

REDUCING THE LEVEL OF SULPHUR IN CANADIAN OFF-ROAD DIESEL FUEL

*A Discussion Paper on Designing a Canadian
Regulation
to Align with the New U.S. Standard*

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August 2003

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REDUCING THE LEVEL OF SULPHUR IN CANADIAN OFF-ROAD DIESEL FUEL:

A discussion paper on designing a Canadian regulation to align with the new U.S. standard

1. Introduction

On April 15, 2003, the U.S. Environmental Protection Agency (EPA) proposed new requirements for off-road¹ engine emission standards and accompanying diesel fuel requirements². Given the integrated nature of the North American economy, and the need to address fuels, engines and vehicles as a system, Environment Canada is moving forward to develop Canadian regulations for off-road engine³ emission standards and sulphur in off-road diesel fuel, in alignment with the recently proposed U.S. requirements.

This discussion paper discusses options for the approach and design of a Canadian regulation aligning requirements for sulphur in off-road diesel fuel with those proposed by the U.S. EPA. There is a separate process for the engine emissions regulations.

The EPA has determined that the new off-road diesel engine emission standards will not be feasible without changes to the fuel quality (i.e., the level of sulphur). The EPA rule therefore includes limits for sulphur in off-road diesel fuel of 500 mg/kg effective 2007, reduced to 15 mg/kg effective 2010. Rail and marine diesel fuel would be subject to the 500 mg/kg limit, but not to the 15 mg/kg limit. The proposed rule also specifies a minimum cetane index⁶ of 40 or maximum aromatics⁷ content of 35 volume percent for all off-road, locomotive and marine diesel fuel. The EPA diesel fuel rule is extremely complex with a banking, credit

¹ For historical reasons, the U.S. use the term "nonroad" while Canada uses the term "off-road". For the purposes of this discussion paper, the terms are identical.

² U.S. Government. "Control of air pollution from new motor vehicles: heavy-duty engine and vehicle standards and highway diesel fuel sulfur control requirements; final rule". U.S. *Federal Registry*, vol. 66, no. 12, pp. 5001-5194, January 18, 2001.

<http://www.epa.gov/fedrgstr/EPA-AIR/2001/January/Day-18/a01a.htm>

³ Examples of "off-road engines" are engines used in construction equipment, forestry equipment, and agriculture equipment.

⁶ Cetane number is a measure of the ignition quality of diesel fuel and influences combustion characteristics. Cetane index is a calculated number that can be used for approximating the cetane number of fuels

⁷ Aromatic compounds are compounds that contain a benzene ring and include mono, di and poly aromatic compounds.

and trading program plus limited extensions for small refiners during the 2006 to 2014 transitional period.

The basic options for the Canadian regulation are:

1. a simple regulation requiring Canadian off-road diesel fuel to meet a 500 mg/kg limit starting 2007, reduced to a 15 mg/kg limit starting 2010 (except for locomotive and marine diesel fuel that would remain subject to the 500 mg/kg limit); or
2. a complex EPA-style regulation providing some flexibility for trading of sulphur credits which would allow for a portion of the off-road diesel fuel pool to exceed the 500 mg/kg and the 15 mg/kg limits during an interim period.

Under the first option, the present approach in Canada of having two sulphur-differentiated grades of diesel fuel would continue. Under the second option there would be three grades of diesel (e.g., <15 mg/kg, <500 mg/kg and <5000 mg/kg) between 2007 and 2010.

Through this document, Environment Canada is soliciting the views of interested parties on the design and approach of the Canadian regulation. Specific issues on which Environment Canada is seeking views are listed in Section 7

2. Context

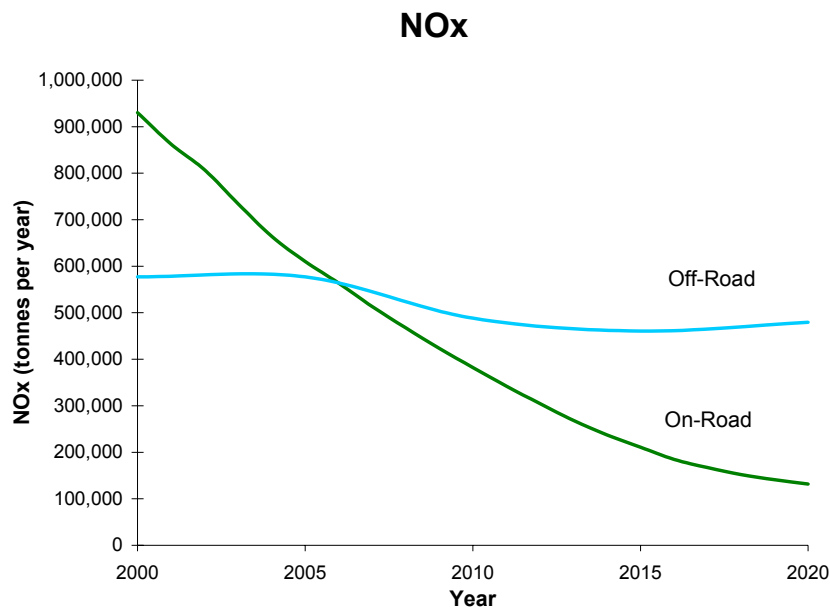
2.1 Background

Emissions from vehicles and engines are a major source of air pollution in Canada. The resulting air pollution has significant negative health impacts on Canadians, contributing to premature mortalities, cardio-vascular ailments and respiratory distress.

Vehicle and engine emission control technology is evolving rapidly and the fuels that power these products have to advance in parallel. The standards for vehicle and engine emissions and fuels each have a number of dimensions requiring an integrated systems approach.

Considerable progress has been made in North America and other jurisdictions to reduce emissions from on-road vehicles. Less progress has been made in addressing emissions from off-road engines. Canadian emissions of NO_x and VOCs from off-road engines are projected to become greater than emissions from on-road vehicles in the 2005 to 2010 time frame; off-road emissions of PM₁₀ already exceed those from on-road vehicles (refer to figures 2.1 to 2.3).

Figure 2.1: Forecast Canadian Emissions of NO_x⁸



⁸ On-road data from Updated Estimate of Canadian On-road Vehicles Emissions for the Years 1995-2020. SENES Consultants Ltd. & Air Improvements Resource Inc. for Pollution Data Branch of Environment Canada. Revised December 18, 2002. Off-road Data from Transportation Systems Branch of Environment Canada via the NONROAD model, October 2002.

Figure 2.2: Forecast Canadian Emissions of PM₁₀⁹

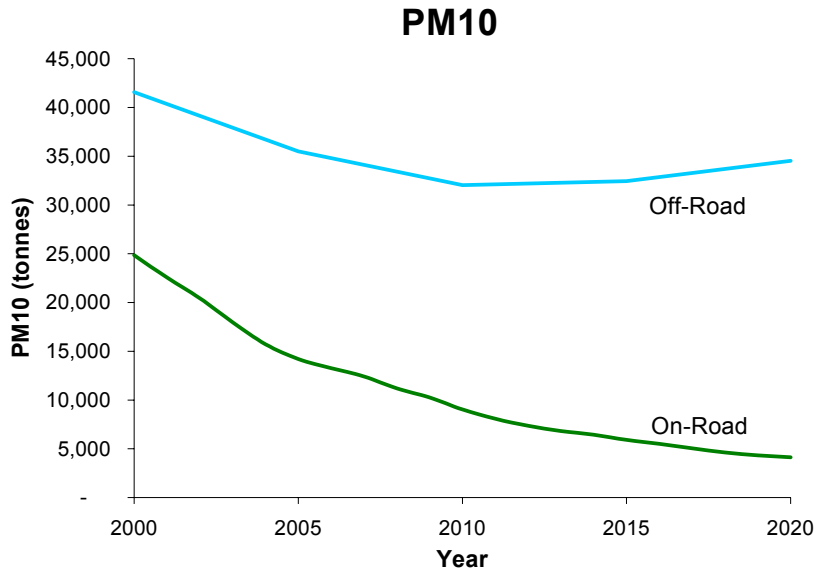
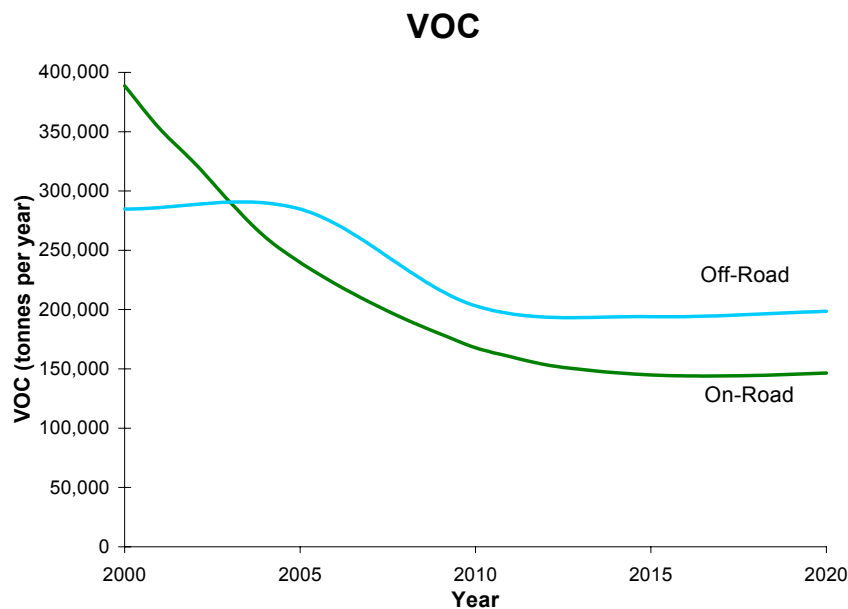


Figure 2.3: Forecast Canadian Emissions of VOCs¹⁰



⁹ On-road data from Updated Estimate of Canadian On-road Vehicles Emissions for the Years 1995-2020. SENES Consultants Ltd. & Air Improvements Resource Inc. for Pollution Data Branch of Environment Canada. Revised December 18, 2002. Off-road Data from Transportation Systems Branch of Environment Canada via the NONROAD model, October 2002.

¹⁰ On-road data from Updated Estimate of Canadian On-road Vehicles Emissions for the Years 1995-2020. SENES Consultants Ltd. & Air Improvements Resource Inc. for Pollution Data Branch of Environment Canada. Revised December 18, 2002. Off-road Data from Environment Canada's Transportation Systems Branch via the NONROAD model, October 2002.

The above off-road emissions graphs include emissions from both gasoline (spark-ignition) and diesel (compression-ignition) off-road engines. On March 29, 2003, Environment Canada published proposed *Off-road Small Spark Ignition Engine Emission Regulations*. In addition Environment Canada is developing *Off-Road Compression-Ignition Engine Emission Regulations* which will establish emission standards, aligning with existing EPA Tier 2 and 3 standards, for new off-road diesel engines¹¹. As an interim measure until the proposed off-road regulations are implemented, Memoranda of Understanding between Environment Canada and manufacturers of off-road engines were put into place in 1999 and 2000¹².

On April 15, 2003, the U.S. EPA proposed new requirements for off-road engine emission standards, known as Tier 4 standards, and accompanying diesel fuel requirements. The EPA has determined that the Tier 4 off-road diesel engine emission standards will not be feasible without fuel changes.

Consistent with the federal Agenda on Cleaner Vehicles, Engines and Fuels, Environment Canada is developing emission regulations for off-road engines, in alignment with U.S. EPA regulations. The intention is to align with the recently proposed EPA Tier 4 standards once they are finalized. Environment Canada is also now moving forward to develop a regulation to control the level of sulphur in off-road diesel fuel, in alignment with the proposed U.S. requirements. This approach is consistent with the policy set out in the federal Agenda on Cleaner Vehicles, Engines and Fuels of generally aligning Canadian environmental fuel requirements with those of the U.S., while taking into consideration environmental standards developed by the European Union.

The EPA's off-road diesel fuel rule is extremely complex because of the flexibility provisions incorporated during the 2006 to 2014 transitional period. The U.S. rule includes a banking, credit and trading program for sulphur plus limited extensions for small refiners. Associated with this flexibility, are extensive administrative and tracking requirements necessary to ensure that low sulphur fuels are available throughout the country during the transitional period and that the appropriate fuel is used in engines.

The intention is to align Canadian requirements for sulphur in off-road diesel fuel with those of the U.S. This will result in all diesel fuel other than that for marine and rail having a sulphur limit of 15 mg/kg.

Regulatory requirements during the 2006 to 2014 transitional period remain one of the key issues to be decided on for the Canadian regulation. New Tier 4 off-road engines will be marketed in Canada during that period and will require low

¹¹ Environment Canada released a [Discussion Draft of the Off-Road Compression-Ignition Engine Emission Regulations](http://www.ec.gc.ca/ceparegistry/documents/part/offroad_dd/diesel_notice.cfm) for review and comment in July 2003 (available at http://www.ec.gc.ca/ceparegistry/documents/part/offroad_dd/diesel_notice.cfm).

¹² The categories of engines covered by the MOU's include handheld and non-handheld small spark-ignition engines, off-road diesel engines and spark-ignition marine engines.

sulphur diesel fuel. A Canadian regulation could apply the 500 mg/kg limit effective 2007 and the 15 mg/kg effective 2010. Alternatively, an EPA-type approach could be followed, allowing for a limited amount of off-road diesel fuel to exceed the limits during an interim period. That approach would require a very complex regulation with extensive administrative and tracking provisions to ensure that low sulphur fuels are available throughout the country during the transitional period and that the appropriate fuel is used in new engines.

The approach taken in the Canadian regulation to address requirements during the 2006 to 2014 period will determine whether the Canadian approach of having two grades of sulphur-differentiated diesel fuel continues, or whether a third grade will be introduced for a short period through a complex regulation with extensive administrative and tracking requirements.

Presently in Canada, it is estimated that about 70% of the diesel fuel used in off-road equipment and engines (including marine and rail) has a sulphur level less than 500 mg/kg (the present limit for on-road diesel fuel)¹³. The main reason for this is the limited distribution infrastructure for two grades of diesel.

2.2 The Cleaner Vehicles, Engines and Fuels Program

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 and engines. Actions over the past several years include federal regulations to reduce the allowable level of exhaust, evaporative and refuelling emissions from new on-road vehicles, to control the sulphur content of diesel fuel used in on-road vehicles, to reduce the amount of sulphur and benzene in gasoline, and to limit the dispensing rate of gasoline dispensing pumps. Most provinces control gasoline vapour pressure, some support vehicle scrappage¹⁴ programs and others are developing or have already introduced vehicle inspection and maintenance programs.

On February 17, 2001, the federal Minister of Environment published the Federal Agenda for Cleaner Vehicles, Engines and Fuels (CVEF) as a Notice of Intent in

¹³ Volume of diesel fuel consumed by off-road (excluding locomotive and marine diesels) engines as calculated from NONROAD model. Environment Canada Sulphur in Liquid Fuels Report (2000) identifies production of >500 and <500 mg/kg sulphur diesel. Several reports identify consumption of locomotive diesel (Programme de surveillance des émissions de locomotives, EC 1999-2000) and marine diesel (Stats Can CANSIM table 128-0003, 2000). Locomotive diesel consumed assumed to be 60% <500 mg/kg and 40% >500 mg/kg (as per referenced report). Marine diesel was assumed to be 100% >500 mg/kg diesel.

¹⁴ [Vehicle scrappage programs are designed to remove older \(pre-1988\), high-emitting vehicles from Canadian roads. Eligible vehicles brought into these programs are recycled according to environmental guidelines which include draining the fluids and recycling the tires and batteries before the vehicle is recycled for scrap metal. Incentives are offered to encourage owners to retire their vehicles.](#)

¹⁶ Minister of Environment. A Federal Agenda for Cleaner Vehicles, Engines and Fuels. *Canada Gazette, Part I*, February 17, 2001, pp. 452-457.

Part I of the *Canada Gazette*¹⁶. The Federal Agenda sets out a ten-year agenda for action.

With respect to sulphur in on-road diesel fuel, the Federal Agenda indicated that Canada planned to align with U.S. EPA requirements. This commitment was fulfilled through the *Sulphur in Diesel Fuel Regulations* which were published on July 31, 2002 and set a limit of 15 mg/kg for sulphur in on-road diesel fuel starting in June 2006. With regard to off-road diesel fuel, the Agenda states that “*Environment Canada plans to recommend a regulatory limit for sulphur in off-road diesel. The limit would be established in the same time frame that the EPA plans for developing limits for sulphur in U.S. off-road diesel*”.

The Government of Canada also committed under the Federal Agenda and under an agreement with the United States (the Ozone Annex¹⁷) to reducing emissions from off-road engines. The Ozone Annex agreement commits Canada to “*Emission regulations under the Canadian Environmental Protection Act 1999 for new off-road engines aligned with the U.S. federal emissions program*”. The new EPA off-road rule proposed on April 15, 2003 includes diesel fuel control as an integral part of the regulation.

Consistent with the federal Agenda on Cleaner Vehicles, Engines and Fuels, Environment Canada is moving forward to develop regulations for off-road engine emission standards and to control the level of sulphur in off-road diesel fuel, in alignment with the U.S. standards. Presently Environment Canada is working on the Tier 2 and 3 rules for off-road engines. Once the EPA finalizes its Tier 4 rule, updates to the Canadian engine emissions regulations will be examined.

2.3 Consultations to Date on Reducing Sulphur in Off-road Diesel Fuel

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 off-road diesel fuel.

Consultations through this process showed agreement by stakeholders that sulphur in off-road diesel is too high and should be reduced. Many stakeholders recommended that Canada align with whatever standard emerges in the U.S. (Canadian Petroleum Products Institute (CPPI), Imperial Oil, Engine Manufacturers Association), while others recommended that the sulphur limit be the same as that for on-road diesel fuel (Toronto Board of Health, STOP). Husky Oil recommended a limit of 500 mg/kg, while Friends of the Earth recommended that off-road diesel fuel (and indeed all fuels) be “*sulphur free*¹⁸” by 2010.

¹⁷ 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.

¹⁸ “Sulphur free” is defined as < 10 mg/kg sulphur.

CPPI recommended a study to assess where off-road diesel fuel is used and the impacts of sulphur reductions on air quality. The Canadian Trucking Alliance was of the view that diesel used by locomotives should be included in any specifications for off-road diesel¹⁹.

Consistent with the federal Agenda on Cleaner Vehicles, Engines and Fuels, Environment Canada is now moving forward to develop a regulation to control the level of sulphur in off-road diesel fuel, in alignment with U.S. standards.

2.4 Action by Other Jurisdictions on Sulphur in Off-road Diesel Fuel

The European Union recently amended its Directive 98/70/EC on the quality of petrol and diesel fuels. This Directive requires full market penetration of 50 mg/kg diesel and the introduction of less than 10 mg/kg sulphur diesel in 2005 with a limit for all on-road diesel of 10 mg/kg in 2009. The directive identifies that in principle the 10 mg/kg limit for sulphur will apply to off-road diesel effective 2009, although there is a planned review of this limit in 2005²⁰.

The California Air Resources Board (CARB) presently has a limit of 500 mg/kg for both on-road and off-road diesel. California has proposed amendments to the California Diesel Fuel Regulations that will phase in a 15 mg/kg limit starting 2006 for both on-road and off-road diesel²¹.

¹⁹ Support Document to the Notice of Intent on Cleaner Vehicles, Engines and Fuels, Environment Canada, February 2001.

²⁰ Report III on the joint text approved by the Conciliation Committee for a European Parliament and Council directive on the quality of petrol and diesel fuels and amending Directive 98/70/EC. January 16, 2003.

²¹ Proposed Amendments to the California Diesel Fuel Regulations, 45-Day Notice Version. May 16, 2003.

3. U.S. and Canadian Limits for Sulphur in Diesel Fuel

3.1 Limits for Sulphur in On-road and Off-road Diesel Fuel – until mid-2006

Both Canada and the U.S. presently regulate a 500 mg/kg maximum limit for sulphur in diesel fuel for use in on-road vehicles. Neither Canada nor the U.S. currently regulate sulphur in off-road diesel fuel. Voluntary commercial standards²² in Canada and the U.S. include a 5000 mg/kg specification for sulphur in off-road diesel fuel. Hence, there are presently two sulphur-differentiated grades of diesel fuel (< 500 mg/kg and < 5000 mg/kg) supplied in both the Canada and the U.S.

3.2 Limits for Sulphur in On-Road Diesel Fuel – post mid-2006

On January 18, 2001, the U.S. EPA passed its final rule limiting sulphur in on-road diesel fuel to a maximum of 15 mg/kg, starting in June 2006. The EPA rule includes a transitional period until 2010 during which some (<20%) diesel fuel for on-road use can exceed the 15 mg/kg limit. The EPA rule is extremely complex because of the flexibility provisions incorporated during the transitional period. The rule includes a banking, credit and trading program. The U.S. rule has extensive administrative and tracking requirements that are necessary to accompany such regulatory flexibility and ensure that low sulphur fuels are available throughout the country during the transitional period and that the appropriate fuel is used in vehicles.

Canada's *Sulphur in Diesel Fuel Regulations* were passed on July 31, 2002. They align in level and timing with the U.S. requirements, but do not include the 4-year transitional period included in the U.S. rule. The Canadian regulation sets a limit of 15 mg/kg effective June 1, 2006 for all diesel fuel produced or imported for on-road use. Other than in remote northern areas, all on-road diesel fuel in Canada is subject to the 15 mg/kg limit commencing in 2006. (The regulation includes a one-year extension for sales of on-road diesel fuel in the northern supply area.) The Canadian on-road diesel fuel regulation avoided the complexities of a transitional period during which two grades of on-road diesel fuel are present in the market place. Hence, the Canadian regulation is much simpler than the U.S. rule.

In summary, during the 2006 to 2010 transitional period, there will be two sulphur-differentiated grades of on-road diesel fuel supplied in the U.S. (<15 mg/kg and <500 mg/kg), and only one grade in Canada (<15 mg/kg). After 2010, all diesel fuel for on-road use in both Canada and the U.S. will be subject to the 15 mg/kg maximum limit.

²² In Canada, by the Canadian General Standards Board; in the U.S., by the American Society for Testing and Materials

3.3 Proposed Limits for Sulphur in Off-road Diesel Fuel – post-2006

The U.S. off-road rule proposed on April 15, 2003 would limit the level of sulphur in off-road diesel fuel to 500 mg/kg starting in 2007, reduced to 15 mg/kg in 2010 (Rail and marine diesel fuel would be subject to the 500 mg/kg limit only). The proposed rule is lengthy and complex, with a credit, banking and trading program and provisions allowing more lead time for small refiners.

During the 2006 to 2010 period, there will be three sulphur differentiated grades of diesel fuel produced in the U.S. (<15 mg/kg, <500 mg/kg and <5000 mg/kg). As with its rule for sulphur in on-road diesel fuel, the proposed EPA rule for off-road diesel fuel includes extensive administrative and tracking requirements necessary to ensure that low sulphur fuels are available throughout the country during the 2006 to 2010 period and that the appropriate fuel is used in engines. Post-2010, there will be two grades of diesel fuel available:

- <15 mg/kg sulphur for on-road and off-road use; and
- <500 mg/kg sulphur for:
 - marine and rail use;
 - until 2012 for off-road diesel fuel produced through the use of credits; and
 - until 2014 for off-road diesel produced by a small company owning a small refinery.

Environment Canada is now moving forward to develop a regulation to control the level of sulphur in off-road diesel fuel, in alignment with the U.S. standards. It is expected that post-2014, the Canadian limits for sulphur in off-road diesel fuel will match the U.S. limits. Requirements during the 2006 to 2014 transitional period remain one of the key issues to be decided on for the Canadian regulation. A decision on this issue will determine whether the Canadian approach of having two grades of sulphur-differentiated diesel fuel supplied continues, or whether a third grade will be introduced.

3.4 Summary of Expected Sulphur-Differentiated Grades of Diesel Fuel

A summary of sulphur-differentiated grades of off-road diesel fuel in Canada and the U.S. (reflecting the limits in EPA's proposed rule) is shown in Table 3.1 below. Until 2006, there will be two sulphur-differentiated grades in Canada and the U.S. Post-2010, there will also be two sulphur-differentiated grades. During the in-between period, there would be three sulphur-differentiated grades in the U.S.

Table 3.1: Sulphur-differentiated Grades of Diesel Fuel (Canada vs. U.S.)

	Sulphur Specification (mg/kg)					
	Canada			U.S.		
Dates	On-road	Off-road	Total no. of sulphur differentiated Grades	On-road	Off-road	Total no. of sulphur differentiated Grades***
pre 2006	500	5,000*	2	500	5,000*	2
2006	15	5,000*	2	15 & 500	5,000*	3
2007-2010	15	TBD	TBD	15 & 500	15, 500 & 5,000	3
2010-2014	15	TBD	TBD	15	15, 500 (off-road produced by small refiners), (&500**)	2
post-2014	15	15 (& 500)**	2	15	15 (& 500**)	2

* Voluntary commercial standard

** Applies to rail and marine diesel fuel

*** This does not reflect complexities for credit generation for early production of low sulphur diesels.

In addition, it should be noted that heating oil, also a distillate product and presently without regulated sulphur limits, is sold in both Canada and the U.S. Environment Canada is assessing options to develop measures to reduce the level of sulphur in heating oil and released a discussion paper on that issue in February 2003²³.

²³ *Setting Canadian Standards for Sulphur in Heavy and Light Fuel Oils*. Fuels Division, Oil, Gas and Energy Branch, Environment Canada. February 2003.

4. Summary of the Proposed U.S. EPA Rule for Sulphur in Off-road Diesel Fuel

The U.S. EPA rule²⁴ proposed on June 15, 2003 includes the following limits for sulphur in off-road diesel fuel:

- 500 mg/kg limit effective:
 - June 1, 2007 at refineries and points of import,
 - August 1, 2007 at diesel bulk storage terminals, and
 - October 1, 2007 at bulk plants, wholesale purchaser-consumers, and retail stations.

- 15 mg/kg limit effective:
 - June 1, 2010 at refineries and points of import,
 - July 15, 2010 at diesel bulk storage terminals, and
 - September 1, 2010 at bulk plants, wholesale purchaser-consumer, and retail stations.

Under the EPA's proposed rule, the 15 mg/kg limits would not apply to marine and rail diesel fuel. However, the EPA has requested comments on reducing the limit for rail and marine diesel fuel to 15 mg/kg in 2010, noting that it anticipates beginning the process of developing new engine controls for those sources in 2004.

In addition, the EPA has requested comments on the option for a 2008 one-step, 15 mg/kg requirement for all off-road diesel fuel.

The following types/uses of fuel are exempt from the limits:

- diesel fuel for export,
- diesel fuel used in research, development and testing,
- diesel fuel for some military applications (national security exemption),
- diesel fuel used in Alaska's rural areas (areas not served by the Federal Aid Highway System), and
- diesel fuel used in Guam, American Samoa, and the Commonwealth of Northern Mariana Islands.

4.1 U.S. Transitional Period (2006 to 2014)

The proposed U.S. rule includes a banking, credit and trading program plus limited extensions for small refiners during a transitional period from 2007 to 2014:

- In 2006, credits may be generated for early production of 500 mg/kg diesel.

²⁴ The U.S. rule and supporting documents can be accessed at: www.epa.gov/otaq/diesel.htm.

- From 2007 to 2010, there would be three sulphur-differentiated grades of off-road diesel fuel (<15 mg/kg, <500 mg/kg, and <5000 mg/kg).
- After 2010, only the 15 mg/kg and 500 mg/kg grades of diesel fuel can be marketed.
- In 2009, credits may be generated for early production of 15 mg/kg diesel
- From 2010 to 2014, a banking and trading system along with special exemptions for small refiners allow for limited production and sale of the 500 mg/kg grade for off-road uses other than rail and marine.
- Post 2014, the 500 mg/kg grade can only be used in marine and locomotive equipment.

The EPA regulation for off-road diesel fuel has extensive administrative and tracking requirements necessary to ensure that the low sulphur fuels are available throughout the country during the 2006 to 2014 transitional period and that the appropriate fuel is used in new engines. These administrative requirements include:

- Registration of refiners and importers;
- Applying for a non-highway distillate baseline percentage;
- Pre-compliance reports;
- Annual compliance reports and batch reports for refiners and importers;
- Product transfer documentation throughout distribution system;
- Dyeing of locomotive and marine diesel;
- Dyeing of home heating fuel;
- Sampling and testing;
- Records of
 - batch volumes,
 - batch designations,
 - the applicable sulphur content standard,
 - whether the fuel is dyed or undyed,
 - whether the fuel is marked or unmarked; and
 - sampling and testing.
- Records of credit generation, use, transfer, purchase, or termination, separately for highway and off-road diesel credit program;
- Business records regarding actions taken in response to any violations discovered;
- Labelling at the pump; and
- Application for small refinery status (does not apply to all).

The extensive administrative and tracking requirements are required to ensure that low sulphur fuels are available throughout the country during the transitional period and that the appropriate fuel is used in engines. Most of these requirements are necessary only because of the flexibility provided for a small amount of the diesel fuel to exceed the lower sulphur limits during the transitional period.

4.2 Credit, Banking and Trading Program for Sulphur

The credit, banking and trading program provides some flexibility for industry in implementing the sulphur in off-road diesel fuel requirements. Refiners that produce 500 mg/kg or 15 mg/kg diesel fuel early can generate sulphur credits. The credits can be either traded or used to postpone production of 500 mg/kg or 15 mg/kg diesel fuel. The program has two phases, the first in respect of the 500 mg/kg off-road diesel fuel requirement in 2007; the second in respect of the 15 mg/kg off-road diesel fuel requirement in 2010.

Phase 1 allows for sulphur credit generation based on early production of 500 mg/kg off-road diesel fuel, from June 1, 2006 to May 31, 2007.²⁵ The credits are tradable and can be used to delay compliance with either the 500 mg/kg standard or the 15 mg/kg standard. Credits are calculated based on either a baseline approach or the total volume of dyed off-road diesel fuel produced by a refinery. The off-road baseline is calculated for a refinery by averaging the volume of off-road diesel fuel and heating oil produced or imported annually over the period from January 1, 2003 to December 31, 2005 and dividing that by the average of all diesel fuel and heating oil produced or imported annually over the same period.

Phase 2 allows for sulphur credit generation based on early production of 15 mg/kg diesel from June 1, 2009 to June 1, 2010 using the off-road baseline.²⁶ Production of 15 mg/kg diesel fuel in excess of the off-road baseline can be used to generate sulphur credits. Phase 2 credits can be used to allow continued production of 500 mg/kg diesel fuel until as late as May 31, 2012. (In addition, under special provisions small refiners can produce 500 mg/kg off-road diesel fuel until 2014 without requiring sulphur credits.) Any 500 mg/kg off-road diesel fuel produced after June 1, 2010 requires EPA approval in advance and a demonstration of how the refiner will segregate 500 mg/kg diesel fuel from 15 mg/kg diesel fuel. On May 31, 2012, all credit provisions will expire.

4.3 Other Flexibility Provisions

The U.S. rule includes a number of other flexibilities during the transitional period. These include:

- Hardship provisions for qualifying small refiners;
- General hardship provisions;
- Temporary waivers for unforeseen circumstances;
- Temporary waivers for extreme hardship circumstances; and
- Flexibility/exclusion provisions for rural Alaska.

²⁵ Small refiners can also generate 500 mg/kg credits from June 1, 2007 to May 31, 2010.

²⁶ Small refiners can generate 15 mg/kg credits from June 1, 2010 to May 31, 2012.

Hardship Provisions for Qualifying Small Refiners

Under the Regulatory Flexibility Act and Small Business Administration guidelines, the EPA must give additional consideration to small businesses than to other regulatees. The U.S. off-road diesel fuel rule, consistent with the U.S. gasoline sulphur rule, defines small refiners as those having no more than 1,500 employees corporate-wide and a corporate-wide crude oil processing capacity of less than or equal to 155,000 barrels per day. Refiners must apply to the EPA for small refiner status. Small refiners have the option of:

- deferring the 500 mg/kg requirement for off-road (including locomotive and marine) diesel fuel until June 1, 2010 and generating sulphur credits for 500 mg/kg diesel produced prior to that date; and
- deferring the 15 mg/kg requirement for off-road (excluding locomotive and marine) diesel fuel until June 1, 2014 and generating sulphur credits for any 15 mg/kg diesel produced from June 1, 2010 to May 31, 2012;

or

- revising upwards by 20% the interim small refiner gasoline sulphur average and per-gallon cap gasoline standard for the duration of the small refiner gasoline sulphur interim program, if they produce 100% 15 mg/kg diesel fuel starting June 1, 2006. (This option requires the refiner to opt out of the above provisions for generation of credits.)

Temporary Waivers for Unforeseen Circumstances

The U.S. proposed off-road diesel rule also provides for temporary, short-term exemptions for unforeseen circumstances (i.e., Acts of God). Any application for such an exemption would need to show that avenues for mitigating the problem, such as purchase of credits toward compliance had been pursued but were insufficient. A refiner granted an exemption under this provision must make-up any air quality deficit and pay back to the government any economic benefits derived as a result of a waiver. Similar waiver provisions are also included in the EPA's rules on sulphur in gasoline and sulphur in on-road diesel fuel.

The economic component that is part of the U.S. 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 mg/kg 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 regulation 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.

Temporary Waivers for Extreme Hardship Circumstances

Under the U.S. rule, a refiner that would suffer extreme financial hardship because of the requirements for sulphur in off-diesel fuel can apply to the EPA for additional flexibility by June 1, 2007 in respect of the 500 mg/kg limit and by June 1, 2010 in respect of the 15 mg/kg limit. Under the hardship provisions, a refiner can defer the 500 mg/kg and 15 mg/kg off-diesel fuel requirements and could receive relief similar to the provisions for small refiners. In support of any such application, a refiner would be expected to fully disclose its financial situation to the EPA. The EPA expects the hardship provisions would apply in respect of less than 1% of the U.S. off-road diesel fuel.

Flexibility Provision for Alaska

In Alaska, it is estimated that heating oil represents approximately 95% of all distillate consumption (about 50% for heating and 45% for electricity generation). Generally one fuel tank supplies all of a northern community's distillate needs, (e.g., heating, vehicles, etc). Highway vehicles account for about 1% and marine engines about 4% in rural Alaska. Consequently, off-road equipment and locomotive engines consume negligible amounts of diesel fuel, particularly in rural area.

Alaska is currently exempt from the federal 500 mg/kg limit for sulphur in on-road diesel fuel. Under the proposed EPA rule for off-road diesel fuel, portions of Alaska served by the Federal Aid Highway System (i.e. communities on the connected road system or served by the Alaska State ferry system) will be subject to the 500 mg/kg then 15 mg/kg standard. Areas of Alaska not served by the Federal Aid Highway System are excluded from the proposed rule.

4.4 Downstream Requirements

Overall, by allowing several grades of diesel fuel to exist in the off-road diesel market during the transitional period, the U.S. rule necessarily became complex and lengthy in order to handle downstream issues.

The EPA rule will result in three sulphur-differentiated grades of off-road diesel fuel (i.e., <5000 mg/kg, <500 mg/kg, and <15 mg/kg) co-existing in the U.S. marketplace during the transitional period. The 500 mg/kg and 15 mg/kg grades of diesel fuel must be used in new (i.e. post-2007 and post-2010 model year) off-road engines and equipment. Consequently, the U.S. rule includes numerous and complex requirements to prevent engine and equipment misfuelling and cross contamination of diesel fuel. The U.S. rule requires dyeing, segregation of the grades and tracking (through Product Transfer Documents) of each batch of diesel fuel through the fuel distribution system.

Dyeing Requirements

During the first part of the transitional period, all heating oil must be marked (e.g., dyed with solvent yellow 124) to differentiate it from off-road diesel (including locomotive and marine) fuel. This is required from June 1, 2007 to June 1, 2010 since flexibility provisions allow small refiners and refiners using credits to produce high-sulphur off-road diesel which must be distinguished from heating oil.

The credit system also makes it necessary to distinguish between off-road diesel fuel and marine and locomotive diesel fuel during the last part of the transitional period. Between June 1, 2010 and May 31, 2014 locomotive and marine diesel fuel will require a marker.

The above marking requirements result from the flexibilities during the 2007 to 2014 transitional period. After June 1, 2014 all marker requirements for distillate fuels end since the fuel standards can then be enforced based on sulphur level.

Product Segregation

The structure of the U.S. requirements for on-road and off-road diesel fuel results in different requirements for product segregation for three time periods:

- From June 1, 2007 to May 31, 2010:
 - 500 mg/kg diesel must be segregated from >500 mg/kg diesel until the point where IRS dye is added;
 - heating oil must be segregated throughout the distribution chain.
- From June 1, 2010 to May 31, 2014:
 - 15 mg/kg diesel must be separated from the higher sulphur distillate products such as 500 mg/kg diesel;
 - refiners and importers distributing 500 mg/kg diesel must provide a plan demonstrating the segregation of such fuel.
- After May 31, 2014, the remaining three distillate fuels (15 mg/kg highway and off-road diesel, 500 mg/kg locomotive and marine diesel, and heating oil (>500 mg/kg) must be segregated.

Labelling

To reduce potential incidents of misfuelling new engines and equipment with high sulphur diesel fuel, the U.S. rule also specifies labelling requirements for diesel fuel dispensing pumps. All pumps must correctly identify the grade of diesel fuel ranging from ultra-low sulphur diesel for off-road to high-sulphur heating fuel oil as detailed in Table 4.1 below. The EPA did not require dispensing nozzle size restrictions, relying instead on misfuelling disincentives for vehicle operators (e.g., damage to equipment, warranty issues, liabilities, costs) to minimize misfuelling.

Table 4.1: Diesel Fuel Pump Labelling Required to Discourage Misfuelling

2006	LOW-SULPHUR HIGHWAY DIESEL FUEL (500 mg/kg Maximum) WARNING
	ULTRA LOW-SULPHUR HIGHWAY DIESEL FUEL (15 mg/kg Maximum)
	NON-HIGHWAY DIESEL FUEL (May Exceed 500 mg/kg Sulphur) WARNING
June 1, 2007 to August 31, 2010	LOW-SULPHUR NON-HIGHWAY DIESEL FUEL (500 mg/kg Maximum) WARNING
	ULTRA-LOW SULPHUR NON-HIGHWAY DIESEL FUEL (15 mg/kg Maximum) WARNING
	HIGH-SULPHUR NON-HIGHWAY DIESEL FUEL (May Exceed 500 mg/kg) WARNING
	HEATING OIL (May Exceed 500 mg/kg) WARNING
September 1, 2010 to August 31, 2014	ULTRA-LOW SULPHUR NON-HIGHWAY DIESEL FUEL (15 mg/kg Maximum) WARNING
	LOW-SULPHUR NON-HIGHWAY DIESEL FUEL (500 mg/kg Maximum) WARNING
	LOW-SULPHUR LOCOMOTIVE OR MARINE DIESEL FUEL (500 mg/kg Maximum) WARNING
	HEATING OIL (May Exceed 500 mg/kg) WARNING
Beginning September 1, 2014	ULTRA-LOW SULPHUR NON-HIGHWAY DIESEL FUEL (15 mg/kg Maximum) WARNING
	LOW-SULPHUR LOCOMOTIVE OR MARINE DIESEL FUEL (500 mg/kg Maximum) WARNING
	HEATING OIL (May Exceed 500 mg/kg) WARNING

5. Findings by the EPA

EPA documentation for its rule includes a vast amount of information in support of the off-road diesel engine program and the accompanying diesel fuel sulphur requirements. A key finding in regard to the reduction of sulphur in off-road diesel was that the new off-road diesel engine emission standards “*will not be feasible without the fuel change*”. Other important findings by the EPA are summarized below.

5.1 Benefits and Costs

This EPA found that “*benefits [of the engine/fuel program] outweigh costs by 54 to one*”. The benefits of the new off-road diesel engine standards and the accompanying diesel fuel sulphur reduction are estimated to be \$81 billion (USD) annually by 2030. Costs for both the engine and fuel requirements are estimated to be \$1.5 billion (USD) annually.

The EPA estimates that the new requirements for off-road equipment and off-road diesel fuel will reduce emissions of particulate matter and nitrogen oxides from off-road diesel engines by 95 percent and 90 percent respectively from today’s engines²⁷. Emissions of carbon monoxide, sulphur dioxide, and toxics such as benzene, 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein will also be reduced. Estimated annual emission reductions when the off-road diesel engine program is fully implemented (c. 2030) are shown in Table 5.1 below:

Table 5.1: Estimated US National (50-State) Emissions Reductions from Diesel Land-Based Off-road Engines, Locomotives, Commercial and Recreational Marine Vessels

Pollutant	Emission reduction in 2030 (imperial tons)	Percent reduction from off-road diesel vehicles and engines
PM _{2.5}	127,708	62%
NOx	826,690	31%
SO ₂	389,337	97%
VOC (including air toxics)	29,660	17%
CO	623,851	57%
Benzene	593	30%
Formaldehyde	3,500	30%
Acetaldehyde	1,572	30%
1,3-Butadienes	59	31%
Acrolein	89	30%

²⁷ 40 CFR Parts 69, 80, 89, *et al.* Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel; Proposed Rule, Environmental Protection Agency (U.S.A) federal Register, Friday, May 23, 2003.

The EPA found that these emission reductions would in turn result in large health benefits for Americans²⁸, as summarized in Table 5.2 below:

Table 5.2: Reduction in Incidence of PM-related Adverse Health Effects Associated with the Proposed Off-road Diesel Engine Standards

Health effect	Reduction in annual number of PM related cases when program is fully implemented (c. 2030)
Premature mortality	9,600
Chronic bronchitis	5,700
Non-fatal heart attacks	16,000
Hospital admissions (respiratory & cardiovascular)	8,300
Emergency room visits for asthma	5,700
Acute bronchitis attacks in children	14,000
Lower respiratory symptoms in children	150,000
Upper respiratory symptoms in children (asthmatic)	110,000
Work days lost	960,000
Adult restricted activity days	5,700,000

The EPA's valuation of these health benefits is approximately \$550 billion (USD-2004) for the period 2007 to 2030²⁹. The annual benefits are approximately \$80.6 billion (USD) by 2030³⁰

The EPA estimated the annualized cost of its off-road program (engines and fuels) to be US \$1.5 billion for the year 2030. The cost of producing 500 mg/kg off-road diesel fuel is estimated to be on average 2.5 US cents per gallon. The cost of producing 15 mg/kg off-road diesel fuel is on average an additional 2.3 US cents per gallon. Thus, the overall average cost for reducing sulphur in off-road diesel fuel from today's levels in the U.S. to 15 mg/kg is 4.8 US cents per gallon (or 1.9 Cdn cents per litre). These costs include an estimated 0.3-0.4 US cents per gallon cost for increased use of lubricity additives and increased distributional costs.

The EPA estimates that the average price increase for 500 mg/kg diesel fuel would range from 1.5 US cents per gallon in eastern and mid-west states to 4.1 US cents per gallon in the Rocky Mountain states. The average price increase

²⁸ 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.

²⁹ Present value in 2004 using 3% inter-temporal discount rate. Value is cumulative from 2007 to 2030.

³⁰ Based on 3% concurrent discount rate.

for 15 mg/kg diesel from today's prices for off-road diesel fuel in the U.S. would range from 3.0 US cents per gallon in eastern and mid-west states to 8.9 cents per gallon in Rocky Mountain states.

For the user of low-sulphur off-road diesel, any increase in its price is expected to be largely off-set by reduced maintenance costs. The EPA estimated that there are substantial maintenance savings for off-road engines using 500 mg/kg diesel fuel. These savings amount to on average 3.0 US cents per gallon for most off-road engines (but are less for locomotive and marine engines).

5.2 Diesel Supply

The EPA found that supply of low sulphur off-road diesel fuel would not be an issue given that requirements already in place for on-road diesel fuel would ensure availability of 15 mg/kg diesel fuel.

5.3 Refining Technology

The EPA determined that no new refining technology is needed to meet the 500 mg/kg and 15 mg/kg requirements for off-road diesel fuel. The EPA found that all refiners will be technically capable of meeting the limits with extensions to the same conventional hydrotreating technology that will be used to meet the 15 mg/kg requirement for on-road diesel fuel. EPA expects the available lead-time should allow refiners to learn from the operating performance of the units used to produce 15 mg/kg on-road diesel fuel and to minimize their costs.

5.4 Lubricity

Hydrotreating diesel fuel tends to reduce its natural lubricating quality. There are a variety of fuel additives which can be used to restore diesel fuel's lubricating quality. These additives are currently used to some extent in highway diesel fuel. It is expected that there will be a need for lubricating additives and that all diesel fuel meeting the 15 mg/kg cap will require lubricating additives.

The EPA decided not to include any requirements for lubricity in its low-sulphur diesel fuel rule, but instead to rely upon a voluntary approach. The EPA did however include a cost for lubricity additives of 0.1 and 0.2 U.S. cents per gallon in its overall cost estimates for the respective 500 mg/kg and 15 mg/kg limits.

5.5 Pipeline Management

The EPA noted that the 2006 requirements for 15 mg/kg on-road diesel fuel would result in resolution of any pipeline issues related to distribution of 15 mg/kg off-road diesel fuel well in advance of the 2010 implementation date for off-road diesel fuel.

6. Issues and Options for Canada

This section discusses the issues and options for the design and approach of a Canadian regulation to control the level of sulphur in off-road diesel fuel. It also poses the questions on which Environment Canada is soliciting the views of interested parties. (For the reader's convenience, the questions are consolidated and repeated in Section 7.)

6.1 General Regulatory Issues

Consultations in developing the Federal Agenda on Cleaner Vehicles, Engines and Fuels showed that stakeholders support Canada aligning with U.S. requirements for sulphur in diesel fuel. The federal government confirmed in the Federal Agenda that it would follow that approach. Environment Canada is now proposing to develop a regulation to align with the new U.S. requirements for sulphur in off-road diesel fuel. (The U.S. EPA proposed rule would restrict the level of sulphur in off-road diesel fuel to a maximum of 500 mg/kg commencing 2007 and 15 mg/kg commencing 2010.)

A uniquely Canadian issue is one of legal authority. Whereas the EPA works under a legal regime that allows broad discretion in setting requirements for fuels, Canadian legislation is more restrictive in what flexibilities can be included in fuels regulations. Regulations under the *Canadian Environmental Protection Act, 1999* (CEPA, 1999) could not include all the types of flexibilities afforded to refiners and importers in the U.S. diesel fuel rule. Specifically, CEPA 1999 does not provide for flexibility to exempt a refinery from regulations because of economic circumstances. Accordingly, while Environment Canada is committed to aligning with U.S. sulphur requirements and timing for off-road diesel fuel, 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 the Canadian regulation include a EPA-style banking, credit and trading program for sulphur in off-road diesel fuel during a short transitional period? Appendix C discusses a possible framework for regulations with and without such a program.

The Table 6.1 below summarizes the advantages and disadvantages of these two options:

Table 6.1: Advantages and Disadvantages of Regulatory Options.

	Option 1 – No Banking/Credit/Trading Program	Option 2 – Banking/Credit/Trading Program
Type of regulation	straightforward limits of 500 mg/kg in June 2007 and 15 mg/kg in June 2010	same, with sulphur banking/credit/trading program during a transitional period
Advantages	<ul style="list-style-type: none"> • simple regulation (likely through amendment of existing <i>Sulphur in Diesel Fuel Regulations</i>) • simple administrative requirements • misfuelling concerns are minimized 	<ul style="list-style-type: none"> • flexibility to refiners and importers • staggered construction timing
Disadvantages	<ul style="list-style-type: none"> • higher initial costs for refiners 	<ul style="list-style-type: none"> • complex new regulation • numerous administrative requirements, incl. on wholesalers and retailers • misfuelling concerns • additional downstream requirements (e.g., segregation, dyeing, labeling) • additional costs to diesel fuel distributors • numerous legal and enforcement issues

Canada's regulation requiring 15 mg/kg for on-road diesel fuel was structured to avoid having three grades of sulphur-differentiated diesel fuel supplied during the transitional period. The structure of the Canadian regulation for off-road diesel fuel that is now being consulted on will determine whether this approach of having two grades of sulphur-differentiated diesel fuel supplied during the transitional period continues.

The EPA approach entails a complex averaging, banking and trading program. Allowing for three grades of diesel that can be used in the off-road market in Canada would result in the same concerns as those in the U.S.: namely, increased risk of contamination of low-sulphur diesel fuel and potential for misfuelling of vehicles with high-sulphur diesel. In the U.S., the EPA addressed some of these concerns by requiring segregation, tracking of each batch, and labelling at the pump. All these requirements tend to shift costs of compliance

away from refiners and on to parties operating storage and fuel distribution systems.

Q 1. Should a temporary credit trading program be included in the Canadian regulation, recognizing that to do so would require a much more complex regulation?

A subsidiary issue is whether a sulphur credit trading program would work in Canada given the smaller number of refiners and importers. If restricted regionally, Canadian regions would likely follow the general refinery supply orbits; namely, the West, Ontario and the East. There are five refineries in the West currently producing off-road diesel fuel, four in Ontario, and four in the East.

Q 2. If a credit and trading program were allowed during a transitional period:

(a) Should trading be restricted within geographic regions? If yes: how should the regions be defined?

(b) Would there be enough refineries/importers within these regions for a trading program to work?

(c) Should generation of early credits be allowed during a transition period?

Other questions regarding any potential Canadian trading program also arise:

(d) Would availability of 500 mg/kg diesel fuel throughout Canada during the transitional period be a concern? If so, what provisions would be required in a Canadian trading program to ensure availability?

(e) What are the competitiveness issues around trading of sulphur credits in relatively small markets?

(f) What requirements would need to be put into place to minimize misfuelling and contamination, given that more than one grade of sulphur-differentiated off-road (non-rail, none-marine) diesel fuel would be marketed?

Limits and Timing

Under the EPA's proposed rule, the 15 mg/kg limits would not apply to marine and rail diesel fuel. However, the EPA has requested comments on reducing the limit for rail and marine diesel fuel to 15 mg/kg in 2010, noting that it anticipates beginning the process of developing new engine controls for those sources in 2004.

Q 3. Should Canada include rail and marine diesel fuel in the final 15 mg/kg limit (resulting in a 15 mg/kg limit for all on-road and off-road fuel)?

The EPA has also requested comments on the option of a 2008 one-step, 15 mg/kg requirement for all off-road diesel fuel.

Q 4. *If the US decides to implement a 15 mg/kg requirement in 2008 for all off-road diesel fuel, instead of the two-step approach, should Canada follow its lead?*

The EPA rule specifies a minimum cetane index of 40 or maximum aromatics content of 35 volume percent for all off-road, locomotive and marine diesel fuel.

Q 5. *Should the Canadian regulation include requirements for cetane and aromatics aligned with those of the EPA?*

Product Transfer Documentation

The EPA requires product transfer documentation containing information on:

- type of diesel fuel (e.g. off-road, locomotive, marine, or motor vehicle);
- the sulphur standard the fuel complies; and
- dyeing.

The above information can be conveyed via a product code to the point where the fuel is transferred to a truck carrier, retailer or wholesale purchaser-consumer. From that point, more explicit details are required.

Q 6. *What requirements for product transfer documentation should be included in the Canadian regulation?*

6.2 Other Issues

Supply in Remote Northern Areas

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. The *Sulphur in Diesel Fuel Regulations* allowed a one-year delay in meeting the sulphur requirement for on sales of on-road diesel in the northern supply area. In large part, primarily because of the lack of storage facilities, many communities in the Arctic are expected to be using 15 mg/kg diesel by September 2007 for all diesel uses. Therefore Environment Canada does not foresee a need to provide extra time for Arctic off-road diesel fuel, since the low-sulphur diesel is already there, but is interested in hearing stakeholders' views on this.

Q 7. *Is extra time required to prepare the diesel distribution system in the Arctic for the 500 mg/kg and 15 mg/kg requirement (in addition to the three months likely to be allowed elsewhere in Canada)?*

Supply from Alaska

Given that all parts of Alaska serviced by roads and ferries will be subject to the 500 and 15 mg/kg limits, Environment Canada does not foresee an issue regarding imports from Alaska. Nevertheless, Environment Canada is interested in hearing stakeholders' views on this.

Q 8. Are there issues about potential imports of off-road diesel fuel from Alaska during the U.S. transition period? (If yes, what are the concerns and how should they be addressed within a regulation under CEPA 1999?)

Sulphur Test Methods

Yet another issue is how sulphur levels should be measured. The U.S. rule proposes using a performance based method for measuring sulphur in diesel fuel. Canada has chosen to use ASTM 5453 for measuring sulphur under the *Benzene in Gasoline Regulations*, *Sulphur in Gasoline Regulations* and the *Sulphur in Diesel Fuel Regulations*.

Q 9. What is the appropriate test method for the Canadian regulation to specify for measuring sulphur in off-road diesel at concentrations of less than 500 mg/kg and 15 mg/kg?

Q 10. Should alternative methods for the purposes of reporting be allowed? If so, what alternative methods should be allowed? Should performance-based methods be considered?

6.3 Non-regulatory Issues

The Federal Agenda 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 fuel in advance of the European Union's 2005 mandatory 50 mg/kg 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 litre³¹.

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.

The National Round Table on Energy and the Environment (NRTEE), Cleaner Transportation Working Group (CTWG) concluded that it was “*not able to reach agreement on a recommendation regarding the use of a differentiated tax to accelerate demand and supply of [on-road] ULSD prior to 2006*”. For off-road diesel, NRTEE concluded: “*With respect to off-road diesel fuel, its sulphur content is likely to fall when [on-road diesel] ULSD becomes mandatory, because some of the companies may find it uneconomical to supply two different fuels to all locations. Further reductions could be achieved by applying a tax to off-road diesel fuel that had more than a specific sulphur content, perhaps 50 or 100 or even 500 ppm. There is some [economic] advantage [for refiners] to maintaining a higher sulphur level in off-road fuel than in on-road fuel, as significant costs may be saved with little loss in benefits*”³².

The European Union amended Directive 98/70/EC which provides for the expectation of off-road diesel meeting the on-road diesel requirement of 10 mg/kg by January 2009, dependant on a review to be completed by December 31, 2005.

Q 11. Should any of the other instruments that are being used by other countries also be considered?

³¹ 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).

³² National Round Table on the Environment and the Economy. “Toward a Canadian Agenda for Ecological Fiscal Reform: First Steps”. 2002, pg 33.

7. Compendium of Questions for Stakeholders

Environment Canada is now moving ahead to develop a regulation to restrict the level of sulphur in off-road diesel fuel to a maximum of 500 mg/kg commencing in June 2007 and a maximum of 15 mg/kg commencing June 1010. Parties are invited to provide their views on how the regulation should be designed. In particular, Environment Canada is soliciting views on a number of issues. These issues are discussed and set out in Section 6.

- 1. *Should a temporary credit trading program be included in the Canadian regulation, recognizing that to do so would require a much more complex regulation?***
- 2. *If a credit and trading program were allowed during a transitional period:***
 - (a) Should trading be restricted within geographic regions? If yes: how should the regions be defined?***
 - (b) Would there be enough refineries/importers within these regions for a trading program to work?***
 - (c) Should generation of early credits be allowed during a transition period?***
 - (d) Would availability of 500 mg/kg diesel fuel throughout Canada during the transitional period be a concern? If so, what provisions would be required in a Canadian trading program to ensure availability?***
 - (e) What are the competitiveness issues around trading of sulphur credits in relatively small markets?***
 - (f) What requirements would need to be put into place to minimize misfuelling and contamination, given that more than one grade of sulphur-differentiated off-road (non-rail, none-marine) diesel fuel would be marketed?***
- 3. *Should Canada include rail and marine diesel fuel in the final 15 mg/kg limit (resulting in a 15 mg/kg limit for all on-road and off-road fuel)?***
- 4. *If the US decides to implement a 15 mg/kg requirement in 2008 for all off-road diesel fuel, instead of the two-step approach, should Canada follow its lead?***
- 5. *Should the Canadian regulation include requirements for cetane and aromatics aligned with those of the EPA?***
- 6. *What requirements for product transfer documentation should be included in the Canadian regulation?***

- 7. Is extra time required to prepare the diesel distribution system in the Arctic for the 500 mg/kg and 15 mg/kg requirement (in addition to the three months likely to be allowed elsewhere in Canada)?**
- 8. Are there issues about potential imports of off-road diesel fuel from Alaska during the U.S. transition period? (If yes, what are the concerns and how should they be addressed within a regulation under CEPA 1999?)**
- 9. What is the appropriate test method for the Canadian regulation to specify for measuring sulphur in off-road diesel at concentrations of less than 500 mg/kg and 15 mg/kg?**
- 10. Should alternative methods for the purposes of reporting be allowed? If so, what alternative methods should be allowed? Should performance-based methods be considered?**
- 11. Should any of the other instruments that are being used by other countries also be considered?**

8. Path Forward

Parties are requested to provide their views in writing on the issues addressed in this discussion document to Environment Canada by September 29, 2003. Written comments should be mailed to:

Sulphur in Off-road Diesel Fuel
c/o Bruce McEwen
Fuels Division
Oil, Gas & Energy Branch
Environment Canada
10th floor, 351 St. Joseph Blvd.
Gatineau, 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 proceed to draft the off-road diesel fuel regulation (or alternatively, amendments to the *Sulphur in Diesel Fuel Regulations*) during 2003. Pending the approval of the Governor in Council, publication in Part I of the *Canada Gazette* would be targetted for the spring of 2004 for the option of a simple regulation. Publication of the final regulation in Part II of the *Canada Gazette* could then occur 8 to 10 months later – that is, in the winter of 2004, presumably after the U.S. has finalized its regulation. A more complex EPA-type regulation would take considerably more time to develop and finalize.

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

Estimated health benefits for reducing sulphur in off-road diesel fuel can be developed in the same manner used by Environment Canada for the regulation reducing sulphur in on-road diesel fuel.³³

In 1997, through the work on setting sulphur levels for gasoline and diesel, an independent expert panel on health and environmental impacts estimated the health impacts of reducing sulphur in off-road diesel in seven Canadian cities from an average of 2400 mg/kg to an average of 400 mg/kg. 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)³⁴. Column 4 of the table below shows the (GWG) estimates adjusted to reflect the change in sulphur level that is now being considered based on actual (2001) regional levels. It should be noted that this does not reflect the impact of the new off-road engine requirements, which would result in greater health benefits.

Table A is based on Scenario 7 of the GWG for off-road diesel fuel. For Table A, columns 1 and 2 are from the GWG report. Column 3 linearly extrapolates the Column 2 values from 2400 mg/kg to the actual regional values for off-road diesel in regions. Column 4 is a linear extrapolation of Column 3 based on regional sulphur values in 2001. Column 5 is the sum of columns 3 and 4, providing an estimate of the health effects of reducing 2001 regional off-road diesel sulphur levels to 10 mg/kg.

This estimate of Canadian health benefits can be compared to one-tenth of the U.S. benefits (i.e., scaling for the relative population of the two countries) that were estimated by the EPA for its new off-road diesel fuel and off-road engine program (Column 6).

³³ 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. Environment Canada. May 2001

³⁴ 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.

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

Health effect	Based on 1998 GWG Work (Scenario 7)					Based on EPA Estimates for Fuel & Engine
	Seven City 2020 (2400 to 400 mg/kg) (Column 1)	Canada 2020 (2400 to 400 mg/kg) (Column 2)	Canada 2020 (regional levels* to 400 mg/kg) (Column 3)	Canada 2020 (400 to 10 mg/kg) - linear extrapolation based on regional scenario 7 (Column 4)	Canada 2020 regional off- road levels* to 10 mg/kg (Column 3 + Column 4) = (Column 5)	1/10 th of US Benefits 2030 (Column 6)
Premature mortality	46	72	83	16	99	960
Hospital admissions	29	45	49	10	59	830
Emergency room visits	145	227	261	51	312	570
New cases of chronic bronchitis	161	252	288	56	344	570
Lower respiratory illness in children (Canada) / Lower respiratory symptoms in children (US)	2,000	3,180	3,636	709	4,345	15,000
Asthma symptom days (Canada)	71,000	111,215	127,298	24,823	152,121	
Upper respiratory symptom in children (asthmatic) (US)						11,000
Restricted Activity Days	33,700	52,687	60,334	11,765	72,099	570,000
Acute respiratory symptoms (Canada)	242,000	380,166	435,127	84,850	519,977	
Acute bronchitis attacks in children (US)						1,400
Lost working days	n/a	n/a	n/a	n/a	n/a	96,000

(*) Regional levels in 2001 were: West 2620 mg/kg, Ontario 2890 mg/kg, Quebec 2620 mg/kg, and Atlantic 760 mg/kg. In most cases, 2001 regional levels are above the level of 2400 mg/kg assumed by the health panel. Source: Environment Canada's *Sulphur in Liquid Fuels* report, 2001.

APPENDIX B: **Estimation of Canadian Refinery Costs**

Estimated costs at Canadian refineries to reduce sulphur in off-road diesel fuel can be developed in the same manner used by Environment Canada in its discussion document on reducing sulphur in on-road diesel fuel.³⁵

In 1997, as part of work undertaken by the Federal-Provincial Government Working Group to determine the appropriate level of sulphur in gasoline and diesel fuel, studies were carried out to estimate costs for one off-road and two on-road diesel fuel scenarios. Kilborn Inc., a consulting firm, carried out these cost analyses³⁶. Based on the results of those analyses for on-road and off-road diesel fuel scenarios and work done by the EPA, it is possible to extrapolate estimates for the 500 and 15 mg/kg requirement for off-road diesel.

The study undertaken by Kilborn 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 consulting firm received direct input on costs from 15 of Canada's refineries and modelled the capital and operating costs for the remainder. In both cases, the cost estimates were based on existing sulphur reduction technologies (i.e., pre 1995) 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.

Cost from Current Levels to 500 mg/kg

Estimated refinery costs for reducing sulphur in off-road diesel to an average of 400 mg/kg with a maximum of 500 mg/kg were developed by Kilborn. Nationally, these costs were, in 1995 dollars, \$433 million in capital cost and \$43 million per year in operating costs³⁷. These costs result in a unit cost of 1.4 cents per litre. However, the volume of regular-grade diesel fuel has decreased significantly since 1995. Currently, much of the off-road diesel pool is desulphurized, primarily because of limitations in the diesel distribution system. By dividing the current volume of regular diesel fuel (3.5 billion litres in 2001) by the 1995 volume (7.9 billion litres), a factor can be computed to adjust the 1995 cost estimates for off-road diesel fuel to reflect current volumes of off-road diesel fuel. The factor equals 0.44. Consequentially, the estimated costs become \$191 million in capital costs and \$19 million in operating costs. The unit cost is unchanged at 1.4 cents per litre. Converting to 2002 dollars (so to be able to compare with EPA costs)³⁸,

³⁵ Environment Canada, 2001. *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*. May 2001, Appendix B.

³⁶ Kilborn Inc., 1997. *Sulphur in gasoline and diesel study: the costs of reducing sulphur in Canadian gasoline and diesel*. March 1997, section 4.7.

³⁷ Range of uncertainty is $\pm 40\%$ for capital costs and $\pm 25\%$ for operating costs.

³⁸ Assuming 2% rate of annual growth over the period.

the cost estimates are \$220 million in capital costs and \$22 million per year in operating costs, with a unit cost of 1.6 cents per litre.

In Table 7.2-42 of the U.S. Regulatory Impact Statement, the average capital cost per refinery estimated as US\$10.7 million and the average operating cost per year per refinery as US\$3.3 million. Assuming that Canadian refinery average costs are the same as for U.S. refineries, the Canadian costs can be estimated. Multiplying the average refinery costs by the 15 refineries in Canada that make regular-grade diesel fuel and converting to Canadian dollars, the estimated capital cost in Canada is \$241 million and the operating cost is \$74 million. The U.S. unit cost is 1.0 Cdn cents per litre. These costs are for producing 500 mg/kg diesel fuel; they do not include the significant maintenance savings for the users of off-road diesel fuel predicted by the EPA. The EPA-based unit cost is based on a rate of return of 7%, while the Kilborn-based unit cost is based on a rate of return of 10%. Consequently, the two estimates of unit cost cannot be directly compared.

Costs from 500 to 15 mg/kg

The discussion paper on reducing sulphur in on-road diesel fuel estimated the costs of reducing sulphur from 500 mg/kg to 15 mg/kg (based on various extrapolations from Kilborn's estimates). These estimates, as reported in Appendix B of the on-road diesel discussion paper, were \$765-2300 million in capital costs and \$86-204 million per year in operating costs. These resulted in unit cost of 1.7-3.1 cents per litre.

Kilborn developed its estimated costs using the 1995 volume of on-road diesel fuel. Currently, much more diesel fuel is desulphurized than is required for just on-road use. This is primarily because of limitations in the diesel distribution system, which will continue to exist after on-road diesel is reduced to 15 mg/kg in 2006. By dividing the current volume of regular diesel fuel (3.5 billion litres in 2001) by the 1995 volume of on-road diesel fuel (16.9 billion litres), a factor can be computed to adjust the 1995 cost estimates for on-road diesel fuel to reflect current volumes of off-road diesel fuel. The factor equals 0.21.

Using the factor of 0.21, the estimate for reducing off-road diesel fuel from 500 to 15 mg/kg is \$160-483 million in capital costs and \$18-43 million per year in operating costs. These result in a unit cost of 1.7-3.1 cents per litre. EPA notes that there will likely be extensive use by refineries of newer desulphurization technology. EPA estimates that these technologies will reduce operating costs by 50%, resulting in a reduction of unit costs by about 25% (capital costs are not thought by the EPA to change much). Using these adjustments to reflect use of newer desulphurization technology, the estimated costs become \$160-483 million in capital costs and \$9-22 million per year in operating costs, resulting in a unit cost of 1.3-2.3 cents per litre. Converting to 2002 dollars, the estimated costs are \$184-555 million in capital costs and \$10-25 million per year in operating costs, resulting in a unit cost of 1.5-2.6 cents per litre.

In Table 7.2-44 of the U.S. Regulatory Impact Statement, the average capital cost per refinery for reducing sulphur in off-road diesel fuel from 500 to 15 mg/kg is US\$19.1 million and the average operating cost per year per refinery is US\$2.6 million. Assuming that Canadian refinery average costs are the same as for U.S. refineries, the Canadian costs can be estimated. Multiplying the average refinery costs by the 15 refineries in Canada that make regular-grade diesel and converting to Canadian dollars, the estimated capital cost in Canada is \$430 million and the estimated operating cost is \$58 million. The U.S. unit costs are 0.9 Cdn cents per litre. The EPA-based unit cost is based on a rate of return of 7%, while the Kilborn-based unit cost is based on a rate of 10%. Tax rates are also different. Consequently, the two estimates of unit cost cannot be directly compared.

The above analyses are summarized in the Table B below.

Table B: Cost Estimates for Reducing Sulphur in Off-road Diesel

	Capital Cost (\$ million)	Operating Cost (\$ million/year)	Avg. Unit Cost (cents per litre)
<i>Current to 500 mg/kg</i>			
BASED ON KILBORN			
Kilborn's off-road estimates (1995 \$)	433	43	1.4
Adjusted to 2001 volume	191	19	1.4
Converted to 2002 \$	220	22	1.6
BASED ON EPA REFINERY AVERAGE COSTS			
Canadianized U.S. estimate	241	74	1.0 (see note)
<i>500 to 15 mg/kg</i>			
BASED ON ON-ROAD APPENDIX B			
Kilborn's on-road estimates (1995 \$)	765-2300	86-204	1.7-3.1
Adjusted for off-road volumes	160-483	18-43	1.7-3.1
Adjusted for new technology (cf. EPA)	160-483	9-22	1.3-2.3
Converted to 2002 \$	184-555	10-25	1.5-2.6
BASED ON EPA REFINERY AVERAGE COSTS			
Canadianized U.S. estimate	430	58	0.9 (see note)
<i>SUMMARY: Total Sulphur Reduction (current to 15 mg/kg)</i>			
Extrapolated Canadian estimates	404-775	32-47	3.2-4.4
Canadianized U.S. estimate	671	132	1.9 (see note)

Note: The EPA-based unit cost is based on U.S. tax rates and a rate of return of 7%, while the Kilborn-based unit cost is based on Canadian tax rates and a rate of return of 10%. Consequently, the two estimates of unit cost cannot be directly compared.

In summary, the estimated Canadian refining costs for reducing sulphur in off-road (regular-grade) diesel fuel from current levels to 15 mg/kg are:

- between \$404 and 775 million in capital cost;
- between \$32 and 132 million per year in operating cost; and
- an average unit cost between 1.9 and 4.4 cents per litre.

APPENDIX C: **Possible Framework for a Canadian Regulation**

The regulations that would be developed under the two options discussed in section 6 would be very different depending on the option selected.

Option 1 – No Banking/Credit/Trading Program

Under this option, Canada would set a straightforward never-to-be-exceeded limit for sulphur in off-road diesel fuel of 500 mg/kg starting 2007, then 15 mg/kg starting 2010. Rail and marine diesel fuel would be subject to the 500 mg/kg limit but not to the 15 mg/kg limit.

This option could likely be achieved through an amendment of the existing federal *Sulphur in Diesel Fuel Regulations*.

Option 2 –Banking/Credit/Trading Program

Under this option, a new off-road diesel fuel regulation would have to be developed. (The structure of the existing *Sulphur in Diesel Fuels Regulations* could not be adapted to include the necessary provisions to address the many issues associated with a banking, credit and trading program.)

Under this option, Environment Canada envisions a regulation that would set the 500 mg/kg then 15 mg/kg limit in 2007 and 2010 respectively, but then provide regulatees the option of electing into a trading program during a transitional period. Regulatees opting into the trading program would be able to generate/trade and use sulphur credits during a transitional period. The regulation would have to define all the rules for the program, including trading restrictions and the tracking and reporting of trades.

Implementation of a trading program would result in multiple sulphur-differentiated grades of off-road (non-rail, non-marine) diesel fuel, requiring extensive administrative and tracking requirements to ensure that the appropriate fuel is used in engines and equipment during the transitional period. 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 multiple grades of off-road (non-rail, non-marine) diesel fuel would also require complex and administratively burdensome provisions to ensure enforceability of the regulation. These provisions would include marking, product transfer documentation and provisions to ensure segregation of the two grades. At refueling facilities, the sulphur-differentiated grade of diesel fuel would have to be identified. There would also likely be a provision to prohibit the dispensing of high-sulphur diesel into new equipment. Other provisions may also have to be included once more details of the regulation are developed.