SETTING CANADIAN STANDARDS FOR SULPHUR IN HEAVY AND LIGHT FUEL OILS

Discussion Paper on Meeting the Commitments of the Notice of Intent on Cleaner Vehicles, Engines and Fuels

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EXECUTIVE SUMMARY

As set out in the "Notice of Intent on Cleaner Vehicles, Engines and Fuels" published in the *Canada Gazette* (February 17,2001), Environment Canada is developing measures to reduce the level of sulphur in fuel oils used in stationary facilities. This Discussion Paper is intended to initiate and facilitate discussions with stakeholders to determine the most appropriate approach. It reviews existing international regulations controlling sulphur levels in fuel oils, discusses analytical results from completed background studies, assesses the potential reductions on acidic deposition and emissions of sulphur dioxide and fine particulates as a result of matching the limits set by the European Union, and explores options for the development of appropriate complimentary measures to regulations, such as economic instruments.

NEXT STEPS

Issues addressed in this paper will be reviewed at a workshop expected to take place in Atlantic Canada in January 2003. The Discussion Paper specifically sets out the following issues on which Environment Canada is seeking the views of interested parties:

1. What should be the appropriate sulphur level in Canadian fuel oils and what should be the timing for reducing sulphur?

2. What liquid fuels should this initiative address?

3. Are there any other (non-sulphur) parameters that should be controlled in fuel oils?

4. Which of the following instruments should be considered for use in Canada to reduce sulphur in fuel oils?

a. Tradable Permits
- *Emission trading*
- *Product trading*

b. Sulphur Taxes
- *Tax differential*
- *Product tax*
- *Sulphur emission tax*

c. Fuel Quality Regulations

d. Combination of Instruments
- *Regulations and tax*
- *Regulations and emission trading*
- *Tax and emission trading*

e. other

5. **Are there any combinations of instruments that improve environmental effectiveness and/or lower overall cost? (e.g., Could fiscal instruments be used to accelerate the *introduction of low sulphur fuel oils in advance of any regulatory requirement?)***

6. How should the instruments be designed to maximize environmental benefits such as reduction in emissions of sulphur dioxide, greenhouse gases, nitrogen oxides and other air contaminants (metals, polycyclic aromatic hydrocarbons, etc.) while ensuring that costs are maintained at a reasonable level?

7. Should any Canadian measures developed to reduce the sulphur in fuel oils include the flexibility included in the European Union's directive of allowing, for example, the combustion of higher sulphur fuel oils in facilities equipped with emission control technology? Should this option differ depending on the industry sector involved?

8. Should measures also be developed to prohibit facilities that currently use fuel oils from switching to higher sulphur fuels or otherwise "dirtier" fuels? How would such measures be structured and should they be incorporated in the design of the measure that reduces sulphur in fuel oils?

In addition, specific questions on a potential design of a regulation are set out in Appendix 6.

Following the workshop, interested parties will be requested to provide written comments on the issues set out in this paper. Based on this process, Environment Canada plans to develop an action plan and path forward to reduce sulphur in Canadian fuel oils.

TABLE OF CONTENTS

CONT'D

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

As stated in the Notice of Intent on Cleaner Vehicles, Engines and Fuels published in the *Canada Gazette* (February 2001), Environment Canada proposes to develop new requirements for the allowable level of sulphur in heavy and light fuel oils. If Canada aligned with European Union and some northeastern States, Canadian heavy and light fuel oils would be restricted to a maximum of 1.0% wt.[1] sulphur level and 0.1% wt. sulphur level, respectively. This paper discusses options for the approach and design of the new Canadian fuel oils requirements.

When fuel oils are combusted, the sulphur in them is emitted into the air as sulphur dioxide (SO_2) and sulphate particles (SO_4). Emissions of SO_2, along with emissions of nitrogen oxides, are a primary cause of acidic deposition (i.e., acid rain) which has a significant effect on the Canadian environment, particularly in central and eastern Canada. Fine particulate matter ($PM_{2.5}$), of which sulphate particles are a significant fraction (30-50%), may potentially affect the health of Canadians.

The objective of this initiative is the reduction of SO_x emissions resulting from the combustion of fuel oils. This will result in the reduction in critical load areas for acidic deposition, particularly in eastern Canada, and it should improve air quality. Implementation of measures to reduce sulphur in fuel oils also has the potential to encourage fuel switching to lower greenhouse gas emitting fuels such as natural gas.

Environment Canada is soliciting the views of interested parties on the appropriate sulphur limits and timing for such limits as well as the design and approach of instruments to reduce the level of sulphur in heavy and light fuel oils. As indicated in the Notice of Intent, complementary measures to regulations, such as economic instruments, are being examined to introduce low-sulphur fuel oils. Specific issues on which Environment Canada is seeking views are presented in Section 10 and in Appendix 6.

Consultation to date on setting Canadian sulphur levels

In April 2000, Environment Canada invited stakeholders to participate in developing the federal government's approach to cleaner vehicles, engines and fuels. The list of issues included the reduction of sulphur levels in heavy and light fuel oils.

Through the consultation process, the Canadian Vehicle Manufacturers Association agreed that the federal agenda should include reducing sulphur in fuel oils. The Canadian Petroleum Products Institute (CPPI) recommended that, since the issue is related to the program to reduce acid deposition (Acid Rain), Canada and the U.S.

[1] Percent sulphur concentration are on mass basis throughout this document.

should act in concert when setting sulphur requirements. CPPI also stated that it will "*support aligning with standards that may emerge in the USA and Europe*."

It was noted during these consultations that whereas the countries of the European Union have a pan-national standard, the U.S. does not have a national standard. The U.S. has many different state-by-state standards, which generally have different requirements for fuel oil used in urban and rural areas. Because of this lack of U.S. national standard, Environment Canada focused on the standards of the European Union, which are similar to many of the standards in the northeastern U.S.

On February 17, 2001, the federal Minister of Environment published the agenda for cleaner vehicles, engines and fuels as a Notice of Intent in Part I of the *Canada Gazette*[2]. The Notice of Intent states that:

"*Environment Canada proposes to develop measures to reduce the level of sulphur in both light and heavy fuel oils used in stationary facilities. Environment Canada intends to commence studies in 2001 of the benefits to the health of Canadians and the environment as well as the cost of reducing sulphur in fuel oils, with the view to matching the requirements set by the European Union for sulphur in fuel oils which will be fully implemented by 2008. Complementary measures to regulations, such as economic instruments, will be examined to accelerate the introduction of low-sulphur fuel oils."*

[2] Minister of Environment. A Federal Agenda for Cleaner Vehicles, Engines and Fuels. *Canada Gazette, Part I*, February 17, 2001, pp. 452-457.

2. BACKGROUND

2.1 Description of fuels

Heavy fuel oil (HFO) is a mixture of hydrocarbons composed of residual fractions from crude oil distillation and processing. It is characterized by its black colour, high specific gravity (0.92 to 0.98) and high viscosity. HFO is usually composed mostly of carbon (86% wt.), hydrogen (11% wt.) and sulphur (currently averaging around 2% wt.). It also contains other impurities such as ash, metals and water. HFO is a low-value "bottom-of-the-barrel" fuel product, with a value generally less than the crude oil feedstock from which it is produced. It is essentially an industrial fuel that is suitable for use in boiler plants and metallurgical operations which generally pre-heat the fuel oil. There are three types:

- **Type 4** is an industrial type of fuel intended primarily for burner installations not equipped with preheating facilities (viscosity of 15 centistokes at 40°C),

- **Type 5** is a residual type of oil for burner installations equipped with preheating facilities requiring an oil with lower viscosity than Type 6 (viscosity of 50 centistoke at 40°C), and

- **Type 6** is a high-viscosity residual oil (360 centistokes at 40°C) for use in burner installations equipped with preheating facilities adequate for handling oil of high viscosity.

Light fuel oil (LFO) is a crude oil distillate used mostly for the production of heat in domestic and small commercial liquid-fuel burning equipment It is light in color and has on average a specific gravity in the range of 0.82 to 0.86. Since it is only slightly viscous (in the range of 1.2 to 3.6 centistokes at 40°C), it can be used without preheating. LFO is usually composed mostly of carbon (86% wt.), hydrogen (13% wt.) and sulphur (0.1 to 0.2% wt.). It also contains trace amounts of ash and sediments. There are three (3) types of LFO:

- **Type 0** is for use in fuel oil burning appliances in northern regions where ambient temperatures as low as -48°C are encountered,

- **Type 1** is for use in atomizing burners in which Type 2 cannot be used satisfactorily as well as certain vapourizing pot-type burners, and

- **Type 2** is for use in most atomizing burner applications (i.e., most domestic furnaces and boilers and some medium capacity commercial-industrial boilers).

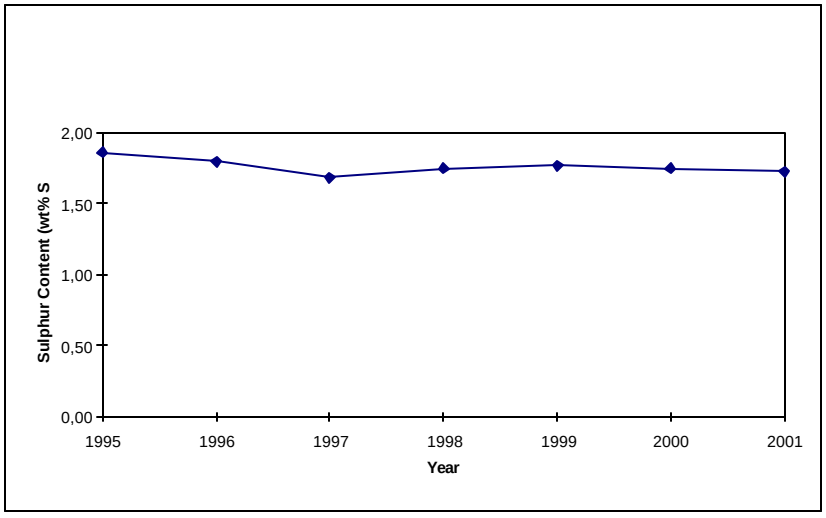
Bitumen emulsion is a highly viscous mixture of natural bitumen (70%) and water (30%). It also contains additives to stabilize the emulsion. The emulsion contains sufficient water to allow for handling and injection of the fuel into a burner. It is an industrial fuel and, in Canada, is primarily used in thermal generating stations in Atlantic Canada. The majority of it is imported into Canada from Venezuela under the trade name *Orimulsion*.

2.2 Sulphur levels in fuel oils in Canada

In 2001, the national average sulphur level in Canadian HFO was 1.7% wt. (17,280 ppm), while it was 0.2% wt. (2,010 ppm) for LFO[3]. Figures 2.1 and 2.2 show national trends of sulphur content in HFO and LFO. Sulphur levels have been relatively constant for both LFO and HFO, except in 1998 when the sulphur levels increased in LFO.

Table 2.1 provides a breakdown of sulphur level in HFO sold in Canada in 2001, based on quarterly volumes and averages submitted by refiners and importers under the *Fuels Information Regulations, No. 1*. Only very small quantities of low sulphur HFO (1% wt. sulphur content or less) were sold in Canada. Table 2.2 provides a similar breakdown for LFO.

Figure 2.1: 2001 National Trend of Sulphur Content in Heavy Fuel Oil



[3] Environment Canada, Sulphur in Liquid Fuels 2001, July 2002 excluding fuels for refinery consumption.

Figure 2.2: 2001 National Trend of Sulphur Content in Light Fuel Oil

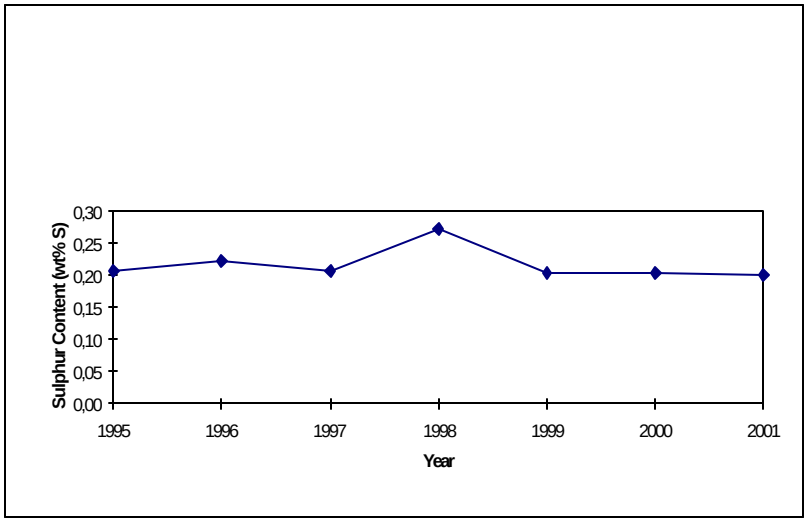


Table 2.1: Sulphur Level in Heavy Fuel Oil Used in Canada in year 2001[4]

Sulphur Content (% wt)	Volume	% of Total
1% or less	699,827	7.6
> 1% to 1.5%	3,246,882	35.5
>1.5% to 2%	2,398,984	26.2
> 2%	2,811,698	30.7
Total	9,157,391	100.0

Table 2.2: Sulphur Level in Light Fuel Oil Used in Canada in year 2001

Sulphur Content (% wt)	Volume	% of Total
0.05% or less	6,483	0.1
> 0.05% to 0.1%	422,662	9.3
> 0.1% to 0.2%	2,079,144	45.6
>0.2%	2,050,799	45.0
Total	4,559,088	100.0

Table 2.3 shows that most of the sulphur (about 82%) in Canadian liquid fuels is found in HFO. LFO accounts for 5.4% of the total sulphur mass in liquid fuels. With new regulations coming into force in the next few years to reduce sulphur in gasoline

[4] Both Tables 2.1 and 2.2 are adapted from quarterly information submitted to Environment Canada under the *Fuels Information Regulations, No. 1* (the plant consumption category in that report has been added into the category of the fuel actually used).

and on-road diesel fuel, it is expected that HFO and LFO will proportionally account for a greater amount of the sulphur in Canadian liquid fuels

Table 2.3 Distribution of Sulphur in Liquid Fuels in 2001[5]

Fuel Type	Fuel Consumption (m^3)	Sulphur Mass (tonnes)	Average Sulphur Content (% wt)	Distribution of Sulphur in Fuel (%)
Heavy Fuel Oil	9,157,390	160,565	1.727	82.0
Motor Gasoline	38,911,587	8,168	0.029	4.2
Light fuel Oil	4,565,310	10,607	0.201	5.4
Diesel Fuel	3,500,151	7,412	0.249	3.8
Low Sulphur Diesel Fuel	20,886,595	5,899	0.034	3.0
Aviation Gasoline	125,198	5	0.005	0.0
Others	7,392,711	3,038	0.051	

2.3 Production, imports, exports and use of fuel oils in Canada

Figure 2.3 shows that HFO and LFO are mostly used in central and eastern Canada, with very little used in western Canada. [6]

Historical data[7] from 1985 to year 2001 on production, imports and exports of HFO and LFO in Canada are shown in Figures 2.4 and 2.5. Historical information by province and territory is provided in Appendix 3 and detailed information on the end use of fuel oils by sector is presented in Appendix 5.

[5] Adapted from Environment Canada, 2001. *Sulphur in Liquid Fuels*, July 2002 reflecting corrected submissions and inclusion of plant consumption for the HFO, LFO and LS diesel. Totals are reported under the *Fuels Information Regs No. 1.*

[6] The background document entitled *Potential to reduce emissions of sulphur dioxide through reducing sulphur levels in heavy and light fuel oils* listed in Appendix 1 provides summary information over the period 1994 to 1999 on HFO and LFO production, countries for imports and exports and mass of sulphur.

[7] Statistics Canada, publication 45-004, 1985 to 2001.

Figure 2.3: Canadian Consumption of Fuel Oils for year 2001 (in million m^3) [8]

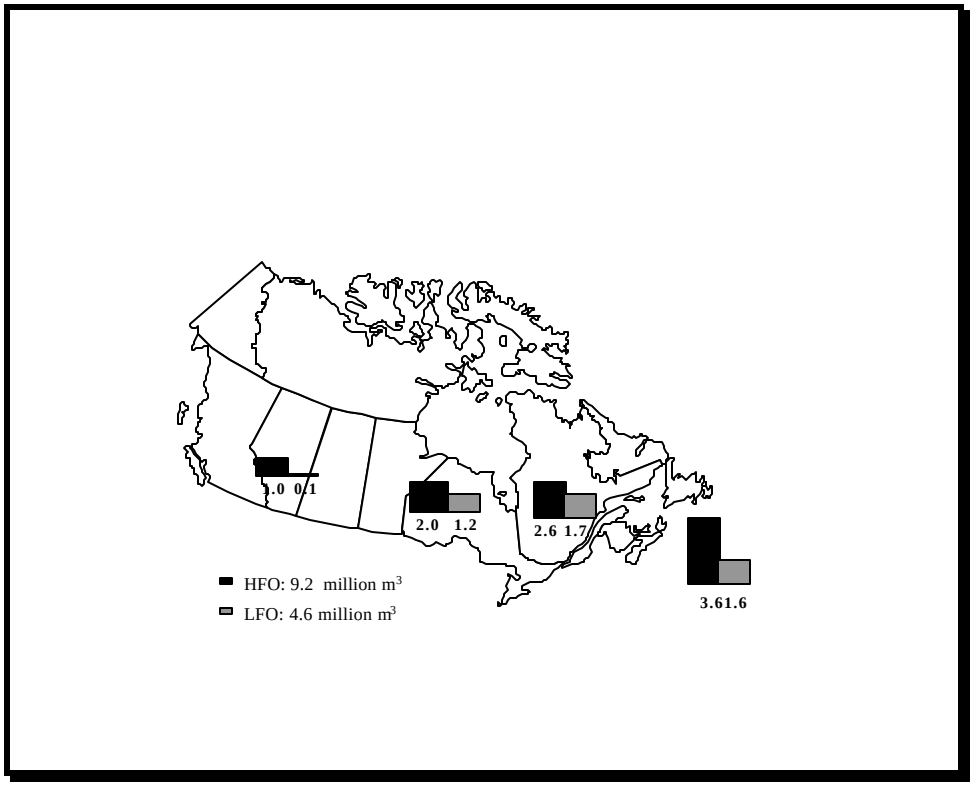
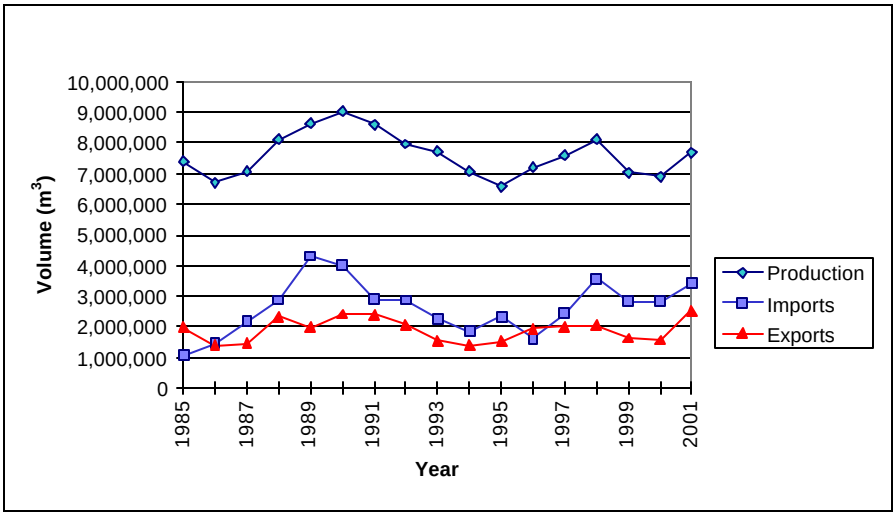
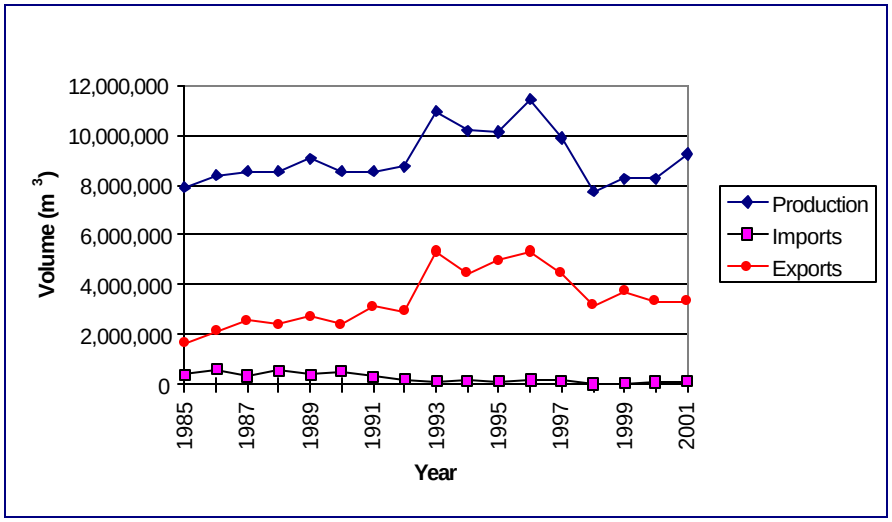


Figure 2.4: Historical data from 1985 to year 2001 on production, imports and exports of heavy fuel oil in Canada



[8] Environment Canada, 2001 Sulphur in Liquid Fuels, July 2002.

Figure 2.5: Historical data from 1985 to year 2001 on production, imports and exports of light fuel oil in Canada



3. EXISTING REGULATIONS CONTROLLING SULPHUR LEVELS IN HFO AND LFO

Requirements of existing regulations for sulphur in HFO and LFO in Canada, United States, and the European Union are further discussed in the following paragraphs.

3.1 Canada

There is currently no regulated national standard for sulphur in either HFO or LFO. British Columbia, Ontario, Quebec, New Brunswick and the Montreal Urban Community regulate the sulphur content in HFO at various levels ranging from 1.1% wt. up to 3.0% wt.[9]. Several provinces including New Brunswick, Ontario and Quebec regulate the sulphur content of LFO at 0.5% wt. (refer to Table 3.1)

The commercial standard set by the Canadian General Standards Board (CAN/CGSB-3.2) specifies limits of 0.3% wt. sulphur content for type 0 LFO and 0.5% wt. for types 1 and 2 LFO. The CGSB does not specify any limit for sulphur in HFO.

3.2 United States

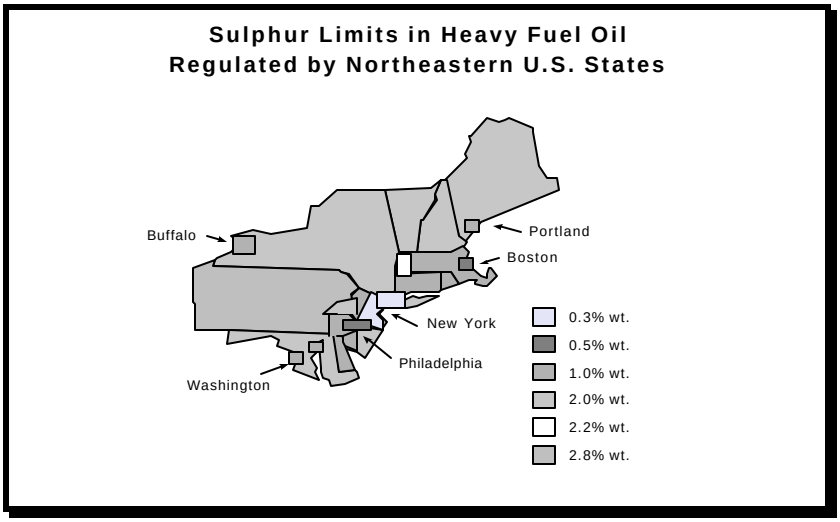
For HFO, northeastern states have sulphur limits ranging from 0.2 to 2.8% wt. (predominately 1% wt. in urban areas and 2% wt. in rural areas) as shown in Figure 3.1. All regulated limits for HFO are per-litre (or per-gallon) maximum limits.

In the United States about 30% of HFO consumed is low sulphur HFO (defined as fuel oil with 1% wt. sulphur content or less). In the northeastern states, around 40% of HFO consumed is low sulphur HFO (See Appendix 4 for details). This contrasts significantly with the Canadian use of low sulphur HFO of less than 8% of all HFO (refer to Table 2.1).

For LFO, a number of states, including Connecticut, Delaware, Massachusetts, New Hampshire, New York and Texas have set sulphur limits generally ranging from 0.2% wt to 0/4% wt.

[9] Environment Canada, A Review of International Initiatives to Accelerate The Reduction of Sulphur in Light and Heavy Fuel Oil, September 2001.

Figure 3.1: Sulphur Limits for Heavy Fuel Oil in Northeastern States



3.3 European Union

Countries of the European Union are subject to its Directive 1999/32/EC requiring them to reduce sulphur in HFO to 1% wt. by January 1, 2003 and sulphur in LFO to 0.1% wt. by January 1, 2008. Some countries such as Austria, Denmark and Finland already have in place a limit of 1% wt. sulphur (or less) for HFO. The current EU sulphur limit in LFO is a maximum of 0.2% wt.

The EU Directive forms part of an overall European strategy to combat acidification. In November 2000[10], the European Union Council adopted national emission ceiling limits (to be met by 2010) for certain atmospheric pollutants including SO_2. Accordingly, some flexibility is built in the Directive (such as described below under bullets 4 and 5) to "*reflect the conclusions from the integrated assessment [for the acidification strategy] and to avoid non cost-effective expenditure…*".

The EU Directive includes the following flexibility:

1. The 1% wt. sulphur limit for HFO does not apply for fuel used in combustion plants that
    - are considered new plants with effective desulphurization technologies and which comply with the sulphur dioxide emissions for such plans set out in Article 4 of the Annex IV to that Directive (Directive 88/609/EEC on large combustion plants);

[10] Official Journal of the European Communities, Common Position (EC) No. 51/2000 adopted by the Council on 7 November 2000 with a view to adopting Directive 2000/C375/01 of the European Parliament and of the Council of European Communities on national emission ceilings for certain atmospheric pollutants, December 28, 2000.

- have thermal input below 50 megawatts where the emissions of sulphur dioxide are at concentrations less than or equal to 1700 mg/Nm^3 (approximately 458 ng/J)[11] (in flue gas with oxygen content 3% by volume on dry basis at standard temperature and pressure); or
- are part of refineries where monthly average emission limits do not exceed 1700 mgSO_2/Nm^3 (approximately 458 ng/J)

According to the Commission, these flexibilities recognize that for power stations and certain industries it would be more cost effective to remove SO_2 from emissions using technology such as flue gas desulphurization rather than using low sulphur HFO. The Commission considers that the emission standard of 1700 mg SO_2/Nm^3 (approximately 458 ng/J) "*is approximately the equivalent, in terms of emissions, of burning heavy fuel oil with a 1% [wt.] sulphur content*."

2. The requirement for sulphur in HFO does not apply to fuels for marine use.

3. While the sulphur requirement for light fuel oils applies to marine gas oils (i.e. distillate fuels intended for marine use), it allows for a derogation for these fuels in Greece, the Spanish Canary Islands, the French Overseas Departments, and the Portuguese archipelagoes of Madeira and Azores, since low sulphur levels *"may present technical and economic problems*" for these countries.

4. The EU Directive allows a member state to authorize HFO with sulphur levels between 1% wt. to 3% wt. to be used in part or the whole of its territory if air quality standards for SO_2 are respected and where emissions do not contribute significantly to acidification in any member state. The Directive specifies that to avail itself of this possibility, a member state has to inform the European Commission and the public at least 12 months beforehand and establishes a process where proposed measures are reviewed by the Commission which then makes a decision.

[11] The European emissions limit is higher than the federal guidelines for thermal generating stations. The *Thermal Power Generation Emissions – National Guidelines for New Stationary Sources* were originally published in 1981. They are intended to provide national emission standards for application by provinces to new coal, oil and gas-fired steam electricity generating plants. The guidelines include emission limits for nitrogen oxides, total particulate matter and sulphur dioxide, and reflect the capabilities of best technologies that were available twenty years ago. These guidelines are now out of date and revisions to the Guidelines have been proposed.
The revised CEPA 1999 guidelines include emission limits which reflect the capabilities of current best available economically feasible technologies. For instance, the previous guidelines included a SO_2 emission limit of 258 nanograms per joule (ng/J) of heat input for a No. 6 fuel oil (HFO) with a sulphur content of 2.3% by weight (compared to approximately 458 ng/J in the European Union). The proposed revised guidelines includes a more stringent SO_2 limit.
There are six thermal generating stations in Canada: Holyrood (NF), Tuft's Cove (NS), Courtney Bay (NB), Coleson Cove (NB), Tracy (QC), and Lennox (ON).

According to the Directive, the Commission's decision is to be reviewed every eight years on the basis of information to be provided to the Commission by member states.[12]

5. The Directive allows a member state to authorize, up to the end of 2012, LFO with sulphur levels between 0.1% wt. to 0.2% wt. to be used in part or the whole of its territory if air quality standards for SO_2 are respected and where emissions do not contribute significantly to acidification in any member state. To avail itself of this possibility, a member state would follow the process identified above for HFO.

Objective and Benefits of EU Directive

The objective of the EU Directive is to reduce emissions of SO_2 across the European Union. According to the European Commission, it "*is an integral part of a cost-effective strategy designed to combat acidification as well as reducing atmospheric pollution by sulphur dioxide and particulate matter."*

The European Commission estimated that the introduction of the 1% wt. sulphur limit for HFO "*will reduce SO_2 emissions in 2010 by approximately 1 million tonnes as compared to what would be the case in the absence of the Commission's proposal"*. In considering benefits to human health, the Commission estimated that, "*on average, the economic costs of the damage resulting from 1 tonne of SO_2 emissions in the [European] Community is approximately 4000 ECU*[13] *[CAN$ 6,000]; the majority (80% +) of these costs being attributed to damage to human health.*" Accordingly, the EU estimated the overall economic cost of the damage resulting from 1 million tonnes of SO_2 emissions to be approximately 4 billion EURO (CAN$ 6 billion).

[12] The authors are not aware of any applications by member states for the use of high sulphur fuel oils.

[13] ECU: European Currency Unit or EURO. Conversion rate used in this report: 1 EURO = CAN$1.5.

Table 3.1: Summary of Regulations for Sulphur in Heavy Fuel Oil in Various Countries[14]

Country	**Current fuel limit - % wt.** (average content is shown in the brackets)	**Measures** (effective date is shown in the brackets)
Canada	No national standard	N/A
British Columbia	1.1 (1.726% wt.)	Sulphur Content of Fuels Regulations (BC Reg 64/89) 1989
New Brunswick	Ranging from 1.5-3.0: Type 4=1.5; Type 5=2.0 (Atlantic 2.2% wt.)	Air Quality Regulations (83-208) amended in 1995
Ontario	1.5 (1.919% wt.)	Sulphur Content of Fuels Regulations (361-90) 1990 amended in 1999 to O. Reg. 522/99, only applies in Metro Toronto
	1.0	Boilers Regulations (338-90), 1990 amended in 1999 to O. Reg. 521/99] only for boiler fuel and exempts Ontario Hydro
Quebec	2.0 (1.249% wt.)	Règlement sur la qualité de l'atmosphère
Montreal Urban Community	Ranging from 1.0-1.5	By-Law # 90 1987
European Union	1.0, exceptions allowed up to 3.0	Directive 1999/32/EC, April 1999 [January 1, 2003]
Austria	1.0	National Legislation for Heavy Fuel Oil, more severe restrictions (0.2-0.6% wt.) on heating plants depending on their age and capacity
Belgium	3.0	National Legislation for Heavy Fuel Oil
Denmark	1.0 (0.034% wt.)	National Legislation for Heavy Fuel Oil
Finland	1.0	National Legislation for Heavy Fuel Oil
France	4.0	National Legislation for Heavy Fuel Oil
Germany	1.0	Industry Standard for Heavy Fuel Oil
Greece	Ranging from 0.7-3.2; 0.7 in Athens	National Legislation for Heavy Fuel Oil
Italy	3.0 (1.9% wt.)	National Legislation for Heavy Fuel Oil

[14] Environment Canada, A Review of International Initiatives to Accelerate the Reduction of Sulphur in Light and Heavy Fuel Oil, September 2001.

cont'd

Table 3.1: Summary of Regulations for Sulphur in Heavy Fuel Oil in Various Countries

Country	**Current fuel limit - % wt.** (average content is shown in the brackets)	**Measures** (effective date is shown in the brackets)
Netherlands	1.0	National Legislation for Heavy Fuel Oil
Norway	1.0 (except for the northern part of the country) (0.64% wt.)	National Legislation for Heavy Fuel Oil
Portugal	3.5	National Legislation for Heavy Fuel Oil
Spain	3.5	National Legislation for Heavy Fuel Oil
Sweden	0.8 (0.35% wt. in 1995)	National Legislation for Heavy Fuel Oil
United Kingdom	1.0	Sulphur Content of Liquid Fuels (England and Wales) Regulations 2000, June 2000 [January 1, 2003]
Czech Republic	1.0: for large (> 5MW) and medium (0.2-5 MW) and 0.2 for small sources (<0.2 MW)	Decree of the Ministry of the Environment of the Czech Republic No. 117/97 Coll.
Slovakia	<1.0 for sources <0.2 MW	National Legislation for Heavy Fuel Oil
United States	*N/A*	No national standard
Connecticut	1.0	State Legislation (Section 22a-174-19)
Delaware	1.0	SO_2 Emissions from Fuel Burning Equipment Regulations (8)] only in New Castle County
Idaho	1.75	State Legislation
Maine	Ranging from 1.0-2.0: In Portland=1.0 and rest of state=2.0	Low Sulphur Fuel Regulation (Chapter 106), 1991
Maryland	Ranging from 1.0-2.0: Urban areas=1.0, Rural areas=2.0	State Legislation
Massachusetts	Ranging from 0.5-2.2: sale or use in excess of following limits prohibited: Metro Boston – 0.5; Berkshire District – 2.2; Other parts of the state – 1.0-2.2	State Legislation (310 CMR 7.05)
Michigan	Ranging from 1.0-1.5: Small boilers=1.5; Large boilers=1.0	Emission Limitations and Prohibitions Regulation (R336.1401) 1978

cont'd

Table 3.1: Summary of Regulations for Sulphur in Heavy Fuel Oil in Various Countries

Country	**Current fuel limit - % wt.** (average content is shown in the brackets)	**Measures** (effective date is shown in the brackets)
New Hampshire	Ranging from 1.0-2.0: No. 4=1.0, No. 5&6=2.0	State Legislation (Chapter Env – A 401)
New Jersey	Ranging from 0.3 (in north) to 2.0 (in south)	State Legislation
New York	Ranging from 0.3-1.5: dependent on region; 0.3 in New York City	Fuel Composition and Use Regulation (ch. III, subpart 225.1)
Pennsylvania	Ranging from 0.5-2.8: 0.5 in Philadelphia	State Legislation
Rhode Island	1.0	Regulation No. 8
Texas	0.3	Environmental Quality Regulation (30 part I, ss.112.9) 1993] only Harrison and Jefferson counties
Vermont	2.0	State Legislation] for the entire state unless another limit is stated in the "bubble" rule

Table 3.2: Summary of Regulations for Sulphur in Light Fuel Oil in Various Countries

Country	**Current fuel limit - % wt.** (average content is shown in the brackets)	**Measures** (effective date is shown in the brackets)
Canada	No national standard	N/A
New Brunswick	0.5 (Atlantic 0.132% wt.)	Air Quality Regulations (83-208) [amended 1995]
Ontario	0.5 (0.223% wt.)	Sulphur Content of Fuels Regulation (361-90) [1990 amended in 1999 to O. Reg. 522/99]
Quebec	0.5: Type 0=0.2 (0.252% wt.)	Petroleum Products Regulation (753-91)

(cont'd)

Table 3.2: Summary of Regulations for Sulphur in Light Fuel Oil in Various Countries

Country	**Current fuel limit - % wt.** (average content is shown in the brackets)	**Measures** (effective date is shown in the brackets)
European Union	0.2 (0.1-0.2% wt. in 1998) 0.1% wt. (with option for 0.2% wt.)	Sulphur Content of Certain Liquid Fuels (93/12/EEC) October 1,1994 Sulphur Content of Certain Liquid Fuels (1999/32/EC) [January 1, 2008]
Austria	0.1	National Legislation for Light Fuel Oil
Finland	0.1	National Legislation for Light Fuel Oil
Germany	0.2 (0.15% wt.)	National Legislation for Light Fuel Oil, 1975
Ireland	0.2 (0.08% wt.)	Regulation of Sulphur Content in Different Oil Products, June, 1995
Norway	0.2 (0.08% wt.)	National Legislation for Light Fuel Oil
United Kingdom	0.2	Sulphur Content of Liquid Fuels (England and Wales) Regulations 2000, June 2000
Czech Republic	1.0: for large (> 5MW) and medium (0.2-5 MW) and 0.2 for small sources (<0.2 MW)	Decree of the Ministry of the Environment of the Czech Republic No. 117/97 Coll.
United States	No national standard	
Connecticut	0.3	State Legislation (Section 16a-21a)
Delaware	0.3	SO_2 Emissions from Fuel Burning Equipment Regulations (8)
Massachusetts	0.3	State Legislation (310 CMR 7.05)
New Hampshire	0.4	State Legislation (Chapter Env – A 401)
New York	0.2-1.5	Fuel Composition and Use Regulation (ch. III, subpart 225.1)
Texas	0.3	Environmental Quality Regulation (30 part I, ss.112.9) 1993

4. EMISSIONS RESULTING FROM THE COMBUSTION OF FUEL OILS

4.1 Inventory of SO_x , $PM_{2.5}$ and PM_{10} Emissions (1995)

4.1.1 Background and Methodology

In the "Action on Future Standards for Fuel Oils" as described in *the Federal Agenda on Cleaner Vehicles, Engines and Fuels*[15], Environment Canada indicated its intention to study the benefits and costs of reducing sulphur in fuel oils. To provide background information on this issue, an analysis of the existing emissions of sulphur oxides (SOx) and particulate matter (PM_{10} and $PM_{2.5}$) from the use of fuel oils in Canada was performed.

Environment Canada's Residual Discharge Information System (RDIS) database is used to compile and store emissions inventory information consisting primarily of Criteria Air Contaminants (CAC)[16] originated from a number of sources at various regions and provinces in Canada. The most recent inventory available is for the year 1995[17].

Estimates of the mass of contaminants (SOx, PM_{10} and $PM_{2.5}$) released over a one year period were obtained from the RDIS database according to source, location, industrial sector (grouped according to *Standard Industrial Classification* code), fuel type and industrial process. These emissions estimates were compiled and analyzed at the national and provincial levels according to categories used by Environment Canada for reporting purposes. Further detail regarding the inventories of emissions from HFO and LFO use can be found in the technical paper listed in Appendix 1, titled *Canadian Inventory of SOx, PM_{10} and $PM_{2.5}$ Emissions Resulting from the Combustion of Fuel Oils (October 2002)*.

[15] Minister of Environment. A Federal Agenda for Cleaner Vehicles, Engines and Fuels. *Canada Gazette, Part I*, February 17, 2001, pp. 452-457.

[16] Criteria air contaminants are: Total Particulate Matter (TPM), Particulate Matter less than or equal to 10 Microns (PM10), Particulate Matter less than or equal to 2.5 Microns (PM2.5) Sulphur Oxides (SOx), Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), and Carbon Monoxide (CO).

[17] Since 1995, two oil-fired plants (approx. 2500 MW or 50% of the total oil-fired capacity) have had the boilers converted to dual-fuel capability. These two plants can burn either natural gas or heavy fuel oil. A third unit (100 MW) has been re-powered to a gas turbine operation fuelled with natural gas. Sulphur dioxide emissions from these plants are nearly zero when the plants are fired on natural gas. A fourth oil-fired plant (1050 MW) is in the planning stages of being modified to fire on Orimulsion. The plans are to have this plant equipped with stack gas scrubber for the removal of sulphur dioxide from the flue gas. In total, about 3700 MW (or 75%) of the total oil-fired capacity have, or are about to have, means reduce sulphur emissions.

4.1.2 Overview of Sulphur Oxide Emissions from the Combustion of Fuel Oils

The majority of SOx, PM_{10} and $PM_{2.5}$ emissions from the combustion of fuel oils occur in the eastern provinces.

Total annual emissions of sulphur oxides from the use of HFO are estimated to be 206.1 kilotonnes (kt) nationwide, for 1995. This represents 5% of CAC. Excluding transportation, open and miscellaneous sources, the combustion of fuel oils accounts for 16% of all SOx emissions in the eastern provinces. Figures 4.1 and 4.2 present the regional contributions to the HFO and LFO inventories of SOx emissions, from which it can be seen that sulphur in fuel oils is clearly an eastern Canada issue

Figure 4.1: 1995 Canadian Estimated Annual SOx Emissions from HFO Use by Province

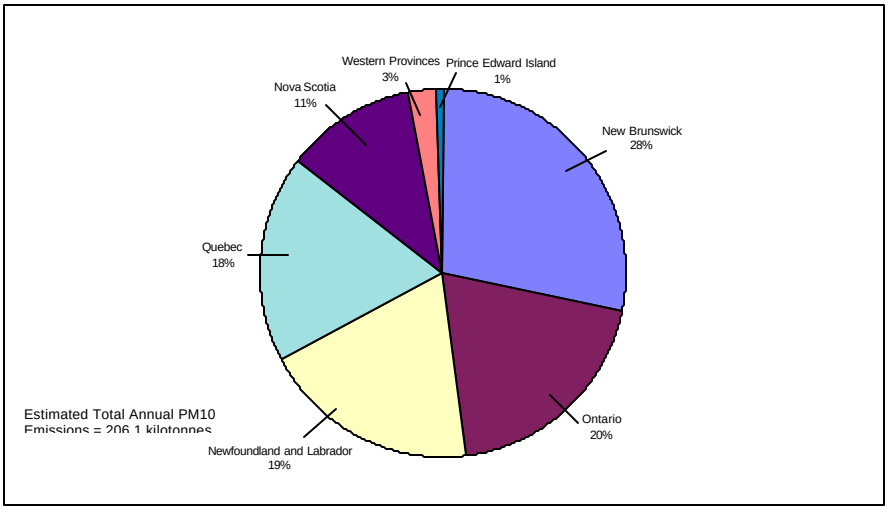
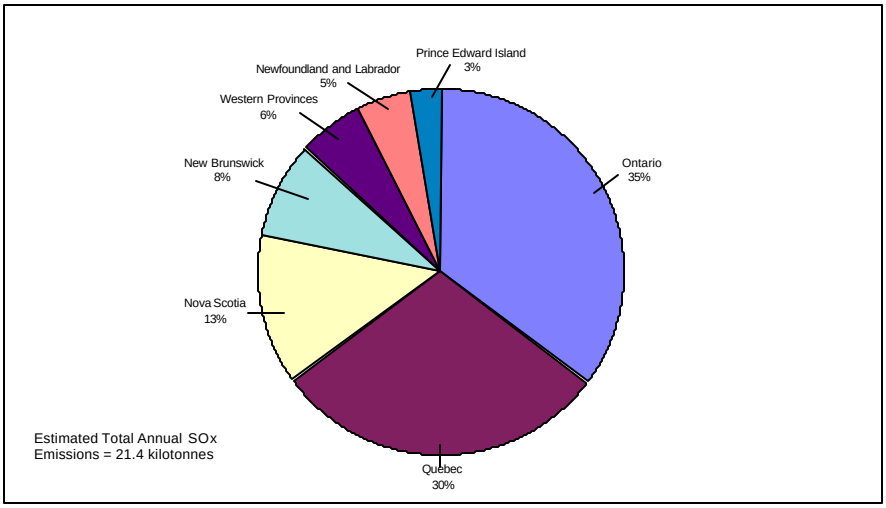


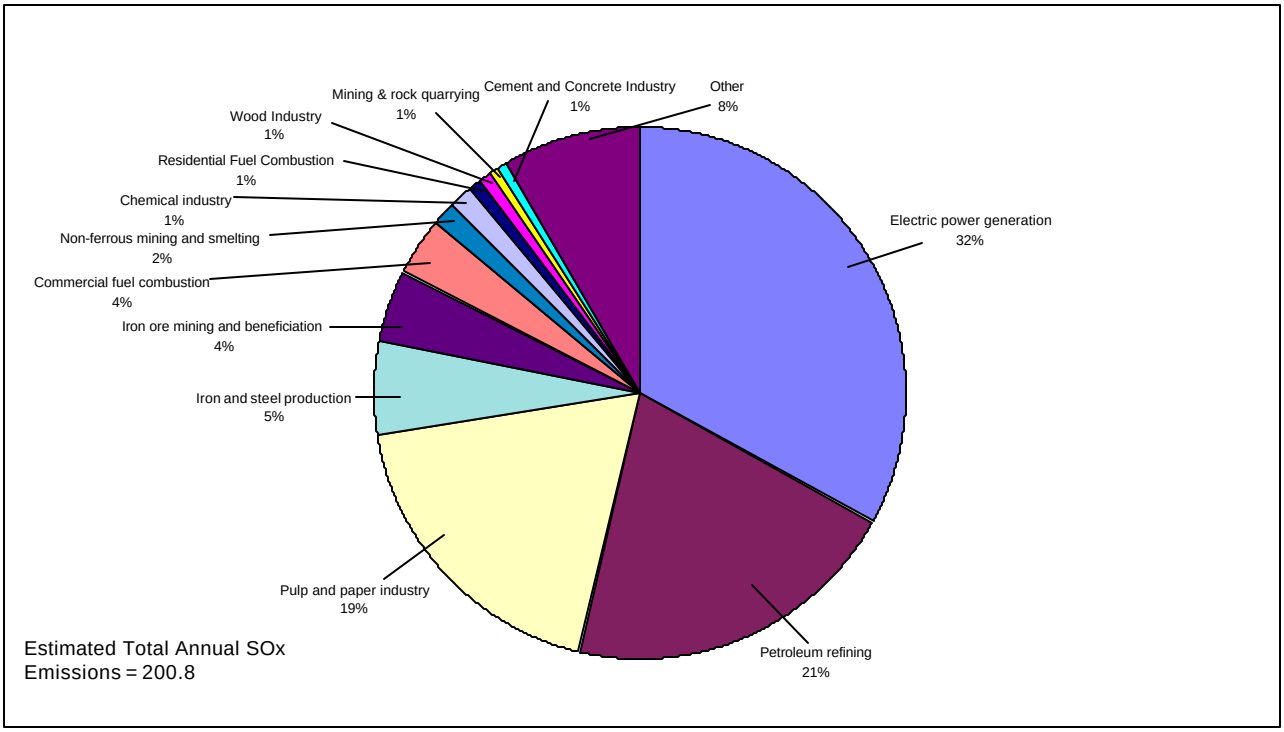
Figure 4.2: 1995 Canadian Estimated Annual SOx Emissions from LFO Use by Province



4.1.3 SOx Emissions from HFO

In 1995, 97% national emissions of SOx from the combustion of HFO emissions is concentrated in the eastern provinces of Ontario, Quebec, New Brunswick, Nova Scotia and Newfoundland. Three industrial sectors account for 73% of the eastern SOx inventory from HFO use: electric power generation, petroleum refining and pulp and paper[18] sectors. Those sectors are also the largest emitters of PM_{10} and $PM_{2.5}$ attributed to the combustion of HFO in eastern Canada[19]. The contributions of the various eastern sectors to the eastern SOx inventory from HFO use are presented in Figure 4.3.

Figure 4.3: Sectoral Contributions to Eastern SOx Inventory from HFO Use (1995)



4.1.4 SOx Emissions from LFO

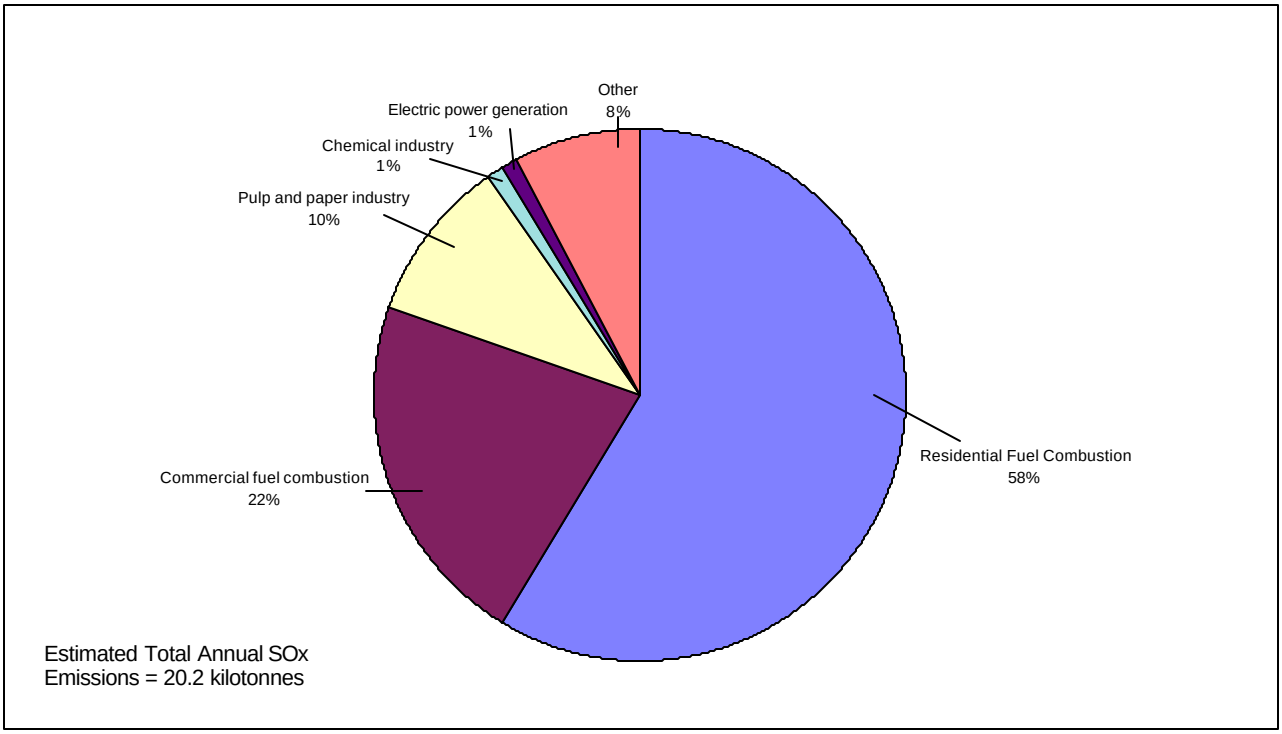
The combustion of LFO results in an estimated at 21kt/y of SOx emissions, with 94% of these emissions in the eastern provinces of Ontario, Quebec, New Brunswick,

[18] Since 1995, HFO consumption in the pulp and paper industry has declined approximately 7-9%. This decline in consumption is most likely attributed to fuel switching to natural gas due to new availability, reduction in the energy intensity of production and varying economic conditions. This decrease is not interpreted as a downward trend, but as a specific response to annual economic conditions.

[19] The large percentage of PM emissions reported from the combustion of HFO in the pulp and paper sector can be attributed to the inclusion of other process variables in the facility data reported to provincial/territorial authorities. These emissions are considered to be caused by either the primary fuel source, such as the combustion of wood waste in power boilers, or process losses in lime kilns from the calcination process.

Nova Scotia and Newfoundland. Most of the SOx, PM_{10} and $PM_{2.5}$ emissions from the combustion of LFO in the eastern provinces is from residential and commercial use. Residential and commercial use is responsible for a combined 80% of the SOx inventory in the east from LFO use. The contributors to the eastern Canada SOx inventory from LFO use are presented in Figure 4.4.

Figure 4.4: Sectoral Contributions to Eastern SOx Inventory from LFO Use



4.2 Effects of Fuel Oil Sulphur Levels on Emissions

4.2.1 Literature Review

Natural Resources Canada's CANMET Energy Technology Center has carried out a literature review of public information on research strategies to examine the impact of sulphur content in fuel oil, fuel oil combustion in stationary combustion equipment and associated gaseous and particulate emissions. (The report listed in Appendix 1 is available on request).

The review indicated that the combustion of fuel oils results in numerous emissions: for example, *"Burning heavy fuel oils releases to the environment of a range of gaseous oxides of sulphur, nitrogen and some of the metals present in the fuel. Carbon particulate matters from incomplete combustion or particulates containing a range of sulphate compounds are also released. Depending on the firing conditions they could be supplemented by other pollutants such as Volatile Organic Compounds (VOC), Poly[cyclic] aromatic Hydrocarbons (PAH) and*

occasionally chlorine, such as HCl. Lowering sulphur content in the heavy fuel oils will lead directly to overall reduction in stack gas emissions of sulphur dioxide."

The review indicated that in oil-fired systems, most of the sulphur in the fuel can be expected to appear in the stack gas as SO_2 with some fuel sulphur that may be oxidized to SO_3 depending on the firing conditions. Typical SO_2 emissions from various grades of fuel oil are provided in Table 4.1. In all cases, SO_2 emissions increased with higher levels of sulphur in the fuel.

Table 4.1 Typical SO_2 emissions from various grades of heavy and light fuel oils

Fuel type	S content wt %, dry fuel	SO_2 in flue gas ppmv at 3 % O_2, dry gas[20]
Lee, 1997[21]		
Ultra-low S No. 2, sulphur	0.0099	31
increased step-wise with	0.1925	110
di-tertiary butyl di-sulphide	0.4900	293
	0.6767	400
	1.1333	624
Miller, et al, 1996[22]		
No. 2	0.41	184
No. 5	1.42	793
No. 6 (low S)	0.49	226
No. 6 (high S)	1.66	740
Razbin, et al, 1991[23]		
No. 4	1.60	560-1000
Friedrich, et al, 1992[24]		
No. 4	1.41-1.46	812-893
No. 6	1.95-1.97	1170-1200
Gulyurtlu, et al, 1996[25]		
Waste oil	0.94	394-427
Whaley, et al, 1995[26]		

[20] Note SO_2 ppmv @ 3% O_2 is not the same as mg SO_2/Nm^3, which is the European units.

[21] W. Lee. "The Performance of Oil-fired Boilers: The Influence of Fuel Sulphur on Emissions and Appliance Integrity." ASHRAE Transactions, vol. 103, part 1, 1997.

[22] C. A. Miller, J. V. Ryan and T. Lombardo. "Characterization of Air Toxics from an Oil-fired Firetube Boiler." JA&WMA, vol. 46, pp. 742 – 748, August 1996.

[23] V. V. Razbin, F. D. Friedrich and S. W. Lee. "Heating Plant Performance and Emissions, Nova Scotia Hospital, Dartmouth, N. S." Energy Research Laboratories Division Report ERL-91-86. CANMET, Energy, Mines and Resources Canada, 1991.

[24] F. D. Friedrich, V. V. Razbin and F. L. Wigglesworth. NO_x and SO_2 Emissions with No. 6 and No. 4 Fuel Oils at Canadian Forces Base Halifax." Energy Research Laboratories Division Report ERL-92-27, CANMET, Energy, Mines and Resources Canada, March 1992.

[25] I. Gulyurtly, H. Lopes and I. Carbita. "The Determination of Emissions of Pollutants from Burning Waste Oils" Fuel, Vol. 75, No. 8, pp. 940-944.

No. 6	1.36	779
Bitumen-water emulsion	5.00	2570
Bitumen-water emulsion	5.12	2785
Bitumen-water emulsion	5.27	3466

The review indicated that a significant fraction (30-50%) of the particulate emissions from the burning of HFO would be less than 2.5 µm in diameter and would contain most of the chemically-bound sulphur with the heavy metals present in the fuel ash.

The U.S. Environmental Protection Agency (EPA) undertook a number of studies conducted on emissions of particulates and hazardous air pollutants from the combustion of a range of fuel oils with different sulphur content. This work indicates, that lowering the sulphur content in the heavy (No. 6) fuel oil from 1.66% wt. to 0.49% wt. (70% sulphur content reduction) reduces total particulate emissions by 86%. It also indicates that total metal emissions are reduced by 87%, mostly due to reduced emissions of vanadium, nickel and lead. Those three metals accounted for most of the metal emissions, but also present were magnesium, chromium, antimony, cadmium, arsenic, selenium, beryllium and mercury, along with ash and chlorine. When sulphur in HFO is reduced, its ash content and chlorine level are also reduced.

Extensive measurements by the EPA of 195 organic compounds during combustion of low sulphur No. 6 oil and high sulphur No. 6 oil, indicate an decrease of total PAH emissions with the lower sulphur No. 6 oil. Lowering the sulphur content in No. 6 fuel oil from 1.66% wt. to 0.49% wt. (70% sulphur content reduction) reduces total PAH emissions by 77%. The PAHs emitted from the combustion of HFO include primarily naphthalene, but also include phenanthrene, fluorene, benzo(*g,h,i*)perylene, and acenaphthylene, with lesser amounts of acenaphthene, anthracene, benzo(*a*)anthracene, chrysene, dibenz(*a,h*)anthracene, fluoranthene, indemo(*1,2,3-c,d*)pyrene and pyrene. PAHs emitted from the combustion of LFO include all those above, except anthracene and chrysene, plus they included benzo(*a*)pyrene, benzo(*b*)fluoranthene, and benzo(*k*)fluoranthene.

4.2.2 CANMET's test results

In addition to the extensive literature review, CANMET Energy Technology Center investigated the impact of fuel sulphur on emissions for oil-fired combustion systems, first for LFO and then for HFO.

The test program for LFO examined emissions from five distillate fuels containing sulphur levels from 0.05 to 0.6% wt. Test fuels were prepared by spiking different quantities of sulphur doping agent to the low sulphur (0.05% wt. sulphur) diesel fuel. A residential scale hot water boiler was used as combustion equipment. Emission performance of the fuels, in terms of their particulate matter and gaseous emissions of O_2, CO_2, CO, SO_2 and NO_x was determined and compared. The key emission

[26] H. Whaley, J. Wong, G. Banks and W. Lee. "The Composition and Handling Properties of Several Heavy Bitumen Emulsions." ASME International Joint Power Conference, Minneapolis MN, 1995.

analysis tool used was CANMET's fine PM sampling system, which is capable of providing source PM concentrations that approximate ambient PM found in the atmospheric plume immediately downwind of the source.

The study indicated that over the range of sulphur concentration studied under selected experimental conditions, flue gas SO_2 emissions increased linearly with the increase of sulphur in LFO (sulphur-spiked diesel fuel), while other emissions remained relatively unchanged. Similar elevation of filterable PM mass concentrations was also observed as the fuel sulphur increased. The results also suggest that a majority of particulate emissions from diesel fuel combustion is in the 2.5 µm size range, and that the sulphate content of particulates would decrease when LFO sulphur is reduced.

Similar investigation using HFO was conducted and results will be communicated as they become available.

5. ENVIRONMENTAL AND HEALTH EFFECTS OF REDUCING SULPHUR IN FUEL OILS

When fuel oils are combusted, the sulphur in them is emitted into the air as sulphur dioxide (SO_2) and sulphate particles (SO_4).

Emissions of SO_2 are a primary cause, along with emissions of nitrogen oxides, of acidic deposition [27] which has a significant effect on the Canadian environment, particularly in central and eastern Canada. Once in the air, SO_2 undergoes chemical reactions to form acids or acidifying sulphates that may be carried hundreds of kilometres before eventually falling to earth in rain, fog, or snow (these forms are often referred to as wet deposition). Sulphate particles and gases also fall to the land and vegetative surfaces (e.g., leaves) during periods without precipitation (dry deposition).

High levels of acid rain can result in the acidification of lakes, rivers and streams which causes the nutrients and metals to leach form the soil into the water. The acidification of lakes means that they cannot support the same variety of life – the fish, frogs, insects and micro-organisms gradually disappear from these waters. Acidic deposition contributes to declining growth rates and increased death rates in trees. It also accelerates the erosion of buildings.

Furthermore, SO_2 in the air can combine with other pollutants and water to form fine particles (i.e., $PM_{2.5}$), that may potentially affect the health for people with heart and respiratory disease. The haze that these particles forms also contributes to visibility reductions.

Some work has been done to better define the benefits to the environment and health of Canadians of reducing sulphur in fuel oils. The findings of these scoping studies are summarized below (see Appendix 1 for complete listing of the studies which are available on request).

5.1 Impact of SO_2 emissions reductions on acidification and particulate emissions

ARM Consultants undertook a study to investigate the impact of lowering sulphur levels in HFO and LFO to 1.0% wt. and 0.1% wt., respectively on changes in acid deposition and SO_2 and SO_4 air concentrations on an annual basis. The study also

[27] Because rain is only one of the means by which the acid reached the earth's surface, scientists often prefer to speak of acid deposition rather than acid rain. However for convenience, the well-known, often-used term "acid rain" is often used in this paper, but always in the broader sense of all forms of acid deposition.

assessed the impact on critical load exceedances (Critical loads are estimates of the amount of acid deposition that a particular region can receive without significant damage to its ecosystems).
Estimates of critical loads for wet sulphate deposition range from more than 20 kilograms of sulphate per hectare per year in the most tolerant areas to less than 8 kilograms per hectare per year in the most sensitive. These highly sensitive areas are found mostly in the Canadian Shield areas of central Ontario, eastern Quebec, and the Atlantic provinces.

The Acid Deposition and Oxidant Model (ADOM) was used to simulate the impact of reducing sulphur in fuel oils in year 2010 compared to a reference scenario corresponding to the actual provincial SO_2 caps expected in 2010 with voluntary over-compliance from some major point sources agreed to under the Eastern Canada Acid Rain Control Program. In the context of this study, concentration of sulphate was used as a surrogate for $PM_{2.5}$ over eastern Canada.

The study found:

- Impacts of the emission reductions would be localized in the Atlantic, with lesser effects in Quebec and Ontario.
- A decrease of 4-8% in wet sulphate deposition (acid rain) which is sufficient to significantly reduce critical load gaps in the Atlantic.
- A 1.4% decrease of the land area in exceedance of the critical load in Quebec and in Newfoundland and Labrador (from 791, 000 km^2 to 780,000 km^2). (Refer to Table 5.1 comparing the reference and the fuel oils emission scenarios).
- A 4.7% decrease of the total eastern Canadian land area where exceedance of wet SO_4 critical load was reduced from above 1 kg SO_4 ha^{-1} yr^{-1} in the reference scenario to below 1 kg SO_4 ha^{-1} yr^{-1} for the fuel oils scenario.

Table 5.1. Eastern Canadian land area in exceedance of wet SO_4 critical load for Reference and Fuel Oils emission scenarios

Scenario Name	Nominal Year	Area (x 1,000 km^2)					
		Ontario	Quebec	New Brunswick	Nova Scotia	Nfld. & Lab.	All Eastern Canada
Reference	2010	204	406	95	82	4	791
Fuel oils	2010	204	399	95	82	0	780

The size of the area of eastern Canada in exceedance for different threshold levels of critical load is summarized in Table 5.2 for the reference and the fuel oil scenarios.

Table 5.2. Eastern Canadian land area (in 1,000 km^2) in exceedance of wet SO_4 critical load for the reference and fuel oils emission scenarios for different thresholds

Scenario Name	Nominal Year	Exceedance threshold (kg SO_4 ha^{-1} yr^{-1})				
		0-2	2-4	4-6	6-8	>8
Reference	2010	290	246	125	81	50
Fuel oils	2010	308	229	122	73	48

In examining particulate emission reductions, the study used ambient sulphate concentration as a surrogate for fine particulate matter (i.e., it was assumed that a reduction in ambient sulphur concentration will result in a reduction in concentration of fine particulate matter). The estimated reduction in ambient sulphate concentration was on the order of 2% in southern Ontario, 6% around Montreal, and about 28% in Atlantic Canada.

The changes in the Atlantic Canada are dominated by the local emission reductions and a small decrease in long-range transport from Ontario and Quebec. The decrease in ambient SO_4 concentrations would also result in a decrease in fine particulate matter ($PM_{2.5}$), of which sulphate particles are a significant fraction in eastern Canada (up to 40%).

5.2 Health and environmental effects from emissions reduction

Environment Canada used the resulting changes in concentrations of pollutant as estimated by the ADOM model to estimate order of magnitude health and

environmental benefits[28]. The estimated avoided physical impacts in 2010 for the fuel oil scenario were calculated[29].

In the interim, new developments in the United States have put into question some of the research underlying on estimated health benefits. It is not yet clear whether, in resolving the uncertainty, the estimates of health benefits will become smaller or larger than the current estimates. Consequently, Environment Canada has decided not to finalize its estimates of health benefits due to reducing sulphur in fuel oils at this time.

Nevertheless, Environment Canada expects that reducing sulphur in fuel oils will result in improvements to air quality, which in turn will result in health benefits for Canadians. However the magnitude of these health benefits is unknown at this time.

[28] The general methodology used in this analysis was the damage-function approach. The damage-function approach uses available scientific and economic information to determine how changes in pollution emissions affect things of value to society. It refers to a quantitative relationship between pollution concentrations and damage to human health and the environment. When pollution is reduced, this approach is used to estimate benefits (i.e., the reduction in damages).
The damage function approach was implemented in this process using the Air Quality Valuation Model (AQVM). Changes in the ambient air quality as a result of reducing sulphur in fuel oils were used as input into the AQVM computer model. The model computes changes in physical impacts such as health events using concentration-response relationships, applying economic values to physical impacts, and aggregating benefits across all affected individuals and all relevant time periods. It should be noted that AQVM currently only includes one environmental endpoint for SO_2 (i.e. material damage) and one environmental endpoint for wet sulphate deposition (i.e., impacts on recreational fishing). It includes many endpoints for particulate matter.

[29] To give readers a point of comparison, these preliminary estimates using the old methodology were found to be about one-quarter of the benefits estimated for the reduction of sulphur in gasoline.

6. POTENTIAL COSTS OF IMPLEMENTING EUROPEAN-STYLE SULPHUR LEVELS

This section provides rough cost estimates to Canadian industry if Canada were to reduce sulphur in fuel oils to European levels. The cost estimates are derived from the United Kingdom's (U.K.) cost assessments of reducing the sulphur level in fuel oils to meet the regulatory requirement of the European Union's directive.

The cost estimates are based on U.K. industry having the option use low sulphur HFO or to use higher sulphur HFO in facilities that meet certain SO_2 emission limits. They do not include fuel switching by facilities, which presumably would reduce the overall cost of compliance. It is believed that actual Canadian costs are not likely to differ too widely, since the refinery technology is roughly the same and current sulphur levels of HFO do not vary that markedly (2.2% wt. for the U.K. and 1.7% wt. for Canada), although they could be slightly higher due to the higher-sulphur crude oils that many Canadian refineries process and the fact that sulphur in LFO is not currently controlled in Canada (the Canadian 2001 average of 0.20% wt. being the same as the current maximum allowed in the U.K.).

Preliminary "high-level" cost estimates to implement measures to reduce sulphur in fuel oils to European levels in Canada are in the range of $123 to 321 million per year, or a unit cost of 1.2 to 3.2 cents per litre. The unit cost is higher than cost estimates for recent initiatives that reduced sulphur in gasoline and on-road diesel, although the total costs are likely to be less for fuel oils than for gasoline and diesel since the volume of fuel oils produced is considerably less. Details of the calculations and assumptions are provided in the report listed in Appendix 1. Further work is required to finalize estimates of the costs to Canadian industry.

These measures, which are estimated to reduce SO_2 emissions by 164,000 tonnes per year from 1999 levels[30], would cost in the range of $750 to $1,960 per tonne of SO_2 . This estimated cost per tonne of SO_2 is within the range of costs of other measures aimed at reducing sulphur dioxide emissions in Canada.

The Canada-wide Standards Compendium of Cost information[31] estimated the average cost of SO_2 removal at $930 per tonnes, with initiatives ranging from as low as $352 to $8,810 per tonne. The Compendium provides "high-level" cost estimates and included only direct costs largely based on using technology to reduce sulphur dioxide emissions. It does not include measures such as fuel switching and energy conservation.

[30] Tushingham, M. and Bellamy, J., 2001. *Potential to Reduce Emissions of Sulphur Dioxide through Reducing Sulphur Levels in Heavy and Light Fuel Oils*. Environment Canada, March 22, 2001.

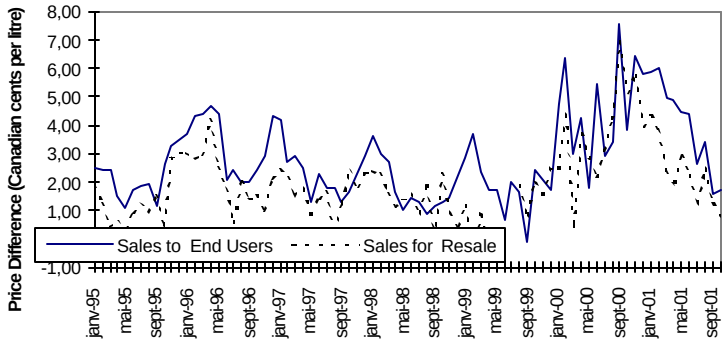
[31] Canada-wide Standards for Particulate Matter and Ozone, 1999. *Compendium of Cost Information*. May 17, 1999.

7. POTENTIAL PRICE DIFFERENTIAL BETWEEN LOW AND HIGH SULPHUR FUEL OILS

A number of US states, particularly in the northeastern states, have requirements for sulphur in HFO ranging 0.5 % wt. to 2.8% wt.[32] (refer to Figure 3.1). Accordingly, low sulphur HFO (1% wt. sulphur level or lower) is a standard fuel available in the US and co-exists in the market place with regular HFO (sulphur level greater than 1% wt.). This section examines price history for HFO to assess the price differential between low sulphur and regular HFO in the northeastern US.

The historical monthly price difference data since January 1995 for the northeastern states[33] are shown in Figure 7.1, summarized in Table 7.1, and listed in full in Appendix 4. Since 1995, the average market price of low sulphur HFO available to end users in the northeastern states was about 3 cents per litre more expensive than regular sulphur HFO, or about 16% more expensive. This is in line with the higher-end unit cost estimates based on U.K. cost data.

Figure 7.1: Historical Price Difference Between Regular HFO and Low Sulphur HFO in US Northeastern States



[32] Environment Canada, *A review of international initiatives to accelerate the reduction of sulphur in light and heavy fuel oil,* September 2001.

[33] Energy Information Administration, based on average monthly data for PADD IA and PADD 1B including the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Delaware, District of Columbia, Maryland, New Jersey, New York and Pennsylvania.

Table 7.1: Historical Monthly Price Differences (CAN cents per litre) in US Northeastern States between Regular Heavy Fuel Oil (>1% wt. Sulphur) and Low Sulphur HFO (1% wt. Sulphur or lower)[34]

Period	Sulphur less than or equal to 1% wt.		Sulphur greater than 1% wt.		Price Differential		Price Differential (%)	
	Sales to End Users	Sales for Resale	Sales to End Users	Sales for Resale	Sales to End Users	Sales for Resale	Sales to End Users	Sales for Resale
January 1995 to October 2001								
Average	20.61	19.23	17.92	17.39	2.8	2.0	16%	11%
Minimum	11.09	9.70	9.70	9.74	-0.13	-0.53		
Maximum	32.62	31.25	27.76	26.08	7.56	6.93		
January 2000 to October 2001								
Average	27.29	25.07	23.01	22.10	4.3	3.1	19%	14%
Minimum	21.99	18.80	20.29	18.29	1.6	0.42		
Maximum	32.62	31.25	27.76	26.08	7.56	6.93		

Potential for fuel switching

It is expected that there would be a cost increase to Canadian users of fuel oils following the implementation of low sulphur requirements. Users of fuel oils will likely assess whether to replace fuel oils with other sources of energy. Such options include switching to natural gas, low-sulphur fuel oils or coal.

In its assessment of the EU Directive, the European Commission recognized that there "*will be significant differences in the additional costs faced by industrial sectors in different parts of the Community if they continue to use heavy fuel oil for heat and power. However, a very strong trend over previous years has been the shift away from solid and liquid fuels to gas. The present proposal will reinforce that trend*."

The US Energy Information Administration reports a similar switch from fuel oil to natural gas for manufacturers in the US. *'When they have flexibility in their fuel choices, manufacturers have favored natural gas over fuel oil … despite fluctuations in relative average prices between fuel oil and natural gas."* [35] It also

[34] Energy Information Administration, based on average monthly data for PADD IA and PADD 1B including the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania.

[35] U.S. DOE's Energy Information Administration, *Fuel Oil Use in Manufacturing* – website: www.eia.doe.gov/emeu/consumptionbriefs/mecs/fueloil/mecs_fueloil_use.html

reports that "*One of the problems of fuel oil relative to other fuels is that manufacturers must maintain large storage tanks. This can prove to be an added expense beyond the price of the fuel. Manufacturers must also guard against the environmental hazards brought about by faulty underground storage tanks*."
Fuel switching can have a significant impact on air pollution as well as on the emissions of greenhouse gases such as carbon dioxide and methane. These are important environmental issues closely linked to the use of the selected energy source.

Environment Canada considers that *"Energy generation from coal, oil and natural gas sources contributes to virtually all of the current environmental air quality priorities for North America - climate change (CO_2, methane), acid rain (SO_2, NO_x), smog (NO_x, [VOCs]), air toxics (trace elements, mercury, particulate). The combustion of coal and heavy oil tends to emit the highest amounts of all of these emissions, much higher than their contribution to total output energy demand."* [36]

It is widely recognized[37] that "*Global climate change is being driven by human emissions of greenhouse gases, and is most evident as a warming trend in global average temperature. …Climate change will include not only a change in average temperature, but also changes in many aspects of weather, such as wind patterns, the amount and type of precipitation, and the types and frequency of severe weather events that may be expected to occur in an area.*"

Most greenhouses gases are emitted as a result of the production of fossil fuels and their use. Activities from these two areas together account for 30% of Canada's greenhouse gas emissions.[38] The greenhouse gas emissions of a specific fuel is directly related to its carbon intensity. The carbon intensity of energy supply is "*a measure of the amount of carbon associated with each unit of energy produced. It directly links changes in carbon dioxide emissions levels with changes in energy usage. Carbon dioxide emissions vary by energy source, with coal being the most carbon-intensive fuel, followed by oil, then natural gas.*" [39]

Accordingly, fuel switching to lower carbon-intensive fuel is one measure to reduce emissions of greenhouse gases as well as air contaminants. To achieve significant environmental benefits, it is thus important that when fuel switching occurs it is towards a "cleaner" and less carbon-intensive fuel. If the reduction of sulphur in fuel oils in Canada promotes fuel switching from fuel oils to natural gas, the reduction in emissions of greenhouse gases is a very important co-benefit.

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[36] Environment Canada, *Climate Change and Cleaner Energy Sources*, Combustion and Global Climate Change Conference, Calgary, May 1999.
[37] Government of Canada, *Canada's perspective on climate change, science, impacts and adaptation*.
[38] Government of Canada, *Action Plan 2000 on Climate Change*.
[39] Energy Information Administration, *International Energy Outlook 2001*.

Switching to more carbon-intensive fuels, such as coal or liquid fuels with similar or higher sulphur content, may result in further environmental degradation. It is not expected that switching from HFO to coal will occur due to the significant investment required to convert combustion facilities. However, switching to a bitumen emulsion (a bitumen-water mixture) is an economically feasible possibility. For example, the New Brunswick Power Corporation is planning to switch from HFO to crude emulsion at its Coleson Cove plant starting in 2004, but is planning to install anti-pollution controls.

8. OTHER CONSIDERATIONS

8.1 Provincial SO_2 plans and actions

Several provinces have recently announced SO_2 emission reduction targets.

Nova Scotia released an Energy Strategy in December 2001 which includes commitments to reduce emissions of SO_2 and NO_X as well as a commitment to promote renewable energy production. The province has committed to a 25% reduction of its existing SO_2 cap, to 142,000 tonnes, by 2005, and has a 2010 target of reducing SO_2 emissions from existing sources by 50% to 94,500 tonnes. The planned reduction will be achieved primarily through fuel switching by Nova Scotia Power. All new facilities will be expected to operate using best available, proven technologies to minimize emissions.

The province has also committed to a 20% reduction from 2000 NO_X levels by 2009. The Energy Strategy also includes a short term renewable energy target totaling 2.5% of Nova Scotia Power's current generation capacity. This target will be monitored for three years, at which time a longer-term mandatory renewable energy portfolio standard will be established.
New Brunswick announced in March 2001 that it will lower its provincial SO_2 emissions cap of 175 kilotonnes (kt), set under the 1985 Eastern Canada Acid Rain Program, by 30 percent to 122.5 Kt by 2005 and by 50 percent to 87.5 kt by 2010. Implementation plans for the new targets will be developed over the next year to establish individual emission reduction strategies for large sources of SO_2.

Quebec announced a new reduction target for SO_2 of 50% for 2010 in April 2001. Reductions are likely to come from the major industries responsible for SO_2 emissions in Québec; namely, the copper and titanium mining operations.

Ontario has committed to reducing the province's SO_2 emissions 50% beyond the Countdown Acid Rain Program cap of 885 kilotonnes (kt) per year, by 2015. Under the Anti-Smog Action Plan (ASAP), Ontario committed to reducing NO_X and VOC emissions by 45% below 1990 levels by the year 2015.

There are several other new Ontario initiatives related to SO_2 which were announced over 2001/02, including the following:

- New regulated electricity sector emissions caps took effect January 1, 2002.
- Consultation is ongoing for a "Clean Air Plan for Industry" to develop options for addressing NO_X and SO_2 reductions from selected industry sectors. This could include emissions caps for major industrial emitters, including sectors such as

pulp and paper, cement, iron and steel, petroleum refineries, chemicals, and non-iron metal smelters.

- The Ontario government has also proposed to consult on reducing the sulphur content in fuel oil and coal used by industry, commercial, institutional and residential sources to further reduce provincial SO_2 emissions.
- In 2002, Ontario revised an order to Inco and Falconbridge to reduce the allowable limits of annual emissions of SO_2 by 34% by 2007.

The announcements by Ontario, Quebec, New Brunswick and Nova Scotia are consistent with *The Canada-Wide Acid Rain Strategy for Post-2000* signed by federal, provincial and territorial ministers of energy and environment. Table 8.1 shows these new targets, and the schedules for their achievement. Previous commitments (emission caps) under the Eastern Canada Acid Rain Program are provided for comparison.

Table 8.1: SO_2 reduction targets for Ontario, Quebec, New Brunswick and Nova Scotia

	Former Eastern Canada Acid Rain Program Caps	**New targets under *The Canada-Wide Acid Rain Strategy***	**Timelines for new targets**
Ontario	885 kt	442.5 kt (50% reduction)	2015[40]
Quebec	500 kt	300 kt (40% reduction) 250 kt (50% reduction)	2002 2010
New Brunswick	175 kt	122.5 kt (30% reduction) 87.5 kt (50% reduction)	2005 2010
Nova Scotia	189 kt	142 kt (25% reduction) 94.5 kt (50% cumulative reduction goal)[41]	2005 2010

8.2 Pollution Prevention and Pollution Control

In keeping with the Federal Strategy for Pollution Prevention, overall environmental benefits including impact on all emissions (such as greenhouse gases, nitrogen oxides, air toxics) will have to be taken into consideration in developing the best approach for Canada.

The European Union's directive allows for the use of technology to remove SO_2 from emissions rather than using low sulphur HFO for certain facilities. Facilities meeting

[40] Ontario has proposed and is consulting on the proposal to advance this timeline to 2010.

[41] Ninety-four and a half kilotonnes is a reduction target and not a cap. Nova Scotia's commitment is to reduce SO_2 emissions by 25% from the existing cap by 2005 and to further reduce emissions to achieve a cumulative reduction goal of 50% by 2010 from existing sources.

an emission standard of 1,700 mg SO_2/Nm^3 are considered by the Commission to be " *approximately the equivalent, in terms of emissions, of burning heavy fuel oil with a 1% [wt.] sulphur content*." An approach that combines both sulphur in fuel oils and emissions would provide more flexibility and hence, if possible in the Canadian context might be a preferred solution.

8.3 Potential for Dumping in Canada of High Sulphur Fuel Oils

In 1999, imports of HFO into Canada accounted for over a third (38%) of the national demand. Imports originated mostly from the United States (45%), Venezuela (35%) and Nigeria (6%).[42] Most of the imports are directed to the Atlantic region where they meet over 60% of the demand[43]. The sulphur levels of these imports are usually higher than the sulphur levels of HFO produced domestically.

With existing low sulphur requirements in some European countries, high sulphur fuel oils are generally exported from the European Union and low sulphur grades are imported[44].

Although imports into Canada of European fuel oils have been negligible in the past, eastern Canada could in the future become vulnerable to imports of HFO from Europe that do not meet the new European standards (i.e., 1% wt. sulphur HFO starting in 2003). In 1995, over 75% of exported volumes of HFO from the 15 countries of the EU, which represented over 14 million tonnes of fuel oils, had a sulphur content in excess of 2.8% wt.

The implementation by the European Union of the 1% wt. sulphur requirement in 2003 would most probably result in more exports of high sulphur HFO. In addition, new markets will be sought for volumes of higher-sulphur HFO presently imported into the European Union (e.g., from northern and western Africa).

In its assessment of the Directive, the European Commission also indicated that it expected *"in the longer term, that the increase in low sulphur heavy fuel oil in EC would lead to an increased price differential between high and low sulphur heavy fuel oils*". This situation would make it economically attractive in countries without standards for sulphur in fuel oils to purchase high sulphur fuel oils.

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[42] Environment Canada, *Potential to Reduce Emissions of Sulphur Dioxide through Reducing Sulphur Levels in Heavy and Light Fuel Oils*, 22 March 2001.

[43] Statistics Canada, Publication 45-004 for 2000 and Environment Canada, *Potential to Reduce Emissions of Sulphur Dioxide through Reducing Sulphur Levels in Heavy and Light Fuel Oils*, 22 March 2001

[44] European Commission, *Explanatory Memorandum to the Proposal for a Council Directive relating to a reduction of the sulphur content of certain liquid fuel and amending Directive 93/12/EEC*, 12 March 1997.

As most states of the U.S. northeast coast already have stringent standards for sulphur in fuels oils (e.g., generally less than 1% wt. in urban areas and less than 2% wt. in rural areas), the high sulphur fuels oils once sold in parts of the EU or exported from the EU could find a convenient market in eastern Canada. In addition to the negative effect that this would have on the Canadian environment and the health of Canadians, this could also undercut the price of HFO produced by Canada's domestic refiners, particularly in eastern Canada.

8.4 Links with Other Federal Initiatives

There are other federal initiatives underway that may have an impact on the fuel oil issue. The most notable is the work undertaken by the National Round Table on the Environment and Economy (NRTEE) Working Group on Sulphur in Heavy Fuel Oil under the Ecological Fiscal Reform Program.

The NRTEE is a multi-stakeholder committee that reports directly to the federal government. The NRTEE Working Group on Sulphur in Heavy Fuel Oil is composed of a variety of industries, environmental groups and federal departments (including Environment Canada). At present, the NRTEE Working Group is examining the issue of sulphur in HFO. The NRTEE plans to make recommendations to governments regarding the best available economic instrument to reduce sulphur emissions from the use of HFO.

Environment Canada's Multiple Emissions Reduction Strategy (MERS) for the power generation sector is also examining the issue of sulphur emissions from thermal generating stations that combust HFO.

Finally, there are synergies between this initiative and the on-going work on the federal climate change and acid rain programs.

9. PATH FORWARD: POTENTIAL INSTRUMENTS TO REDUCE SULPHUR IN CANADIAN FUEL OILS

In the Government of Canada's Notice of Intent for cleaner vehicles, engines and fuels, Environment Canada proposed "*to develop measures to reduce the level of sulphur in both light and heavy fuel oils used in stationary facilities… with the view to matching the requirements set by the European Union for sulphur in fuel oils which will be fully implemented by 2008*." The NOI noted that "*Complementary measures to regulations, such as economic instruments, will be examined to accelerate the introduction of low-sulphur fuel oils.*"

Environment Canada is now moving forward on this initiative, with a target of reducing sulphur levels in HFO to 1.0% wt. and in LFO to 0.1% wt. Through this discussion document, Environment Canada is initiating public consultation on the basic approach to and timing of this initiative.

The following section provides an overview of instruments that can be used to reduce sulphur in fuel oils.

9.1 Overview

Economic instruments are policy tools that use market-based incentives to influence behaviour and achieve environmental objectives. Economic instruments include tradable permits, user charges and pricing, taxes, deposit-refund schemes, liability or insurance schemes, and subsidies.

Reasons that support the use of a market-based approach to environmental policy are:

- Economic instruments can be less costly to industry and consumers than command-and-control regulations because they provide firms and consumers the flexibility to choose among various mitigation options. For instance, emissions trading used under the US Acid Rain program has been estimated to have resulted in cost savings of about 50 per cent compared to command-and-control regulations.
- Economic instruments provide a continuing economic incentive for firms to reduce pollution, thereby stimulating innovation., and
- Economic instruments can result in lower administrative costs for government.

International organizations, such as the OECD, the United Nations' Environment Program and the World Bank, have supported the use of economic instruments for many years, in the name of achieving national environmental goals in the most environmentally effective and economically efficient ways possible. The Policy Report prepared by the OECD's Sustainable Development Task Force urges that

"*Governments should make greater use of environment-related taxes, and use the revenues to reduce other distortionary taxes, thereby maintaining revenue neutrality*".

The OECD has also made specific recommendations for Canada on this respect. For example, the 2001 Economic Review of Canada and the 1995 Environmental Performance Review of Canada urged this country to "*ensure that economic signals are right … [by] moving forward with the wider use of economic instruments to prevent pollution and conserve natural resources*".

Economic instruments have not yet been widely used in Canada, particularly at the federal level. There are several reasons for this.

First, both government and the public have more experience with traditional, command-and-control regulations. Secondly, the federal government has only recently acquired the legal authority (under the *Canadian Environmental Protection Act, 1999*) to implement tradable permit systems and deposit-refund schemes. Finally, although the federal government has long had the authority to implement environmental taxes, there has been some reluctance to adopt these measures because of the public's aversion to new taxes.

As noted in the *Review of International Initiatives to Accelerate the Reduction of Sulphur in Light and Heavy Fuel Oils* (March 2001*)* report, there is evidence from other countries that economic instruments can be cost-effective tools to reduce SO_2 emissions from LFO and HFO. The following sections examine examples of economic instruments that have been successfully used in other OECD countries for this purpose.

9.2 Economic Instruments

Two economic instruments have been used by jurisdictions to reduce SO_2 emissions from LFO and HFO, namely: tradable permits and taxation.

9.2.1 Tradable Permits

Under tradable permit systems, the government sets a limit on emissions or on total sales of particular substance used. There are two design options for a tradable permit program:

1. **Emission trading** can be used to control emissions of a substance. Generally, tradable permits schemes consist of three elements: first, the government would set a cap or limit on emissions. Second, the government would allocate permits allowing each designated emitter to release a specified amount of the pollutant, up to the total allowable limit. Finally, the firms are allowed to trade their allocated

permits. Thus, firms with higher abatement costs may purchase permits from firms with lower abatement costs, resulting in lower abatement costs overall.

2. **Product trading.** A trading system can also be designed to control total product sales. For example, a tradable allowances system has been put in place to phase out the use of methyl bromide in Canada.

The main advantages of using tradable emissions permits are that:

- The desired SO_2 emissions target would be achieved; and
- Targets would be achieved at lower cost than command and control instruments, both to industry and government, mainly due to a high level of flexibility for industry and a relatively low level of information needs for governments.

Some of the main concerns around trading schemes are that:

- The cap may not be set at an optimal level of pollution from a social welfare point of view.
- Trading can lead to emission reductions in less-polluted (seller) regions and to an increase in heavily-polluted (buyer) regions, where local problems may be exacerbated. Correction factors can be considered to address these concerns.

The following example illustrates how emission trading has been applied to reduce SO_2 emissions in the US. It is also possible to conceive of a tradable allowance system for sulphur in fuels, whereby a cap would be set on total sulphur content, but there are no examples of this type of system. Further analysis would be required to determine the applicability of tradable permits systems to control emissions from HFO or LFO in Canada.

9.2.2 Example 1 – US Sulphur Dioxide Trading Program

Under the U.S. Acid Rain Program, emissions trading is used to reduce SO_2 emissions from electric power utilities. The US government set a goal of reducing annual SO_2 emissions by 10 million tons below 1980 levels.

Phase I began in 1995 and affected mostly coal-burning electric utility plants. Emissions data indicate that, in that year, SO_2 emissions at these units were reduced nationwide by almost 40% below their required level. Phase II, which began in 2000, tightened the annual emissions limits imposed on these large, higher emitting plants. Restrictions were also placed on smaller, cleaner plants fired by coal, oil, and gas. The program now affects existing utility units serving generators with an output capacity of greater than 25 megawatts and all new utility units.

The trading system consists of three elements. First, the U.S. government set a ceiling (or cap) on emissions. This cap firmly restricts emissions and ensures that

environmental benefits will be achieved and maintained. During Phase II of the sulphur trading program, the Act set a permanent ceiling of 8.95 million tons.

Secondly, when Phase II was introduced in 2000, the government allocated emissions permits allowing each designated emitter to release a specified amount of the pollutant, up to the total allowable limit. Allowance allocation calculations were made for various types of units, such as coal- and gas-fired units with low and high emissions rates or low fuel consumption.[45]

Finally, the utilities are allowed to trade their allocated permits. Thus, utilities that require permits in excess of those allowed must buy them from utilities willing to sell their unused credits. To facilitate trading, the U.S. Environmental Protection Agency (EPA) holds an allowance auction annually. The auctions help to send the market an allowance price signal, as well as furnish utilities with an additional avenue for purchasing needed allowances.

The U.S. SO_2 trading program is considered to be a highly successful example of the use of economic instruments and continues to meet its goals. The volume of transactions among firms has more than doubled annually since 1994, SO_2 emissions have fallen faster than required by law, and the cost of reducing emissions has been substantially lower than predicted ($1/5^{th}$ to $1/7^{th}$ of pre-program estimates).

According to the EPA, the General Accounting Office recently confirmed the benefits of this approach, projecting that the allowance trading system could save as much as $3 billion per year – over 50% – compared with a command and control approach typical of previous environmental protection programs.

9.2.3 Sulphur Taxes

Sulphur taxation is another type of economic instrument that has been used as an effective means of achieving government targets in managing the risks from SO_2 emissions. There are three design options for a sulphur tax:

- **Tax differential:** to levy a higher charge on those fuel oils that have the higher sulphur content, thus encouraging consumers to purchase more of the cleaner fuel.
- **Product tax:** to levy a tax on the sulphur content of the fuel. The higher the sulphur content, the more tax the user would pay.
- **Sulphur dioxide emission tax:** the tax would be levied not on the sulphur content *per se*, but rather on how much SO_2 is emitted.

Economic theory suggests that an emission tax represents a preferred tool to reduce a pollutant since it addresses the environmental goal or target more directly than

[45] U.S. EPA allocated allowances to each unit at an emission rate of 1.2 pounds of SO_2/mmBtu of heat input, multiplied by the unit's baseline.

other taxes. However, other factors such as transaction and compliance costs, e.g. for mobile sources, may well make a differential tax or a product tax the optimal instrument.
The advantages of using tax instruments are:

- Depending on its design, a tax may provide more flexibility and thus be less costly to producers and consumers;
- A tax provides a continuing incentive to reduce emissions; and
- A tax may be less costly to government to administer than a command-and-control regulation.

The main disadvantages of using a tax are that:

- It is not certain that the environmental target would be achieved; and
- A tax may be less politically acceptable than a traditional regulation.

The examples below illustrate how taxes have been applied in European countries to control SO_2 emissions from LFO and HFO. Further analysis would be required to determine the applicability of tax instruments to the Canadian context. Some of the issues that would have to be thoroughly examined as part of a successful tax design, include: the application of the tax, market behaviour, government revenue stream, distributional impacts, competitiveness concerns from industry, and effectiveness of the tax in achieving the environmental objective.

9.2.4 Example 2 – Tax Differential in Italy

In January 1988, the Italian government introduced two sulphur taxes: 45 Lira (CA$0.034) per kilogram for HFO with a sulphur content below 1% wt. and 90 Lira (CA$0.068) per kilogram for HFO with sulphur content above 1% wt. Each year, the amount of the tax is confirmed or revised, but the tax for high sulphur HFO is always twice that of low sulphur HFO.

The key sectors targeted by the tax are the industrial and heating sectors. Refineries are exempted from the tax in respect of fuels that are self-produced and used internally. Electricity generators, the largest consumers of high sulphur HFO, are not obliged to pay the tax.

The differential sulphur tax is credited with reducing the sulphur content in HFO from an average sulphur content of 3.3% wt. in 1988 to 1.9% wt. in 2001.

9.2.5 Example 3 – Sulphur Content Tax in Sweden

In 1991, Sweden introduced a sulphur tax for all fuels, including LFO, HFO, peat and coal. The sulphur tax for liquid fuels is at the rate of 27 SEK (or CA$3.96) per cubic metre for each 0.1% wt. sulphur. The tax was aimed at encouraging the use of cleaner fuels (to reduce acid rain) and increase desulphurization technology in the combustion process with the goal of reduced sulphur emissions.

The tax rate was based on the estimated emission abatement costs. Large-scale consumers who restrict their sulphur emissions through desulphurization technologies are eligible for a refund of the sulphur tax. In 1997, approximately one quarter of the 240 taxpayers had implemented such emission control measures, thereby reducing their assessed taxes by 70%.

The sulphur tax is credited with reducing average sulphur content in LFO from 0.2% wt. in 1990 to 0.076% wt. in 1995, and with reducing average sulphur content in HFO from 0.7% wt. to 0.35% wt. over the same time period. According to the Swedish Environmental Protection Agency, sulphur emissions from combustion of LFO and HFO have decreased by approximately 8.5 tonnes owing to the sulphur tax.

The actual revenues from the sulphur tax have been considerably lower than expected because emissions have declined more rapidly than projected. The Swedish Environmental Protection Agency also reports that residual oil with a high sulphur content, which is a by-product from the manufacture of low-sulphur HFO, is often exported to countries with lower environmental standards than Sweden.

9.2.6 Example 4 – Sulphur Content or Product Tax in Denmark

As part of ecological tax reform, energy products in Denmark are subject to an energy tax, a carbon dioxide tax and a sulphur tax. Since 1996, Denmark has levied a sulphur tax with choice provided to larger fuel consumers for application either as a product tax or an emission tax. When levied as a product tax, the rate on sulphur content in fuel is DKK 20/kg (CA$3.90/kg) of sulphur in the fuel. When charged as an emissions tax, the rate is DKK 10/kg (CA$1.95/kg) of SO_2. These two rates are equivalent based on sulphur content. The tax applies to fuels with sulphur content of greater than 0.05% wt.

Larger HFO and LFO consumers who have invested in desulphurization technology have an option to register as a sulphur taxpayer, which exempts them from the sulphur tax on fuel. Instead, they must measure and pay the tax on the basis of their SO_2 emissions. A further option is available to register to pay the sulphur product tax on the fuel, but to generate a tax refund based on the measured sulphur content in the ashes as a result of the combustion process.

According to the Danish Government, the total SO_2 emissions decreased by approximately 24% between 1995 and 1997, and they estimate that total reduction of sulphur emissions will reach 34,000 tonnes by 2005 as a result of the sulphur tax on all fuels. The sulphur tax is credited with dramatically reducing the sulphur content of fuel oils and reducing emissions from combustion plants. Only fuel oils with a sulphur content of less than 0.05% wt. are now sold.

9.3 Potential Combination or Hybrid Instruments

Although a single economic instrument may very well achieve the environmental objective, there are many examples worldwide that show that a combination of different policy tools may sometimes achieve this objective more effectively.

Considering the OECD experience, fiscal incentives have seldom been stand-alone measures. They are often introduced as one component in a package of measures. The policy context as well as efficiency considerations greatly influence the decision of using an economic instrument in tandem with other policy tools.

For example, Switzerland pools the revenues from both of the taxes on LFO and volatile organic compounds to redistribute it to Swiss citizens. Many OECD countries have regulations in place, both those of the European Union and their own national standards, in addition to the economic instruments.

Below are three combination or hybrid instruments that may be worthy of examination, in the context of reducing sulphur in fuel oils; and within each of these, different design and structure can give different results.

1. **Fuel quality regulations and a tax:** This approach has been adopted by many European countries. Regulations have been used in combination with a tax for various reasons. First, the tax can be used as a means to accelerate the response to a planned regulation. Secondly, a tax can be used to complement a regulation as it can both accelerate implementation as well as provide continuing incentives for firms and consumers to lower sulphur emissions below levels required by regulations. Thirdly, the regulation can be seen to be a complement to the tax in that it can support the intent of the tax, and back it up in case the desired results are not attained.

2. **Fuel quality regulations and emission trading:** Emission trading systems are normally implemented by regulation. There are cases however, where a command-and-control regulation is appropriate for a certain sector of the industry, whereas trading may be best suited for another. For example, trading may involve high transaction costs for smaller users, such as the transportation sector, whereas it may represent a cost-efficient policy for larger users, such as the electric power generation sector.

3. **Tax and emission trading:** Similarly, this approach may be appropriate when different sectors have very different economic structures, and different transaction costs for emissions trading.

The list of combinations above is by no means a comprehensive one, it merely illustrates the fact that the optimal outcome may be achieved through the use of economic instruments in combination with other policy tools.

9.4 Fuel Quality Regulations

A regulatory approach could be used to prescribe the maximum sulphur limits in fuel oils. This has been the traditional method of implementing environmental requirements for fuels in Canada. A regulation could include some flexibility to allow for the use of higher sulphur fuels in facilities that are equipped with emission control technologies. A sample regulation is provided in Appendix 6.

10. QUESTIONS FOR STAKEHOLDERS

Environment Canada is soliciting the views of interested parties on the appropriate sulphur limits and timing for such limits as well as the design and approach of Canadian instruments to reduce the level of sulphur in LFO and HFO. Specific issues on which Environment Canada is seeking views are[46]:

1. What should be the appropriate sulphur level in Canadian fuel oils and what should be the timing for reducing sulphur?

The European requirements come into effect on:

- January 1, 2003 for 1.0% wt. sulphur HFO, and
- January 1, 2008 for 0.1% wt. sulphur LFO.

The Federal Government's Notice of Intent, published in February 2001, recommended matching the requirements set by the European Union which "*will be fully implemented by 2008*".

2. What liquid fuels should this initiative address?

This initiative focuses mainly on fuel oils. However, other liquid fossil fuels such as bitumen emulsions have sulphur levels similar or higher than HFO. Bitumen emulsions are used in Canada in thermal generation plants, particularly in Atlantic Canada.

3. Are there any other (non-sulphur) parameters that should be controlled in fuel oils?

4. Which of the following instruments should be considered for use in Canada to reduce sulphur in fuel oils?

a. Tradable Permits

- *Emission trading*
- *Product trading*

b. Sulphur Taxes

- *Tax differential*
- *Product tax*
- *Sulphur emission tax*

c. Fuel Quality Regulations

d. Combination of Instruments

- *Regulations and tax*

[46] Environment Canada is also requesting parties' views on specific regulatory design issues as noted in questions that appear in Appendix 6.

- *Regulations and emission trading*
- *Tax and emission trading*

e. other

Many European countries have successfully used a combination of tax differentials and fuel quality regulations.

5.* Are there any combinations of instruments that improve environmental effectiveness and/or lower overall cost? (e.g., Could fiscal instruments be used to accelerate the *introduction of low sulphur fuel oils in advance of any regulatory requirement?)

Many European countries have used tax differentials in advance of a regulatory requirement to (a) obtain environmental benefits at an earlier date and (b) to facilitate the introduction of low sulphur fuel oils. The regulatory requirement provides a level of certainty for both the government and the industries involved.

6. How should the instruments be designed to maximize environmental benefits such as reduction in emissions of sulphur dioxide, greenhouse gases, nitrogen oxides and other air contaminants (metals, polycyclic aromatic hydrocarbons, etc.) while ensuring that costs are maintained at a reasonable level?

7. Should any Canadian measures developed to reduce the sulphur in fuel oils include the flexibility included in the European Union's directive of allowing, for example, the combustion of higher sulphur fuel oils in facilities equipped with emission control technology? Should this option differ depending on the industry sector involved?

The European Union's directive includes flexibilities for facilities to use higher sulphur fuel oils where the facility uses effective emission control technologies and where emissions limits are established under other directives. The directive allows for certain exemptions (see Section 3 for details).

8. Should measures also be developed to prohibit facilities that currently use fuel oils from switching to higher sulphur fuels or otherwise "dirtier" fuels? How would such measures be structured and should they be incorporated in the design of the measure that reduces sulphur in fuel oils?

Obviously, any measure that resulted in facilities converting to higher sulphur fuels is counter-productive.

11. NEXT STEPS

Environment Canada is proceeding with public consultation on the initiative to reduce sulphur in fuel oils in accordance with the Notice of Intent on Cleaner Vehicles, Engines and Fuels.

Environment Canada is inviting interested parties to provide their views in writing on the issues addressed in this discussion document to Environment Canada by the date indicated in the cover letter to this document. Written comments should be mailed to:

Low Sulphur Fuel Oils
c/o Bruce McEwen
Oil, Gas and Energy Branch
10th floor, 351 St. Joseph Blvd.
Hull, Quebec
K1A 0H3

Comments may also be provided by e-mail to Bruce.McEwen@ec.gc.ca or by fax to (819) 953-8903.

After Environment Canada has reviewed all comments by interested parties, it will develop an action plan to reduce sulphur in fuel oils.

Workshop

In addition, to facilitate greater understanding of the issues involved and to promote exchange of views, Environment Canada is inviting interested parties to participate in a workshop to present and discuss the federal initiative to reduce sulphur levels in fuel oil. It is Environment Canada's intention to hold the workshop in Atlantic Canada prior to the due date for comments from parties. Details on the time and location of the workshop are indicated in the cover letter to this document.

To attend the workshop, parties are requested to register by completing and returning the registration form attached to the cover letter to the address and by the date specified on the form.

Appendix 1: List of background reports

Reports are available, electronically at www.ec.gc.ca/oged-dpge. Paper copies are also available by contacting:

Marie-Claude Kirouac
Oil, Gas and Energy Branch
10th floor, 351 St. Joseph Blvd.
Hull, Quebec K1A 0H3

tel: (819) 953-3363
fax: (819) 953-8903
e-mail: marie-claude.kirouac@ec.gc.ca

Federal Activities:

- Government of Canada, 2001. *Notice of Intent on Cleaner Vehicles, Engines and Fuels*. Canada Gazette, Part I, February 17, 2001, pp. 452-457.

- Environment Canada, 2001. *Support Document to the Notice of Intent on Cleaner Vehicles, Engines and Fuels.* February 2001.

- Environment Canada, 2000. *Use of Heavy Fuel Oil by Federal Departments in Atlantic Canada*. Environment Canada, Atlantic Region, June 2000.

- Tushingham, M. and Bellamy, J., 2001. *Report on Potential to reduce emissions of sulphur dioxide through Reducing Sulphur Levels in Heavy and Light Fuel Oils*. Environment Canada, March 2001.

Emission Inventory:

- Thompson, L. and Dufour, J., 2002. *Sulphur in Liquid Fuels – 2001*. Environment Canada, July 2002.

- Thompson, L. and White, M., 2002. *Canadian Inventory of SO_x, $PM_{2.5}$ and PM_{10} Emissions Resulting from the Combustion of Fuel Oils*. Environment Canada, October 2002.

Effects of Sulphur in Fuel Oils:

- Razbin, V.V., Lee, S.W. and Friedrich, F.D., 2002. *Research Strategies Relevant to Heating Fuel Oil Specifications: Fuel Sulphur Aspects - Literature Review,* CANMET Energy Technology Centre, Natural Resources Canada, Report CETC 02-01(TR), May 2002.

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International Activities:

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Appendix 2: Federal Notice of Intent on Cleaner Vehicles, Engines and Fuels (February 2001)

In the *Notice of Intent on Cleaner Vehicles, Engines and Fuels*, published in the *Canada Gazette I* in February 2001, Environment Canada commits to developing measures to reduce the level of sulphur in both light and heavy fuel oils used in stationary facilities. Scoping studies commenced in 2001 of the benefits to the environmental, health, as well as the cost of reducing sulphur in fuel oils, with the view to matching the requirements vet by the European Union (i.e., 1% wt. for heavy fuel oil starting in 2003 and 0.1% wt. for light fuel oil starting in 2008).

Complimentary measures to regulations, such as economic instruments, will be examined to accelerate the introduction of low-sulphur fuel oils.

Appendix 3: Production, imports, exports and use of light and heavy fuel oils in Canada from 1985 to year 2001

Table A3.1: Production, Imports, Exports and Sales of Fuel Oils in Canada[47]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	7,405,706	1,063,078	1,967,080	5,868,091	746,072
1986	6,710,013	1,462,140	1,401,114	6,322,562	777,855
1987	7,072,831	2,168,542	1,450,710	6,874,463	623,164
1988	8,123,693	2,871,975	2,315,740	8,125,013	840,926
1989	8,627,179	4,301,565	1,982,072	9,836,435	958,021
1990	9,010,376	3,989,666	2,412,542	9,625,574	958,650
1991	8,598,166	2,891,499	2,408,211	7,995,532	1,018,680
1992	7,970,194	2,880,152	2,066,483	8,022,159	919,839
1993	7,721,396	2,275,215	1,549,694	7,386,907	1,000,205
1994	7,080,664	1,841,880	1,383,486	6,699,480	861,349
1995	6,574,472	2,333,371	1,520,940	6,416,422	921,806
1996	7,209,091	1,617,053	1,932,057	6,097,294	973,997
1997	7,596,464	2,428,202	2,013,008	6,878,312	1,047,748
1998	8,102,309	3,563,008	2,028,236	8,549,869	931,556
1999	7,033,404	2,812,507	1,638,115	7,484,554	922,638
2000	6,901,444	2,837,233	1,568,484	7,664,676	946,349
2001	7,680,344	3,395,856	2,520,082	8,499,138	700,134

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	7,902,365	403,653	1,647,210	7,372,304	12,450
1986	8,391,459	605,413	2,127,679	6,977,610	21,822
1987	8,551,732	357,800	2,562,146	6,290,282	11,934
1988	8,537,765	571,164	2,429,743	6,654,075	5,739
1989	9,056,141	422,743	2,731,971	6,874,165	6,076
1990	8,530,322	534,848	2,401,967	6,424,459	5,990
1991	8,563,955	329,295	3,128,481	5,742,436	5,746
1992	8,740,930	204,578	2,952,467	5,781,190	4,510
1993	10,955,278	130,345	5,318,883	5,924,851	13,040
1994	10,194,608	164,783	4,455,439	5,858,757	3,190
1995	10,131,843	125,236	4,979,932	5,430,863	3,570
1996	11,437,959	185,893	5,319,881	5,991,473	9,191
1997	9,899,043	166,406	4,456,957	5,559,024	23,295
1998	7,733,199	21,358	3,170,452	4,715,508	21,812
1999	8,255,126	56,726	3,746,065	4,895,393	17,887
2000	8,273,028	106,902	3,331,114	5,098,616	19,669

[47] Source: Statistics Canada, publication 45-004, 1985 to 2001 (Units: m^3 = 1000 litres)

2001	**9,248,187**	**128,354**	**3,331,114**	**4,877,431**	**17,670**

Table A3.2: Production, Imports, Exports and Sales of Fuel Oils in Atlantic[48]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	1322166	1,047,084	123,638	2,231,061	89,234
1986	1,568,513	1,116,707	195,720	2,367,951	67,917
1987	1,986,128	1,649,130	333,168	3,070,961	90,675
1988	2,800,860	1,759,701	989,007	3,478,016	274,753
1989	3,061,214	2,706,581	966,952	4,391,663	335,682
1990	3,087,681	2,187,310	1,036,322	3,820,109	428,007
1991	3,124,465	1,983,876	1,310,384	3,533,698	431,632
1992	2,747,020	2,016,094	638,288	3,855,695	328,243
1993	2,984,179	1,699,942	782,767	3,476,495	374,495
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	2,583,964	2,155,809	1,018,557	3,498,510	372,158
2000	2,665,230	2,155,809	1,018,557	3,593,405	359,308
2001	2,802,693	2,453,456	1,610,085	3,521,348	262,836

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	1887721	217,374	448,000	1,705,355	3,387
1986	3,007,006	148,061	1,290,585	1,647,775	3,201
1987	3,028,142	0	1,213,320	1,644,095	2,612
1988	3,440,800	92,828	1,581,237	1,728,733	2,003
1989	3,551,134	128,707	1,609,296	1,826,536	3,061
1990	3,438,785	172,948	1,445,602	1,857,582	3,436
1991	4,157,370	290,586	2,067,301	1,785,972	2,398
1992	3,998,125	94,384	1,952,913	1,812,272	3,041
1993	6,347,363	12,400	4,442,777	1,760,118	5,992
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	5,126,921	2,700	2,613,050	1,560,125	3,999
1999	4,634,456	10,173	3,212,567	1,549,467	2,275
2000	5,281,713	36,714	2,668,193	1,565,576	3,406
2001	6,257,257	8,791	3,894,698	1,547,537	1,929

[48] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.3: Production, Imports, Exports and Sales of Fuel Oils in Québec[49]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	2,476,691	0	536,916	1,965,962	157,478
1986	1,917,577	224,411	266,330	1,876,948	255,412
1987	1,767,880	381,502	342,109	1,622,053	116,729
1988	1,838,942	862,964	360,723	2,178,767	115,052
1989	1,865,767	1,271,905	111,570	2,771,955	108,607
1990	2,102,153	1,365,788	314,349	2,680,906	114,613
1991	2,040,482	590,215	278,699	2,120,479	134,786
1992	2,148,377	692,250	683,455	1,913,282	123,502
1993	1,799,041	325,194	321,748	1,771,788	167,105
1994	1,963,449	220,810	452,770	1,700,900	243,578
1995	1,623,400	291,223	447,653	1,431,897	272,859
1996	1,870,956	80,106	492,695	1,671,013	284,398
1997	1,981,352	376,916	653,805	1,849,844	295,552
1998	2,343,390	743,679	646,862	2,660,996	288,912
1999	1,975,985	336,700	261,561	2,190,659	188,660
2000	1,813,056	266,100	44,261	2,336,095	225,457
2001	2,046,428	454,900	324,135	2,785,143	159,297

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	2,342,932	130,792	328,723	2,597,872	3,193
1986	2,074,656	308,278	291,676	2,422,694	2,786
1987	2,175,597	330,567	443,778	2,110,343	2,678
1988	1,711,084	410,814	302,089	2,226,447	998
1989	1,734,340	257,711	338,190	2,335,479	1,196
1990	1,552,329	265,435	275,378	2,094,825	623
1991	1,439,714	1,100	376,126	1,864,696	382
1992	1,822,233	62,800	331,108	1,963,625	849
1993	1,778,225	19,300	334,454	1,979,711	6,911
1994	2,057,191	123,726	359,235	2,030,921	607
1995	2,077,834	67,537	487,456	1,887,968	801
1996	2,525,531	96,552	322,436	2,060,729	2,370
1997	2,346,294	72,487	376,972	1,901,070	1,889
1998	1,930,276	0	360,817	1,649,149	968
1999	2,080,480	20,814	343,677	1,723,545	404
2000	1,468,661	47,300	434,229	1,759,413	900
2001	1,626,488	85,600	64,076	1,740,582	585

[49] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.4: Production, Imports, Exports and Sales of Fuel Oils in Ontario[50]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	2,539,618	4,000	1,088,550	844,543	483,544
1986	2,320,906	41,550	893,876	1,162,720	444,389
1987	2,323,397	38,251	680,539	1,219,392	398,942
1988	2,422,811	80,933	828,690	1,407,788	440,894
1989	2,644,293	78,319	814,206	1,513,526	496,873
1990	2,701,476	30,190	954,409	1,834,676	398,425
1991	2,282,155	10,900	756,017	1,049,925	438,615
1992	2,008,322	78,008	558,605	1,224,850	450,075
1993	1,984,195	82,575	317,692	1,239,720	440,214
1994	2,207,551	122,034	363,407	1,282,821	390,466
1995	1,849,921	87,640	253,295	1,139,471	295,067
1996	2,142,513	27,900	276,152	1,151,900	317,388
1997	2,050,185	25,800	228,919	913,677	359,302
1998	2,185,574	289,100	301,972	1,251,535	322,082
1999	1,628,268	29,098	157,381	929,191	359,379
2000	1,517,399	65,100	249,838	889,035	356,890
2001	1,902,739	36,700	341,077	1,089,767	369,322

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	2,842,515	55,487	816,325	2,302,881	5,572
1986	2,592,368	149,074	532,907	2,220,434	15,585
1987	2,641,037	27,233	859,078	1,879,126	6,454
1988	2,602,410	47,067	507,438	2,008,862	2,242
1989	2,963,717	30,625	766,041	2,000,156	1,549
1990	2,785,137	90,165	672,521	1,796,675	1,629
1991	2,217,789	32,809	683,246	1,465,730	2,520
1992	2,277,441	19,594	660,755	1,454,816	147
1993	2,246,176	49,216	536,911	1,587,294	70
1994	2,064,833	30,962	307,905	1,606,525	42
1995	1,812,832	33,638	212,021	1,417,807	62
1996	1,855,089	31,965	159,962	1,774,424	492
1997	1,587,320	12,888	253,717	1,467,367	15,684
1998	1,212,215	4,772	180,628	1,168,072	16,448
1999	1,155,023	14,200	173,560	1,262,197	15,033
2000	1,517,553	11,804	211,126	1,375,953	14,891
2001	1,359,840	3,400	171,012	1,206,154	14,967

[50] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.5: Production, Imports, Exports and Sales of Fuel Oils in Manitoba[51]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	133,291	0	133,460	80,007	0
1986	0	0	2,637	72,991	0
1987	0	0	0	65,607	0
1988	0	0	0	64,427	0
1989	0	0	764	61,485	2
1990	0	0	0	64,697	0
1991	0	0	0	73,484	0
1992	5,604	0	0	67,607	0
1993	0	0	0	0	0
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	57,535	0	0	60,754	0
1986	47,199	0	0	58,533	0
1987	33,805	0	0	71,162	3
1988	42,200	0	0	57,693	0
1989	49,968	0	623	56,944	3
1990	47,917	0	0	49,452	1
1991	51,595	0	0	46,293	0
1992	84,004	0	0	37,580	0
1993	64,570	0	0	34,406	0
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

[51] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.6: Production, Imports, Exports and Sales of Fuel Oils in Saskatchewan & NWT[52]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	72,233	0	3,206	21,598	525
1986	67,511	0	23,952	22,039	23
1987	102,179	0	53,789	62,202	11,628
1988	66,283	0	35,300	39,746	4,005
1989	86,995	0	56,343	38,984	7,554
1990	107,269	0	54,144	49,080	7,945
1991	65,954	0	29,535	38,581	11,657
1992	53,942	0	19,531	64,364	17,073
1993	55,054	0	22,334	16,420	14,658
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	129,175	0	1,575	-	-
1986	87,876	0	1,954	-	-
1987	100,379	0	0	138,090	1
1988	90,003	0	0	133,769	2
1989	77,206	1,100	1,958	126,297	15
1990	66,227	900	25	120,559	32
1991	75,862	0	0	114,221	17
1992	104,368	400	0	101,659	0
1993	86,650	1,800	0	124,017	0
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

[52] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.7: Production, Imports, Exports and Sales of Fuel Oils in Alberta[53]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	209,074	0	27,534	24,936	8,620
1986	176,611	0	18,599	38,253	-7,882
1987	190,288	0	24,523	33,668	76
1988	204,305	0	32,226	34,521	137
1989	236,701	0	32,237	37,822	0
1990	275,861	0	50,110	71,609	0
1991	290,883	0	15,025	53,532	0
1992	172,295	0	9,932	66,871	0
1993	242,910	304	32,082	34,088	0
1994	251,061	200	33,845	85,486	0
1995	305,534	0	36,958	155,229	0
1996	387,345	0	41,480	116,773	0
1997	506,822	0	20,910	62,141	0
1998	571,091	0	27,377	48,962	0
1999	662,735	0	34,148	54,618	0
2000	775,567	0	9,090	54,618	0
2001	755,811	0	37	30,993	0

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	152,736	0	12,750	79,187	0
1986	165,734	0	647	80,631	0
1987	137,094	0	0	58,513	1
1988	157,590	0	1,654	64,481	0
1989	119,110	0	492	55,106	0
1990	178,367	0	45	60,788	0
1991	127,157	0	0	49,042	0
1992	65,474	0	86	36,255	0
1993	78,819	1,600	56	49,149	0
1994	118,508	0	0	69,888	0
1995	93,772	0	3,974	49,479	0
1996	107,167	0	0	62,037	1
1997	143,363	0	0	63,456	10
1998	105,408	0	0	46,924	3
1999	84,217	0	0	34,643	0
2000	99,891	36	0	45,429	0
2001	144,188	0	0	30,017	0

[53] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.8: Production, Imports, Exports and Sales of Fuel Oils in BC[54]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	652,633	11,994	53,776	665,093	976
1986	658,895	79,472	0	748,659	5,083
1987	702,959	99,659	16,582	813,031	5,114
1988	790,492	168,377	69,794	921,748	6,085
1989	732,209	244,760	0	1,021,000	9,303
1990	735,936	406,378	3,208	1,134,497	9,660
1991	794,227	306,508	18,551	1,124,452	1,990
1992	834,634	93,800	156,672	829,398	946
1993	656,017	167,200	73,071	768,503	3,407
1994	506,158	246,300	33,120	723,079	9
1995	276,865	429,863	93,571	606,057	10
1996	150,430	318,538	148,889	517,576	0
1997	159,728	238,400	118,958	552,322	0
1998	216,735	201,400	129,534	600,428	0
1999	-	-	-	-	-
2000		-	-	-	-
2001	-	-	-	-	-

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	489,751	0	39,837	437,055	261
1986	416,620	0	6,858	366,851	194
1987	426,888	0	44,344	360,192	84
1988	493,678	10,000	37,325	403,471	114
1989	560,666	4,600	13,611	445,194	164
1990	461,560	5,400	7,497	415,900	191
1991	494,468	4,800	49	389,519	341
1992	389,285	27,400	30	350,605	14
1993	374,020	44,300	3,046	364,505	2
1994	274,273	0	149	226,528	13
1995	244,742	8,500	4,614	222,332	6
1996	256,781	17,200	800	250,603	405
1997	242,968	17,700	0	222,736	195
1998	219,863	1,000	84	189,384	190
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

[54] Source: Statistics Canada, publication 45-004, 1985 to 2001

Table A3.9 Production, Imports, Exports and Sales of Fuel Oils in Yukon[55]

HEAVY FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	0	0	0	0	0
1986	0	0	0	0	0
1987	0	0	0	0	0
1988	0	0	0	0	0
1989	0	0	0	0	0
1990	0	0	0	0	0
1991	0	0	0	170	0
1992	0	0	0	0	0
1993	0	0	0	0	0
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

LIGHT FUEL OIL

Year	Production	Imports	Exports	Domestic Sales	Plant Consumption
1985	0	0	0	22,348	37
1986	0	0	3,052	27,513	56
1987	8,790	0	1,626	28,761	101
1988	0	10,455	0	30,619	380
1989	0	0	1,760	28,453	88
1990	0	0	899	28,678	78
1991	0	0	1,759	26,963	88
1992	0	0	7,575	24,378	99
1993	0	1,729	1,639	25,651	65
1994	-	-	-	-	-
1995	-	-	-	-	-
1996	-	-	-	-	-
1997	-	-	-	-	-
1998	-	-	-	-	-
1999	-	-	-	-	-
2000	-	-	-	-	-
2001	-	-	-	-	-

[55] Source: Statistics Canada, publication 45-004, 1985 to 2001

Appendix 4: Consumption of Low Sulphur and Regular Heavy Fuel Oils in the United States by PAD Districts

(Source: US Energy Information Agency, 2002)

Year	PADD	Total Vol. Low Sulphur HFO (<1% wt. S)	Total Vol. Regular HFO (>1% wt. S)	Total Volume	% of Total Low Sulphur HFO
1995	District I	101,895.00	93,490.90	195,386.10	52.15
	District II	10.60	349.80	5,827.90	0.18
	District III	8,936.60	41,904.90	50,841.40	17.58
	District IV	4.10	30.60	635.90	0.64
	District V	17,190.00	46,935.00	64,125.20	26.81
	US Total	129,518.20	187,297.80	316,816.00	40.88
1996	District I	92,253.60	107,152.10	199,405.80	46.26
	District II	629.60	1,134.50	7,433.00	8.47
	District III	7,868.70	55,767.80	63,636.40	12.37
	District IV	22.10	51.10	465.50	4.75
	District V	18,994.90	58,920.70	77,915.80	24.38
	US Total	120,922.20	227,934.10	348,856.50	34.66
1997	District I	77,604.00	111,983.50	189,587.90	40.93
	District II	637.50	3,694.70	7,272.20	8.77
	District III	9,160.30	70,979.20	80,139.60	11.43
	District IV	19.60	97.10	266.10	7.37
	District V	18,116.10	52,763.60	70,879.70	25.56
	US Total	106,360.00	241,785.40	348,145.40	30.55
1998	District I	82,651.00	134,153.40	216,804.50	38.12
	District II	443.40	1,175.10	6,197.30	7.15
	District III	5,641.90	58,805.80	87,172.70	6.47
	District IV	W	W	359.00	NA
	District V	18,509.00	49,080.40	67,589.70	27.38
	US Total	110,422.80	267,700.70	378,123.50	29.20
1999	District I	84,814.40	105,619.50	190,434.00	44.54
	District II	432.80	1,472.00	6,331.50	6.84
	District III	3,036.00	24,552.30	70,176.30	4.33
	District IV	W	W	353.60	NA
	District V	17,943.00	52,395.60	70,338.80	25.51
	US Total	110,438.00	227,195.90	337,634.00	32.71
2000	District I	80,811.00	101,644.00	182,455.00	44.29
	District II	367.20	1,511.60	6,034.00	6.09
	District III	1,217.80	14,456.70	61,814.00	1.97
	District IV	W	W	474.60	NA
	District V	17,496.00	51,657.20	69,153.10	25.30

	US Total	103,494.00	216,436.70	319,930.60	32.35
2001	District I	71,229.10	102,498.30	173,807.40	40.98
(up to Oct)	District II	1,068.00	3,029.20	7,328.70	14.57
	District III	3,503.70	31,340.60	51,383.70	6.82
	District IV	67.90	68.70	478.00	14.21
	District V	15,161.10	42,110.90	57,271.90	26.47
	US Total	92,847.40	198,624.40	291,471.70	31.85

W = Data withheld by EIA for reasons of confidentiality.
NA = Not available.

Appendix 5: End Use of Fuel Oils by Sector

(Source: Natural Resources Canada, End-Use Energy Data Handbook 1990 to 2000, June 2002)

HEAVY FUEL OIL	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total Growth 1990-2000
Commercial Energy Use	11.4	11.0	11.5	11.2	11.9	8.6	9.0	11.8	16.8	17.0	19.8	73.7%
Commercial Energy Use by Building Type												
Schools:	2.3	2.2	2.3	2.3	2.5	1.6	1.8	2.4	3.3	3.3	3.8	65.2%
Health Care Institutions:	2.1	1.8	2.1	2.1	2.4	1.8	2.0	2.6	3.6	3.7	3.9	85.7%
Religious Institutions:	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	100.0%
Other Institutions:	0.5	0.4	0.5	0.5	0.5	0.4	0.4	0.6	0.9	1.0	1.0	100.0%
Offices:	2.5	2.5	2.4	2.4	2.6	1.9	1.8	2.4	3.4	3.3	4.3	72.0%
Retail Organizations:	1.9	2.0	2.0	1.9	1.8	1.3	1.2	1.6	2.6	2.5	3.2	68.4%
Hotels and Restaurants:	0.7	0.9	0.8	0.8	0.8	0.6	0.6	0.8	1.1	1.1	1.4	100.0%
Recreational Facilities:	0.5	0.4	0.5	0.5	0.5	0.3	0.4	0.5	0.7	0.7	0.8	60.0%
Warehouses:	0.7	0.7	0.7	0.7	0.6	0.5	0.5	0.7	1.0	1.0	1.0	42.9%
Industrial Energy Use	201.1	179.5	160.7	162.2	160.4	147.0	154.2	154.4	149.4	140.8	142.9	-28.9%
Agriculture Energy Use	0.6	0.6	0.7	0.8	0.8	0.5	0.5	0.3	0.3	0.5	1.0	66.7%

LIGHT FUEL OIL	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	Total Growth 1990-2000
Residential Energy Use	186.4	162.3	166.5	172.5	163.0	138.0	158.9	147.1	126.1	131.0	132.4	-29.0%
Commercial Energy Use	62.0	58.1	56.9	57.7	52.4	61.2	59.7	57.5	47.6	47.0	60.4	-2.6%
Commercial Energy Use by Building Type												
Schools :	12.2	11.5	11.2	11.3	10.2	12.6	12.1	11.8	9.4	9.6	12.2	0.0%
Health Care Institutions:	11.4	10.5	10.2	10.3	9.4	11.1	9.9	9.8	8.0	8.1	11.0	-3.5%
Religious Institutions:	1.4	1.3	1.3	1.2	1.1	1.2	1.2	1.2	1.0	1.0	1.2	-14.3%
Other Institutions:	3.0	2.8	2.8	2.9	2.6	3.1	3.2	3.0	2.4	2.5	3.0	0.0%
Offices:	12.8	12.0	12.1	12.5	11.6	12.5	13.2	12.9	10.6	10.3	13.0	1.6%
Retail Organizations:	9.3	8.7	8.5	8.4	7.5	9.2	8.0	7.2	6.3	6.0	8.2	-11.8%
Hotels and Restaurants:	4.0	4.0	3.7	3.7	3.4	3.7	3.8	3.8	3.3	3.1	3.9	-2.5%
Recreational Facilities:	4.1	3.8	3.9	4.2	3.8	4.7	5.1	4.9	4.1	4.1	4.8	17.1%
Warehouses:	3.8	3.4	3.3	3.3	2.9	3.1	3.2	2.9	2.4	2.4	3.0	-21.1%
Industrial Energy Use	126.7	118.7	107.8	114.6	127.4	128.7	148.1	148.2	134.2	136.5	145.0	14.4%
Agriculture Energy Use	10.8	14.7	16.6	11.9	10.8	14.0	13.8	13.8	13.0	13.5	9.5	-12.0%

Appendix 6: Example of Regulatory Text for Setting Requirements for Sulphur in Fuel Oils

As an aid to facilitate discussions on the merits of setting requirements for sulphur in LFO and HFO, a draft of possible regulatory text is presented below. Note: this does not imply that Environment Canada has decided to use a regulatory approach to reduce sulphur in fuel oils.

Setting aside for the moment the merits of setting sulphur requirements for fuel oils, Environment Canada is interested in the views of stakeholders on several regulatory design issues. As can be observed below, this example sets out the "dual" approach used by the European Union for setting requirements for HFO; that is, one limit for HFO used in facilities without any emission control equipment to reduce emissions of SO_2 and a higher limit allowed for HFO used in facilities with such equipment.

SULPHUR IN FUEL OILS REGULATIONS

INTERPRETATION

1. (1) The following definitions apply in these Regulations.

"Act" means the *Canadian Environmental Protection Act, 1999*. (*Loi*)

"authorized official" means
(*a*) in respect of a corporation, an officer of the corporation who is authorized to act on its behalf;
(*b*) in respect of any other person, that person or a person authorized to act on behalf of that person; and
(*c*) in respect of any other entity, a person authorized to act on its behalf. (*agent autorisé*)

"heavy fuel oil" means petroleum residual fuel that is used in liquid-fuel-burning equipment. (*mazout lourd*)

"light fuel oil" means petroleum distillate fuel that is used in liquid-fuel-burning equipment and does not require pre-heating of the fuel. (*mazout léger*)

"sulphur-controlled facility" means any combustion plant where
(*a*) the emissions of sulphur dioxide from the plant are less than or equal to X mg/Nm^3 at an oxygen content in the flue gas of 3% by volume on a dry basis,
(*b*) the emissions of sulphur dioxide described in clause (*a*) are measured in accordance with subsection 3(2), and
(*c*) the person owning the combustion plant has provided to the Minister the information required under subsection 4(6).

(2) Any standard or method that is incorporated by reference in these Regulations is incorporated as amended from time to time.

[QUESTION A: SHOULD EMULSIONS BE COVERED BY THE DEFINITION OF HFO?]

[QUESTION B: SHOULD LFO AND HFO BE DIFFERENTIATED BY A VISCOSITY CUT-OFF INSTEAD OF A USE/PRE-HEATING CRITERIA?]

[QUESTION C: WHAT IS THE APPROPRIATE EMISSION LIMIT FOR? SHOULD THERE BE A DIFFERENT CUT-OFF EMISSION RATE? ARE THE EUROPEAN UNITS APPLICABLE IN THE CANADIAN CONTEXT?]

[QUESTION D: THE EUROPEAN EMISSION LIMIT IS AN INSTANTANEOUS LIMIT FOR ALL FACILITIES, EXCEPT FOR REFINERIES WHICH MEET THE SAME LIMIT BUT AVERAGED OVER A ONE MONTH PERIOD. SHOULD CANADA ADOPT AN INSTANTANEOUS OR AVERAGE LIMIT? IF AN AVERAGE LIMIT, WHAT SHOULD BE THE DURATION? HOW WILL THIS BE MEASURED, REPORTED, AUDITED AND ENFORCED? SHOULD DIFFERENT TYPES OF FACILITIES BE ALLOWED DIFFERENT AVERAGING PERIODS?

MAXIMUM CONCENTRATION OF SULPHUR

2. (1) For the purpose of section 139 of the Act and effective January 1, 2008, the concentration of sulphur in light fuel oil produced in Canada or imported into Canada that shall not be exceeded is 0.10% by mass.

(2) For the purpose of section 139 of the Act and effective January 1, 2008, the concentration of sulphur in heavy fuel produced in Canada or imported into Canada for use in a facility other than a sulphur-controlled facility that shall not be exceeded is 1.00% by mass.

(3) For the purpose of section 139 of the Act and effective January 1, 2008, the concentration of sulphur in heavy fuel oil produced in Canada or imported into Canada for use in a sulphur-controlled facility that shall not be exceeded is 2.00% by mass.

[QUESTION E: SHOULD A HIGHER LIMIT FOR SULPHUR-CONTROLLED FACILITIES BE ALLOWED? SHOULD IT BE IN LINE WITH GENERAL RURAL LIMITS IN THE U.S.?]

ANALYSIS

3. (1) For the purpose of determining compliance with the prescribed concentration in section 2 of these Regulations, the concentrations of sulphur in light fuel oil fuel oil shall be measured in accordance with the National Standard of Canada method CAN/CGSB-3.0

No. 16.0-95, *Methods of Testing Petroleum and Associated Products, Sulphur in Diesel Fuel by Energy Dispersive X-ray Fluorescence Spectrometry (EDXRF)*.

(2) For the purpose of determining compliance with the prescribed concentration in section 2 of these Regulations, the concentrations of sulphur in heavy fuel oil fuel oil shall be measured in accordance with the American Society for Testing and Materials method ASTM D 4294.

(3) For the purpose of determining the emissions of sulphur dioxide from a sulphur-controlled facility, the emissions of sulphur dioxide shall be measured in accordance to the method specified in subsection (4).

[QUESTION F: WHAT SHOULD BE THE METHOD FOR MEASURING SULPHUR DIOXIDE EMISSIONS FROM A FACILITY? IS A MASS-BALANCE METHOD SUFFICIENT OR SHOULD EMISSIONS BE MONITORED ON A CONTINUOUS OR SEMI-CONTINUOUS BASIS?]

REPORT

4. (1) Every person who produces in Canada, or imports into Canada light fuel oil or heavy fuel oil shall submit to the Minister on or before January 31 following the end of the calendar year during which the fuel oil was produced in Canada or imported into Canada, a report containing the information set out in Schedule 1 for each calendar quarter during which the person produced or imported fuel oil.

(2) For the purpose of subsection (1), the information relating to the concentration of sulphur set out in Schedule 1 shall be calculated using

(*a*) the standard test method referred to in subsection 3(1);
(*b*) the standard test method referred to in subsection 3(2);
(*c*) the American Society for Testing and Materials method ASTM D 1266;
(*d*) the American Society for Testing and Materials method ASTM D 1552;
(*e*) the American Society for Testing and Materials method ASTM D 2622; or
(*f*) the American Society for Testing and Materials method ASTM D 5453.

[QUESTION G: ARE ALL THESE ALTERNATIVE METHODS NECESSARY? ARE ALTERNATIVE METHODS FOR REPORTING PURPOSES ONLY NECESSARY AT ALL FOR LFO AND HFO? SHOULD EQUIVALENT METHODS BE ALLOWED, SIMILAR TO OTHER FEDERAL FUEL REGULATIONS?]

(3) Subsection (2) shall not be interpreted as an exemption from any requirement under section 2.

(4) Every person who produces light fuel oil or heavy fuel oil in Canada or imports light fuel oil or heavy fuel oil into Canada shall submit the information specified in Schedule 2 to the Minister by the later of

(*a*) September 1, 2007, and
(*b*) 15 days before the person starts to produce light fuel oil or heavy fuel in Canada or to import light fuel oil or heavy fuel oil into Canada.

(5) With the exception of changes in the information on typical annual volumes, if the information submitted under subsection (4) changes, the person identified in subsection (4) must advise the Minister in writing of the change no more than five days after the change.

(6) Every person who owns a sulphur-controlled facility shall submit the information specified in Schedule 3 by the later of

(*a*) September 1, 2007, and

(*b*) 15 days before the sulphur-controlled facility commences operation.

(7) Each report referred to in subsections (1), (4), (5) and (6) shall be signed by an authorized official.

(8) A copy of each report referred to in subsections (1), (4), (5) and (6) shall be maintained in Canada for a period of five years after the report is made

(*a*) at the facility in Canada where the light fuel oil or heavy fuel oil was produced,

(*b*) at the place of business of the importer in Canada as identified in Schedule 2, or,

(*c*) in the case of the report required under subsection (6), at the sulphur-controlled facility.

RECORDS

5. (1) Every person who produces in Canada, imports into Canada, or sells in Canada light fuel oil or heavy fuel oil shall keep a record of the volumes of light fuel oil or heavy fuel oil that the person produces in Canada, imports into Canada, and sells in Canada.

(2) Effective January 1, 2008, every person who produces in Canada or imports into Canada heavy fuel oil shall identify in a record any heavy fuel oil that is for use in a sulphur-controlled facility prior to the dispatch or importation of the heavy fuel oil, along with the volume and the date of dispatch from the production facility or of importation into Canada of the heavy fuel oil.

(3) A record referred to in subsections (1) and (2) shall be maintained in Canada, at the point of production or retail sale or place of business of the importer as identified in Schedule 2, for a period of five years after the record is made.

COMING INTO FORCE

6. These Regulations come into force on the day they are registered.

SCHEDULES

SCHEDULE 1
(Subsection 4(1))

QUARTERLY REPORT OF SULPHUR CONCENTRATION IN LIGHT FUEL OIL AND HEAVY FUEL OIL

Calendar Quarter _____
Year _____

Name of Producer or Importer: _____
Name of Facility Producing Light Fuel Oil or Heavy Fuel Oil: _____

Street Address of Facility Producing Light Fuel Oil or Heavy Fuel Oil:

_____
_____
_____

Street Address of Importer's Place of Business in Canada:

_____
_____
_____

Volume of Light Fuel Oil (m^3) and Quarterly Average Sulphur Concentration (percent by mass):

Volume Sulphur Concentration

(a) Produced at a facility in Canada _____ _____

(b) Imported into a province from outside Canada_____ _____

(c) Sold (only volume information) _____

Volume of Heavy Fuel Oil used in a Sulphur-controlled Facility (m^3) and Quarterly Average Sulphur Concentration (percent by mass):

Volume Sulphur Concentration

(a) Produced at a facility in Canada _____ _____

(b) Imported into a province from outside Canada _____ _____

(c) Sold (only volume information) _____

Volume of Heavy Fuel Oil not used in a Sulphur-controlled Facility (m^3) and Quarterly Average Sulphur Concentration (percent by mass):

Volume Sulphur Concentration

(a) Produced at a facility in Canada _____ _____
(b) Imported into a province from outside Canada_____
_____
(c) Sold (only volume information) _____

_____
Name of Authorized Official

_____
Signature of Authorized Official

_____
Title

_____
Telephone no.

_____
Fax no.

_____
Date of Signature

Note: The information contained in Schedule 1 must be submitted separately for each facility that produces light fuel oil or heavy fuel oil and for each province that light fuel oil or heavy fuel oil is imported into from outside Canada.

SCHEDULE 2
(Subsection 4(4))

INFORMATION ON PRODUCERS AND IMPORTERS OF LIGHT FUEL OIL OR HEAVY FUEL OIL

Company name _____
Company mailing address _____
_____
_____

Registration number(s) under section 7 of the *Benzene in Gasoline Regulations* (if one or more were provided to the company by the Minister):

_____

Check one or more:

[ ] Producer in Canada of light fuel oil
[ ] Producer in Canada of heavy fuel oil for use in a sulphur-controlled facility
[ ] Producer in Canada of heavy fuel oil not for use in a sulphur-controlled facility
[ ] Importer into Canada of light fuel oil
[ ] Importer into Canada of heavy fuel oil for use in a sulphur-controlled facility
[ ] Importer into Canada of heavy fuel oil not for use in a sulphur-controlled facility

For refineries in Canada:

Name and street address (and mailing address if different) of each facility that produces light fuel oil or heavy fuel oil

Typical annual volume, in m^3, of:
(a) light fuel oil _____
(b) heavy fuel oil for use in a sulphur-controlled facility
_____
(c) heavy fuel oil not for use in a sulphur-controlled facility
_____

For importers into Canada:

Street address (and mailing address if different) for place of business in Canada where records and reports will be kept.

Each usual customs entry point into Canada and mode of importation (e.g., ship, rail, truck, pipeline, etc.)

Typical annual volume, in m^3, of:
(a) light fuel oil _____
(b) heavy fuel oil for use in a sulphur-controlled facility
_____

(c) heavy fuel oil not for use in a sulphur-controlled facility

_____

_____
Name of Authorized Official

_____
Signature of Authorized Official

_____
Title

_____
Telephone no.

_____
Fax no.

_____
Date of Signature

SCHEDULE 3
(Subsection 4(6))

INFORMATION ON SULPHUR-CONTROLLED FACILITIES

Company name _____
Company mailing address _____
_____
_____

For each sulphur-controlled facility owned by the company:

Street address (and mailing address if different) of the sulphur-controlled facility

_____
_____
_____

Type of sulphur-controlled facility (check one):

[ ] Refinery
[ ] Power Generation Station
[ ] Pulp and Paper Facility
[ ] Mining or Ore Processing Facility
[ ] Hospital or Educational Institution
[ ] Government Facility
[ ] Other: Specify _____

Is the facility subject to a regulatory or permit limit on its emissions of sulphur dioxide?

[ ] No
[ ] Yes

If Yes, what is the limit _____
If Yes, which level of government set the limit _____

_____
Name of Authorized Official

_____
Signature of Authorized Official

_____
Title

_____
Telephone no.

_____
Fax no.

_____
Date of Signature