Environment Canada Environnement Canada

Reducing the Level of Sulphur in Canadian On-Road Diesel Fuel - A Discussion Paper on Designing Canadian Regulations to Align with the New U.S. Standard

Canada

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1.0 Introduction

Environment Canada is developing new requirements for the allowable level of sulphur in diesel fuel that is used in on-road vehicles. In alignment with requirements recently passed by the U.S. Environmental Protection Agency (EPA), Canadian on-road diesel fuel would be restricted to a maximum of 15 parts per million (ppm) commencing in mid-2006. This paper discusses options for the approach and design of the new Canadian diesel fuel regulations.

Specifically, Environment Canada is soliciting the views of interested parties on the design and approach of Canadian regulations to reduce the level of sulphur in on-road diesel fuel to 15 ppm, starting in 2006. Specific issues on which Environment is seeking views are listed in section 5.

The basic options for the Canadian regulations can be reduced to:

1. simple regulations requiring all Canadian on-road diesel fuel to meet a 15 ppm limit starting June 1, 2006; or
2. complex EPA-style regulations providing for some flexibility for a small portion of the on-road diesel fuel pool to exceed the 15 ppm limit during for a short transition period.

In conjunction with the new requirements for low-sulphur on-road diesel, Environment Canada also intends to develop new regulations for heavy-duty engines and vehicles.

1.1 *Background*

Emissions from vehicles and engines are the largest contributor to air pollution in Canada. The resulting air pollution has significant negative health impacts on Canadians, contributing to premature mortalities, cardiovascular ailments and respiratory distress.

In cooperation with provincial governments, the federal government is putting in place a comprehensive cleaner vehicles and fuels program to reduce harmful emissions from vehicles. Actions over the past several years include federal regulations to reduce the allowable level of exhaust, evaporative and refueling emissions from new on-road vehicles, to control the sulphur content of diesel fuel, to reduce the amount of benzene in gasoline and to limit the dispensing rate of gasoline dispensing pumps. In addition regulations passed in 1999 will reduce the amount of sulphur in gasoline starting in 2002, with full implementation complete by the end of 2004. Most provinces control gasoline vapour pressure, and some are developing or have already introduced vehicle inspection and maintenance programs and scappage programs.

As part of the cleaner vehicles and fuels program, the federal Minister of Environment announced in May 2000 and again in February 2001 that Canadian standards for sulphur in on-road diesel fuel would be aligned with requirements that were being developed by the U.S., both for level and timing. On December 7, 2000, this commitment was reiterated when the governments of Canada and the United States signed an agreement on reducing transboundary movement of smog-causing pollutants (the Ozone Annex[1]). This international agreement commits Canada to "develop and implement … *a regulation under the Canadian Environmental Protection Act 1999 to reduce the allowable level of sulphur in on-road diesel fuel to align with future U.S. standards*."

On December 21, 2000, the U.S. released its final rule setting emission standards for heavy-duty engines and vehicles and requirements for sulphur in on-road diesel fuel[2] . The EPA program will reduce emission levels of particulate matter and nitrogen oxides by 90 percent and 95 percent respectively from the standard levels in effect today. Emissions of carbon monoxide, sulphur dioxide, and toxics such as benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein and dioxin will also be reduced.

The U.S. final rule sets a maximum level of 15 parts per million (ppm) for sulphur in diesel fuel that is used in on-road vehicles. The 15-ppm limit comes into effect on June 1, 2006. The U.S. rule is lengthy and complex, since it includes "safety valve" provisions to allow a small part of the US on-road diesel pool to meet the existing 500-ppm limit for a short period of time.

1.2 *Consultations to date on the Canadian Regulations*

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 level and timing of any requirements for sulphur in on-road diesel fuel.

Consultations through this process showed near universal support by stakeholders for Canada to align with US requirements for sulphur in on-road diesel. Stakeholders supporting alignment included the Canadian Petroleum Products Institute, Imperial Oil, Sunoco, Petro-Canada, North Atlantic Refining, the Greater Vancouver Regional District, the Manufacturers of Emission Controls Association, Toronto Board of Health, Canadian Trucking Alliance, and the Canadian Vehicle Manufacturers' Association. A few stakeholders want sulphur levels to be lower than 15 ppm (e.g., Volkswagen and Friends of the Earth). Husky Oil, while supporting harmonization with US fuel standards and timing, noted that it is "unable to meet the contemplated 15 PPM sulphur in diesel mark without making significant capital investment", and recommended a level of 50 PPM

In a letter to Environment Canada dated December 13, 2000, the Canadian Petroleum Products Institute reiterated its "commitment to our position of general alignment with the US [on-road diesel standard], including the end point for sulphur content".

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*[3] . The Notice of Intent states that "Environment Canada intends to align with the final US level and timing for sulphur in on-road diesel fuel… The Canadian regulatory process will be initiated shortly with a discussion paper soliciting views from stakeholders on the need for and the form of "safety valve" provisions similar to those in the US final rule." (This document is that discussion paper.)

2.0 Summary of the U.S. Final Rule on Sulphur in On-road Diesel Fuel

The US rule[4] reduces the current 500-ppm limit for sulphur in on-road diesel fuel to 15-ppm. The 15-PPM limit comes into effect on June 1, 2006 at refineries and points of import. To allow for the diesel fuel produced or imported just prior to this date to flow through the distribution system, the effective date is July 15, 2006 at diesel bulk storage terminals and September 1, 2006 at retail and wholesale facilities. The US rule exempts exports of diesel fuel and diesel fuel used in research and some military applications from the sulphur requirements. Diesel used in Guam, American Samoa, and the Northern Mariana Islands is also exempt.

2.1 *Supply safety valve provisions*

The EPA's challenge in setting the diesel requirements was to ensure that 15-PPM diesel fuel will be widely available in all parts of the US while maintaining adequate overall supply of on-road diesel fuel. To this end, the EPA provided some flexibility for a small portion of the on-road diesel pool during a 3½ to 4 year transition period. In 2010, at the end of the transition period, all on-road diesel fuel must meet the 15 PPM limit.

The key flexibility provisions, the so-called "safety valve", allow a refiner or importer between June 2006 and December 2009 to have up to 20% of their annual on-road diesel pool with a sulphur level above 15 PPM during the transition period. (Such volumes must meet the current 500-PPM sulphur limit.) In addition, a refiner or importer may run up to a 5% deficit (e.g., produce up to 25% of its on-road diesel fuel with a sulphur level above 15 PPM) in a year but must make up the deficit the following year (e.g., by producing less than 15% of its on-road diesel fuel with a sulphur level above 15 PPM).

A regional banking and trading program for sulphur credits is an important complement to the EPA's "20%" provision. Between June 2006 and December 2009, refiners and importers can generate one sulphur credit

for each gallon of 15-PPM on-road diesel fuel that is in excess of 80% of their on-road diesel pool. In addition to the above, sulphur credits can be generated between June 2005 and May 2006 for each gallon of 15-PPM diesel sold as 15-PPM diesel, and between June 2001 and May 2005, for each gallon of 15-PPM diesel used in an engine or vehicle meeting the 2007 emission requirements (this latter provision is very restrictive and unlikely to generate many credits).

Sulphur credits can be banked for later use or traded to other parties. Until December 2009, sulphur credits can be used to comply with the 80% pool requirement for 15-PPM diesel, including making up any deficit. Credits can also be used to extend production or importation of 500-PPM diesel fuel until May 2010. Credits can only be traded twice (so that the EPA can effectively track the credits) and are restricted to be used in the same PADD[5] (petroleum supply) region of the US as they are generated in. All credits expire on June 1, 2010.

2.2 *Other flexibility provisions*

In addition to the safety valve provisions, the US rule includes a number of other flexibilities during the transitional period. These are primarily targeted at small refineries.

Flexibility Provision for Small Refining Companies

The US diesel rule, consistent with the US gasoline sulphur rule, defines small refining companies as those having less than 1500 employees corporate-wide and a corporate-wide crude oil processing capacity of less than 155,000 barrels per day. Refineries owned by a company meeting this definition have the option of:

> deferring the 15-PPM requirement for on-road diesel fuel until June 1, 2010 and generating sulphur credits for any 15-PPM diesel produced during the transition period; or
> delaying compliance with the US gasoline sulphur rule for up to two years if they produce 100% 15-PPM diesel fuel starting June 2006.

Flexibility Provision for Refineries in the Rocky Mountain States

Under the US gasoline sulphur rule (passed in December 1999), refineries in seven Rocky Mountain states were allowed extra time to meet the sulphur in gasoline requirements. Consequently, without special provisions in the new US diesel rule, these refiners would have had to reduce sulphur in both gasoline and diesel fuel at nearly the same time. The US diesel rule, therefore, allows Rocky Mountain refineries an extra two years to meet the US gasoline requirements provided that they produce 100% 15-PPM diesel starting June 2006.

It should be noted that Canadian requirements for sulphur in gasoline will be fully implemented by the end of 2004 and thus do not overlap with the 2006 implementation date for 15-PPM diesel fuel.

Flexibility Provision for Alaska

In Alaska, unlike other states, only a small amount (about 5%) of the total distillate pool is used in on-road diesel vehicles. Alaska is currently exempt from the federal limit of 500 PPM for sulphur in on-road diesel fuel.

Alaska will be subject to the new 15-PPM limit. However under the US rule, the Alaskan government may apply to be subject to a special state-developed program for the introduction of 15-PPM diesel. The provisions of the US federal diesel rule will apply in Alaska unless the state applies for a special program by April 2002 and the EPA approves the application.

Flexibility Provision for extreme finance hardship

Under the US rule, any refiner claiming that it would suffer extreme finance hardship because of the requirements on sulphur in diesel fuel can apply to the EPA for additional flexibility during the transition period. In such applications, refiners must open their financial books to the EPA. If the EPA approves an application, the refiner can delay meeting the 15-PPM diesel fuel requirement until the date approved by the EPA, which can be no later than June 2010. The EPA expects that less than 1% of the US on-road diesel pool would be covered by this provision.

The table below summarizes the dates associated with the various flexibility provisions during the transition period:

Period	Safety Valve	Other Flexibilities
June 2001 to May 2005	Early credits for use of 15-PPM diesel in MY2007-type engines	April 2002 – deadline for Alaska to apply for special program
June 2005 to May 2006	Early credits for sales of 15-PPM diesel	
June 2006 to Dec. 2009	15-PPM diesel comes into effect 20% 500-PPM diesel may be produced and imported Credits for 15-PPM diesel in excess of 80% of on-road diesel pool Banking and trading of credits allowed	100% 15-PPM diesel for small refining companies and GPA refineries opting to delay gasoline requirements Special program for Alaska, if granted, would commence
Jan. 2010 to May 2010	No further creation of credits Trading of credits allowed Credits can be used to continue to produce and import 500-PPM diesel	
June 2010 and thereafter	100% 15-PPM diesel All credits expire	15-PPM diesel for small refining companies Latest date for 15-PPM diesel for "hardship" refineries

Short-term exemptions for unforeseen circumstances

In addition to the above provisions which apply only during the transitional period, the US diesel rule also provides for temporary, short-term exemptions for unforeseen circumstances (i.e., Acts of God). A refiner granted such an exemption must make-up any air quality deficit and pay back to the government any

economic benefits derived as a result of the waiver. Similar waiver provisions are also included in the EPA's rule on sulphur in gasoline.

The economic component that is part of the US waiver provisions is important in preventing potential abuses by companies and consequently affecting the competitive balance in the market. California did not include any economic penalties in its waiver provisions when it introduced 500-PPM diesel in 1993, and it found that the provisions were misused. Subsequently, California included a penalty of 15 US cents per gallon for gasoline produced under a waiver in its 1996 regulations for Phase 2 gasoline. To date, the one refiner that was granted a waiver (or "variance" as it is called in California) did not use it, because the refiner found other ways to supply gasoline and thus avoid the financial penalty.

2.3 *Downstream Requirements*

The EPA regulations will result in two grades of on-road diesel fuel (i.e., 15 PPM and 500 PPM) coexisting in the US marketplace during the transitional period. The 15 PPM diesel fuel must be used in new (i.e. post-2007 model year) vehicles. Consequently, the US rule includes numerous and complex requirements to prevent vehicle misfuelling and contamination of 15 PPM diesel fuel. The US rule requires segregation of the two grades and tracking (through Product Transfer Documents) of each batch of diesel through the fuel distribution system.

The US rule includes provisions to handle contamination of 15-PPM diesel fuel that may occur in the diesel distribution system. The rule allows "downgrading" in the distribution system of 15-PPM diesel fuel to 500-PPM diesel fuel through re-designation of a batch in its accompanying documentation. Under the US rule, a person may downgrade up to 20% of the volume of diesel fuel that the person handles in a year. There is also a 2 PPM measurement tolerance that is allowed at points downstream of the refinery and point of import.

To reduce potential incidents of misfuelling new vehicles with high sulphur diesel fuel, the rule also specifies (in some detail) labeling requirements for dispensing pumps. All pumps must correctly identify the grade of diesel fuel as one of low-sulphur, high-sulphur or off-road diesel. The EPA decided not to require nozzle size restrictions, fuel dying or other "refueling" requirements (at least at this time). Instead, the EPA decided to rely on misfuelling disincentives for vehicle operators (e.g., damage to equipment, warranty issues, liabilities, costs) to minimize misfuelling.

Overall, by allowing an extra grade of diesel fuel to exist in the on-road diesel market during the transitional period, the US rule necessarily became complex and lengthy in order to handle downstream issues.

Notes:
[1] Protocol between the Government of Canada and the Government of the United States of America amending the "*Agreement between the Government of Canada and the Government of the United States of America on air quality*". December 7, 2000.
[2] US Government. "Control of air pollution from new motor vehicles: heavy-duty engine and vehicle standards and highway diesel fuel sulfur control requirements; final rule". US*Federal Registry*, vol. 66, no. 12, pp. 5001-5194, January 18, 2001. **www.epa.gov/fedrgstr/EPA-AIR/2001/January/Day-18/a01a.htm**
[3] Minister of Environment. A Federal Agenda for Cleaner Vehicles, Engines and Fuels. *Canada Gazette*, *Part I*, February 17, 2001, pp. 452-457.
[4] The US rule and supporting documents can be accessed at: **www.epa.gov/otaq/diesel.htm**
[5] Petroleum Administrative Defense Districts: 1 - East Coast, 2 - Midwest, 3 - Gulf Coast, 4 - Rocky Mountains, 5 - West Coast.

3.0 Findings by the EPA

EPA documentation on its rule includes a vast amount of information in support of the heavy-duty vehicle program and the accompanying diesel fuel sulphur requirements. A key finding in regards to the reduction of sulphur in on-road diesel was that the new heavy-duty diesel vehicle emission standards "*will not be feasible without the fuel change*". Other important findings by the EPA are summarized below.

3.1 *Benefits and costs*

The benefits of the new heavy-duty vehicle standards and the accompanying diesel sulphur reduction are very substantial. The EPA found that "*benefits outweigh costs by 16 to one*".

The focus of the heavy-duty vehicle program is to reduce emissions of NOx and PM10. In addition to these reductions, emissions of carbon monoxide (CO), sulphur oxide (SOx), volatile organic compounds (VOCs) and air toxics will also be significantly reduced. Annual emission reductions when the heavy-duty vehicle program is fully implemented (c. 2030 when the vehicle fleet has completely turned over) will be significant, as shown in the table below:

Pollutant	Emission reduction in 2030 (imperial tons)	Percent reduction from heavy-duty vehicle fleet
NOx	2,570,000	87%
PM10	109,000	73%
CO	1,290,000	~90%
SOx	142,000	~97%
VOCs	115,000	25%
Toxics	17,000	25%

These emission reductions in turn result in large health benefits for Americans[6] , as summarized below:

Health Effects	Reduction in annual number of cases when program is fully implemented (c.2030)
Premature Mortality	8,300
Hospital admissions	7,100
Emergency room visits	2,400
New cases of chronic bronchitis	5,500
New cases of acute bronchitis in children	17,600
Asthma attacks	360,000
Respiratory symptoms in children	386,000
Lost working days	1.5 million

The EPA estimated the annualized cost of its heavy-duty vehicle program to be US $3.6 billion for the year 2010. The costs of low-sulphur diesel fuel is estimated to be between 4½ and 5 US cents per gallon or between 1.8 and 2.0 Cdn cents per litre[7] (not including a vehicle maintenance savings of 1 US cent per gallon).

The EPA noted that there will be "*significant costs*" for pipeline operators and owners of storage facilities as a result of its decision to allow some high-sulphur diesel fuel in the on-road market during the transition period. In other words, some of the costs of compliance have been shifted from refiners to companies

engaged in transporting and marketing of diesel fuel. However, the EPA believes that "*the existing system is capable of handling two grades [of on-road diesel]… in a limited fashion during the transition period*".

3.2 *Diesel supply*

The rule proposed by the EPA in May 2000 had a straightforward requirement of 15 ppm effective in 2006. U.S. refiners and the U.S. Department of Energy expressed considerable concern regarding the effect of such a rule on overall supply of on-road diesel in the U.S. It was in response to this concern about supply that the EPA added the safety valve provisions to its final rule.

In its final rule, the EPA found that there would be sufficient supply even if all on-road diesel fuel were required to be 15 ppm in 2006. With the safety valve provisions included, the EPA concluded that "*there is ample capability in the [U.S.] refining industry*". At safety valve levels above 20%, there would be local regions of the U.S. with likely shortages of 15-ppm diesel. Given the flexibility of the credit banking and trading scheme, the EPA believes that most U.S. refineries will choose to produce either all 15-ppm or all 500-ppm on-road diesel fuel, and that more than half the refineries (presumably the smaller ones) will delay capital cost investments by some degree by buying sulphur credits.

3.3 *Refining technology*

The EPA determined that no new refining technology is needed to meet the 15-ppm requirement, although technology under development has the potential to reduce costs by up to 25%. The EPA found that all refiners will be technically capable of meeting the 15-ppm requirement with extensions to the same conventional hydrotreating technology currently used to meet the 500-ppm requirement. About 20% of U.S. refiners will likely invest in new two-stage hydrotreaters rather than revamp their current units.

3.4 *Lubricity*

On the issue of lubricity and possible effects of low-sulphur diesel on current engines, EPA found that:

"[It is] uncertain about the potential impacts of the 15-ppm sulfur standard on fuel lubricity. There is evidence that the typical process used to remove sulfur from diesel fuel – hydrotreating – can impact lubricity depending on the severity of the treatment process and characteristics of the crude. Because refiners will likely rely on hydrotreating to achieve the proposed sulfur limit, there may be reductions in the concentration of those components of diesel fuel which contribute to adequate lubricity. As a result, the lubricity of some batches of fuel may be reduced compared to today's levels, resulting in an increased need for the use of lubricity additives in highway diesel fuel."

The EPA decided not to include any requirements for lubricity in its low-sulphur diesel rule, but instead to rely on a voluntary approach. The EPA did however include a cost for lubricity additives of 0.2 U.S. cents per gallon in its overall cost estimates. One oil company (BP-Arco) has stated that "*lubricity is addressed in all our products. We continue to work on optimizing lubricity for both performance and cost.*"[8] It is expected that other companies will make similar efforts.

3.5 *Pipeline management*

The EPA examined how pipelines would have to be managed to minimized contamination of low-sulphur diesel by other (much higher sulphur) fuel products. The EPA found that more careful pipeline management, including larger product interface and increased volumes of reblending contaminated batches would occur. The EPA estimated the costs of these additional pipeline and distribution system management issues, as summarized in the table below[9] :

Cost Components	**Distribution Costs (U.S. cents per gallon of all on-road diesel supplied)**	
	Fully Effective	**Initial**

	Program (2010+)	Period (2006-2010)
Cost to distribute additional volume needed to compensate for reduced energy density of 15-ppm diesel	0.17	0.14
Cost to downgrade additional volume of 15-ppm diesel to lower value product during transportation by pipeline	0.14	0.10
Increased cost for the current volume of on-road diesel that must be downgraded in the pipeline system	0.09	0.08
Increased cost to downgrade the interface volume between pipeline shipments of on-road diesel and jet fuel or kerosene to off-road diesel	0.07	0.03
Cost of increased terminal testing	0.002	0.002
Cost of additional tanks to handle pipeline interface between shipments of jet fuel and 15-ppm diesel	Completely amortized during initial period of the program	0.009
Cost of downgrading the interface volumes associated with pipeline shipments of 500-ppm on-road diesel during the initial period of the program	No additional cost	0.004
Cost of additional tanks at refineries, terminals, bulk plants and truck stops to handle two grades of on-road diesel during the initial period of the program	Completely amortized during initial period of the program	0.7
Cost of optimizing the distribution system to limit sulphur contamination	0.025	0.027
TOTAL (U.S. cents per gallon)	0.5	1.1
TOTAL (Canadian cents per litre)TOTAL (Canadian cents per litre)	0.2	0.4

From the EPA's analysis, it is noted that about half of the distribution costs are associated with having a second grade of on-road diesel. Most of the remainder of the distribution costs are on-going costs related to contamination issues.

Canada differs from the U.S. in that at least one Canadian pipeline company (Trans Mountain) ships crude oil and fuel products in the same pipeline. Crude oil can have higher sulphur levels than most fuel products; however, heavy fuel oil has sulphur levels as high or higher than those of crude oil.

4.0 Issues and Options for Canada

4.1 Regulatory issues

Consultations in developing the Notice of Intent on Cleaner Vehicles, Engines and Fuels showed that all stakeholders supported Canada aligning with U.S. requirements for sulphur in diesel fuel. The federal government confirmed in the Notice of Intent that it would follow that approach. Environment Canada is therefore developing regulations to restrict the level of sulphur in on-road diesel fuel to a maximum of 15 ppm commencing on June 1, 2006.

In the US, the vast majority (> 80%) of on-road diesel fuel will contain less than 15 PPM of sulphur commencing in 2006. During a transitional period, a second grade of 500-PPM on-road diesel will exist in the US in small amounts. Overall, by allowing an extra grade of diesel fuel to exist in the on-road diesel market during the transitional period, the US rule necessarily became extremely complex and lengthy in order to address downstream concerns.

Allowing for a second on-road diesel grade in Canada would result in the same concerns and complexities as those in the US: namely, contamination of low-sulphur diesel and potential for misfuelling of vehicles with high-sulphur diesel. In the US, the EPA addressed these concerns by having numerous provisions requiring segregation, tracking of each batch, labeling at the pump, and a complex "downgrading" process. All these requirements tend to shift costs of compliance away from the refiners and on to parties operating storage and fuel distribution systems (such as pipelines and fuel trucks).

A uniquely Canadian issue is one of legal authority. Whereas the EPA works under a legal regime that allows it broad discretion in setting requirements for fuels, Canadian legislation is more restrictive in what flexibilities can be included in fuels regulations. It is unlikely that Canadian regulations under the *Canadian Environmental Protection Act, 1999* (CEPA, 1999) could include all the types of flexibilities afforded to refiners and importers in the US diesel fuel rule. Accordingly, while Environment Canada is committed to aligning with the US on-road diesel fuel rule, the Canadian regime will have to be within the legal framework and enabling provisions of CEPA, 1999.

The main issue, therefore (and being cognizant of Canadian legal constraints), is: should Canada include some flexibility allowing companies to produce and import a small amount of on-road diesel fuel that does not meet the 15-PPM requirement for a short transitional period? In other words, should Canada's regulations for sulphur in on-road diesel fuel be aligned with the US requirements that apply to the large majority (80%+) of its on-road diesel fuel (i.e., 15 PPM in 2006), or should the regulations include the flexibilities included in the US rule (to the extent possible under CEPA, 1999)?

The table below summarizes the advantages and disadvantages of these two options:

	Align with requirements that apply to at least 80% of US on-road diesel fuel	**Align with flexibilities included in the US rule (to the extent possible)**
Type of regulations	straightforward 15 PPM in June 2006	15 PPM in June 2006 with U.S.-style flexibilities
Advantages	▸ simple regulations(likely through amendment of existing *Diesel Fuel Regulations*) ▸ simple administrative requirements ▸ no misfuelling concerns ▸ should not have a negative impact on tankage requirements	flexibility to refiners and importers reduced supply concerns

	minimal requirements on wholesalers and retailers	
Disadvantages	possible supply concerns higher initial costs for refiners	complex new regulations numerous administrative requirements, incl. on wholesalers and retailers misfuelling concerns two-grade distribution problems and costs, incl. additional tankage numerous legal and enforcement issues

Appendix C provides a possible framework for regulations under both options.

Besides the basic conceptual issue of whether or not U.S.-style flexibilities should be included in Canadian regulations, there are other (more technical) issues, particularly if such flexibilities are granted.

One set of issues addresses contamination and misfuelling concerns. Should "downgrading" be allowed in Canada? If so, how should this be handled? What sort of records will need to accompany a batch of low-sulphur diesel throughout the distribution system? Is labeling at the pump sufficient in the Canadian context to avoid misfuelling? Is fuel dyeing needed?

Another issue is whether a sulphur credit trading program would work in Canada given the smaller number of refiners and importers. Under the US rule, sulphur credits must be used in the region that they are generated in. There are seven regions defined by the US rule: the five PADD regions plus Alaska and Hawaii. Most of these regions have more refineries within them than does all of Canada. In Canada, to ensure regional availability of low-sulphur diesel fuel, trading would have to be restricted regionally. Canadian regions would likely follow the general refinery supply orbits; namely, the West, Ontario and the East. There are six refineries (plus Suncor) in the West currently producing on-road diesel, five (plus Petro-Canada's lubrications plant) in Ontario, and six in the East. There are a number of questions regarding a potential Canadian trading program. Are there enough refineries in these regions for a trading program to work? Should other regional groupings be considered? How could a Canadian trading program be designed to ensure that 15-PPM diesel fuel would be available throughout Canada during the transitional period? What are the competitiveness issues around trading of sulphur credits in relatively small markets?

There are some unique aspects to fuel distribution in the Arctic. Often only one shipment of a fuel is sent to a northern community each year. Shipments in the winter can be difficult or impossible. For these reasons, and because of the relatively short time between the finalization of the regulations and the coming into effect of the limit on benzene at the point of sale (22 months), the *Benzene in Gasoline Regulations*, provided a extra nine months for the limits on benzene at the point of sale in the Arctic (three months was allowed elsewhere in Canada, as it is in the US diesel rule). However, Canada's *Sulphur in Gasoline Regulations* did not provide more time for arctic gasoline, due to the longer time between the finalization of the regulations and the coming into effect of the limit on sulphur at the point of sale (54 months) and the nature of the interim 2½-year averaging provisions. It is foreseen that companies should have about 48 months between the finalization of the upcoming diesel regulations and the coming into effect of the limits on sulphur. Is extra time required for the Arctic's diesel distribution system to prepare for the 15-PPM requirement?

Another arctic issue is that, under the US diesel rule, the State of Alaska has the option of applying to the EPA for its own 15-PPM diesel transition program. If it does not make an application, the transition program applicable in the rest of the US will also apply in Alaska. The state has until April 2002 to make this application. If Alaska makes such an application, it could be several months later until EPA makes a determination on Alaska's application (shortly after it is foreseen that the Canadian regulations would be finalized). It is expected that even under a state program there would be a considerable portion of Alaska on-road diesel fuel production meeting the 15-PPM level (although possibly less than the 80% portion in the rest of the US). Some of Canada's diesel supply comes from Alaska refineries, particularly in the Yukon[10]. Working within the legal constraints of CEPA, 1999, how should Canadian regulations handle imports of on-road diesel from Alaska during the US transition period?

Yet another issue is how should sulphur levels be measured. The US rule specifies method ASTM D-6428-99 for measuring sulphur in diesel fuel. Should Canada adopt this method, or should Canada develop its own method? Should alternative methods for the purposes of record keeping and reporting be allowed? If so, what alternative methods should be allowed? In the past, Environment Canada has relied largely on advice from the Canadian General Standards Board and its own internal experts on such matters.

4.2 *Non-regulatory issues*

The Notice of Intent on Cleaner Vehicles and Fuels commits Environment Canada to "*explore complementary measures to regulations, such as economic instruments and other measures, to promote the early introduction of cleaner fuels including low sulphur fuels*".

Tax differentials for promoting the introduction of low-sulphur diesel in advance of the European Union's 2005 mandatory 50-PPM standard are being widely and successfully used in many European countries: namely, Finland, Denmark, Britain, Germany, Sweden, Norway and Hong Kong, with Austria, Netherlands, Switzerland and Australia seriously considering a tax differential for low-sulphur diesel. For example, in Britain the tax differential switched the market to over 99% low-sulphur diesel fuel – 5½ years ahead of the regulated requirement; in Denmark 100% of the diesel pool switched literally overnight, with ambient levels of particulate matter in Copenhagen consequently dropping significantly. The tax differentials vary between countries, ranging from 2 to 6 Canadian cents per litre[11].

Canada has some limited experience with tax differentials for clean fuels. In 1989, the federal government set a tax differential of one cent per litre for unleaded versus leaded gasoline (British Columbia and Ontario also had such a tax differential in 1987 and 1988). In addition, the federal government exempts the ethanol portion of ethanol-blended gasoline from the federal excise tax.

5.0 Questions for Stakeholders

Environment Canada is now moving ahead to develop regulations to restrict the level of sulphur in on-road diesel fuel to a maximum of 15 ppm commencing in June 2006. Parties are invited to provide their views on how the regulations should be designed. In particular, Environment Canada is soliciting views on the following issues:

1. Should the Canadian regulations permit companies to produce or import a small amount of on-road diesel fuel that does not meet the 15-PPM requirement between for a short period of time after June 2006, recognizing that to so would require complex regulations to address downstream issues? Working within the legal constraints of CEPA, 1999, which, if any, of the U.S.-style flexibilities for refiners and importers should be considered? What would be the costs and benefits of this relative to regulations without such flexibilities?
2. If two grades of on-road diesel were allowed for some short period of time:
    a. How could the availability of 15-PPM diesel throughout Canada be assured? What specific regulatory provisions would be required?
    b. What safeguards would need to be put into place to minimize misfuelling and contamination of low-sulphur diesel fuel?
    c. How could contamination of low-sulphur diesel batches be handled?

    d. Should a temporary sulphur credit trading program be included? How would trading regions be defined? Should generation of early credits be allowed?

3. Is extra time required for the Arctic's diesel distribution system to prepare for the 15-PPM requirement (in addition to the three months likely to be allowed elsewhere in Canada)?
4. Working within the legal constraints of CEPA, 1999, how should Canadian regulations handle imports of on-road diesel from Alaska during the U.S. transition period?
5. What is the appropriate test method for measuring sulphur in on-road diesel at concentrations of less than 15 PPM? Should alternative methods for the purposes of record keeping and reporting be allowed? What alternative methods should be allowed? Should performance-based methods be considered?
6. Should any of the other instruments that are being used by other countries also be considered?

6.0 Path forward

Parties are requested to provide their views in writing on the issues addressed in this discussion document to Environment Canada by **June 15, 2001**. Written comments should be mailed to:

Low-Sulphur Diesel Regulations
c/o Bruce McEwen
Oil, Gas & 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.

Environment Canada intends to draft the on-road diesel regulations over the summer. Pending the approval of the Governor in Council, publication in Part I of the *Canada Gazette* is targeted for the fall of 2001. Publication of the final regulations in Part II of the *Canada Gazette* would be expected to occur 8 to 10 months later – that is, in the summer or fall of 2002. The Canadian Petroleum Products Institute, on behalf of most Canadian refiners, has indicated that it supports this timing.

Notes:
[6]Appendix A provides a comparison of the U.S. benefits for the total heavy-duty vehicle and fuel program and estimates for Canada for just reducing sulphur in on-road diesel.
[7]Appendix B provides estimates of costs for Canadian refiners based on several methodologies.
[8]"ULSD supply, demand spreading much wider across the U.S." Diesel Fuel News, February 19, 2001, p. 3.
[9] Source: Regulatory impact analysis for the U.S. diesel sulphur rule, EPA-420-R-00-026, chapter V, page V-124, table V.C-26.
[10]Based on data from Customs Canada, 31,249 m3 of 500-ppm diesel and 17,135 m3 of regular diesel were imported into Yukon in 1998. This represents roughly 40% of the diesel sales in the Arctic.
[11]Environment Canada. "*A review of international initiatives to accelerate the reduction of sulphur in diesel fuel*". Prepared for Oil, Gas & Energy Branch by B. Olvastri and M. Williamson, December 2000, 47 p. **www.ec.gc.ca/oged-dpge**

APPENDIX A: Comparison of Canadian and U.S. Health Benefits

In 1997, through the work on setting sulphur levels for gasoline and diesel, the independent expert panel on health and environmental impacts estimated the health impacts of reducing sulphur in on-road diesel in seven Canadian cities from an average of 475 ppm to an average of 50 PPM These estimates can be extrapolated to all of Canada using the methodology developed by the 1998 Government Working Group on Setting a Sulphur Level for Sulphur in Gasoline and Diesel (GWG). Column 4 of the table below shows the (GWG)[12] estimates adjusted to reflect the change in sulphur level that is now being considered. It should be noted that this does not reflect the impact of the new heavy duty vehicles requirements, which would result in greater benefits.

This estimate of Canadian health benefits can be compared to one-tenth of the US benefits (i.e., scaling for the relative population of the two countries) that were estimated by the EPA for its new diesel fuel and heavy duty vehicle program.

Health effect	Reduction in annual number of cases			
	Based on 1998 GWG Work			Based on EPA Estimates
	Seven City 2020(475 to 50 PPM)	Canada 2020 (475 to 50 PPM)	Canada 2020 (regional levels* to 10 PPM)	1/10th of US Benefits 2030
Premature mortality	19	30	24	830
Hospital admissions	22	35	28	710
Emergency room visits	61	97	77	240
New cases of chronic bronchitis	67	107	85	550
Lower respiratory illness in children (Canada) /New cases of acute bronchitis in children (US)	843	1,340	1,060	1,760
Asthma symptom days (Canada) /Asthma attacks (US)	29,578	47,000	37,200	36,000
Restricted Activity Days	14,025	22,300	17,600	n/a
Acute respiratory symptoms (Canada) /Respiratory symptoms in children (US)	101,000	160,700	127,000	38,600
Lost working days	n/a	n/a	n/a	150,000

(*) Regional levels in 1999 were: Pacific & Yukon 330 PPM, Prairies & Northern 250 PPM, Ontario 360 PPM, Quebec 410 PPM, and Atlantic 390 PPM In all cases, 1999 regional levels are well below the level of 475 PPM assumed by the health panel. Source: Environment Canada's Sulphur in Liquid Fuels report, 1999.

APPENDIX B: Estimation of Canadian Refinery Costs

Studies to estimate costs for two on-road diesel fuel scenarios were carried out as part of work undertaken in 1997 to determine the appropriate level of sulphur in gasoline and diesel fuel. As part of the sulphur in gasoline and diesel fuel process, the Cost and Competitiveness Assessment Panel engaged Kilborn Inc., a consultant, to carry out cost analyses. Based on the results of those analyses for on-road diesel fuel scenarios, it is possible to extrapolate estimates for the 15-PPM maximum limit.

The study entitled "*Sulphur in gasoline and diesel study: the costs of reducing sulphur in Canadian gasoline and diesel*" undertaken by Kilborn Inc. provides an understanding of the technical changes and associated capital and operating costs that would be required at refineries in Canada to meet various fuel standards. The consultant received direct input on costs from 15 of Canada's refineries and modeled the capital and operating costs for the remainder. In both cases, the cost estimates were based on existing sulphur reduction technologies and existing refinery configurations. The consultant verified the information submitted by the refineries for technical consistency. The cost information was aggregated by region in order to protect confidential company data.

Estimated refinery costs for reducing sulphur in on-road diesel to an average of 50 PPM with a maximum of 100 PPM are outlined in the following table. Details on the calculation of these estimates can be found in the consultant's report (i.e.. Tables 4.1, 4.2 and 4.6).

Region	Capital[13] ($ millions)	Operating ($ millions per year)	Capital & Operating Recovery (cents per litre)
Atlantic & Quebec	431	18.3	1.47
Ontario	374	25.7	2.67
West	348	35.3	1.16
Canada	1153	79.3	1.56

Generating cost estimates for the 15 PPM scenario proposed by the Regulations can be undertaken using a number of methodologies. Three methods of estimation are outlined below.

The first method is to extrapolate the estimated costs of a 15-PPM scenario from the costs developed by the consultant for the 50-PPM scenario assuming a linear relationship between costs and sulphur reduction. Based on this assumption, the compliance costs of introducing a 15-PPM level of sulphur in diesel fuel standard would be approximately 108%[14] of those found for the 50 PPM scenario, specifically $1.25 billion capital and $86 million operating. Total capital and operating recovery would be approximately 1.7 cents per litre. It is recognized that the relationship between sulphur reduction and costs below 50 PPM is not linear. As a result, this estimate will likely *understate* the compliance costs to the refining industry.

The second method is to apply the estimation of costs in the United States to the industry in Canada. The US EPA estimated that the overall compliance costs for the US refining industry of a 15 PPM maximum limit would amount to 4½ to 5 US cents per gallon. The average US refinery is expected to spend approximately $30 million (US) in capital expenditures during 2004 and 2005, and a further $8 million (US) per year in operating costs starting in 2006 (note: US refineries are, on the average, larger than those in Canada). If these figures are converted into Canadian dollars and applied to the 17 refineries in Canada that make on-road diesel[15] , then the total capital costs would be approximately (in Canadian dollars) $765 million capital and $204 million per year operating costs. Under this methodology, the unit cost would be the same as in the US; that is 1.8 to 2.0 cents per litre.

A third approach is to develop a rough estimate of the costs based on the expectation of the American Petroleum Institute (API) that the costs of introducing a 15-PPM standard would be approximately double the costs of implementing a 50-PPM standard. Based on the estimates compiled by Kilborn Inc., this method results in an estimated cost for the Canadian refining industry of approximately $2.3 billion in capital costs

and $159 million per year in operating costs, representing an average unit cost of 3.1 cents per litre. Kilborn Inc. indicated that costs would be borne unequally amongst Canada's refineries.

It is reasonable to assume that an aggregate of individual refinery costs based on a rigorous technical analysis would yield a result somewhere in between the application of the API's approach (i.e. $2.3 billion) and extrapolating results for a 15-PPM scenario from Kilborn's estimate for a 50-PPM scenario (i.e. $1.25 billion). Thus, the average unit cost would likely be between 1.6 and 3.1 cents per litre, and probably close to the EPA's estimate of 2.0 cents per litre. Give the level of uncertainty in the Kilborn analysis (±40% on capital costs), another such study is unlikely to provide a more precise range of costs than noted above. It should be noted that EPA found that technology currently under development has the potential to reduce the cost of reducing sulphur in on-road diesel by 25%. The experience in the United States on reformulating fuels shows that compliance costs are usually less, and sometimes much less, than first estimated. The consultant who estimated the effect on competitiveness on Canadian refineries of reducing sulphur in gasoline and diesel (Purvin & Gertz) concluded that:

"*All of these [US] programs -- from unleaded gasoline through RFG [reformulated gasoline] -- have met with a similar series of responses from the petroleum industry. Typically, the early stages of the proposals are met with protest and warnings of supply shortages. The programs have generally been modified heavily to accommodate some portion of industry's concerns. Studies are conducted which typically demonstrate extremely high costs of compliance and large price impacts, but implementation continues. As deadlines approach, the refining industry has usually discovered that compliance costs are much less than anticipated*."[16]

APPENDIX C: Possible Framework for Canadian Regulations

The regulations that would be developed under the two options discussed in section 4 would be very different depending on the option selected.

Option 1

If Canada aligned with most of the US on-road diesel quality, Canada would set a straightforward never-to-be-exceeded limit for sulphur in on-road diesel of 15 PPM starting June 1, 2006 at the refinery and import level and 15 PPM starting September 1, 2006 at the retail and wholesale level. This could be achieved through a simple amendment to the existing federal *Diesel Fuel Regulations*. In this amendment, the test method for sulphur in diesel would also be changed[17] .

Option 2

If Canada aligned with most of the flexibilities in the US on-road diesel rule, Canada would have to develop new diesel fuel regulations to replace the existing *Diesel Fuel Regulations*. (The structure of the existing regulations could not be adapted to include the necessary provisions to address the many issues associated with having two grades of on-road diesel.)

Under this option, Environment Canada envisions regulations that would set the 15-PPM limit in 2006, but then provide regulatees the option of electing to be part of a transition program. If a regulate did not opt into the transition program, it would then be subject to the 15-PPM limit starting in June 2006, but would avoid a few of the administrative requirements placed on those who opt into the transition program.

Regulatees opting into the transition program would be able to produce some small portion of their on-road diesel pool to meet the existing 500-PPM limit. Such regulations might also include a credit generation, banking and trading program. If it did, the regulations would have to define all the rules for the program, including trading restrictions and the tracking and reporting of trades.

However these flexibilities would have to be accompanied by considerable additional administrative requirements. There would have to be records and testing to ensure that the regulatee produced or imported the required volume of 15-PPM diesel. The various types of diesel would have to be identified in records prior to dispatch from a refinery or importation into Canada. Reporting to Environment Canada would be

more comprehensive than under Option 1. In addition, an annual independent audit would likely be required by a regulation under Option 2.

The existence of a second grade of on-road diesel would also require extremely complex and administratively burdensome provisions to ensure enforceability of the regulations. These provisions would include product transfer documentation and provisions to ensure segregation of the two grades, and to handle the occasional contamination of low-sulphur diesel. At refueling facilities, the type of diesel would have to be identified somehow. There would also likely be a provision to prohibit the dispensing of high-sulphur diesel into the new heavy-duty vehicles. Other provisions may also have to be included once more details of the regulations are developed.

Notes:

[12] Health and Environmental Impact Assessment Report, June 25, 1997 (revised March 1998), Table B-34; Government Working Group, 1998. "Setting a level for sulphur in gasoline and diesel". June 14, 1998, Table A.4.6.

[13] Range of uncertainty is + 40% for capital costs and + 25% for operating costs.

[14] Computed based on average levels of (475 - 10) / (475 - 45 PPM) = 1.08%.

[15] Suncor and Petro-Canada's lubrication plant also produce a small amount of diesel, but it is not their primary business.

[16] Purvin & Gertz's review of the US experience with fuel reformulation, Phase II report, May 1997, p. VI-1.

[17] In order for Environment Canada to better understand the regulated community, Environment Canada may also take this opportunity to add a provision requiring refiners and importers of diesel to register with Environment Canada. This would be similar to the registration requirement under section 7 of the Benzene in Gasoline Regulations for refiners and importers of gasoline.