generating units (EGUs) larger than 25 MWe, the control level was determined by applying a uniform NO<sub>x</sub> emissions rate region-wide with the assumption that the air quality benefits could be achieved at a cost-effectiveness less than \$2000 per ton of fuel (primarily coal).

**Table 8:** Required NO<sub>x</sub> Emission Reductions from Selected Source Sectors

Source Sector	% decrease*
Non-EGU boilers and turbines	60
Stationary internal combustion engines	90
Cement manufacturing plants	30
*from uncontrolled levels	

As a result of the rule, for the purpose of calculating the state NO<sub>x</sub> budgets, the emissions decreases shown in Table 8 *from uncontrolled levels* would be required of the large (greater than 250 mm BTU or 1 ton/day) non-EGU (electrical generating units) sources:

#### Delay of NO<sub>x</sub> SIP Call Schedule and its Resolution

In May 1999, the US Court of Appeals for the District of Columbia remanded the EPA's 8-hour ozone standard, and postponed the September 1999 deadline for states to submit their modified NO<sub>x</sub> State Implementation Plan (SIP) to the USEPA.

The court's decision to postpone the deadline for the states to submit their NO<sub>x</sub> implementation plans was limited and did not address the technical basis of the USEPA's NO<sub>x</sub> SIP call rule.

On March 3, 2000 the US Court of Appeals for the District of Columbia ruled on a suit brought by the states of Michigan and West Virginia against the US EPA challenging the basis for that agency's call for State Implementation Plans (SIPs). Canada and Ontario, along with the New England states, were interveners on the side of the USEPA in this suit.



By a 2 to 1 majority, the Court rejected the following claims by the two states i) that the USEPA could not call for a revised SIP without convening a transport commission; ii) that the USEPA failed to make a sufficiently state-specific determination of ozone contribution; iii) that the Agency unlawfully overrode past precedent regarding "significant" contribution; and iv) that the USEPA's consideration of cost as a factor in determining reductions was a violation of the statute; v) that the USEPA scheme of uniform controls was arbitrary and capricious; and vi) that the Agency was exercising powers not delegated to it by the Congress. A request for exclusion from compliance with the SIP call by the state of South Carolina was also rejected by the court.

The court did, however, rule that the record did not support inclusion of Wisconsin in the SIP call nor did it support creating NO<sub>x</sub> budgets based on the entire NO<sub>x</sub> emissions of the states of Missouri and Georgia. Development of SIPs may now proceed, assuming the states do not elevate their suit to a higher court.

- (2) Proposed federal requirements to reduce regional ozone transport in these States if any State does not submit the required SIP provisions in response to the NO<sub>x</sub> SIP call.

The USEPA has proposed federal requirements to reduce NO<sub>x</sub> emissions, even if a state does not submit the required plan provisions in response to the NO<sub>x</sub> SIP call mentioned above. The proposal outlines reduction requirements for both utilities and large non-utility point sources, including large industrial boilers and turbines, large internal combustion engines, and cement manufacturing. The proposed requirements use the same cut-off levels, categories, and control levels as were used to develop the final NO<sub>x</sub> SIP call budgets and have the same implementation date of May 1, 2003.

- (3) Proposed action on petitions filed by eight Northeastern states under Section 126 of the Clean Air Act, seeking to reduce ozone concentrations in these states by reductions in NO<sub>x</sub> emissions from upwind states.

USEPA has also proposed action on petitions filed by eight Northeastern states seeking to reduce ozone transport across state boundaries through reductions in NO<sub>x</sub> emissions in upwind states. Each petition requests that EPA make a finding that NO<sub>x</sub> emissions from certain stationary sources, particularly coal-fired utilities, significantly contribute to ozone non-attainment in the petitioning state. The utilities and some states have challenged the USEPA's action on the Section 126 petitions because they are based on the new 8-hour ozone standard currently in abeyance as a result of a US federal court decision. In response, the USEPA has modified its justifications, basing them solely on a 1-hour standard.

The polluting states identified in the petition include all of the 22 states and the District of Columbia that are subject to the NO<sub>x</sub> SIP call, plus a few other states. The USEPA has found that seven of the eight Section 126 petitions have technical merit and that sources in 19 States and the District of Columbia significantly contribute to non-attainment in, or interfere with, the ability of states to maintain clean air in one or more of the petitioning states.



#### 6.1.4 Canadian Update on Emission Management Program

##### Strategic Attack on Air Pollution (Ontario Program)

The Ontario government recently proposed (January 24, 2000) air pollution reductions to the electric utilities sector, through the implementation of a *Strategic Attack On Air Pollution*, a clean air plan which applies only to oil and coal burning electricity generating facilities. Net emissions of smog-causing NO (not NO<sub>2</sub>) are to be reduced by 5 per cent and sulphur dioxides by 10 per cent below current caps, beginning in 2001, through the implementation of three major initiatives: revised emission caps, emission performance standards, and emission credit trading. Also, the Province will adopt any future regulations imposed on the electric utilities sector in the US, provided that such standards are more stringent than the present Ontario standards.

*Emission Caps:* Initial regulations would cap total annual emissions of NO<sub>x</sub> and SO<sub>2</sub> from all coal and oil-fired electric generating stations in Ontario greater than 25 MW in capacity through:

- an annual cap for NO (rather than NO<sub>2</sub>) of 36 kilotonnes per year for the year 2001 (*current cap 38 kt/year*);
- an annual cap for SO<sub>2</sub> of 157.5 kilotonnes per year for the year 2001 (*current cap 175 kt/year*)

The government has also made a commitment to reduce total NO emissions by 45 per cent below the 1990 levels by the year 2015 as part of the "Anti-Smog" Program.

*Emissions Performance Standards:* The emission performance standards (EPSs), will apply to coal and oil-fired electrical generating plants with a capacity greater than 25 MW. The EPSs will also apply to any electricity generated in other provinces or the United States and sold for use in Ontario. The EPSs would require that electricity produced or sold in Ontario must generate NO<sub>x</sub> or SO<sub>2</sub> at rates less than or equal to the rate specified in Table 9 below.

**Table 9.** Emission Performance Standards for Coal/Oil Fired Units

POLLUTANT	CAP (kg/MWh)	CAP (lbs/mmBTU)
Nitrogen Oxides (NO <sub>x</sub> )	1.3 (reported as NO)	0.30 lb NO/mmBTU (0.46 lb NO <sub>2</sub> /mmBTU)*
Sulphur Dioxide (SO <sub>2</sub> )	4.6	—

\*Note: Comparable USEPA benchmark is 0.15 lb NO<sub>2</sub>/mmBTU

Emissions associated with power imported into Ontario from the US would not be included in the NO and SO<sub>2</sub> cap calculation; however, American utilities selling into Ontario will have to meet the same emissions standards that govern in-province producers.



## Emissions Trading

As part of their Strategic Attack, the Ontario Ministry proposed a "Cap, Credit and Trade" emissions trading program. The proposal is meant to maintain environmental protection while providing flexibility for industry to adapt to the new standards. Capped emitters of NO<sub>x</sub> and/or SO<sub>2</sub> would be allowed to purchase Emission Reduction Credits (ERCs) from non-capped sources to meet their regulated limits. Any emitter of NO<sub>x</sub> and/or SO<sub>2</sub>, not subject to a cap, that reduces emissions of NO<sub>x</sub> and/or SO<sub>2</sub> below its current legal limit would be permitted to create emissions reduction credits saleable to capped emitters. The new pollution credit trading system is designed to leverage environmental benefits on local air quality, by giving greater value to pollution credits purchased within a given airshed.

The new Strategic Plan states that some emission reduction credits used by the purchaser in Ontario must not have been created outside of the Ontario airshed. The ERCs will be subject to some restrictions including:

- NO<sub>x</sub>: directionally NNW to SSE, distance 1,500 km; and,
- SO<sub>2</sub>: directionally NE to W to SE, distance 3,000 km.

The Ontario plan notes that discounting the value of the credits from distant sources shall be used beyond 300 km to reflect the relative impact on the airshed.

Environmental officials from the USEPA are considering Ontario's approach, since neither the NO<sub>x</sub> SIP call nor the Acid Rain Program employ it. Utility sources in the US are currently reviewing the plan to determine if it is effective and feasible.

*Broader Air Strategy:* The new action plan commits the province to reducing by 75 per cent the number of times the province's one-hour air quality criterion for ozone is exceeded. To reach this goal, provincial emissions of NO<sub>x</sub>'s and VOC's are to be reduced by 45 per cent of 1990 levels by the year 2015.

In addition to reductions in NO<sub>x</sub> and VOCs, a strategy to reduce levels of particulate matter in air is also in development under the Anti-Smog Action Plan. Scientists state that the strategy indicates that up to a 75 per cent reduction in SO<sub>2</sub> emissions from both parts of Canada and parts of the US is needed to fully protect aquatic ecosystems in Ontario and eastward. The electricity sector accounts for only a portion of NO<sub>x</sub> and SO<sub>2</sub> emissions in the province, therefore, in order to ensure Ontario's progress towards the targets of Anti-Smog Action Plan and the Canada Wide Acid Rain Strategy for Post 2000, other sectors will need to reduce air emissions.

## Emissions Reporting

Other provisions announced by the Province include a requirement for annual reporting by all electric power plants of emissions of their pollutants including mercury, SO<sub>x</sub>'s, NO<sub>x</sub>'s and carbon



dioxide, starting in May of 2000. The government has set a target of reducing total sulphur dioxide emissions in the province by 50 per cent, by 2015, as part of a national plan to reduce acid rain emissions.

#### Comments From Environment Canada on Ontario's New Strategic Attack on Air Pollution

Environment Canada offered comments and suggestions that may strengthen or clarify key areas of focus.

#### □ Emission Limits

##### Emissions Caps and Emissions Performance Standards (EPSs)

##### *Sulphur Dioxide*

- although the new provincial cap of 442.5 kt/yr on total emissions of SO<sub>2</sub> falls short of the *up to 75 per cent* reduction in emissions in Ontario and the US west (from the Canada-wide Acid Rain Strategy for Post-2000), it is still a positive step
- the new SO<sub>2</sub> cap of 157.5 kt/yr for oil and coal electricity generating units is only a 10 per cent reduction from the current emission cap of 175 kt/yr, (which is 11 per cent above the actual 1999 emissions of 142 kt/yr), and does not appear consistent with the 50 per cent province-wide reduction target by 2015. It is assumed that a more aggressive emission cap will be applied to electric utilities in the future to provide the additional reductions
- such actions are important for achieving the Canada-wide standard for PM<sub>2.5</sub>, since the utilities are located in the poor air quality region of Ontario, and the metal smelters (Sudbury, Ontario) are probably not a significant contributor to the southern Ontario PM and sulphate problem
- the 2015 target date for the SO<sub>2</sub> cap, along with the 2015 date set for NO<sub>x</sub> and VOC reductions, seem to infer that the entire Ontario smog program has a target date of 2015 also, which is inconsistent with the 2010 target date set for PM<sub>2.5</sub> in the proposed Canada-wide Standard

##### *Nitrogen Oxides*

- neither the 55 kt/yr NO<sub>2</sub> cap (expressed by the Ministry as 36 kt/yr as NO) or the 2.0 kg/MWh NO<sub>2</sub> (1.3 kg/MWh as NO) Environmental Performance Standards (EPS) are very aggressive commitments for electricity generating units located in a mainly poor air quality region



- calculations by Environment Canada, indicate that, if the methodology used by the USEPA to set NO<sub>2</sub> budgets for 22 states, based on an electric utility NO<sub>2</sub> cap of 0.15 lb/MMBTU, had been used to develop the proposed Ontario electric utility cap, it would have been set at 33 kt/yr of NO<sub>2</sub>, 40 per cent lower than the 55 kt/yr cap (36 kt/yr NO)
- the EPS apparently excludes gas-fired utilities, which contribute approximately 12 kt/yr of NO<sub>2</sub>, making the actual Ontario utility cap about 67 kt/yr of NO<sub>2</sub>, twice the amount it would have been using the US methodology. Should conversion of some units to natural gas at the Lakeview Generating Station, west of Toronto continue, these units would also be outside the cap
- the Ontario commitment to adjust the NO<sub>x</sub> cap to match the new US regulation is therefore very important, although no clear commitment is made to a particular standard or benchmark
- the US emission cap of 0.15 lbs/MMBTU (0.65 kg/MWh) plays a very important role in reducing pollution in the US and Canada. It is the rate that power plants in most states in the Ozone Transport Commission (OTC) are required to meet by the year 2003. It has also been the basis of:
  - all three major US actions being pursued to reduce NO<sub>2</sub> emissions in the - west and Eastern states
  - the NO<sub>x</sub> budgets established for the State Implementation Plans (SIP) call under Section 110 of the US Clean Air Act
  - the regulatory limit for new coal-burning power plants in the US since 1998
- the proposed Ontario cap has no provisions to limit emissions during ozone episodes, which could render it ineffective in reducing peak ozone levels
- Environment Canada urges that Ontario introduce NO<sub>2</sub> caps and EPSs now that are equivalent to the US 0.15 lb/MMBTU cap, extend the cap to gas-fired utilities, and incorporate provisions for limiting emissions during ozone episodes
- confirmation of the 45 per cent NO<sub>x</sub> and VOC reduction target levels is welcome, however, the re-confirmation of the 2015 target date for this per cent reduction is disappointing, revealing that health benefits for residents of Ontario will not be assured for a long time.



Emission Trading

- Environment Canada supports the proposal to introduce NO<sub>x</sub> and SO<sub>2</sub> trading in Ontario, as long as the system can be designated to ensure environmental integrity and does not allow the total proposed provincial SO<sub>2</sub> or NO<sub>x</sub> caps to be exceeded
- to ensure that the trading system has integrity, rules for distance, direction, and, in the case of NO<sub>x</sub>, seasonality and short term episodes, are needed, given that sources of SO<sub>2</sub> within 500 km make a greater contribution to acidification per tonne of SO<sub>2</sub> emitted than do more distant sources, and also, sources of NO<sub>x</sub> within 100-200 km make a greater contribution to ozone formation than do more distant sources
- Environment Canada urged that the trading systems for individual sectors be designed such that the province-wide **total** SO<sub>2</sub> (50 per cent) and NO<sub>x</sub> (45 per cent) reduction commitments cannot be exceeded

Emissions Reporting (reporting of all harmful air emissions by industrial and commercial emitters; substances including mercury, nitrogen oxides and sulphur dioxide)

- the proposal has the potential to be a powerful emission reduction instrument through public disclosure
- if the program is well designed and resourced, it has the ability to aid in streamlining the emissions inventory estimation methodology

Recommendation

**With respect to the Ontario Strategic Attack on Air Pollution, the Commission should recommend:**

- i. the inclusion of gas fired units within any nitrogen oxides cap for Ontario electrical generation facilities;**
- ii. rather than the current cap of 36 kt/year on NO emissions, a commitment to a lower cap of 21.6 kilotonnes/year from all combustion electrical generation facilities consistent with application of the USEPA NO<sub>2</sub> performance benchmark for such facilities of 0.15 lb of NO<sub>2</sub>/mmBTU (0.65 kg/MWh);**
- iii. an acceleration of the province-wide, multi-sectoral programs for SO<sub>2</sub>, NO<sub>x</sub>, and VOCs to an attainment year of not later than 2010, with ongoing and careful review to determine if reduction actions are adequate to meet air quality objectives; and,**



- iv. **that the use of emissions trading not allow total SO<sub>2</sub> and NO<sub>x</sub> emissions to exceed the province-wide targets established by Ontario. The Commission should encourage that any emissions trading system for SO<sub>2</sub> and NO<sub>x</sub> deployed by any government, including Ontario, include limits on the distance and direction of sources traded with and, with regards to NO<sub>x</sub> emissions, additional actions outside the trading processes to deal with seasonal variability and the amelioration of short term episodes.**

#### 6.1.5 Comparison of Ontario, Eastern Canada, Ohio Valley and US Northeast Utility Emissions

Within these four regions, a total of 312 coal-fired electric utility stations were operating in 1995. Over the past few years, nuclear stations in these regions have experienced operational difficulties which have resulted in a greater reliance on the use of coal stations. Besides the excess generation capacity currently available at many operating stations, there are an additional 201 non-operational coal-fired stations in these regions. This includes 11 stations reported to be under construction, and 154 listed as being retired. Together, these two categories of non-operating stations represent 12.5 per cent of the total capacity of all operating coal-fired stations in the regions under investigation.

Table 10 presents data for SO<sub>2</sub>, NO<sub>x</sub> and CO<sub>2</sub> emissions for the year 1995 for the largest 100 coal-fired stations contained within the four regions studied (Institute for Environmental Studies, Pollution Probe, 1998). It is particularly significant to note from this table that the Ohio Valley/US Great Lakes region generated a great majority of the emissions for each of the three pollutants studied. This could be due to the fact that, out of the 100 largest coal stations in the designated area, 90 (or 90 per cent) were located in the Ohio/Great Lakes region. Also, when comparing the various ages of these facilities, over 80 per cent of the stations were built before 1970, and therefore likely contain very limited pollution control technologies. It is 'grandfathered' plants such as these that the USEPA is pursuing in court for their failure to adapt or upgrade their pollution control equipment.

The much greater reliance on coal-fired stations to supply electricity in this Ohio Valley/US Great Lakes region also resulted in it having the highest per capita generation of all emissions, with the exception of SO<sub>2</sub>. A higher per capita SO<sub>2</sub> level was found in the Eastern Canada region, caused by the use of coal with a high sulphur content at a number of stations there.

Due to the long-range transport of many of these air pollutants, any increase in the use of coal in the US Ohio Valley/Great Lakes States region without additional emission control would affect all areas to the east and northeast, including Ontario, Quebec, the US Northeast and Atlantic Canada.



**Table 10:** 1995 Emissions of SO<sub>2</sub>, CO<sub>2</sub> and NO<sub>x</sub> from the Largest 100 Coal-Fired Electric Stations within Four Transboundary Regions

Region (# of plants)		Ontario (3)	Eastern Canada (1)	Ohio Valley/US Great Lakes (90)	US Northeast (6)
Capacity MW		7,519	2,063	117,280	4,547
Annual Generation (MWH)		16,148,700	11,439,044	592,832,570	21,569,811
Emissions (1995 tons)	SO <sub>2</sub>	81,637	165,816	4,787,033	185,438
	CO <sub>2</sub>	16,838,331	11,861,000	667,803,943	25,646,815
	NO <sub>x</sub>	31,052	23,972	2,195,444	58,902
Emission Rates (lbs/MWH)	SO <sub>2</sub>	10.11	-	16.15	17.19
	CO <sub>2</sub>	2,085	-	2,252	2,378
	NO <sub>x</sub>	3.85	-	7.41	5.46

Source: Institute for Environmental Studies, University of Toronto & Pollution Probe. January, 1998



## 6.2 Mobile Sources

### 6.2.1 US - Tier 2 Regulations

On December 21, 1999, the US Environmental Protection Agency signed the final Tier 2 mobile source emission regulations. The new standards set more stringent exhaust emission levels for light duty vehicles and establish a new maximum sulphur level in gasoline.

The new standards will apply for new passenger cars and light-duty trucks. The program, for the first time, will apply the same set of standards to all passenger cars, light trucks and medium-duty passenger vehicles, regardless of vehicle or engine size. Light trucks include "light light-duty trucks" (LLDT's), rated at less than 6000 lbs (2700 kg) gross vehicle weight and "heavy light-duty trucks" (HLDT's), rated at more than 6000 lbs gross weight. "Medium-duty passenger vehicles" (MDPV's) form a new class of vehicles covered by the new standards. It includes sport utility vehicles (SUVs) and passenger vans rated between 8500 and 10000 lbs (3600 and 4500 kg) gross vehicle weight.

For the Tier 2 standards, the same requirements will apply to all vehicles regardless of fuel (gasoline or diesel). The Tier 2 standards will reduce new vehicle NO<sub>x</sub> emissions to an average of 0.07 g/mi, compared to the Tier 1 standards of 0.4 g/mi for gasoline cars and 1.0 g/mi for diesel cars. The projected reductions in NO<sub>x</sub> from mobile sources are compared to overall estimated future emissions in Table 11.

#### *Overview of Tier 2 Regulations for Vehicle Emissions*

- for new passenger cars and LDT's, standards will phase in beginning in 2004, with implementation by 2007
- for heavy LDT's and MDPV's, the Tier 2 standards will be phased in beginning in 2008, with full compliance by 2009
- during the phase in period between 2004-2007, all passenger cars and light LDT's not certified to the primary Tier 2 standards will have to meet an interim average standard of 0.30 g/mi NO<sub>x</sub>
- during the period between 2004-2008, heavy LDT's and MDPV's not certified to the final Tier 2 standards will phase in to an interim program with an overall average standard of 0.20 g/mi NO<sub>x</sub>, with those not covered by the phase-in meeting a per-vehicle cap of 0.60 g/mi NO<sub>x</sub> for HLDT's and 0.09 g/mi NO<sub>x</sub> for MDPV's.

Under the Tier 2 standards, the USEPA has also set stringent requirements for particulate matter emissions. It allows manufacturers to have a choice of certifying their vehicles to any of 10 'certification bins,' which will vary from 0 (zero emissions), through 0.01, to a maximum of 0.02 grams/mile. Three temporary bins, scheduled to expire at the end of the 2006 model year, allow for certification up to a 0.08 g/mi standard, which is identical to the current Tier 1 PM limit for



diesels. Manufacturers will be allowed to distribute their vehicles among 'bins' as long as their fleet averages .07 grams/mile of NO<sub>x</sub> or less. Primary particulate matter will be lowered markedly from the current 0.1 gram/mile standard largely prevalent under Tier 1, particularly given the fuel neutrality (equivalent treatment for both diesel and gasoline) of the new regulation. Secondary particulate formation (not measured as PM at the tailpipe) will also be lowered as a result of the reductions in SO<sub>2</sub> and NO<sub>x</sub> associated with the lower allowed sulphur level in gasoline and the more stringent NO<sub>x</sub> requirements respectively.

Along with limiting vehicle emissions, the Tier 2 standards also set a maximum sulphur limit for gasoline.

#### *Overview of Tier 2 Regulations for Sulphur in Gasoline*

- The standards require that most refiners and importers meet an average gasoline sulphur standard of 120 ppm and a maximum of 300 ppm, beginning in the year 2004.
- By the year 2006, the standard will be reduced to 30 ppm average and a maximum of 80 ppm.
- Temporary, less stringent standards will apply to a few smaller refiners through the year 2007.

The lower sulphur levels will enable use of automotive emission control technology necessary to meet the more stringent standards over the useful life of vehicles. Also, as soon as the low sulphur gasoline is available, gasoline vehicles already on the road should achieve reduced emissions from less degradation of their catalytic converters.

The new regulation has not addressed the issue of sulphur levels in diesel fuel. Concern has been expressed that unless ultra low sulphur diesel fuels are required, the new Tier 2 particulate standard cannot be attained by diesel vehicles. The USEPA has concluded that it would address this issue separately, with a notice of proposed rulemaking (NPRM) expected in early spring of this year.

One area of concern about the new standards are the costs to the public. According to the USEPA's estimates, complying with the Tier 2 standards will:

- cause a cost increase of less than \$100 per passenger car;
- cause an average cost increase of less than \$200 for light trucks;
- cause an average cost increase of \$350 for medium-duty passenger vehicles; and,
- cause an average cost increase of less than 2 cents per gallon of gasoline.

Along with reductions in NO<sub>x</sub>, some SO<sub>2</sub> reductions will occur; however, they are less when



compared to NO<sub>x</sub>. It is estimated the SO<sub>2</sub> emissions will be reduced by 1.3 per cent by the year 2007, as a result of the Tier 2 program.

### 6.2.2 Canadian Action

In Canada, with imminent declaration of the Canadian Environmental Protection Act, the authority for regulation of motor vehicle emissions will be moved under that Act from its current location in the Canada Motor Vehicle Safety Act, administered by Transport Canada.

Almost from the inception of auto emissions controls, given the active trade in vehicles and parts between the US and Canada, the federal government has recognized the benefits of compatible auto regulations extending through both countries, resulting in comparable regulations to date. Over the next few years, it is the established intention of the government to introduce Canadian regulations compatible with the new USEPA Tier 2 requirements in time for incorporation of necessary technology in production of 2004 model year vehicles.

**Table 11:** NO<sub>x</sub> Reductions from Tier 2 Standards  
US Mobile Sources compared to Total NO<sub>x</sub> Emissions

NO <sub>x</sub> Category	Base Case (annual emissions)			Control Case			
	1996	2007	2030	2007	% Red.	2030	% Red.
Stationary and Area	11,768,720	8,690,766	8,765,165	8,690,766		8,765,165	
Non-road Vehicles	6,215,200	5,950,291	5,675,190	5,950,291		5,675,190	
HD & MC Highway	2,372,476	1,484,071	1,286,233	1,452,462		1,251,626	
LD Highway	3,908,147	3,095,698	3,704,747	2,239,227	27.667	909,196	75.459
Total Highway	6,280,624	4,578,769	4,990,979	3,691,688		2,160,821	
Total Inventory	24,264,544	19,220,826	19,431,335	18,332,746	4.620	16,601,177	14.565

Source: EPA - Notice of Final Tier 2 Rulemaking, December 21, 1999

Forty-seven state non-attainment area, FRM Inventory, annualized season tons. In annualized ozone season tons.

Note: HD= heavy-duty, MC= medium-class, and LD= light-duty.

On October 23, 1998, the Environmental Minister announced the government will introduce regulations to significantly lower the allowable level of sulphur in gasoline sold in Canada. The new regulation was published in Canada Gazette, Part II, June 1999. The regulations would reduce the sulphur content in gasoline to an average level of 30 ppm with a maximum of 80 ppm, which is a 90 per cent reduction from current average levels. To reduce the impact on industry, the requirement will be phased in as follows:



- gasoline produced or imported into Canada must meet an average of 150 ppm in the phase in period of July 1, 2002 to December 31, 2004; and,
- gasoline produced or imported into Canada must meet an annual average of 30 ppm starting on January 1, 2005.

Refiners have indicated that they require three years or more to plan, design and build the equipment to remove sulphur from gasoline. Therefore, -2002 is the earliest time at which low sulphur gasoline could be made widely available in Canada.

Sulphur levels in gasoline now average 360 ppm in Canada, among the highest in the world. The proposed regulations would bring Canadian gasoline sulphur levels in line with those in California, Japan and the European Union.

By decreasing the level of sulphur in gasoline, and thus allowing emission control systems on automobiles to function optimally, the emission of air pollutants, health impacts and premature deaths will all be reduced. A federal-provincial work group estimated that, over 20 years, low sulphur gasoline would prevent 2,100 premature deaths, 93,000 incidences of bronchitis in children, and over 5,000,000 other health related effects such as asthma.

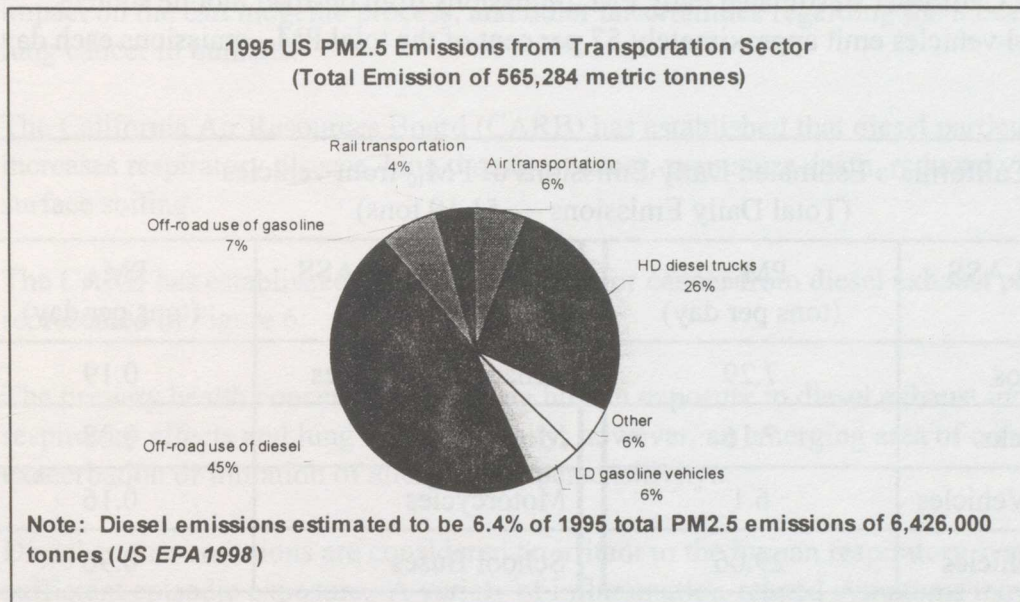
It is expected that the introduction of low sulphur gasoline would result in a one cent per liter increase at the pumps, or about \$20 a year per car on average.

### 6.2.3 Diesel Emissions (Particulate)

Diesel exhaust (DE) is a complex mixture of gases and particles with hundreds of chemical constituents, including many organic compounds, found both in gaseous form and on particles. The gaseous fraction is composed of nitrogen, oxygen, carbon dioxide, and water vapor, as well as smaller amounts of other substances such as carbon monoxide, sulfur oxides, nitrogen oxides, volatile organics, alkenes, aromatic hydrocarbons, and aldehydes, such as formaldehyde and 1,3-butadiene, and polycyclic aromatic hydrocarbons.

The particulate emission fraction is composed of very small (typically  $\leq 0.2$   $\mu\text{m}$  in diameter) particles that are highly respirable. It can be divided into two categories: primary and secondary particulate. Primary particulate is formed during the fuel combustion process in the engine, and is released as exhaust from the tailpipe. It includes soot, the soluble organic fraction which contains polycyclic aromatic hydrocarbons (PAHs), and sulphate. Secondary particulate is formed when the sulphur dioxide ( $\text{SO}_2$ ) emissions from diesel exhaust are converted to sulphate particulate in the atmosphere.





**Figure 4:** US Sources of PM<sub>2.5</sub> from the Transportation Sector

Diesel particulate matter (DPM) emissions have increased almost steadily since the introduction of diesel engines to the trucking industry first occurred in the 1930's. Although diesel fuel use has increased from one per cent of total fuel use in 1949 to 18 per cent in 1995 (U.S. Federal Highway Administration, 1995), DPM emission per individual vehicle have been reduced by roughly a factor of six by advances in control technologies and changes in diesel fuel chemical composition. Estimates of the contribution of diesel fueled vehicles to the total fine particulate burden in the United States and Canada are given in Figures 4 and 5, respectively.

**Figure 5:** Canadian Sources of PM<sub>2.5</sub> from the Transportation Sector

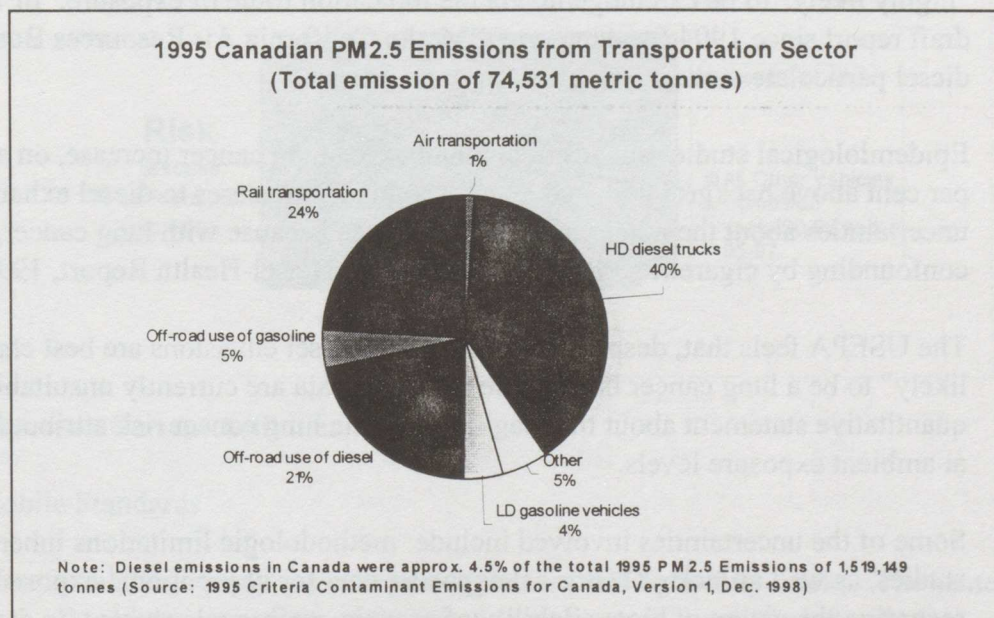




Table 12 displays California's estimated daily PM<sub>10</sub> emissions from on-road mobile sources. Heavy-duty diesel vehicles emit approximately 57 per cent of the total PM<sub>10</sub> emissions each day in California.

**Table 12:** California's Estimated Daily Emissions of PM<sub>10</sub> from vehicles  
(Total Daily Emissions — 51.19 tons)

VEHICLE CLASS	PM <sub>10</sub> (tons per day)	VEHICLE CLASS	PM <sub>10</sub> (tons per day)
Light-Duty Autos	7.29	Urban Diesel Buses	0.19
Light-Duty Trucks	7.16	Motor Homes	0.27
Medium-Duty Vehicles	6.1	Motorcycles	0.16
Heavy-Duty Vehicles	29.06	School Buses	0.96

*California Resources Board, Mobile Sources and Alternative Strategies, Subcommittees meeting, Nov. 17, 1999*

#### 6.2.3.1 Health Effects

In its previous reports, the Board has noted some of the negative environmental impacts associated with several of the primary constituents emitted from operating diesel engines. For example, diesel vehicles, through their release of nitrogen oxides, make a substantial contribution to the formation of ozone and acid rain. More recent concerns focus on diesel particulate matter (DPM) because of its potential carcinogenic effect in humans. In 1996 the USEPA in its Proposed Guideline for Carcinogen Risk Assessment, declared that diesel engine exhaust is "highly likely" to be carcinogenic via the inhalation route of exposure. In 1998, in their third draft report since 1994 focusing on DPM, the California Air Resources Board (CARB) identified diesel particulate matter as a "toxic air contaminant."

Epidemiological studies suggest that incidents of lung cancer increase, on average, about 33-47 per cent above background levels in occupational exposures to diesel exhaust. There are some uncertainties about the magnitude of the increase because with lung cancer, the question of confounding by cigarette smoke is present (EPA Diesel-Health Report, 1999).

The USEPA feels that, despite the finding that diesel emissions are best characterized as "highly likely" to be a lung cancer hazard, the available data are currently unsuitable to make a confident quantitative statement about the magnitude of the lung cancer risk attributable to those emissions at ambient exposure levels.

Some of the uncertainties involved include: methodologic limitations inherent in epidemiologic studies, as well as lack of historical exposure data for occupational exposed cohorts; uncertainties regarding the extent of bioavailability of organic compounds present on diesel particles and their



impact on the carcinogenic process; and other uncertainties regarding the mode of action of DE on lung cancer in humans.

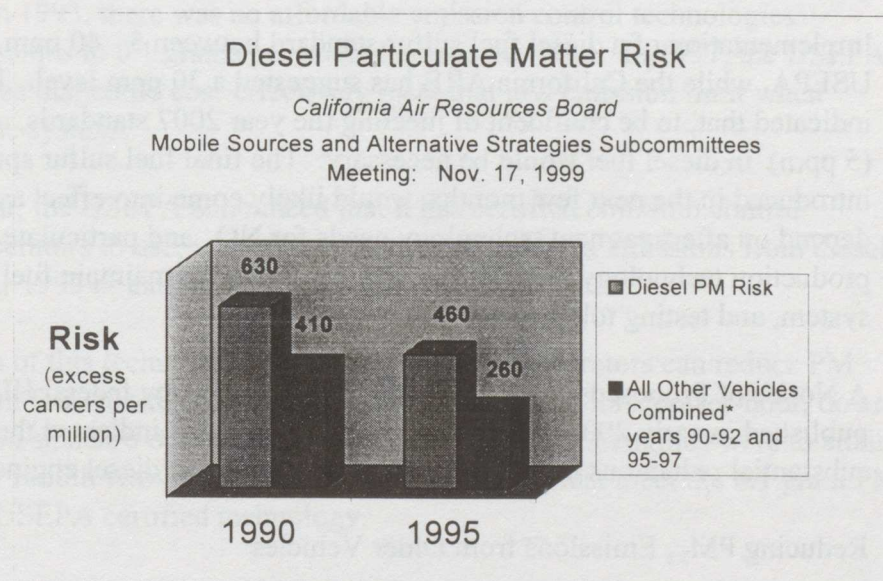
The California Air Resources Board (CARB) has established that diesel particulate matter increases respiratory disease, lung damage, cancer, premature death, reduced visibility, and surface soiling.

The CARB has established unit risk estimates for cancer from diesel exhaust particulates represented in Figure 6:

The primary health concerns surrounding human exposure to diesel exhaust include nonmalignant respiratory effects and lung carcinogenicity; however, an emerging area of concern is exacerbation or initiation of allergenic hypersensitivity.

Diesel engine emissions are considered an irritant to the human respiratory system given sufficient episodic exposure. A variety of inflammation-related symptoms may result which include, but are not limited to, headache, eye discomfort, asthma-like reactions, and nausea, depending on individual susceptibility to diesel emission constituents. A recommended human chronic exposure level to diesel exhaust without appreciable hazard from adverse noncancer respiratory effects is  $5 \mu\text{g}/\text{m}^3$  (Inhalation Reference Concentration, RfC).

**Figure 6:** Unit risk estimates from diesel exhaust particulates



#### 6.2.3.2 Diesel Regulations - Current Activities

##### i) US Tier 2 Mobile Standards

As mentioned, the Tier 2 standards apply for new passenger cars and light-duty trucks. The same standards will apply to all vehicles regardless of fuel used (gasoline and diesel-fueled vehicles



will be certified to the same NO<sub>x</sub> emission standard). However, the regulation has not yet addressed the issue of sulphur levels in diesel fuel.

The new standard is expected to require exhaust gas after-treatment technologies, including diesel particulate traps. Ultra low sulfur diesel (ULSD) fuel will also play a key "technology enabler" role in making the standard feasible. ULSD fuels improve the emission reduction effectiveness and durability of diesel oxidation catalysts and particulate filters and are expected to enable future advances in emission controls.

#### Emission Reductions Using Low Sulphur Diesel

Currently, in the US, the regulated level of sulphur in diesel fuel used in highway vehicles is set at 500 ppm, and averages between 300 and 400 ppm.

Recent test results on the use of particulate filters and diesel fuel with 30 ppm sulphur levels in test diesel engines indicated particulate traps achieve approximately 73 per cent efficiency (or 0.02 grams per brake horsepower-hour (g/bhp-hr)) in PM reduction. It allows for an emission level of 0.02 g/bhp-hr, which is a level being considered by the USEPA for the year 2007 regulations. The USEPA sees a potential for 70-90 per cent reduction in PM emissions by utilizing lower sulphur fuels, relative to today's standards. That is approximately a 0.01 g/bhp-hr PM standard, down from the 0.1 g/bhp-hr PM standard.

Implementation of a diesel fuel sulfur standard between 5 - 40 ppm is under consideration by the USEPA, while the California ARB has suggested a 30 ppm level. The engine manufacturers have indicated that, to be confident of meeting the year 2007 standards, a sulphur content of five ppm (5 ppm) in diesel fuel would be necessary. The final fuel sulfur specification, which may be introduced in the next few months, would likely come into effect as of the year 2007 and would depend on aftertreatment technology needs for NO<sub>x</sub> and particulate matter control, refinery production technology feasibility, costs, the ability to maintain fuel quality in the distribution system, and testing tolerances.

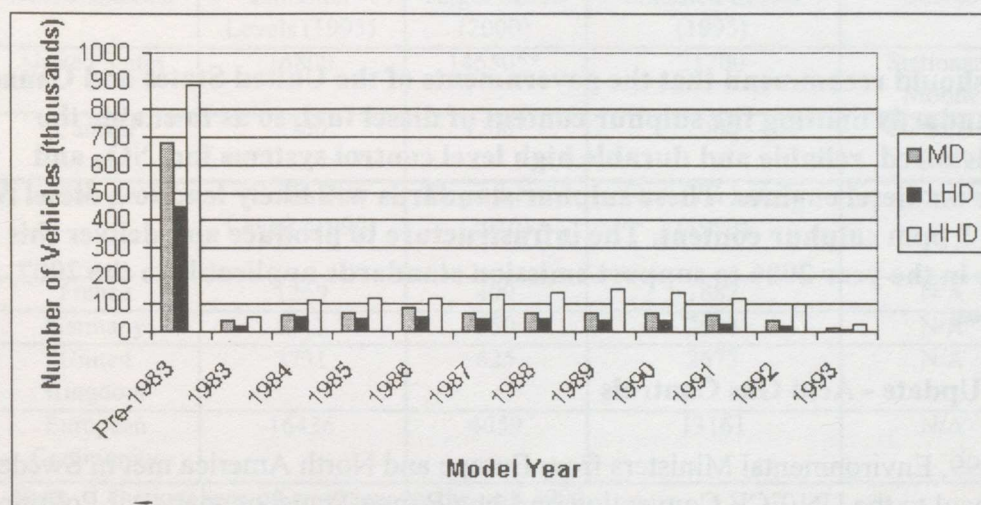
A Notice of Proposed Rule Making (NPRM) on the new federal HD standards is expected to be published in early 2000. Both the USEPA and CARB indicated they would also regulate substantial reductions in PM emissions from non-road diesel engines.

#### Reducing PM<sub>2.5</sub> Emissions from Older Vehicles

Understanding the prevalence of diesel engine penetration into the motor vehicle market is an important aspect of estimating the potential health effects of diesel exhaust emissions. According to data from the US Census of Transportation (1995), in 1992, out of the 1,966,200 Heavy Heavy-Duty (HHD) trucks in use, 87.8 per cent were diesel powered; out of the 732,000 Light Heavy-Duty (LHD) trucks in use, 35.8 per cent were diesel; and out of the 1,259,000 Medium Duty (MD) trucks in use, 25.9 per cent were diesel. For all three vehicle classes in 1992 there were a



large number of vehicles more than 10 years old: 54 per cent MD, 60 per cent LHD, and 43 per cent for HHD. Figure 7 displays the model distribution of in use trucks in 1992. For Heavy Heavy-Duty trucks, there were roughly 100,000 vehicles in each model year from 1983 to 1993 (USEPA Health Report).



**Figure 7:** Model Year Distribution of In-Use Truck Fleet in 1993

The USEPA certifies emission control technologies under its urban bus retrofit/rebuild program. Before the program began in 1993, there was no affordable emission control technologies available to reduce PM emissions to 0.1 grams per brake horsepower-hour. In 1997, the USEPA certified the first technologies that could cost-effectively meet that low emission limit when applied to older diesel engine systems.

In early February of this year, the USEPA announced that it has certified emission control technology for urban bus operators to use, in order to reduce PM and NOx emissions from diesel buses built in the model year 1993 or earlier.

Recognition and application of this technology means that urban bus operators can reduce PM emissions on their buses with four-stroke engines to 0.1 grams per brake horsepower-hour, down from the original certification standard of 0.6 gram PM that most pre-1993 engines were to attain when they were new. Many rebuilt two-stroke diesel engines already must meet the 0.1 gram PM standard because of earlier USEPA certified technology.

ii) Canadian Update

In Canada, particulate matter emissions were first regulated in the year 1988, when heavy-duty diesel emissions standards from the United States (0.1 g/bhp-hr PM standard) were adopted. The federal 'Diesel Fuel Regulations,' of January 1, 1998 also limit the sulphur concentration in diesel fuel used in on-road light-duty vehicles, light-duty trucks and heavy-duty vehicles to 500 ppm.



Designing a specific diesel engine for Canada to meet a distinct set of Canadian emission requirements would be inefficient from a manufacturing point of view, while at the same time increasing costs to the consumer. These considerations strongly argue for the continuation of harmonizing Canadian diesel vehicle emission standards with those in the United States.

### **Recommendation**

**The Commission should recommend that the governments of the United States and Canada move to adopt standards limiting the sulphur content of diesel fuel, so as to enable the introduction of advanced, reliable and durable high level control systems for NO<sub>x</sub> and particulate matter on diesel engines. These sulphur standards will likely lead to a diesel fuel with an estimated 5 ppm sulphur content. The infrastructure to produce and deliver this fuel must be place in the year 2006 to support emission standards applicable to the 2007 model year vehicles.**

### **6.3 European Update - Acid Gas Controls**

In December of 1999, Environmental Ministers from Europe and North America met in Sweden to sign a new Protocol to the UN/ECE Convention on Long Range Transboundary Air Pollution, 'The Protocol to Abate Acidification, Eutrophication and Ground-Level Ozone' aims to reduce emissions of sulphur oxides, VOC's, NO<sub>x</sub>'s and ammonia from energy generation, and industrial sources as well as motor vehicles.

The Protocol sets reduction targets for all four major pollutants. By the year 2010, Europe's sulphur dioxide emissions should be reduced by 63 per cent, its NO<sub>x</sub> emissions by 41 per cent, VOC emissions by 40 per cent and ammonia levels by 17 per cent compared to their 1990 levels. As participants in the UN/ECE, Canadian and US reductions in sulphur oxides, nitrogen oxide and VOC emissions will be incorporated when the protocol is ratified.

The protocol also sets limit values for specific emission sources and requires use of best available techniques including control of agricultural ammonia emissions.

Once all the targets are met, the area in Europe with excessive levels of acidification should shrink from 93 million hectares in 1990 to 15 million hectares in 2010. Those with excessive levels of eutrophication should fall from 165 million hectares in the year 1990 to 108 million hectares in the year 2010. Also, the number of excessive ozone days should be cut in half. Table 13 compares emissions, targets and target timeframes for North America and some selected European countries, illustrating that this issue is a global concern.



**Table 13:** SO<sub>x</sub> and NO<sub>x</sub> Emissions Comparison Between North America and Selected European Countries

Region	SO <sub>x</sub> Emissions (thousands of tonnes)		NO <sub>x</sub> Emissions (thousands of tonnes)		
	Emission Levels (1995)	Target Levels (2000)	Emission Levels (1995)	Source	Target Levels (2007)
<i>North America</i>					
United States	16800	14550**	21700	Stationary Mobile	6767 13333
Canada	2700	3200*	2000	Stationary Mobile	870 (for 2000) 530 (for 2000)
<i>Europe</i>	Emission Levels (1990)	Target Levels (2010)	Emission Levels (1990)	Source	Target Levels (2010)
France	1269	400	1882	N/A	860
Germany	5313	550	2693	N/A	1081
United Kingdom	3731	625	2673	N/A	1181
European Community	16436	4059	13161	N/A	6671

Note: \*national cap on emissions by the year 2000

\*\*sum of national cap for electric utilities and industrial source emissions by year 2000

Source: UN/ECE News, November 24, 1999.



## 7.0 CLIMATE CHANGE

### 7.1 US National Research Council Report

In the discussion over global warming, while surface temperatures tended to increase, satellite measurements indicate that the temperature of the lower to -troposphere exhibited a smaller rise of 0.0 to 0.2 degrees Celsius. Estimates based on balloon-borne observations tend to agree with the satellite readings. Because of this dilemma, the National Research Council of the National Academy of Science was asked to determine if the recorded surface values were accurate.

In the last few months, the Council has issued a report stating that the warming of the Earth's surface is "undoubtedly real," given a rise in surface temperatures in the past two decades substantially greater than the average for the past 100 years. The report indicates that the global-mean temperature at the earth's surface has risen by 0.25 to 0.40 degrees Celsius during the last two decades.

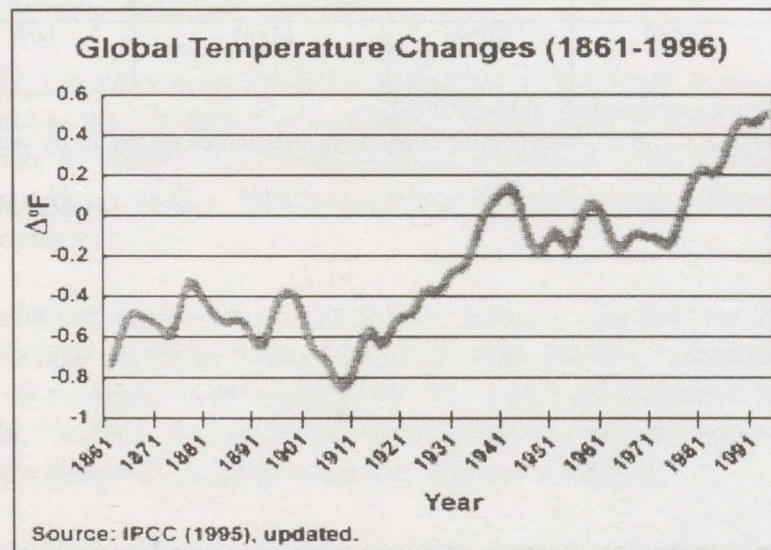


Figure 8: Temperature changes over time

In the opinion of the Council, the differences between the surface and upper air temperatures in no way invalidate the conclusion that the surface temperature of earth is rising. Actually, evidence suggests that the troposphere (lower atmosphere) may have warmed less rapidly than the surface from 1979 into the 90's, due to both human activities (stratospheric ozone depletion cools the upper troposphere, while the burning of coal and oil blocks the sun's heat rays from reaching the earth) and natural causes (volcanic eruptions).



The Council cautions that, although the temperature differences are real, temperature trends based on such short periods are not necessarily indicative of the long-term behavior of the climate system. Also, they did not ascribe these changes as an effect of greenhouse gas emissions.

Reducing uncertainties in the evaluation of temperature trends would require:

- an improved climate monitoring system;
- making raw and processed atmospheric measurements accessible.

The report also offers a number of possible research strategies for improving the understanding of uncertainties and the relationship between surface and upper-air temperatures.

## **7.2 Cuts in SO<sub>x</sub> to Control Acid Rain Could Increase Temperature**

A study released June 29, 1999, by the Pew Center on Global Climate Change predicts that worldwide cuts in sulphur emissions to reduce acid rain would cause the average global temperature to rise. The sulphate particles have a reflective quality, which directs the sun's light rays back out into space away from Earth, resulting in a cooling effect. As more countries reduce their sulphur emissions around the world, the foundation claims that the sulphur blanket will weaken, and more heat energy will penetrate the atmosphere, eventually adding to the global warming effect.

This study suggests that the predicted warming of just the greenhouse gases alone will be magnified, increasing heat energy contacting the Earth's surface.

The effects predicted by the Pew Center study include:

- temperature extremes during warm weather will become more frequent;
- temperature extremes during cold weather will become less frequent;
- the frequency of torrential rainstorms, major snowstorms and other large precipitation events is likely to increase; and,
- the amount of rainfall associated with hurricanes is likely to increase.

The Pew Center on Global Climate concludes that the "data and likely impacts outlined in this study should encourage concrete steps to reduce greenhouse gas emissions."

## **7.3 Possible Impacts**

A review of available data has shown that the global mean surface temperatures have increased 0.6 - 1.2 °F since the late 19<sup>th</sup> century. The 20<sup>th</sup> century's 10 warmest years all occurred within the last 15 years. Corresponding with this warming, alpine glaciers have been retreating, sea levels have risen, and climatic regions are shifting.



Many physical and biological processes are climate dependent. Scientists expect long-term shifts in average climatic conditions and/or a change in the frequency of extreme climate events as a result of climate change; both will have significant direct and indirect impacts on lands, oceans and resources. The possible impacts of climate change as determined by the Intergovernmental Panel on Climate Change (IPCC) are summarized below.

### *Key Impacts of Climate Change to Physical, Biological and Socioeconomic Systems*

#### Ecosystems

- Increased temperatures could reduce sub-arctic ecosystems. Loss of migratory wildfowl, mammal breeding and forage habitats may occur within the tundra, which is projected to nearly disappear from mainland areas.
- The relatively certain northward shift of the southern boundary of permafrost areas will impact ecosystems, infrastructure, and wildlife in the altered areas through terrain slumping, increased sediment loadings to rivers and lakes, and dramatically altered hydrology.
- Elevated CO<sub>2</sub> concentrations may alter the nitrogen cycle, drought survival mechanisms, and fire frequency - potentially decreasing forage quality and impacting forage production on rangelands.
- Arid lands may increase.
- Landslides and debris flows in unstable Rocky Mountain areas and possibly elsewhere could become more common.
- Forests may die or decline in density in some regions because of drought, pest infestations, and fire; and in other regions, forests may increase in both area and density.
- Geographic ranges of forest ecosystems are expected to shift northward and upward in altitude, but not as rapidly as the climate is projected to change.
- Longer forest fire seasons and potentially more frequent and larger fires are likely.

#### Hydrology and Water Resources

- Increases or decreases in annual runoff could occur over much of the lower latitudes and in -continental regions of and high latitudes.
- Climate projections suggest increased runoff in winter and early spring but reduced flows during summer in regions in which hydrology is dominated by snowmelt. Glaciers are



## Coastal Systems

- In the next century, rising sea levels could inundate approximately 50 per cent of North American coastal wetlands and a significant portion of dry land areas that currently are less than 50cm above sea level.
- Rising sea levels are likely to increase flooding of low-lying coastal areas
- Saltwater is likely to intrude further inland and upstream.

## Human Settlements and Industry

- Projected changes in climate could increase risks to property and human health/life as a result of changes in exposure to natural hazards.
- Climate warming could result in increased demand for cooling energy and decreased demand for heating energy, with the overall net effect varying among geographic regions.

## Human Health

- Direct health effects include increased heat-related mortality and illness and the beneficial effects of milder winters on cold-related mortality.
- Climate warming may exacerbate respiratory disorders associated with reduced air quality.
- Changing climate conditions may lead to the northward spread of infectious diseases and potentially enhance transmission dynamics due to warmer ambient temperatures.

### **7.4 Currently Observed Phenomena**

This section describes a number of observed phenomena related to recent warming trends, which may be indicative of some of the effects of a longer-term global warming should such a warming trend be verified. A study by the University of Washington determined that the Arctic ice has thinned about 40 per cent over the last 18 years; there is evidence that the thinning accelerated in the 1990's.

By studying aerial and satellite pictures, Canadian scientists have found a long-term decline in the area of the ice cap of about three per cent a decade since the year 1978. In some parts of the Canadian Arctic, the shrinkage is even more pronounced. In the Hudson Bay region, the area of ice has shrunk by more than 30 per cent since the year 1978. Because of this shrinkage and warming, polar bears are starving; the floes they need to carry them to their fishing grounds on the open sea have melted. Houses once built solidly on permafrost are falling into the sea, while



others are split by the melting and cracking of the permafrost. Arctic ice is melting at an accelerated rate such that the North West Passage may be navigable by regular ships for part or all of the year in as little as 10 to 15 years.

Recent research, to be completed in the year 2002, indicates that the ocean water is both warmer than in the year 1975 and much less salty, which are both signs of rapid melting. The melting process is known as a 'positive feedback mechanism.' When ice is covered with snow, it reflects energy back up to the atmosphere, but when it starts to melt, the black of the water collects solar radiation and accelerates the process. As noted above, there are concerns about large scale flooding, drought and species extinction as a result of this melting.

## 7.5 Commitment to Kyoto

In 1997, 160 countries drafted the Kyoto Protocol, which called for countries to severely reduce their emission of carbon dioxide (CO<sub>2</sub>) and five other gases, with a target of reducing emissions an average of five per cent below the 1990 levels (6 per cent for Canada, 7 per cent for the US and 8 per cent for the European Union (EU)). The magnitude of this challenge varies from region to region. For example Germany, with the integration of the former East Germany, has seen many major sources closed completely since 1990. However, Canada, has increased its CO<sub>2</sub> emissions substantially since that time; some estimates indicate that a cut of 25 per cent would be required to meet its year 2010 emissions target. However, the Protocol would allow countries to meet their target levels by trading emissions commitments with other countries emitting less than their target.

In order for the developed nations to meet Kyoto targets, it is suggested that they:

- replace carbon-intensive fuels with fuels containing less or no carbon;
- seriously curtail the use of energy; and,
- reduce emissions, through the adoption and invention of new technology.

### 7.5.1 The Cost of Carbon

A recent article in the "Economist" (January 22, 2000) asked, 'What is the cost of carbon?'. Currently industries can emit carbon dioxide, the main agent suspected of causing global warming, free of charge, since there are no regulations specific to its control. The 1997 Kyoto Protocol seeks stringent restrictions on greenhouse gas emissions and advocates international trade in emissions to lower compliance costs. In anticipation of this and other possible regulations, a market has sprung up suggesting a price for carbon emissions. An emissions broker at Natsource, a leading over-the-counter broker of energy products, states that companies have



already begun trading greenhouse gases, and the most recent trades have been at \$1 to \$3 per tonne.

The world's largest single trade in greenhouse gas emission reduction credits was concluded October 29, 1999, in Toronto, Canada. Ontario Power Generation (OPG), formerly known as Ontario Hydro, purchased credits equivalent to 2.5 million tonnes of CO<sub>2</sub> from the US based Zahren Alternative Power Corporation. The company generated the credits through its collection and combustion of landfill gas (methane). Without methane collection systems, the gas would have vented into the atmosphere.

OPG has voluntarily committed to cap its greenhouse gas emissions at 26 million tons, its 1990 emission level, from the year 2000 and forward.

As the price of carbon rises, it is likely that more companies will become interested in cutting emissions. It is conceivable that the price of carbon could rise to a value between \$15 and \$30 per tonne. Some countries such as Japan, that have a comparatively more energy-efficient economy might not find such pricing attractive, but less efficient countries, such as US and Canada, may find it appealing.

Large businesses are realizing that, whatever happens under the Kyoto Protocol, emissions restrictions appear inevitable in the next 5 years. Royal Dutch/Shell, has promised to cut their greenhouse gas emissions to 10 per cent below their 1990 levels within 3 years. Apparently Shell has started to use shadow carbon prices, that is, all large investments are to be analyzed to see if they provide fair returns if carbon emissions are priced at \$5, \$20 or \$40 per tonne.

Also, some investors in agriculture and forestry anticipate that the price of carbon emissions will rise to a much higher value. Drawing carbon dioxide out of the air and into the trees and plants (biomass) is the only known practical method to remove large quantities of greenhouse gas from the atmosphere. The final Kyoto treaty may include provisions to permit a trade in the carbon stored naturally in forests and farms (carbon 'sinks'), which may lead polluting companies to pay the owners of such carbon 'sinks' for emission credits to meet their own requirements. Large investment flows into rural areas are expected if the market for carbon management takes root and rises significantly.

Canada is one country that is severely challenged by the Kyoto Protocol. National greenhouse gas emissions are 9 per cent above the 1990 totals. Under the Kyoto protocol, Canada is to reduce emission levels to six per cent below 1990 levels by the year 2010. However, if Canada carries on at its present pace of economic growth, without implementing any climate change programs, they will miss their Kyoto target by at least 25 per cent in 2010. In recognition of this dilemma, in its most recent budget, the Canadian government has invested several million dollars in the development of strategies to cope with climate change.



Canada could fulfill at least part of its required carbon cuts by buying emissions allowances from other countries. Potential sellers would likely include Russia and Ukraine, because their industrial base has actually declined since 1990 and thus they are likely to have more emission credits than they can use domestically. However, some view this as a mechanism that would allow Canada to avoid action to reduce emissions from domestic sources.

Canada and other countries maintain they should receive emissions credits for proper forest management, because forests, in their use of carbon dioxide for photosynthesis, decrease its concentration in the atmosphere. Canada has also asked for credits for exporting nuclear reactors to developing countries, a plan which was rejected by many European countries because of unanswered questions about disposal of nuclear waste.

Australian firms have worked out a clever way to measure, and trade, the carbon dioxide stored in trees. Firms pay companies to plant and manage forests, and in return, receive tradable emission credits. Pacific Power and Delta Energy, two local firms, and Tokyo Electric Power Company have already committed themselves to such an arrangement.

#### 7.5.2 The World Bank Prototype Carbon Fund

In January, the World Bank launched the Prototype Carbon Fund (PCF) which aims to set a figure on the cost of carbon emissions. Its objectives include:

*i) High quality emission reductions*

- The PCF is intended to invest in projects that will produce high quality greenhouse gas emission reductions that could be registered with the United Nations Framework Convention on Climate Change (UNFCCC) for purposes of the Kyoto Protocol.

*ii) Knowledge*

- The PCF would maximize the value of its experience by collecting, analyzing, and disseminating information and knowledge to NGO's, governments, private sector interests, and any other stakeholders involved in the climate change negotiations.

*iii) Public-Private Partnership*

- PCF will draw upon both public and private sectors, while demonstrating how insights and experience from both sectors can be pooled to mobilize additional resources to address global environmental concerns.



Some of the participants in the Fund are given in Table 14.

**Table 14:** Prototype Carbon Fund Participants - US and Canadian

<b>Company</b>	<b>Sector</b>	<b>Country</b>
Environmental Bank Exchange, Ltd.	Financial	US
Hydro Quebec	Electricity	Canada
Ontario Power Generation	Electricity	Canada
Shell/Canada/Shell International	Oil	Canada

The PCF aims to invest in projects linked with green technologies, such as renewable energy and solar power, thus reducing greenhouse gas emissions. Reductions are to be verified by independent experts, and transferred as emission credits to the fund's investors, which include such companies as Electrabel of Belgium, several Japan utilities and various Nordic governments. The recent Canadian Federal budget announced a \$15 million contribution to the fund.

Projects are selected and established by the World Bank. The first project will be to capture greenhouse gases (largely methane) from open landfills in Latvia, and use them to produce electricity.



## 8.0 TOXIC PERSISTENT SUBSTANCES

### 8.1 Toxic Releases from Power Plants

Along with the emission of acid rain/smog causing pollutants, the utility sector is also responsible for the release of toxic metals including arsenic, cadmium, hexavalent chromium, lead, mercury and nickel.

As of 1998, electric power plants burning coal or oil must estimate and report their annual releases of toxic substances listed in the US Toxics Release Inventory (TRI). The TRI is a comprehensive public database of annual emissions to air, water and land of over 600 chemicals and chemical categories designated as toxic by the USEPA. Any facility within a listed industry sector is required to report to TRI if it has the equivalent of 10 or more full-time employees and 'manufacturers' or 'processes' more than 25,000 lbs of any listed chemical during the reporting year or 'otherwise uses' more than 10,000 lbs per year of any listed chemical. For mercury and other chemicals that never will be produced in greater amounts than the reportable threshold noted above, the USEPA has proposed lowering the reporting threshold to 10 lbs/yr beginning in the year 2000. At this proposed value, mercury would become reportable for most coal-fired plants. The primary focus of the reporting is on coal-fired power plants, which are the dominant source of US power generation, accounting for roughly 50 per cent of electricity production.

The newly listed facilities are given a year following the report year to submit their TRI emissions to the EPA. There is usually a one year lag period before the EPA makes the emissions inventory available to the public.

Any of the 17 metals in Table 15 below, that are 'manufactured' in amounts totaling more than 25000 lbs/yr are reportable. However, affected sources are not required to conduct any new measurement programs for purposes of TRI reporting; rather a facility can estimate its reportable emissions using currently available information.

Most US power plants do not measure emissions of trace substances, and many coal-fired plants lack data on the trace substance content of the coals they burn. To estimate the TRI releases in the absence of site-specific data, a computer model has been developed, called the PISCES model. It employs a fundamental mass balance approach to account for multimedia flows of chemical substances in fossil fuel power plants. The PISCES Model is used to identify and quantify reportable TRI chemical releases for a representative coal-fired power plant design, determined to be a 650 MW facility, burning an average 1995 bituminous coal (28380 kJ/kg, 1.5 per cent

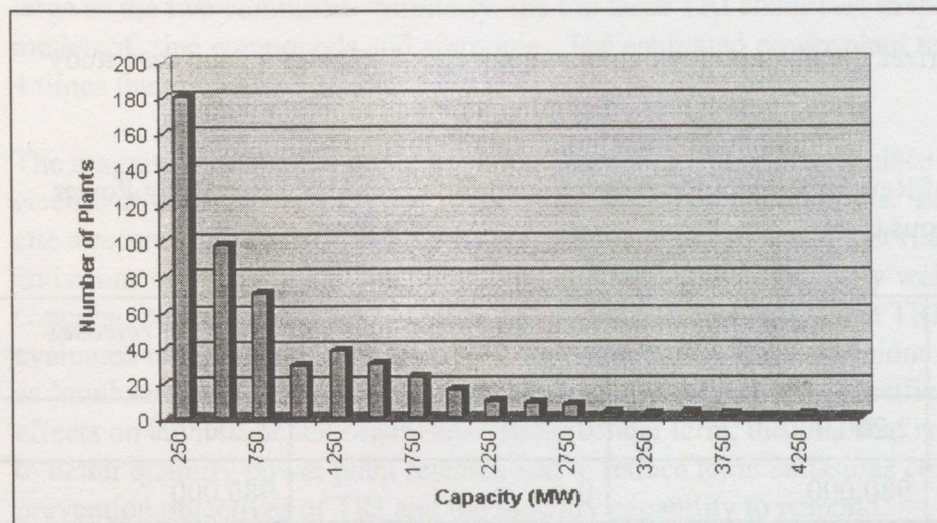


**Table 15:** Toxic Release Inventory Chemicals Potentially Relevant to the Electric Utility Industry (Source: Environmental Science and Technology, September, 1999)

metals	organics	other
antimony	benzene	ammonia
arsenic	dichloromethane	asbestos
barium	ethylbenze	chlorine
beryllium	ethylene glycol	chlorine dioxide
cadmium	formaldehyde	hydrazine
chromium	formic acid	hydrogen fluoride
cobalt	methanol	hydrochloric acid
copper	naphthalene	nitric acid
lead	PCB's	ozone
manganese	polycyclic aromatics	sulphuric acid
mercury	propylene	thiourea
molybdenum	toluene	
nickel	xylene	
selenium		
silver		
thallium		
zinc		



sulphur, 9.8 per cent ash, 6.7 per cent moisture) operating in compliance with the Phase I acid rain emissions cap. This plant size was selected to approximate the average size of US coal-fired facilities, whose sizes span a large range (see Figure 9).



**Figure 9:** Size Distribution of US Coal-Fired Power Plants, 1994

The trace element concentrations in coal were taken as median values for all bituminous coal used for power generation, as reflected by approximately 200 coal samples in the PISCES database.

The PISCES study determined that the reportable releases for the representative plant included seven of the 17 metals in the previous table, plus hydrochloric acid, hydrogen fluoride and sulphuric acid aerosols. The dominant emissions are HCl (hydrochloric acid) and H<sub>2</sub>SO<sub>4</sub> (sulphuric acid); HCl accounts for 56 per cent and H<sub>2</sub>SO<sub>4</sub> for 24 per cent of the total mass of emissions. Overall, air releases amount for 85 per cent of the total plant release inventory; land releases are 15 per cent and trace metal air emissions are less than 0.1 per cent of the total. Total toxic releases for this average plant exceed 4 million pounds per year.

The case study was intended to provide representative estimates of power plant TRI releases. However, the nature and quantity of such releases will vary significantly across the population of US coal-fired plants. A number of factors affecting reportable releases include:

- Plant size and operation:* The size of a given facility is a key determinant of annual chemical discharges. Chemical releases would scale in proportion to plant size, if all other factors are held constant. Larger plants or higher capacity values also can cause additional chemical species to exceed the TRI threshold and become reportable.
- Fuel Properties:* Variations in coal composition across the US can have a marked impact on the number of reportable TRI chemicals and the magnitude of TRI releases.



- *Plant Configuration:* The specific configuration of a power plant can have a marked effect on the magnitude of chemical releases to different environmental media.

The table below summarizes the magnitude of combustion-related releases for the case study facility.

**Table 16:** Summary of Reportable TRI Releases (lbs/yr) for a 650 MW Case Study Power Plant Burning Bituminous Coal

<i>chemical</i>	<i>air releases</i>	<i>land releases</i>	<i>total releases</i>
hydrochloric acid	2,200,000	0	2,200,000
sulphuric acid	980,000	0	980,000
barium	830	270,000	280,000
hydrogen fluoride	180,000	0	180,000
manganese	540	65,000	66,000
zinc	290	64,000	64,000
copper	470	60,000	61,000
chromium	460	54,000	54,000
nickel	220	47,000	47,000
arsenic	750	20,000	20,900
total	3,390,000	618,000	4,010,000

*Source: Environmental Science and Technology, September, 1999.*

- *Plant Operating Practices:* Plant operating practices can influence the types and quantities of TRI chemicals that are otherwise used since utilities may have a choice of chemicals employed for water treatment and plant maintenance activities that contribute to TRI releases.

The analysis suggests that the dominant chemical emissions from most coal-fired power plants in the US will exceed the reporting thresholds for the Toxics Release Inventory (25,000 lbs/year). Some oil-fired facilities also may have reportable emissions.



Emissions from the electric utility sector will substantially alter the national picture of toxic releases currently portrayed by the TRI. For comparison, the total 1996 release for the US chemical industry was 785 million lbs and, for the metals industry, 564 million lbs. These have been the two top industry groups on the TRI in the recent years. The total estimated utility release of over one billion pounds/year substantially exceeds either of these industries and could be as large as the two combined. Similarly, the top three TRI chemicals in the past have been methanol, zinc compounds and ammonia. The estimated power plant releases of HCl alone is 2 to 4 times their values.

The magnitude and prominence of power plant toxic releases will place increasing pressure on the electric utility industry and EPA to explain and interpret TRI results. Electric utilities will likely cite a recent EPA study of hazardous air pollutants which found that risks from power plant emissions of HCl, mercury and other TRI substances were typically well below the level of concern. At the same time, EPA can be expected to emphasize that TRI data are intended to be evaluated in the context of site specific and community-level situations and that designations such as 'nonhazardous' do not necessarily imply the absence of site -specific risks or toxicological effects on environmental organisms. In the longer term, the TRI also is likely to stimulate efforts to better quantify power plant releases and to reduce toxic emissions consistent with the pollution prevention objectives of TRI and the industry capability to respond.

## 8.2 Mercury

### 8.2.1 Great Lakes Binational Toxics Strategy

The Binational Toxics Strategy was signed by Canada and the US in 1997. It is a strategy to virtually eliminate Level 1 and Level 2 persistent toxic substances, some 40 in all, including mercury, in the Great Lakes and the surrounding areas.

#### US Mercury Challenge and Progress:

- to achieve a 50 per cent reduction in mercury use *nationwide* by 2006, and a 50 per cent reduction in the aggregate of US air emissions; *nationwide* and releases to water in the Great Lakes [emphasis added]
- Use: 21 per cent reduction achieved from 1995-1997 levels
- Release: 28 per cent reduction from 1990-1995 levels

#### Canadian Mercury Challenge and Progress:

- to achieve a 90 per cent reduction in the release of mercury, or where warranted, the use of mercury *in the Great Lakes Basin*, by 2000 [emphasis added]
- Release: 73 per cent reduction from 1988 levels



## 8.2.2 New England Governors/Atlantic Premiers - Mercury Action Plan

The New England Governors/Eastern Canadian Premiers *Mercury Action Plan* (1998), has set an overall regional objective of reducing mercury emissions by at least 50 per cent, by year 2003. These reductions will be carried out through emission reductions as well as source reductions.

The Mercury Reduction Plan recommends the following:

1. Municipal Solid Waste Combustors: Regionally adopt a 0.028 mg/dscm (dry standard cubic meter) mercury emission limit for large facilities (250 tons/day or more). Limits for smaller units would be on a case-by-case basis.
2. Medical Waste Incinerators: Regionally adopt a 0.055 mg/dscm emission limit. Evaluate the feasibility of adopting the 0.028 mg/dscm limit or lower within 3 years.
3. Sewage/Sludge Incinerators: Evaluate the feasibility of adopting a 0.1 mg/dscm limit.
4. Utility and Non-Utility Boilers: Adopt technologically and economically feasible control strategies or practices to reduce emissions. Identify mercury emission control options and regional emission reduction targets for these sources within one year (by June 1999), and begin implementation of the regional reduction strategies by the year 2003.

### 8.2.2.1 Coal Boiler Mercury Control Technology Options and Targets

The Mercury and Acid Rain Workgroups, established under the Conference, has focused on fulfilling the commitments concerning utility boilers and related mercury and acid gas emissions adopted by the Conference of New England Governors and Eastern Canadian Premiers on October 5, 1999. Their study of control options and reduction targets for electrical utilities recognized the need for a multi-pollutant control strategy.

In further development of a 'Mercury Action Plan,' the Joint Coal Boiler Workgroup, drawing on members from the *Acid Rain Steering Committee* and the *Mercury Task Force*, proposed action on the following objectives consistent with a multi-pollutant approach.

- Complete a cross cutting investigation of new technologies to reduce mercury, sulphur dioxide (SO<sub>2</sub>), and nitrogen oxide (NO<sub>x</sub>) emissions from coal-burning boilers.
- Encourage further studies to assess technical and economic characteristics
- Recommend control options and targets.

The Workgroup believed that the economic feasibility of controlling mercury emissions from coal-fired boilers could be evaluated by estimating the costs, both capital and operating, of emerging and available controlling technologies, and pricing these on the basis of an increase in cost (in cents) per kWh of electricity to the residential consumer.



Based on estimates in the March 1999 EPA report 'Analysis of Emissions Reductions Options for the Electric Power Industry', a 70 per cent reduction of current utility mercury emissions in the US is expected to cost approximately \$1.7 - 1.9 billion per year (or about \$20,000/lb mercury reduced). The estimated equivalent cost to consumers would be an increase of 0.2 - 0.3 cents per kWh (or about a 2 - 3 per cent increase on the consumers monthly bill). These estimated costs are largely similar to those associated with NO<sub>x</sub> removal from boilers in the part of the US subject to the revised NO<sub>x</sub> SIP Call.

While the estimated cost for mercury reduction can be assigned to the reduction of mercury alone, in reality, current control technologies can also reduce other pollutants simultaneously. For example, wet scrubbing reduces mercury emissions, and has the potential to also eliminate a significant portion of sulphur dioxide and particulate emissions. Along with control technologies, conversion of coal-fired boilers to natural gas fuel would reduce emissions of SO<sub>2</sub>, NO<sub>x</sub>, and mercury substantially. Thus, the technologies for mercury control must be evaluated for their cost effectiveness in ameliorating the entire utility emissions stream.

#### *Deregulation and Standards*

The targets and goals suggested by the Joint Coal Boiler Workgroup take into account the expected joint benefits (multi-pollutant reduction) of potential control technologies. The need to establish a common cost calculation method for this multi-pollutant approach is also emphasized in the report to the Governors and Premiers.

Currently, most Northeast states have taken steps to restructure the utility industry and introduce competition in electricity generation. Deregulation was expected to provide significant economic benefits for industry and perhaps consumers; however, if not appropriately bounded, it could lead to a noticeable increase in the negative environmental impact of the electricity industry.

In order to address this concern, state and local regulatory agencies are establishing a variety of laws and regulations, including Emission Performance Standards (EPSs) and information disclosure. An Emission Performance Standard requires that the average emission rates of the electricity created and marketed be at or below a specific EPS level for each pollutant. Failure to comply with the EPS could lead to withdrawal of the supplier's license to sell electricity within a given region.

Information disclosure procedures have been developed by some states to educate consumers about the environmental consequences of their electricity purchase decisions, and allow for 'comparison shopping.' Typically, suppliers are to indicate their supply fuel characteristics and emission rates to consumers, including a comparison of the latter to the emissions performance benchmarks.

When combined, EPSs and information disclosure could encourage the purchase of electricity from cleaner, more efficient generating facilities. However, effective implementation of these provisions would require the establishment of verified information systems linking suppliers'



power supply characteristics to specific electricity generating facilities.

i) *Recommendation to Offset Emissions of 'New' Mercury*

'New' mercury is mercury released from below the earth's surface as a result of natural and industrial processes. While many of these actions described above, if implemented, would curtail 'new' mercury emissions, even after the best controls, some residual emissions of 'new' mercury may occur.

To minimize the addition of mercury to the global pool, it is recommended that the post-control emissions of mercury from all coal-burning electric power generators be required to be offset by a reduction of an equal or greater amount from the existing global pool, as long as emissions from the generator continue. To ensure permanent removal, a national repository for the safe storage of mercury so recovered is recommended.

ii) *Emissions Reduction Timelines and Targets*

The Joint Coal Boiler Workgroup is developing proposed emission targets and timelines for mercury, sulphur dioxide, and oxides of nitrogen from coal-burning electrical facilities for consideration by the Conference. The targets are preliminary and are regional goals, rather than jurisdictional or point source measures.

At the moment, the workgroup is considering total mercury reductions from coal-fired utilities of approximately 70-90 per cent from 1995 levels by approximately the year 2010, accompanied by simultaneous reductions of NO<sub>x</sub>\* and SO<sub>2</sub> of 50 per cent within the same timeframe, through the implementation of the NEG/ECP Acid Rain Plan and the Canada-wide Standards.

Regulations to achieve these reductions should be based on performance standards and emission rate limits, not percentage reductions.

New control standards for mercury, and NO<sub>x</sub> are also under consideration by the Group for coal-fired industrial/commercial/institutional (ICI) boilers with a rating greater or equal to 250 mmBTU per hour gross heat input.

\*Note: The input to output conversion factor found in the USEPA's New Source Performance Standard for both utility and industrial units, is 0.15 lb NO<sub>x</sub>/mm BTU heat input, approximately equivalent to an 1.6 lb NO<sub>x</sub>/MWh gross output.

8.2.3 Commission for Environmental Co-operation (CEC): Utility Mercury Reduction Workshop/Output

In North America, coal-fired electric utility boilers represent the largest source of anthropogenic mercury emissions. It is the only source that continues to operate in the absence of a mercury reduction strategy. In an effort to address this issue, in March of 1999, the CEC organized a



meeting of air quality professionals in Montreal, Canada. As a result of the meeting, a number of findings and recommendations for action were developed, specific to the reduction of mercury from coal-fired electric generation plants. An edited selection of these is reproduced here, along with the table (Table 17) of some of the CEC technical findings on this issue.

*Finding 1 - Data Acquisition and Dissemination*

- The quality and quantity of mercury emissions data from coal-fired power plants be improved for the public and policy makers.

*It is Recommended That:*

- By December 31, 2000, the threshold limit for mercury emissions for inclusion in the pollutant release and transfer registers of the countries in North America be lowered to amounts that: (1) better reflect the level of impact associated with this pollutant, and (2) would result in the reporting of mercury emissions from a majority of coal-fired power plants in each country.
- All load serving entities in North America be required to disclose both their pollutant emissions characteristics, and fuel sources of the power sold to all individual, including residential, retail customers.
- The initial verification of emission factors for mercury from coal-fired utility boilers be completed by no later than June 30 of this year. These factors should be used to determine mercury emissions per unit of energy produced. This value should be benchmarked against a national average of all retail suppliers and reported on consumers' monthly bills.
- Sampling and analyses of the mercury content of coal, as well as emissions stack testing, should be extended to ensure the quality of emissions data.

*Finding 2 - Role of Technology-Forcing Performance Standards*

- It appears that coal will continue to be a dominant fuel in North American power plants, for some time in the future.

*It is Recommended That:*

- A national, technology forcing performance standard, to achieve a 90 per cent reduction in mercury from all existing and new coal-fired utility boilers, be proposed on or before December 31, 2003, and final compliance required within 2007 to 2010 time frame. Incidental reductions of mercury resulting from the control of other pollutants should be considered part of the 90 per cent requirement.
- Public funding be made available in sufficient amounts to ensure completion of the needed demonstration projects for the most promising mercury reduction technologies by June 30, 2003.



- The handling and storage of mercury contaminated waste be controlled so as not to allow re-entry into the environment.

***Finding 3 - Retail Supply Standard***

- Alternative energy sources such as wind, solar, etc., have the capacity to meet a greater portion of the current and future demands for electricity, therefore reducing the resultant pollution emissions.

*It is Recommended That:*

- Retail supply standards be initiated, which promote maximum use of renewable energy, cleaner technologies and alternative fuels. A retail supply standard would take the form of a mass emission of mercury per unit of electrical power produced.

***Finding 4 - Use of Market-Based Strategies***

- Appropriate and bounded market-based strategies have the potential to lower the overall level of bio-accumulative, neurotoxic exposure to mercury without increasing individual exposure

*It is Recommended That:*

- No market-based approaches be employed which create the opportunity for increased individual exposure to mercury.
- Market-based approaches serve to augment traditional regulatory approaches, not replace them.
- In the evaluation of any market-based approach, uncertainties in measurement and environmental impacts be interpreted conservatively.

***Finding 5 - Multi-Pollutant Benefits***

- Control strategies are developed on a pollutant-by-pollutant basis. As a result, even though a control device could reduce the emissions of several pollutants, it is viewed in a single pollutant context. This inflates the cost by assigning the full cost of the emission control strategy to the targeted pollutant, while ignoring the environmental benefits realized in the control of other pollutants.

*It is Recommended That:*

- Mercury emission control strategies should continue to focus on maximizing mercury emission reductions. However, in evaluating a given control strategy, its benefit and/or cost effectiveness should be considered within the context of the whole emissions stream, including SO<sub>2</sub>, NO<sub>x</sub>, PM and carbon dioxide.



**Table 17.** Outputs of Commission for Environmental Cooperation- Findings of Utility Technology Workshops

Characteristics of Coal-Fired Boilers, Fuel Use, and Pollution Control Systems:

- 23 plants in Canada release two tons of mercury per year;
- currently, there are a reported two plants in Mexico; a third plant is being converted from oil to coal
- 1035 boilers in the United States release 52 tons per year (TPY) of Hg emissions
- the Northeast states emit about 2 TPY out of the total mercury released
- seven per cent of US utilities use baghouses for PM control
- 10 per cent of US utilities have wet scrubbers for SO<sub>x</sub> control
- post-combustion NO<sub>x</sub> control is in its infancy

Transport and Deposition

- Thirty-three per cent of US anthropogenic emissions are deposited within the US, with the remainder becoming part of the global reservoir.
- Twenty per cent of anthropogenic emissions are deposited into the US from the global reservoir.

#### 8.2.4 Canada-wide Standard for Mercury

Once a mercury molecule is in the atmosphere, it can circle the globe several times before returning to earth, and entering the streams, lakes, forests and fields. Mercury levels in most wildlife and fish have not declined over the last ten years, notwithstanding the reduction in anthropogenic mercury emissions. This is largely due to the continuing cycling of anthropogenic and natural emissions around the globe.

The mercury levels in wildlife and fish in most parts of Canada are at a level that consumption is cautioned by the government. This deprives some communities, particularly First Nations, of a substantial portion of their traditional diet.

Canada maintains that a large part of the threat comes from the mercury emitted by other countries in North America and around the world reaching Canada by atmospheric transport. Therefore, while controlling Canadian emissions will reduce the overall burden, it alone will not eliminate the problem.

In developing the Canada-wide standards for mercury, the Ministers noted that three sectors contribute significantly to the total anthropogenic mercury emissions of 12 tonnes/year; the base



metal mining sector (2.8 T/y), waste incineration (1.2 T/yr) and coal-fired electrical generation (1.5 T/yr).

The CCME proceeded to propose standards for two of the three segments; base metal mining and incineration. In the case of the third sector, coal-fired utilities, they indicated that the complexity of the issue would preclude completion of a standard into the latter part of 2000.

i.) *Base Metal Smelting*

Canada's largest industrial source for mercury emissions has always been base metal smelting. Since 1988, Canada's leading smelters have lowered their emissions by 94 per cent, but further reductions will be required.

For *new and expanded facilities*, the proposed emission guideline is .2 g mercury per tonne of finished zinc, nickel and lead, and 1 g/tonne of finished copper, as well as a consideration of a mercury offset in which a new facility will recover and retire an amount of mercury equivalent to its annual emissions to ensure no 'net' emissions increases. The guideline for *existing facilities* is set at 2 grams of mercury per tonne of total production of finished metals. All facilities are expected to make a 'determined effort' to meet the standard by year 2008. Attainment of this standard at current production levels should reduce mercury emissions by 800 kg/yr by that year.

ii.) *Incineration*

Estimated emissions within the incineration sector include 446 kg/yr from municipal waste incinerators, 250 kg/yr from medical waste incinerators, 550 kg/yr from hazardous waste and 285 kg/yr from sewage sludge incineration facilities. Changes in waste content, treatment technology and processes have reduced the mercury content in incinerator emissions by an estimated 60 per cent since 1990.

For *new and expanded facilities*, the following standards would apply immediately

- For municipal waste incinerators, a stack gas concentration of 20  $\mu\text{g}/\text{Rm}^3$  at 11 per cent  $\text{O}_2$
- Medical waste incinerators, a stack gas concentration of 20  $\mu\text{g}/\text{Rm}^3$  at 11 per cent  $\text{O}_2$
- Hazardous Waste incinerators, 50  $\mu\text{g}/\text{Rm}^3$  at 11 per cent  $\text{O}_2$  and
- Sewage Sludge incinerators, 70  $\mu\text{g}/\text{Rm}^3$  at 11 per cent  $\text{O}_2$

Individual jurisdictions will determine what constitutes an expansion sufficient for application of the standard.

For *existing facilities*, the stack gas concentrations would, in some cases, be determined by the capacity of the facility. All municipal waste incinerators would be required to meet the 20  $\mu\text{g}/\text{Rm}^3$  standard, while medical waste incinerators with capacities above 120 tonnes per year



Each jurisdiction will determine the exact means of ensuring compliance in a manner consistent with the typical or desired programs for the affected facility or sector.

The proposal standard does consider the issue of data reporting, noting that a consolidated data-report and an 'achievement of compliance' report is to be made available to all jurisdictions and the Ministers, along with a draft public report; the latter would be released to the public upon approval by the Ministers. The suggested form of the public report would demonstrate progress based on an aggregate of data to the provincial level; although jurisdictions must provide a contact to the public for facility specific information, such data are to be supplied in a manner consistent with the normal data and compliance reporting procedures of the jurisdiction in question. The consolidated spreadsheet is not to be made public as it may include propriety information.

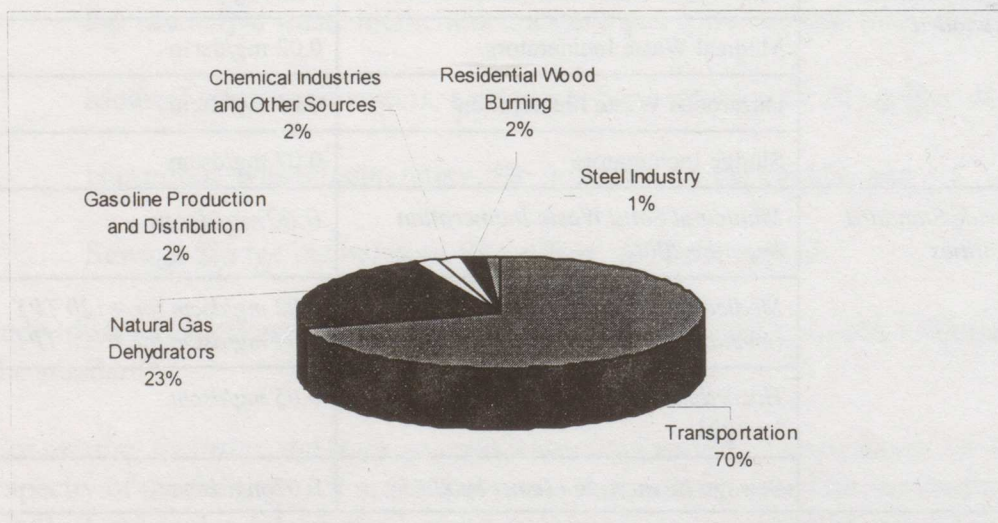
The proposed CWS limits for mercury in incineration exhaust gases are compared to other relevant standards in Table 18.

### Recommendation

**The Commission should recommend to the Canadian Council of Ministers of the Environment that data on mercury emissions from individual facilities be made available to the public through the CCME website and other means. If absolutely necessary, provisions could be made for the exclusion of process (not emissions) details from this information due to confidentiality agreements; the rationale for doing so should be described.**

### 8.3 Benzene

For some time, benzene has been classified as a known human carcinogen. It is also a non-threshold toxin, that is a substance considered to harm health at any level of exposure. The primary management goal for a non-threshold toxin such as benzene is to limit human exposure. Human exposure routes are given in Figure 10.



**Figure 10.**  
Canadian  
Benzene Sources  
(1995)

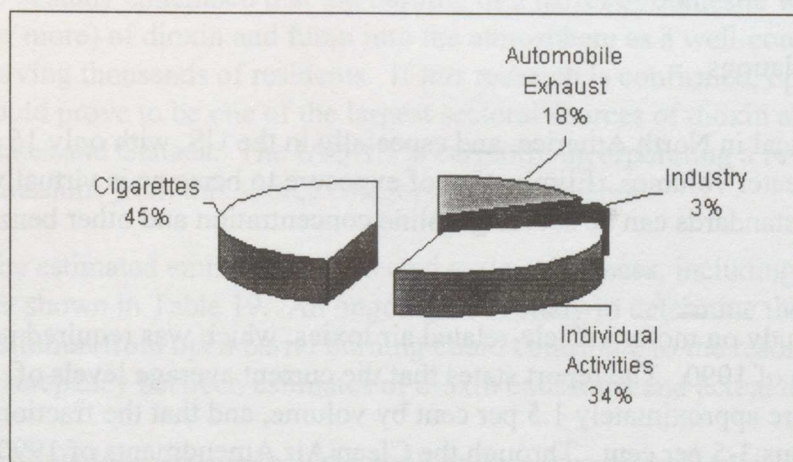


Transportation emissions and natural gas dehydrators are Canada's leading sources of benzene, accounting for 90 per cent of the nation's total release. Some minor sources include: residential wood/garbage burning, production of gasoline, the steel industry, and chemical manufacturing. The largest source of benzene exposure to Canadians is vehicular emissions, and to cigarette smokers, the exposure levels are even higher.

### 8.3.1 Canada-wide Standard for Benzene

#### Canadian Emissions and Regulation

The largest source of benzene emissions into the atmosphere, in both Canada and the US, is from gasoline combustion, as seen in Figure 10. Regulations have been developed under the 'Canadian Environmental Protection Act' (CEPA), and further Canada-wide Standards are being considered to control the level of benzene and other harmful compounds in gasoline. These regulations will reduce the amount of benzene in vehicle exhaust, as well as emissions of benzene throughout the gasoline distribution network particularly pumps at gas serving stations.



**Figure 11.** Average Sources of Benzene Exposure to Humans

Figure 11 suggests that human exposure to benzene is mostly due to cigarette smoke inhalation, rather than automobile exhaust, even though there are more benzene emissions released from total fuel combustion.

New regulations controlling the amount of benzene in gasoline at 1 per cent by volume, came into effect in Canada in 1999, with the introduction of the "Benzene in Gasoline Regulations." The goal of the regulations, along with the proposed Canada-wide Standard on benzene, is to reduce the releases of benzene from gasoline-fueled vehicles by developing a gasoline which contains lower concentrations of such chemicals as toluene and benzene.

These regulations should reduce emissions/release of benzene from vehicles and service stations significantly. The estimated cost of reducing the benzene content in gasoline (standard) is between 0.2 and 0.4 cents per litre. Once these standards apply fully (estimated to be May 2000), Canada will have one of the most stringent national gasoline standards in the world.

- Phase 1 of the benzene CWS sets a target of 30 per cent reduction in national benzene emissions from 1995 levels, to be achieved by the end of year 2000.



It provides an accountability mechanism for various current actions towards a Canada-wide control strategy and the coordination of monitoring and reporting on these activities, as well as a means of establishing a baseline for future action at no incremental cost. Ambient air concentrations of benzene will be reported as an indicator of air quality, with the first public report by September 30, 2001. Reports on the achievement and maintenance of the standard will follow annually and comprehensive reports are to follow every 5 years, beginning in 2006.

- Phase 2 is to be developed by the spring of 2001 through consultation with stakeholders and will identify the long term direction for benzene control. The target and goal of phase 2 may include an ambient concentration level, a further national reduction target, or a combination of initiatives.

The key actions which will achieve this standard include:

- 1) regulation of benzene in gasoline;
- 2) voluntary initiatives to reduce emissions from natural gas dehydrators and the chemical industry; and,
- 3) reduction measures in the steel industry.

#### 8.3.2 US Emissions and Regulations

Benzene is a widely used chemical in North America, and especially in the US, with only 15 other chemicals being produced at greater volumes. Elimination of exposure to benzene is virtually impossible; however, stringent standards can be set for gasoline concentration and other benzene sources.

The USEPA has completed a study on motor vehicle-related air toxics, which was required under the Clean Air Act Amendments of 1990. The report states that the current average levels of benzene in gasoline in the US are approximately 1.5 per cent by volume, and that the fraction of benzene in exhaust generally runs 3-5 per cent. Through the Clean Air Amendments of 1990, the USEPA has required a reduction in the benzene content of reformulated gasoline, to a limit of 1.0 per cent by volume. A similar regulation is expected for benzene content in gasoline (non-reformulated).

Since benzene can also be produced from engine combustion of other aromatic hydrocarbons present in gasoline, other regulatory approaches such as alternative fuels may also be necessary for further significant benzene emission reduction. The USEPA is considering using several regulatory programs to further limit the amount of benzene in gasoline, one being a simple cap, which would lower the level in gasoline. In addition, the USEPA is offering an emission performance standard similar to that of the RFG (reformulated gasoline) program, in which refiners of all gasoline, instead of just reformulated gasoline, would be forced to reduce emissions of benzene, as well as other toxics.



## 8.4 Dioxin and Furan Emissions

The term 'dioxin' is commonly used to refer to a family of toxic chemicals that all share a similar chemical structure and a common mechanism of toxic action. Dioxin is widely distributed throughout the environment in low concentrations, and bio-accumulates in the human system; most people have detectable levels of dioxin in their tissue. These levels have accumulated over a lifetime and will persist for years, even if no additional exposure were to occur. Current background exposure is likely to result in an increased risk of cancer and is close to levels suspected of causing subtle adverse non-cancer effects in animals and humans. Over the last two years, the Board has undertaken a modeling of the atmospheric transport and deposition of this substance from sources and source regions across the United States and Canada to the Great Lakes basin.

### 8.4.1 Uncontrolled Combustion of Refuse: Open Barrel Burning

As part of the deposition study referred to earlier, the Board has overseen the development of an emissions inventory for dioxin that is among the most current available. However, a recent US EPA study concluded that the burning of a barrel of domestic waste could emit the same amount (or more) of dioxin and furan into the atmosphere as a well-controlled municipal waste incinerator serving thousands of residents. If this research is confirmed, open refuse small scale burning could prove to be one of the largest sectoral sources of dioxin and furan emissions in the United States and Canada. The IAQAB is currently incorporating a revised estimate of national dioxin emissions from this source category into its database.

The estimated emissions of selected toxic substances, including dioxin, from burn barrels per year are shown in Table 19. An ongoing EPA study to determine the contribution of dioxin and furan pollution from open barrel burning could contribute to the resolution of a long-standing discrepancy between estimates of dioxin emissions and actual deposition measurements.

Household waste can include anything from papers to plastic, metals and organic wastes. Allowing combustion gases and particulate to intermingle at a low temperature, as in barrel burning, provides an ideal atmosphere for dioxin formation. The features of a combustion system which will increase the production of dioxins include:

- poor gas-phase mixing;
- low combustion temperatures;
- oxygen-starved conditions;
- high PM loading;
- PM-bound copper;
- presence of HCl and/or chloride; and,
- significant gas-phase residence time in the 250-700 °C temperature range.

In the EPA study, ordinary household waste was incinerated in a 55 gallon drum. The mixture of trash included newspapers, books, magazines, mail, cardboard, milk cartons, organic wastes, plastic, cans, bottles and jars. No paints, grease, oils, tires or other hazardous wastes were burned.



## 8.5 MTBE (Methyl Tertiary Butyl Ether) Update

The 1990 Amendments of the US Clean Air Act established a number of programs to produce cleaner motor vehicles, and cleaner fuels, which, so far, have been highly successful. One main program is the Reformulated Gasoline (RFG) Program. The RFG requirements emerged from combining several Congressional objectives, including air quality improvement, the use of oxygenates (such as MTBE) to improve fuel combustion and lower emissions of pollutants, and encouraging the use of renewable energy sources.

Cleaner gasoline was made widely available in all or part of 16 states, including much of the Northeast and California in early 1995, primarily to reduce the emissions of smog causing pollutants, and to reduce overall smog levels. RFG is quite effective at reducing smog precursors such as volatile organic compounds (VOCs), and oxides of nitrogen (NOx). The first phase of the RFG program (1995-1999) required that volatile organic compound emissions be reduced by 17 per cent, and NOx by 1.5 per cent. The second phase of the program began this year, and requires further emission reductions of 27 per cent for VOCs, 22 per cent for toxics, and a 7 per cent for nitrogen oxides; this action is estimated to be equivalent to taking more than 16 million vehicles off the road.

The introduction of the second phase of the RFG program has been complicated by significant fouling of groundwater supplies by one RFG agent used in the current gasoline supply, Methyl Tertiary Butyl Ether (MTBE), in several parts of the United States, including several areas in California, as well as Maine and New Hampshire. MTBE is also a suspected human carcinogen.

Neither the Clean Air Act nor other actions of the EPA require the use of MTBE in RFG; rather, the Clean Air Act Amendments required that the RFG contain a minimum of 2 per cent oxygenate content by weight. No individual oxygenate is specified for use; however, both ethanol and MTBE are currently used successfully in the RFG program, with fuel providers choosing to use MTBE in about 80 per cent of RFG.

In response to concerns associated with the use of oxygenates in gasoline, the USEPA established a blue-ribbon panel of leading experts from the scientific community, water utilities, environmental groups and local and state government agencies, to discuss and formulate solutions on issues posed by the use of oxygenates in gasoline. Reporting in July of 1999, the panel stated that RFG has provided significant reductions to the emissions from vehicles, but the use of MTBE has resulted in growing incidence of detectable concentrations of MTBE in drinking water. The panel presented several recommendations to the USEPA Administrator for possible implementation. They include:

- Enhanced water protection and monitoring programs.
- Prevention of gasoline leaks through improvement of existing programs.
- Remediation of existing contamination.
- Amend the US Clean Air Act to remove the requirement that federal reformulated gasoline contain 2 per cent oxygenate by weight.
- Maintain current air benefits.



- Reduce the use of MTBE.
- Accelerate research on MTBE and its possible substitutes.

On March 20, 2000 the Clinton Administration announced that the USEPA will move to reduce use of MTBE on grounds that it poses a public health risk to humans and the environment. As the gasoline additive is linked to groundwater pollution in California and other states, the USEPA announced they will seek to "significantly reduce or eliminate" within three years, the use of MTBE under the Toxic Substance Control Act, which allows the USEPA to ban any substance proven to be an unreasonable risk to the public.

The agency will also ask Congress for changes in the Clean Air Act that would encourage the use of ethanol, a gasoline additive derived from corn, instead of MTBE, since a 1990 law requires the use of oxygenates in fuel in several parts of the country.

Two Northeast states, New Hampshire and New York, continue to consider the implementation of lower groundwater and drinking water standards for MTBE. Currently, New Hampshire has a drinking water standard of 70 ppb and New York has a groundwater standard of 50 ppb. The new lower standards proposed are 13 ppb for New Hampshire and 10 ppb for New York state.







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## ACRONYMS

AEP	American Electric Power
CAA	Clean Air Act
CARB	California Air Resources Board
CCME	Canadian Council of Ministers of the Environment
CEC	Commission for Environmental Cooperation
CEPA	Canadian Environmental Protection Act
CEPA	Canadian Environmental Protection Act
CWG	Coal Boiler Workgroup
CWS	Canada-wide Standards
DE	diesel exhaust
DPM	diesel particulate matter
E-GRID	Emissions & Generation Resource Integrated Database
EBR	Environmental Bill of Rights
EGU	electrical generating units
EIA	Electrical Industry Association
EPS(s)	Emissions Performance Standard(s)
ERCs	Emission Reduction Credits
EU	European Union
FERC	Federal Energy Regulatory Commission
FERC	Federal Electrical Regulatory Commission
FRM	Federal Reference Method
g/bhp-hr	grams per brake horsepower-hour
HCl	hydrochloric acid
HHD	heavy heavy-duty
HLDT(s)	heavy light-duty truck(s)
IAQAB	International Air Quality Advisory Board
ICI	industrial/commercial/institutional
IJC	International Joint Commission
IPCC	Intergovernmental Panel on Climate Change
LHD	light heavy-duty
LLDT(s)	light light-duty truck(s)
MD	medium duty
MDPV(s)	medium-duty passenger vehicle(s)
MTBE	Methyl Tertiary Butyl Ether
NO <sub>2</sub>	Nitrogen dioxide
NO <sub>x</sub>	Nitrogen oxides
NPRM	notice of proposed rulemaking
NSPS	New Source Performance Standard
O <sub>3</sub>	ozone
OPG	Ontario Power Generation
OTAG	Ozone Transport Assessment Group
OTC	Ozone Transport Commission
PAH(s)	polyaromatic hydrocarbon(s)



PCF	Prototype Carbon Fund
PM	particulate matter
PM <sub>10</sub>	Coarse particulate matter
PM <sub>2.5</sub>	Fine particulate matter
RfC	Inhalation Reference Concentration
RFG	reformulated gasoline
SIP(s)	State Implementation Plan(s)
SO <sub>2</sub>	Sulfur dioxide
SUV(s)	sport utility vehicle(s)
TEOM	Tapered Element Oscillating Balance Monitor
TPY	tons per year
TRI	Toxics Release Inventory
TSP	Total Suspended Particulate
TVA	Tennessee Valley Authority
ULSD	ultra low sulfur diesel
UNFCCC	United Nations Framework Convention on Climate Change
USEPA	United States Environmental Protection Agency
VOC(s)	volatile organic compound(s)



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