THE CLEAN AIR ACT
ANNUAL REPORT
1978-1979

Air Pollution Control Directorate
Environmental Protection Service
Department of the Environment

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Minister
Environment Canada

Ministre
Environnement Canada

His Excellency
The Right Honourable Edward Schreyer
Governor General and Commander-in-Chief of Canada

May It Please Your Excellency:

I have the honour herewith, for the information of Your Excellency and the Parliament of Canada, to present the Annual Report on the Clean Air Act for the fiscal year ended March 31, 1979.

Respectfully submitted,

John Roberts
Minister of the Environment

Deputy Minister
Environment Canada

Sous-ministre
Environnement Canada

The Honourable John Roberts
Minister of the Environment
Ottawa, Canada

Dear Mr. Roberts:

I have the honour to submit the Annual Report on the Clean Air Act for the fiscal year ended March 31, 1979.

Respectfully submitted,

J.B. Seaborn

HIGHLIGHTS

The atmosphere. On a clear, sunny day it seems to be limitless. In reality, it is a fragile envelope surrounding our planet as the skin surrounds an apple. This thin envelope and the shallow crust of land and water beneath it form the only part of our planet where life can exist. It is virtually a closed system - once in it, substances cannot easily escape.

This thin envelope of air has never been completely pure. Before man began to dump his industrial contaminants into it, natural pollutants were there: salt particles from the seas, smoke from forest fires, dust from the soil, gases from the decay of dead plants and animals, and dusts and gases from volcanos. But the system cleaned itself - natural cleansing processes purified the air faster than the pollutants entered it.

With continuing industrialization, these natural cleansing processes are becoming overburdened and unable to cope with the huge amounts of man-made pollutants entering the atmosphere.

Fortunately, man-made controls can be added to complement nature's cleansing powers to protect the quality of the air we breathe. This requires the cooperation of government and industry and the determination to protect our thin envelope of air from irreversible damage.

The Department of the Environment's efforts to protect air quality during the past year are described in detail in this report. For those who wish to have a quick overview, the highlights follow.

- The federal government's special concern about air contaminants deemed hazardous to health led to further preventive action. National emission standards now cover lead from secondary lead smelters, mercury from chlor-alkali plants and asbestos from mines and mills. Standards will become effective for vinyl chloride from manufacturing operations (July 1, 1979) and arsenic from gold roasters at a later date.
- An agreement was negotiated with the Province of Quebec for the implementation of the federal asbestos mining and milling emission regulations.
- Federal government guidelines for the cement, asphalt paving, coke oven and arctic mining industries continued to serve as models for provincial legislation. Guidelines for packaged incinerators were published in November, 1978.

- Transboundary air pollution and the resulting problem of acid precipitation came to the forefront as a prominent issue between Canada and the United States. A joint scientific research program was started and exploratory discussions held on approaches to solving the problem.
- Compilation of an inventory of benzene sources and emissions brought to thirteen the number of inventories of air contaminants that may present a significant danger to health or the environment. The report on benzene will be published in the next fiscal year. These inventories indicate the potential for a problem and enable control agencies to plan their control activities.
- The National Air Pollution Surveillance (NAPS) network was expanded and now consists of 562 instruments located at 159 stations in all major centres. This extensive coverage includes over 40 stations that provide continuous monitoring for all five major pollutants. Results were published as monthly and annual summaries.
- The national air quality trends for the 1970-77 period, based on NAPS network data, indicate pollution levels for most contaminants generally to be on the decrease. The exceptions are nitrogen dioxide and ozone levels. The report will be published early in the next fiscal year.
- To examine the problem of long range transport of air pollution, one of the more serious aspects of which is acid rain, a comprehensive inventory of the Canadian sources and emissions of sulphur compounds was compiled. Reports summarizing the findings will be released shortly. Similar studies for nitrogen oxides and hydrocarbons will be undertaken during the next fiscal year.
- To identify and rank air pollution problems, the Directorate developed a framework for deciding which substances or industrial sectors should be investigated with a view to promulgating regulations or guidelines.
- Projects supported under the federal 'unsolicited proposal' program included:
  - the successful development of a laboratory prototype instrument for the continuous measurement of sulphur trioxide in the presence of sulphur dioxide in simulated stack gases; and
  - a study to improve the efficiency of electrostatic precipitators in the non-ferrous smelting industry.
- Under a program to provide aid to industry for the development of new technology, a joint contract let with the Ontario Ministry of the Environment was completed on the evaluation of commercially available remote sensors for the measurement of

sulphur dioxide emissions from industrial sources. The study showed that this technique has good potential for the quantitative measurement of sulphur dioxide mass emissions at some distance from the source.

- Source testing took place at many industrial sites in cooperation with provincial authorities. Included were sampling such diverse operations as a kraft pulp mill, non-ferrous smelters, a heating plant, gold roasting and thermal power plants.
- The ambient air survey of fluorides at Cornwall Island continued. Early results indicated that gaseous fluoride levels remained the same while particulate fluoride levels were substantially reduced.
- Assistance went to Saskatchewan to implement area surveys for sulphur dioxide and particulates at two locations. Support continued for a monitoring program for automobile-related pollutants during the winter in Whitehorse.
- Two monitoring stations were equipped as part of the Nanticoke Environmental Monitoring Program and advice was given to technical committees of the Program.
- A report was issued on the continuous monitoring study for particulates at a secondary lead smelter in Ontario.
- With motor vehicles a major source of urban air pollution, federal research and regulations continued their role in reducing unwanted tailpipe emissions by:
  - ensuring compliance with new-car standards. About 50 such vehicles were subjected to more than 400 emission tests under controlled driving conditions.
  - gathering more information on emissions from vehicles in consumers' hands. A two-week vehicle checking project was completed in Edmonton and Calgary in cooperation with the Alberta Department of the Environment and the Alberta Motor Association. Over 1000 vehicles were checked and 750 found to have excessive emissions.
  - testing vehicle emissions at winter temperatures. Several years of testing at typical Canadian temperatures (down to -30°C) have indicated that modern vehicles are achieving equivalent emission reductions at colder tem-peratures. At the same time the fuel consumption of the modern vehicles does not deteriorate as much in cold weather.
  - testing 2696 lead-free gasoline samples in a national monitoring program. One hundred and fourteen exceeded the allowable lead limit and corrective action followed immediately.

- A report prepared by Environment Canada and the Alberta Department of the Environment on the Syncrude operation was published. Technology for controlling sulphur dioxide emissions is described.
- Progress was made toward the adoption of federal guidelines as territorial regulations for base metal mines and asphalt paving plants in the Yukon.
- The Directorate provided technical assistance to the Ad Hoc Group on Incineration at Sea. An international maritime regulation concerning such incineration became effective in March, 1979.
- An extensive air quality study was done in June with the Province of Ontario at the Nanticoke industrial development site. The data are being used to develop strategies for regional air management and environmental planning.
- Recently obtained Canadian STRATOPROBE ozone layer measurements were reported and discussed at the World Meteorological Organization symposium on "Geophysical Aspects and Consequences of Changes in the Composition of the Stratosphere" held in June in Toronto.
- To provide basic information on the long-range transport of air pollutants, a sulphur budget was prepared for the atmosphere over eastern North America.
- Departmental participation in the Alberta Oil Sands Environmental Research Program terminated following completion of field data analyses and the proposal of prediction models for air quality management.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The Clean Air Act was officially proclaimed on November 1, 1971. This report, submitted in accordance with Section 41 of the Act, covers operations for the period ending March 31, 1979.

The Clean Air Act provides the basis for the federal government's air pollution control activities and has three main objectives. The first and foremost is to protect the health of the public of Canada from air pollution. To this end, federal regulations are promulgated limiting the emission of hazardous pollutants such as lead, mercury, vinyl chloride, asbestos and arsenic from specific industrial sectors. The second objective is to promote a uniform approach across Canada in the control of other pollutants. To achieve this and to provide appropriate leadership by the federal government, the Act enables the issuance of industrial sector guidelines aimed at preventing so-called "pollution havens", a matter that is of great concern to both federal and provincial authorities.

The third objective is to make provision for the mechanisms and institutions needed to ensure that all measures to control air pollution can be taken. Of major significance is the recognition that provinces have a direct responsibility in controlling air pollution and that cooperative efforts between provincial and federal authorities are required. To this end, the Act enables the federal government to enter into agreements with individual provinces and allows the establishment of arrangements for the implementation of regulations made under the Act; the Act also provides for direct action by the federal government when this is necessary.

RESPONSIBILITIES OF THE MINISTER

The responsibilities of the Minister under the Clean Air Act include:

(a) ensuring the development of regulations limiting the emission of hazardous substances and guidelines indicating limits to the quantities and concentrations of air contaminants that may be emitted from any source;

(b) establishing, operating, and maintaining a system of air pollution monitoring stations throughout Canada;

(c) collecting, both through the operation of air pollution monitoring stations and from other appropriate sources, data on air pollution in Canada and processing, correlating, and publishing such data on a regular basis;

(d) conducting research and studies relating to the nature, transportation, dispersion, effects, control, and abatement of air pollution and providing consultative, advisory and technical services, and information related thereto;

(e) formulating comprehensive plans and designs for the control and abatement of air pollution and establishing demonstration projects and publicizing, demonstrating, and making such projects available for demonstration; and

(f) publishing or otherwise distributing or arranging for the publication or distribution of all pertinent information which would serve to inform the public in respect to all aspects of the quality of the ambient air and of the control and abatement of air pollution.

ENVIRONMENTAL PROTECTION SERVICE

Within the Department of the Environment the Clean Air Act is administered by the Environmental Protection Service through its five regional offices across Canada and through the Air Pollution Control Directorate and the Federal Activities Branch in Ottawa. A resource summary for the Air Pollution Control Program is shown in Table 1.

TABLE 1 AIR POLLUTION CONTROL PROGRAM RESOURCE SUMMARY

Fiscal Year	End of year strength	Salaries ($)	Goods and services ($)	Capital ($)	Total expenditure ($)
1970-1971	38	268 326	113 527	157 458	539 311
1971-1972	76	900 000	455 000	660 000	2 015 000
1972-1973	147	1 711 000	644 000	1 079 000	3 434 000
1973-1974	151	1 859 000	1 053 000	958 000	3 870 000
1974-1975	163	2 533 279	1 077 210	1 132 507	4 742 996
1975-1976	176	3 171 686	1 231 818	827 838	5 231 342
1976-1977	165	3 069 500	1 210 300	795 487	5 075 287
1977-1978	156	3 411 000	2 024 800	781 800	6 217 600
1978-1979	147	3 580 000	1 410 000	1 260 000	6 250 000

Air Pollution Control Directorate

The responsibilities of the Air Pollution Control Directorate are divided among three branches.

The *Air Pollution Programs Branch* is responsible for development and co-ordination of Canada's National Air Pollution Surveillance (NAPS) Program as well as specific ambient air monitoring and source sampling surveys. Nationwide inventories of air contaminant emissions are developed and maintained as prerequisites to the national program of air pollution control and abatement and as an effective evaluation mechanism. The Branch is responsible for air quality trend analyses, population exposure analyses and emission trend analyses for past and future years and also for the non-technical aspects of emission standards regulations and guidelines development. The Branch coordinates the development and prescription of National Ambient Air Quality Objectives and is also responsible for interservice, intergovernmental and international liaison and coordination. These functions are performed in three divisions: Surveillance, Pollution Data Analysis, and Program Coordination.

The *Abatement and Compliance Branch* is primarily concerned with the application of known technology to the capture and containment of pollutants from stationary and mobile sources. The Branch is the focal point of engineering and technical expertise on air pollution emissions and control and abatement methods. Technical assessments, state-of-the-art reviews and industry studies are prepared and used as technical bases for the development of air pollution control standards, regulations and guidelines. Government-industry task forces, planned, organized and chaired by the Branch, recommend abatement technology for use in establishing regulations and guidelines. Major stationary sources of air pollution, such as iron and steel mills, non-ferrous smelters, pulp and paper mills, thermal power generating stations and incinerators are the responsibilities of three divisions of the Branch: Mining, Mineral and Metallurgical, Chemical Process Sources, and Combustion Sources. Emissions from motor vehicles, ships, locomotives and aircraft are the responsibility of the Mobile Sources Division. A fifth division, Fuels, is responsible for fuel composition and additive regulations, inventories of fuels and for guidelines for major production or refining sources.

The *Technology Development Branch* has two primary responsibilities. One is to manage a cost-shared program with Canadian industry for the development and demonstration of new air pollution control technology and the other is to provide the

technical and scientific services required by the Directorate. These services include the development and certification of analytical techniques required to support regulations and guidelines; the preparation of standard reference materials for analytical laboratories across Canada that are engaged in analysis of air pollutants; the provision of a computerized information service on air pollution control; the editing, publication and distribution of all Directorate reports on its scientific and technical activities; the transfer of technical information and technology through seminars; and the training of inspectors, analysts and enforcement officers in federal, provincial and municipal jurisdictions. These functions are performed in three divisions: Control Development, Chemistry, and Publications and Training.

Environmental Protection Service Regional Offices

The primary points of contact with provincial environmental protection agencies are the five Environmental Protection Service Regional Offices located in Halifax, Montreal, Toronto, Edmonton and Vancouver. Regional Directors, as part of their role, are responsible for providing, within their region, direction and supervision of Environmental Protection Service programs arising from the Clean Air Act together with policies and commitments resulting from bilateral and international agreements. Regional Directors formulate and administer enforcement and other operational programs in accordance with national policies and guidelines.

Federal Activities Branch

The Federal Activities Branch was established to demonstrate the federal government's concern for its own activities. The Branch is the Department of the Environment's interface on pollution matters with all federal departments, agencies and crown corporations. It also represents the Department in negotiations on environmental matters with any organization receiving financial assistance or operating under permits granted by the federal government. The Branch is concerned with the treatment and disposal of waste water, toxic and hazardous substances, solid waste management, air pollution and noise for all land and off-shore facilities.

Centres for facilitating exchanges between the many organizations which have needs and those which have expertise have been established in the Environmental Protection Service Regional Offices. Guidelines, technical advice and assistance are arranged through these centres to ensure that all new federal projects are examined for possible environmental effects and that proper environmental protection measures are

incorporated into project designs and operations. The Federal Activities Branch is also charged with defining pollution problems at existing facilities, developing courses of remedial action and, in consultation with other departments, recommending clean-up project priorities and allocating funds from a central Federal Activities Clean-up Fund.

DETERMINATION OF AIR POLLUTION PROBLEMS

General

Section 3 of the Clean Air Act makes provision for the collection and publication of data on air pollution. This includes a responsibility for maintaining a continuing record of ambient air pollution levels in urban areas on a national basis, for defining problems through field investigations and for providing consultative services to federal or provincial agencies on air pollution surveillance.

Emission Inventories

A prerequisite to an effective air pollution control program is an accurate definition of the pollution problem. Such a definition can be made only through the compilation of inventories of the sources and emissions of contaminants and through a determination of the concentration of contaminants in the atmosphere. The latter is accomplished through the NAPS network and ambient air quality studies which are discussed in later sections, the former through compilation of national inventories of air contaminant emissions. Inventories are compiled for the five most common air contaminants and for those that are potentially hazardous.

Inventories of potentially hazardous air contaminants. The air contaminants dealt with in these inventories may present a significant danger to human health and/or to the environment. These inventories are used in defining air pollution problems and to assist federal and provincial control agencies in developing programs and establishing control priorities. To date, twelve such inventories have been published. During the review period an inventory of the sources and emissions of benzene was compiled by the Air Pollution Control Directorate. A summary of the results is shown in Table 2. In addition, data previously collected by a consultant were complemented with other data to form the bases for national inventories of the sources and emissions of nickel, cobalt, antimony, tin, bismuth, chromium, copper, barium, phosphorus, chlorine and hydrogen sulphide. Some of these inventories will be compiled and published during the next review period. The inventories will be updated as new data become available.

TABLE 2 SUMMARY OF BENZENE EMISSIONS IN CANADA, 1976

Source	Emissions (tonnes*)
Crude Oil Operations	92
Petroleum Refineries	
a) General	
1. Refinery operations	175
2. Gasoline storage	62-488
b) Benzene Production	
1. Process	125
2. Storage	803
Chemical Processes using Benzene and its Derivatives	3 103
Coke Ovens	124
Mobile Sources	
a) Gasoline-Powered Motor Vehicles	
1. Exhaust	36 079
2. Evaporative	297-2 350
b) Diesel-Powered Engines	
1. Trucks	100
2. Railway	180
3. Marine	137
Fuel Combustion in Stationary Sources	unknown
Miscellaneous	
a) Benzene Loading/Unloading Operations	102
b) Gasoline Marketing	
1. Distribution	23-179
2. Service Stations	125-991
Surface Coating Application	1 790
Asphalt Plants	38
Miscellaneous Chemical Industries	unknown
TOTAL	43 355-46 856

* Tonne (metric ton) is equivalent to 1.1023 short tons.

In Quebec, a study was completed to determine what proportion of mercury emissions in the province arises from the combustion of petroleum fuels. Data were obtained by analyzing petroleum samples from refineries. The results will be compared with inventory data compiled for 1970.

Inventories of common air contaminants. One of the first actions taken after passage of the Clean Air Act was to let a contract for the compilation of a nationwide inventory of air contaminant emissions for Canada. The first inventory provided an overview for 1970 of air pollution problems with respect to the five contaminants that are the most significant in quantity: sulphur oxides, particulate matter, carbon monoxide, hydrocarbons and nitrogen oxides. The inventory was subsequently revised and updated by the Air Pollution Control Directorate to provide similar overviews of nationwide emissions for 1972 and 1974. Results of the 1974 inventory were published during the review period. A further revision based on 1976 data is in progress.

The inventory is being updated biennially to provide a mechanism to evaluate the effectiveness of air pollution control programs in Canada. In addition, it provides vital information for the development of air pollution control strategies.

National Emissions Inventory File Management System. All inventory information about the five common air contaminants is now stored in the National Emissions Inventory File Management System that provides easy access to and retrieval of data and has rapid updating capabilities. The inventory information developed for the potentially hazardous air contaminants will be added to the system in due course. During the review period, discussions took place with some provincial and municipal agencies during which they were invited to participate in the national system by providing air contaminant emissions data. At the same time the national systems' retrieval capabilities, from which the participating agencies could benefit, were described.

The Long-Range Transport of Air Pollution. The long-range transport of air pollution is recognized as the most important environmental issue facing eastern North America. Consequently Environment Canada has assigned highest priority to a research program that has two major objectives. The first is to determine the current state of the environment in eastern Canada, before the impact of emissions from increased coal-burning in North America is felt. The second is to develop a clear understanding of the occurrence and effects of long-range transport of air pollution within and into Canada, including geographical extent, severity and socio-economic costs. The departmental

program has four major components: sources and emissions; atmospheric transport, transformation and deposition; aquatic effects; and terrestrial effects.

During the review period, work progressed in the Air Pollution Control Directorate on the sources and emissions component of the program. The major objective was to identify and quantify the sources, both man-made and natural, and the emissions of sulphur compounds in Canada in order that the atmospheric transport, transformation and deposition aspects of the problem can be adequately studied. The objective was met and a comprehensive inventory of sulphur dioxide sources and emissions was completed. Reports summarizing the findings will be published during the next fiscal year. Studies similar to that completed on sulphur compounds will be undertaken next year for nitrogen oxides and hydrocarbons, important precursors in the formation of ozone.

The Directorate also continued to be significantly involved in other aspects of the program through the assessment of available control technologies and the introduction of routine sulphate measurements at stations of the National Air Pollution Surveillance Network.

As part of an investigation of the long-range transport of air pollution, the Atlantic Region of the Environmental Protection Service initiated a new project to sample for sulphates in aerosol form and to determine the chemical composition of individual precipitation events. It was found that when the sampled air flowed from the densely populated areas of the eastern United States and Canada, the aerosol sulphate concentrations were twice as high as when the air originated in other parts. The precipitation events were found to be consistently very acid: the pH of precipitation ranged from 3.3.to 4.8.

The Ontario Region prepared a report on the effects of ozone in the atmosphere of Ontario. The report documents the transboundary movement of ozone into Ontario and recommends ways of controlling the problem.

Air Quality Monitoring

The *National Air Pollution Surveillance Network.* To ensure sound planning of activities within the air pollution control program, it is important to have a continuously updated knowledge of the nature and extent of air pollution across Canada. The National Air Pollution Surveillance (NAPS) activity regularly collects data on ambient air concentrations of the most common contaminants on a continuing basis. Short-term surveys are used to provide information in response to special requirements. The National Air Pollution Surveillance network consists of air monitoring instruments located in major

population centres across Canada. The network is a cooperative effort of the federal, provincial and municipal governments. The accumulation of network data has permitted the detection of trends in the levels of pollution with changing industrial activity, population density and air pollution abatement progress. Information collected by the network can be used in epidemiological studies and in the development of air quality objectives.

During 1978-79, the NAPS network was expanded and improved. On March 31, 1979, the network consisted of 562 air monitoring instruments at 159 sampling stations in all major urban areas of the ten provinces and the two territories. Figure 1 shows the location of the cities with sampling stations. This extensive coverage includes 43 stations that have continuous monitoring equipment for the five most common air contaminants (sulphur dioxide, suspended particulate matter, carbon monoxide, nitrogen oxides and ozone) and five other stations in which four contaminant concentrations are monitored continuously. Of the 562 instruments in the network, 232 are continuous monitors: 88 for sulphur dioxide, 51 for carbon monoxide, 48 for nitrogen dioxide, and 45 for ozone. Suspended particulate matter is monitored by 111 high-volume samplers each of which operates for an unbroken 24-hour period every sixth day.

The majority of NAPS stations are now operated by provincial or municipal personnel. Technical assistance and advice on the maintenance and repair of monitoring equipment were provided to operators by headquarters and regional staff of the Environmental Protection Service. The data collected by NAPS network operators are compiled by the Air Pollution Control Directorate and published as monthly and annual summaries. During 1978-79 improvements in the data processing procedures were introduced so that monthly data summaries are now available within five months of the data being collected. Data from annual summaries are shown in Tables 3, 4, 5, 6 and 7.

The development and implementation of a complete quality assurance program for data collected through the NAPS network received priority during 1978-79. Air monitoring data that are used for regulatory, health assessment and trend determination purposes must be reliable, and therefore it is essential to ensure that they satisfy objectives for representativeness, accuracy, precision and completeness. The cost of a complete quality assurance program is considerable but it is far less than the cost of making incorrect regulatory decisions.

A quality assurance plan for the NAPS network was drafted and circulated to all provincial and municipal operating agencies. A number of continuing calibration

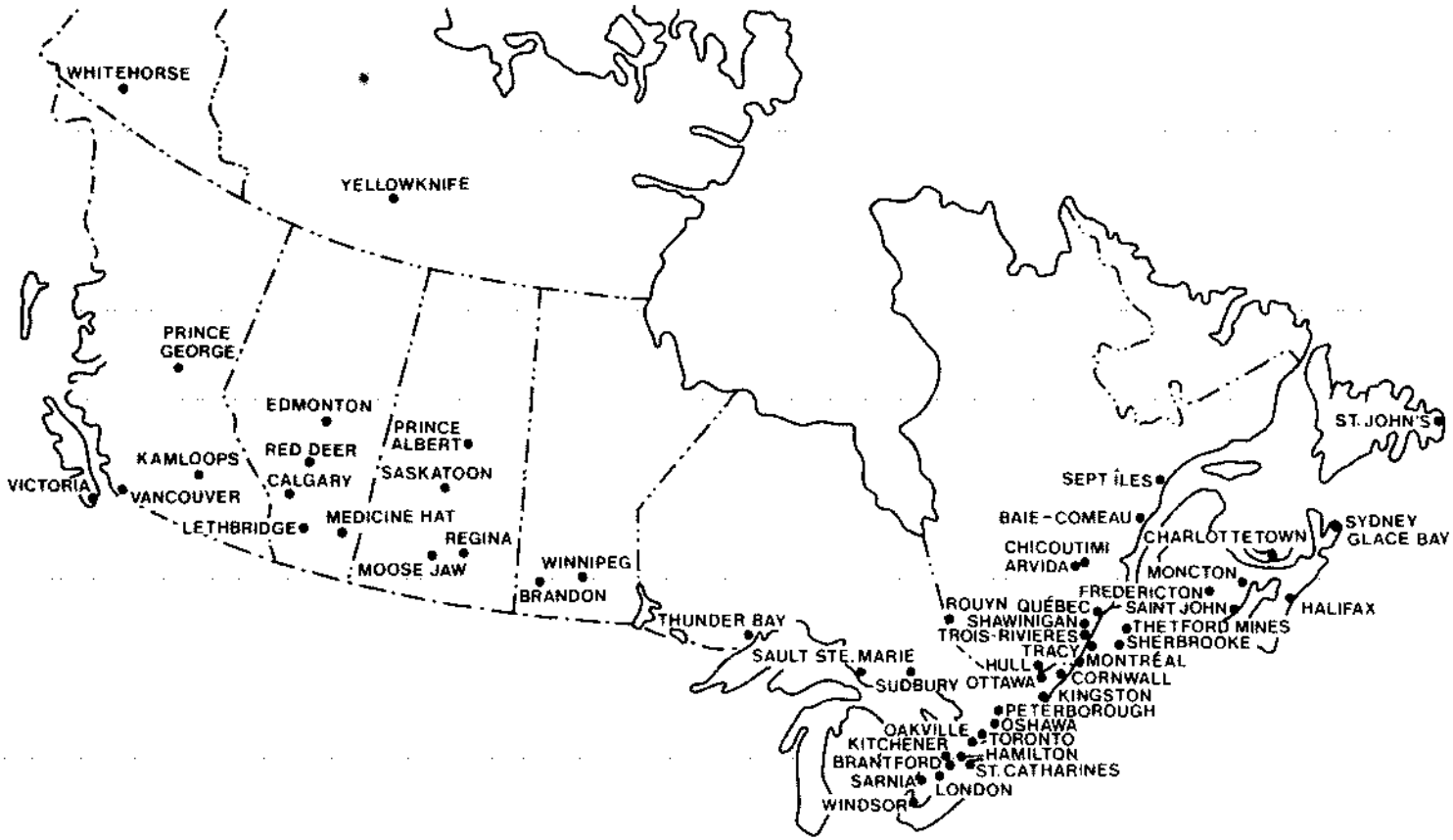

FIGURE 1 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK (MARCH 1979)

TABLE 3 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR SUSPENDED PARTICULATES -- SELECTED SITES

Location	Annual geometric mean (micrograms per cubic metre)					
	1973	1974	1975	1976	1977	1978
St. John's, Duckworth & Ordinance	55	51	49	50	*	37
Charlottetown, 56 Fitzroy	50	49	43	44	39	32
Halifax, N.S. Tech. College	49	47	52	49	47	42
Sydney, County Jail	66	68	*	73	53	52
Fredericton, York			46	43	52	52
Saint John, 110 Charlotte	55	60	55	55	62	57
Montreal, 1212 Drummond	101	128	101	78	74	76
Montreal, Duncan & Décarie		167	136	112	99	121
Montreal, 2900 boul. Concorde				68	59	62
Hull, Gamelin & Joffre					*	41
Quebec, Parc-Autos Paquet-Laliberté	101	104	103	85	*	76
Sherbrooke, Wellington & Albert			*	54	*	*
Chicoutimi, 222 Racine						73
Rouyn, Hôtel de Ville					*	31
Trois-Rivières, Hart & Ste-Cécile				72	51	89
Arvida, Powell & Hoopes					*	66
Tracy, Garneau & Rte 132					56	56
Shawinigan, Frigon & Laval					*	147
Ottawa, Slater & Elgin	87	91	77	60	63	56
Windsor, City Hall	121	122	80	76	83	79
Kingston, Queen's University	38	*	42	38	36	30
Toronto, 67 College	101	81	71	63	67	65
Toronto, Lawrence & Kennedy				65	58	60
Toronto, Elmcrest				*	49	82
Hamilton, Barton & Sanford	128	105	98	101	85	*
Sudbury, 19 Lisgar	63	55	50	46	44	48
Sault Ste. Marie, 550 Queen St. W.						62
Thunder Bay, 14 Algoma	76	60	54	*	49	42

TABLE 3 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR SUSPENDED PARTICULATES -- SELECTED SITES (Continued)

Location	Annual geometric mean (micrograms per cubic metre)					
	1973	1974	1975	1976	1977	1978
London, King & Rectory	94	92	73	64	62	73
Sarnia, 156 Victoria	104	89	73	74	77	79
Peterborough, 500 George				*	*	42
Cornwall, Memorial Park				44	46	43
St. Catharines, North & Geneva				*	69	60
Brantford, Dalhousie & Queen				57	53	49
Kitchener, Edna & Frederick					54	68
Oakville, Rebecca & Woodside					38	44
Winnipeg, Jefferson & Scotia				57	43	36
Winnipeg, 65 Ellen						76
Brandon, 11th & Princess	68	69	49	62	59	**
Regina, 12th & Smith	58	66	64	57	58	47
Saskatoon, 4th Ave. & 23rd St.	65	71	77	91	112	*
Moose Jaw, Fairford & 1st Ave.	65	69	74	74	65	53
Prince Albert, 1257-1st Ave. E.	69	77	68	73	73	*
Edmonton, 100 St. & 102 Ave.	65	71	117	137	92	63
Calgary, 316-7th Ave.	147	122	125	111	93	94
Red Deer, 4747 50th	61	62	57	63	66	53
Medicine Hat, 770 1st St. SE	74	88	71	78	61	*
Lethbridge, 13th St. & 9th Ave. S.	57	45	37	46	44	45
Yellowknife, 50th Ave. & 51st St.	79	60	49	54	*	*
Vancouver, 970 Burrard			*	68	69	67
Victoria, 1106 Cook			*	47	50	44
Whitehorse, Federal Bldg.		85	52	51	61	62

* Insufficient data available to calculate valid annual geometric mean concentrations.

** Station closed.

TABLE 4 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR SULPHUR DIOXIDE -- SELECTED SITES

Location	Annual arithmetic mean (parts per hundred million)					
	1973	1974	1975	1976	1977	1978
St. John's, Duckworth & Ordinance			*	*	<1.0	1.0
Charlottetown, 56 Fitzroy		1.1	1.1	1.1	*	*
Halifax, Barrington & Duke			1.8	1.3	<1.0	1.1
Sydney, County Jail		*	*	*	<1.0	<1.0
Saint John, Post Office		2.5	1.4	*	1.6	<1.0
Montreal, 1125 Ontario	2.0	2.7	2.5	2.4	1.9	1.8
Montreal, 1212 Drummond	4.7	5.2	3.6	2.7	3.6	2.8
Montreal, Duncan & Décarie		1.3	1.8	1.7	<1.0	1.1
Montreal, 2900 Boul. Concorde			*	1.0	1.0	<1.0
Hull, Gamelin & Joffre					*	<1.0
Quebec, 155 Dorchester		*	*	2.4	2.6	1.5
Rouyn, Hôtel de Ville			*	*	*	1.1
Sept-Îles, City Hall			*	<1.0	<1.0	<1.0
Trois-Rivières, Hart & Ste-Cécile			*	2.2	2.3	2.2
Arvida, Powell & Hoopes			*	*	*	2.0
Tracy, 3225 Courshesne					<1.0	<1.0
Shawinigan, Frigon & Laval					*	2.6
Baie-Comeau, 39 Marguette					*	3.6
Ottawa, Slater & Elgin	2.5	2.4	2.0	*	1.3	1.5
Ottawa, Rideau & Wurtemburg				1.8	1.2	1.3
Windsor, 471 University	3.2	3.3	2.9	2.7	2.2	1.8
Kingston, Napier Street				<1.0	<1.0	<1.0
Toronto, 67 College	1.4	1.2	1.5	1.5	1.4	1.1
Toronto, Lawrence & Kennedy	<1.0	*	1.2	1.4	1.2	<1.0
Toronto, Elmcrest				1.1	1.1	<1.0
Hamilton, Barton & Sanford	1.8	2.2	2.0	2.1	2.3	1.6
Sudbury, Ash Street	1.8	3.3	2.8	1.9	1.5	1.2
Sault Ste. Marie, 550 Queen West						<1.0

TABLE 4 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR SULPHUR DIOXIDE -- SELECTED SITES (Continued)

Location	Annual arithmetic mean (parts per hundred million)					
	1973	1974	1975	1976	1977	1978
Thunder Bay, 435 James				*	<1.0	<1.0
London, King & Rectory	<1.0	<1.0	<1.0	1.3	<1.0	<1.0
Sarnia, 156 Victoria	1.7	2.6	2.3	2.4	2.3	1.9
Peterborough, 500 George					<1.0	<1.0
Cornwall, Memorial Park			1.3	2.2	1.7	1.7
Brantford, Dalhousie & Queen				<1.0	*	<1.0
St. Catharines, North & Geneva				*	<1.0	<1.0
Kitchener, Edna & Frederick				*	<1.0	<1.0
Oakville, Rebecca & Woodside					<1.0	<1.0
Winnipeg, 270 Osborne			<1.0	<1.0	*	**
Brandon, 11th St. & Princess			*	<1.0	<1.0	**
Regina, 12th & Smith	<1.0	<1.0	<1.0	*	*	**
Saskatoon, 4th Ave. & 23rd St.	<1.0	<1.0	<1.0	*	<1.0	<1.0
Moose Jaw, Fairford & 1st Ave.	<1.0	<1.0	<1.0	*	*	*
Prince Albert, 1257-1st Ave., E.			*	<1.0	<1.0	*
Edmonton, 10255-104th St.					<1.0	<1.0
Calgary, 620-7th Ave. SW	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vancouver, 970 Burrard			1.1	<1.0	*	*
Victoria, 625 Fisguard	<1.0	<1.0	<1.0	*	*	<1.0
Whitehorse, Federal Bldg.		<1.0	<1.0	*	*	<1.0

* Insufficient data available to calculate valid annual arithmetic mean concentrations.

** Station closed.

TABLE 5 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR CARBON MONOXIDE -- SELECTED SITES

Location	Annual arithmetic mean (parts per million)				
	1974	1975	1976	1977	1978
Halifax, Barrington & Duke				1.4	1.3
Montreal, 1125 Ontario	2.5	2.4	2.7	2.3	2.1
Montreal, 2900 Boul. Concorde		*	0.7	*	1.3
Montreal, 677 Ste-Catherine, W.		*	5.4	4.3	3.6
Montreal, Peel & Maisonneuve				*	3.1
Quebec, 155 Dorchester S.	*	2.4	2.4	*	1.7
Ottawa, Slater & Elgin	3.2	3.1	3.0	2.2	2.4
Ottawa, Rideau & Wurtemburg			0.9	0.9	0.5
Windsor, 471 University	5.1	4.8	*	2.2	2.2
Toronto, 67 College***	1.9	1.3	1.1	2.8	3.5
Toronto, Lawrence & Kennedy	*	2.1	2.4	1.8	2.0
Toronto, Elmcrest			1.0	1.3	1.6
Hamilton, Barton & Sanford	2.0	1.5	1.4	1.4	*
Sudbury, Ash	*	*	1.0	0.8	<0.5
London, King & Rectory	1.0	1.5	1.7	1.1	0.9
Sarnia, 156 Victoria	*	0.9	1.3	1.8	**
St. Catharines, North & Geneva			*	1.5	0.9
Kitchener, Edna & Frederick			*	*	1.4
Oakville, Rebecca & Woodside				1.6	1.6
Winnipeg, 270 Osborne		1.2	1.5	1.4	**
Winnipeg, 65 Ellen					1.2
Winnipeg, Jefferson & Scotia			0.7	0.8	0.7
Regina, 12th & Smith	0.6	0.8	*	*	**

TABLE 5 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR CARBON MONOXIDE -- SELECTED SITES (continued)

Location	Annual arithmetic mean (parts per million)				
	1974	1975	1976	1977	1978
Saskatoon, 4th Ave. & 23rd St.	1.0	0.7	*	*	0.5
Edmonton, 10255-104th St.				2.0	2.0
Calgary, 620-7th Ave. SW	3.1	2.5	2.1	2.3	2.8
Vancouver, 2294 West 10th Ave.	2.6	*	*	1.7	*
Victoria, 1106 Cook		1.2	1.8	*	1.7

* Insufficient data available to calculate valid annual arithmetic mean concentrations.
** Station terminated.
*** Sampling height in 1977 was 3 metres above ground; in previous years, 20 metres.

TABLE 6 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR OZONE -- SELECTED SITES

Location	Annual arithmetic mean (parts per hundred million)				
	1974	1975	1976	1977	1978
Halifax, CFB Shearwater				2.7	2.8
Montreal, 1125 Ontario	1.1	1.3	1.4	0.8	1.5
Montreal, Peel & Maisonneuve				*	0.7
Montreal, 2900 Boul. Concorde		*	*	2.4	2.7
Quebec, 155 Dorchester S.	*	1.8	1.2	1.7	*
Ottawa, Slater & Elgin		*	1.1	1.7	1.6
Ottawa, Rideau & Wurtemburg			1.7	1.9	1.9
Windsor, 471 University	1.3	1.7	2.0	2.1	1.8
Toronto, 67 College	2.0	2.4	1.7	1.6	1.7
Toronto, Lawrence & Kennedy	*	1.9	1.5	1.5	1.7
Toronto, Elmcrest			1.7	1.7	1.9
Hamilton, Barton & Sanford	1.8	2.3	1.8	1.7	1.6
Sudbury, Ash	*	2.2	*	1.7	1.8
London, King & Rectory		1.6	1.9	2.1	2.0
Sarnia, 156 Victoria	1.7	2.4	1.9	1.9	**
St. Catharines, North & Geneva			*	2.2	2.4
Kitchener, Edna & Frederick			*	2.5	2.8
Oakville, Rebecca & Woodside				2.2	2.1
Winnipeg, 270 Osborne	0.9	1.0	1.2	1.4	**
Winnipeg, 65 Ellen					1.3
Winnipeg, Jefferson & Scotia			2.8	2.2	1.8
Edmonton, 127 St. & 133 Ave.	*	2.4	2.7	1.5	1.7

TABLE 6 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR OZONE -- SELECTED SITES (continued)

Location	Annual arithmetic mean (parts per hundred million)				
	1974	1975	1976	1977	1978
Edmonton, 10255-104th St.			*	1.4	0.9
Calgary, 620-7th Ave. SW	1.3	1.4	1.1	1.2	1.4
Calgary, 39 St. & 29 Ave. NW	*	2.2	2.6	2.2	2.2
Vancouver, 2294 West 10th Ave.	1.3	1.1	1.0	0.9	1.1
Vancouver, 970 Burrard			0.8	*	0.7
Victoria, 1106 Cook		2.4	2.2	2.4	1.2

* Insufficient data available to calculate valid annual arithmetic mean concentrations.
** Station terminated.

TABLE 7 NATIONAL AIR POLLUTION SURVEILLANCE NETWORK FOR NITROGEN DIOXIDE -- SELECTED SITES

Location	Annual arithmetic mean (parts per hundred million)				
	1974	1975	1976	1977	1978
Halifax, Barrington & Duke	*	*	1.1	*	3.3
Montreal, 1125 Ontario	3.0	2.1	3.5	3.6	*
Montreal, 2900 Boul. Concorde		*	2.8	2.7	3.0
Quebec, 155 Dorchester S.	*	2.0	2.4	2.1	3.1
Ottawa, Rideau & Wurtemburg			2.0	2.0	1.8
Windsor, 471 University	2.6	2.9	3.4	3.3	4.0
Toronto, 67 College	3.2	2.8	3.2	3.2	3.2
Toronto, Lawrence & Kennedy	2.6	2.1	2.4	4.0	3.1
Toronto, Elmcrest			2.2	2.2	2.5
Hamilton, Barton & Sanford		*	3.9	5.7	4.6
Sudbury, Ash		*	<1.0	1.3	1.2
London, King & Rectory		*	*	2.8	*
Sarnia, 156 Victoria		*	2.5	2.7	**
St. Catharines, North & Geneva			*	2.4	2.2
Kitchener, Edna & Frederick			*	*	3.2
Oakville, Rebecca & Woodside				2.0	2.0
Winnipeg, Jefferson & Scotia			1.6	1.9	1.9
Winnipeg, 65 Ellen					2.9
Edmonton, 127 St. & 133 Ave.	*	3.0	2.5	1.9	2.7
Edmonton, 10255-104th St.			*	3.9	4.3
Calgary, 620-7th Ave. SW		*	3.1	4.4	4.6
Calgary, 39 St. & 29 Ave. NW			*	2.4	2.6
Vancouver, 2294 West 10th Ave.				*	2.4

* Insufficient data available to calculate valid annual arithmetic mean concentrations.
** Station terminated.

projects were combined with new projects so that all aspects of the air monitoring data collection process are now performed under the umbrella of a quality assurance program.

During 1978-79, the quality assurance program comprised the following activities:

1. Analysis and distribution of nitric oxide and carbon monoxide compressed gases and sulphur dioxide sources, all of known concentrations. This activity ensures the standardization of field calibration materials.
2. Provision of 15 complete calibration systems to cooperating agencies. These devices allow routine multi-point calibrations to be performed for all continuous gas analyzers. Laboratory and field training programs were also provided and standard procedures for multi-point calibrations were prepared and distributed.
3. Drafting of general rules for the numbers and locations of stations in the NAPS network and probe siting criteria. All agencies are now in the process of assessing the adequacy and representativeness of their established monitoring network based on these rules and criteria.
4. Preparation of performance audit procedures and subsequent discussions with provincial and municipal operating agencies. The implementation of the performance audit program during 1979-80 will permit an independent appraisal of NAPS network data quality to be made.
5. Initiation of a comprehensive site documentation project. This site information for all major monitoring sites in the NAPS network will be published to assist all data interpretation activities. An acceptance testing program for all new instrumentation purchased for the NAPS network was developed and implemented.

A study of commercially available filters for high-volume samplers was undertaken to evaluate the suitability of various filters for the routine measurement of ambient airborne sulphates throughout the network. New ultraviolet photometric analyzers for ozone were evaluated before being integrated into the NAPS network. The replacement of twelve chemiluminescent ozone monitors in the network with photometric analyzers is planned for the next two years.

Air Monitoring Surveys. During the review period, the Environmental Protection Service undertook a number of air monitoring surveys, some near point sources and others over wider areas.

In New Brunswick the Atlantic Region of the Service and the Air Pollution Control Directorate surveyed mercury concentrations in the ambient air in the vicinity of

the chlor-alkali plant at Dalhousie. The mercury concentrations were less than the equivalent of the 24-hour ambient air quality criteria set by the Province of Ontario. Additional improvements should reduce the concentrations in the ambient air even further.

The survey undertaken by the Ontario Region of the Service in cooperation with the Air Pollution Control Directorate and the Ontario Ministry of the Environment to monitor fluoride concentrations in the ambient air and vegetation of Cornwall Island continued. Preliminary results obtained during the review period showed that both vegetation damage and the concentrations of particulate fluorides in the ambient air decreased. The concentration of gaseous fluorides in the ambient air was unchanged. The source of the fluoride emissions is an aluminum smelter in New York State. The results of the surveys are presented regularly to the International Joint Commission, and the problem forms an important part of the bilateral negotiations concerning the trans-boundary flow of air pollution. The studies will continue through the 1979 growing season.

In accordance with the Canadian Public Health Association Task Force's recommendations and based upon the federal government's concern for the health of the local population, the Service continued its arsenic monitoring program in Yellowknife. Arsenic concentrations in both suspended and settleable particulates were monitored. The results showed substantial reductions in ambient arsenic concentrations and total arsenic deposition rates since 1974.

A survey was conducted in Uranium City, Saskatchewan, from July to October, 1978, to measure concentrations of specific radio-isotopes in both suspended and settleable particulates in the ambient air. An interim report is being prepared. The survey will be resumed in the 1979-80 fiscal year.

The Environmental Protection Service continued its involvement in the Nanticoke Environmental Monitoring Program. The growth of heavy industry in the Nanticoke area has led to an increase in the emissions of air contaminants. The local and regional effects of the air pollution are under study and comprehensive air quality monitoring and precipitation analyses have formed an important part of the survey. The Service is represented on management and technical committees on which participants from the Ontario Ministry of the Environment, Ontario Hydro and industry also sit. The study will probably be continued for several years.

In Whitehorse, Yukon, the Service continued to monitor the ambient air for concentrations of the automobile-related contaminants, carbon monoxide and nitrogen

oxides, during the winter. In British Columbia, the Service continued its involvement in the Lower Mainland Air Monitoring program.

During the review period, the Air Pollution Control Directorate continued its projects in support of ambient air quality monitoring. Method development activities continued for elemental mercury, water soluble sulphates and for benzene. As part of a quality assurance program for laboratories engaged in analyzing air samples, a round robin exercise was completed using samples of sulphates from ambient air and involving 40 laboratories. A second such exercise involving fluoride samples was underway at year's end.

The Directorate undertook numerous chemical analyses in support of surveillance activities during the year. These included the analysis of PAH (polycyclic aromatic hydrocarbon) samples from the vicinity of coke ovens, the analysis of high-volume filters for heavy metals, and the provision of a quality assurance program for a survey of vinyl chloride in the ambient air at Shawinigan, Quebec. An epidemiological study concerning vinyl chloride in the Shawinigan region was completed in cooperation with the United States' Environmental Protection Agency and the University of Laval.

In other ambient air surveillance work, the Pacific Regional Office of the Service provided technical advice to two committees chaired by the Province of British Columbia. One was investigating the potential impact of fugitive coal dust emissions from the proposed Ridley Island coal terminal on nearby pulp mill operations, the other the effects on vegetation of fluoride emissions from the Alcan aluminum smelter at Kitimat and the need for more stringent control measures.

A workshop on ambient air monitoring was held in which over 40 federal and provincial persons responsible for air monitoring in Canada met to discuss common problems and new developments in air quality monitoring.

DEVELOPMENT OF AIR POLLUTION CONTROL MEASURES

Regulations for Stationary Sources

Section 7 of the Clean Air Act empowers the Governor in Council to prescribe national emission standards for air contaminants which constitute a significant danger to human health. The Air Pollution Control Directorate consults with the Health Protection Branch of Health and Welfare Canada to obtain advice on the potential health hazards of such contaminants. In response to Health and Welfare Canada's advice that it would be

prudent to control atmospheric emissions of vinyl chloride and arsenic to minimize the danger to public health, development of regulations for these contaminants began in 1976. Health and Welfare Canada had previously made similar recommendations for lead, mercury and asbestos.

Vinyl Chloride. Polyvinyl chloride resin is used in the manufacture of a wide range of plastic products including pipes and conduits, phonograph records, wire insulation, floor coverings and plastic bags, films and sheets. It is produced by the polymerization of vinyl chloride molecules. In Canada, vinyl chloride is produced by only one process, i.e., the pyrolysis of ethylene dichloride.

In 1973, two companies operated plants in Canada to produce approximately 245 million pounds of vinyl chloride. More than 90% of the vinyl chloride was used to produce polyvinyl chloride resins. The remainder was used in the production of trichloroethane. In 1973, four plants were operated to produce approximately 228 million pounds of polyvinyl chloride resin. Plastic fabricators consumed approximately 257 million pounds of resin in the manufacture of finished products.

For 1973, the estimated total emissions of vinyl chloride from all sources in Canada is 5 000 short tons. Polyvinyl chloride manufacturing operations accounted for approximately 89%, vinyl chloride and associated manufacturing operations for about 10% and polyvinyl chloride fabrication for about 1% of these emissions.

Vinyl chloride is a colourless gas and a proven human carcinogen. No safe human exposure level has been established. Health and Welfare Canada has recommended that, as a public health protection measure, vinyl chloride emissions from stationary sources in Canada be controlled and maintained at the lowest possible level. Accordingly, the Department of the Environment initiated action in 1975 to regulate vinyl chloride emissions. In 1977, proposed regulations were announced in the Canada Gazette. The amended regulations incorporating comments received in response to the proposal were published in the Canada Gazette on August 26, 1978. Additional comments were received but did not result in further changes to the final regulations that will be published in Part II of the Canada Gazette in April, 1979. The regulations, entitled "Regulations prescribing national emission standards for vinyl chloride emitted by vinyl chloride and polyvinyl chloride plants", become effective on July 1, 1979. The regional offices of the Service are now developing implementation agreements with the provincial governments.

A recommended code of operating practice was published in the Canada Gazette on August 26, 1978. It is expected that adherence to the regulations and the code

will reduce vinyl chloride emissions by approximately 95%. The standard reference method for the measurement of vinyl chloride emissions from the regulated sources was completed and will be published in July, 1979.

Arsenic. The major sources of emissions of arsenic into the atmosphere have been identified as the gold roasting industry, the iron ore processing industry and the non-ferrous primary metallurgical industry.

During the review period, draft regulations concerning the emission of arsenic from the gold roasting industry were completed. They are now being reviewed by the department's legal advisors. The development of the standard reference method for the measurement of arsenic emissions from the industry proceeded with stack tests being done or witnessed by staff of the Environmental Protection Service at gold mines in the Yukon, Northwest Territories and Ontario. The method was completed by year's end and will be published in the next fiscal year. Preparation of the socio-economic impact analysis for these emission standards regulations continued.

Asbestos. Work continued on the development of national emission standards regulations for asbestos manufacturing operations. The Pacific Regional Office completed an inventory of such operations within the region. A source monitoring survey was conducted at an asbestos cement pipe manufacturing plant to determine the applicability of current testing procedures to such sources. The results indicated that the available testing methods should be adaptable to asbestos manufacturing operations.

Lead, Mercury and Arsenic. The non-ferrous smelting industry in Canada is a major source of emissions of lead, mercury and arsenic. The federal government has therefore begun to develop regulations to limit these emissions. During the review period, numerous activities were underway, including deliberations of a government-industry task force, information gathering, and source test method development. Emission tests were done at a copper smelter, a copper-zinc smelter and a sintering plant, and development of the associated analytical methods proceeded. Interference problems caused by sulphur dioxide when sampling for mercury remain to be resolved. The assessment of appropriate control technology continued and the Department of Energy, Mines and Resources undertook research into control techniques for mercury emissions. Liaison with the United States' Environmental Protection Agency continued to exchange information on emission control for non-ferrous smelters.

Regulations for Mobile Sources

With the passage of the Motor Vehicle Safety Act the federal government initiated a program to combat air pollution from all new motor vehicles manufactured in or imported into Canada starting with 1971 models. Transport Canada was made responsible for the administration of the Motor Vehicle Emissions Regulations and Environment Canada for the execution of the required compliance testing and for the provision of technical advisory services in support of the regulations.

To achieve significant reductions at low cost, the federal government, in the past, followed the policy of paralleling United States motor vehicle emission regulations. As a result, by meeting standards of 3.4, 39.0 and 3.0 grams per mile (CVS test procedure) for hydrocarbons, carbon monoxide and oxides of nitrogen, respectively, 1973-74 model year cars were emitting only about one third as much as uncontrolled vehicles. The Canadian standards for 1975 were established at 2.0, 25.0 and 3.1 grams per mile (CVS-CH test procedure) for hydrocarbons, carbon monoxide and oxides of nitrogen, respectively. In July, 1978, Transport Canada announced its decision that these standards, which reduce emissions to about 72% of uncontrolled values, will remain the same through the 1984 model year. Corresponding United States standards for 1981 and later require about 95% control. A new standard designed to limit carburetor maladjustment on cars of the 1981 and later model years is about to be promulgated by Transport Canada. To facilitate the tuning of motor vehicles with respect to emissions, new labelling requirements are also being considered.

The official test for emissions is done at a standard temperature of about 20°C. Several years of research testing at more typical Canadian temperatures (down to -30°C) have indicated that modern vehicles are achieving equivalent emission reductions at colder temperatures. At the same time the fuel economy of the modern vehicles, due to more sophisticated engine controls, is three to four times less sensitive to cold weather than that of earlier models. The test procedures used for fuel economy are the same as those used for emission testing.

Sampling and analytical methods were developed to measure the concentrations of benzene and other aromatic compounds in gasoline and automobile exhaust samples. Approximately 200 samples were analyzed.

The Air Pollution Control Directorate has been studying emissions from other mobile sources at ports, airports and railway yards. Studies completed to date indicate

that these sites have lower emission densities (measured as the concentration of pollutants emitted per square mile per year) than the associated cities.

Regulations Relating to Fuel Composition

Sections 22 through 26 of the Clean Air Act provide for the regulation of fuel composition and fuel additives and for the necessary administrative procedures to reduce emissions of air pollutants when fuels are burned. To develop appropriate limits for Section 22 of the Act, regulations have been developed to obtain the required information on the current composition of petroleum fuels, including sulphur content, and on their additives and the impurities in crude oils. The Fuels Information Regulations, No. 1, were published in Part II of the Canada Gazette on August 10, 1977. An amendment to clarify the regulations was prepared during the review period and will be published in the Canada Gazette early in the 1979-80 fiscal year. The amendment does not affect the intent of the regulations, and information is required for 1978.

Heavy oils and Canadian coals were analyzed for trace elements during the fiscal year.

Guidelines for Stationary Sources

Under Section 8 of the Clean Air Act, provision is made for the federal government to publish national emission guidelines indicating the quantities and concentrations in which any air contaminant should not be emitted into the ambient air from sources of any class, whether stationary or otherwise. Each guideline consists of a document specifying emission limits for new sources and an industry study report in which available emission control strategies for existing sources are assessed. The technical review and assessment of control strategies is done by advisory committees consisting of federal and provincial government representatives and advisors from industry. The limits specified in the guidelines can become enforceable if they are prescribed by other regulatory agencies as standards or requirements. Guidelines have been published for the cement industry, the asphalt paving industry, the coke oven industry, arctic mining operations and for packaged incinerators.

Packaged incinerators. National Emission Guidelines for new packaged incinerators were published in Part I of the Canada Gazette on November 25, 1978.

The term packaged incinerator is used to describe a prefabricated unit that burns up to 900 kg/h of solid waste at the site where the waste is generated. Industrial, commercial and institutional establishments in every province use these units to dispose

of waste containing paper, furniture, food, animal products and pathological remains. There are over 10 000 packaged incinerators in Canada and they consume approximately half of the solid waste that is incinerated in Canada.

Packaged incinerators can be a significant cause of local pollution and nuisance complaints. While there are many contaminants emitted by these incinerators, the most important ones are particulate matter, sulphur dioxide and hydrogen chloride. The guidelines, which were developed in consultation with the provincial governments and incinerator manufacturers, specify emission limits for particulate matter and plume opacity based on the use of new incinerator technology. Emissions are reduced by approximately 50% compared with older installations.

Emission limits for sulphur dioxide and hydrogen chloride were included in the guideline to control these emissions from incinerators burning waste with significant quantities of rubber or polyvinyl chloride.

The draft standard reference method for hydrogen chloride emissions from packaged incinerators was completed.

Wood Pulping Industry. The industry study report on the wood pulping industry was published and work continued on the development of emission limits for total reduced sulphur compounds, sulphur dioxide and particulate matter from this industry. Development of the standard reference method for total reduced sulphur compounds progressed well.

Residential Heating. A comprehensive study of residential heating in Canada was completed. The report includes a description of the types of units used, the fuels burned, and the air pollution problem areas. Recommendations to minimize air pollution emissions are included. The report will be published in the next fiscal year.

Ferrous Foundries. The industry study report on the ferrous foundry industry was completed and will be published early in the next review period. The task force consisting of representatives of the federal government, the provincial governments and industry completed its work and recommended emission limits for new foundries. These limits will be published in the Canada Gazette during the next fiscal year. Reports on the status of air pollution controls in this industry sector were completed by the regional offices.

Thermal Power Generation. Work continued on the acquisition of current data on emissions from thermal power generating stations and from compressor and pumping

stations associated with fuel pipelines. The standard reference method for determining the concentration of nitrogen oxides in stack gases from combustion sources was completed. It will be published early in the next fiscal year. The reduction of sulphur dioxide emissions from thermal power stations through the combustion of lignitic coal was studied in collaboration with the Department of Energy, Mines and Resources. Several reports concerning the absorption of sulphur by the ash were published in technical journals. The Hat Creek thermal power station and mine complex being considered in British Columbia was evaluated for emissions of sulphur dioxide and particulate matter.

Petroleum Refineries. Preparation of the industry study report on petroleum refining and identification of emission limits continued. A draft of the standard reference method for carbon monoxide emissions was completed.

Natural Gas Processing. Work continued on the development of recommended emission limits for this industry sector and on the preparation of the associated industry study report.

Other Industry Sectors. Emission limits were formulated for pollutants arising from boilers used in the Canadian iron and steel industry. The fertilizer industry cooperated with the Environmental Protection Service in a study of the industry by responding to a questionnaire. An overview of the surface coatings industry was prepared under contract. The report is being reviewed to determine the need to issue emission limits for the industry. The requirement for guidelines concerning the operation of compressors on the proposed northern pipeline was assessed and recommendations were made to the Northern Pipeline Commission. A study of world markets for sulphuric acid was completed under contract as part of the activity to develop limits for the emission of sulphur dioxide from non-ferrous smelters.

Guidelines for Mobile Sources

There are no direct provisions in the Clean Air Act for the regulation of air pollution emissions from mobile sources. The Act does, however, address itself to mobile as well as stationary sources under its general provisions for air quality objectives, air quality monitoring and surveillance, vehicle emissions, fuel composition regulations and federal-provincial cooperative programs.

Although the control of emissions from in-use motor vehicles is outside federal jurisdiction, the very high concentrations of air pollutants emitted by badly maintained vehicles are of great concern. A program to review and evaluate compulsory emission

inspection systems used in Canada, the United States and several European countries is continuing with a view to developing, with the cooperation of industry and the provinces, a federal guideline for the implementation of such inspection programs.

To gather more data on emissions from in-use vehicles, a two-week vehicle checking project was done in Edmonton and Calgary in cooperation with the Alberta Department of the Environment and the Alberta Motor Association. Over 1000 vehicles were checked and 750 were found to have excessive emissions.

Control Technology Development

Program for the Development and Demonstration of Pollution Abatement Technology (DPAT). The effective abatement of air contaminant emissions from industrial sources depends upon the availability of technically sound and economically feasible control technology. Recognizing that it might be necessary for the federal government to encourage the development and demonstration of new control technology, provision was made in Section 3 of the Clean Air Act for the establishment of appropriate demonstration projects. On this basis, the Environmental Protection Service developed the DPAT Program, which provides for cost-shared agreements with industry to develop and demonstrate new control technology. This program began on April 1, 1975. In the air sector, initial emphasis was placed on the development of technology for the capture and containment of fine particulates and sulphur dioxide. Later the scope of the program was broadened to include pollutants for which regulations and guidelines have been published or which are under development. During the review period it was announced that, because of fiscal constraints, funding for the DPAT program would be terminated on March 31, 1979; however, the program itself has not been terminated. Four projects were supported by the Air Pollution Control Directorate during the fiscal year 1978-79.

British Columbia Forest Products Limited is developing a new type of granular-bed filter for the removal of fine particulates from hot combustion gases released by boilers fired with wood waste. If successful, this technology could find application not only in the forest products industry but also in other industrial sectors in Canada. Trial runs with the filter system have been made; these revealed a number of operational problems that are currently being addressed.

The St. Anne-Nackawic Pulp and Paper Company Limited in New Brunswick is developing a scrubber for the simultaneous collection of fine particulate matter and sulphur compounds emitted from the recovery boiler of its kraft paper mill. This new technology has attracted considerable interest in the pulp and paper industry because it

should result not only in a significant decrease in air contaminant emissions but also in the recovery, and recirculation to the plant, of valuable chemicals that are currently emitted into the atmosphere.

A study was completed by Moniteq Ltd., Toronto, on the evaluation of correlation spectrometers for the remote measurement of sulphur dioxide mass emissions from industrial sources. The experimental measurements were made in the vicinity of an Ontario Hydro coal-fired generating station; good agreement was obtained between remote sensing measurements made up to 3 kilometres from the station and sulphur dioxide mass emissions calculated from the sulphur content of the coal. This study provides the basis for the development of standard procedures for determining point-source sulphur dioxide emissions that do not require access to proprietary information or private property, and for the measurement of sulphur dioxide transport from, or to, industrial areas or across international boundaries.

The final DPAT contract, with the Algoma Steel Corporation Limited, is for the demonstration of a high-pressure water-jet system for cleaning coke oven doors. During the coking cycle, volatile matter from the coal condenses on the doors and door jambs, which are cooler than the oven. To obtain satisfactory door sealing, and thereby minimize the emission of hydrocarbons into the atmosphere from leakage, these deposits must be removed, preferably after each cycle. At present, this is done mechanically by scraping, a method that is not satisfactory. The successful demonstration of the water-jet cleaning system could lead to its adoption by the four steel companies in Canada and by similar plants in other countries.

Projects Sponsored under the Department of Supply and Services' Unsolicited Proposal Program. This program provides bridge financing for unsolicited proposals in science and technology submitted by the private sector that are worthy of support by one or more government departments. Proposals that fall within the mission of the department but cannot be accommodated with current funds are eligible for assistance under the Unsolicited Proposal Program. Several projects are now receiving support from the Environmental Protection Service.

One project supported by the Air Pollution Control Directorate was completed during the year. It resulted in the successful development of a laboratory prototype instrument for the continuous quantitative measurement of sulphur trioxide in the presence of a relatively large excess of sulphur dioxide in a simulated stack gas. In the atmosphere, sulphur trioxide can be converted into sulphuric acid and sulphate

particulates. The environmental effects of these secondary pollutants are of great concern to the federal government. There are no known commercial instruments for monitoring sulphur trioxide in the presence of sulphur dioxide.

A second project being sponsored by the Directorate is for the identification of conditions that will enhance the collection efficiency of electrostatic precipitators used in non-ferrous smelting applications. The project is addressed in general to the containment of particulates and heavy metals and in particular to the containment of arsenic emissions. It involves a detailed physico-chemical study of the properties of the particulates and carrier gas.

In British Columbia, two proposals to evaluate the operating characteristics of incinerators were approved during the fiscal year. One concerns a municipal incinerator at Lake Cowichan, the other a hospital incinerator at the Royal Jubilee Hospital in Victoria.

Other Technology Development Programs. In the Pacific Region, funds from the Cooperative Pollution Abatement Research[1] program were used to support two projects. In the first, the effect of certain sampling techniques on the measurement of particulate emissions was evaluated on a recovery boiler and a power boiler. In the second, a photo-ionization method is being developed for measuring low concentrations of malodorous sulphur compounds in ambient air samples.

A new program for the Development of Resource and Energy Conservation Technology (DRECT) was initiated in the review period. It is administered jointly by the Department of Energy, Mines and Resources and Environment Canada and promotes the development of technology to reduce waste or recover it for material recycling or energy production. Two proposals for funding under the DRECT program were reviewed by the Pacific Regional Office. Both proposals concern the incineration of municipal waste with associated heat recovery and minimal air pollution emissions.

The Ontario Region of the Service published a report on a continuous particulate monitoring study done at a secondary lead smelter in 1976-77. The development of reliable continuous source monitors is being investigated in cooperation with the Ontario Ministry of the Environment.

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[1] A cooperative program between the federal government and the pulp and paper industry to abate water and air pollution in the industry. Funded on an equal cost-sharing basis for more than $2.5 million in 1978.

A preliminary investigation was done to determine the feasibility of removing sulphur dioxide from flue gases of coastal power stations through the use of seawater scrubbers. Consultations were held with Norsk Hydro, Norway, where such scrubbers are in operation. Although the process offers the promise of high efficiency for the removal of sulphur dioxide, the return of the spent seawater to the ocean has the potential for damage to marine life. A proposal to measure the conversion of nitric oxide to the polluting nitrogen dioxide in the exhaust plume of a large gas turbine pipeline compressor was reviewed. The degree to which this chemical conversion takes place will influence the stringency of pollution control measures introduced for these engines.

IMPLEMENTATION OF AIR POLLUTION CONTROL MEASURES

Implementation of Regulations for Stationary Sources

Secondary Lead Smelters. National Emission Standards Regulations for Secondary Lead Smelters were adopted by the Governor in Council and promulgated in Part II of the Canada Gazette on July 28, 1976. The regulations became effective on August 1, 1976.

Normal enforcement monitoring activities continued during the review period. The Province of Alberta and the Greater Vancouver Regional District have agreed to enforce these regulations on behalf of the federal government and are doing the necessary enforcement activities. The Province of Quebec is enforcing the regulations in cooperation with Environment Canada; all smelters in the province were visited and emission tests done at four plants. The Province of Ontario has reviewed the effects of its legislation on secondary lead smelters and has made arrangements for emission tests to be done at three of the major smelters. The Northwest Region of the Service inspected the three smelters in Manitoba and the Atlantic Region inspected the smelter in Nova Scotia and requested another emission test.

The standard reference method for the measurement of emissions of lead and particulates from secondary lead smelters was modified. The method will be published in the next review period.

Mercury Cell Chlor-Alkali Plants. National Emission Standards Regulations for Mercury Cell Chlor-Alkali Plants were promulgated in Part II of the Canada Gazette on July 27, 1977 and became effective on July 1, 1978.

Installation of control equipment was completed at both plants in the Atlantic Region. At the year's end, testing was being done to determine whether the plants were in compliance with the regulations. Three of the four plants in Quebec closed during the review period and the fourth was shut down for several months because of a fire. This plant resumed operations in November and was being tested for mercury emissions at the year's end. The only mercury cell chlor-alkali plant in Ontario continued to operate within the limits specified in the federal regulations. The company has agreed to continue its monitoring program indefinitely.

In the Northwest Region, the only plant that used the mercury cell process changed to the membrane cell system during the review period. The control equipment at the only mercury cell chlor-alkali plant in British Columbia was in place at the year's end and tests for mercury emissions were underway.

Asbestos Mining and Milling Operations. National Emission Standards Regulations for Asbestos Mines and Mills were promulgated in Part II of the Canada Gazette on July 13, 1977 and took effect on December 31, 1978.

During the review period progress continued in ensuring that asbestos mines and mills across the country were in compliance when the regulations became effective. The air pollution control program at the Advocate Mine and Mill in Baie Verte, Newfoundland progressed well and tests on controlled sources showed that these were operating in compliance with the regulations. The entire complex will be operating within the emission limits by the fall of 1979.

There are some 150 sources of asbestos emissions at the nine asbestos mines and mills in Quebec. All of the companies are following emission control programs and almost all sources are now operating in compliance with the regulations. A source testing program has been negotiated with the Association des Mines d'amiante du Québec and the testing will start in the spring. There are no plants in Ontario that are subject to these regulations.

The asbestos mine in the Yukon closed during the review period because of depletion of the ore body. Advice continued to be provided to the Yukon Territorial Water Board on the adequacy of environmental protection plans for the abandonment of the mine site. The company operating the asbestos mine in British Columbia has stated its intention to comply with the regulations and is expected to be in compliance by July 1979. The compliance program was delayed by a prolonged shutdown at the mine.

Emission tests were done at a number of plants during the review period and the testing program will continue during the next fiscal year. An amendment to the regulations to include dry drilling operations was completed. It will be published in 1979.

The Air Pollution Control Directorate participated in a study sponsored by the American Society for Testing and Materials to determine improved methods for defining fibrous asbestos particles. A new microscope system for counting asbestos fibres was evaluated and a program to investigate the application of computerized image analysis systems to asbestos fibre counting was initiated.

Other Activities. A continuous monitor for particulates in stack gases was evaluated on two sources. The Environmental Protection Service is developing a cooperative field testing program with industry to evaluate the applicability and reliability of continuous source monitoring equipment.

A computer program for random error analysis was written to permit the analysis of all source test data to reveal the random variations in each measurement. Other programs for calibration and analysis were written and new data sheets were designed. A quality assurance check was completed on the procedure to test for leaks in source sampling trains and an improved procedure identified.

Implementation of Fuels Regulations

Leaded Gasoline Regulations. Refineries have been submitting quarterly reports to Environment Canada since September 1974 on the quantities of lead being added to gasolines at each refinery. In 1978, about 27.2 million pounds of lead were added to the premium and regular gasolines. This represents a decrease of approximately 1.8 million pounds from the amount added in 1977. This is attributable to the increased use of lead-free gasoline.

Lead-free Gasoline Program. Lead-free gasoline production has increased from 3.1% of the total gasoline marketed in 1975 to 21% in 1978. During the review period, 2696 samples of lead-free gasoline were tested in the national monitoring program. One hundred and fourteen samples exceeded the allowable concentration of 0.06 g of lead per imperial gallon of lead-free gasoline. Corrective actions were taken immediately to rectify these violations of the regulation.

Implementation of Regulations for Mobile Sources

Automobile manufacturers are required to certify that new motor vehicles offered for sale in Canada conform to current emission standards. The federal

government's compliance monitoring program, operated jointly by Transport Canada and Environment Canada, is designed to ensure that emission rates from new automobiles do not exceed those standards.

Each year approximately 50 new motor vehicles, representing the most popular makes, models and engine families and family combinations sold in Canada, are tested for compliance with the emission standards. During the review period more than 500 000 kilometres were accumulated on approximately 50 vehicles driven on a prescribed urban-rural route in the Ottawa area. More than 400 emission tests were completed.

Implementation of Guidelines for Stationary Sources

Arctic Mining Industry National Emission Guidelines. The Government of the Yukon Territory prepared draft regulations for the arctic mining industry that incorporate the intent of the federal government's national emission guidelines. The Government of the Northwest Territories previously promulgated similar regulations.

Asphalt Paving Industry National Emission Guidelines. In the province of New Brunswick, the national emission guidelines for the asphalt paving industry were adopted in 1976 as regulations that will take effect in 1980. The Nova Scotia Department of the Environment and the Environmental Protection Service cooperated in a study of the asphalt paving industry in the province. A plant inspection procedure was developed and recommendations made for abatement of emissions. In Ontario, emission limits will be incorporated into the province's approval requirements for new installations. Draft regulations were developed by Quebec and Manitoba for their asphalt paving industries. These regulations are similar to the federal guidelines. In Alberta, the control program for asphalt paving plants is in place. Provincial permits have been issued in British Columbia to 41 of the 57 asphalt paving plants in the province. Sixteen of these permits reflect the requirements of the federal guidelines. The Environmental Protection Service assisted the Yukon Territorial Government in drafting regulations for asphalt plants in the territory.

Cement Industry National Emission Guidelines. New plants built in the Province of Ontario are being requested by the provincial government to meet its emission guidelines. The limits specified are the same as those in the federal guidelines. Emissions of particulates from existing cement plants in Ontario are now generally lower than the limits specified in the federal guidelines. In British Columbia, three of the five plants have been issued provincial permits. The Clean Environment Commission in Manitoba has issued orders that reflect the federal guideline emission limits for both of

the cement plants in Winnipeg. In Alberta and Saskatchewan, emissions of particulates from cement plants have been addressed by the provincial governments and emissions are within acceptable limits. The Province of Quebec deals with cement plant emissions on a case-by-case basis. The Montreal Urban Community has issued regulations that are slightly more stringent than the federal regulations.

Metallurgical Coke Manufacturing Industry National Emission Guidelines. The Ontario Ministry of the Environment will shortly incorporate the federal emission limits into its approval requirements for new coke manufacturing installations. There is one coke manufacturing plant in British Columbia; a provincial permit was issued for it during 1978 that specifies substantial additional air pollution controls to contain particulate emissions. Sulphur dioxide emission controls, although considered by the provincial government, were not imposed in view of the age of the plant and the substantial capital investment required. The coke ovens at Sydney, Nova Scotia, are the only ones in the Atlantic Provinces. The province has chosen not to develop regulations because of the age of the coke ovens.

Technical Information Dissemination

Air Pollution Information System. During the development of a regulation or guideline for a stationary source, a major "state-of-the-art" review for the industry under study is compiled. The information in it is drawn from many sources: published literature, consultants' reports and computerized information banks. To ensure that Service staff have access to all available information, an information system on air pollution control was established in 1973. The system also serves current awareness requirements for senior staff and the special air pollution information requirements of Canadian universities and industry. The system has full access through the Lockhead DIALOG on-line computer system to the Air Pollution Technical Information Center (APTIC) computer-stored information system of the United States' Environmental Protection Agency (EPA) and to more than 80 other data bases. Free searches of the APTIC file are provided to all levels of government in Canada. Searches are done at cost for others. In accordance with an information agreement with the EPA, microfiche copies of APTIC documents are provided free of charge to all Canadian users. During the review period more than 100 computerized literature searches were completed for federal, provincial and municipal government agencies in Canada and approximately 6 000 individual information requests were answered. The system has more than 100 000 documents available on microfiche and 4 500 books and reports in hard copy.

Training in Air Pollution Control Technology. In support of the regulatory activities of air pollution control agencies across Canada, air pollution control training courses were again presented for enforcement officers of the federal, provincial and municipal governments. Five courses were offered during the year, on stationary source testing, air pollution meteorology and the statistical evaluation of air pollution data. The courses were attended by 125 persons. The Industrial Research Institute of the University of Windsor developed and presented the course on stationary source testing under contract. The course on air pollution meteorology was developed internally and presented by lecturers of the Environmental Protection Service and the Atmospheric Environment Service. The course on statistical evaluation of data was prepared and presented under contract by two professors of the Université de Montréal.

Additions were again made to the library of videotapes on air pollution control topics. The tapes are loaned to enforcement agencies across Canada for training purposes. Other audiovisual material on air pollution control was added to the library which now contains about 350 videotaped lectures and 50 audio-cassettes.

Courses for inspectors in the reading of plume opacity were held in the Quebec and Northwest regions of the Environmental Protection Service during the review period. Forty-seven enforcement officers were certified. Courses are held at six- or twelve-month intervals for recertification.

Publications. The Air Pollution Control Directorate edits, publishes and distributes the scientific and technical reports produced by its staff and consultants. During the review period, 32 reports in the EPS series were published. Normal distribution is about 800 copies of each report. The clientele includes foreign governments, international organizations, universities, industries, members of the public, and federal, provincial and municipal government departments. Nine scientific papers written by Directorate staff were published in international journals.

The reports published during the review period were the following:

Regulations, Codes and Protocols Series

EPS 1-AP-78-2 The Clean Air Act - Compilation of Regulations and Guidelines (Bilingual)

Economic and Technical Review Series

EPS 3-AP-75-6F Pollution atmosphérique et techniques antipollution dans l'industrie du chlore

EPS 3-AP-77-1	An Annotated Bibliography of Air Pollution Literature: Supplement
EPS 3-AP-77-4	Air Pollution Emissions and Control Technology: Vinyl Chloride Industry
EPS 3-AP-77-4F	Technologie de la lutte contre la pollution atmosphérique: industries de fabrication du chlorure de vinyle
EPS 3-AP-77-6	Air Pollution Emissions and Control Technology: Wood Pulping Industry
EPS 3-AP-77-8	National Inventory of Sources and Emissions of Selenium (1973)
EPS 3-AP-77-8F	Inventaire national des sources et émissions de sélénium (1973)
EPS 3-AP-78-2	A Nationwide Inventory of Emissions of Air Contaminants (1974)
EPS 3-AP-78-2F	Inventaire national des rejets de polluants dans l'atmosphère (1974)
EPS 3-AP-79-1	Canadian Vehicle Survey

Technology Development Series

EPS 4-AP-78-1	Automobile Emissions and Fuel Economy at Low Ambient Temperatures

Surveillance Series

EPS 5-AP-77-14	Emissions of Vinyl Chloride to the Ambient Air around Manufacturing Facilities in Ontario
EPS 5-AP-78-13	National Air Pollution Surveillance. Annual Summary, 1977 (Bilingual)
EPS 5-AP-78-8*to	National Air Pollution Surveillance. Monthly
EPS 5-AP-78-22	Summaries August 1977 to October 1978 inclusive (Bilingual)

Miscellaneous Publications

List of Publications - Air Pollution Control Directorate (Bilingual)
Clean Air Act Annual Report 1976-77 (Bilingual)
Clean Air Act Annual Report 1977-78 (Bilingual)

Control of Emissions from Federal Facilities

The federal government's conduct of its own activities, as perceived by the public, has a powerful potential to work for or against the endeavours of the government in its role as a leader in environmental and public health protection. The Department of the Environment has direct responsibility for ensuring that the federal government

minimizes adverse environmental effects from all of its works, undertakings and businesses.

During the review period, a pathological waste incinerator was installed at the Agriculture Canada Animal Disease Laboratory in Sackville, New Brunswick, and a rotary-cup type oil burner was installed at the Agriculture Canada Research Station Heating Plant at Fredericton, New Brunswick to reduce air pollution emissions, noise and fuel consumption. Several new activities were initiated:

- an integrated waste management project at the Ste. Anne de Bellevue Veterans' Affairs Hospital;
- installation of a controlled-air incinerator at the airport at Yarmouth, Nova Scotia;
- environmental assessment studies at two Canadian Forces bases to determine the air pollution emissions from coal-fired central heating plants;
- the purchase of an exemplary incinerator for a government vessel; and
- the acquisition of a continuous air pollution monitoring system for the Ste. Anne de Bellevue incinerator.

Stack tests were done on the No. 3 boiler stack at the central heating plant of the Experimental Farm, Ottawa, at the request of the Department of Energy, Mines and Resources for a study on the boiler's efficiency in normal and modified modes. The Air Pollution Control Directorate participated in the development of selection criteria for a fluidized-bed boiler at the Canadian Forces Base in Summerside, Prince Edward Island.

Technical Review and Advisory Activities

During the year, the Air Pollution Control Directorate and the Environmental Protection Service's regional offices undertook numerous technical reviews and provided advice on a broad range of issues. These activities, done in cooperation with provincial agencies, municipalities, other government departments and industry, included the following:

- discussions with the Government of the Northwest Territories on the development of a code of good practice for open burning in the Territories;
- participation in a committee composed of representatives of the CNR, the CPR, the Northern Alberta Railways Corporation and the Alberta Department of the Environment to review and recommend methods of disposal of used railway ties;

- provision of technical advice to the Province of Saskatchewan in the development of emission control regulations for the potash industry and to the Province of Manitoba concerning a non-ferrous smelter;
- review of flaring practices at an oil refinery and development of environmentally acceptable practices in cooperation with the company;
- participation in the Interdepartmental Committee on District Heating investigating and promoting energy conservation and environmentally acceptable methods of heating and cooling;
- joint evaluation with the Department of Energy, Mines and Resources of a new ultrasonic water emulsifier designed to improve oil combustion in burners and to increase boiler efficiency and reduce air pollution emissions;
- completion of a testing program for air pollution emissions and combustion efficiency on a small fluidized-bed burner for wood waste generated by small isolated sawmills;
- participation in a government-industry task force developing guidelines for the safe destruction of polychlorinated biphenyls in cement plants;
- provision of technical advice to the Department of Regional Economic Expansion on numerous projects under consideration for funding;
- participation in the review of the environmental impact potential of major developments in the regions, including the Kitimat Oil Port, the Northern Gas Pipeline, the Roberts Bank Port Expansion, expansion of the Vancouver International Airport, gas processing plants, and a major chemical storage and shipping terminal;
- provision of technical information to Port Moody Town Council about the environmental effects of sulphur emissions from a bulk loading terminal;
- review of applications for the Accelerated Capital Cost Allowance program through which the capital cost of pollution abatement equipment can be written off on an accelerated depreciation scale;
- provision of technical advice to the Province of British Columbia and the Greater Vancouver Regional District on permit applications; and
- participation in numerous technical committees, including the National Research Council's Committee on Criteria for Pollutants, the Canadian Standards Association, the American Society for Testing and Materials and the Aquatic Environmental Quality Committee of the Ontario Regional Board.

The Air Pollution Control Directorate undertook special chemical analytical studies and provided advice to other organizations to promote the development of analytical methods. Activities completed during the review period included:

- assessment of the interference of the manganese-containing gasoline additive MMT on the measurement of the concentration of lead in gasoline;
- analysis of dust samples from Dickenson Mines to determine the effectiveness of control equipment;
- analysis of dioxins in samples from an incinerator; and
- construction and provision of cell room monitors for mercury.

The Directorate continued research to maintain its expertise in x-ray fluorescence, gas chromatography and mass spectrometry. Projects continued to develop expertise in high-pressure liquid chromatography, high-resolution capillary chromatography, ion chromatography, electrochemical analysis, gas mixing, and the production of test atmospheres. These techniques will be used in the development of standard reference methods for the measurement of air contaminants in gas streams and in the ambient air.

LIAISON, PROGRAM PLANNING AND PROGRAM EVALUATION

National and International Participation and Cooperation

General. Air pollution control is a shared federal-provincial jurisdiction. The National Air Pollution Control Program is therefore developed with a great deal of emphasis on consultation and cooperation with provincial environment agencies. Control programs initiated by the federal Environmental Protection Service are intended to be implemented by provincial agencies whenever possible.

The Canada-U.S. section of this report makes special mention of bilateral activities related to long-range transboundary air pollution and acid rain. Because the air contaminants involved are subject to provincial control, there is a domestic dimension for Canada to this international problem. For this reason, a federal-provincial workshop was held in March 1979 to elicit provincial support for Canadian preparations for further discussions with the U.S. Government on this problem.

Federal-Provincial Committee on Air Pollution. The Federal-Provincial Committee on Air Pollution is the principal national mechanism for obtaining federal-provincial cooperation and for promoting provincial participation in specific national

projects. The committee was established on an ad hoc basis in 1969 by the Department of National Health and Welfare. With the formation of Environment Canada in 1971, the committee was formally established under the aegis of the Minister of the Environment. The committee provides a forum for the exchange of technical and scientific information and methodologies and for the regular discussion of air pollution control programs in Canada. During the review period, the annual meeting of the committee was held in Ottawa, May 9-11, 1978.

In 1970, a subcommittee of experts was established to recommend to the parent committee appropriate levels for National Air Quality Objectives. Recommendations of the subcommittee have permitted air quality objectives to be prescribed at the desirable and acceptable levels. A separate subcommittee was established to develop the tolerable level air quality objectives.

The two subcommittees meet twice each year and are currently reviewing the existing objectives as well as considering the need for objectives for other air contaminants.

In 1975, an ad hoc subcommittee was established to examine the possibilities for, and development of, a system of national air quality indices. Following some preliminary recommendations, a complete report on a short-term and an annual system was submitted to, and accepted by, the parent committee at its 1978 meeting. As a result of experience gained in using the annual system during the period under review, the subcommittee met again in January 1979 and will submit recommendations for modifications to the system at the 1979 meeting of the committee.

The Federal-Provincial Committee on Air Pollution has instituted an interlaboratory quality control program for methods of analysis of air pollutants. Approximately 60 laboratories are participating. Comparative analyses on samples containing lead and sulphates have been completed.

An important concern of the committee is the National Air Pollution Surveillance (NAPS) network. The NAPS network is a cooperative effort of the federal, provincial and municipal levels of government that monitors the concentrations of locally significant air pollutants in all major centres of population. The network enables the monitoring of progress in air pollution control across the country. Its method of operation and other pertinent details are explained elsewhere in this report.

Participation in Canada-U.S. Programs. The cooperative relationship developed over past years with the EPA will be of increasing importance over the next

several years as the two governments endeavour to develop mutually acceptable policies and control strategies to deal with transboundary air pollution. During the period covered by this report, Canada and the United States established a Bilateral Research Consultation Group, which met twice during the year, to coordinate scientific activities in the two countries related to long-range transport of air pollutants and the resulting problem of acid rain.

The most recent projections indicate that the source of the acid rain problem can be attributed almost equally to U.S. and Canadian sources; therefore, the ultimate solution must evolve in cooperation with the United States. To this end, the first in a series of exploratory meetings between Canadian and U.S. officials was held in December 1978, at which policies and procedures were examined. Further meetings planned for the coming year are expected to lead to a bilateral agreement on air quality.

Through regular attendance at various meetings in the United States, the Department of the Environment is kept informed on many areas pertaining to air quality research, priorities and programs. The Directorate continued to cooperate with the EPA in quality assurance programs by testing the Agency's analytical methods and by exchanging samples for interlaboratory comparisons.

The International Air Pollution Advisory Board is a Standing Board of the International Joint Commission (IJC). Air pollution problems that arise along the Canada-United States border are investigated by the Board and reported to the Commission. The Air Pollution Control Directorate provides the Canadian Chairman of the Board, one other member, and technical assistance. The Atmospheric Environment Service also provides a member.

During the year, the Board continued to monitor the status of several problems on which it had previously reported to the Commission. These include fluoride air pollution on Cornwall Island and thermal power generation projects at Poplar River in Saskatchewan and Atikokan in Ontario. The Board also reported to the Commission on developments related to the long-range transport aspect of transboundary air pollution.

In 1975, the Premier of Ontario and the Governor of Michigan signed a memorandum of understanding to implement an integrated cooperative program for the abatement of transboundary air pollution in the southeastern Michigan-southwestern Ontario area. As a result of this memorandum, the two governments requested the IJC to create the International Michigan-Ontario Air Pollution Board to monitor the progress of air pollution control programs being implemented in the transboundary area. The Air

Pollution Control Directorate provides the Canadian Chairman and technical assistance to this Board.

The Michigan-Ontario Board issued its 3rd Annual Report on October 4, 1978, in which it noted the continuing improvement of air quality in the area and drew attention to a number of problems of non-attainment of strict IJC objectives for particulate matter and sulphur oxides. A special report was also prepared by the Board, and submitted to the IJC on April 4, 1978, on the best available method for safe disposal of waste liquids containing polychlorinated biphenyls (PCBs). The recommended method is by incineration in cement kilns.

Participation in other International Programs. In order that Canada may be well informed about developing policies and technology concerning air pollution control in other countries, the Service continued to participate in a broad spectrum of international programs. Projects conducted within these international organizations, on such subjects as long-range transboundary air pollution, control of toxic substances, and the study of control strategies for nitrogen oxides, are of direct relevance to Canadian programs. Participation in such projects, where experts from a number of countries come together to focus on a specific problem area, enables Canada to contribute to and benefit from an ever increasing fund of knowledge on these subjects.

The participation of the Service in such programs is coordinated through the Department of External Affairs and involves programs of the World Health Organization (WHO), the Organization for Economic Cooperation and Development (OECD), the Economic Commission for Europe (ECE), the North Atlantic Treaty Organization Committee on the Challenges of Modern Society (NATO/CCMS) and the United Nations Environment Program (UNEP). The Canadian delegate to the OECD Air Management Group is provided by the Air Pollution Control Directorate and is currently Chairman of the Group. The Air Pollution Control Directorate provided Canada's representative to the ECE Special Group on Long-Range Transboundary Air Pollution. This group met several times during the review period to develop proposals for international cooperation by all ECE member countries in the control of this form of air pollution. The work of the Group is under review by the Senior Advisors on Environmental Problems to the ECE, with the object of developing an appropriate document for agreement at a proposed high level meeting of ECE member countries within the next year.

The Air Pollution Control Directorate continued to participate in the WHO Air Quality Monitoring Project. Air quality data for sulphur dioxide, suspended particulate

matter and soiling index from 11 stations located in Vancouver, Hamilton, Toronto and Montreal are forwarded quarterly to the WHO headquarters in Geneva. One station in Toronto will be operated as a comparison station where WHO standard reference measurement methods will be used concurrently with standard instrumental methods.

The Directorate has been providing Canada's representative to meetings of the Assessment Methodology Panel of the Air Pollution Pilot Study of NATO/CCMS. Canada has contributed to the preparation of NATO/CCMS documents on Air Pollution Emissions Inventory Systems, Air Pollution Emissions Projection, and Glossary of Terms. During the review period, Canada hosted the 8th meeting of the Pilot Study and the Assessment Methodology Panel terminated its activities. Canada may be involved in follow-up activities related to this Pilot Study.

Other international activities completed during the period under review included:

- participation in an ECE Task Force on emissions from non-ferrous smelters and the preparation of two chapters of the report;
- provision of 150 standards from the Directorate's bank of polyaromatic hydrocarbons in response to 21 requests;
- participation in a European Economic Community bilateral working group on the asbestos industry; and
- provision of advice to the Mexican government on the development of a quality assurance program for the Mexico City monitoring network.

Inter-Departmental Negotiation and Liaison. The Directorate consults regularly with the Environmental Health Directorate of Health and Welfare Canada on public health aspects of air pollution control. On the international scene, the Service is the primary advisor to External Affairs on technical matters and on policies and negotiating strategies related to air pollution control. The Department is represented on the Air subcommittee of the National Research Council's Associate Committee on Scientific Criteria for Environmental Quality.

The Department of Indian and Northern Affairs is kept informed of Service activities with the governments of the Yukon and Northwest Territories concerning the development and implementation of air pollution control programs. Regular liaison is maintained with the Department of Energy, Mines and Resources and the National Energy Board on environmental matters related to energy and with the Department of Industry, Trade and Commerce on the environmental aspects of industrial policies.

National Air Quality Objectives. National Air Quality Objectives are designed to protect public health and the environment by setting limits on the concentrations of contaminants in the ambient air. The Clean Air Act makes provision for three levels of air quality objectives: desirable, acceptable, and tolerable, for major air contaminants.

The maximum desirable level defines the ultimate goal for air quality and provides a basis for an anti-degradation policy for the unpolluted parts of the country and for the continuing development of control technology.

The maximum acceptable level is intended to provide adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being.

The maximum tolerable level denotes a concentration of an air contaminant that requires abatement without delay to avoid further deterioration to an air quality that endangers the prevailing lifestyle or, ultimately, to an air quality that poses a substantial risk to public health.

National Air Quality Objectives are developed by expert subcommittees of the Federal-Provincial Committee on Air Pollution. Those published to date in the Canada Gazette are shown in Table 8. During the review period, work continued on the development of standard reference sampling and analysis methods for hydrogen fluoride and hydrogen sulphide. The method for hydrogen fluoride was completed.

Trend Analysis. During the review period, a national trend analysis for the 1970-77 era of air quality data from the National Air Pollution Surveillance (NAPS) network was compiled. Summaries of the results are shown in Tables 9 and 10. The report will be published early in the next fiscal year. This analysis will be updated periodically as new data become available.

The Directorate also investigated the possibility of doing population exposure analyses for major Canadian urban areas. This was done through a pilot study of the population in the Montreal area that is exposed to ozone. Experience gained will be utilized during the next fiscal year to study sulphur dioxide and particulate matter population exposures for Montreal and another major urban area. Also planned for the next review period is a study of the past and future trends in air contaminant emissions for those sectors of the economy that are contributing the most to the Canadian air pollution burden.

Program Planning and Program Evaluation. The format of this report has been changed this year to reflect the project planning system now being used by the

TABLE 8 NATIONAL AIR QUALITY OBJECTIVES*

Air contaminant	Maximum desirable level	Maximum acceptable level	Maximum tolerable level
Sulphur dioxide			
Annual arithmetic mean	30 $\mu g/m^3$ (0.01 ppm)	60 $\mu g/m^3$ (0.02 ppm)	
Average concentration over a 24-h period	150 $\mu g/m^3$ (0.06 ppm)	300 $\mu g/m^3$ (0.11 ppm)	800 $\mu g/m^3$ (0.31 ppm)
Average concentration over a 1-h period	450 $\mu g/m^3$ (0.17 ppm)	900 $\mu g/m^3$ (0.34 ppm)	
Suspended particulate matter			
Annual geometric mean	60 $\mu g/m^3$	70 $\mu g/m^3$	
Average concentration over a 24-h period		120 $\mu g/m^3$	400 $\mu g/m^3$
Carbon monoxide			
Average concentration over an 8-h period	6 mg/m^3 (5 ppm)	15 mg/m^3 (13 ppm)	20 mg/m^3 (17 ppm)
Average concentration over a 1-h period	15 mg/m^3 (13 ppm)	35 mg/m^3 (31 ppm)	
Oxidants (ozone)			
Annual arithmetic mean		30 $\mu g/m^3$ (0.015 ppm)	
Average concentration over a 24-h period	30 $\mu g/m^3$ (0.015 ppm)	50 $\mu g/m^3$ (0.025 ppm)	
Average concentration over a 1-h period	100 $\mu g/m^3$ (0.05 ppm)	160 $\mu g/m^3$ (0.08 ppm)	300 $\mu g/m^3$ (0.15 ppm)
Nitrogen dioxide			
Annual arithmetic mean	60 $\mu g/m^3$ (0.03 ppm)	100 $\mu g/m^3$ (0.05 ppm)	
Average concentration over a 24-h period		200 $\mu g/m^3$ (0.11 ppm)	300 $\mu g/m^3$ (0.16 ppm)

TABLE 8 NATIONAL AIR QUALITY OBJECTIVES* (Continued)

Air contaminant	Maximum desirable level	Maximum acceptable level	Maximum tolerable level
Average concentration over a 1-h period		400 $\mu g/m^3$ (0.21 ppm)	1000 $\mu g/m^3$ (0.53 ppm)
Hydrogen fluoride**			
Average concentration over a 70-day period		0.20 $\mu g/m^3$ (0.2 ppb)	
Average concentration over a 30-day period		0.35 $\mu g/m^3$ (0.4 ppb)	
Average concentration over a 7-day period	0.20 $\mu g/m^3$ (0.2 ppb)	0.55 $\mu g/m^3$ (0.7 ppb)	
Average concentration over a 24-h period	0.40 $\mu g/m^3$ (0.5 ppb)	0.85 $\mu g/m^3$ (1.0 ppb)	
Hydrogen sulphide **			
Average concentration over a 24-h period		5.0 $\mu g/m^3$ (3.6 ppb)	
Average concentration over a 1-h period	1.0 $\mu g/m^3$ (0.7 ppb)	15.0 $\mu g/m^3$ (10.8 ppb)	

* Conditions of 25°C and 1013.2 mb are used as the basis for conversion from $\mu g/m^3$ to ppm and ppb.

** Proposed.

TABLE 9 AVERAGE OF THE ANNUAL MEANS OF NAPS STATIONS FOR 1974-77

Air Contaminant	1974	1975	1976	1977	Change (1974-77)
Sulphur dioxide (pphm)	1.6	1.5	1.4	1.4	-13%
Suspended particulates ($\mu g/m^3$)	78.6	65.9	65.7	61.9	-21%
Lead ($\mu g/m^3$)	0.68	0.55	0.49	0.46	-32%
Nitrogen dioxide (pphm)	2.80	2.77	2.69	3.17	+13%
Carbon monoxide (ppm)	2.44	1.89	1.60	1.55	-36%
Soiling Index (COH)	0.38	0.28	0.28	0.27	-29%

TABLE 10 PERCENTAGE OF STATIONS EXCEEDING MAXIMUM ACCEPTABLE AIR QUALITY OBJECTIVES, 1974-77

Objective	1974	1975	1976	1977
Sulphur dioxide (annual)	18	11	10	5
Suspended particulates (annual)	49	42	37	24
Nitrogen dioxide (annual)	0	0	0	4
Carbon monoxide (8 hours)	29	27	16	10

Environmental Protection Service. In addition to the introductory sections, the report is organized on the basis of the four projects that form the National Air Pollution Control Program: 1) Determination of air pollution problems; 2) Development of air pollution control measures; 3) Implementation of air pollution control measures; and 4) Liaison, program planning and program evaluation. The operating budget of the Air Pollution Control Directorate for fiscal year 1979-80 was developed using this project planning system to give management improved control over resource allocation and to provide flexibility to meet changing priorities. An evaluation system is now being developed that will provide management with information on the efficiency and effectiveness of resource utilization in achieving program objectives.

During the review period, the Air Pollution Control Directorate recognized the requirement for a mechanism to identify and rank air pollution problems and for a management tool to ensure that problems are dealt with in a coherent manner. A decision-making framework was therefore developed through which air pollution problems

are selected with a view to promulgating regulations or guidelines. Mechanisms to establish priorities for subsequent regulation or guideline development are also incorporated into the decision-making framework. There are four phases, with appropriate feedback loops, in the framework:

- the identification of existing and potential air pollution problems and the relative ranking of these concerns in each of three categories: immediate, medium-term and long-term concerns;
- the development of work plans based on the approved list of Directorate concerns;
- the detailed assessment of a contaminant or industrial sector of concern and information-gathering activities; and
- the activities that must be completed after the decision has been made by Directorate Management that a concern investigated in Phase III warrants the development of a regulation or guideline.

During the latter part of the review period, the Directorate began to implement Phase I of the decision-making framework by compiling contaminant and industrial sector profiles for existing and potential air pollution concerns. These profiles are two-page summaries of various objective and subjective criteria that justify identification of a concern. Completion of this activity will continue during the next fiscal year and a relative ranking of concerns will be completed thereafter.

ATMOSPHERIC ENVIRONMENT SERVICE

General

The objective of the Atmospheric Environment Service's activities with respect to the Clean Air Act is to develop a clear understanding of the nature of the important atmospheric processes of transport, distribution and transformation of pollutants to provide an improved assessment of their impact on the environment. Activities include participation in the development of air quality objectives and criteria, the monitoring of concentrations of atmospheric constituents and the development of procedures to predict future states. Studies are done or supported to specify: pollution sources; the processes of dispersion and transport by air currents; pollutant concentrations; chemical modification in the ambient air; and deposition on the earth's surface. Work on pollution sources is generally of a review nature and is done in conjunction with

regional assessments. Experimental studies are carried out using sophisticated equipment and data analysis procedures that describe atmospheric processes and effects on the biosphere. These are used in combination with theoretical research to develop forecasting models and in the development of departmental air management strategies.

The work is done by two Branches of the Atmospheric Research Directorate. The Air Quality and Inter-Environmental Research Branch manages a program pertaining to the lower atmosphere (troposphere), up to an altitude of about 10 kilometres, although most studies are done within the first kilometre. The Atmospheric Processes Research Branch is concerned with studies of physical and chemical properties and behaviour in the stratosphere, in particular effects on solar radiation and the ozone layer brought about by man-made pollutants.

Further research support is accomplished through consultation and committee participation with associated departmental, federal, provincial and other agencies including international groups. In addition, contracts are arranged with private companies for research and development support. These amounted to an expenditure of $304 100 during the fiscal year. Subventions to university projects administered by the Service totalled $155 200. The total expenditure for the fiscal year was $3 294 000, consisting of $1 851 000 in salaries, $876 000 in goods and services, and $567 000 in capital. End-of-year strength was 74.

Long-Range Transport of Air Pollutants

Research in several countries has indicated links between damage to freshwater and terrestrial biological communities and atmospheric pollutants that have been transported 1000 kilometres or more from their points of origin. Since 1976 the Department has sponsored a program to investigate the problem. An atmospheric subprogram is administered through the Air Quality and Inter-Environmental Research Branch.

Over the past year activities have been organized to produce a provisional statement of sulphur quantities being added to the atmosphere and subsequently transported over great distances to be deposited within a three million square kilometre area in eastern Canada. This area includes large portions of Ontario, Quebec and the Maritime Provinces. Use has been made of the 50-station Canadian Network for Sampling Precipitation for verifying theoretical pollutant transport, concentration and deposition estimates. During the year a daily-reporting precipitation and particulate sampling

network of four stations in eastern Canada was installed. A fifth station at Kejimkujik National Park, Nova Scotia, is planned for installation during the next fiscal year.

It is noteworthy that much of this study area has a limited capacity to absorb increased sulphur dosages such as may occur with industrial growth and greater use of coal in regions up-wind.

Stratospheric Pollution

The layer of the atmosphere above an altitude of 10 kilometres, the stratosphere, is a region of major global air circulation. It also contains sufficient ozone to prevent dangerous levels of ultraviolet solar radiation from reaching the earth's surface. Gaseous compounds such as nitrogen oxides and chlorofluoromethanes emitted into the atmosphere by industrial processes may chemically destroy ozone in quantities which have been difficult to specify precisely, but which, in some regions at least, are dangerously high. The Atmospheric Processes Research Branch has undertaken stratospheric balloon experiments at Cold Lake, Alberta and Palestine, Texas to measure quantities of pertinent stratospheric chemical constituents and contaminants to verify information gathered by the NIMBUS VII satellite and to produce theoretical predictions of future states.

Measurements of total ozone in the atmosphere are made daily from ground level at five sites across Canada. Instrumentation has recently been improved and test programs are being continued. Considerable work is done in collaboration with universities and other public institutions.

Environmental Contaminants Program

The Service's contribution to this federal program consists of research into interactions, between the atmosphere and biosphere, of a number of inorganic and organic contaminants. Of immediate concern is determining the quantities and movement patterns of these contaminants and how they affect those plants and animals that ingest heavy metals and compounds such as polycyclic aromatic hydrocarbons.

Among metals residing for a period in the atmosphere, mercury is of particular concern because of its toxicity and widespread occurrence. Research has not yet yielded sufficient detail on the distribution, behaviour and ultimate fate of airborne mercury and its compounds. Aircraft surveys over southern Ontario have shown considerable variability in mercury concentrations in the atmosphere. Values as high as 5 nanograms per cubic metre have been reported, but the immediate challenge is to develop instruments

having sufficient sensitivity and accuracy to establish background concentrations in various regions of Canada.

Plants that build up residues of airborne metals may serve as gauges of environmental contamination. Lichens are particularly useful because of their long life and widespread distribution. Moreover, the primary source of nutrients for lichens is the atmosphere. Statistical procedures have been developed to aid in determining the origin of metals collected in plant samples, and one study completed this year described background quantities at 45 locations in the Canadian North. In experiments with vanadium, high concentrations were found to produce damage to plants. Global background levels of vanadium are increasing as a result of the increase in fossil fuel combustion.

Alberta Oil Sands Environmental Research Program

This is a joint study by the Department and the Province of Alberta of the meteorological physics and air pollution chemistry affecting air quality in the region of the oil sands extraction and refining operations. Winter and summer field studies identified many characteristics of pollutant-bearing smoke plumes, but no universally successful method to predict plume rise was developed. The results from a number of integrated experiments revealed valuable information respecting air circulation and chemical behaviour, such as oxidation rates of sulphur and the timing of pollutant deposition from the atmosphere. In addition, much was learned about the original sources and ultimate sinks of a number of pollutant species, although it was noted that most pollutants were deposited within 10 kilometres of the plant.

The field experiments assisted the development of a number of air pollution prediction procedures and these were suggested to the Management Committee of the Oil Sands Program.

Environmental Assessment

In June, a study was done at Nanticoke, Ontario, cooperatively with the Province of Ontario. This produced information on airborne pollutant transport during a stable weather situation, i.e., clear skies with light airflow off Lake Erie. A variety of instruments was employed to describe in detail the atmospheric structure from the ground to levels above 500 metres. These were related to measured pollutant concentrations and deposition downwind. The study has enabled estimates to be made of air pollution effects during the 1980's when the industrialization will be completed.

A second study to obtain detailed measurements of low-level atmospheric structure took place in November in the Shakwak Valley, Yukon Territory, in connection with environmental studies pertaining to the proposed Alaska-Canada petroleum pipeline.

At Saint John, New Brunswick, a study of airborne metals assimilated by vegetation continued. Higher concentrations of vanadium, nickel and sulphur, which are mainly attributable to local industry, were noted. The data collection network was improved by setting out a number of moss bags and analyzing the contents monthly, giving better seasonal perspective on element deposition rates.

Environmental Modelling

Environmental processes described mathematically according to the laws of physics may provide a satisfactory means of predicting site or regional conditions, in lieu of expensive field surveys. Such modelling is also an end product of experimental studies where the measured data are fitted to mathematical equations and used to verify predicted values.

A number of projects carried out this year addressed problems associated with turbulent airflow near the earth's surface over terrain and man-made structures. One was the assessment of pesticide spray drift over a forested region of New Brunswick in connection with spruce budworm research. Other models were developed to describe the atmospheric transport of sulphur and the concentration, chemical modification and washout by rain of sulphur dioxide.

Air Quality Criteria and Objectives

This year greater emphasis was given to the development of national air quality objectives. More resources were allocated to study the interactions of air pollutants with the biosphere and the Atmospheric Environment Service accepted responsibility to coordinate the compilation of technical information needed by the Federal-Provincial Subcommittee on Air Quality Objectives.

A number of studies were undertaken to assess effects of heavy metals and sulphur dioxide on vegetation, in particular indicator plants such as lichens, and on agricultural crops. Some of the results are presented elsewhere in this report. These studies are critical in establishing tolerance levels of the biological community to toxic or otherwise ecologically deleterious substances in the atmosphere.

For example, Branch biometeorologists, in collaboration with the University of Guelph, studied ozone damage to white beans in southwestern Ontario. Large-scale and

regional airflows were correlated with the distribution of ozone in existing and potential bean-growing areas. A concurrent study being done under contract indicates that leaf injury in corn and white beans may well be related to ozone assimilation by plant tissues. In this region ozone concentrations are often associated with stagnated, warm, moist air masses originating in the southern part of the continent, augmented at times by local daytime lake breezes.

Boundary Layer* Experimental Studies

Boundary Layer over Snow and Ice. Experiments to measure solar energy exchanged between the atmosphere and the ground with variations in wind and temperature over the snow-covered ice surface of Lake Simcoe took place during a six-week period in early 1978. Because this surface simulates conditions found extensively during the Canadian winter, results from these experiments will have broad practical application, for example, in environmental impact assessment.

Polynya Experiment. Persistent open water areas in the Arctic sea ice (polynyas) have important influences on regional heat exchanges with the atmosphere and produce anomalous local weather, e.g., fog, affecting transportation and other economic activities. Ocean-air heat transfer through a polynya located north of Dundas Island at 76°N, 94°W is being cooperatively studied by the Atmospheric Environment Service and the Environmental Management Service. The atmospheric characteristics and energy exchanges will be measured in 1979 and 1980 at and near this polynya, which fluctuates in size from about one half to ten square kilometres.

Environmental Techniques

In connection with experimental studies, extensive use has been made of a number of ground-based remote sensing devices. These have been developed to their present operational state through cooperation with the Instruments Branch. Notable improvements in the processing of data associated with these and other instruments, such as sounding and profiling equipment, were also made during the year.

A multi-wavelength sun photometer for measuring atmospheric turbidity received final testing prior to release for commercial manufacturing. A project to measure the characteristics of heat exchange at the earth's surface with a portable

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* The boundary layer is the lowest layer of the atmosphere (troposphere) extending from the earth's surface to about 1500 metres aloft.

scintillation laser was begun. To aid in determining the size and shape of suspended particulates in polluted air over cities, a polar nephalometer to measure light scattering has been developed.

Environmental Monitoring

The Canadian Network for Sampling Precipitation continued in full operation with 50 nationally distributed reporting stations filing monthly reports. Ninety percent of the possible samples were received and of these 81% met quality standards for publication. The data indicate that marked acidity in rain water regularly occurs in eastern Canada; in this region precipitation plays a greater role in depositing acidic compounds of industrial origin than in western and northern areas.

Instrument design improvements, network enhancement in eastern Canada, and greater coordination with the American sampling network are expected in the near future. As an example, cooperative testing of precipitation samplers is taking place at Pennsylvania State University. Currently available samplers lack accuracy, particularly for snowfall measurements.

In cooperation with the Environmental Management Service, three carbon dioxide and turbidity measurement sites were operated as part of the World Meteorological Organization's background network. With the expected demise of Ocean Ship PAPA (50°N, 145°W) in 1980-81, a West Coast replacement station is being considered.

Data for an evaluation of the transport of air pollutants in southern Ontario are being collected at three sites in the Toronto area. Two of the stations are located on the edge of the city in order to examine urban influences on the transport of oxidants and their precursors. In cooperation with the National Research Council and the University of Toronto, a third station was put into operation on the 557-metre CN Tower to measure wind, temperature and pollutant concentrations at these altitudes. The data will be useful in interpreting the uniformity of vertical mixing of pollutants above ground level and relationships with their regional transport.

Technology and Information Transfer

Conferences. Personnel participated in a number of scientific meetings, conferences and working groups of organizations such as the World Meteorological Organization (WMO). In addition there were four national and international meetings in which Service scientists were organizers and major participants. The Proceedings from

the Workshop on Air Quality Criteria and Standards (January, 1978) were published in February, 1979.

The WMO held a symposium on Boundary Layer Physics Applied to Specific Problems of Air Pollution, June 19-23, at Norkopping, Sweden, in which four Service scientists participated. The meeting was organized through the Commission for Atmospheric Sciences by the Working Group on Air Pollution and Tropospheric Chemistry and the Working Group on Boundary Layer Problems.

In August, Canada hosted meetings of the NATO Committee on the Challenges of Modern Society (NATO/CCMS) Air Pollution Pilot Study (Assessment Methodology and Modelling). The 8th Meeting of the Working Group and Panels took place August 22-25 and the proceedings were reported through the 14th Progress Report prepared by the Federal Republic of Germany. There were 22 delegates from eight member countries present. Separate Methodology and Modelling Panels met to assess draft contributions and requirements for compendia such as Guidelines for Air Quality Management Systems (NATO/CCMS No. 71). The meeting marked the completion of the Assessment Methodology Panel's work and the combined group submitted proposals for a new pilot project regarding air quality criteria to begin following the 9th meeting in Rome in November, 1979.

The 9th Technical Meeting on Air Pollution Modelling and its Application was held August 28-31. Fifty-five papers on five topical themes were presented, with strong participation by private industry.

The WMO Symposium on Geophysical Aspects and Consequences of Changes in the Composition of the Stratosphere was held at York University, Toronto, from June 26-30. It was reported that the effects of industrially produced chlorofluoromethanes in removing stratospheric ozone are greater than previously supposed, although supersonic transport emissions below 24-26 kilometres and nitrous oxides originating from fertilizers have much less effect than once feared. The WMO surface network for measuring ozone is accurate to only plus or minus two percent of global ozone changes and it requires the support of satellite and other ground-based measurements. Recommendations will be made to member countries on the urgent need to control emissions of chlorofluoromethanes.

Publications. Staff from the two Branches contributed 34 research papers to refereed Canadian and international journals.