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Domestic Emissions Trading

Experience with Mobile Source Emissions Trading and Its Potential Application to Greenhouse Gas Emissions by the Transportation Sector

Prepared for:
Sustainable Transportation Task Force

National Round Table
on the Environment
and the Economy

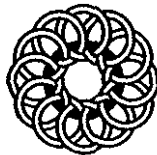


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Purpose

The purpose of this document is to provide the Sustainable Transportation Task Force of the National Round Table on the Environment and the Economy a first look at the issue of emissions trading for mobile sources.

Study Objectives

The objectives of the study are:

- To identify and summarize experience to date with transportation-related emissions trading initiatives;
- To compare transportation-related emissions trading with traditional regulatory approaches; and
- To outline options for a transportation-related greenhouse gas emissions trading program.¹

These objectives will be addressed in order in the next three sections.

¹ To date there have been no trading programs for greenhouse gas emissions, but some of the actions to create mobile source emission reduction credits probably reduced emissions of greenhouse gases as well.

Experience with Transportation-Related Emissions Trading Initiatives

Transportation-related emissions trading initiatives appear only to have been implemented in the United States to date. Three programs have been implemented:

- Averaging, banking and trading (ABT) provisions for heavy-duty engine emissions standards for nitrogen oxides (NO_x) and particulate matter (PM);
- Trading for the lead content of leaded gasoline; and
- Mobile source emission reduction credits (MERCs) for NO_x and volatile organic compounds (VOCs) for use by stationary sources in non-attainment areas.

The first two programs are national and apply respectively to engine manufacturers and fuel producers.

The last program involves credits created by vehicle owners and gasoline refiners and purchased by stationary sources in participating non-attainment areas.

Heavy-Duty Engine Emissions Standards

The Environmental Protection Agency (EPA) regulates emissions from heavy-duty and non-road engines. The regulations cover carbon monoxide (CO), hydrocarbons

(HC), non-methane hydrocarbons (NMHC), NO_x, PM and smoke, but the emissions regulated differ for different engines. Some standards must be met by every engine, while others must be met by engine categories as a group. The NO_x and PM standards allow the use of averaging, banking and trading (ABT) provisions.²

The regulations apply to manufacturers of spark ignition (Otto cycle) and compression ignition (diesel) engines for heavy-duty trucks and urban buses. The averaging, banking and trading (ABT) provisions are limited to NO_x and PM because the emissions standards for these pollutants have been tightened to the point where they are driving engine technology.³ The ABT provisions were introduced to facilitate compliance with the lower standards that came into effect for the 1990 model year.

Where ABT is allowed, the regulations specify both the standard and a maximum emission rate for the pollutant. Every engine must have an emission rate lower than the maximum rate for each ABT pollutant.⁴ The standards and maximum emission rates for the NO_x and PM for different types of engines are shown in Table 1.

2 More information on the ABT provisions is provided in Appendix A.

3 In other words, since all engines meet the standards for the other pollutants, these standards are not binding constraints. Thus, there would be no demand for such credits and the price would be zero. A trading program would serve no purpose.

4 Every engine must also have an emission rate below the standard for each of the other regulated pollutants for that engine.

Table 1 Standard and Maximum Emission Rates for Heavy-Duty Engines (rates are in grams per brakehorsepower-hour)								
Standard					Maximum			
	NOx	NOx + NMHC	PM Trucks	PM Urban Buses	NOx	NOx NMHC	PM Trucks	PM Urban Buses
1988 - 1989 ^a								
Diesel	10.7		0.6	0.6				
Otto	10.7							
1990 - 1992								
Diesel	6.0		0.6	0.6	10.7			
Otto	6.0				10.7			
1993								
Diesel	5.0		0.25	0.1	6.0		0.6	0.25
Otto	5.0				6.0			
1994 - 1995								
Diesel	5.0		0.1	0.07	6.0		0.6	0.25
Otto	5.0				6.0			
1996 - 1997								
Diesel	5.0		0.1	0.05 ^c	6.0		0.6	0.25
Otto	5.0				6.0			
1998 - 2003								
Diesel	4.0		0.1	0.05 ^c	5.0		0.6	0.25
Otto	4.0				5.0			
2004 -								
Diesel		2.4 ^b	0.1	0.05 ^c		4.5	0.6	0.25
Otto	4.0				5.0			

Notes: a) The ABT provisions did not come into effect until the 1990 model year.
b) The standard for 2004 and subsequent years is 2.4 g/bhp-hr for NOx+NMHC or 2.0 g/bhp-hr for NOx with a cap of 0.5 g/bhp-hr for NMHC
c) This is combined with a 0.07 g/bhp-hr in-use standard

Engines whose emissions are lower than the specified standard generate emission credits. Credits can be used to help engines in the same category whose emissions exceed the standard (but are below the maximum rate) achieve compliance with the standard. Averaging, banking and trading are possible uses of the credits.

- *Averaging:* Credits offset emissions for engines manufactured during the same year whose emissions are above the specified average to help the company achieve compliance during that year.
- *Banking:* Credits offset emissions for engines manufactured during a future year whose emissions are above the average specified to help the company achieve compliance during that year.

- **Trading:** Credits are sold to another company and are used to offset emissions for engines manufactured during the current or a future year whose emissions are above the average specified for the year the credits are used.

Credits can only be created and used within the same engine category. There are three categories of diesel truck and bus engines: light, medium and heavy-duty engines. Otto cycle engines is a separate category.

Credits previously had a life of three years, but beginning in 1998 they have an unlimited life. Previously banked or traded credits were discounted by 20%, but beginning in 1998 a differential discount is applied depending on the emission rate of the engines used to generate the credit.

At present, credits can only be traded among engine manufacturers. Beginning in 2004 it will also be possible to use the credits in other programs subject to meeting the conditions of the programs for which they are purchased. For example, if new urban buses for use in an ozone non-attainment area exceed the NOx standard, the regulatory authority might allow the NOx credits created to be used for compliance purposes by stationary sources.

Eleven manufacturers are covered by the program. Reports on ABT activity for on-highway diesel engines have been submitted on paper and are confidential. Data on use of the ABT provisions are expected to be made public late in 1998, but are currently not available. Program staff indicate that manufacturers have used averaging a little more than banking.⁵ Banking tends to be used just before standard changes. The first inter-company trade occurred in 1997 and involved a small quantity of PM credits.

Averaging, banking and trading provisions have also been adopted or proposed for emissions from several categories of non-road engines. Specifically:

- NOx emissions by diesel engines of more than 50 hp used in non-road equipment such as farm tractors, bulldozers, cranes and forklifts;⁶
- HC + NOx emissions by spark ignition outboard engines beginning with the 1998 model year and for personal watercraft engines beginning with the 1999 model year;
- NOx and PM emissions by locomotives, beginning in 2000;
- proposed revised HC + NOx standards for non-road spark ignition engines of less than 25 hp.

The extension of ABT provisions to other engine categories suggests satisfaction on the part of the EPA and engine manufacturers with such a trading program.

Trading for the Lead Content of Leaded Gasoline

Effective November 1982, the EPA introduced trading as part of its program for phasing out lead in gasoline.⁷ The program included all refiners and importers of leaded gasoline. Trading encouraged more efficient use of lead by taking advantage of the non-linear octane response to lead.⁸

Refiners and importers were allowed to sell lead credits so long as their individual quarterly average of actual lead used plus rights sold did not exceed the regulatory limit.⁹ The quarterly average of actual lead used by buyers could not exceed the mandated limit plus the quantity of rights purchased.

Lead credits could only be used during the quarter in which they were created. Trades were reported to the EPA at the end of each quarter. Trades were not subject to an approvals process, only a potential audit.

5 Averaging is more attractive because banked credits have been discounted by 20% while credits used for averaging are not discounted.

6 The EPA has proposed to replace the existing HC and NOx standards with a NMHC + NOx standard, to revise the PM standard and to allow ABT for both. The EPA is also in the process of finalizing rules to implement emissions standards for non-road diesel engines of less than 50 hp beginning in 1999. Current proposals for those rules include ABT provisions for NMHC + NOx and PM.

7 More information on the lead credit trading program is provided in Appendix B.

8 The initial few tenths of a gram of lead provide most of the desired octane boost. Reducing the lead content from prevailing levels did not cause a corresponding reduction in the octane rating. And adding the lead saved to gasoline with no lead provided most of the desired octane boost. Thus trading encouraged more efficient use of lead.

9 The lead content was limited to a maximum of 1.1 grams per gallon.

Faced with new evidence of health damage from lead the EPA realized that the natural reduction in lead use as leaded fuel vehicles retired would not address the problem quickly enough. In August 1984 the EPA set a maximum lead content for leaded gasoline of 0.5 grams per gallon effective July 1, 1985 and 0.1 grams per gallon after January 1, 1986.¹⁰

To facilitate the reduction from 1.1 grams per gallon at the beginning of 1985 to a 0.1 grams per gallon at the beginning of 1986, the EPA introduced banking into the trading system effective January 1, 1985. Refiners and importers were allowed to bank lead credits during calendar 1985 and to withdraw credits until the end of 1987. In other words, banking changed the credits from a three-month life to a maximum three-year life ending at the end of 1987.

The lead credit trading program saved refiners over \$200 million. The EPA originally estimated that approximately 9.1 billion grams of lead would be banked, and that banking alone would save refiners \$226 million. The actual amount of credits banked, 10 billion grams, was close to the initial estimate, resulting in a projected average savings of 2.5 cents per gram banked.

A large number of firms entered (and exited) the gasoline "refining" business over the five years of the trading program which probably contributed significantly to the cost savings.¹¹ The fact that so many firms entered the industry suggests that profits were relatively high. The added competition probably reduced producer profits and prices to gasoline consumers. The allocation rule, which did not restrict participation to refiners and importers operating at the time the program was introduced, made this possible.

The lead credit trading program allowed the government to reduce the maximum lead content of leaded gasoline much more quickly than under a program without trading where each refiner would need to have adequate time to adjust to the new standards. The lead credit trading program probably did not affect overall volume of lead use or the net environmental effects. The number of violations under the trading program was similar to the number under the previous regulatory phase down.

Mobile Source Emission Reduction Credits (MERCs) for Use by Stationary Sources

Under the Clean Air Act the EPA establishes maximum ambient concentrations of designated pollutants that may endanger public health or welfare. These concentrations are called National Ambient Air Quality Standards (NAAQS). The EPA has established NAAQS for six pollutants: particulate matter, sulfur oxides, carbon monoxide, lead, nitrogen oxides and ozone. Ozone is the pollutant with the largest number of non-attainment areas. Since ozone is formed by chemical reactions in the atmosphere, regulatory efforts focus on reducing emissions of the precursors — NOx and VOCs.

All areas of the country are designated as either attainment (where the NAAQS are met) or non-attainment (where NAAQS are exceeded) areas for each of the six pollutants. Ozone non-attainment areas are classified as marginal, moderate, serious, severe, or extreme.

Each state is required to develop and implement a State Implementation Plan (SIP) to achieve attainment in non-attainment areas and prevent deterioration in attainment areas. Plans must include some programs specified by the EPA, such as vehicle inspection and maintenance, and other programs, such as creation and use of mobile source credits, that are optional. State implementation plans, including the mandatory and optional programs, must be approved by the EPA.

Different regulations apply to major new (and expanding) sources whose emissions will exceed minimum threshold levels and to existing sources in attainment and non-attainment areas. These requirements and the emissions trading options available (in bold) are summarized in Table 2.

¹⁰ Note that the total quantity of lead was not constrained. The maximum lead content per gallon combined with declining sales of leaded gasoline due to the decreasing number of vehicles using leaded gasoline led to a reduction in lead emissions.

¹¹ A "refiner" was anyone who manufactured gasoline, thus someone who added ethanol to leaded gasoline was deemed to make an amount of leaded gasoline equal to the amount of ethanol added.

**Table 2
Goals and Requirements of New and Existing Source
Regulatory Programs in Attainment and Non-Attainment Areas**

	Attainment Area	Non-Attainment Area
Major new sources	<p>Goal: <i>Prevent significant deterioration (PSD)</i></p> <p>Best available control technology (BACT) Air quality analysis Cannot exceed PSD increments Netting allowed</p>	<p>Goal: <i>Cannot interfere with attainment efforts</i></p> <p>Lowest achievable emissions rate (LAER) Offsets mandatory State-wide compliance Netting allowed in some areas</p>
Existing sources	<p>Goal: <i>Maintain air quality standards</i></p> <p>Maintain level of pollution control</p>	<p>Goal: <i>Attain air quality standards</i></p> <p>Reasonably available control technology (RACT) for large sources Offsets allowed in some areas Reductions from existing sources</p>

Offsets are required in non-attainment areas for major new sources as part of the New Source Review (NSR) process. These sources must implement lowest achievable emissions rate (LAER) technology. Any remaining emission increases must be offset by purchasing from existing sources emission reduction credits (ERCs) at least equal to the expected increase.¹²

Large existing sources in non-attainment areas are often required to install reasonably available control technology (RACT) to help reduce overall emissions. In some areas sources are allowed to meet RACT requirements by purchasing ERCs or through other forms of trading.

An ERC is any emission reduction by an existing source in a non-attainment area that meets the criteria established by the EPA. An emission reduction must be "real," "surplus," "quantifiable," "enforceable" and "permanent" before it can be certified by the relevant regulatory authority as an ERC. These criteria are intended to ensure that the emission reduction is a permanent reduction from the emissions that would otherwise be allowed to offset the permanent increase in emissions from the new or expanding source. Creation of ERCs is voluntary.

The need to demonstrate permanence has meant that most ERCs have been created through shutdowns, installation of pollution control equipment, or process changes, including fuel switches. The difficulty of scheduling permanent emission reduction actions to match emission increases by new or expanding sources has led many non-attainment areas to allow banking. Banking allows emissions reductions to be created and stored for later use.

Netting allows an expanding firm to balance expected emission increases with emission decreases at the same facility to keep the net increase below the minimum threshold level at which the New Source Review requirements are triggered. Netting enables the expansion to qualify for a quicker and simpler review process than the NSR and to avoid the offset requirement associated with the NSR. A state may choose not to allow netting in non-attainment areas.

Economic growth is constrained in non-attainment areas unless a sufficient supply of ERCs is available. Offsets are mandatory in a non-attainment area for new (and expanding) sources with planned emissions beyond the minimum threshold. These sources cannot locate (expand) in the area unless they are able to purchase sufficient ERCs from existing sources. Mobile source

¹² Offset rules require a major new source to purchase more ERCs than their planned increase in emissions (i.e. the "offset ratio" of ERCs to planned emissions is greater than 1:1). The EPA specifies minimum offset ratios depending on the degree of non-attainment.

emission reduction credits (MERCs) can be used instead of ERCs to meet offset requirements and so facilitate economic growth in non-attainment areas.

The EPA has allowed mobile source emission reductions to be a source of tradable credits since 1986, but states have only recently begun to incorporate mobile sources into their offset and banking programs.¹³ The delay is due to the focus on stationary source emissions to achieve NAAQS attainment prior to the 1990 Clean Air Act amendments and the lack of EPA guidance on quantifying mobile source emission reductions and translating those reductions into mobile source emission reduction credits until 1993.

The EPA's *Interim Guidance on the Generation of Mobile Source Emission Reduction Credits* specifies that:

- MERCs must first and foremost be (1) quantifiable; (2) enforceable at the state and federal levels; (3) surplus, i.e., reductions that are above and beyond those required by state and federal regulations; and (4) permanent within the timeframe specified by the MERC program.
- MERCs can be used to: (1) satisfy emission reduction requirements beyond the Reasonably Available Control Technology (RACT) requirements; (2) meet RACT requirements; (3) mitigate temporary increases in emissions or temporary non-compliance with regulations; and (4) meet New Source Review (NSR) offset requirements for new and expanding sources in ozone non-attainment areas.
- MERCs can NOT be used to satisfy the requirements of Best Available Control Technology (BACT)¹⁴, Lowest Achievable Emissions Rate (LAER), New Source Performance Standards (NSPS)¹⁵, Federal Inspection and Maintenance (I/M)¹⁶ programs, or Employer Trip Reduction (ETR)¹⁷ programs.

¹³ More information on the mobile source emission reduction credit trading programs is provided in Appendix C and in Goldschein.

¹⁴ New and expanding sources with planned emissions beyond the minimum threshold level in attainment areas must install BACT.

¹⁵ New Source Performance Standards are technology-based national emissions standards that apply to new and expanding facilities, in specific industries, located in non-attainment areas.

¹⁶ Serious ozone non-attainment areas are required to develop and implement enhanced motor vehicle inspection and maintenance programs.

¹⁷ Severe ozone non-attainment areas were required to develop and implement employer trip reduction programs. These programs are no longer mandatory, but they are still used in some non-attainment areas.

¹⁸ Several jurisdictions have implemented programs to scrap vehicles, lawn mowers and outboard motors funded by industry, government, or special levies on vehicles. The objective of these programs is to reduce overall emissions rather than to create credits that can be used by other sources.

- Due to the short-term nature of some mobile source emission reductions, MERCs generally have a limited life. As a result when MERCs are used for offsets, the new or expanding source must obtain other ERCs or MERCs before the MERCs expire.

MERCs can be generated by a variety of actions that include: (1) instituting vehicle scrappage initiatives; (2) reducing the Reid Vapour Pressure of gasoline below mandated levels; (3) adding cleaner-burning vehicles to existing fleets; (4) replacing existing fleet vehicles with cleaner-burning vehicles; (5) conducting annual inspection and maintenance programs where not already required; and (6) implementing trip reduction measures.

The experience with mobile source emission reduction credit programs is summarized in Table 3. Three districts in California and 12 states have adopted rules that permit MERC creation. The number of jurisdictions that allow MERC creation and use has increased slowly since the EPA guidance documents were released in 1993. Progress is slow because it can take several years to develop a rule and get the associated regulations adopted.

The main purpose of most of the programs is to provide additional sources of credits for use by stationary sources to meet NSR offset and RACT requirements. MERCs can also be used by stationary sources for netting, bubbles, BACT requirements (under some conditions), and penalties for non-compliance in various jurisdictions.

Actual experience with MERC creation is limited to two California districts and three states. Where MERCs have been created they typically represent a tiny fraction (<1%) of the ERCs created by stationary sources over the same period. Although the EPA guidance allows a variety of options for generating MERCs, virtually all of the credits actually created have come from scrapping high-emitting vehicles and selling reformulated gasoline.¹⁸

These are also the most common options in pilot programs.

The relatively limited creation of MERCs in jurisdictions where they are allowed is probably due to difficulties in quantification and the need to get approval for new quantification protocols. As a result of experience gained since the early 1980s, there are many accepted methods for quantifying stationary source emission reductions. Increasing experience with mobile source emission reductions should make the approvals process more routine and may reduce the quantification difficulties.

The relatively limited use of MERCs in jurisdictions where they are allowed is partly due to the poor match between the needs of the buyer and the characteristics of the credits. To meet NSR offset requirements a new or expanding source needs credits with an indefinite life. MERCs typically have a life of three years, which means the firm needs to replace the MERCs every three years over the life of its facility. A single purchase of stationary source ERCs with an indefinite life is simpler. On the other hand, non-compliance penalties typically involve a one time offset, but use of MERCs is typically restricted to a maximum of one-third of the total reduction during any one year.

Table 3 Summary of Mobile Source Emission Reduction Credit Creation Program Experience					
State/District	MERC Rule Adopted	MERCs Created	Main Actions to Create MERCs	Stationary Uses of MERCs	Mobile Uses of MERCs
Mobile Source Credit Creation Programs					
California SMAQMD	May 1997 1992	NO YES	Scrappage, clean fuel buses	NSR offsets, RACT NSR offsets	Depends on District Being developed
San Diego SCAQMD	Nov. 1994 1993-1996	Proposed YES	Replace marine engine Scrappage	NSR offsets NSR offsets, RACT	Ridesharing
Colorado	Oct. 1996	NO		NSR offsets, RACT, BACT ¹	
Connecticut	mid 1995	Proposed	Reformulated gasoline	NSR offsets, RACT, penalties	Offset casino patron emissions
Delaware	Oct 1997	NO		NSR offsets, RACT	
Louisiana	Aug. 1994	NO		NSR offsets, netting	
Maine	June 1998	NO		NSR offsets	
Massachusetts	Jan. 1994	YES	Reformulated gasoline	NSR offsets, RACT, netting ¹	
Michigan	March 1996	YES	Reformulated gasoline	NSR offsets, RACT, netting, BACT ¹	
New Hampshire	Jan. 1997	Proposed	Gasoline additive	NSR offsets, RACT, bubbles	
New Jersey	Aug. 1996	YES	Reformulated gasoline	NSR offsets, RACT	
New York	Oct. 1994	Proposed	Clean fuel taxis	NSR offsets, netting	
Oklahoma	1993	NO		Temporary offsets	
Texas	March 1993	NO		NSR offsets	
Note: 1. Allowed under some conditions					

Although, reducing overall emissions is not one of the purposes of MERCs, they probably yield an environmental benefit. Calculation of the emission reductions tends to be conservative, the number of credits is often discounted for uncertainty, several jurisdictions retire 10% of the credits to create an environmental benefit, some credits are not used before the end of their limited life, and MERC creation actions typically create credits for multiple pollutants and the credits for some of the pollutants may not be used.

Summary

The American emissions trading programs involving mobile sources differ in terms of their objectives, participants, emissions, and geographic scope.

- The heavy-duty engine program is intended to help engine manufacturers develop and adopt technologies to reduce NO_x and PM emissions. The program involves 11 manufacturers and is national in scope.
- The lead in gasoline program was designed to facilitate rapid reduction of the lead content of leaded gasoline. The program was national in scope and involved 300 to 900 refiners and importers over a five-year period.
- The mobile source emission reduction credit (MERC) program is designed to help accommodate economic growth in ozone non-attainment areas. MERCs can be used by stationary sources to comply with regulations to offset some of their emissions. Only a few MERC credits have been created to date.

In general, emissions trading programs are intended to reduce the cost of meeting environmental goals. By reducing the cost, they may make more aggressive environmental goals feasible; lower NO_x and PM emissions or faster reduction of lead content, for example. Beyond that, any environmental benefits of a trading program are largely incidental; retiring 10% of MERC credits or expiry of some MERC credits before they are used, for example.

Credit creation and use is simpler in the heavy-duty engine and lead programs than in the MERC program. Credits are created in the engine and lead programs by having lower emissions or lead content than specified by the standard. Credits are used by firms in the same industry, often the firm that creates them, to offset emissions or lead content above the specified standard. In the MERC program a variety of different credit creation actions are possible by various groups. Procedures for calculating the reductions are still being developed. Credits are used by stationary sources to meet regulatory obligations to offset emissions. The lifetimes of the credits do not match the lifetimes of the offset obligations very well.

While it is risky to generalize from such very different programs, an emissions trading program should have a clear objective and be designed for the context in which it will operate. A good match between credit creation and use, in terms of the entities and the credit creation and need lifetimes, facilitates trading activity. Although none of programs involved the use of a cap on total emissions and government-issued allowances, such designs probably could be used for some mobile source emissions.

Comparison of Emissions Trading with Regulatory Approaches

Emissions trading will be compared with selected regulatory approaches as a means of reducing greenhouse gas emissions from the transportation sector. Emissions can be reduced by:

- Changing the characteristics of vehicles produced by manufacturers;
- Changing the characteristics of fuels sold;
- Changing the characteristics of vehicles purchased;
- Changing the composition of the active vehicle stock;
- Changing the performance of the vehicle stock; and
- Changing the use of vehicles.

Each of these approaches will be discussed in turn.

Changing the Characteristics of Vehicles Produced by Manufacturers

The two most common regulatory approaches used to require manufacturers to reduce emissions from the vehicles they produce are emissions standards and corporate average fuel efficiency (CAFE) standards. These approaches are compared with a tradable emissions standard, similar to the ABT provisions for heavy-duty truck engine emissions.

Emissions Standards

Emissions standards establish maximum allowable emissions of specified pollutants for each vehicle. The maximum emissions are generally established on a per

kilometre basis using specified test procedures. Actual emissions may differ dramatically from the test levels due to poor maintenance, driving patterns and other factors. But reducing the maximum allowable emissions per kilometre under the test procedure tends to reduce actual emissions.

Manufacturers have no incentive to reduce emissions below the maximum level allowed unless this allows other attractive features to be added to the vehicle. Manufacturers may need to develop better technology to be able to offer air conditioning, larger engines, faster acceleration, etc. If total emissions are to be reduced while the vehicle fleet grows, the regulators must continually reduce the maximum emissions standards. Dates at which the standards become effective must allow manufacturers sufficient time to change the designs and manufacturing processes for all of their models. This means the standards have to be specified for a considerable time (say five to 10 years) into the future or relatively long lags in achievement of the emissions reductions have to be accepted.

CAFE Standards

CAFE standards establish an average fuel efficiency for all vehicles to which the standard applies sold by each manufacturer. A similar regulation could be used for average emissions for all vehicles sold by each manufacturer. The fuel efficiency standard is established on a per kilometre basis using specified test procedures. Actual emissions may differ dramatically from the test levels due to poor maintenance, driving patterns and other factors.

CAFE standards were established in the U.S. by the Energy Policy and Conservation Act of 1975. The standard for automobiles increased from 18.0 miles per gallon for the 1978 model year to 27.5 miles per gallon for the 1990 and subsequent model years. The standard for light-duty trucks is 20.7 miles per gallon. Under the Corporate Average Fuel Consumption program Canadian automobile manufacturers have, since 1980, voluntarily agreed to achieve the CAFE standards for vehicles sold in Canada.¹⁹

There is considerable debate in the literature concerning the cost-effectiveness of past and proposed CAFE standards. The demand for gasoline in a given year depends on the price of gasoline as well as the fuel efficiency of the total vehicle fleet. The fuel efficiency of the vehicle fleet in turn depends on past CAFE standards and the effect of past gasoline prices on the mix of new vehicles purchased. Because of the complexity of the relationships, disentangling the effects of gasoline prices and CAFE standards is difficult.²⁰

As long as the average constrains manufacturers in terms of the mix of vehicles (higher-profit less-efficient vehicles) or mix of features (larger engines, air conditioning, etc.) they wish to sell, they have an incentive to develop and sell more fuel-efficient vehicles. Manufacturers have considerable flexibility in developing strategies to meet the average. They can improve the fuel efficiency of a given model by improving engine performance, reducing vehicle weight or incorporating other features to improve fuel efficiency. They can also implement strategies to increase sales of more efficient models.

The average can generally be reduced more quickly than a maximum emissions standard because it is not necessary to redesign every model. Allowing banking would tend to enable even quicker reductions in the average.²¹ If total emissions are to be reduced while the vehicle fleet grows, the regulators must continually reduce the maximum emissions standards.

19 Due to the higher fuel prices and lower disposable incomes in Canada, the light-duty vehicles purchased in Canada are more fuel-efficient than those purchased in the U.S. Thus achieving the standard has been easier in Canada than in the U.S.

20 See, for example, Sykuta, and Nivola and Crandall.

21 The U.S. CAFE standard allows banking and borrowing over limited time periods.

22 Kling compares California's standards for sales of low, ultra low and zero emission vehicles with a tradable emissions standard to achieve the same result and finds cost savings of 1% to 18%.

23 Conceptually it is possible to use a tax approach as well. A tax could be imposed on the ingredient whose use is to be reduced. The tax would discourage use of the ingredient. No instance of a tax having been used for this purpose has been found in the literature.

Tradable Emissions Standards

A tradable emissions standard, such as the ABT provisions for heavy-duty truck engine emissions, is very similar to a CAFE standard for emissions. Maximum emission levels are established that each engine or vehicle must meet. An average emission standard is established that each manufacturer must meet. Engines or vehicles whose emissions are below the standard create credits that can be used to offset the emissions from engines or vehicles whose emissions are above the standard. The credits can be banked for future compliance or can be traded to other manufacturers.

The main difference between such a trading program and the CAFE standard for emissions is that the CAFE standard cannot be banked or traded among manufacturers.²² But in the heavy-duty engine program there has only been one trade between manufacturers. Thus the difference may be small in practice.

In general, CAFE standards and tradable emissions standards are superior to maximum emissions standards for individual vehicles in terms of cost-effectiveness because of the additional flexibility they provide. They also provide better incentives to develop and introduce new vehicle and emission control technologies. Finally, they allow a regulator to reduce emissions more quickly by giving manufacturers more flexibility to meet a declining corporate average.

Changing the Characteristics of Fuels Sold

The most common regulatory approach used to change the characteristics of fuels sold is to establish fuel specifications. This approach is compared with a tradable fuel ingredient program, similar to the lead in gasoline program, and mobile source emission reduction credits from gasoline.²³

Fuel Specifications

A regulator can establish maximum (or minimum) levels of ingredients for fuels, which can change over time. The allowable levels for each ingredient must not cause engine damage nor significantly compromise performance of the engine or the emissions control equipment.

Manufacturers and importers are required to meet the fuel specifications for the fuel they sell subject to penalties for non-compliance. This approach was used to phase out lead in gasoline in Canada.

Trading Program for Fuel Ingredients

A trading program for fuel ingredients, such as the lead in gasoline program, establishes an average level of the ingredient for all fuel sold. This may be accompanied by maximum (and/or minimum) levels of the ingredient that all fuel sold must meet to prevent damage to the engine or the emissions control equipment. The average content of the ingredient may change over time.

Manufacturers or importers whose fuels contain less than the allowable average of the ingredient can sell the difference to manufacturers or importers whose fuels contain more than the allowable average. The principal advantage of the trading program is that it should allow the average emissions to be reduced more quickly since it is not necessary to give every manufacturer and importer enough time to meet the new specification.

If the final specification allows only a narrow range for the content of the ingredient, a trading program is no longer advantageous after this specification comes into effect. As in the case of the American lead program, the trading program could be terminated after the transition phase.

It must be possible to reduce the content of the ingredient in the fuel, otherwise the trading program simply leads to price increases to consumers and higher profits for producers and importers. To reduce greenhouse gas emissions, the carbon content of the fuel must be reduced. This can be done to a limited extent by mixing biomass ethanol with the fuel to obtain blends that can be used in most vehicles.

Mobile Source Emission Reduction Credits from Gasoline

In some cases it may be possible to change the characteristics of the fuels sold by allowing credits to be

created by the different formulation. Biomass ethanol could be blended with vehicle fuels to reduce CO₂ emissions. Unlike the two approaches discussed above, this approach does not reduce total emissions of the ingredient. The lower CO₂ emissions from fuels are approximately offset by increased CO₂ emissions by the buyers of the credits.

This approach requires a buyer for the credits created. Buyers may not exist for the ingredient regulators wish to reduce, the geographic scope of the market may differ from the region where the fuel is distributed, and the demand may be lower than the desired reduction in the use of the ingredient. These are not serious problems for a greenhouse gas trading program. There are many sources, and hence potential buyers, and the credits can be traded over a very wide geographic area without creating environmental problems.

Either fuel specifications or a trading program for fuel ingredients provides an incentive to produce reformulated fuels. A trading approach may allow the ingredient to be reduced more quickly and at lower cost. Both approaches are superior to the use of mobile source emission reduction credits as a means of changing the characteristics of fuels sold.

Changing the Characteristics of Vehicles Purchased

Changing the characteristics of vehicles purchased (as distinct from vehicles manufactured) is possible through imposition of differential taxes on new vehicles, regulations on the mix of new vehicles sold, clean-fuel vehicle requirements for fleet owners, or mobile source emission reduction credits for low emission vehicles.

Ontario imposes a Tax for Fuel Conservation on new vehicles. California is implementing regulations for minimum percentages of low, ultra low, and zero emissions vehicles over the next decade. Fleet owners with more than 10 vehicles in some ozone non-attainment areas will face requirements to purchase clean-fuel vehicles beginning with the 1999 model year. Georgia and Texas are implementing trading programs for those clean-fuel fleet vehicle requirements. Creation of mobile source emission reduction credits through purchase of clean-fuel or low emission vehicles is allowed in some jurisdictions. These approaches are discussed in turn.

Differential Taxes on New Vehicles

Various jurisdictions impose taxes on new vehicles based on the vehicle's price, weight, or fuel efficiency. Vehicle price and weight tend to be inversely related to fuel efficiency. Higher tax rates on more expensive, heavier or less fuel-efficient vehicles induce people to purchase more fuel-efficient (and lower emitting) vehicles. When such a tax is complemented by rebates for more fuel-efficient vehicles, the policy is called a feebate. Ontario's Tax for Fuel Conservation is a feebate.

The available evidence suggests that such taxes and feebates exert only a marginal impact on the mix of new vehicles purchased.²⁴ This is probably because the taxes or rebates tend to apply uniformly to all but a modest fraction (up to about 15%) of the vehicles purchased and to represent only a small fraction (less than 5%) of the purchase price of the vehicle.²⁵ A tax or feebate on new vehicles high enough to have a significant impact on the mix of vehicles sold would probably be very difficult to implement politically.

Regulations on the Mix of New Vehicles Sold

The California Air Resources Board has passed regulations that require manufacturers to ensure that minimum percentages of light-duty vehicles sold in the state are low, ultra low, and zero emission vehicles. California has the worst air quality in the U.S. and needs to reduce vehicle emissions substantially to meet the NAAQS for ozone. Despite the need for lower emissions and the size of the California market, manufacturers have resisted these requirements.

The requirements for sales of zero emission vehicles (ZEV) have recently been amended to provide manufacturers with more flexibility to achieve compliance. The original requirement was that ZEV sales represent at least 2% of total sales for the 1998, 1999 and

2000 model years, 5% of total sales for the 2001 and 2002 model years, and 10% of total sales for the 2003 and subsequent model years. The amended regulation eliminates the requirements for the years prior to 2003 and replaces them with agreements with each of the vehicle manufacturers. Under the agreements the manufacturers will adopt the California low emission vehicle (LEV) standard nationally beginning in 2001 and accelerate commercialization of advanced batteries and zero emission vehicle technology.²⁶

Using regulations of this type to drive technology beyond what is easily provided is very difficult even for a large market such as California. This approach would be difficult for a much smaller jurisdiction to implement.

Clean-Fuel Vehicle Requirements for Fleet Owners

Under the 1990 Clean Air Act amendments, vehicle fleets in some ozone non-attainment areas are required to purchase specified percentages of "clean fueled" vehicles.²⁷ The program starts in 1998 with 1999-model-year purchases. For participating light-duty vehicle fleets, 30% of 1999-model-year purchases must be EPA-certified as "clean fueled." This rises to 50% for the 2000 model year and 70% beginning in 2001. For heavy-duty vehicle fleets, the requirement is 50% for every model year starting with 1999.

Affected fleets include local government fleets with more than 15 vehicles (excluding law enforcement and emergency vehicles), private fleets with more than 25 vehicles (excluding emergency vehicles), and certain mass transit fleets operating primarily in ozone non-attainment areas.

In anticipation of the clean-fuel fleet requirements that come into effect with the 1999 model year, Georgia and Texas have adopted programs that allow credits to be

24 The Gas Guzzler tax in the United States applies only to a small percentage of the new vehicles sold and so has only a very small impact on the fleet composition.

25 The history of the Ontario tax is illustrative. A tax ranging from \$600 to \$3,500 was imposed on fuel-inefficient vehicles beginning in 1989. Less than 3% of the vehicles sold in Ontario were subject to the tax. In 1992 the tax was changed to \$75 per vehicle on 90% of the cars purchased in Ontario with rebates of \$100 for fuel-efficient vehicles. The taxes on sport utility vehicles are equal to or less than those for passenger cars of comparable fuel efficiency. Light trucks and vans are exempt from the tax. The Fair Tax Commission recommended in 1992 that the tax be extended to light trucks and vans, and that the rate be increased to provide a stronger incentive to purchase fuel-efficient vehicles. That recommendation was not implemented.

26 National adoption of the California standard helps reduce emissions in California as well because a substantial percentage of the vehicles registered in California are originally purchased in other states.

27 Clean fueled vehicles are those that meet or exceed the Federal low emission vehicle (LEV) standards.

created through early overcompliance. The credits can be sold to other fleet owners who may wish to buy fewer clean fueled vehicles than mandated. In the Texas program these credits can also be converted to MERCs for use by stationary sources.

Mobile Source Emission Reduction Credits for Low Emission Vehicles

In some cases it may be possible to change the characteristics of the vehicles purchased by allowing credits to be created for purchasing more low emission vehicles or vehicles with lower than mandated emissions. Unlike differential taxes, regulations on the mix of vehicles sold, or clean-fuel fleet requirements, creating MERCs does not reduce total emissions because the reduced emissions from cleaner vehicles are approximately offset by increased emissions by the buyers of the credits.

Given the relatively small reductions available from an individual vehicle and the time and expense involved in securing regulatory approval for MERCs, creators and sellers of MERCs are likely to be fleet operators rather than individual vehicle owners. MERCs are most likely to be purchased by sources with a regulatory requirement to reduce or offset emissions. These are likely to be relatively large fixed sources rather than individual vehicle owners.

In summary, differential taxes or feebates, and requirements on fleet owners to purchase clean-fuel vehicles, can be implemented for almost any jurisdiction, although it may be possible to avoid the requirements.²⁸ Clean-fuel vehicle requirements for fleet owners can be tradable, although there is no actual experience with these programs yet. Regulations on the mix of new vehicles sold may be feasible only for jurisdictions that represent very large markets for new vehicles. All of these

approaches are environmentally superior to the use of mobile source emission reduction credits as a means of changing the characteristics of vehicles purchased.

Changing the Composition of the Active Vehicle Stock

The composition of the active vehicle stock can be changed by retiring high-emitting vehicles. Accelerated scrappage programs have been implemented in some jurisdictions. MERCs have also been created through accelerated scrappage of high-emitting vehicles.²⁹

An accelerated scrappage program requires a means to identify high-emitting vehicles. This is generally done in conjunction with voluntary or mandatory inspection and maintenance programs. It can also be done using remote sensing to identify high-emitting vehicles or by advertising for volunteers.³⁰

Vehicle scrappage programs funded from general revenue or from a special vehicle registration levy have been implemented in Chicago, Phoenix, San Diego, and San Joaquin.³¹ The vehicle owners have to be paid, typically \$400 to \$800, for their vehicle. Similar programs for lawn mowers have been implemented in Maricopa County, Arizona, Baltimore, Maryland and Portland, Oregon and for outboard motors in Milwaukee, Wisconsin.

MERCs have also been created through accelerated scrappage of high-emitting vehicles. Unlike a scrappage program, creating MERCs does not reduce total emissions because the reduced emissions from scrapped vehicles are approximately offset by increased emissions by the buyers of the credits.

²⁸ For example, it may be possible to change from fleet ownership to independent owner-operators or to change the jurisdiction where the vehicles are registered to avoid the requirements.

²⁹ Conceptually it is possible to design a program that provides a tax signal to retire older, high-emitting vehicles. The annual registration fee could vary with vehicle model and age based on average emission rates or on actual emission rates for the individual vehicle if it is tested. No programs of this type were found.

³⁰ It might also be possible to identify candidate vehicles through a safety inspection program, but the vehicles would still need to be tested to determine their potential to reduce emissions substantially.

³¹ U.S. Generating Company implemented a pilot program in 1992 to retire 125 vehicles to Delaware to offset increased emissions from tugboats supplying coal to a new generating station in New Jersey. Since the scrappage program simply offset the tugboat emissions, there was no net reduction in emissions.

Changing the Performance of the Vehicle Stock

The performance of the active vehicle stock can be changed by requiring vehicles to be tested and maintained. Inspection and maintenance programs are a component of the attainment strategy for many ozone non-attainment areas in the U.S. MERCs have been created through inspection and maintenance programs where they are not mandatory and through early maintenance of vehicles where inspection and maintenance are mandatory.³²

Inspection and maintenance programs typically require vehicles to undergo an emissions test every year or every two years as a condition of registration renewal. If the vehicle does not meet the emission levels specified for that model and year, appropriate repairs are identified. The vehicle owner is given a few weeks to have the repairs made and to have the vehicle re-tested. Most programs set an upper limit, such as \$200, on the cost of the repairs the owner is required to make.

Where inspection and maintenance are not mandatory, MERCs can be created by testing high-emitting vehicles, repairing them, and re-testing them to document the reduction achieved. Unless the vehicles are repeatedly re-tested, the life of the emission reduction is generally assumed to be quite short (a year or less). Where inspection and maintenance is mandatory, high-emitting vehicles can be identified by remote sensing. If repairs to reduce emissions are implemented early, MERCs can be created for the reduced emissions over the period from the time they are implemented until the date of the mandatory inspection.

An inspection and maintenance program reduces total emissions by requiring vehicle owners to maintain and repair their vehicles to reduce emissions. MERC programs

also reduce emissions from high-emitting vehicles, but allow the credits to be sold to stationary sources. Thus, the reduced emissions from better maintained vehicles are approximately offset by increased emissions by the buyers of the credits.

Changing the Use of Vehicles

Numerous programs are possible to reduce the use of vehicles and so reduce emissions. These include: car/vanpooling, high-occupancy vehicle lanes, subsidies for public transit, public transit lanes, restrictions on parking, and gasoline taxes. These and other programs are designed to reduce the number of vehicle trips, to shift trips to modes with lower emissions per passenger kilometre and, in the long run, to encourage the purchase of lower emitting vehicles.³³

It is not possible within the scope of this report to discuss experience with the wide range of possible programs to reduce vehicle use. It is sufficient to note that most of the programs have only a marginal impact on vehicle use. People value the comfort and convenience of personal automobile travel very highly. Actions that raise the relative "cost" of automobile use through slower travel times, decreased convenience or higher cost of parking, or reduced cost or increased speed of public transit have only a marginal impact on automobile travel. The effectiveness of such actions is reduced by policies, such as municipal plans, that stimulate increased vehicle traffic.

The economics literature on the impact of gasoline taxes confirms this result. Economists estimate the price elasticity of demand — the percentage reduction in gasoline consumption due to a 1% increase in the price of gasoline.³⁴ Estimates in the literature suggest a short-run (one year) price elasticity of -0.1 to -0.3.³⁵ The long-run elasticity is somewhat higher because people have more

32 Conceptually it is possible to design a program that provides a tax signal to maintain older, high-emitting vehicles. The annual registration fee could be based on the vehicle's actual emissions. Rather than being faced with mandatory repairs, owners would have a financial incentive to maintain or repair the vehicle to reduce its emissions. No programs of this type were found.

33 It is also possible to envisage vehicle registration fees based on actual distance travelled during the previous year or, in the future, road pricing for a significant share of all automobile travel. Registration fees based on distance are essentially the same as gasoline taxes. Making the payment an annual payment may make it more visible, but the payment becomes a fixed cost after the fact and so may have less impact on behaviour. Making costs that are currently fixed, such as insurance, variable with distance travelled may increase the incentive to reduce vehicle use.

34 If the reduction in demand is small (<1%) the price elasticity is less than 1 and demand is said to be inelastic. If the reduction in demand is greater than 1%, demand is said to be elastic.

35 Berkowitz, Gallini, Miller and Wolfe estimate the fuel price elasticity in Canada at -0.24. Laferrière presents a direct price elasticity for auto travel of -0.40 and a price elasticity of total demand of -0.23 for autos. IBI Group suggests a range of -0.1 to -0.3.

opportunity to adjust the vehicle stock.³⁶ The inelastic demand for gasoline reflects the high “value” of the comfort and convenience of private automobile travel.

Employers and other destinations can be required to implement trip reduction initiatives. Employer trip reduction programs are used in some ozone non-attainment areas to help achieve attainment. MERCs can be created through early or overcompliance with trip reduction requirements and can be used to help meet such obligations.

The evidence clearly indicates that it is difficult to induce large shifts in vehicle use. Gasoline taxes provide the most comprehensive incentive to change vehicle use.³⁷ They focus the incentive on the vehicle user. Many other programs, including employer or destination trip reduction programs, put the responsibility or incentive elsewhere.

Summary

Mobile source emissions can be reduced by:

- Changing the characteristics of vehicles produced by manufacturers;
- Changing the characteristics of fuels sold;
- Changing the characteristics of vehicles purchased;
- Changing the composition of the active vehicle stock;
- Changing the performance of the vehicle stock; and
- Changing the use of vehicles.

These strategies can be implemented using regulations, emissions trading, or taxes, although some policy instruments appear to be better suited than others to a particular emissions reduction strategy.

The heavy-duty engine emissions ABT program can be used as a model for changing the characteristics of vehicles produced by manufacturers. The lead in gasoline program can be used as a model for changing the characteristics of fuels sold. All of the other strategies have been, or could be, used to create mobile source emission reduction credits. But under the MERC program the credits are used to offset emissions by stationary sources, so there is no net reduction in emissions.

To use emissions trading to reduce mobile source emissions by changing the composition, performance and operation of the vehicle fleet, responsibility for reducing emissions from such sources would need to be assigned to appropriate entities, such as large airlines, railways, trucking companies and fleet owners. Requiring individual vehicle owners to participate in an emissions trading program is probably impractical for administrative and enforcement reasons.

³⁶ See Dahl and Goodwin for surveys of price elasticity estimates. IBI Group suggests a range of -0.35 to -0.6 for the long-run price elasticity.

³⁷ The Bureau of Transportation and Communications Economics working paper on emissions trading concludes by asking whether a carbon tax might not be preferable for the transportation sector.

Options for a Greenhouse Gas Emissions Trading Program

The transportation sector is a significant and growing contributor to Canada's greenhouse gas emissions. The federal and provincial governments have agreed that all sources will be expected to bear a fair share of the burden of meeting Canada's commitments under the Kyoto Protocol. Thus, options for limiting greenhouse gas emissions by the transportation sector need to be explored.

This section considers emissions trading as an option for limiting greenhouse gas emissions by the transportation sector in Canada. Emissions trading for greenhouse gas emissions by the transportation sector could be implemented in any of the following ways:

- Corporate average greenhouse gas emission standards for vehicles sold in Canada, with the ability to create credits that can be banked or traded among vehicle manufacturers and importers through overcompliance with the standard.
- A cap on the carbon content of fossil fuels produced in, and imported into, Canada with trading by producers, importers and exporters.
- A cap on greenhouse gas emissions by fossil fuel users and municipalities, with large airlines and railways participating directly and municipalities responsible for the emissions from urban transportation.

Each of these options is outlined briefly below.

Corporate Average Greenhouse Gas Emission Standards for Vehicle Manufacturers and Importers

This option is similar to the CAFE standard for fuel efficiency and the averaging, banking and trading (ABT) provisions for heavy-duty engine emissions. Vehicle manufacturers and importers would be responsible for the estimated lifetime greenhouse gas emissions of the vehicles they sold in Canada.

Lifetime greenhouse gas emissions would be estimated using tests for vehicle fuel efficiency. Vehicle fuel efficiency would be converted to estimated lifetime fuel consumption, which in turn would be used to calculate the greenhouse gas emissions associated with the fuel consumption.³⁸ The corporate average emissions would be calculated from the estimated lifetime emissions for the vehicles sold in Canada by each vehicle manufacturer and importer.³⁹ This is similar to the approach used for the ABT provisions for heavy-duty engine emissions.⁴⁰

Each vehicle manufacturer and importer would need to meet the specified corporate average for each (calendar or

38 Since other sources of greenhouse gas emissions would probably also be managed in some way, the calculation would probably be based on the direct emissions due to the fuel consumption rather than the life cycle emissions associated with the fuel used.

39 Vehicles manufactured in Canada and exported would not be included in the calculation.

40 The emission rates are multiplied by the estimated average lifetime distance traveled so that the credits can be measured in terms of CO₂ equivalent tonnes. This facilitates trade with credits and allowances from other domestic and international trading programs for greenhouse gases.

model) year.⁴¹ Failure to meet the corporate average would lead to imposition of large penalties. Credits could be created through overcompliance. The credits could be banked for future compliance or be sold to other manufacturers or importers.

This approach focuses on changing the vehicle stock. Because vehicles have an average lifetime of 10 to 20 years, the greenhouse gas emissions from the vehicle fleet only change slowly. This approach also does not provide an incentive to change fuels in ways that reduce greenhouse gas emissions or to change vehicle use.

The approach described above reflects the ABT provisions of the heavy-duty engine emissions program. No limit is imposed on total emissions; rather, total emissions depend on the standard and the number of engines (vehicles) sold. More precise control on total emissions may be preferred to ensure that Canada will meet its commitment under the Kyoto Protocol.

A trading program for engine (vehicle) manufacturers with a cap on total emissions is also possible. Allowances equal to the cap could be issued to engine (vehicle) manufacturers based on a specified formula, for example the emissions standard multiplied by production during the current, or a recent, year. Manufacturers would need to remit allowances equal to the actual emissions of the engines (vehicles) they sold in Canada. They could trade allowances to achieve compliance.

Regardless of the design, inter-company trading might be limited due to the small number of firms in the industry. Companies with surplus credits or allowances might prefer to keep them rather than sell them to a competitor. The potential for such strategic behaviour is diminished if the trading program for engine (vehicle) manufacturers is linked to greenhouse gas emissions trading programs for other sources.

A Cap on the Carbon Content of Fossil Fuels Produced and Imported

Fossil fuel producers, importers and exporters are included in a carbon content trading program. Each producer and importer must hold allowances equal to the carbon content of the crude oil, natural gas, coal, and imported petroleum products sold. Exporters receive allowances equal to the carbon content of the crude oil, natural gas, coal and petroleum products exported.⁴²

Participants in the trading program are companies that produce, import or export oil, natural gas, coal, or petroleum products. A cap is imposed on the CO₂ equivalent emissions by these firms from the carbon content of the fuels they sell in Canada.⁴³ This option is assumed to be implemented cooperatively by the federal and provincial governments since the former has jurisdiction over foreign trade while the provinces have jurisdiction over production of fossil fuels.

Downstream of the trading program the effect is the same as a tax. For each barrel of crude oil sold in Canada a producer or importer needs allowances equal to the carbon content of the oil. The market value of those allowances will be reflected in the price of the barrel of crude oil. When a refinery buys the crude oil to make gasoline, the market value of the allowances reflected in the price of the crude oil is passed on in the price of the gasoline. And when an importer brings gasoline into the country, it will need to hold allowances equal to the carbon content of the gasoline. So the price of the imported gasoline will also reflect the market value of the allowances.

Refiners and importers have an incentive to reduce the greenhouse gas emissions associated with the use of their product and so to reduce its price. They could do this, for example, by blending gasoline with ethanol from biomass.

41 The ABT program has both a standard and a maximum emission rate. A maximum rate is not essential. Trading focuses on achieving the standards, as an average for all vehicles sold. If some vehicles have very high emissions, those excess emissions must be offset by sales of low emission vehicles.

42 Sources of other greenhouse gas emissions amenable to allowance trading also participate in the program. Participants may purchase credits from other specified sources, such as landfills and sequestration to augment the cap. Increasing the emissions allowed in Canada through one or more of the international cooperative implementation mechanisms can also raise the cap.

43 The greenhouse gas emissions may need to be determined through monitoring of methanol and CO₂ emissions from oil and gas wells and coal mines, together with periodic testing of the carbon content of crude oil, natural gas and coal produced. Alternatively, they could be calculated from the carbon content of the different products produced.

While the ethanol contains carbon, producing it from biomass means that the carbon was first removed from the atmosphere. At present only a limited range of ethanol blends can be used in the vehicle fleet, so the scope for reducing the price is limited.

Vehicle operators will pay higher prices for the fuels they purchase, so the response should be similar to that for a gasoline tax. The tax will reflect the carbon content of the fuel purchased and hence may differ across fuels if some are blended using ethanol from biomass. In that case vehicle operators have an incentive to choose the lower emitting fuel. Vehicle operators also have financial incentives to reduce vehicle use, to switch to alternative modes, and to purchase more energy-efficient vehicles.

The approach described above reflects the lead in gasoline program. No limit is imposed on total carbon content; rather, total emissions depend on the carbon content standard and the quantities of each of the fuels sold. More precise control on total emissions may be preferred to ensure that Canada will meet its commitment under the Kyoto Protocol.

A trading program for fossil fuel producers, importers, and exporters with a cap on the total carbon content of the fuels used in Canada is also possible. Allowances equal to the cap could be issued to fossil fuel producers and importers based on a specified formula, for example the carbon content standard multiplied by production during the current, or a recent, year. Exporters would receive allowances equal to the carbon content of the fuels exported. Producers and importers would need to remit allowances equal to the actual carbon content of the fuels sold. They could trade allowances to achieve compliance.

The number of fossil fuel producers, importers and exporters is larger than the number of engine or vehicle manufacturers, so strategic behaviour should be less of a concern in this case.

A Cap on Greenhouse Gas Emissions by Fossil Fuel Users and Municipalities

This option establishes a cap on CO₂ emissions by fossil fuel users such as electric utilities, large industrial sources, large airlines and railways, federal and provincial governments as managers of government buildings, and municipalities. Municipalities would have caps covering the emissions from residential and commercial buildings and urban transportation.⁴⁴ Participants would need to hold allowances equal to their actual emissions and could trade surplus allowances.⁴⁵

Under this option municipalities would have an incentive to implement measures to reduce vehicle emissions. Possible measures might include zoning regulations designed to minimize vehicle use, restrictions on parking, promotion of public transit, public transit and high-occupancy vehicle lanes. Employers and destinations might be required to implement trip reduction programs and developers might be required to purchase offsets for the traffic emissions generated by their projects. Municipalities may also be able to implement road pricing systems. As a result, vehicle users would face a variety of mostly non-financial incentives to reduce vehicle use.

This approach to greenhouse gas emissions trading is more likely to be based on an emissions cap with allowances allocated to each participant using a specified formula. Each source would be required to monitor (or calculate) its actual emissions using specified procedures. And each source would need to remit allowances equal to its actual emissions to the regulatory authority. Sources could trade allowances to achieve compliance.

44 The IBI Group estimates that the top 25 census metropolitan areas in Canada account for 63% of the automobile and light truck passenger kilometres and 100% of the surface bus, rapid transit and passenger rail passenger kilometres. Urban areas also account for an estimated 11% of truck freight tonne-kilometres.

45 As with the other options in this section, sources of other greenhouse gas emissions amenable to allowance trading would also participate in the trading program and the cap established for participants could be augmented through international trade or purchases of credits from specified domestic sources.

Combinations of Emissions Trading Programs to Reduce Greenhouse Gas Emissions by the Transportation Sector

It is possible, perhaps even desirable, to implement combinations of these greenhouse gas emissions trading programs. A trading program for corporate average vehicle emission standards could complement either of the other options. A corporate vehicle emission standard is designed to ensure that manufacturers produce lower emitting vehicles. And the trading program provides them with more flexibility in complying with the standard. A program targeted at vehicle manufacturers and importers has little impact on vehicle use.⁴⁶

Both of the other design options seek to influence vehicle use. A trading program for the carbon content of fossil fuels does so through gasoline price increases. A trading program involving municipalities does so primarily through travel demand management to affect vehicle use. Implementing a trading program both for the carbon content of fossil fuels and for greenhouse gas emissions by fossil fuel users could lead to double counting. The program for the carbon content of fossil fuels already covers all of the emissions associated with the fuels consumed by fossil fuel users. If the user implements actions to reduce emissions, this automatically lowers the carbon allowances need by the fuel producer as well. Giving the fuel user a credit for such a reduction could count the emission reduction twice.

However, a trading program for fossil fuel users including municipalities as the “manager” of vehicle emissions could be complemented by a carbon tax. The tax would complement the measures implemented by municipalities to reduce vehicle use by making them financially more attractive. Alternatively, a trading system for the carbon content of fossil fuels could be complemented by initiatives designed to reduce vehicle use implemented by municipalities, but not for greenhouse gas credits.

In short, transportation sector emissions could be managed through a trading program for the carbon content of fossil fuels complemented by measures designed to reduce vehicle use or a trading program for fossil fuel users with municipalities responsible for vehicle transportation complemented by a carbon tax on fossil fuels. A corporate average emissions standard for vehicle manufacturers and importers with trading could complement either of those options.⁴⁷

46 Appendix B in Hinchey, Fisher and Graham compares the effects of trading programs targeted at vehicle manufacturers and at fuel suppliers.

47 No analyses of these (or other) emissions trading options for the transportation sector have yet been identified.

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Appendix A

**Heavy-Duty Vehicle
Engine Emissions**

Heavy-Duty Vehicle Engine Emissions

The Environmental Protection Agency regulates emissions from heavy-duty and non-road engines. The regulations cover different emissions for different engines. Some standards must be met by every engine, others must be met by engine categories as a group and allow the use of averaging, banking and trading (ABT) provisions.

This description focuses on the use of ABT provisions to meet emissions standards for heavy-duty truck and bus engines. The regulated emissions by type of engine and whether the standard can be met through the use of averaging, banking and trading (ABT) provisions are shown in Table A-1.

The regulations apply to new motor manufacturers. The averaging, banking and trading (ABT) provisions were introduced to facilitate compliance with the lower standards that came into effect for the 1990 model year. The ABT provisions are limited to NO_x and PM because the emissions standards for these pollutants have been tightened to the point where they are driving engine

technology. Thus the need for flexibility in achieving compliance is greatest for these pollutants.⁴⁸

Where ABT is allowed, the regulations specify both the standard and a maximum emission rate for the pollutant. Every engine must have an emission rate lower than the maximum rate for each ABT pollutant and below the standard for each of the other regulated pollutants. The standards and maximum emission rates for the pollutants for which ABT is allowed are shown in Table A-2.

California has its own emissions standards for heavy-duty engines which are more stringent than the federal standards shown in Table A-2. But beginning in 2004, the federal and California standards will be the same.

Engines whose emissions are lower than the specified standard generate emission credits. Credits can be used for averaging, banking or trading to help engines in the same category whose emissions exceed the standard (but are below the maximum rate) achieve compliance with the standard.

	CO	NMHC	HC	NO _x	PM	Smoke
Diesel trucks	X		X	ABT	ABT	X
Diesel urban buses	X		X	ABT	ABT	X
Otto cycle trucks	X	X	X	ABT		

⁴⁸ All engines are able to meet the standards for the other pollutants. Hence those standards are not binding constraints. There would be no demand for credits for those pollutants. The prices for such credits would be zero. So a trading program would serve no purpose.

Table A-2 Standard and Maximum Emission Rates for Heavy-Duty Engines (rates are in grams per brakehorsepower-hour)								
	Standard				Maximum			
	NOx	NOx + NMHC	PM Trucks	PM Urban Buses	NOx	NOx + NMHC	PM Trucks	PM Urban Buses
1985 - 1987 ^a								
Diesel	10.7							
Otto	10.7							
1988 - 1989 ^a								
Diesel	10.7		0.6	0.6				
Otto	10.7							
1990 - 1992								
Diesel	6.0		0.6	0.6	10.7			
Otto	6.0				10.7			
1993								
Diesel	5.0		0.25	0.1	6.0		0.6	0.25
Otto	5.0				6.0			
1994 - 1995								
Diesel	5.0		0.1	0.07	6.0		0.6	0.25
Otto	5.0				6.0			
1996 - 1997								
Diesel	5.0		0.1	0.05 ^c	6.0		0.6	0.25
Otto	5.0				6.0			
1998 - 2003								
Diesel	4.0		0.1	0.05 ^c	5.0		0.6	0.25
Otto	4.0				5.0			
2004 -								
Diesel		2.4 ^b	0.1	0.05 ^c		4.5	0.6	0.25
Otto	4.0				5.0			

Notes: a) The ABT provisions did not come into effect until the 1990 model year.
b) The standard for 2004 and subsequent years is 2.4 g/bhp-hr for NOx+NMHC or 2.0 g/bhp-hr for NOx with a cap of 0.5 g/bhp-hr for NMHC
c) This is combined with a 0.07 g/bhp-hr in-use standard

Averaging: Credits offset emissions for engines manufactured during the same year whose emissions are above the specified average to help the company achieve compliance during that year.

Banking: Credits offset emissions for engines manufactured during a future year whose emissions are

above the average specified to help the company achieve compliance during that year.

Trading: Credits are sold to another company and are used to offset emissions for engines manufactured during the current or a future year whose emissions are above the average specified for the year the credits are used.

Credits can only be created and used within the same engine category. There are three categories of diesel truck and bus engines: light, medium and heavy-duty engines. Otto cycle engines is a separate category.

Credits previously had a life of three years, but beginning in 1998 they have an unlimited life. Previously banked or traded credits were discounted by 20%, but beginning in 1998 a differential discount is applied depending on the emission rate of the engines used to generate the credit. Specifically, no discount is applied to credits generated from engines with NOx emissions of less than 3.5 g/bhp-hr and a 10% discount is applied to engines with higher emissions. This provision is intended to provide an additional incentive to develop low emissions engines.

Currently calculation of the credits created by low emission engines uses the lowest horsepower configuration while credit use is based on the highest horsepower configuration. Beginning in 2004, credit creation and use will be calculated using the production-weighted average value.

At present, credits can only be traded among engine manufacturers. Beginning in 2004 it will also be possible to use the credits in other programs subject to meeting the conditions of the programs for which they are purchased.

Eleven manufacturers are covered by the program for heavy-duty truck and bus engines. Reports on ABT activity for on-highway diesel engines have been submitted on paper and are confidential. Data on use of the ABT provisions is expected to be made public late in 1998, but is currently not available. Program staff indicate that manufacturers have used averaging a little more than banking, probably because banked credits have been discounted by 20% while credits used for averaging are not discounted. Banking tends to be used just before standard changes. The first inter-company trade occurred in 1997 and involved a small quantity of PM credits.

Non-Road Engines

Averaging, banking and trading provisions have also been adopted or proposed for emissions from several categories of non-road engines.

Non-Road Diesel Engines

This category includes diesel engines used in non-road equipment such as farm tractors, bulldozers, cranes and

forklifts. At present a NOx standard that applies to engines of 50 to 750 hp. can be met through the use of averaging, banking and trading provisions. These engines must also meet non-tradable standards for CO, HC, PM and smoke. All of the standards will apply to engines larger than 750 hp beginning with the 2000 model year.

The EPA has proposed to replace the HC and NOx standards with a NMHC + NOx standard, to revise the PM standard and to allow ABT for both.

The EPA is also in the process of finalizing rules to implement emissions standards for non-road diesel engines of less than 50 hp. The standards would be phased in beginning in 1999. Current proposals for those rules include ABT provisions for NMHC + NOx and PM.

Locomotives

The EPA recently finalized rules governing emissions by locomotives that will come into effect in 2000. Standards have been adopted for CO, HC, NOx, PM and smoke emissions for line haul and switching locomotive engines of different vintages. ABT provisions have been included for the NOx and PM standards. The EPA did not judge the CO, HC and smoke standards to be sufficiently stringent to justify their inclusion in the ABT program.

Non-Road Spark Ignition Engines less than 25 hp

Regulations governing emissions from non-road spark ignition engines came into effect with the 1997 model year. The regulations define five size categories.

Depending upon the category, engines must meet CO, HC and NOx or CO and HC+NOx standards. The EPA has proposed revised HC + NOx standards for which ABT would be allowed beginning in 2001.

Spark Ignition Outboard, Personal Watercraft and Jet Boat Engines

Standards for HC+NOx emissions by spark ignition outboard engines went into effect with the 1998 model year and go into effect for personal watercraft engines beginning with the 1999 model year. The standard declines by 75% over the period to the 2006 model year. Averaging, banking and trading provisions are included to facilitate compliance with the rapidly declining standard.

Appendix B

Lead Credit Trading

Lead Credit Trading

Lead credit trading was instituted from November 1982 through December 1987 to enable refiners and importers to reduce the lead content of leaded gasoline quickly at lower cost.

Lead Phase Down Program

Due to concerns over adverse health effects resulting from exposure to airborne lead, the U.S. Environmental Protection Agency (EPA) implemented the Lead Phase Down Program to significantly reduce the use of lead in gasoline. The program took effect in the late 1970s and initially set increasingly stringent limits on the lead content of all gasolines. Lead credit trading, and subsequently banking, were allowed from late 1982 through 1987. Banking and trading were discontinued after 1987 when all leaded gasoline was required to meet the final concentration limit. The program expired on January 1, 1996 when the Clean Air Act ban on leaded gasoline for highway use took effect.

The EPA required that unleaded gasoline be made available to consumers by July 1974. The maximum allowable average lead content of leaded and unleaded gasolines sold by large refiners declined from 0.8 grams-per-gallon after Oct. 1, 1979 to 0.5 grams-per-gallon after Oct. 1, 1980. These limits applied separately to each refiner during each calendar quarter.

Small refiners (generally with capacity of less than 50,000 barrels per day) were not subject to the regulations until January 1, 1980. Small refiners were subject to a sliding scale for maximum average lead content ranging up to 2.65 grams per gallon of leaded and unleaded gasoline sold. Importers were not subject to the lead content limits.

During this period, the demand for leaded gasoline decreased because new vehicles required unleaded gasoline. The rising demand for unleaded gasoline and declining demand for leaded gasoline helped refiners meet the limits.

While trading was not explicitly part of the regulation, some "trading" was possible. A refiner could vary the mix of leaded and unleaded gasoline and the mix of octane levels to meet the cap. A refiner could control the production schedule for different types of gasoline to meet the quarterly limits. And companies with several refineries could allocate production to among the plants to meet the lead content caps.

Lead Credit Trading

Effective November 1982, the EPA regulated the lead content of leaded gasoline to a maximum of 1.1 grams-per-gallon for large refiners and importers. Small refineries were required to meet the standard of 1.1 grams-per-gallon of leaded gasoline on July 1, 1983.⁴⁹

49 From November 1, 1982 until July 1, 1983 small refiners were limited to the sliding scale of up to 2.65 grams per gallon of gasoline for their previous production volumes. Any additional production during that period had to meet the 1.1 grams per gallon standard for leaded gasoline.

A trading program was introduced to take advantage of the non-linear octane response to lead. Reducing lead content does not cause a corresponding reduction in the octane rating. When the lead saved is added to gasoline with no lead, the initial few tenths of a gram provide most of the desired octane boost. Thus trading encouraged more efficient use of lead in gasoline.

Refiners and importers were allowed to sell lead credits so long as their individual quarterly average of actual lead used plus rights sold did not exceed the regulatory limit. The quarterly average of actual lead used by buyers could not exceed the mandated limit plus the quantity of rights purchased.

Banking was not allowed initially. Lead credits could only be used during the quarter in which they were created. Trades were reported to the EPA at the end of each quarter. Trades were not subject to an approvals process, only a potential audit.

Faced with new evidence of health damage from lead the EPA realized that the natural reduction in lead use as leaded fuel vehicles retired would not address the problem quickly enough. In August 1984 the EPA set a maximum lead content for leaded gasoline of 0.5 grams-per-gallon effective July 1, 1985 and 0.1 grams per gallon after January 1, 1986.

To facilitate the reduction from 1.1 grams-per-gallon at the beginning of 1985 to a 0.1 grams-per-gallon at the beginning of 1986, the EPA introduced banking into the trading system effective January 1, 1985. Refiners and importers were allowed to bank lead credits during calendar 1985 and to withdraw credits until the end of 1987 (withdrawals could begin during the second quarter of 1985). In other words, banking changed the credits from a three-month life to a maximum three-year life ending at the end of 1987.

The EPA determined that a minimum amount of lead was needed to avoid wear to engine valve seats in the old engines using leaded gasoline. Continuing a trading program would likely lead to production of some leaded gasolines with insufficient lead content. Thus trading was discontinued after 1987 and all refiners and importers had to meet a standard of a maximum of 0.1 grams of lead per gallon for the leaded gasoline they sold.

Note that there is no overall cap on lead used in gasoline. Total lead use is limited by the quantity of unleaded gasoline produced and imported multiplied by the maximum lead content. Trading shifted lead use forward in time and may have produced geographical shifts in use patterns, but did not affect overall volume of lead use or net environmental effects.⁵⁰

Allocation

“The program is notable for its lack of discrimination among different sources, such as new and old sources. It is also notable for its rules regarding the creation of credits. Lead credits are created on the basis of existing standards. A firm does not gain any extra credits for being a large producer of leaded gasoline in the past. Nor is it penalized for being a small producer. The creation of lead credits is based solely on current production levels and average lead content. For example if the standard were 1.1 grams per gallon, and a firm produces 100 gallons of gasoline, it would receive rights entitling it to produce or sell up to 110 (100 * 1.1) grams of lead. To the extent that current production levels are correlated with past production levels, the system acknowledges the existing distribution of property rights. However, this linkage is less explicit than those made in other trading programs.”⁵¹

50 Robert C. Anderson, Lisa A. Hofmann and Michael Rusin, *The Use of Economic Incentive Mechanisms in Environmental Management*, Research Paper 051, American Petroleum Institute, Washington, D.C., June 1990, p. 31.

51 Robert W. Hahn, “Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor’s Orders,” *Journal of Economic Perspectives*, vol. 3, no. 2, Spring 1989, p. 102.

Hahn notes that one of the reasons EPA set up the allocation this way was to transfer some of the economic rents from producers to consumers.⁵² Anderson *et al.* believe the program was effective in this regard. "There is clear evidence that the program provided a gain in efficiency, although the precise amount of gain is difficult to estimate with available data. ... There is also good reason to believe that prices to gasoline consumers were lowered by the trading program... and that under plausible assumptions, the price decrease exceeded efficiency gains, lowering overall gasoline producer profits."⁵³

Trading Activity

The number of "refiners" reporting grew from 265 in 1983(3) to 849 in 1985(3) and then fell to 547 in 1987(4).⁵⁴ Only a fraction of this total were actual refiners.⁵⁵ A "refiner" was anyone who manufactured gasoline, thus someone who added ten percent ethanol to leaded gasoline was deemed to make an amount of leaded gasoline equal to the amount of ethanol added. If the leaded gasoline was already at the maximum concentration, adding the ethanol would reduce the concentration to 90% of the allowed level and so generate credits equal to the volume of ethanol times the maximum concentration. The number of importers was more stable, rising from 48 to 80 and then falling to 60.

The fraction of refiners that traded during a quarter varied between 50% and 70% between 1983(3) and 1985(4). During 1986 and 1987 the fraction of refiners that engaged in trading varied between 15% and 25%. The fraction of importers that engaged in trading was less than 25% every quarter between 1983(3) and 1987(4).

⁵² Hahn, *op cit.*, footnote 4.

⁵³ Anderson, *et al.*, p.31. A key assumption in their analysis is that the demand for leaded gasoline is close to, but not completely, inelastic — the quantity demanded is almost fixed. When lead credits are traded, the marginal costs decrease for the purchaser (its marginal cost is lower than if it reduced lead content in its own operations) more than they increase for the seller (the seller's cost of reducing lead content is less than the price paid by the buyer for the credit) so the total and (marginal) cost decline (if the total cost did not fall, the trade would not have been made— there is gain from trade). If the marginal costs of the buyer are lowered more than the marginal cost of the sellers are raised, and the demand for leaded gasoline remains unchanged, industry profits fall. The incidence depends on whether the overall industry marginal cost curve rotates as a result of trading. It is likely that the industry marginal cost curve rotates for gasoline refiners leading to lower industry profits.

⁵⁴ See Anderson, *et al.*, *op cit.*, Table 111.3, p. 30 for quarterly data on number of refiners and importers reporting, trading and banking and on the quantities traded, banked and withdrawn from the bank.

⁵⁵ Suzi Kerr and David Marc, "Efficient Regulation through Tradeable Permit Markets: The United States Lead Phasedown," Working Paper, Department of Agricultural and Resource Economics, University of Maryland at College Park, 1997. Table 3 reports the total number of refineries for 1983-84 as 191. Thus most of the 265 "refineries" reporting in 1983(3) were actual refineries, but less than 25% of the 849 "refineries" reporting in 1985(3) were actual refineries.

The quantity of lead traded as a fraction of total lead used ranged between 10% and 14% from 1983(3) through 1984(4). During 1985 it ranged from 4.5% to 6.5% and during 1986 and 1987 it varied between 1% and 4%.

Roughly half of the refineries engaged in banking during 1985, mostly depositing credits for future use. During 1986 and 1987 about 25% of the refineries withdrew banked credits. During 1986 and 1987, the withdrawals represented from 50% to 75% of total lead use.

Prices

Price information was not collected. Because participants were not required to report prices to the EPA and involvement by intermediaries was limited, little data exist as to the actual transaction prices of lead credits. "Anecdotal evidence indicates, however, that lead rights traded in the range of 0.75 to 4.0 cents per gram."⁵⁶ Analysis of the banking program suggests an average saving of 2.5 cents per gram of lead banked.⁵⁷

Administration and Enforcement

EPA required refiners and importers to report the quantities of trades and of banking deposits, withdrawals and balances, along with gasoline volumes, each quarter. The forms consisted of one page of summary information accompanied by two lists: (1) a list of the names of the individual entities with whom the refiner or importer traded and the quantities traded, and (2) a list of any physical transfers of lead additives to or from anyone other than lead additive manufacturers. The

second list contained not only physical transfers of lead additives, but also any sales of gasoline components or unfinished gasolines to which lead had been added.

The forms provided enough information to determine whether each refiner or importer was in compliance. The information from buyers and sellers could also be matched to see if the quantities of credits and lead additives reported agreed. Any discrepancies in totals could trigger further investigation and enforcement action. Physical testing of batches of gasoline is relatively simple, but not a feasible means of auditing compliance. Thus, enforcement was confined largely to analysis of reported data.

EPA undertook approximately 56 audits between 1986 and 1988, reviewing records back to 1983. "EPA discovered numerous violations in the generation of false lead credits, and penalties were high."⁵⁸ During 1983 and 1984 the number of violations was similar to the number under the previous regulatory phase down. The number of violations doubled during 1895 and then fell sharply during 1986 and 1987.⁵⁹

Conclusions

The lead credit trading program did not affect overall volume of lead use or net environmental effects. The number of violations under the trading program was similar to the number under the previous regulatory phase down.

The lead credit trading program saved refiners over \$200 million. The EPA originally estimated that approximately 9.1 billion grams of lead would be banked, and that banking alone would save refiners \$226 million. The actual amount of credits banked, 10 billion grams, was close to the initial estimate, resulting in a projected average savings of 2.5 cents per gram banked.

⁵⁶ Anderson, *et al.*, *op cit.*, p. 29.

⁵⁷ Anderson, *et al.*, *op cit.*, p. 29.

⁵⁸ Alan P. Loeb, "Three Misconceptions about Emission Trading," Air and Waste Management Association, 83rd Annual Meeting, Pittsburgh, June 1990, p.8.

⁵⁹ Loeb, *op cit.*, p. 14.

The large number of firms that entered (and exited) the gasoline "refining" business over the five years of the trading program probably contributed significantly to the cost savings. The allocation rule, which did not restrict participation to refiners and importers operating at the time the program was introduced, made this possible.

There is good reason to believe that prices to gasoline consumers were lowered by the trading program. It is possible that the price decrease exceeded efficiency gains, thus lowering overall gasoline producer profits.

Appendix C

**Mobile Source Emission
Reduction Credits**

Mobile Source Emission Reduction Credits

Clean Air Act National Ambient Air Quality Standards

Under the Clean Air Act the U.S. Environmental Protection Agency (EPA) establishes maximum ambient concentrations of designated pollutants that may endanger public health or welfare. These concentrations are called National Ambient Air Quality Standards (NAAQS). The EPA has established NAAQS for six pollutants: particulate matter, sulfur oxides, carbon monoxide, lead, nitrogen oxides and ozone.

All areas of the country are designated as either attainment (where the NAAQS are met) or non-attainment (where NAAQS are exceeded) areas for each of the six pollutants. The Clean Air Act also mandates the EPA to develop regulations to bring non-attainment areas into compliance and to ensure that attainment areas remain in compliance.

Non-attainment areas for some pollutants are classified by degree of non-attainment. Ozone non-attainment areas, for example, are classified as marginal, moderate, serious, severe, or extreme. The classification affects the range and stringency of the measures that must be implemented, and the time allowed, to attain the NAAQS. Some attainment areas are classified as maintenance areas (former non-attainment areas) or as Class I areas (areas requiring special protection) and are subject to additional protective requirements.

Each state is required to develop and implement a State Implementation Plan (SIP) to achieve attainment in non-attainment areas and prevent deterioration in attainment areas. The SIP must be consistent with EPA minimum requirements for the various categories of non-attainment and attainment areas in the state.

Different minimum requirements apply to major new sources and to existing sources in attainment and non-attainment areas. Major new sources are new or expanding sources whose emissions will exceed a minimum threshold level. The minimum threshold differs by pollutant and the degree of non-attainment and can be as low as zero, meaning the provisions apply to all new and expanding sources.

The requirements that apply to major new and existing sources in attainment and non-attainment areas are summarized in Table C-1. The emissions trading options available to these sources — offsets and netting — are shown in bold in Table C-1.

Offsets are required in non-attainment areas for major new sources as part of the New Source Review (NSR) process. These sources must implement lowest achievable emissions rate (LAER) technology. Any remaining emission increases must be offset by purchasing from existing sources emission reduction credits (ERCs) at least equal to the expected increase.⁶⁰

⁶⁰ Offset rules require a major new source to purchase more ERCs than their planned increase in emissions (i.e. "offset ratio" of ERCs to planned emissions is greater than 1:1). The EPA specifies minimum offset ratios depending on the degree of non-attainment.

**Table C-1
Goals and Requirements of New and Existing Source
Regulatory Programs in Attainment and Non-Attainment Areas**

	Attainment Area	Non-Attainment Area
Major new sources	<p>Goal: <i>Prevent significant deterioration (PSD)</i></p> <p>Best available control technology (BACT) Air quality analysis Cannot exceed PSD increments Netting allowed</p>	<p>Goal: <i>Cannot interfere with attainment efforts</i></p> <p>Lowest achievable emissions emissions rate (LAER) Offsets State-wide compliance Netting allowed in some areas</p>
Existing sources	<p>Goal: <i>Maintain air quality standards</i></p> <p>Maintain level of pollution control</p>	<p>Goal: <i>Attain air quality standards</i></p> <p>Reasonably available control technology (RACT) for large sources Offsets allowed in some areas Reduction from existing sources</p>

Offsets are mandatory in non-attainment areas for major new sources. These sources cannot locate in a non-attainment area unless they are able to purchase sufficient emission reduction credits (ERCs) from existing sources in the area. Thus, economic growth is constrained in non-attainment areas unless there is a sufficient supply of ERCs.

Large existing sources in non-attainment areas are often required to install reasonably available control technology (RACT) to help reduce overall emissions. In some areas, sources are allowed to meet RACT requirements by purchasing ERCs or through other forms of trading.

An ERC is any emission reduction by an existing source in a non-attainment area that meets the criteria established by the EPA. An emission reduction must be “real,” “surplus,” “quantifiable,” “enforceable,” and “permanent” before it can be certified by the relevant regulatory authority as an ERC. These criteria are intended to ensure that the emission reduction is a permanent reduction from the emissions that would otherwise be allowed to offset the permanent increase in emissions from the new or expanding source. Creation of ERCs is voluntary.

The need to demonstrate permanence has meant that most ERCs have been created through shutdowns, installation of pollution control equipment, or process changes, including fuel switches. The difficulty of scheduling permanent emission reduction actions to match emission increases by new or expanding sources has led many non-attainment

areas to allow banking. Banking allows emissions reductions to be created and stored for later use.

Netting allows an expanding firm to balance expected emission increases with emission decreases at the same facility to keep the net increase below the minimum threshold level at which the New Source Review (NSR) requirements are triggered. Netting enables the expansion to qualify for a quicker and simpler review process than the NSR and to avoid the offset requirement associated with the NSR. A state may choose not to allow netting in non-attainment areas.

Ozone is the pollutant with the largest number of non-attainment areas. Since ozone is formed by chemical reactions in the atmosphere, regulatory efforts focus on reducing emissions of the precursors — NOx and VOCs. Mobile sources typically account for a significant share of total NOx and VOC emissions in an ozone non-attainment area. They are therefore subject to various regulatory requirements, such as vehicle inspection and maintenance, trip reduction programs, and requirements for clean fuel vehicles, depending upon the non-attainment classification.

Where allowed, emission reductions beyond those requirements can create mobile source emission reduction credits (MERCs) that can be used instead of ERCs to help meet offset requirements under New Source Review and, where allowed, to meet RACT.

Mobile Source Emission Reduction Credits (MERCs)⁶¹

EPA has allowed mobile source emission reductions to be a source of tradable credits since 1986, but states have only recently begun to incorporate mobile sources into their offset and banking programs.⁶² Two factors contributed to the delay:

- the lack of EPA guidance on quantifying mobile source emission reductions and translating those reductions into mobile source emission reduction credits until 1993; and
- the focus on stationary source emissions to achieve NAAQS attainment prior to the 1990 Clean Air Act amendments.

The EPA has released five guidance documents relating to MERC programs. They are:

Interim Guidance on the Generation of Mobile Source Emission Reduction Credits, 58 FR 11134, February 23, 1993.

Guidance for Implementation for Employee Commute Option Programs, January 1993.

Guidance for Emission Reduction Credit Creation by Clean Fuel Fleets and Vehicles, January 1993.

Program for Generation of Emission Credits by Urban Buses, January 1993.

Guidance for Implementation of Accelerated Retirement of Vehicle Programs, February 1993.

The first document gives guidelines for incorporating mobile sources into emissions banking and trading

programs. It covers key issues involving the generation of MERCs, including the calculation of emissions baselines for participating sources, the projection of future emissions levels, and the time-averaging of mobile source emission reductions that vary over time. It also addresses methods of discounting credits to reflect the level of uncertainty surrounding actual mobile source emission reductions likely to be realized by proposed control programs.

The last four documents listed provide procedures for computing emission baselines and credits from employee commute programs, the conversion of fleets to alternative clean-fuel vehicles, the conversion or purchase of clean-fuel buses, and accelerated retirement (scrappage) programs.

Interim Guidance on the Generation of Mobile Source Emission Reduction Credits specifies that:

- MERCs must first and foremost be (1) quantifiable; (2) enforceable at the state and federal levels; (3) surplus, i.e., reductions that are above and beyond those required by state and federal regulations; and (4) permanent within the timeframe specified by the MERC program.
- MERCs can be used to: (1) satisfy emission reduction requirements beyond the Reasonably Available Control Technology (RACT) requirements;⁶³ (2) meet RACT requirements; (3) mitigate temporary increases in emissions or temporary non-compliance with regulations; and (4) meet offset requirements for new and expanding sources in ozone non-attainment areas.
- MERCs cannot be used to satisfy the requirements of Best Available Control Technology (BACT)⁶⁴, Lowest Achievable Emissions Rate (LAER)⁶⁵, New Source Performance Standards (NSPS)⁶⁶, Federal Inspection

⁶¹ This section is based on *Emissions Banking and Trading: A Survey of U.S. Programs*, Georgia Institute of Technology, Atlanta, April 1994, pp.23-27.

⁶² Environmental protection Agency, *Emissions Trading Policy Statement: General principles for Creating, Banking and Use of Emission Reduction Credits; Final Policy Statement and Accompanying Technical Issues Document*, 51 FR 43834, 1986. This document states that "ERCs from mobile source measures may be used to meet SIP requirements applicable to existing stationary sources, so long as such measures are surplus, permanent, quantifiable, and enforceable."

⁶³ Major stationary sources located in areas that are classified as being in "moderate" or higher ozone non-attainment must apply RACT. Whether a stationary source is "major" depends on its annual emissions and the non-attainment status of the area.

⁶⁴ New and expanding sources with planned emissions beyond the minimum threshold level in attainment areas must install BACT.

⁶⁵ New and expanding sources with planned emissions beyond the minimum threshold level in non-attainment areas must install LAER technology. Emissions that remain after LAER must be offset through purchase of ERCs from existing sources in the area.

⁶⁶ New Source Performance Standards are technology-based national emissions standards that apply to new and expanding facilities, in specific industries, located in non-attainment areas.

and Maintenance (I/M)⁶⁷ programs, or Employer Trip Reduction (ETR)⁶⁸ programs.

- Due to the short-term nature of some mobile source emission reductions, MERCs generally have a limited life. As a result when MERCs are used for offsets, their use must be conditioned by a permit requirement specifying that continued operation of the new or expanding source beyond the life of the MERCs is contingent upon the source obtaining other ERCs or MERCs before that time.

In short, in the non-attainment areas where MERCs are allowed, emissions by mobile sources can be reduced to create credits that can be used to meet offset requirements, RACT requirements, or to mitigate temporary increase in emissions or temporary non-compliance.

Overview of MERC Programs⁶⁹

Before MERCs can be used in an area, the state must include mobile source emission reduction provisions in its banking and trading rules. The state rules must be approved by the EPA, so they tend to reflect the provisions of the EPA guidance documents, although they may be more restrictive than the guidance documents.⁷⁰

MERC provisions have been included in state rules for California, Colorado, Connecticut, Delaware, Louisiana, Maine, Massachusetts, Michigan, New Hampshire, New Jersey, New York, Oklahoma, and Texas. The MERC provisions in each of these states are reviewed below. Since virtually all of the rules reflect the EPA guidance documents, many of the provisions are similar, even identical. In addition Georgia and Texas have adopted trading programs for the clean-fuel fleet vehicle requirements that come into effect with the 1999 model year.

California

California has an air quality management structure that includes both state-wide regulations and local regulations implemented by 35 regional air quality management and air pollution control districts. The California Air Resources Board, the Sacramento Metropolitan Air Quality Management District (SMAQMD), San Diego Air Pollution Control District (APCD) and the South Coast Air Quality Management District (SCAQMD) all have regulations relating to mobile source emission reduction credits.

California Air Resources Board (ARB)

In May 1997, the California ARB adopted a state-wide regulation for Interchangeable Air Pollution Emission Reduction Credits pursuant to the 1995 Health and Safety Code. The Code requires the ARB to develop and adopt a methodology for use by local air pollution districts to calculate the value of "interchangeable" emission reduction credits generated from stationary, mobile, and area sources. An interchangeable credit is "an emission reduction credit generated from a stationary, mobile, or area source that can be used, traded, or banked among programs and/or source categories" (as specified in the regulation and in accordance with state and Federal law).

The regulation sets out general requirements that local air pollution control and air quality management districts ("districts") must meet when developing rules governing the generation and use of interchangeable credits. The regulation applies only to districts that choose to adopt, implement, or amend a rule or regulation that authorizes the interchangeable use of emission reduction credits other than as offsets for new source review (NSR). The primary purpose of the regulation is to facilitate the use of emission reduction credits as a compliance alternative for meeting district control requirements (e.g., California RACT — or "BARCT" Best Available Retrofit Control Technology).

⁶⁷ Serious ozone non-attainment areas are required to develop and implement enhanced motor vehicle inspection and maintenance programs.

⁶⁹ The material in this section is largely drawn from the EPA database of market programs which is available at: www.epa.gov/omswww/market.htm. Information on the extent of MERC creation and use was obtained from contacts for the individual programs. The database is not comprehensive; it doesn't include the MERIT program in Tulsa for example. However, no additional programs were identified from other sources.

⁷⁰ Individual actions can be approved by the EPA on a case-by-case basis before a rule is approved, but this involves considerable time and effort.

Districts may develop interchangeable credit rules for any criteria pollutants for which they have regulatory requirements, including VOCs, NO_x, SO_x, PM, and CO, but not air toxics.⁷¹ To standardize and facilitate credit trading, the regulation establishes a uniform credit currency, expressed in pounds of pollutant in the year generated.

Interchangeable credits are expected to be used primarily by stationary sources. But they can also be used for compliance with other requirements, such as trip reduction commitments for companies required to reduce single occupancy vehicle use by their employees.

Interchangeable credits must represent verified emission reductions that are real, permanent over the period of credit generation, quantifiable, enforceable, and surplus to emission reductions that are already needed to comply with an existing requirement (local, state, or Federal) or air quality plan.

Interchangeable credits must be certified by the district in which they were generated and be registered in that district's emission reduction credit bank prior to use. Districts within the same non-attainment area may establish a multi-district banking program. While banked, a certified and registered credit retains its full value.

Districts must adopt enforceable technical protocols that define how emission reductions will be calculated for purposes of certifying them as interchangeable credits.⁷² The protocols must include procedures for calculating, certifying, and registering credits in one-year increments when the credits are generated from multi-year emission reductions. Emission reductions must be calculated based on the most stringent of historic actual emissions, applicable regulatory requirements, the district's air quality plan, or the State Implementation Plan (SIP).

The ARB determines the appropriate life for credits generated from mobile sources and from consumer products under its jurisdiction. But the regulation gives districts the discretion to establish the time period during which a banked credit generated from a stationary source is available for use.

71 The regulation allows the interchangeable use of credits to meet air toxics requirements only if authorized by Federal and state regulations. Currently, neither federal nor state provisions allow for emissions trading to meet air toxics requirements.

72 Districts are required to use ARB calculation methodologies for credits generated from mobile sources and from consumer products subject to ARB regulatory authority.

Once certified by a district, interchangeable credits can be used according to district rules regardless of how they were generated. This is intended to stimulate the use of the credits as a compliance alternative to certain district rules, as well as facilitate the flow of credits between compliance-based ("open market") trading programs and attainment-based ("cap & trade") trading programs within districts. Districts must allow the use of emission reduction credits to meet BARCT requirements, and may allow their use for other purposes, such as NSR offsets. However, interchangeable credits cannot be used to comply with BACT, MACT, NSPS, or LAER.

Currently, only the Sacramento Metropolitan Air Quality Management District has an interchangeable credit program in place; its SEED (Sacramento Environment and Economic Development) program, which allows inter-facility trading for NO_x and VOC emissions but not inter-pollutant trading.

The South Coast Air Quality Management District is working on a comprehensive open market program that is scheduled for adoption in the first quarter of 1999. Two other districts, the Bay Area Air Quality Management District and the San Joaquin Valley Air Pollution Control District, are in the process of developing interchangeable credit trading rules which are scheduled for adoption later this year.

Sacramento Metropolitan Air Quality Management District (SMAQMD)

In 1992 the SMAQMD initiated a program that allows MERCs to be used or sold as stationary source offsets (mobile-to-stationary MERCs). These MERCs can be generated by: (1) adding cleaner-fuel vehicles to existing fleets; (2) replacing existing fleet vehicles with cleaner-fuel vehicles; (3) converting existing fleets with cleaner-fuel vehicles; or (4) implementing telecommuting programs.

Two applications to generate mobile-to-stationary MERCs have been filed: an industrial facility wants to implement an early retirement program and the City of Sacramento is interested in purchasing alternatively fueled buses.

The SMAQMD is currently developing a second program that will allow firms to generate MERCs for complying with mobile source regulations, such as fleet conversion requirements and state-mandated employer trip reduction programs. These mobile-to-mobile MERCs can be generated by: (1) adding cleaner-burning vehicles to existing fleets; (2) replacing existing fleet vehicles with cleaner-burning vehicles; (3) converting existing fleets to cleaner-burning vehicles; (4) implementing telecommuting programs; (5) conducting annual inspection and maintenance programs; or (6) instituting vehicle scrappage initiatives.

For both programs, MERC generators must develop compliance plans that include provisions for recordkeeping, contractual agreements, and auditing procedures. If a credit generator fails to meet its contractual obligations, the district will levy a fine against it. If a credit generator sells its MERC to another firm and then fails to meet its contractual agreement, a fine may also be levied against the buyer.

Mobile-to-mobile and mobile-to-stationary MERCs are discounted by 30% to account for uncertainty in estimating mobile source emission reductions. Ten-thirteenth's of the remaining credit goes to the credit generator; 2/13 of the remaining credit is retired for clean air; and 1/13 of the remaining credit is placed in a community bank.⁷³ The lives of mobile-to-stationary MERCs are determined on a case-by-case basis. Mobile-to-mobile MERCs have a three-year life with no depreciation.

San Diego Air Pollution Control District (APCD)

Rule 27 of the San Diego APCD governs the creation, ownership, use, and transfer of mobile source emission reduction credits (MERCs). Five alternative MERC-generating programs are set forth: (1) accelerated vehicle retirement; (2) purchasing and operating new low-emission urban buses; (3) purchasing zero-emission vehicles; (4) retrofitting passenger cars, light-duty trucks,

and medium-duty vehicles to reduce emissions; and (5) retrofitting on-road heavy-duty vehicles and engines to low-emission configurations.⁷⁴

MERCs, in total pounds, are calculated as the average annual decrease in emissions multiplied by a three-year program life. The MERCs can be used for up to five years, though no more than one-third can be used in the first year and no more than two-thirds in the first two years. Different actions can create VOC, NOx, CO and PM MERCs.

MERCs can be used by stationary sources as emission offsets for new source review (NSR). MERCs can be transferred (traded) in whole or in part as long as both the transferor(s) and transferee(s) comply with all applicable conditions of the MERC certificate and all applicable requirements of the rule.

No MERCs have been created in San Diego to date under Rule 27. One application for MERC credit resulting from replacement of a marine diesel engine is under review. The limited interest in MERCs might be due to the limited demand for emission reduction credits in San Diego and/or the short life of a MERC relative to a stationary source credit.

South Coast Air Quality Management District (SCAQMD)

NOx and VOC reductions have been generated from mobile sources in the SCAQMD by scrapping old vehicles. These MERCs have been used to offset emissions by both stationary and mobile sources. The SCAQMD has adopted five rules for mobile source emission reductions which have not yet been approved by the EPA.

Vehicle Scrappage Program

SCRAP was a buyback and scrappage program conducted by UNOCAL for old vehicles registered in the SCAQMD (encompassing all of Los Angeles, Orange, and Riverside Counties, and the non-desert portion of San Bernardino County) in four projects from June 1990 to February 1995.

⁷³ This means that the credit generator receives credits equal to approximately 54% of the emissions reduction (10/13 of 70% of the emissions reduction).

⁷⁴ Other mobile source emission reduction strategies are eligible to generate MERCs subject to the approval of the San Diego APCD's Air Pollution Control Officer and concurrence from the California Air Resources Board (ARB).

Owners were offered payment to turn in their old vehicles for scrapping and recycling.⁷⁵ Altogether, 10,371 vehicles were scrapped.⁷⁶ Mobile source emission reduction credits (MERCs) were generated from the SCRAP III and SCRAP IV projects — pursuant to the SCAQMD's Rule 1610, Old-Vehicle Scrapping — to defer the installation of vapor recovery equipment at UNOCAL's marine terminal in Los Angeles Harbor.

Eligible vehicles were "old" (and therefore high-emitting) cars and light-duty trucks registered in the SCAQMD. The program resulted in NO_x, VOC, and CO emissions reductions.⁷⁷ The SCRAP III and SCRAP IV projects earned Rule 1610 VOC and NO_x MERCs for three years. Since the SCAQMD had no regulations for CO from stationary sources, there were no potential uses for CO credits.

SCRAP I (June-September 1990) was a voluntary, unilateral demonstration project. The goal was to demonstrate the feasibility and cost-effectiveness of a market-based approach to reducing motor vehicle emissions.⁷⁸ The major aim of SCRAP II (June 1993) was to gather emissions data for a different vehicle population — 1971-1979 model years, which use first-generation catalytic converters. In both SCRAP I and SCRAP II, a database was established by measuring tailpipe emissions from every purchased vehicle and by performing the Federal Test Procedure (FTP) on a statistically significant sample. The emissions reductions from both projects accrued to the SCAQMD.

SCRAP III (July, August 1993) was the nation's first old-vehicle buyback project for the purpose of generating emission reduction credits. Although the emissions reductions were offset by emissions at the marine terminal, there was a likely net air quality benefit because the MERCs were applied at a 1.2 to 1.0 offset ratio. As a compliance alternative, generating MERCs was more

cost-effective to UNOCAL than making the modifications at the marine terminal.

The MERCs generated in SCRAP III had three-year lives. The VOC MERCs were applied against emissions at the marine terminal. NO_x credits were not needed at the terminal, however, so the NO_x MERCs generated were used instead as RECLAIM trading credits.⁷⁹ The NO_x MERCs from SCRAP III represent less than 2% of the combined ERCs and MERCs converted to credits for the RECLAIM program and less than 0.1% of total NO_x emissions by RECLAIM sources.

SCRAP IV (January, February 1995) was also undertaken to generate MERCs for the marine terminal. Rule 1610 had been amended by the time of SCRAP IV, still granting three years' worth of MERCs, but now allowing the credits to be used within a five-year period. Most of the VOC MERCs have been applied to the marine terminal. Some of the VOC MERCs and all of the NO_x MERCs have been used for compliance with an SCAQMD rideshare regulation (Rule 2202).

MERC Rules

Regulation XVI — Mobile Source Offset Programs — is composed of five rules which provide for the generation of MERCs from various categories of mobile sources. The five rules are as follows:

- Rule 1605 — Credits for Voluntary Repair of On-Road Motor Vehicles Identified through Remote Sensing Devices. NO_x, VOC and CO MERCs can be generated through voluntary repair of emissions-related components of high-emitting vehicles identified by remote sensing devices. Reductions are calculated based on the number of days from the repair until the next mandatory inspection. The MERCs expire two years after the date of issuance.

75 \$700 for pre-1971 model year vehicles (which have little or no emission controls) in SCRAP I; \$700 for 1971-1979 model year vehicles in SCRAP II; \$700 for pre-1972 model year vehicles in SCRAP III; and \$700 for pre-1972 and \$600 for 1972-1974 model year vehicles in SCRAP IV.

76 8,376 in SCRAP I, 502 in SCRAP II, 335 in SCRAP III, and 1,167 in SCRAP IV.

77 SCRAP I, the largest of the SCRAP projects, eliminated an average of 142 tons of NO_x, 1,219 tons of VOC, and 4,946 tons of CO per year over the course of three years.

78 The total cost of SCRAP I was about \$6 million, or about 40 cents per pound of pollutants removed.

79 The Regional Clean Air Incentives Market (RECLAIM) is an emissions trading system for NO_x and SO_x emissions by point sources adopted by the SCAQMD for implementation beginning January 1, 1994. All major stationary sources that hold permits for equipment or processes that generally emit more than 4 tons per year of NO_x or SO_x or which emit more than 4 tons of NO_x or SO_x per year during any year after 1990 must participate.

- Rule 1610 — Old Vehicle Scrapping. NO_x, VOC, CO and PM MERCs can be generated by scrapping old, high-emitting vehicles. Reductions are calculated assuming that each vehicle has a remaining useful life of three years. The MERCs are valid for five years and the share that can be used in a given year is restricted. As of early 1998, the SCAQMD had approved 15 scrappage plans and approximately 22,000 vehicles had been scrapped.
- Rule 1612 — Credits for Clean On-Road Vehicles. Switching to low- or zero-emission vehicles can generate SO_x, NO_x, VOC, CO and PM MERCs. The MERCs expire in two years and can only be used in the air basin where the vehicle operator is based.
- Rule 1620 — Credits for Clean Off-Road Mobile Equipment. SO_x, NO_x, VOC, CO and PM MERCs can be generated through operation of low- or zero-emission off-road equipment. The MERCs expire in two years and can only be used in the air basin where the equipment operator is based.
- Rule 1623 — Credits for Clean Lawn and Garden Equipment. NO_x, VOC, CO and PM MERCs can be generated through purchase of low-polluting lawn and garden equipment or the early retirement of older, high-polluting lawn and garden equipment. The MERCs can be used in the year they are created or the following year.

MERCs can be used as offsets for new and expanding sources under the new source review (NSR) process, as RECLAIM credits, as a method of compliance with Rule 2202 (On-Road Motor Vehicle Options), as an alternative method of compliance with Regulation XI (Source Specific Standards) rules that have future compliance dates, and as an alternative method of compliance with any other SCAQMD regulation that allows the use of MERCs.⁸⁰ The MERCs are discounted by 20% for some uses.

Colorado

The Colorado Air Quality Control Commission adopted a Generic Emissions Trading and Banking program on October 24, 1996 that becomes effective when approved by EPA as a SIP revision. The program had not been approved by EPA as of June 1998 and, as a result, there has been no activity under the program.

The program involves the banking and trading of emission reduction credits (ERCs). The program is applicable statewide, including in attainment, non-attainment, and maintenance areas. There are two basic types of ERCs: permanent and temporary. Permanent ERCs reflect emission reductions that are permanent, while temporary ERCs reflect emission reductions that are of limited duration. As a result, permanent ERCs are measured in tons/year, and temporary ERCs in tons. The program also accommodates mobile source emission reduction credits (MERCs), which are considered temporary ERCs.

The program applies to stationary, mobile, and area sources. Mobile sources are limited to vehicles used on the highway. The criteria pollutants, with the exception of lead, are covered. Ten percent of all credits are retired when certified.

MERCs can be generated by scrapping vehicles with relatively high emissions and replacing them with lower-emitting vehicles, switching fuels, installing add-on emissions control systems, and implementing "operational strategies" such as trip reduction plans and revised routing strategies. MERCs are quantified from the product of the annual emission reduction and the remaining useful life of the vehicle constituting the baseline. To ensure a nontrivial impact, the remaining useful life must be more than three years, and total emissions reductions must be at least 10 tons.

ERCs can be used as new source review (NSR) offsets, as well as for RACT and BACT compliance, though only prospectively for new BACT requirements. The ERC provisions do not allow a source to remove BACT where already installed. Prohibited uses include for netting out of NSR, or to meet NSPS, LAER or hazardous air pollutant standards.

ERCs can only be traded within the same non-attainment, attainment, or maintenance area, or from a non-attainment or maintenance area to an attainment area. Also, ERCs cannot be traded outside of the PM-10 prevention of significant deterioration area in which they were generated. Temporary ERCs for seasonal pollutants such as the ozone precursors must be used in the same season they were generated or in a season of "lower concern."

⁸⁰ Rule 2202 establishes options for employers to reduce mobile source emissions from employee commutes.

Connecticut

Connecticut has had a NO_x Emission Reduction Credit Trading Program since mid-1995. The program involves voluntary trading and banking of NO_x ERCs. Two types of ERCs are defined: mass-based, reflecting discrete emission reductions; and rate-based, reflecting continuous emission reductions. The discrete ERCs are measured in tons and the continuous ERCs in tons per year. Credit generators have shown a preference for discrete ERCs because they offer more flexibility than the permanent commitment associated with continuous ERCs. All ERC generation and use requires the Commissioner's approval.

Both stationary and mobile sources may participate in the program, either as ERC generators or users. Participation is primarily by stationary sources, however. So far, ERCs have been approved from five stationary sources. Approximately 15 ERC-generation requests are currently being reviewed, two of which are from mobile sources (for reformulated gasoline). The approved ERCs are being used by about 35 stationary sources as well as one mobile source.⁸¹

The program is primarily intended for cost-effective and flexible RACT compliance but ERCs are also being used as offsets in new source review (NSR) and for penalty purposes. An environmental benefit is ensured by a ten percent discount on credits created. The department is also considering a discount for measurement (emissions quantification) uncertainty on a case-by-case basis, such as ERCs generated by mobile sources and used by stationary sources.

The program is scheduled to run until 1999 (the attainment target), at which time a review by the Commissioner will determine whether or not it will be continued.

Delaware

Delaware's voluntary state-wide Emission Banking and Trading Program became effective in October 1997. Under the program, reductions from stationary, area, or mobile sources that are greater than one ton per year are eligible for credit if they are determined to be real,

surplus, permanent, quantifiable, and enforceable. All reductions must be certified by the state prior to banking or use. Certified reductions are termed emission reduction credits (ERCs) and are incorporated into permit terms.

Reductions must have occurred after January 1, 1991 and can be generated by overcontrol, materials substitution, production limitations, process changes, shutdowns, early reductions, pollution prevention, and other activities approved by the Department of Natural Resources and Environmental Control (DNREC). VOCs and NO_x ERCs generated during the ozone season (April 1 through October 31) can be used at any time of the year; however, ERCs generated outside of the ozone season (November 1 through March 31) can only be used in the same season as generated. Inter-sector (e.g., mobile source to stationary source) trading is allowed, as is inter-state trading within the Ozone Transport Region.

Prior to certification, emission reductions are assessed a 10% discount, unless generated by a shutdown or early reduction. If generated by a shutdown, a 50% discount is assessed, half of which is permanently retired by the state and half of which is transferred to Delaware's Economic Development Office to help offset any job loss due to the shutdown.

Once certified, credits do not expire (unless the underlying regulation changes) and can be used for compliance with certain standards (e.g., RACT) or as offsets. ERCs cannot be used to meet NSPS, NESHAPs, LAER, BACT or MACT. In addition, ERCs generated in an attainment area cannot be traded to or used in a non-attainment area, and ERCs generated in a non-attainment area cannot be traded to or used in a higher non-attainment area.

No emission reduction credits — stationary or mobile source — have been certified by the DNREC to date.

Louisiana

The Louisiana Regulations on Control of Emissions through the Use of Emissions Reduction Credits Banking became effective in 1994. The regulations govern the use of emission reduction credits (ERCs) and mobile

⁸¹ The mobile source is a casino that opened in October 1996. The casino is required to compensate — analogous to the concept of an offset — for its customers' automobile emissions. This includes VOC as well as NO_x emissions. Currently no VOC credits are available in Connecticut. As a result, the Department is temporarily allowing the casino to offset VOC emission increases with NO_x ERCs on a 1.1 to 1.0 (in tons).

emission reduction credits (MERCs) as new source review (NSR) offsets and in netting. The regulations are mandatory in the seven ozone non-attainment parishes and voluntary in ten attainment parishes.

MERCs are generated by scrapping vehicles and provide an alternative method of compliance for stationary sources. Fair market value, and a minimum of \$450, must be paid to motorists who offer up their vehicles for scrapping. Vehicles must be scrapped by a certified automobile crusher. MERCs must be surplus, enforceable, permanent, quantifiable and real. MERCs are valid for three years and must be used internally (i.e., MERCs cannot be traded).

All MERC transactions must be approved by the Department of Environmental Quality (DEQ). The DEQ maintains a directory of vehicles available for scrapping. The DEQ will release to stationary-source facilities looking to create MERCs (e.g., for NSR) the names and telephone numbers of vehicle owners sufficient to meet all or part of the desired number of emission reduction credits.

To date, ERCs have been generated, but none have been used as offsets or for netting. No MERCs have been generated. The DEQ believes that generators are holding on to their credits in anticipation of future internal use.

Maine

Maine's offset trading rule was adopted in June 1998. While the rule does not prohibit generation and use of mobile credits, it does not specifically provide for them. A backlog of trades is pending, but none are from a mobile source. Maine will accept credits from other states as long as they are certified by that state's air pollution agency. It might be easier to use MERCs generated in another state than to generate mobile source credits in Maine.

Maine's offset rule was delayed several years because emissions trading became a hugely controversial issue in 1994. A paper plant needed offsets to expand, but no credits were available, so it was proposed that the state give the facility some credits generated by excess NO_x reductions from Maine's automobile inspection and maintenance program, which was targeted at VOC reductions. A public outcry ensued, against emissions trading and against the already unpopular I/M program.

Massachusetts

The Innovative Market Program for Air Credit Trading (IMPACT) was launched in January 1994 and was approved by the EPA in October 1996.

IMPACT is a voluntary, state-wide emission banking and trading program. Reductions must be real, quantifiable, surplus, enforceable, and permanent to be eligible for certification as ERCs. The Department of Environmental Quality (DEP) must certify all ERCs prior to use, banking or trading, and conditions for generation or use are incorporated into permit terms.

ERCs are quantified in terms of the average hourly or daily emission rate, expressed in pounds. DEP is currently proposing the creation of a Mass ERC Bank for credits calculated in tons and a Rate ERC Bank for credits calculated in tons per year. Credit life is equal to the expected life of the reduction — either a discrete timeframe or forever. Credits in the Rate Bank will only be available for use as offsets and expire after 10 years.

Reductions from stationary, area, or mobile sources that occurred after December 31, 1990 may be certified under the program. Eligible activities include implementing more stringent emission controls, source reduction, fuel switching, energy conservation programs, lawn and garden equipment trade-in programs, fleet conversions, vehicle scrapping, or ride sharing. Reductions from shutdowns or curtailments are also eligible, subject to certain restrictions.

Reductions of VOCs, NO_x, and CO are eligible for certification. ERCs generated by reductions of VOCs and NO_x during the ozone season can be used at any time of the year; however, those generated outside of the ozone season can only be used during that period. Similarly, ERCs generated by reductions of CO from November 1 to February 28 may be used at any time of the year, while ERCs generated from March 1 to October 31 must be used during those months. Interpollutant trading is not allowed.

At the time of certification, DEP applies a variable "compliance assurance multiplier" to the difference between the pre- and post-reduction emissions. The value of the multiplier is based on the measures proposed by the applicant to ensure continuous compliance and can range from 0-50% (e.g., implementation of irreversible

process changes vs. use of emission factors). After applying the multiplier, DEP certifies the remaining reductions as ERCs.

ERCs can be used for offsets, netting (as long as they are generated at the same source and used within five years of the reduction), and compliance with other regulations not relied on for SIP purposes (e.g., RACT). Users must hold an amount five percent greater than what is needed for compliance purposes. This five percent increment must be held in escrow by the company until DEP releases it for use. ERCs cannot be used to meet BACT, LAER, MACT, NSPS, or NESHAPs.

Since the inception of the program, DEP has received a total of 51 applications for emission reduction credit (ERC) generation, of which 17 are in various stages of the approval process, 17 have been rejected or withdrawn, and 17 are undergoing review.⁸² DEP has received one application to use ERCs to delay compliance with NOx control requirements. And seven sources plan to use ERCs as a result of DEP enforcement actions.

Only one mobile source credit creation action has been approved. It involved early introduction of low Reid Vapour Pressure gasoline. The quantity of credits created was small. There have been no mobile source uses.

Michigan

The Michigan Offset Trading Program became effective at the state level in March 1996. The U.S. EPA proposed approval of the Michigan program once certain deficiencies were addressed through revisions to the rules and procedures. The Michigan Department of Environmental Quality (MDEQ), EPA and stakeholders have arrived at acceptable compromises regarding the issues and MDEQ will resubmit the revised rules and operational procedures to EPA following the completion of the state rulemaking process in the fall of 1998. Final federal approval of the revised submission is anticipated.

The Michigan Emission Trading Program is a voluntary, open-market program with statewide applicability. The unit of currency is the Emission Reduction Credit (ERC), equal to one ton of emissions reductions. The program applies to all criteria pollutants and is open to

participation by any type of emissions source, stationary, mobile, or area.

The program is intended to facilitate the attainment and maintenance of National Ambient Air Quality Standards (NAAQS) and create market-based incentives for emissions reductions. A ten percent net air quality benefit contribution is deducted before ERCs can be used. For VOC and NOx ERCs an additional 10% discount is applied for every ozone season that use is deferred.

Emission reductions must be real, surplus, enforceable, permanent, and quantifiable.

Allowable credit-generating activities include installation or modification of control equipment, process or operational changes, reformulation of raw materials or products, energy conservation, pollution prevention programs, production curtailment or shutdown, early emissions reductions, and area and mobile source controls if a baseline can be established. Quantification and compliance monitoring methods must be determined in a manner approved by the MDEQ or the EPA.

Allowable uses of ERCs are NSR offsets, netting and RACT compliance. ERCs can also be used for BACT and LAER compliance, but only if the required control equipment has been installed, operated, and maintained properly and the associated emission limit cannot be achieved. Otherwise, ERCs cannot be used in lieu of the technology or work practice requirements of BACT, LAER, MACT, NSPS, or NESHAPs.

ERC generation, use, and trading are self-certified by sources. Notices to generate or use ERCs are not certified or approved by the DEQ; rather, the DEQ only determines whether the notices are complete or incomplete. Interpollutant trading is not permitted except for interstate trading where the use is consistent with a regional ozone strategy and the SIP. The program contains restrictions addressing seasonal, air toxic, and other air quality concerns. ERCs can be used for up to five calendar years after the year in which they were generated.

⁸² Most of the applications that have been disapproved by DEP to date were determined to not meet one of the five criteria, most frequently the requirement that reductions be real. Others, specifically those involving the shutdown of unpermitted equipment, did not meet the definition of surplus.

Over 80 submittals have been received under the program to date. Submittals to generate ERCs have documented the following emission reductions: over 750 tons of VOC reduced, over 37,000 tons of NOx reduced, over 225 tons of CO reduced, and over three tons of PM10 reduced. ERC Uses and Transfers (the trading of ERCs) have increased dramatically during the first quarter of 1998, likely the result of increased market confidence due to the pending EPA approval and increased broker activity in Michigan.

The only mobile source credits created to date and VOC and CO reductions achieved through voluntary production and sale of low Reid Vapour Pressure (RVP) gasoline in southeast Michigan by Marathon Oil. This action accounts for about 17% of the ozone season VOC reductions under the program to date. A small portion of these VOC credits, 3.5 tons, have been traded and used.

New Hampshire

New Hampshire adopted both an Emissions Reduction Credits (ERC) Trading Program and a Discrete Emissions Reductions (DER) Trading Program in early 1997. ERCs are rate-based units (1 ERC = 1 ton/year) representing continuous, permanent emission reduction while DERs are mass-based units (1 DER = 1 ton) representing discrete, retrospective emission reductions.

Both ERCs and DERs can be generated by stationary, mobile, or area (e.g., off-road equipment, consumer products) sources. NOx and VOCs are included because New Hampshire is in the Ozone Transport Region.

The programs are intended to give RACT sources and sources subject to New Source Review (NSR) compliance flexibility and the opportunity to reduce compliance costs. ERCs generated through shutdowns can only be used by the generator (they can't be traded). If the generator cannot use them, they become "public ERCs" in a state-controlled account. The state can use these ERCs for purposes of job retention (highest priority), economic development, and job creation. Ten percent of all DER credits are retired before they are used to provide an environmental benefit.

Allowable protocols for ERC or DER generation by mobile sources are as in EPA's Guidance to States Developing Generic ERCs from Mobile Sources (MERC) Regulations (February 1994), such as vehicle scrappage, clean fuel fleets, and employee commute options. The

Department of Environmental Services (DES) will evaluate mobile source ERC and DER generation protocols to determine the applicability of the credits to stationary sources. If necessary, a discount factor reflecting emissions quantification uncertainty may be added.

Credits can be used by stationary sources for RACT and NSR compliance and bubbling. Prohibited uses are as in EPA's Proposed Model Open Market Trading Rule, such as BACT, LAER, and MACT.

ERCs require DES approval before they can be registered and used. They cannot be banked. DERs, on the other hand, can be banked for future use and do not require DES approval before use. However, the buyer may be liable if the DES finds any shortfalls.

NOx for VOC trading is permitted for both ERCs and DERs, but not vice versa. This is intended to encourage NOx reductions, which contribute more than VOC reductions to ozone improvement in New Hampshire. Inter-pollutant trading ratios have not yet been worked out. The programs allow interstate trading, but to date, New Hampshire has not reached such an agreement with any other state.

The only mobile emission reduction credit proposed to date is a gasoline additive that slows the increase of NOx emissions over time. Due to quantification uncertainties, the DES proposed either a large discount factor or a test program to better document the reductions. The proponent chose the latter option, but the test program has not yet begun.

New Jersey

The regulation establishing New Jersey's Open Market Trading Program was promulgated in July 1996 and became operative in August 1996. Several trades have been approved or are underway, and agreements for interstate trading with Connecticut and Massachusetts are in place.

New Jersey's open market trading program authorizes the creation, use, and trading of discrete emission reductions (DERs). A DER represents 100 pounds of emission reductions from stationary or mobile sources. Generators and users must supply notice and certification to the state registry, and all DERs must be verified by an independent third party prior to use.

NOx and VOC DERs can be generated by stationary or mobile sources. Reductions must be real, surplus, and quantifiable. The generation and use periods for any "batch" of DERs cannot exceed one year; however, additional batches can be generated and used over consecutive periods. DERs cannot be generated by shutdowns or curtailments. DERs cannot be generated or used if this causes an increase in HAP emissions above the de minimis level established by EPA. DERs generated outside the ozone season cannot be used during the ozone season. Inter-pollutant trading is prohibited. Interstate trading is subject to certain restrictions, depending on the pollutant, locations of the generator and user, and reciprocal state provisions. A 10% discount is assessed at the time of use to benefit the environment.

In general, DERs can be used to meet requirements for VOC and NOx RACT, and offsets. DER use may be required by the State as compensation for excess VOC and NOx emissions under alternative emission limits (AELs), innovative control technology plans, and MEG alerts. DERs cannot be used to comply with NSPS, LAER, BACT, NESHAPs, and certain motor vehicle standards, and other requirements specified by the regulation.

DERs used for compliance purposes must be verified by an independent third party. To be verified, the independent third party must confirm that the DERs were generated from allowable activities, approved quantification protocols were used to calculate the amount of DERs, and that all required notices, certifications and supporting documentation prepared by the generator are sufficient. In any enforcement action, the generator, verifier, and user bear the burden of proof on their respective responsibilities as outlined in the regulation.

To date only one action has been implemented to create mobile source credits; the sale of low Reid Vapour Pressure gasoline to create 18.85 tons of VOC credits. This represents well under 1% of the total credits created in the state.

New York

The NSR Emission Offset Program authorizes the creation, use, and trading of emission reduction credits (ERCs). The ERCs are rate-based units (1 ERC = 1

ton/year) representing continuous, permanent emission reductions. ERCs can be used by stationary sources for new source review (NSR) netting and as NSR offsets only. ERCs must be certified by and registered with the NYSDEC before they can be used or traded. Emission reductions that are quantifiable, enforceable, permanent, and surplus are eligible for certification as ERCs. Once certified and registered, ERCs are not discounted and have unlimited life.

All types of emission reductions from stationary sources are allowable, including overcontrol, process changes, energy conservation, and production curtailments or shutdowns. Stationary sources can also implement demand-side management measures — energy-saving process or equipment changes that generate NOx credits for electric utilities. The NYSDEC is considering adding provisions for generating credits from mobile sources, pending the release of mobile source quantification protocols in EPA's Open Market Trading Guidance.

So far in the program, two ERC trades have been approved, both for NOx, and both inter-firm. Another NOx trade is expected to be approved soon. This pending trade will include — under a Memo of Understanding with Pennsylvania — the transfer of 100 tons of NOx ERCs from Pennsylvania. Currently in the State registry (bank) there are 3,067 tons of NOx ERCs, 1,756 tons of VOC ERCs, 1,151 tons of CO ERCs, and 26 tons of PM-10 ERCs.

Oklahoma⁸³

Tulsa's MERIT (Maximizing Emission Reductions by Intersource Trading) Program, established in 1993, allows industrial firms that need to temporarily increase emissions above permitted levels to do so by generating MERCs. MERCs can be generated from a range of methods — from carpooling and telecommuting to corporate-sponsored tuneups for employees. Credit value and life are determined on a case-by-case basis. No MERCs have been generated in the program to date.

Texas

Texas has an emissions banking and trading program for its four ozone non-attainment areas. ERCs under the program can be generated by stationary, mobile and area sources. It also has an accelerated vehicle retirement

⁸³ This section is from *Emissions Banking and Trading: A Survey of U.S. Programs*, Georgia Institute of Technology, Atlanta, April 1994, p.27.

program that enables MERCs to be generated by scrapping automobiles and light-duty trucks. The ERCs and MERCs can only be used by stationary sources for offsets. Finally, the clean fleet program that will go into effect in late 1998 can generate MERCs or facilitate compliance with the Federal Clean Fuel Fleet Program requirements.

Emissions Banking Program

The Texas Emissions Banking Program is an emission reduction credit (ERC) banking and trading program currently in place in the state's four ozone non-attainment areas: Beaumont/Port Arthur, Houston/Galveston, Dallas/Fort Worth, and El Paso. The ERCs are used as offsets for new source review (NSR). Although the ERCs can only be used by stationary sources (for NSR), they can be generated by mobile and area sources as well as stationary sources.

The ERCs, equal to one ton of emissions per year, can be used as offsets only in the non-attainment area in which they were generated. ERCs must be certified by the Texas Natural Resources Conservation Commission (TNRCC) before they are sold, so there is no risk to the buyer. In the three years since the program was established there has been only one transaction (125 tons of NO_x ERCs in Houston). Activity has been low because there has been little NSR permitting, and new sources that have applied for permits have been netting out of NSR and its offset requirements. Due to the low level of participation an original 3% per year banking discount was rescinded and the life of ERCs was extended from five to ten years.⁸⁴

Texas also allows non-attainment areas to establish Area Emission Reduction Credit Organizations (AERCOS) to make it easier for new sources and expanding sources to find offsets needed for NSR. AERCOS are funded by "supplemental environmental projects" undertaken by companies penalized for non-compliance (up to 50% of such projects can be contributions to AERCOS). The AERCO must retire five to ten percent of banked ERCs per year to benefit the environment. Houston/Galveston

and Beaumont/Port Arthur have AERCOS, but neither has acquired any ERCs.

Accelerated Vehicle Retirement Program

The Texas Accelerated Vehicle Retirement Program is currently in effect in the state's four ozone non-attainment areas. Mobile source emission reduction credits (MERCs) generated by scrapping automobiles and light-duty trucks can be used by stationary sources as offsets for new source review (NSR). While the program is intended for companies that want to generate MERCs for their own use (as offsets), technically the MERCs can be traded to other sources. The program rewards motorists who turn in their vehicles typically with a cash payment and with avoided repair costs to pass the state I/M emissions test.

The MERCs can be banked for three years and also can be used (as offsets) for only three years, the estimated average remaining life of a vehicle that is scrapped. Unlike ERCs (which in Texas can be banked for 10 years and used indefinitely), MERCs do not represent permanent emissions reductions. MERCs can only be traded within a non-attainment area.

To date, there has been no activity in the scrappage program. This is due to an overall low demand for offsets, but also to the advantage of ERCs, with an unlimited life, over MERCs, with only a three-year life. A limited life is particularly inconvenient for offsets.⁸⁵

Clean Fleet Program

The Texas Clean Fleet Program is an alternative to the Federal Clean Fuel Fleet Program. Starting September 1, 1998, affected fleets must ensure that certain percentages of their new vehicle purchases and total fleet are "clean-fuel vehicles" meaning that they have a vehicle/fuel combination certified by the U.S. EPA to meet or exceed the Federal low emission vehicle (LEV) standards.

Mobile emission reduction credits (MERCs) and program compliance credits (PCCs) can be earned by (1) acquiring LEVs earlier than required, (2) acquiring more LEVs than

⁸⁴ TNRCC is currently in the early stages of developing a new emissions banking and trading program based in part on the Open Market Trading Guidance. The new program is expected to incorporate the use of both ERCs and discrete emission reductions (DERs). Other expected changes are the possible use of ERCs and DERs for RACT and limiting mobile and area sources to generating DERs (not ERCs).

⁸⁵ This may change under the new program being developed by TNRCC. The new program is expected to allow the use of MERCs for RACT compliance — a much more convenient use for credit with limited life.

required, or (3) acquiring vehicles certified to meet an emission standard more stringent than LEV, such as the ultra-low emission vehicle (ULEV), the inherently low emission vehicle (ILEV), and the zero emission vehicle (ZEV).

Affected fleets include local government fleets with more than 15 vehicles (excluding law enforcement and emergency vehicles) and private fleets with more than 25 vehicles (excluding emergency vehicles), and certain mass transit fleets operating primarily in the four ozone non-attainment areas.

Participating fleets can choose between MERCs and PCCs when claiming credit. One MERC is equal to one LEV-equivalent, or the emission reductions from a standard light-duty vehicle certified as a LEV. The number of MERCs associated with being certified as a LEV will depend on the type and size of vehicle. PCCs do not vary by type and size of vehicle; one PCC is granted for LEV, two for ULEV, and three for ILEV or beyond. For most credit-generating activities, more MERCs can be earned than PCCs, though there are exceptions.

PCCs have application only in the Texas Clean Fleet Program. In contrast, MERCs, subject to conversion formulas, can be used as offsets for new source review (NSR) by stationary sources, and in the future, for RACT compliance. MERCs and PCCs can be converted into each other unless they have been traded. For example, a fleet that created and still holds PCCs can convert them into MERCs. Once traded, however, MERCs and PCCs must be used "as is." MERCs and PCCs can be used for as long as the life of the vehicles from which they were created, normally about five years. There is no discounting for use in future years.

Georgia

The major aim of the Clean Fueled Fleet Program is to reduce ozone formation. A secondary aim is to stimulate the markets for alternative fuels such as propane and methanol. The credit trading component of the program aims to reduce the costs of compliance.

The Clean Fueled Fleets Program is a requirement of the 1990 Clean Air Act Amendments. Fleets of ten or more vehicles in ozone non-attainment areas are required to participate. In Georgia the program applies to the ozone non-attainment area comprising 13 counties around

Atlanta. The program starts in 1998 with 1999-model-year purchases. For participating light-duty vehicle fleets, 30% of 1999-model-year purchases must be EPA-certified as "clean-fueled." This rises to 50% for the 2000 model year and 70% beginning in 2001. For heavy-duty vehicle fleets, the requirement is 50% for every model year starting with 1999.

Vehicle fleets can earn credits by purchasing clean-fueled vehicles earlier than required, by purchasing extra or exempted clean-fueled vehicles, or by purchasing clean-fueled vehicles that meet stricter emission standards than required. The credits can, in turn, be used to meet current or future clean-fueled-vehicle purchase requirements.

Credits can be banked for future use, with unlimited life, or traded to other fleets. They cannot be used outside the Clean Fueled Fleet Program in the Atlanta ozone non-attainment area. For example, they cannot be used by stationary sources.

Rules and regulations are in place; participating vehicle fleets have been determined and the program is set to start up in March 1998.

Pilot Program MERC Actions

Actions to create mobile source emission reduction credits have been implemented as part of the NESCAUM/MARAMA Emission Reduction Credit Demonstration Project and the PERT project.

NESCAUM/MARAMA Emission Reduction Credit Demonstration Project

The Northeast States for Coordinated Air Use Management (NESCAUM) and the mid-Atlantic Regional Air Management Association (MARAMA) sponsored an Emission Reduction Credit demonstration project that ran from 1993 through 1995.⁸⁶ The purpose of the demonstration project was to develop insights into emissions reduction trading policy through review of actual emission reduction creation strategies, trades and uses proposed by participants. The demonstration project focused on NOx and VOC reductions.

Of the 24 emission reduction creation strategies reviewed as part of the project, 10 involved mobile sources. The mobile source reductions included:

⁸⁶ NESCAUM and MARAMA are associations of the air quality directors of the states in their respective regions.

- Reid Vapour Pressure reduction in gasoline (multiple actions)
- A strategy to reduce vehicle emissions through automated toll collection (not implemented)
- Reduced vehicle emissions through establishment of a vanpool/carpool system
- Conversion of heavy-duty diesel vehicles to natural gas
- A lawn mower scrappage program
- A vehicle scrappage program
- Repair of high-emitting light-duty vehicles identified through remote sensing

With one exception, all of the emission reduction credits created were used by stationary sources for RACT compliance. The one exception was a trade to achieve compliance with Reid Vapour Pressure requirements.

Pilot Emission Reduction Trading (PERT) Project

The PERT project was established in early 1996 to demonstrate actual emission reduction creation strategies, trades and uses. The project is aimed primarily at ozone precursors — NO_x and VOCs — in southern Ontario, but tracks changes in all emissions resulting from the actions implemented. To date only one credit creation action has involved mobile sources.

Between November and December 1996, ProtectAir removed 140 older high-emitting vehicles from Ontario's roads through the payment of a C\$400 per vehicle incentive.

All vehicles were screened to ensure that they were active vehicles in Ontario's fleet. ProtectAir identified, measured emissions and facilitated the retirement, recycling and destruction of component parts. The vehicles were tested using the US Environmental Protection Agency's enhanced I/M 240 Test Procedures. The purpose of the demonstration was to generate inexpensive Mobile Emission Reduction Credits (MERCs) by voluntary early removal of high-emitting vehicles.

At the time, there was no vehicle inspection program in Ontario. Therefore, all VOC, CO and NO_x reductions attributable to the vehicle retirement program were surplus. The emissions that would have been released into the atmosphere by the retired vehicles were estimated (using standard U.S. Environmental Protection Agency formulae, adjusted to reflect Ontario conditions) and accumulated, and an emission reduction credit calculated. MERCs created as a result of the removal of 140 vehicles totaled 17.8 tonnes of VOCs, 113 tonnes of CO and 5.8 tonnes of NO_x.

To demonstrate both mobile sector creations and intersector trading, Ontario Hydro acquired the reductions from ProtectAir.

Conclusions

The experience with mobile source emission reduction credit programs is summarized in Table C-2. Three districts in California and twelve states have adopted rules that permit MERC creation. The number of jurisdictions that allow MERC creation and use has increased slowly since the EPA guidance documents were released in 1993. Progress is slow because it can take several years to develop a rule and the associated regulations get them adopted.

The main purpose of most of the programs is to provide additional sources of credits for use by stationary sources to meet NSR offset and RACT requirements. MERCs can also be used by stationary sources for netting, bubbles, BACT requirements (under some conditions), and penalties for non-compliance in various jurisdictions.

Actual experience with MERC creation is limited to two California districts and three states. Where MERCs have been created they typically represent a tiny fraction (<1%) of the ERCs created by stationary sources over the same period. Although the EPA guidance allows a variety of options for generating MERCs, virtually all of the credits actually created have come from scrapping high-emitting vehicles and selling reformulated gasoline.⁸⁷ These are also the most common options in pilot programs.

⁸⁷ Several jurisdictions have implemented programs to scrap vehicles, lawn mowers and outboard motors funded by industry, government, or special levies on vehicles. The objective of these programs is to reduce overall emissions rather than to create credits that can be used by other sources.

The relatively limited creation of MERCs in jurisdictions where they are allowed is probably due to difficulties in quantification and the need to get approval for new quantification protocols. As a result of experience gained since the early 1980s, there are many accepted methods

for quantifying stationary source emission reductions. Increasing experience with mobile source emission reductions should make the approvals process more routine and may reduce the quantification difficulties.

Table C-2 Summary of Mobile Source Emission Reduction Credit Creation Program Experience					
State/District	MERC Rule Adopted	MERCs Created	Main Actions to Create MERCs	Stationary Uses of MERCs	Mobile Uses of MERCs
Mobile Source Credit Creation Programs					
California SMAQMD	May 1997 1992	NO YES	Scrappage, clean fuel buses	NSR offsets, RACT NSR offsets	Depends on District Being developed
San Diego SCAQMD	Nov. 1994 1993-1996	Proposed YES	Replace marine engine Scrappage	NSR offsets NSR offsets, RACT	Ridesharing
Colorado	Oct. 1996	NO		NSR offsets, RACT, BACT ¹	
Connecticut	mid-1995	Proposed	Reformulated gasoline	NSR offsets, RACT, penalties	Offset casino patron emissions
Delaware	Oct 1997	NO		NSR offsets, RACT	
Louisiana	Aug. 1994	NO		NSR offsets, netting	
Maine	June 1998	NO		NSR offsets	
Massachusetts	Jan. 1994	YES	Reformulated gasoline	NSR offsets, RACT, netting ¹	
Michigan	March 1996	YES	Reformulated gasoline	NSR offsets, RACT, netting, BACT ¹	
New Hampshire	Jan. 1997	Proposed	Gasoline additive	NSR offsets, RACT, bubbles	
New Jersey	Aug. 1996	YES	Reformulated gasoline	NSR offsets, RACT	
New York	Oct. 1994	Proposed	Clean fuel taxis	NSR offsets, netting	
Oklahoma	1993	NO		Temporary offsets	
Texas	March 1993	NO		NSR offsets	
Clean Fueled Fleet Vehicle Programs					
Georgia	March 1998		Early over compliance	NO	Clean fuel fleet req'ts
Texas	Sept. 1998		Early over compliance	NSR offsets, RACT	Clean fuel fleet req'ts

Note: 1. Allowed under some conditions

The relatively limited use of MERCs in jurisdictions where they are allowed is partly due to the poor match between the needs of the buyer and the characteristics of the credits. To meet NSR offset requirements a new or expanding source needs credits with an indefinite life. MERCs typically have a life of three years, which means the firm needs to replace the MERCs every three years over the life of its facility. A single purchase of stationary source ERCs with an indefinite life is simpler. Use of MERCs for RACT, netting and bubble requirements may also entail periodic replacement of the credits. On the other hand, non-compliance penalties typically involve a one time offset, but use of MERCs is typically restricted to a maximum of one-third of the total reduction during any one year.

In anticipation of the Clean Fueled Fleet requirements that come into effect with the 1999 model year, Georgia and Texas have adopted programs that allow credits to be created through early overcompliance. The credits can be sold to other fleet owners who may wish to buy fewer clean fueled vehicles than mandated. In the Texas program these credits can also be converted to MERCs for use by stationary sources.