FRASER RIVER ACTION PLAN

POTENTIAL ECONOMIC INSTRUMENT APPROACHES TO AIR QUALITY MANAGEMENT IN THE GVRD

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POTENTIAL ECONOMIC INSTRUMENT APPROACHES TO AIR QUALITY MANAGEMENT IN THE GVRD

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Preface

This study of the potential for economic instrument approaches to be used as part of the implementation strategy for the Greater Vancouver Regional District's Air Quality Management Plan has been sponsored by the three levels of government: the Greater Vancouver Regional District (GVRD); the British Columbia Ministry of Environment, Lands and Parks (MELP); and Environment Canada.

This study comprises the second phase of a two phase project. The first was a study of the benefits and costs of the Air Quality Management Plan, which was submitted in April, 1994.[1]

The main members of the study team for the economic instruments study were John Martin and Douglas Williams of The ARA Consulting Group and Anne Scholtz of Scholtz and Associates of Pasadena, California. The study team was assisted by a Steering Committee consisting of representatives from the project sponsors and other interested parties, including government, private industry, and the public.

Notwithstanding this assistance, the study team has full responsibility for the analysis and conclusions of the report.

1 *Clean Air Benefits and Costs in the GVRD, The ARA Consulting Group Inc. and BOVAR-CONCORD Environmental, April 13, 1994.*

Executive Summary

Introduction

In 1990 the Greater Vancouver Regional District (GVRD) adopted *Creating Our Future*, which proposed actions aimed at improving air quality and ensuring that the region retains its liveability. One of the goals of *Creating Our Future* is to achieve, by the year 2000, reductions in emissions of five major air pollutants in the GVRD by an amount equal to 50% of the 1985 emission levels. The proposed measures for achieving this goal are outlined in the GVRD's *Air Quality Management Plan* (AQMP), which was approved by the GVRD Board of Directors in December, 1994. The measures identified in the AQMP are aimed at industrial operations, commercial facilities, residential activities, consumer products, and transportation sources.

Command-and-control regulations, which are currently used by the GVRD, are the traditional approach to protecting the environment used by governments throughout most of the industrialized world. They are based on the premise that, because there is a lack of financial incentives to encourage polluters to change their behaviour to a sufficient degree, it is the regulator's responsibility to control the activities that give rise to excessive pollution. This is achieved by restricting the behaviour and activities of firms and consumers through the implementation of regulations which prescribe the actions that polluters and the general public must take to address a given pollution problem. In the area of air pollution, command-and-control regulations generally specify the acceptable abatement methods and technologies that must be used to control emissions or performance standards which specify the allowable amount of emissions.

Economic instruments can supplement or replace many command-and-control regulations. Instead of prescribing behaviour, economic instruments use financial incentives and the market to influence behaviour in a manner that is consistent with environmental goals. For example:

- Fee systems attempt to directly associate a cost or financial burden with the behaviours that give rise to the pollution. The theory is that by increasing the costs of polluting appropriately, market forces will force polluters to reduce their emissions.

- Transferable emission limits set a cap on emissions and allow the market to distribute the financial burden efficiently. In this case, market forces do not cause the reduction in emissions (it is set by a cap that may decline), but the market is used to reduce the cost of achieving the mandated reductions.

In both cases, these systems provide consumers and firms with incentives to reduce their pollutant emissions more effectively.

This all sounds fine in theory, but could it work in reality? Could economic instruments provide a practical, attractive alternative or supplement to command-and-control regulations for implementing the GVRD's Air Quality Management Plan? The overall goal of this study was to begin to answer these questions by assessing the "potential for application of economic instruments to increase the overall cost-effectiveness of the Plan." The specific study objectives were:

- to review the applicability, feasibility, and economic effectiveness of the application of economic instruments and incentives as a component of air quality management strategies in the Lower Fraser Valley (LFV);
- to identify the pollutants and sectors most amenable to an economic instruments program;
- to make recommendations concerning the most promising economic instruments and programs; and
- for the recommended instruments, provide an assessment of the design characteristics that should be considered in order to facilitate practical application.

There are a number of reasons for carrying out a study of this type and considering the use of economic instruments for implementing the AQMP. The main ones are that economic instruments hold the promise of achieving air quality goals with **greater certainty** and at a **lower overall cost** than command-and-control regulatory approaches. However, while there are many studies in the theoretical economics literature which show the potential positive impacts of using economic instruments to regulate air pollution,[1] specific detailed designs of economic instrument programs have been left largely untouched. In addition, there are not a large number of economic instrument programs in existence from which to draw practical lessons concerning the feasibility of economic instruments and the ways in which they should be designed to meet specific objectives. This study was intended to be a first step in addressing these practical issues.

Background

The AQMP addresses five pollutants which contribute to air pollution in the GVRD airshed:

- particulates, including the inhalable PM_{10} fraction containing coarse (2.5 - 10 microns) and fine (less than 2.5 microns) particulate matter;
- sulphur oxides (SO_x);

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[1] See, for example:
- Barakat and Chamberlin (1991), "The Feasibility of NO_x and VOC Trading in the Lower Fraser Valley," *Study of Atmospheric Emission Trading Programs in the United States*, or
- Economic Instruments Collaborative (1993), *Achieving Atmospheric Quality Objectives Through the Use of Economic Instruments*.

- nitrogen oxides (NO_x);

- carbon monoxide (CO); and

- volatile organic compounds (VOCs).

The concentrations of CO, NO_x (as a contaminant on its own), SO_x, and total suspended particulate matter (TSP) appear to pose little threat at present. Based on the AQMP and the cost-benefit assessment,[2] the pollutants which appear to be of main concern include fine particulate matter of less than 10 microns in diameter (PM_{10}), a component of TSP, and ground level ozone. (Ozone is often referred to as "photochemical smog," and it results from chemical reactions between NO_x and VOCs in the presence of sunlight.) Ground-level ozone is currently seen as one of the major air quality problems in the LFV air basin, with June, July and August being the months with the highest peak ozone concentrations. Ambient levels of PM_{10} also pose a significant problem. As noted in the AQMP cost-benefit analysis, the health effects associated with PM_{10} are pronounced and can occur even at low concentrations.

The implementation of the AQMP (and associated federal vehicle emissions standards), while making a significant contribution to improved air quality levels, will not meet the GVRD goal of an overall 50% reduction from 1985 levels in aggregate emissions. It will result in only a 38% decline in aggregate emissions (and a 58% reduction in per capita emissions) by the year 2000. The reductions will stem from significant declines in CO (by 45%), VOCs (by 33%), and SO_x (by 50%). However, NO_x is expected to decline only marginally (by 2%), while particulates (excluding road dust) are expected to increase by 3% from 1985 levels.

It appears, then, that the priority pollutants for additional regulatory action are particulates, especially PM_{10}, and NO_x. The main source of PM_{10} is point sources (large industrial and commercial operations). They account for 61.5% of particulate emissions in the LFV. Point sources are also a significant contributor to NO_x; they account for 16.5% of emissions. However, in order to control NO_x, the mobile sector must be addressed, since this sector accounts for 77.3% of NO_x emissions.

The primary focus of this study, therefore, was on the design of an economic instruments program for NO_x in the point and mobile source sectors and PM_{10} in the point source sector.

Types of Economic Instruments Considered

The study assessed the potential applicability of three main types of economic instruments:

- subsidies;
- environmental charges; and
- transferable emissions limits.

2 *Clean Air Benefits and Costs in the GVRD*, ARA/Bovar-Concord, May, 1994.

"Subsidies" refer to various forms of financial assistance which seek to provide either an incentive for polluters to alter their behaviour (such as subsidies for carpooling and public transportation) or provide assistance to firms facing financial problems in complying with regulatory standards. Low interest loans provided to polluters if they adopt certain pollution abatement measures are an example of the latter kind of measure.

"Environmental charges" are charges for the "use" of environmental resources, which are intended to provide consumers and producers with a financial incentive to use the environment more wisely. The most common type of environmental charges are emission fees or taxes. These generally involve charges levied on each unit of a particular pollutant that a facility releases, and they often vary with the toxicity of the pollutant. Other types of environmental charges are user fees (payments to cover the costs associated with the public management of emissions), bridge and road tolls, product charges (charges levied on the prices of products which result in pollution), and tax differentiation (more favourable tax treatment for "environmentally friendly" products).

"Transferable emissions limits" programs (often referred to as emissions trading programs) are the type of measure most commonly associated with the term "economic instruments". The basic concept of such programs is as follows.

Under a transferable emissions limits program, an "emissions cap" is first set by the regulator. The cap specifies the total quantity of allowable emissions in the region in a given time period (usually a year). A set number of coupons are then distributed to emitters in the region. Each coupon represents an entitlement to emit a specific amount of discharge in the time period, and the sum of these entitlements is equal to the emissions cap. Each emitter must hold coupons equal to the amount of a given pollutant they emit. The emissions limits these coupons represent are transferable and can be bought and sold by emitters in the marketplace.

In this system emitters are given the freedom to determine how best to reduce their emissions. Those emitters with relatively low abatement costs will reduce emissions by more than their allotment of coupons would require, because they will be able to sell the unused coupons to emitters who find it financially difficult to meet a required reduction. Another market for unused coupons is new sources that wish to operate in the airshed; these sources must purchase coupons from existing sources to completely offset their emissions.

There are two major advantages -- at least in theory -- to transferable emissions limits programs in comparison with both command-and-control measures and price-based economic instruments (such as subsidies and environmental charges):

- They can achieve improvements in air quality with greater certainty than can be achieved with other measures, because the desired emission limits are specified, and emitters have no choice but to adjust their behaviour in a way that total emissions are less than or equal to the specified level. (With emission fees, in contrast, regulators must guess what levels of fees are required to bring about the necessary changes in behaviour.)

- Transferable emissions limits programs offer the potential that air quality improvements can be achieved with a substantially lower commitment of resources to pollution control. This is because emitters are able to select the most cost-effective abatement measures within their facilities, and they are able to make cost-effective trades across facilities (e.g., those who can abate cheaply and extensively can reduce emissions more and be compensated by those for whom abatement is expensive).

As a consequence of this latter point, while the polluters still pay (since the low cost emitter has to incur abatement costs and the high cost emitter has to purchase the privilege to emit in the form of coupons), the overall cost of control is reduced.

Note that the three types of economic instruments discussed above can be used in combination (and they can also be used in combination with command-and-control measures). One particular hybrid system involves a combination of a transferable emission limits program and emission fees. This type of program has a number of positive features. For example, such systems are generally more publicly acceptable, since the public sees that the system generates revenues and explicitly reflects the "polluter pays" principle. Also, the revenues generated by such a system can be used to cover the cost of its administration.

Assessment of Alternative Management Measures

A portion of this study was devoted to screening the range of management measures available in order to narrow the range of choices and provide an indication of what types of measures hold the most promise for implementing the AQMP. The measures screened included both command-and-control measures and economic instruments. The command-and-control measures were:

- Enforceable restrictions -- restrictions regarding products or processes that can be used (e.g., CFC restrictions); and

- Uniform emission standards -- standards regarding technology that has to be used or emission limits that have to be met by emitters.

The economic instruments assessed are listed under these two measures in Exhibit E.1. (The definitions of these economic instruments are contained in the previous section.)

The criteria used in the assessment were:

- *Environmental Effectiveness:* The degree to which the measure is capable of achieving the environmental goals and/or other social objectives of an air quality management program.

- *Cost Effectiveness:* Whether the measure leads to the achievement of the designated environmental goals at the lowest cost to emitters, the government, and the public.

Exhibit E.1: Assessment of Alternative Emission Management Measures

Alternative Management Measures	Criteria					
	Environmental Effectiveness	Cost-Effectiveness	Polluter Pays	Administrative Simplicity	Equity	Acceptability
Enforceable Restrictions	✔	✔	✔✔	✔✔	✔✔	✔✔
Uniform Emission Standards	✔	✔	✔✔	✔	✔	✔✔
Subsidies for Public Transportation/ Carpools	✔	✔	✘	✔✔	✔✔	?
Emission Reduction Subsidies	✔	✔	✘	✔	✘	✔
Emission Fees/Taxes	✔✔	✔✔	✔✔	✔	✔	✔
User Charges	?	?	✔✔	✔✔	✔	✔✔
Bridge and Road Tolls	✔✔	✔	✔✔	?	✔✔	?
Product Charges/Tax Differentiation (e.g., disposal levies on batteries and tires)	✔✔	✔✔	?	✔✔	✔✔	✔✔
Transferable Emissions Limits	✔✔✔	✔✔✔	✔✔	?	?	?
Dual Coupon/Fee Programs	✔✔✔	✔✔✔	✔✔	?	?	?

Compliance with Criteria:

✔	Low	✘	Violates Criteria
✔✔	Medium	?	Uncertain as criteria does not generally apply or the effect is uncertain
✔✔✔	High		

- *Equity:* Whether the costs of compliance are fairly distributed across emission sources (e.g., are the costs distributed across sources in proportion to their relative contributions to emissions).

- *Administrative Simplicity:* Whether the rules are clear and predictable, and the administrative monitoring and enforcement burdens borne by government, regulated parties, and the public "reasonable".

- *Polluter Pays:* Whether the measure is consistent with the polluter pays principle; i.e., are those who emit pollutants responsible for the costs imposed by their discharge?

- *Acceptability:* Whether there is support for the measure among the regulated, the regulators, and the public.

The results of the assessment are shown in Exhibit E.1. A shown in that exhibit, there are advantages and disadvantages associated with each of the management measures. Some measures rank high relative to certain criteria, while not against others. However, it is also clear from the exhibit that, with the possible exception of acceptability, transferable emissions limits programs (or transferable emissions limits programs combined with emissions fees) appear to be very attractive relative to other measures.[3] (Administrative simplicity and equity are also given ambiguous ratings in the exhibit, but, for reasons explained in the text, these measures are unlikely to fare worse on these criteria than command-and-control measures.) The main reasons are discussed above -- namely, the fact that transferable emissions limits programs are quantity measures which force the aggregate emissions from all sources (including new sources) to remain under the emissions cap, and the fact that, in theory, these programs are highly cost-effective.

As a result of the above, the study concludes that a program utilizing transferable emissions limits for stationary source emissions of PM_{10} and NO_x and mobile source emissions of NO_x would be worthy of further consideration. (The study also concludes that any measure which is directly linked to financing the costs of administering air quality management and which makes these costs more apparent to industry and the public will also serve a useful role in addressing the AQMP goals. Such measures include bridge and road tolls, fees related to motor vehicle emissions, other charge-based transportation demand measures, and user fees.)

Recommended Economic Instrument Design

The key assumptions underlying the recommended design of the economic instrument program are as follows:

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[3] It should be kept in mind, however, that this assessment is largely based on the theoretical or expected properties of the programs. It can vary dramatically with specific program designs.

(1) the objective of the economic instruments program would be to achieve the emission reductions specified in the AQMP at the greatest speed and the least cost (other possible objectives are discussed in the report);

(1) the program must be designed for pollutant-specific reductions, not simply an aggregate 50% reduction;

(3) source sectors participating in the program, as well as new sources, would not be subject to specific control equipment or process requirements, but rather subject to emission limits as defined by the economic instrument program.

There are also certain assumptions regarding the current or future availability of information (e.g., an accurate emissions baseline for the airshed) and the legal ability of the GVRD to implement the program.

Assumption (1) is called in the report our "Case 1" assumption regarding the role of economic instruments. Other alternative assumptions that could have been made are:

- *Case 2:* In this case it is assumed that the emission reduction measures outlined in the AQMP will be fully implemented and the objective of an economic instruments program is to provide emitters with an incentive to achieve emission reductions in excess of those achieved through the application of the AQMP emission reduction measures alone. Essentially, this case assumes that economic instruments will be utilized primarily to fill the gap between the 38% reduction in annual emissions achievable under the AQMP and the 50% reduction goal.

- *Case 3:* In this case it is assumed that the objectives of the AQMP will be achieved through the application of the emission reduction measures outlined in the AQMP and through the retention of new source performance requirements. The principal objective of an economic instruments program in this case will be largely limited to providing a means of accommodating economic growth (as opposed to achieving improved cost-effectiveness and/or greater/earlier reductions).

This study was based on the Case 1 assumption primarily because it provides a good basis for assessment. It provides a clear picture of the potential feasibility and advantages and disadvantages of economic instruments. In addition, an analysis of Cases 2 and 3 would require more detailed information regarding the implementation plan for the AQMP and additional assumptions regarding how and to what sources economic instruments would be applied and how they would be integrated with the AQMP and other regulatory measures.

Cases 2 and 3 could be the subject of further study, as could any other cases involving a mix of command and control measures and economic instruments. Such analyses could take into consideration the measures that are already in place or committed.

The program design recommended for further consideration involves the management of both the mobile and point source sectors by means of a hybrid transferable emissions limits/emissions fees program -- i.e., in addition to a transferable emissions limit component, emissions fees (fees per unit of emissions) would be charged to cover the costs of program administration and monitoring.

Trading across sectors would be allowed in this recommended system. The program is illustrated in Exhibit E.2. The transferable emissions limits components for both sectors are further described below.

Exhibit E.2: Economic Instruments Program Design Features

Mobile Sources

- Emissions allocation (coupons) for each vehicle, summing to an overall cap for the mobile sector.
- Fees per unit of emissions to cover administration and monitoring.

Point Sources

- Emissions allocations (coupons) for each point source, summing to an overall cap for the point source sector.
- Fees per unit of emissions to cover administration and monitoring.
- The coupons would be issued with staggered dates.
- For No_x there would be separate coupons for the ozone season and the off season.

The system for the mobile sector can be described **conceptually** as follows. First, each vehicle would be allocated coupons equal to the total vehicle emissions attributable to that particular vehicle in a year. The initial allocation could be based on AirCare data for older vehicles (i.e., vehicle emissions and kilometres travelled) or expected emission rates for new vehicles. Then, in order to register the vehicle each year, the coupons in that vehicle's account must be sufficient to cover the estimated emissions of the vehicle in the previous year (this could be estimated from AirCare data or the vehicle's emission rate and the kilometres travelled in the previous year). If the vehicle has created emissions in excess of its number of coupons, then the owner must purchase additional coupons. If, instead, the vehicle has been prudently driven, or the owner has otherwise reduced the emissions from the vehicle (for example, by installing emissions control equipment or utilizing alternative fuels), then excess coupons in the owner's account can be sold to any other motor vehicle owner or facility.

In reality, individual vehicle owners would not need to search for buyers and sellers of coupons. This would likely be handled through some form of broker, and individuals would understand the system simply as having to pay for excess emissions or receiving payment for lower emissions. Additional details of this system -- for example, how new vehicles would be introduced and old vehicles retired -- are discussed in the text.

Point sources of NO_x would also be subject to a hybrid transferable emissions limits/emissions fees program, with the additional features that the coupons issued to point sources would be staggered (i.e., the coupons would be issued with staggered dates, with half the annual coupons covering emissions from January through December, and the other half covering emissions from July through June of the following year), and there would be separate caps for the ozone season (May through September) and the off-season. The caps for both mobile and point sources would decline over the time frame of the AQMP, eventually ending at the targeted reduction.

The same type of declining balance, staggered coupon system is recommended for point sources of PM_{10}. The difference would be the absence of seasonal and off-season caps. Over time, mobile sources would also be included in the program.

The report contains considerable discussion of the details associated with implementing this system, as well as additional necessary program design considerations. For example, the spatial distribution of ozone probably requires some form of zonal control of NO_x, whereby no source in the western region of the GVRD can increase its emissions above a specified level by using coupons from the eastern region.

Over time a transferable emissions limits program could also be applied to other contaminants and source sectors. However, the approach taken in this report is that a transferable emissions limits program would have a greater chance of being accepted (and therefore of being a success) if it is first implemented in "problem" areas; i.e., to address the Priority 1 air quality issues in the region.

Potential Cost Savings

The study contains a preliminary assessment of whether the potential cost savings of an economic instruments program, compared with command-and-control measures are likely to be significant. (Cost savings are often touted as the main reason for adopting such systems, although in reality the ability to set and maintain a cap on emissions may be a larger benefit.)

The following is a simplified example of how cost savings could occur:

> Shown below are our estimates of the emission reductions and cost-effectiveness of two alternative control measures for cement kilns in the GVRD.

Measure	Control Levels	Total Reduction in NO_x (tonnes)	Cost Effectiveness ($ per tonne)
A	50%	30,819	$917
B	89%	54,858	$2,771

Measure A is required in the AQMP. Measure B is available to cement kilns if they could afford it. Under a regulatory regime of required control measures by facility type -- or required reductions in emissions by facility type -- there would be no incentive for cement kilns to adopt these stricter control measures.

Under the AQMP gas fired boilers are required to use a stricter control option (call it C), which has cost-effectiveness of approximately $6,091/tonne reduced. Rather than pay $6,091/tonne, it would clearly make more sense for gas fired boilers to subsidize cement kilns (by paying them, say, $3,000/tonne) to adopt measure B. The emissions reduced as a result of such a trade would be reduced at less overall cost than if gas fired boilers were required to adopt measure C.

Much of the analysis in the study is based on the data from the RECLAIM program in Southern California. The cost savings from that program are estimated to be approximately 55% of the cost associated with command-and-control measures. The study concludes that in the GVRD the cost savings associated with implementing the recommended economic instruments would be positive, and likely very significant.

As discussed in some detail in the report, the actual magnitude of realized cost savings will depend on a host of factors -- for example, whether the program is implemented as a substitute for or a compliment to command-and-control measures, whether specific control technology policies and new source performance standards are retained, and so on. It does appear, however, that the implementation of an economic instruments program would allow the emission reductions required under the AQMP to be achieved at a reduced cost to society.

This study was not intended to design the final instrument. Rather, it highlights both the design features of an instruments program that are likely to work best and which hold promise for application in the GVRD; and the regulatory issues, design parameters and trade-offs that would have to be addressed before a final design could be reached and an implementation plan developed.

Based on the general design principles outlined in this study, the next step would be to identify more definitively the role that economic instruments could play in combination with other measures that are in place or committed and investigate further the feasibility of that role.

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1.0 Introduction

1.1 Economics and the Environment

In 1989 the Greater Vancouver Regional District (GVRD) initiated the *Choosing Our Future* program as part of its effort to identify the major regional planning issues of greatest public concern in the Greater Vancouver area and to facilitate discussion about how best to address these issues. As part of the program's public consultation process, the GVRD conducted the *Urban Futures Opinion Survey* to solicit opinion as to the key issues of concern to the residents of the GVRD. The results of this survey indicated that air quality is an area of primary concern and an issue that requires public policy action.[1] The demand for such action reflects the importance residents place on maintaining a healthy and livable region.

As a response, in 1990 the GVRD adopted the *Creating Our Future Action Plan* aimed at improving air quality and assuring that the region retain its high livability. One of the goals of the *Action Plan* is to achieve, by the year 2000, reductions in the regional emissions of several major air contaminants by an amount equal to 50% of 1985 emission levels.[2] The measures to be implemented to achieve this goal are addressed in the GVRD's *Air Quality Management Plan* (AQMP),[3] which was approved in December 1994.

The AQMP was developed on the basis of two previous technical reviews: (i) Stage 1 (1989) review of emission and air quality trends in the region; and (ii) Stage 2 (1993) assessment of promising emission reduction initiatives and an update of the emissions inventory and emissions reduction forecasts. The emission reduction measures addressed in the AQMP apply to industrial operations, commercial facilities, residential activities, consumer products, and transportation sources. The implementation of the emission reduction measures addressed in the AQMP will allow the GVRD to achieve a substantial proportion of its overall regional emissions reduction goal.

Having completed various technical studies to identify both the emission reductions that it considers a high priority and the means of achieving these reductions, the GVRD began to investigate the economics of the AQMP. As part of these investigations, a cost-benefit analysis of the AQMP was prepared for the GVRD which assessed both the costs of obtaining the recommended source-specific emission reductions and the benefits associated with the resultant improvements in air quality.[4] The principal conclusions from the base case analysis provided in the draft cost-benefit study are:

- The total cost of implementing the AQMP (excluding monitoring, enforcement, and administration costs) is estimated at $3.8 billion. It will generate health and economic benefits estimated at $5.4 billion and net benefits of $1.6 billion.[5]

- In addition to the quantified benefits, the implementation of the AQMP will lead to additional benefits associated with improvements in visibility and the aesthetics of the region (these benefits could not be quantified in the draft cost-benefit study).

- Of the estimated control costs of the AQMP, 34% are borne by mobile sources, 54% by point sources and 12% by area sources.

In short, the draft cost-benefit study demonstrated that the benefits associated with the implementation of the AQMP exceed the total costs of installing and operating the AQMP recommended emission reduction measures under a variety of assumptions.[6]

1.2 Why Study Potential Economic Instruments?

The cost-benefit analysis was conducted under the assumption that the AQMP was constructed and would be implemented as a command-and-control environmental regulation. Hence, the study did not explore the capacity of industry and the public to absorb the control costs, nor the question of whether alternative control measures, or an alternative emissions management approach (such as greater reliance on economic instruments) might achieve the same air quality benefits as the AQMP but in a more cost-effective manner.

As noted in the AQMP, the earth's atmosphere is finite; however, so too is the ability of an economy to support both the air quality objectives and the economic growth desired by the public. Thus, in developing air quality management programs, the trade-offs between the attainment of desired air quality objectives and other social and economic goals can become important factors. Recognizing this reality, if the costs of achieving the air quality improvements associated with the AQMP could be reduced, a balance between environmental, social and economic objectives could be easier to strike. In addition, to the extent that the costs of the AQMP could be reduced without affecting the attainment of overall air quality improvements, then the net benefits (i.e., total benefits less total costs) of the Plan to the residents of the Lower Fraser Valley (LFV) would effectively increase. Furthermore, if the goals of the AQMP can be met at a lesser cost, then resources that would otherwise be committed to emission reduction activities could be released for additional activities of social and economic importance.

It is within this context that the GVRD, the Province of British Columbia, and Environment Canada jointly commissioned a study to consider *market-based economic incentives*, or *economic instruments*, as supplements to, or alternatives to, the traditional *command-and-control* regulatory approach that has dominated environmental regulation in the GVRD, the province, and the nation as a whole. The principal objective underlying this initiative is to assess the "... potential for application of economic instruments to increase the overall cost-effectiveness of the Plan."[7]

The rationale for this study is based largely on the theoretical proposition that economic instruments—such as emissions trading, emission fees, various transportation demand management measures (TDM) and other economic incentives—have the potential of achieving or exceeding the AQMP's air quality goals with a greater degree of certainty and at a lower overall cost to residents and industry than emission standards, best available control technology (BACT) requirements, or other more traditional command-and-control regulatory approaches. In addition, the incentives that economic instruments provide may induce emitters to achieve the emission reductions called for under the Plan over a shorter period of time. Furthermore, provided that the existing (estimated) costs of the Plan can be absorbed by sources in the LFV, then, by applying economic instruments, the potential exists to achieve greater emission reductions in the LFV for the same costs that are associated with the AQMP as it is currently defined.

In addition to the potential for realizing reductions in overall control costs, a study of this kind is of interest since market-based economic instrument/economic incentive alternatives to regulatory command-and-control also offer a number of other potential advantages. For instance, they create incentives for emitters to investigate and develop new, innovative emissions reduction technologies. Furthermore, they generate the funding required for these research and development activities: it comes from the firms that generate emissions, not the public purse.

Another potential advantage of economic instruments stems from the fact that, in the past, the environmental costs of pollution have not been adequately reflected in product prices. Using well-designed economic instruments and incentives, meeting the AQMP goals should increase the costs of products and practices that create the most air pollution. This would serve to align the goals of the AQMP with prices reflected in the marketplace and would provide consumers and producers with the price signals and incentives they require to help them make environmentally beneficial choices.

Finally, by providing polluters with the incentive to investigate and develop new, innovative emissions reduction technologies as a result of the application of economic instruments and incentives, it may be possible to effectively address certain contaminants that may be particularly difficult to cost-effectively control with existing technologies. For example, the AQMP draft cost-benefit study demonstrated that most of the economic benefits that will accrue in the GVRD and the Eastern Lower Fraser Valley (ELFV) as a result of the Plan, stem from reduced growth in emissions of primary particulate matter (and especially fine particulate matter of less than 10 microns in diameter). However, even with the application of control measures identified in the AQMP, emissions of primary particulates in the year 2000 are estimated to be only marginally less than emissions in 1990, and slightly greater than emissions in 1985.[8] Thus, economic instruments may be of interest in that, while currently known technologies may not yield significant and cost-effective reductions in particulate emissions, when economic instruments are applied sources are able and often willing to invest in the research and development of new technologies. In addition, they have the incentive to develop new, cost-effective technologies; under command-and-control style programs this incentive is missing.

1.3 Economic Instruments and the AQMP

While the theoretical economics literature is replete with studies showing the potential, positive impacts of using economic instruments to regulate air pollution, specific detailed designs of the programs have been left largely untouched. In addition, while economic incentives such as bridge tolls, road tolls, parking charges, and subsidies for public transportation and carpools are more common, there are not a large number of economic instrument programs such as emissions trading or transferable emissions limits programs in place from which to draw practical lessons concerning program design and implementation issues. There are many factors underlying the design of a program; however, certain types of instruments and classes of programs are better than others depending upon the characteristics of the regulated area.[9]

In combination with the characteristics of the airshed, a particularly important factor affecting the design of economic instrument applications in the LFV is the goals and objectives of the AQMP itself and the role to be assigned to economic instruments with respect to their achievement. For example, one of the principal objectives of the AQMP is to achieve a reduction in the levels of several pollutants including ozone, sulphur and nitrogen oxides, particulates, carbon monoxide, and volatile organic compounds. One of the objectives of this study is to describe the economic instrument programs that are likely to work most effectively at meeting the air quality objectives for at least a subset of these individual contaminants. However, the type of economic instruments available for this purpose depends on as yet unresolved issues concerning the manner in which economic instruments generally would be integrated within the AQMP. Furthermore, these contaminants have distinct characteristics that may make the components of the most beneficial regulatory policy differ across both the priority contaminants and sources (e.g., ozone is a seasonal pollution problem while other contaminants do not share this characteristic). In addition, the ability of economic instrument applications to effectively address the contaminants of concern in the LFV will depend on the role assigned to them, with respect to specific air quality issues, under the AQMP.

Another key goal of the AQMP which has bearing on instrument selection and design is the need to reduce the expected growth in mobile source emissions. The AQMP suggests that this may be accomplished by discouraging the use of automobiles -- and particularly single occupant vehicles -- as the primary mode of transportation and encouraging the use of alternative transportation modes, such as public transit, car pooling, increased bicycle commuting, etc. The inclusion of mobile sources into any economic incentives/instruments program can be beneficial to all source types, and can ensure that emissions decline rather than increase as new vehicles move into the regulated area as a consequence of population growth and economic development. In addition, measures taken to address the mobile source sector can result in benefits in addition to reduced emissions, such as reduced congestion, improved land use, and reductions in noise.

Finding the means to effectively address mobile sector emissions is especially important in the LFV as mobile sources currently generate 85% of total emissions in the region.[10] This study suggests an innovative approach to reducing vehicle emissions and, perhaps for the first time, directly incorporating a significant part of the environmental cost of vehicle emissions into consumer decisions.

1.4 Purpose of the Study

There is a variety of potential economic instruments and incentives that could be used to address air quality issues in the LFV, and an almost unlimited number of design alternatives associated with each. The overall goal of this report is to narrow the instrument choices and design alternatives to those the Study Team sees as offering viable policy options for the GVRD to use in meeting their AQMP objectives. In meeting this overall goal, the purpose of this study is essentially four-fold:

- To review the applicability, feasibility and economic effectiveness of the application of economic instruments and incentives as a component of air quality management strategies in the LFV. (The Terms of Reference for this study indicated that the focus of the economic instruments/incentives evaluation would be primarily on a program for marketable permits and/or higher permit fees in the LFV; however, alternative incentives are also included.)

- To identify the contaminants and sectors most amenable to an economic instruments program, with emphasis (particularly in the case of an emissions trading program) on nitrogen oxides and volatile organic compounds, and with reference to the results of the draft AQMP cost-benefit study indicating which contaminants account for the greatest damage.

- To make recommendations concerning the most promising economic instrument programs that, given the characteristics of the LFV airshed, would facilitate the attainment of the AQMP air quality goals.

- For the recommended instruments, provide an assessment of the design characteristics that should be considered in order to facilitate practical application.

However, some critical regulatory decisions necessary for carrying out these analyses had not been made in advance of this study. As a result, some important pieces of information for this study were missing, including:

- a description of the specific objectives that economic instruments applications should be designed to achieve (e.g., to facilitate economic growth, to meet the full emission reductions required by the AQMP, or to fill the gap between the reductions achievable under the AQMP and the overall 50% reduction goal);

- the type of emission reduction required (e.g. a 50% reduction in total emissions or individually limited contaminants, peak versus aggregate reductions);

- the manner in which economic instruments will be integrated into the overall air quality management program (e.g., will they supplement or replace specific command-and-control strategies, will they be integrated into the AQMP in a complimentary way or stand as an addition to the AQMP as defined);

- the type of monitoring that the GVRD would be willing to require, and that facilities would find feasible; and
- the treatment of old versus new sources.

In the absence of this information, the Steering Committee directed the Study Team to make appropriate assumptions, and the analysis presented in this report is premised on those assumptions.

1.5 Study Scope

This study is meant to answer broad questions regarding: which contaminants/sources in the GVRD/ELFV are amenable to an economic instruments program; whether the application of economic instruments would have the potential to produce cost savings and/or lead to greater/earlier emission reductions than envisaged under the AQMP; what are the most appropriate economic instruments to recommend for application in the LFV; and what design characteristics should the recommended programs exhibit.

On the basis of this study, further analysis could address itself to much more specific issues such as: the full design specifications for an instrument program; the definition of an implementation plan; specification of monitoring, enforcement, administrative and legislative requirements; comprehensive costing of the fully designed instruments; and an assessment of the compliance, administrative and monitoring costs associated with the implementation of the instruments. While this study is not intended to answer this latter set of questions, it does provide the basic framework for any subsequent analysis. In addition, it identifies the types of data that would be required, the regulatory choices that would have to be considered, and the decisions that would have to be made, prior to conducting a full fledged instrument design and implementation study.

It should be noted that the economic instrument recommendations presented in this report have been developed in light of the fact that much of the literature pertaining to economic instruments is of U.S. origin, and that the vast majority of experience with the application of economic instruments to address air pollution issues resides in that country as well. However, while the broad use of economic instruments is a relatively new concept in the Canadian policy making arena, a number of studies have been conducted to assess the merits and feasibility of economic instrument applications within a more "Canadian" context. Some examples of the studies that have been conducted in the area include:

- CCME (1992), *Emissions Trading: A Discussion Paper*.
- Environment Canada (1992), *Economic Instrument for Environmental Protection*.

- NERA (1990), *The Impact on Ontario Hydro of Emissions Trading for Nitrogen Oxides: A Preliminary Analysis.*

- NERA (1993), *An Emissions Trading Program for Sulphur Dioxide Sources in Canada.*

- Economic Instruments Collaborative (1993), *Achieving Atmospheric Quality Objectives Through The Use Of Economic Instruments.*

- Barakat and Chamberlin (1991), "The Feasibility of NO_x & VOC Trading in the Lower Fraser Valley", *Study of Atmospheric Emission Trading Programs in the United States.*

- GVRD (1993), *GVRD Air Quality Management Plan Phase 1 Consultation Report: Appendix 1 - Economic Instruments, Stakeholder Report #7.*

- West Coast Environmental Law Research Foundation (1993), *Economic Instruments and the Environment: Selected Legal Issues.*

The Study Team has drawn extensively on the information presented in reports such as those named above. However, the feasibility of most economic instrument programs needs to be studied on a case by case basis, and the majority of economic instrument studies conducted in Canada have not focused on specific applications and design issues in specific jurisdictions. As a consequence, jurisdiction-specific program design issues, and especially the traps and pitfalls associated with certain program designs, are not well documented. This comes as no surprise as such information only emerges through experience with practical applications. By necessity, then, much of the practical knowledge underlying the Study Team's recommendations for economic instrument program designs is drawn from US experience. However, despite the necessity to draw on practical experience in the U.S., the theoretical approaches and understanding of the implications of many practical design issues have been tailored to meet the particular circumstances and needs of the GVRD/ELFV.

1.6 The Study in Context

It is important to recognize that this study represents the results for the earlier stages of the instruments design process and not the final word. As noted above, this study is in essence an extension of the AQMP draft cost-benefit study, and this is reflected by the fact that the principal objective is to assess the potential for application of economic instruments to increase the overall cost-effectiveness of the AQMP. The study does identify potentially viable economic instruments and specifies the appropriate design features for the instrument programs. However, given that regulators in the GVRD have now begun to consider economic instrument alternatives for air quality management, part of the purpose of this study is also to identify the issues that regulators need to address (and the trade-offs implied by many of these issues) in order to further the development of economic instrument programs in the LFV. For example, while assumptions are utilized in this study concerning the issues raised in Section 1.4 above, as regulators begin to address such issues, the choice and design of economic instruments programs may evolve.

This study does not address issues arising as a result of the international dimensions of the LFV airshed. Emissions from the U.S. may affect air quality in the Canadian segment of the airshed. While issues surrounding trans-boundary emission are outside of the scope of this study, they may effect the eventual design of an instruments program.

1.7 Organization of the Report

The balance of this study is organized into six sections, each of which is described below.

Section 2.0 provides an overview of the study region; the characteristics of the airshed; the types and distribution of emission sources in the GVRD; and existing and currently projected levels of pollutant emissions and their implications for ambient air quality. The main purpose of this section is to identify the priority air quality issues in the region and to provide a preliminary indication of which contaminants (and source sectors) should receive priority in the application of an instruments program. In addition, this section briefly compares the types of issues being addressed in the GVRD to those found in some of the other jurisdictions that have an economic instruments program in place or are considering such applications.

While Section 2.0 is meant to provide a synopsis of the characteristics of the Lower Fraser Valley airshed and provide a basic understanding of the nature of the air quality problems being faced in the LFV, the purpose of Section 3.0 is to provide a synopsis of the regulatory alternatives available to address air quality management issues. In addition, this section provides the contextual information necessary to more fully understand and interpret the material presented in subsequent sections. To these ends, Section 3.0 provides a general discussion of:

- the two main approaches to controlling emissions (command-and-control and economic incentives/economic instruments), their rationale and their defining characteristics;

- the array of management measures available to address air pollution issues under each regulatory approach, a sub-set of which might be applicable to the air quality management issues being addressed in the LFV; and

- the differences and similarities that exist between the regulatory approaches, and the advantages and disadvantages associated with the application of each approach.

As the discussion in Section 3.0 indicates, there is a variety of alternative control measures available for air quality management. Hence, in Section 4.0 a set of criteria that can be used as a basis for screening, assessing and selecting among alternative management measures are outlined. In addition, on the basis of a number of assumptions concerning the goals and operational objectives of the AQMP, and the role of economic instruments vis-a-vis these goals and objectives, a preliminary assessment of management measures relative to these criteria is provided.

Drawing on this assessment, Section 4.0 outlines the Study Team's *general recommendations* concerning the choice of management measure(s) that might best facilitate the attainment of the goals and objectives of the AQMP. As part of the discussion, we outline some of the reasons why the GVRD might want to consider economic instruments, and particularly emissions trading, as a supplement to, or an alternative to, a command-and-control approach to the implementation of the AQMP and the attainment of regional air quality goals. In addition, we outline the general arguments that support our conclusions concerning the specific economic instrument being recommended for consideration. In addition, we identify the pollutants and source sectors that would be the most practical candidates for instrument applications in the short-term. Finally, while we do not describe specific instrument designs in this section of the report (that is left to Section 5.0), we do introduce a variety of issues concerning the characteristics that an emissions reduction program containing economic instruments would need to exhibit in order for it to be effective. As part of this discussion, we also outline our assumptions concerning these issues that frame the analysis presented in Section 5.0 of this report.

Section 5.0 describes the specific economic instrument designs being recommended by the Study Team for possible application in the GVRD/ELFV. Our recommendations are provided primarily for point and mobile source emissions of particulate matter of less than ten microns and nitrogen oxides[11] (design recommendations for all pollutants and sources in the GVRD/ELFV are provided in Appendix B). As part of the discussion, any key design/implementation characteristics required to avoid or mitigate any constitutional/legal issues, jurisdictional concerns, or strategic responses by emitters that could compromise the effectiveness of the instruments program are noted. In addition, for each of the instrument recommendations, we also provide an example of how the recommended instrument(s) could work in practice to generate environmental benefits within the GVRD/ELFV.[12] Furthermore, since the characteristics of the recommended instrument programs can vary with the objectives assigned to them under the AQMP, design variations are described for each of three different scenarios concerning the purpose and goals of an emissions reduction program containing economic instruments. Section 5.0 concludes with a review of some outstanding issues that could not be addressed in this study (e.g., jurisdictional, legal, and trans-boundary issues).

Section 6.0 provides a quantitative assessment of the potential cost savings that might accrue in the LFV from the application of a management program employing economic instruments versus a program implemented on the basis of a traditional command-and-control approach alone. The assessment provides a gross estimate of the control cost savings arising from the potential for point sources of NO_x and PM_{10} to utilize alternative abatement strategies as defined by existing technology. The analysis is based on abatement cost data collected for the AQMP cost-benefit study and on data prepared by the South Coast Air Quality Management District (SCAQMD). Due to data limitations and the necessity for the Study Team to make various assumptions about the structure of source's abatement costs, the estimates provided are broad; however, they indicate the magnitude of the cost savings for a static analysis of NO_x and particulates. This section concludes with a brief discussion of the expected administrative and monitoring costs associated with the implementation of an economic instruments program which incorporates our recommendations.

The Study Team's overall conclusions and recommendations for future work are presented in Section 7.0. As part of this section, any issues and assumptions which regulatory bodies in the GVRD/LFV must decide upon before consideration is given to extending the analysis (e.g., data collection and monitoring issues, geographic considerations, jurisdictional/legal considerations) are enumerated. In addition, an outline is provided of the tasks required to further refine the design of the economic instruments program and determine an implementation plan; to provide a comprehensive, quantitative assessment of the environmental and cost implications of adopting the recommended instruments program; and to provide a quantitative assessment of the program's economic feasibility and general acceptability.

The sections described above are supported by four appendices. Appendix A provides supporting detail for the material presented in Sections 3.0 and 4.0. Appendix B provides supporting detail for the material presented in Section 5.0 as well as design recommendations for all pollutants and sources in the GVRD/ELFV. Appendix C describes some of the potential difficulties that regulators may have to contend with when dealing with seasonal ozone controls. Appendix D provides an example of the types of trading rules that regulators in the GVRD/ELFV may have to define if they elect to proceed with the implementation of an economic instruments program.

Endnotes

1. The results of the survey indicated that out of the list of the top 54 public policy concerns identified by the residents of the GVRD, air pollution from industry and air pollution from automobiles ranked third and eighth respectively.

2. This 50% calculation is based on the *sum* of the total tonnes of each of the following pollutants: particulates, carbon monoxide, sulphur oxides, nitrogen oxides, and volatile organic compounds.

3. Referenced as GVRD (1994d).

4. Referenced as ARA/Bovar-Concord, (1994).

5. The cost and benefit estimates are expressed in 1993 dollars and are discounted over the time period from 1985 to 2020 at a discount rate of 4%.

6. The cost-benefit study addressed the 33 recommendations and 54 emission reduction measures specified in the draft AQMP in aggregate (i.e., the costs and benefits associated with individual measures was not explored), as well as the federal new vehicle emission standards. In addition, costs and benefits were assessed for the GVRD and for the three regional districts in the Eastern Lower Fraser Valley that share the common airshed. Furthermore, the study assumed a "command-and-control" approach under which the specified emission reductions would be fully realized; however, enforcement, monitoring and administrative costs were not addressed.

7. GVRD (1994e), pg. 9-1.

8. Calculated from GVRD, (1994e), Tables 4-1 and 11-1.

9. To name just a few, these characteristics include the type and variety of sources in the airshed, the geographic nature of the pollution distribution, the meteorology of the area, how the pollutant can be measured and monitored, and whether aggregate or peak emission controls are most important.

10. GVRD (1994b), pg. 7.

11. While it is suspected that NO_x emissions drive ozone formation in the LFV, there is some uncertainty as to whether volatile organic compounds (VOCs) is the key pollutant behind ozone; hence, design recommendations are provided for this pollutant in Appendix B.

12. Various alternative methods of applying the instruments are likely and should be thoroughly reviewed in the next phase of the study as part of the detailed definition of an implementation plan.

2.0 Emissions and Air Quality in the GVRD

Regional air quality management programs -- irrespective of whether they are based on command-and-control, economic instruments, or a combination of the two -- are not "off-the-shelf" products: one size does not fit all. The characteristics of such programs are shaped by the features of the regional airshed in which they are applied, the contaminants of concern in the airshed, and their emission levels and distribution across sources, space and time.

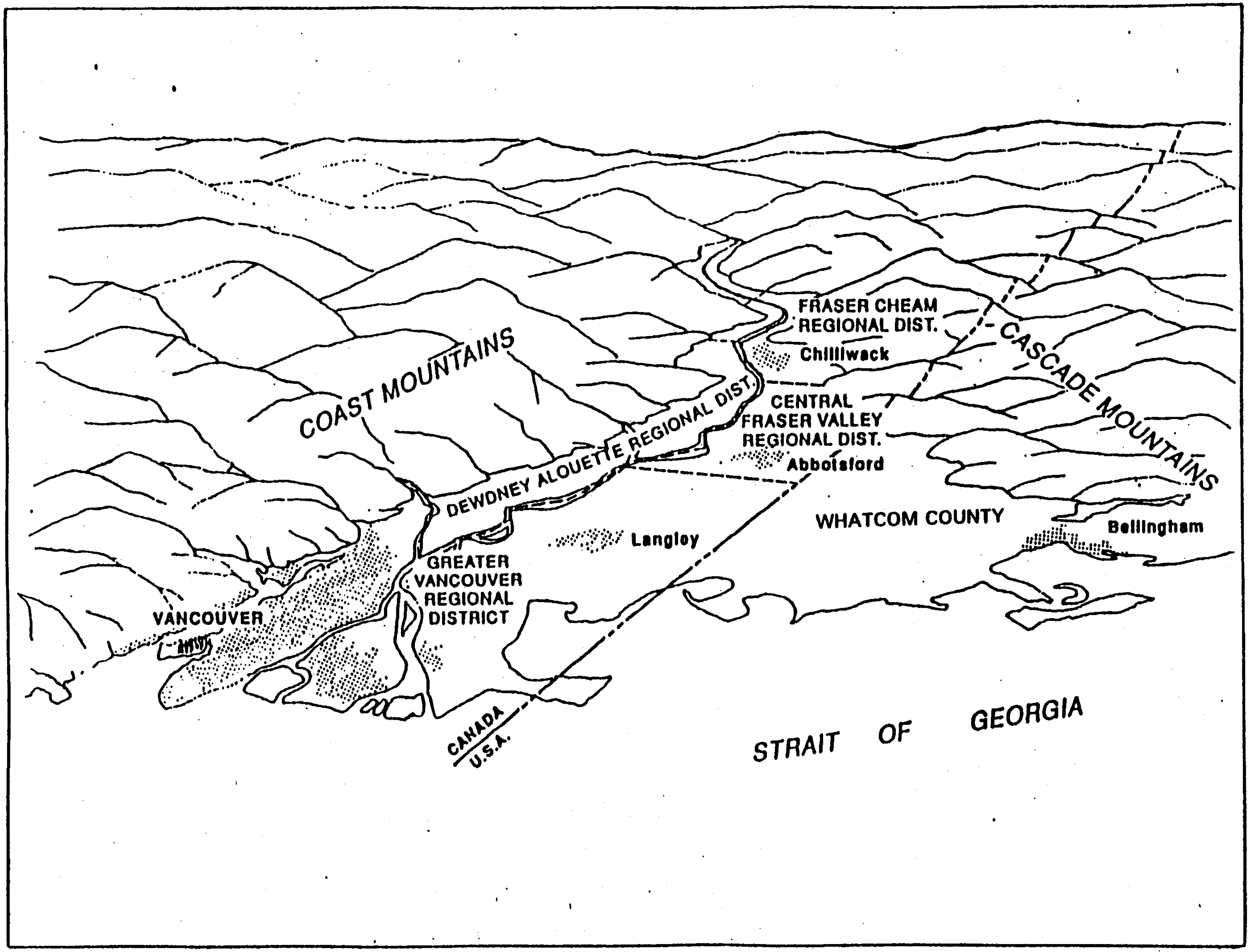
In this section we review the characteristics of the air quality concerns in the Lower Fraser Valley air basin in terms of the physical features of the airshed; current air quality issues; emission levels and source distributions; and future projections of emissions and source distributions. The purpose of this review is to provide the reader with an understanding of the physical factors that influence air quality and that may have a bearing on a determination of whether a command-and-control and/or an economic instruments approach to air quality management is appropriate in the LFV. In addition, in the case of economic instruments, the purpose is also to provide an indication as to which contaminant emissions/source sectors should receive priority as candidates for the application of economic instruments, at least in the short-term. For those readers who are quite familiar with this material, this Section can be by-passed without a loss in continuity.

2.1 The Lower Fraser Valley Air Basin

The Lower Fraser Valley Air Basin is a roughly triangular airshed encompassing territory on both sides of the Canada-United States border (see Exhibit 2.1). The northern, Canadian segment of the airshed is comprised of the Greater Vancouver Regional District, occupying the western reaches of the airshed; and the three Regional Districts of Dewdney-Alouette, Central Fraser Valley and Fraser-Cheam, which occupy the Eastern Lower Fraser Valley (ELFV). The southern reaches of the airshed extend across the Canada-United States border into Whatcom County in the State of Washington.

The natural features which bound and define the air basin include the Cascade Mountains in the southeast, the Coast Mountains to the north, and the Strait of Georgia to the west. The prevailing wind directions in the LFV are predominantly east to west, which at first glance might suggest that emissions generated in the airshed would tend to circulate out of the valley along the east-west axis. However, the Coast and Cascade mountains, combined with the meterological conditions associated with the Strait of Georgia, form natural barriers to air circulation in the basin and preclude the dispersion of regionally generated air contaminant emissions out of the valley and away from population centres in the LFV.

Exhibit 2.1 Lower Fraser Valley Air Basin



The natural characteristics of the LFV airshed creates complex circulation patterns in many areas of the region that, despite the prevailing wind patterns, cause emissions from the more urbanized, western part of the region to be transported eastward (i.e., inland) during the day.[1] At night the airflow reverses, with air movement generally back toward the coast. In addition to the limited transport of regional emissions out of the valley along its east-west axis, the natural features of the airshed also hinder the vertical movement of air. Temperature inversions are common in the valley, and they effectively act as a "lid" on the airshed; thus, inhibiting the vertical movement of emissions.

As a consequence of the airshed's natural features, air pollution has the potential to be a greater problem in the LFV than for many other urban centres with a similar population and industrial base. This is especially true of certain air quality problems such as ozone. The features of the basin tend to transport emissions within the airshed in patterns conducive to the eastern formation of ozone. Multi-day episodes are to be expected within this type of airshed as emissions accumulate from day to day, producing worsening conditions than those that would normally arise from daily emissions alone.

The dimensions of the airshed are such that residents of the GVRD/ELFV can also be exposed to emissions that are not generated by Canadian sources. While this study does not review emissions or air quality in the United States portion of the LFV, nor the potential for trans-boundary transport of these emissions, such issues could pose legitimate concerns for regional air quality management planning and are the subject of on-going evaluation.

2.2 Regional Air Quality: Present Conditions and Future Projections

The GVRD AQMP address five criteria contaminants which contribute to air pollution in the LFV airshed. These contaminants include:

- airborne coarse and fine particulate matter (Part.);
- sulphur oxides (SO_x) which include sulphur dioxide (SO_2), sulphur trioxide (SO_3) and sulphates (SO_4);[2]
- nitrogen oxides (NO_x) which include nitric oxide (NO) and nitrogen dioxide (NO_2);[3]
- carbon monoxide (CO); and
- volatile organic compounds (VOCs) containing carbon but excluding methane, CO, carbon dioxide, carbonic acid, carbonates and carbides.

An emissions inventory has been prepared for each of these contaminants and this inventory forms the basis of the AQMP.

Existing air quality in the GVRD/ELFV is assessed through a comparison of ambient concentrations of the five common air pollutants in the valley to Environment Canada's *National Ambient Air Quality Objectives (NAAQOs)* which specify three benchmarks for air quality:

- *Maximum Desirable Level:* is the long term goal for air quality. Ambient pollutant concentrations at or below this level exhibit no measured effects on human health or the environment (this objective is designated by the GVRD as Level A).

- *Maximum Acceptable Level:* provides adequate protection against adverse effects on human health, vegetation and animals (this objective is designated by the GVRD as Level B).

- *Maximum Tolerable Level:* due to diminishing margins of safety, air contaminant concentrations above this level require appropriate action without delay to protect the general population's health (this objective is designated by the GVRD as Level C).

2.2.1 Current Air Quality

The total emissions of each of the five criteria contaminants addressed by the AQMP (as per the 1990 emissions inventory) are presented in Exhibit 2.2 below.[4]

Exhibit 2.2: Summary Inventory of Emissions in the GVRD in the Year 1990

Contaminant Emissions (Tonnes)					
CO	**VOC**	**NO_2**	**SO_x**	**Part.**	**TOTAL[a]**
384,822	85,307	53,441	7,975	19,476	551,021

a. Total excludes 50,616 tonnes of road dust

In terms of the air quality levels associated with these emissions, using the NAAQOs as benchmarks, "air quality in the GVRD over the past decade has generally been good for a very high percentage of the time. However, there continues to be periods of fair air quality and, less frequently, poor air quality with respect to some contaminants, especially ozone, carbon monoxide and total suspended particulate matter."[5]

In terms of defining the key contaminant emissions of concern in the LFV, the GVRD has established priorities for each of 13 air quality issues based on the severity of impact or damage currently being experienced or considered to represent a growing problem in the LFV air basin.[6] The *Priority 1* issues are defined as those that are not currently meeting air quality objectives and/or current or projected impacts are significant enough to justify new emission reduction measures as soon as possible.[7] Two air quality issues fall within the Priority 1 category: fine particulate matter (a component of total suspended particulate (TSP) matter) and ground level ozone.

As noted in the draft AQMP cost-benefit study, the majority of the benefits derived from improved air quality management stem from reductions in fine particulate matter and, more specifically, fine particulate matter of less than ten microns in diameter (PM_{10}). With respect to PM_{10}, there are no NAAQOs (these objectives are defined for TSP only). However, the GVRD Board has adopted the California PM_{10} standard for the purpose of evaluating regional air quality. Studies carried out by the GVRD have noted that the annual PM_{10} concentrations have been lower that the annual GVRD PM_{10} objective.[8] However, the one day average concentrations have exceeded the GVRD objective approximately 6% of the time.[9] The seriousness of this is difficult to assess primarily due to the fact that, as noted in the draft AQMP cost-benefit study, it is not clear from the scientific evidence what the "safe" concentration level for PM_{10} might be. Further work is required to resolve this question.

Ground-level ozone is not directly emitted from any source. Rather, it is the product of photochemical reactions in the atmosphere between two precursor contaminants: NO_x and VOCs. While the greatest density of ozone precursor emissions occurs in the central to western half of the GVRD, given the physical characteristics of the airshed, the highest concentrations and greatest frequency of exceedences of the NAAQOs for ozone have occurred in the eastern portion of the GVRD and areas in the ELFV.

Given that ozone forms in the presence of sunlight, it is not surprising that ozone is a seasonal problem in the LFV. The ozone season is May to September with June, July and August being the months with the highest peak ozone concentrations. However, even in these periods, the average concentrations of ozone generally remain below the Level A standard.[10]

2.2.2 Future Air Quality

Future air quality depends on a number of influencing factors. One is that the region is expected to experience strong population growth over the next few decades. With a current population of 1.8 million (in 1993), projections are that the population will reach an estimated 1.9 million people by 2000, and 2.6 million by 2020.[11] Hand in hand with this growth in population are expected increases in both vehicle population and vehicle distances travelled, both showing growth of about 25% over 1990 levels by the year 2000, and by 40% by the year 2005.[12] Emissions from vehicles, if left without further controls, would increase dramatically, nearly doubling total emissions for the region in the forecast timeframe. However, current legislation requiring that new vehicle standards be met will create a significant drop in aggregate emissions in the region by 2000.

Given the expected growth in the valley, the total, projected emissions of each of the five criteria contaminants addressed by the AQMP for the year 2000 are presented in Exhibit 2.3 below (the emissions inventory projections assume that the 1996 Federal Vehicle Emission Standards will be implemented but that no further emission control measures, such as those recommended in the AQMP, will come into effect).[13]

Exhibit 2.3: Summary of Projected Emissions in the GVRD in the Year 2000

Contaminant Emissions (Tonnes)					
CO	VOC	NO_x	SO_x	Part.	TOTAL[a]
300,778	75,471	53,082	8,419	22,961	460,711

a. Total excludes 63,350 tonnes of road dust

In comparison to emissions in 1990 (Exhibit 2.2), total emissions decline by about 16% by the year 2000. Furthermore, despite expected population growth, per capita emissions also experience a significant decline of about 30%. In terms of the air quality associated with these emissions, however, it is difficult to draw any definitive conclusions. In the absence of additional control measures, by the year 2000 total emissions and the emissions of CO and VOCs decline, emissions of NO_x stay at about the same level, and emissions of SO_x and total particulates increase. It is not clear what implication the change in emissions (or lack thereof) for the latter three contaminants might have on overall air quality. However, a comparison of Exhibits 2.2 and 2.3 does suggest that, in the absence of additional control measures, the current ranking of air quality issues will remain the same in the future; i.e., particulates (particularly PM_{10}) and ozone will continue to pose a threat to air quality in the GVRD. It is important to note that, the conclusion with respect to ozone is based on the assumption that NO_x is the key pollutant driving ozone formation. The issue of whether NO_x or VOCs drives ozone formation is currently being examined as part of a Regional Urban Airshed Modelling study (the results of the study are due in 1995).

2.3 Distribution of Emission Sources

Total emissions in the LFV arise from a variety of sources. Not only are there industrial sources, but commercial sources, municipal sources and biogenic (i.e., natural) sources that all contribute to emissions. However, the greatest contribution to regional emissions stem from personal behaviours, as opposed to industrial activity, and especially from motor vehicle use.

2.3.1 Current Source Distribution

Emissions sources in the GVRD can be segmented into three broad categories: *point sources*, *area sources* and *mobile sources*. These source sectors are defined as follows:

- *point sources*: include all commercial and industrial sources regulated under a waste management discharge permit from the GVRD, the GVRD-Burnaby municipal solid waste incinerator, as well as other stationary sources with significant air emission

- *area sources*: these include residential and commercial space heating and ventilation, open burning of wastes, agricultural practices, paint and solvent use, gasoline marketing activities (e.g., vapour emissions from storage tanks, bulk fuel transfer operations, refuelling of automobiles, etc.), landfills and natural sources (such as forests, croplands, wetlands, wildlife, etc.).

- *mobile sources*: these include light and heavy duty motor vehicle exhaust, road dust, and train, ship and airplane engine exhaust.

The distribution of emissions across these sources in 1990 is presented in Exhibits 2.4 and 2.5 below.[14]

Exhibit 2.4: Summary of 1990 GVRD Emissions Inventory by Sources

	Contaminant Emissions (Tonnes)					
Source	CO	VOC	NO_x	SO_x	Part.	TOTAL[b]
Point:	6,527	8,576	8,811	3,766	11,969	39,649
Mobile:[a]	373,493	42,662	41,327	3,858	4,474	465,814
Area:	4,802	34,069	3,303	351	3,033	45,558
ALL:	384,822	85,307	53,441	7,975	19,476	551,021

a. Mobile Sources exclude 50,616 tonnes of road dust
b. Total excludes 50,616 tonnes of road dust

Exhibit 2.5: Summary of 1990 GVRD Emissions Inventory by Sources

	Contaminant Emissions (Percent Distribution)					
Source	CO	VOC[a]	NO_x	SO_x	Part.	TOTAL[b]
Point:	1.7%	10.1%	16.5%	47.2%	61.5%	7.2%
Mobile:	97.1%	50.0%	77.3%	48.4%	23.0%	84.5%
Area:	1.2%	39.9%	6.2%	4.4%	15.6%	8.3%
ALL:	69.8%	15.5%	9.8%	1.4%	3.5%	100.0%

a. About 7% of area source VOC emissions are from natural sources
b. Total excludes 50,616 tonnes of road dust

The major contributors to emissions within each source sector are presented in Exhibits 2.6 to 2.10 below.[15]

Exhibit 2.6 Relative Contributions to CO Emissions by Sector (1990)

Broken Down By Largest Contributors
(% of GVRD Total Emissions)

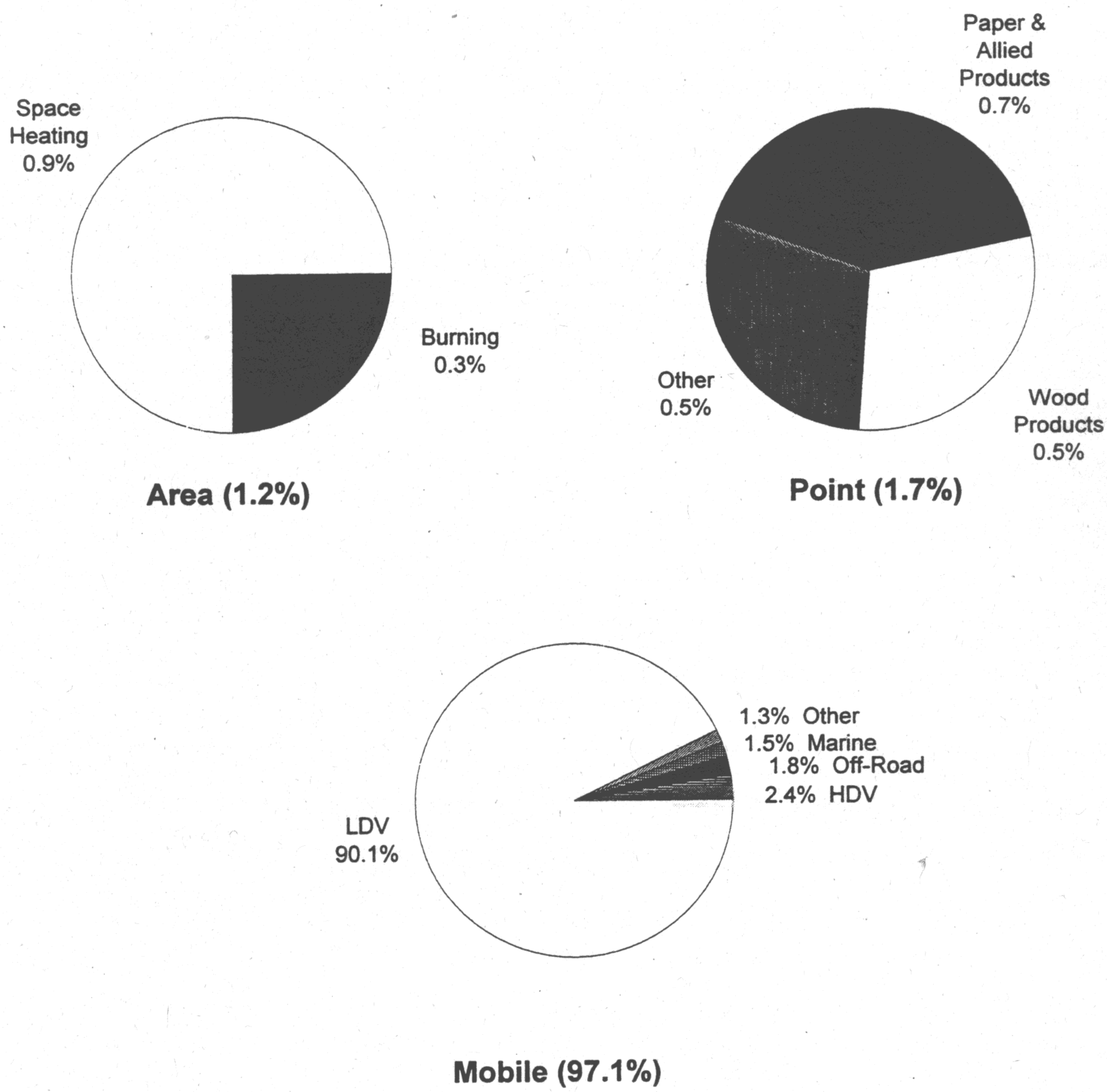
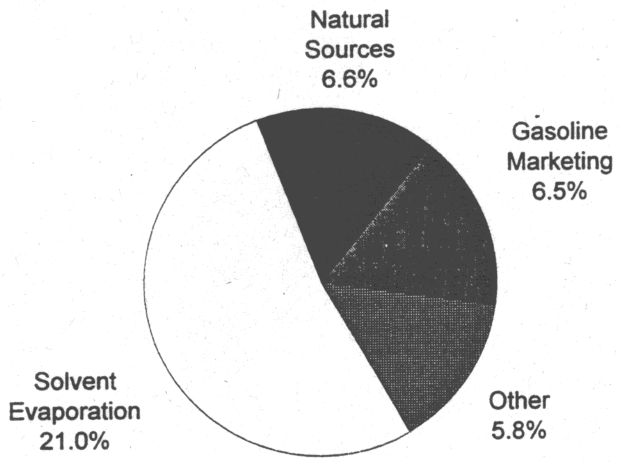
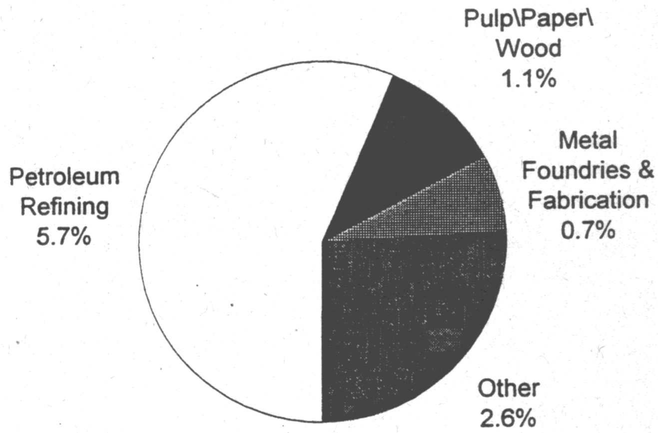


Exhibit 2.7: Relative Contributions to VOC Emissions by Sector (1990)

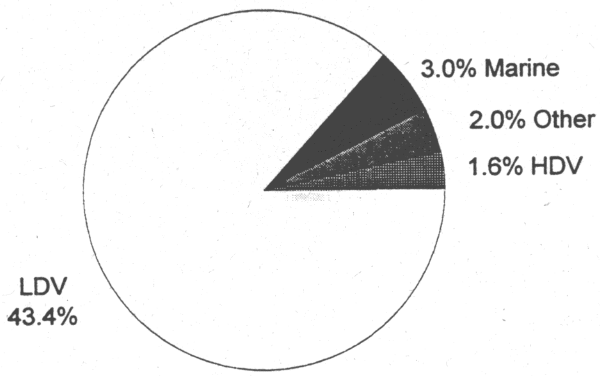
Broken Down By Largest Contributors
(% of GVRD Total Emissions)



Area (39.9%)



Point (10.1%)



Mobile (50%)

Exhibit 2.8 Relative Contributions to NO_X Emissions by Sector (1990)

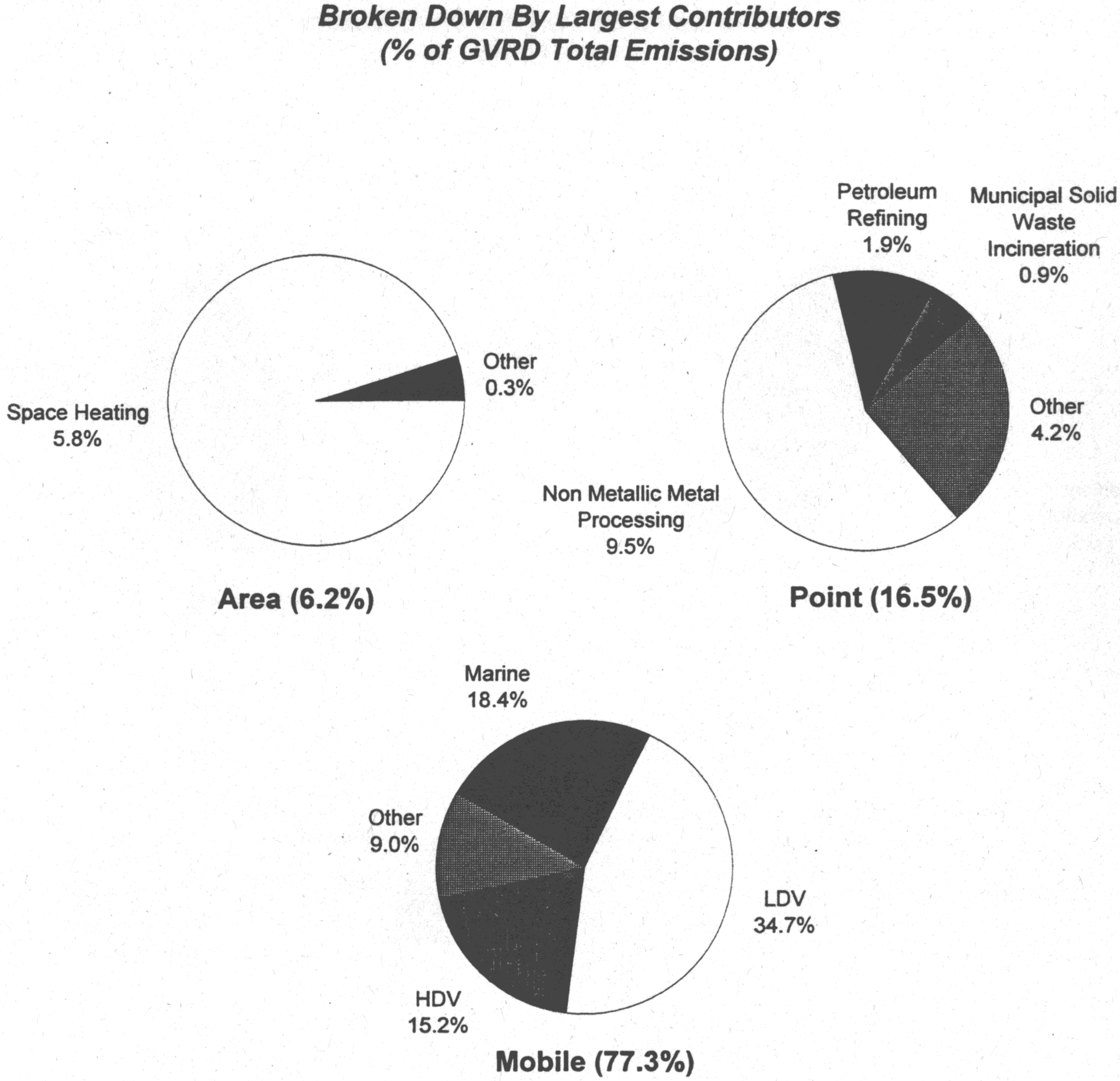
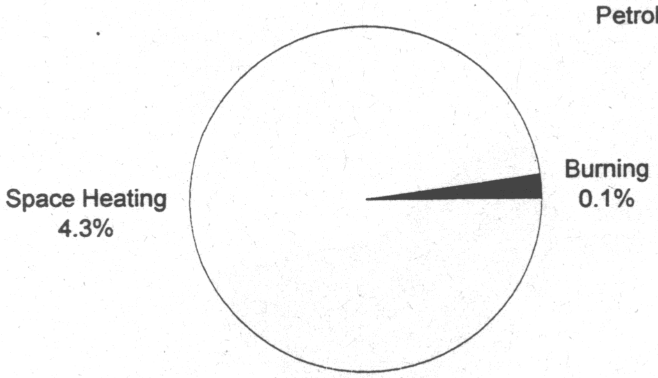
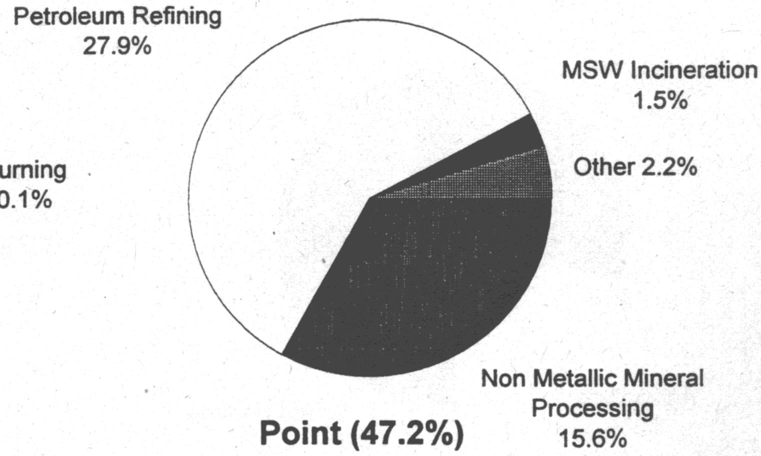


Exhibit 2.9 Relative Contributions to SO_X Emissions by Sector (1990)

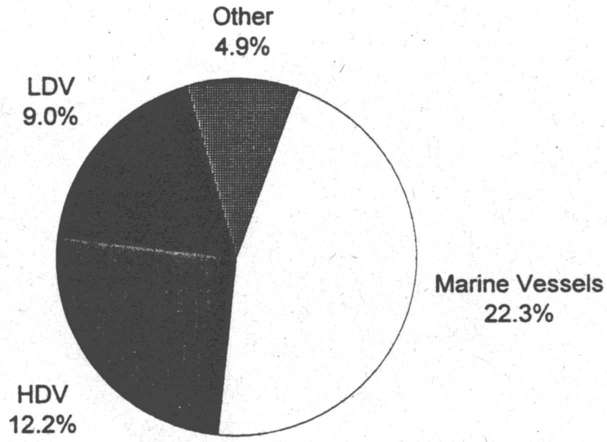
Broken Down By Largest Contributors (% of GVRD Total Emissions)



Area (4.4%)



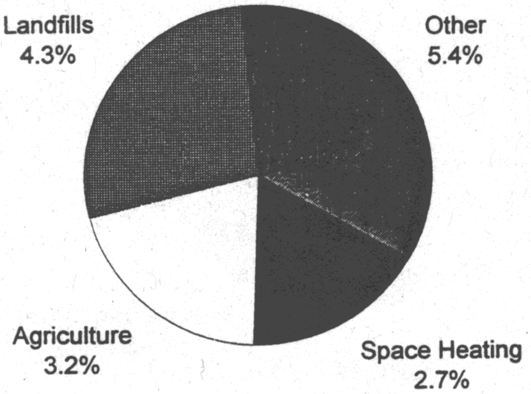
Point (47.2%)



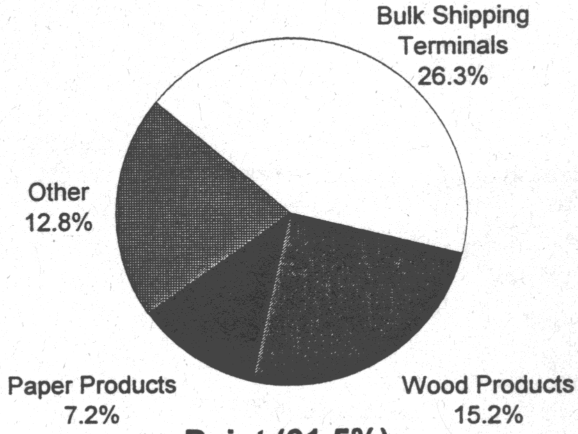
Mobile (48.4%)

Exhibit 2.10 Relative Contributions to Particulates by Sector (1990)

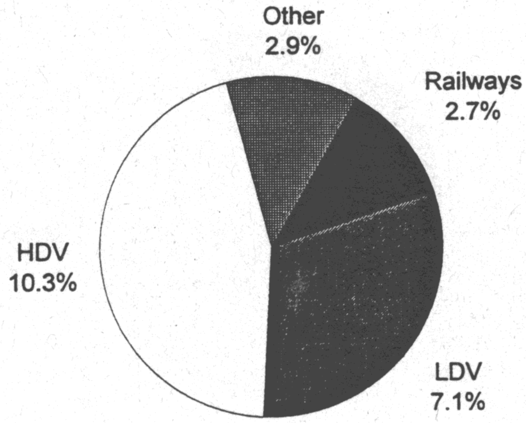
Broken Down By Largest Contributors
(% of GVRD Total Emissions)



Area (15.6%)



Point (61.5%)



Mobile (23%)

The bulk (90%) of total emissions generated within the Canadian segment of the LFV air shed flow from sources within the GVRD. The remaining 10% are attributable to sources in the ELFV.[16]

Point Sources

There are 277 individual point sources in the GVRD (as of 1990), covering a variety of industrial categories and over 2,100 individual discharge points.[17] As noted in Exhibit 2.5, of the three source sectors, point sources are the smallest contributors to overall regional emissions (accounting for 7.2% of the 1990 inventory); however, they represent the largest contributors of man-made particulate emissions (accounting for 61.5% of emissions), and the second largest contributors of SO_x (at 47.2%) and NO_x (at 16.5%) emissions.

While there are a large number of individual point sources in the GVRD, the majority of the emissions from this source sector are accounted for by a relatively small number of individual sources, as indicated in Exhibit 2.11 below.[18]

Exhibit 2.11: Contribution to Total Emissions by Number of Point Sources (1990)

Contaminant	*Number of Sources Contributing 80% or More of Total Emissions*	*Number of Sources Contributing 90% or More of Total Emissions*
Carbon Monoxide:	8	11
Volatile Organic Compounds:	17	33
Nitrogen Oxides:	9	15
Sulphur Oxides:	4	5
Particulates:	33	56

As indicated in Exhibits 2.6 through 2.10, the industries that account for the majority of emissions from the point source sector in 1990 include:

- bulk shipping terminals (dominates PM emissions);
- non-metallic mineral processing (dominates NO_x emissions and is a significant contributor to SO_x emissions);
- paper and allied products (dominates CO emissions and is a contributor to PM

- petroleum refining; (dominates VOC and SO_x emissions and is a significant contributor to NO_x emissions); and

- wood products (a significant contributor to CO and PM emissions).

Area Sources

As noted earlier in Exhibits 2.4 and 2.5, area sources are the second largest contributor to overall regional emissions (accounting for 8.3% of the 1990 inventory), and the second largest contributor of VOC emissions (accounting for 39.9% of total VOC emissions). In terms of emissions from this source sector, as indicated in Exhibits 2.6 through 2.10, the key area sources are:

- solvent evaporation, which accounts for 52.5% of area source VOC emissions; and

- space heating, which accounts for 71.7% of area source CO emissions, 94.4% of NO_x emissions and 98.2% of SO_x emissions.

Mobile Sources

Mobile sources account for the vast majority of overall regional emissions (84.5% of total direct emissions in 1990), and they dominate regional emissions for every one of the five criteria contaminants save SO_x emissions (point and mobile source emissions of this contaminant are about equal) and direct particulate emissions (see Exhibit 2.5). The principal contaminant emitted from mobile sources is CO, which accounts for 97% of overall CO emissions in the LFV, and 68% of the total emissions of all contaminants in the region.

Of total mobile sector emissions, 94.3% stem from motor vehicle use (the balance is accounted for by aircraft, rail and marine vessels). Light-duty vehicles alone account for 86.8% of mobile source emissions, and 73.4% of overall emissions from all sources in the region.

2.3.2 Future Distribution of Emission Sources

The projected distribution of emissions across point, area and mobile sources in 2005 (again assuming that the emissions inventory takes into account the 1996 Federal Vehicle Emission Standards but no further emission control measures) is presented in Exhibits 2.12 and 2.13 below.[19] As indicated, the relative ranking of emission sources exhibited in 1990 continues to hold in the year 2000: mobile sources continue to dominate regional emissions by a wide margin, followed by area and point sources.

Exhibit 2.12: Summary of GVRD Emissions Inventory by Sources (2000)

Contaminant Emissions (Tonnes)

Source	CO	VOC	NO_x	SO_x	Part.	TOTAL[b]
Point:	3,407	5,767	9,105	3,098	13,867	35,244
Mobile:[a]	291,706	31,186	39,879	4,893	5,623	373,287
Area:	5,665	38,518	4,098	428	3,471	52,180
ALL:	300,778	75,471	53,082	8,419	22,961	460,711

a. Mobile Sources exclude 63,350 tonnes of road dust
b. Total excludes 63,350 tonnes of road dust

Exhibit 2.13: Summary of 2005 GVRD Emissions Inventory by Sources

Contaminant Emission (Percent Distribution)

Source	CO	VOC	NO_x	SO_x	Part.	TOTAL[a]
Point:	1.1%	7.6%	17.2%	36.8%	60.4%	7.7%
Mobile:	97.0%	41.3%	75.1%	58.1%	24.5%	81.0%
Area:	1.9%	51.1%	7.7%	5.1%	15.1%	11.3%
ALL:	65.3%	16.4%	11.5%	1.8%	5.0%	100.0%

a. Total excludes road dust

Point Sources

Relative to the source distribution in 1990, by the year 2000 the contribution of point sources to total emissions is down across all contaminants except NO_x and particulates. In terms of the overall contribution of point sources to regional emissions, in the year 2000 point sources continue to be the smallest contributors to overall, regional emissions with their share increasing slightly over the period from 7.2% in 1990, to 7.7% in the year 2000.

Area Sources

Area sources continue to be the second largest contributors to regional emissions in the year 2000, with their share increasing from 8.3% to 11.3% of total emissions over the period from 1990 to 2000. In terms of the relative contribution of area sources to total emissions, increased emissions are noted for each contaminant.

Mobile Sources

In the year 2000, mobile sources will continue to dominate regional emissions (accounting for 81% of overall emissions, down from 84.5% in 1990). In terms of their relative contribution to total emissions, mobile sources will also continue as the largest single contributor of all contaminants. Their share of NO_x, SO_x and particulates increases over the period from 1990 to 2000, their contribution to CO remains relatively constant, and their contribution to VOCs declines.

2.4 Summary and Implications for Economic Instrument Applications

The information presented above provides a basis on which to draw preliminary conclusions concerning the specific contaminants and emissions source sectors which may be candidates for the application of economic instruments.

2.4.1 Priority Contaminants

Air quality in the GVRD over the past decade has generally been good for a very high percentage of the time. While ground level ozone (and therefore NO_x and VOC emissions) and PM_{10} represent the Priority 1 air quality issues in the airshed, even their performance relative to existing air quality standards is generally good. Over the period from 1990 to 2000, and in the absence of any emissions controls over and above the 1996 Federal Vehicle Emission Standards, overall annual emissions in the region show a decline of 16.4%. At first glance, this might suggest that, in the absence of the AQMP, air quality in the LFV airshed should improve. However, changes in aggregate emissions are not necessarily a good measure of improving health and welfare. Basing air quality goals on aggregate emissions assumes that the damage associated with a one tonne decline in any one contaminant is the same across all contaminants. However, as noted in the draft AQMP cost-benefit study, the damage to the environment and to human health can vary quite significantly by contaminant.

As an illustrative example, the benefits per tonne of emissions reduced (calculated from the draft AQMP cost-benefit study in terms of averted damage to human health, materials, crops, etc. per tonne) vary as follows:[20]

- CO: <$1/tonne[21]
- VOC: $84/tonne[22]
- NO_x: $120/tonne[23]
- SO_x: $320/tonne
- PM_{10}: $75,150/tonne

By the year 2000, then, if no further controls (aside from the vehicle emission standards) are put in place, reductions in CO (of 21.8%) and VOCs (of 11.5%) will be realized, emissions of NO_x will remain about the same, and emissions will increase for SO_x (by 5.6%) and particulates (by 17.9%). While it is difficult to specify whether a 5.6% increase in SO_x, or relatively unchanged emissions of NO_x, would significantly affect air quality in the LFV (i.e., whether it would mean that the Level A or B standards would be exceeded and/or how often), the damages associated with emissions of NO_x, SO_x and PM_{10} are the highest (on a per tonne basis) of the five contaminants assessed in the draft AQMP cost-benefit study.

The implementation of the GVRD AQMP changes the situation substantially. Relative to its 1985 baseline, the implementation of the AQMP (and the federal vehicle emission standards) will result in a 38% decline in overall, annual emissions by 2000. The reductions stem from significant declines in CO (by 45.4%), VOCs (by 33.2%) and SO_x (by 50.4%); however, NO_x emissions decline only marginally (by 2.3%), while direct particulate emissions -- the contaminant likely to cause the most damaging health effects -- shows a 2.9% increase from 1985 levels by the year 2000 (excluding road dust).[24] This would suggest that even with the implementation of the AQMP, the Priority 1 air quality issues will still require further action; i.e., additional controls (in the form of command-and-control style additions to the AQMP, or through the application of economic instruments) will be required for particulates (especially PM_{10}) and NO_x. As noted above, the inclusion of NO_x as a Priority 1 issue (and a proxy for ozone) is based on the assumption that NO_x is the key pollutant driving ozone formation.

2.4.2 Priority Sources

As noted above, the greatest contributor to emissions in the LFV is the operation of motor vehicles. To bring this point into sharper focus, by the year 2000, the implementation of the AQMP achieves annual, regional emissions reductions equal to 38% of the annual emission levels in 1985. If mobile source control measures, in addition to those in the AQMP, are not implemented, achieving the goal of annual, regional emissions equal to 50% of the annual emission levels in 1985 could only be reached if all point and area sources in the GVRD could be entirely eliminated. If we abstract from localized air quality issues for the moment then, in order to ensure that the LFV's current regional air quality is maintained and improved on over time, regulatory action in addition to the AQMP is required in the mobile sector -- with the exception of particulate emissions and some local air quality issues (e.g., "hot spots"), controls on area and point sources are almost immaterial.

With respect to the priority contaminants identified in Section 2.4.1 above, the priority source sector for NO_x is the mobile sector. In terms of PM_{10} emissions, as Exhibits 2.5 and 2.13 indicate, point sources are the priority followed by mobile sources.

2.4.3 Implications for Economic Instrument Applications in the LFV

The characteristics of the air quality issues of concern in the LFV have implications for the potential role of economic instruments as a control measure in the LFV. For instance, for most of the priority contaminants, performance relative to the NAAQOs has been good most of the time: it is growth in emissions that needs to be avoided. In addition, the contaminants that do represent the Priority 1 air quality issues are small in number -- basically PM_{10} and NO_x. This puts the GVRD in stark contrast to many other jurisdictions of a similar population and industrial base in that the current objective of air quality management in the GVRD can be taken as largely being one of minimizing air quality episodes and maintaining good air quality over time, as opposed to the situation faced by many other jurisdictions where significant and costly across the board emission reductions in a wide variety of contaminants are required simply to achieve the air quality levels currently enjoyed in the LFV.

A number of jurisdictions have recently looked at economic instruments as management measures for many of the same contaminants that are of concern in the LFV. However, as opposed to the situation in the GVRD, many of these jurisdictions have explored economic instruments precisely because their air quality problems have become so acute, the emission reductions required are so large, and the costs associated with emission abatement are relatively high. In these circumstances, the need to realize the potential cost savings associated with economic instrument programs becomes a critical issue in their selection as measures for effective air quality management. In the case of the GVRD, then, a window of opportunity exists to explore economic instrument alternatives which could generate cost-savings. This window is significant if for no other reason than the fact that if such instruments are implemented early on, before the region's emitters have had to install large amounts of control equipment in response to a steadily worsening air quality problem, then the potential exists to realize significant cost savings.

The other key characteristic of local emissions patterns that would have a bearing on applications of economic instruments in the LFV is the dominance of the mobile sector, which can present problems for an economic instruments program. Namely, beyond the consideration given to bridge tolls, road tolls and other transportation demand measures (which are addressed under *Transport 2021* and incorporated in the AQMP), few studies of economic instruments have specifically addressed the mobile sector in any detail, and none have considered emissions trading within this sector. For example, Barakat and Chamberlin (1991), in their study of the feasibility of NO_x and VOC trading in the LFV, specifically excluded mobile (and area) sources from consideration. Similarly, Apogee Research (1994), in their study of potential economic instrument applications for reducing NO_x emissions from the mobile source sector in Quebec, focused predominantly on fee-based measures and provided little detail on design criteria. This can present problems in that the development of certain types of economic instrument programs (such as emissions trading) for mobile sources requires "breaking new ground" -- there is little practical experience to draw on as one moves away from fee-based measures. On the positive side, however, if an effective economic instrument program (such as a trading program) can be developed, then it may be possible to firmly take command of air quality in the LFV.

In summary, ozone (primarily NO_x for the reason noted in Section 2.4.1) and PM_{10} are the primary contaminants of concern in the LFV, and the principal emitters are mobile sources and point sources. The question that needs to be addressed next is whether economic instruments appear to have sufficient potential that they should be considered further as a potential management measure. We begin to address this question in Section 3.0.

Endnotes

1. This land/sea breeze phenomenon occurs predominantly in the summer months.

2. The GVRD emissions inventory reports the various sulphur oxides in SO_2 equivalents.

3. The GVRD emissions inventory reports the various nitrogen oxides in NO_2 equivalents.

4. GVRD (1994e), Table 4-1.

5. GVRD (1994e), pg. 5-2.

6. GVRD (1994e), pg. 6-3.

7. GVRD (1994e), pg. 6-4.

8. GVRD (1993b), pg. 34.

9. GVRD (1993b), pg. 34.

10. No Level B exceedences have occurred for more than 1% of the hours in any year from 1982 to 1992, and over the entire period, Level C standards have only been exceeded for 5 hours (Source: GVRD (1993b), pgs. 12-17).

11. GVRD (1993a).

12. Calculated from GVRD (1994b), Table 6c.

13. GVRD (1994e), Table 11-1.

14. GVRD (1994e), Table 4-1.

15. GVRD (1994b), Table 2.

16. ARA/Bovar-Concord (1994).

17. GVRD (1994c), pg. A-16.

18. GVRD (1994c), Table A-4.

19. GVRD (1994e), Table 11-1.

20. Calculated from ARA/Bovar (1994).

21. No discernable damage to human health or the environment was identified for CO.

22. The damage averted per tonne of VOC reduced includes ozone-related damage.

23. The damage averted per tonne of NO_x reduced includes ozone-related damage.

24. GVRD (1994e), Table 11-1.

3.0 Potential Approaches to Controlling Emissions

In the previous section, current and expected emissions and air quality in the LFV were reviewed, and the pollutants and sources that dominate regional emissions were identified. In addition, we discussed the contaminant emissions/sources that are most likely to require further regulatory action, even with the implementation of the AQMP, in order to ensure that regional air quality objectives are achieved. Furthermore, we briefly reviewed some of the characteristics and dimensions of the air quality issues in the LFV that may have a bearing on the design, implementation and acceptance of economic instruments as either alternatives to, or supplements to, command-and-control regulation.

In this section, we turn our focus from the pollutants and sources in the LFV that require regulatory action and focus instead on the two dominant forms that regulatory action might take: command-and-control and economic instruments.[1] The purpose of this section is to provide those readers who may be unfamiliar with either the range of regulatory alternatives available or their relative merits with the contextual information necessary to appreciate the suite of measures that can be used to address air quality concerns; their differences and similarities; and their relative effectiveness.

We begin this section with an overview of the economics of pollution and its implications for regulatory action. We then proceed to describe the two dominant approaches to controlling emissions; their rationale and defining characteristics; the array of management measures available under each approach that might be relevant to the air pollution issues faced in the LFV; and the advantages and disadvantages associated with the application of each approach and its constituent measures.

3.1 Economics of Pollution and the Possible Approaches to Emissions Management

Environmental resources (e.g., water, air, land, trees, etc.) are of value to the residents of the LFV (and Canadian society generally) for a variety of reasons. They provide inputs to the production of the goods and services required by valley residents; they are consumed by the public to fulfil their material, recreational, educational, tourism, and aesthetic wants and desires; and they are used by firms and the general public as a depository for the waste generated by their daily activities (i.e., the "garbage can"). As with all consumption and production decisions, our choices with respect to the use of environmental resources are largely guided by the prices we face in the marketplace, and herein lies the problem.

While the residents of the GVRD/ELFV place significant value on clean air, clean water, etc., these values cannot be *effectively expressed* in the market since these resources are not *private*.[2] Rather, they are common property, and this feature of environmental resources results in the expression of low or non-existent prices for these resources in the marketplace. For example, while a particular industrial plant, or a poorly maintained fleet of automobiles, may emit all manner of foul by-products into the air, individuals cannot effectively express their dislike for the fact that the air is becoming unbreathable, or that their homes are turning black, in a way that will cause industrial plants or automobile owners to reduce their pollution; i.e., by penalizing emitters in the marketplace by charging them for the damage they cause.

In terms of economic theory, the problem here is twofold. First, polluters do not take the full cost of their actions (i.e., the damages they impose on others) into account.[3] Second, individuals cannot purchase the "rights" to the air and charge a price which would dissuade the industrial plant or the automobile owner from polluting "their air".[4] As a consequence, industry, the driving public, etc., tend to generate and emit too many pollutants into the air largely because they incur little or no direct cost in doing so. They are not penalized in the marketplace by being charged for what they do; i.e., they receive no market signal to alter their behaviour.

Economists call this type of problem *market failure*, and it occurs when the market prices associated with a good or service do not completely reflect their true cost to society. It is the existence of market failure which has necessitated some type of government intervention to control pollutant emissions. The most common forms of intervention fall into two general categories: command-and-control, and economic instruments. Each of these approaches to emissions management is discussed in turn below.

3.2 Command-and-Control

Environmental law in British Columbia, across Canada, and throughout most of the industrialized world, has been developed on the basis of command-and-control regulation. The rationale behind command-and-control is that, given the lack of market incentives to guide emitters to voluntarily curb emissions and emission rates (i.e., the problem of market failure), it is the regulator's responsibility to control the activities that give rise to excessive emissions.[5] This is achieved by restricting the behaviours and activities of consumers and firms through the implementation of regulations, enforceable restrictions and standards that indicate the actions that emitters, and the general public, must take to address a given air quality concern.

To support regulatory directives which depict proper emission control equipment or process performance requirements, additional constraints may also be imposed on an emitter's activities that are not necessarily process specific. Examples of these include limits on total emissions during a given hour or day, or stricter limits during environmentally sensitive seasons (e.g., for ozone control in the summer months). In addition, since command-and-control restricts the behaviour of emitters, they may have little incentive or inclination to voluntarily comply with the regulations and adopt the prescribed restrictions. As a consequence, command-and-control regulations (*as with all regulatory approaches, including economic instruments*) are implemented in conjunction with administrative and monitoring systems, to track an emitter's degree of compliance; and enforcement and sanction systems, to provide an incentive to comply, and to penalize non-compliance.

Command-and-control regulation of air pollutants generally takes the form of either enforceable restrictions on the use of certain products/substances for specific purposes (e.g., as an input in the production process); and/or uniform emission standards. These regulatory measures are discussed below.

3.2.1 Enforceable Restrictions

Enforceable restrictions generally set conditions regarding the processes or products available for use by firms and private consumers. For example, regulations may stipulate that certain products must be recyclable or contain some percentage of recycled material. Alternatively, they may take the form of prohibitions (or scaled phase-outs) in the use of certain substances in production processes (e.g., phase-outs of chlorofluorocarbons -- CFCs -- in an effort to combat ozone depletion). Similarly, they may stipulate the types of fuels to be used in certain applications (e.g., propane conversions, use of clean fuels). Enforceable restrictions may also be used to establish zoning regulations that do not permit certain industries to site in certain areas. Enforceable restrictions are common in British Columbia; however, as a regulatory tool for achieving the emission reduction goals of the AQMP, they have not been extensively relied upon.

3.2.2 Uniform Emission Standards

A principle that underlies most applications of command-and-control regulation is that industrial firms should shoulder roughly the same share of the burden of pollution control. This is typically accomplished by setting uniform standards for all firms within an industry, and more specifically, for all new or expanding firms within the industry.[6] As a control measure, uniform standards have been relied upon as one of the most common forms of emissions control regulation, and they generally take the form of either technology-based standards or performance standards.[7]

Technology-based standards identify the particular technology or piece of equipment that must be used by emitters if they are to comply with a given regulation. This type of standard is the basis for *best available control technology (BACT)* policies and programs. Specific BACT choices for emissions control are seldom mandated in most jurisdictions in Canada, including the GVRD.

As opposed to technology-based standards, performance standards set emission control targets for each emitter (this type of standard is the basis for many permit programs). These standards do not *explicitly* state a control technology that has to be applied in order to ensure compliance. Rather, the regulator sets allowable discharge levels based on an evaluation of the process and control technology options available to various emission sources. Thus, performance standards allow emitters some degree of flexibility in selecting the control technologies they need to meet their emission reduction targets.

It is worth noting that the difference between technology-based standards and performance standards often becomes blurred in practice. While performance-based standards do not explicitly specify control technologies, they are usually established on the basis of a particular technology (e.g., BACT). Thus, these standards *implicitly* imply a control technology, which often results in the selection of control technologies that are similar to what would emerge under an explicit, technology-based standard.

Relative Merits of Command-and-Control

Command-and-control can provide an extremely useful approach for addressing air quality concerns. To begin with, command-and-control regulations, in the form of enforceable restrictions, can be very effective in controlling emissions that are related to easily defined products or substances used as inputs in production. For example, by banning CFCs, the emissions of these contaminants are quite effectively controlled.[8] Command-and-control regulations are also very useful as a means of facilitating emissions control in situations where the monitoring of abatement equipment, rather than actual emissions, is the only practical enforcement tool (e.g., in the regulation of emissions from automobiles and other mobile sources that travel among many regulated zones).[9] New vehicle emission standards are one example of command-and-control regulations in such a situation. Command-and-control can also be quite useful, and may offer the only practical control approach, when the contaminants of concern are particularly toxic, and/or where the damages associated with the contaminants are dramatic for even small variations in emissions. Another circumstance where command-and-control can be highly effective is when emissions largely stem from a single source, and/or where the emissions (and emission-related damages) are confined to a relatively small, local region. Finally, command-and-control offers the advantage that it is publicly acceptable as the public sees that government is acting to restrict the activities of waste dischargers.

While there are a numerous advantages associated with the use of a command-and-control regulatory approach to air quality management, there are a number of disadvantages associated with this approach as well. To begin with, standard-based command-and-control regulations, particularly of the scale employed in Canada, the United States, Europe, etc., can impose a significant planning and administrative burden on regulatory agencies. In order for standards and/or restrictions to be effective in meeting specified emission reduction targets, regulators need to predict future emissions (within the context of a dynamic economic and demographic environment) and review process and abatement technologies in order to develop meaningful control guidelines and standards. In addition, to be accepted by emitters, regulators must demonstrate that the emission reductions are required and that the proposed restrictions will achieve the specified emissions standards or reductions.[10] Finally, to ensure compliance, a variety of administrative, monitoring and enforcement functions are required. Each of these activities requires the dedication of often substantial regulatory resources.

The second shortcoming of the command-and-control approach to environmental regulation that is often noted in the literature is that it is not particularly attractive from an economic standpoint since it is neither cost-effective nor efficient.[11] The reason is that by requiring all firms to meet a specific, uniform standard, command-and-control may result in some emitters having to adopt unnecessarily expensive measures to comply with the standards. The reason for this is straightforward. All emitters do not exhibit the same characteristics: they have plants of different ages, different production processes, different existing emission control technologies and equipment, etc. As a consequence of the differences in the characteristics of emitters, the costs of controlling emissions can vary dramatically across source sectors and among, and even within, firms in a given source sector.

In setting command-and-control requirements, regulators cannot differentiate between emitters that face low abatement costs versus those that face high costs; nor can they differentiate between those that can easily alter their plants and production facilities to accommodate the regulatory controls from those that cannot. This is not surprising in so far as the information that would be required to effectively differentiate between emission sources would be immensely difficult and expensive to collect and would significantly increase the administrative burden of regulation.[12] The negotiation process that Canadian industries typically engage in with regulators may allow for some degree of differentiation; however, a command-and-control regulatory approach does not induce individual emitters to truthfully reveal their abatement costs or alternative production or abatement processes.

As a consequence of the regulator's practical inability to obtain sufficient and accurate information about the characteristics of individual firms and their facilities, it is not possible for the regulator to define the "best available control technology" *for each firm* (either explicitly in the form of technology-based standards, or implicitly in the form of performance standards) that would provide the required emission reductions at the least cost. Rather, the best that can be hoped for is to identify what might seem to be (on the basis of current technology) the "best available control technology" on average for a source sector, and utilize it as a basis for a standard. Complying with the standard may require the installation of control measures that may be the "worst available control technology" for a number of firms, in that it may be very costly to adopt, and the emission reductions resulting from the application of the regulatory standard may be less than expected since control measures may have to be grafted on to differing types of equipment and production processes. For other firms, the costs of complying with the standard might not be too high, but higher than the costs that would be incurred if the emitter were able to select the most effective control technology given the specific characteristics of its facilities (e.g., the age of equipment, types of production processes, etc.). Finally, for some firms the technology which underlies the regulatory standard may be the same as the "best available control technology" the firm would select if given the freedom to do so.

The third shortcoming associated with command-and-control is that it may allow for greater levels of emissions over the short to medium-term. Command-and-control does not motivate facilities to capture further emission reductions because the incentives that this approach employs (e.g., non-compliance penalties) only motivate emitters to operate as cleanly as their "permit" specifies.[13] For example, consider a facility operating under command-and-control specifications that emits 100 tonnes of a contaminant each year. Suppose the regulator imposes a performance standard that requires the facility to reduce its emissions by 10%, and the plant complies by installing additional abatement equipment that achieves the required reduction. Further, assume that at the new emission level of 90 tonnes, the incremental cost of abating an additional five tonnes is very minor. Despite the minimal cost, why would the facility incur the cost to reduce emissions further? The facility already complies with its regulatory permit conditions; it sees no reduction in, or credit for, the permit fees it pays to the regulator; and it receives no compensation for mitigating the damages that the additional 5 tonnes of emissions would cause.

Of course, the facility may decide to incur the costs because of the public goodwill it might yield, but if the market for the firm's product is at all competitive, it would be penalized for undertaking the reduction. It is precisely the missing "market for air" (i.e., the problem of market failure) that prevents some polluters from making additional reductions, even where the benefits outweigh the costs to society. In short, with command-and-control, if facilities face effective and substantial penalties for non-compliance, then they have every reason to meet mandatory emissions regulations. However, they also have no incentive to go beyond the standards.

Finally, command-and-control may allow for greater levels of emissions over the medium to long-term by acting to forestall the development of cheaper and more effective emission reduction technologies that could provide greater levels of emission control. By explicitly or implicitly specifying the control measures that must be adopted by firms in order to comply with the regulations, emission sources have little or no incentive (financial or otherwise) to exceed these controls and abate to higher levels than specified by the regulations and/or their permits. In addition, command-and-control regulations generally provide an incentive *not* to experiment with or investigate new technologies. In fact, if a firm develops a new technology that more effectively reduces emissions beyond that associated with the control measure that is implicitly or explicitly stipulated by regulation, the only reward the firm might receive is that it will be subsequently held to a higher standard.

In summary, there are numerous advantages associated with the application of command-and-control regulations to control emissions. However, while environmental regulations have traditionally been developed on the basis of a command-and-control approach, there is growing recognition in many jurisdictions that command-and-control strategies are not cost-effective (i.e., in terms of total cost per unit of emissions abated). In addition, there is growing recognition that this approach has limitations in terms of its ability to modify the behaviours of industry and the public on the basis of enforcement and sanctions alone; rather, other types of "incentives" are required. The need for better incentives "... is based on poor levels of compliance with environmental regulations. Low levels of compliance frequently are due to inadequate enforcement. However, even if expenditures on enforcement were increased the criminal court system is often not an adequate deterrent for many offenses because of low levels of prosecution and fines."[14] As a consequence of the need for better incentives, economists, many regulators, and some environmental organizations, have advocated the use of economic instruments, alone or in concert with command-and-control regulations, to create and improve incentives for compliance. The economic instrument alternatives to command-and-control are discussed below.

3.3 Economic Instruments

As a complimentary or alternative approach to emissions management, economic instruments have the *potential* to achieve environmental goals with a greater degree of certainty, and at a lower overall cost, than emissions standards or other more traditional command-and-control regulatory approaches. In contrast to command-and-control, which implicitly or explicitly prescribes behaviour, economic instruments use market signals to influence behaviour in a manner that is more consistent with environmental goals by making the use of environmental resources an explicit part of the decision-making processes of producers and consumers.

While the term *economic instruments* has come to be more narrowly associated with *emission trading programs*, it covers a broad spectrum of measures, many of which have been a feature of command-and-control policies for a number of years. For example, many existing environmental regulations in British Columbia, throughout Canada, and elsewhere, incorporate emission fees and effluent discharge fees; deposit-refund programs; environmental levies on tires, batteries, etc.; user charges such as tipping fees, used oil disposal levies, bridge and road tolls and permit fees; differential product charges; and emission reduction subsidies, tax allowances and grants.

The command-and-control and economic instrument approaches to emissions management exhibit a number of common features: both approaches are based on emission reduction goals that are specified by the regulator; both approaches are implemented in conjunction with administrative and monitoring systems to track an emitter's degree of compliance; and both require effective enforcement and sanction systems, to ensure compliance and to penalize non-compliance. However, the economic instruments approach differs from command-and-control in (at least) three key ways.

First, as noted in Section 3.1, emitters may tend to "over-pollute" largely because they have little incentive to do otherwise -- they incur little if any direct costs. In contrast to command-and-control, economic instrument applications attempt to address this problem by directly tackling the issue that gave rise to the pollution problem in the first place: market failure. Specifically, economic instruments attempt to associate a *price* or *cost* with the behaviours and activities of the public and industry that give rise to waste emissions. This provides firms and consumers with a financial incentive or market signal (that is lacking under command-and-control) to modify their activities so as to reduce emissions. The theory is that, by increasing the costs associated with discharging wastes, market forces will provide the public and industry with a direct financial incentive to reduce those wastes: faced with a cost for doing something that had previously been free, or at least very inexpensive, emitters will change their emissions to reduce this "new" cost of doing business. In their attempts to reduce these "new" costs, they reduce the environmental damage associated with economic activity as well.

The second key difference between the two approaches relates to the amount of discretion that regulated sources have in developing abatement strategies. At the simplest level, command-and-control defines both the required emission reductions (or simply a maximum allowable emissions rate) and, either explicitly or implicitly, the control measures sources need to apply in order to achieve the defined emission level and comply with the regulatory requirements. Under an economic instruments program, the regulator again defines the required emission reductions;[15] however, the choice of control measure (be it the installation of abatement equipment, changes in production process, changes in production inputs, etc.) is left up to the individual emitters. Thus, in contrast to command-and-control, decisions are made on a decentralized, individual or firm-specific basis.

The third key difference relates to the fact that, with economic instruments/incentives, decisions with respect to control measures are made on the basis of a desire to minimize costs, rather than to achieve air quality results. This is one of the reasons the economic instrument applications have become so controversial. The focus on cost minimization presents both advantages and disadvantages. By placing the choice of control measures in the hands of emitters, the required reductions will be met at the minimum cost to the facilities, and to society as a whole. In essence, application of economic instruments tacitly acknowledge that emitters are likely to know best how to achieve the required reductions in their own facilities. In addition, they have an economic incentive (both in terms of the financial "carrot" of reducing costs and the "stick" of penalties for non-compliance) to find the most inexpensive and effective ways of achieving compliance. In short, regulated emitters and not the regulators are left with the task of defining the "best available control technology" or the most appropriate performance standard that fits the individual circumstances of each facility.

However, while the end result (at least theoretically) is that the application of economic instruments leads to lower overall control costs and a reduced regulatory burden, economic instrument applications, and more to the point, emissions trading programs and emission fees, may not necessarily guarantee that a region will meet a particular air quality goal, in the same way as traditional, *explicit* command-and-control requirements with appropriate monitoring and enforcement. The difference arises from the fact that, depending on the type and design of economic instrument, it may not be particularly adept at handling new scientific knowledge about atmospheric processes or health effects. For example, if new research suggests that stricter air quality standards are required, under command-and-control (and assuming appropriate enforcement), new controls can be imposed to further reduce emissions. However, under an economic instruments application (such as tradeable emissions coupons or emissions fees) the emission reduction has to be met by altering the incentive (e.g. changing the fee or altering the emission coupon allocation), and this can create problems in that it can undermine the effectiveness and credibility of the incentives these programs offer. (We will return to these points in Section 3.3.3 and 5.0 below and, with respect to emissions trading, we will suggest some design alternatives -- such as callable coupons -- that can help circumvent these problems).

The term economic instruments covers a broad spectrum of measures for achieving emission management goals. However, to properly appreciate their role and value in different applications, it is convenient to differentiate between four categories of instruments: subsidies, environmental charges, tradeable permits or transferable emission limits, and dual coupon-fee instruments. Each of these categories, and the dominant measures within each category, are discussed in turn below. Appendix A provides a more detailed explanation of some of the key instruments discussed, their effects upon emissions, and the positive and negative aspects of each.

3.3.1 *Subsidies*

Subsidies refer to various forms of financial assistance which seek to provide either an incentive for emitters to alter their behaviour, or to provide assistance to firms facing financial problems in complying with regulatory standards. Subsidies have been included as an element of a variety of regulatory policies for many years (e.g., subsidies for public transportation usage). The types of subsidies that are most common, and that could be applied in the LFV as part of an emissions reduction program include:[16]

- ***Subsidies for Public Transportation and Carpooling:*** These subsidies serve to lower the cost of a particular travel mode relative to alternative, non-subsidized travel choices, thereby providing an incentive for users to substitute the subsidized travel modes for non-subsidized modes.

- ***Emission Reduction Subsidies:***[17] This type of subsidy takes the form of a per unit monetary award that is paid *to* facilities for each additional unit of emissions they abate.

- ***Soft Loans:*** These are low interest loans provided to emitters if they adopt certain abatement measures.

- ***Tax Allowances:*** These allowances provide individuals with reduced tax rates, exemptions or rebates if certain environmentally responsible activities are adopted.

Relative Merits of Subsidies

In theory, subsidies (as well as grants and tax allowances) can provide an effective emissions management alternative in so far as they provide a monetary incentive to switch to less environmentally damaging activities. For example, in the absence of subsidized public transportation, the cost of this travel mode alternative for many individuals may be too high; thus, dissuading its use in favour, possibly, of the private automobile. In general, the key to the effectiveness of a subsidy rests in determining what the level of the subsidy has to be in order to cause a desired substitution: this issue is not at all simple to resolve. As a tool for emissions management, subsidies can also suffer from three additional problems, the seriousness of which will depend on the type of subsidy being considered.

First, certain types of subsidies are often viewed as short-term price changes or incentives. Therefore, using them as a tool to modify behaviour that in turn requires individuals to invest or make long-term plans may fail. Even if the long-term payback of changing behaviour is positive, the perceived risk in such systems is likely to be too great to induce people to make long-term behavioral modifications based upon future payoffs.

Second, subsides are open to abuse. In an effort to receive more lenient regulatory treatment, firms have an incentive to overstate their abatement costs and exaggerate their problems. This creates problems for subsidies as a cost-effective management measure since it is difficult to determine whether they are *actually* required by a particular firm in order for it to adopt the control measures required for regulatory compliance. Most people, if given the chance, would rather spend someone else's money rather than their own. Hence, given the opportunity to receive a subsidy, many emitters would likely try to build a case for why they should receive a subsidy, irrespective of whether they actually need it. The end result is that monies are often wasted by providing unnecessary subsidies.

The third problem with the use of subsidies as an emissions management measure is that they violate the "polluter pays principle", which is the basis on which the AQMP (and most environmental regulations in the province and elsewhere) is built. The potential severity of this violation from a regulatory point-of-view may become great, especially if the possibility for abuse is an issue.

3.3.2 Environmental Charges

Environmental charges are implemented in order to raise the price of environmental resources, and the products and activities which make use of them, in order to provide consumers and producers with a financial incentive to use the environment more wisely (e.g., to reduce waste discharges into the air). Environmental charges have been included in regulatory policies in a wide variety of jurisdictions for many years. Some examples of charges that have been implemented include: charges per unit of emissions; penalties for emitting more than permitted levels; environmental levies on vehicle tires and lead batteries; tolls on roads and bridges; and stationary source permit fees. While each of these variations offers consumers and firms an incentive to make more responsible use of the environment, the significance of the charge as an incentive and the manner in which it operates to influence behaviour differ across the various types of charges.

The types of environmental charges that are most common and that could be applied in the LFV as part of an emissions reduction program include:

- ***Emission Fees or Emission Taxes:*** Emission fees/taxes are charges levied on each unit of emissions that a facility releases, and they generally vary with the toxicity of the contaminant emitted. Emissions fees are not supposed to be designed primarily as revenue generators (especially of the revenues required to fund an air quality management program).[18] Rather, they are levied to provide a continuing incentive for emitters to abate to the point where the cost of abating one more unit of emissions equals the financial "penalty" or fee for releasing that same unit.

- ***User Fees:*** This type of charge represents a payment to cover the costs associated with the public management of emissions and air quality, as opposed to providing an explicit emissions reduction incentive.

- ***Bridge and Road Tolls and Parking Charges:*** These are flat, per vehicle fees levied per bridge crossing, segment of highway travelled, or per use of a parking space. These fees increase the cost of travel per vehicle, but are unrelated to a vehicle's emissions per mile. Accordingly, they create an incentive to reduce the usage of the toll bridge, road, or parking space, perhaps through the use of public transit, increased vehicle ridership, or by adopting other transportation or work alternatives.[19]

- ***Product Charges:*** These are charges levied on the price of products which, when used in production or consumption activities, tend to result in a fair amount of pollution. Product charges can be based on the characteristics of the products (e.g., charges on the sulphur content of mineral oil, or on the carbon content of fuels -- the "carbon tax"), or on the product itself (such as a mineral oil charge, new vehicle tire and lead acid battery disposal levies, etc.).[20]

- ***Tax Differentiation:*** This leads to more favourable prices for "environmentally-friendly" products versus "environmentally-unfriendly" products (e.g., the removal of the social services tax exemption on disposable diapers, sales tax exemptions for agricultural use of biological control agents, etc.).

Relative Merits of Environmental Charges

In assessing the relative merits of environmental charges, it is useful to distinguish between the various charges discussed above (that might best be categorized as *non-market based economic incentives*) and emission fees (which belong to a category of what might be called *market based economic instruments*).

As indicated above, user fees stand by themselves to a degree in that this type of charge is not meant to provide an explicit emissions reduction incentive. For example, under *Bylaw 725* the GVRD levies a permit fee on stationary point sources of air pollution.[21] The main purpose of this fee is to recover the costs of GVRD's emissions monitoring system; the development, implementation and enforcement of the AQMP; and inventory development.[22]

In contrast to measures like user fees, charges such as bridge and road tolls, parking charges, and other charge-based transportation demand management (TDM) measures, are aimed at reducing vehicle trips, vehicle use, vehicle miles travelled, vehicle idling or traffic congestion for the purpose of reducing motor vehicle emissions. Travel time and marginal cost are the two most important factors that a person considers in making a decision to drive a car or use public transit, and the role of TDMs is to influence these variables and alter the balance between the use of the automobile (which is currently favoured by the residents of the GVRD) and other modes of transportation.[23] The effect of these measures on regional emissions depends on the setting of the charge.

As tools for emission management, charges such as these essentially offer what economists call an *all-or-nothing* choice to individual automobile operators. Specifically, these charges represent a one time increase in the relative costs of transportation alternatives, and firms and consumers will either make a one time substitution to cheaper, less polluting alternatives, or they will simply pay the charge and carry on as before. For example, in the case of bridge tolls, some drivers will elect to pay the toll; thus, their driving frequency, and by extension their emissions, will not decline. It is important to note that these charges apply to the specific usage of a vehicle (e.g., crossing a bridge); thus, they create an incentive for substitution in travel modes but they do not create incentives for substitution to newer, cleaner vehicles or fuels.

While some individuals will make the substitution in transportation modes and others will not, it can be quite difficult to determine the level of the charge that is required to achieve a certain level of substitution and, therefore, a certain reduction in emissions. In most cases, these types of charges are not set at sufficient levels to gain significant emission reductions (the imposition of significant charges can often run into public acceptability and equity concerns).[24] Rather, such charges tend to be utilized to generate revenues, while achieving whatever emission reductions are possible.

Emissions fees (or emission taxes) can be quite effective in reducing emissions. In fact, the integration of an emissions fee into current regulations was one of the key elements called for in the revision of the provincial *Waste Management Permit Fee Regulation*.[25] Emissions fees establish a cost for *each unit of emissions* that a facility releases. Thus, emission fees will result in decreased emissions as long as the fees are greater than the costs of abatement for some amount of emissions currently being released. In addition, as opposed to the *all-or-nothing* role of tolls and parking charges, fees offer a continuing incentive to abate: as long as the facility operates, it has a *continuing* incentive to abate in order to avoid the per-unit charge.

From a regulatory point-of-view, emission fees provide the regulator with a fairly direct mechanism for controlling emissions. For example, they can start levying a fee per unit of contaminant emitted, and if after a period of time emissions are still too high, then the fee can be raised until the desired emissions level is obtained. Emission fees are also attractive from an economic standpoint since, as long as they are set at the "correct" level, they can (theoretically) produce the same level of cost-effective emissions control that is commonly claimed for emissions trading/transferable emissions limits programs.

Another advantage of emission fees is that, since they are levied on a per unit of emissions basis, they can be applied to most sources of emissions (e.g., point and mobile sources). For example, in terms of mobile sources, if vehicle registration fees were levied as a flat tax for every unit of emissions released (or estimated to be released based upon emission tests of the vehicle), then the registration fee is essentially an emissions tax. Such a tax provides an incentive to substitute from dirty vehicles to cleaner vehicles. In fact, a proposal to apply per unit fees to the emissions of light duty vehicles in the GVRD is currently being reviewed.[26]

While there are a number of advantages associated with the use of emissions fees, as a measure to achieve emission reduction goals they can suffer from three problems. The first relates to defining what is the "correct" fee level to achieve a certain reduction in emissions. In order to "correctly" set the fee, the regulator needs to have an accurate understanding of the *abatement cost curve* (i.e., a curve that relates the costs of abatement at various levels of emission reductions) for each facility within the regulated region. As noted earlier, for a variety of reasons it is unlikely that the regulator will have sufficient information to accurately depict this curve. Thus, unless a regulator is particularly lucky, the initial setting of a fee will likely be incorrect in terms of rendering the desired final outcome (i.e., the emissions reduction goal).[27]

Those who advocate emissions fees argue that this does not matter in that the fee can be used by the regulator as a searching device; i.e., the fee can be raised or lowered until the right level is found (this is at least theoretically what is supposed to happen). However, there are a couple of problems with this as well. First, the objective of emission fees and taxes is to motivate emitters to *change* their activities and behaviours, their plant structures and production processes, etc. However, it is unlikely that individuals and firms will react to continual iteration of the fee as the regulator searches for the "correct" setting (emitters will take the position that whatever fee is advocated, the government will likely change it in short order and so they will take a "wait and see" attitude); nor are regulators likely to indulge in experiments with continually differing fee settings.[28]

The second problem relates to the fact that, even if emitters were to respond to the fee or tax (in the manner dictated by theory), when is it clear whether the setting is right or wrong? For example when a fee is set, emitters are expected to respond to this new cost of polluting by changing production processes, driving habits, size of car engines, and perhaps even where they live or set-up facilities, in order to make the best long-run adjustment to the fee. This can take a considerable period of time. The question is, how and when will the regulator know if the fee is too high, too low or just right?

Finally, emission fees do not establish an upper limit or cap on the amount of emissions facilities and the driving public may find economically beneficial to release. For example, if a new, highly profitable industry develops whose abatement costs are above the emission fee, then that facility will produce new emissions and elect to pay the fee. The only way to prevent such increases in emissions is to increase the fee each time such new developments occur, which leads once again to the problems noted above. In addition, existing industries are penalized each time such a new industry enters the region. This may lead to pressure from industry to keep the new entrant out; thus stunting overall, long-term economic growth.

Given the difficulties involved, in most cases emission fees (as with most tolls and charges) are not set at a level sufficient to gain significant emission reductions.[29] Rather, their function is often one of generating revenue to cover air quality management costs while achieving whatever emission reductions are possible.

3.3.3 Emissions Trading/Transferable Emissions Limits Programs

In contrast to the various economic instruments discussed above, emission trading programs (also called transferable emissions limits programs) focus on the *quantity* of allowable emissions as opposed to the *price* or *cost* of those emissions. Consequently, emission trading programs provide a more direct economic instrument for addressing emission management issues. Emission trading programs can range from smaller scale programs such as the *Old Vehicle*

SCRAP Program being contemplated in British Columbia, to comprehensive multi-source interpollutant trading programs. However, regardless of the scale of the emission trading program, the basic concept is disarmingly simple.

Under an emission trading program, a set number of coupons (defined for a given time period and denominated in physical units such as tonnes of a contaminant) are distributed to emitters in the region.[30] The number of coupons distributed is determined by the emissions limit, or the *emissions cap*, that is *defined by the regulator*. Each coupon distributed under the program represents an entitlement to allow an emitter a specific amount of discharge, and the emissions limits these coupons represent are transferable and can be bought and sold by emitters in the marketplace. Each emitter must hold coupons equal to the amount of a given contaminant that they emit in a given time period.

Given the emissions limits specified by the regulator (i.e., the total quantity of allowable emissions or the emissions cap) and the associated allocation of coupons, emitters are given the freedom to determine how best to meet their reduction obligations so as to remain under the cap. Those emitters with relatively low abatement costs will reduce emissions by more than their allotment of coupons would require. The incentive offered to the low cost emitter is that they will be economically rewarded for taking such actions since they can sell (transfer) the additional emission reductions (which represent the emissions they otherwise would have been permitted to emit, given the limits defined by their coupon allocation), in the form of emission reduction coupons. Those emitters who find it financially difficult to meet a required reduction due to high abatement costs will buy the coupons.

The advantage of these programs is that the regulator takes direct control of the quantity of allowable emissions but is relieved of the task of allocating the burden of control. Rather, that task is left to the market, which allocates the control burden across emitters according to their ability to abate cost-effectively -- those that can abate cheaply will bear the greatest share of the control, but not the cost, burden. In addition, the regulator is relieved of the task of reviewing best available control technologies and setting uniform emission standards -- that task also falls to the individual emitters. Furthermore, since emitters have the freedom to choose how best to meet emission reduction targets, abatement is achieved in the most cost-effective manner. As a consequence, while the "polluters still pay" (the low cost emitter has to incur abatement costs while the high cost emitter has to purchase the privilege to emit in the form of coupons), the overall costs of control are reduced.

Elements of Emissions Trading Programs

Emissions trading programs can involve a broad spectrum of measures for achieving emission management goals. Some of the standard elements which can constitute such programs include:[31]

- *Emission Reduction Coupons/Credits:* are created when a firm controls to a greater degree than the law requires either by changing process inputs (e.g., fuel switching), process changes, installation of emission control technologies, curtailing production, or by shutting down an emission source. Under the U.S. *Emissions Trading Program*, for example, an emission reduction credit can be granted for any emission reduction that meets certain criteria established by the U.S. Environmental Protection Agency (EPA). Specifically, to qualify as a valid credit, emission reductions must be real, surplus (i.e., the result of an actual reduction and not a "paper" reduction),[32] quantifiable, enforceable and permanent. Emission reduction credits/coupons are the basic element or currency of emission trading programs.

- *Offsets or Growth Coupons/Credits:* are designed to allow new or modified sources to operate in an airshed that is subject to emission restrictions by purchasing emission reduction credits from existing sources in the airshed. Rather than allowing new facilities that set-up in a regulated airshed to only implement the control technologies and other regulatory measures specified by the regulator, offset programs require that, in addition to meeting the existing regulations, new facilities must *offset* their remaining emissions by obtaining growth or offset credits from existing facilities in the airshed (who in turn will have to implement additional controls to provide the emission reductions and offset coupons required).[33] Offsets must be used in conjunction with other regulatory options such as limited emission rates, emission fees, uniform emission standards, or some form of emissions trading program. Their purpose is to accommodate economic growth while protecting air quality in the region; however, they can also be used as a means of bringing an area into attainment.[34]

- *Facility Bubbles:* are a policy tool that allows regulators to establish a legal limit (a *cap*) on total allowable emissions for each facility, while allowing the facility to design the emissions reduction strategy required to comply with the cap. Under a bubble program, changes in emission levels within a bubble are treated in the aggregate rather than on a point-by-point basis. Thus, a facility manager can make emission control decisions in aggregate for all sources covered by the "imaginary bubble" rather than on a source by source basis. A facility manager, using a bubble strategy, may trade emissions between its individual sources (e.g., a boiler, a furnace) and "over control" at individual emission points that are inexpensive to control (on a dollar per tonne basis), while relaxing controls at emission points for the same contaminant that are more expensive to control. The only restriction on the facility manager's choice of abatement strategy is that there must be no net decline in air quality or, in cases where reductions are the regulatory goal, the facility must decrease emissions within "its bubble" by the prescribed amount. Given this constraint, the net result of the bubble strategy is that the facility manager is allowed the freedom to meet the reductions prescribed by the regulator in the most cost-effective manner, given the facility's individual circumstances and characteristics.[35]

- ***Banking:*** is a general term used to convey the ability to carry *forward* unused emission coupons. In other words, banking permits movement of emissions forward in time. Extra reductions made today may be used in the future. Banking has many uses and can affect the market, air quality, and regulatory control over the program. In fact, depending upon how banking is instituted, an emissions trading program can achieve very different results.[36] However, as a general rule, banking is meant to create continuity and certainty in the markets for emissions limit coupons.

- ***Fully Tradable Emissions Coupon or Transferable Emission Limits Program:*** are largely an extension of the emission reduction credit and offset concepts discussed above with some import differences. Namely, the creation and trading of emission reduction coupons is not limited to, or sparked by, the need to accommodate new or modified sources. Rather, the emissions coupons involved are issued (largely on an annual basis) by the regulator in an amount equal to overall allowable emissions; i.e., the emissions limit or cap. These coupons are fully tradeable between new sources, modified sources, existing sources and, possibly, any other interested party (e.g., environmental groups, etc.). Trades occur to facilitate economic growth (new and modified sources) and to achieve least-cost compliance across all sources (new, modified and existing sources) with regulatory emission reduction requirements. The trading that occurs is based on the abilities of different sources to cost-effectively abate emissions to a level equal to the number of coupons held.

Emissions Trading and Emissions Fees

Given the prominence of emissions trading and emissions fee programs in the economic instruments literature and the requirement in the terms of reference for this study to examine the relative merits of a program for marketable permits and/or higher permit fees in the LFV, it is worthwhile to compare and contrast these two approaches before we proceed to examine the relative merits of trading programs. Such a comparison is useful as it allows for a better understanding of how each instrument works, and it points out a variety of issues that can have an important bearing on the selection of management measures.

At a theoretical level, emissions trading and emission fee programs are opposite sides of the same coin. Under either program, an emissions reduction goal or emissions cap is defined by the regulator, emitters receive an allocation of that cap (directly in the case of trading and indirectly in the case of fees),[37] and a *cost* or *price* is associated with each unit of a contaminant that a facility emits (directly in the case of fees and indirectly in the case of trading programs). The per unit *price* provides emitters with an incentive to reduce emissions and a guide to aid in the development of their abatement strategies. In addition, both emissions trading and emissions fee programs offer emitters a continuing incentive to abate.

The key difference between emissions trading and emission fee programs is that, with emissions fees, while the regulator starts with an emissions reduction target, the policy tool that the regulator controls is the fee that can be manipulated to reach the target. In effect the regulator has only indirect control over the policy objective. Under an emissions trading program, again the regulator begins with an emissions reduction target (the policy objective). However, since the number of tradeable coupons is directly determined by the emission reduction target, the policy tool that the regulator controls is the quantity of allowable emissions; i.e., the policy objective is also the regulator's policy tool. Thus, the regulator in effect has direct control over the policy objective.

Under an emissions trading program, then, the regulator controls the *quantity* of allowable emissions and lets the market determine the *price*. Under an emissions fee program the converse is true: the regulator controls and manipulates the *price* of emissions and lets the market determine the *quantity* of emissions that correspond to that price. In short, emissions fee programs (as with all charge-based instruments) are *price* instruments, while emissions trading programs are *quantity* instruments. This feature of emissions trading affords regulators with a relatively greater degree of control over emissions, since they have more direct control over the quantity of allowable emissions.

Relative Merits of Emissions Trading/Transferable Emission Limit Programs

It is difficult to draw general conclusions as to the advantages and disadvantages of emissions trading programs. This is partly the result of limited practical experience upon which conclusions can be drawn and partly a result of the fact that the relative merits of these programs, and the benefits they provide, depend on how they are designed, where they are applied and how they are implemented. However, as a general rule, a well designed emissions trading program offers a number of benefits to both the regulator and the regulated. From the regulator's perspective, the benefits of emission trading programs include:

- they provide the mechanisms necessary to define policies that effectively place a "cap" on industrial, sectoral or regional emissions, which allows the regulator to exercise more direct control over emission limits;

- the regulator has the ability to maintain a fixed cap (i.e., constant emissions), or implement a declining cap to facilitate achievement of an emissions target that is below current emission levels;[38]

- by delegating the job of determining control measures to the regulated, these programs allow the regulator to focus more on monitoring and enforcement and forgo the task of forecasting future emissions patterns and assessing control measures;

- they provide the incentives necessary to achieve potentially greater degrees of compliance with environmental regulations and, therefore, improve the possibility that environmental goals will be met;[39]

- they provide emitters with a continued incentive to abate and an incentive to develop new technologies and dynamic emission control strategies that may involve changes in process inputs, process changes, installation of pollution control technologies, curtailing production, or the closing down of facilities; and

- by providing emitters with an incentive to implement least cost control measures, and the opportunity to shift emissions through time, the application of these programs holds out the possibility that more cost-effective control can be achieved and that greater and/or earlier emission reductions may be realized.

From the perspective of the regulated, the advantages of emission trading programs include:

- they provide pollution sources with the flexibility and the economic incentives to determine what the most appropriate and cost-effective measures are for achieving an emission reduction requirement;[40]

- they provide emitters with an alternative to abatement -- namely the purchase of coupons; and

- they remove the bias toward expensive, add-on, end-of-pipe technologies that is common under a traditional, uniform emission standard-based command-and-control strategies.

In terms of the disadvantages of emissions trading/transferable emission limits programs, again it is difficult to generalize. Some of the general disadvantages identified in the literature include:

- unless properly designed, transferable coupon programs are not adept at handling new scientific knowledge about atmospheric processes or health effects, hence there can be uncertainty about environmental outcomes;

- emission coupons become an asset to the firm that holds them and this value provides a profit incentive to cheat;

- a greater possibility exists for strategic behaviour (this depends largely on market size);

- unless properly designed, transferable coupon programs can lead to detrimental local air quality impacts;

- there is no mechanism inherent in these programs to determine in advance how environmental choices made at the individual or firm level will change the distribution of income or air quality among regions in the air shed (this can largely be addressed in program design); and

- at program initiation, the costs of abatement are unknown and emitters will need to estimate the future price of coupons and base their abatement strategies on these forecasts -- if emitters underestimate the future price of coupons, they will under-invest in emissions control and vice versa.[41]

Many of these disadvantages are affected by, or the result of, the design of a program. As indicated at the beginning of this section, the basic concept of emissions trading is disarmingly simple; however, it has substantial policy implications. Consequently, the magnitude of the benefits of emissions trading programs, relative to both command-and-control measures and other economic instruments, and the degree of certainty surrounding their realization will largely depend on the policy/regulatory decisions made concerning the specific design of the program; the level of trading envisaged (e.g., offsets, fully tradeable emission coupons, etc.); the pollutants and sources to which a program is applied; the nature of the airshed; the level of enforcement involved; and the constraints placed on trading. The potential for the disadvantages of emission trading to materialize increases if each of these issues are not properly taken into account in the design of both the program and its implementation plan. While issues concerning program design are discussed in Section 5.0 below, some general comments can be made concerning their relationship to the realized benefits of emission trading.

As a rule, the probability that trading programs will generate and realize air quality benefits and cost-savings improves if the program exhibits the following characteristics:

- the number of participating sources is relatively large and/or control costs are sufficiently diverse;
- the level of permitted trades is broad (e.g., trading is allowed within sites, between firms, between source types, between jurisdictions, etc.);
- command-and-control limitations on the program are minimized;
- interpollutant trading is permitted (where the science allows);
- regulatory restrictions on trading are well defined and minimized (e.g., no preapprovals on trades), and thus the necessary restrictions, such as those to avoid creating "hot spots" or those to handle toxic emissions, are well thought out and defined at the program's initiation;
- either limited banking is permitted or coupons have some overlapping lifetimes (i.e., they do not all expire on the same date), and emitters receive some reasonable and stable guarantees concerning the bankable life of emission coupons and the freedom from unforeseen discounting and confiscation of valid emission coupons;
- unlawful activities (e.g., cheating) must be detectable and subject to meaningful censure;
- trading and banking rules are clear, predictable, consistent, timely and relatively stable over time; and
- the program is designed to provide the mechanisms necessary to accommodate new information concerning atmospheric processes and health effects without reducing the incentives offered by the program and/or its credibility.

If an emissions trading program is not designed and implemented to ensure that it exhibits at least some of these characteristics, at least approximately, then the restrictions on trading will increase and/or the scope and opportunities for trading will diminish, and the disadvantages of such programs will come to the fore. Under such circumstances, a trading program can lead to substantial additions to regulatory costs while generating very little if any benefits (in terms of air quality improvements and/or cost-savings). *The chances that this might occur in practice is not at all remote.* Some of the key factors that might lead to this outcome are briefly reviewed below.

First, a basic principal of emission trading is that regulatory control is placed on the overall level of emissions; therefore, no matter who makes the emission reductions, they are regarded as equally valuable. However, the truth of this statement depends on the contaminants of interest. For those that are defined as *global* or *uniformly mixed pollutants* (i.e., where the emissions-related damage are solely related to the volume of emissions, such as with greenhouse gases), the benefits of emission reductions are truly independent of where the reductions are made. Reductions in CO_2 in the LFV will have the same affect on global warming as an equal reduction in China. For contaminants that do not share this property (what are often termed *local pollutants*), however, reductions by different sources in different areas may not be regarded equally.[42] For example, the environmental and human health damages associated with PM_{10}, ozone precursors and, to a degree, SO_2 emissions, can be localized. By treating all reductions in the emissions of these contaminants as equally valuable (for example by allowing one-to-one interpollutant trading), localized pollution "hotspots" can result.

Since certain areas within an airshed may be more sensitive to emissions, when implementing a emissions trading/transferable emissions limits system, sometimes *trading zones* may need to be established to ensure that emissions do not increase in protected areas as a result of trading.[43] In and of themselves, designated trading zones are not a difficulty; however, restrictions on transfers of coupons within and between zones can pose problems. Specifically, depending on the type of restriction, they may constrain and limit opportunities for trading which in turn will heighten the costs and reduce the benefits of the trading programs.

Second, emission trading programs, as with all economic instruments, are not designed and implemented in a vacuum. As a consequence, in practice they are almost always grafted on top of existing command-and-control regulatory systems in which permits and standards already play a dominant role. If the integration is not carefully considered, this has the effect of increasing the cost of regulation (there are now two administrative systems) and reducing the latitude and scope for trading. As a consequence, the costs of the program can increase while the benefits of trading are reduced.

The development and implementation of effective emissions trading programs will require regulators to take a step back from the traditional, micro-management of industrial operations and pollution control methods and adopt a more goal-oriented approach to pollution control. However, given that trading programs are a relatively new concept in the policy-making arena (especially in Canada), many government officials and regulators may be understandably cautious about removing regulatory restrictions in favour of relying on a trading program. The degree of caution can be exacerbated by the fact that, since regulators and the regulated have traditionally found themselves in adversarial positions, it may be difficult for regulators to embrace a strategy that relies on the regulated to make prudent decisions regarding control strategies -- even where severe sanctions are in place to penalize those who do not comply. As a consequence, many of the existing command-and-control requirements (such as performance standards) may remain.[44] While there is no environmental reason to maintain such command-and-control measures under a trading system that includes a cap, issues of public acceptability may dictate otherwise. However, maintenance of these restrictions will increase overall control costs and limit the scope and incentive for trading and, therefore, the benefits.

Third, the costs and restrictions imposed on a trading system may also be high due to the fact that the public and various stakeholders may also be understandably cautious about removing specific regulatory restrictions in favour of an emissions trading/transferable emissions limits program. The perceptions held by certain segments of the general public is that somehow economic instruments mean *less* regulation, and that the solution to air quality concerns is to have *more* regulation. While this concern is unfounded,[45] such perceptions may lead to demands for the preapproval of trades, continuous monitoring of participants in the market, retention of BACT policies or performance standards, etc. These restrictions will increase the overall costs of participating in the program and will limit the scope and incentive for trading.

Fourth, restrictions imposed on a trading system may also be high due to the fact that the regulator has to contend with the perception held by many stakeholders and segments of the population that emissions trading programs provide emitters with a "property right" that acts as a "license to pollute". While these programs provide emitters with no more of a "license to pollute" than permit-fee programs (such the *B.C. Waste Management Permit Fee Regulation*) and most command-and-control regulations,[46] in practice regulators in jurisdictions that have considered trading systems have been very sensitive to this issue.

For example, as pointed out in Hahn (1989), in order to provide industry with greater flexibility to trade under its *Emissions Trading Program*, the U.S. EPA attempted to define a set of "property rights" concerning emission coupons that placed few restrictions on their use. The issue being that, for a tradable system to operate, the coupons must behave like property rights in a *market* sense, (not necessarily in a *legal* sense); i.e., they must have some asset characteristics or they will not be used.

However, at the same time, the EPA had to be sensitive to the concerns of environmentalists and avoid giving businesses too clear a "property right" to their existing levels of pollution. The concern here relates to one of the disadvantages of tradeable coupon programs noted earlier: the difficulty of these programs to accommodate (on the basis of new scientific data) the need to alter emission reduction requirements to meet air quality objectives. If clear property rights are given, regulators may not be able to make any necessary mid-course corrections; and if they restrict or remove those property rights, then the coupons have no asset value and the market does not function.

The conflicting interests of the two groups led regulators to design a set of policies specifically designed to *de-emphasize* property rights. However, the consequence of this was that the costs associated with trading -- and particularly external trading -- were quite high. As a result, in practice firms have tended to either indulge in internal trades (i.e., trading within their bubble) or not trade at all. In essence, while the intent of most trading programs is to provide flexibility, the rules of the trading system can become so restrictive and cumbersome that the flexibility they offer is more imaginary than real. Hence, the program imparts costs but few benefits. (In Section 5.0 we describe a particular design feature -- callable credits -- that provides regulators with the flexibility they need to make mid-course corrections while providing emitters with the asset characteristics they require).

Finally, non-competitive markets can also create problems for emissions trading. If the holders of permits are few in number, they may attempt to collude in an effort to raise the price of coupons to new sources. This could stifle growth and create windfall profits for the sellers. This problem can be dealt with through program design in a variety of ways; however, care must be taken to not place undo restrictions on the transferability of, or access to, emissions coupons.[47]

3.3.4 Dual Tradeable Emissions Coupon/Emissions Fee Instruments

The actual implementation of tradeable emissions programs often involves grafting these programs on to an existing permit-fee system; therefore, a hybrid system may emerge that is a combination of a transferable emission limit coupon and an emission fee. Thus, it is useful to explicitly explore the merits of dual coupon-fee systems as an instruments choice.

Emission fees and tradable coupons each have positive features and drawbacks. The inherent limitations of each of these policy instruments may be largely mitigated if a dual instrument is implemented. If properly designed, such an instrument will provide an emissions cap and generate revenue. The design is not very different from a tradable emissions coupon system; in fact the same allocation of coupons is necessary for the dual instrument. Sources must still hold the same number of coupons to cover emissions as in the pure tradable emissions coupon system, but they also must pay a flat fee (tax) for every unit of pollution released. A facility's least-cost abatement choices should be the same under this and the pure emissions coupon system.

The advantage of such a system is that, in addition to the benefits outlined above for transferable emissions limits programs and emissions fees, it may be more publicly acceptable: the public is more likely to agree with a system that generates revenues and appears to explicitly reflect the "polluter pay principle". From the emitter's point-of-view, the emissions coupon's price should fall by the amount of the fee; therefore, this instrument does not result in an increase in regulatory costs when compared to a pure emissions trading system. From the regulator's point-of-view, the benefits of a pure trading system are retained; however, the dual instrument can be designed to regulate peak emissions better than any single instrument alone.

Endnotes

1. For the moment, the term economic instruments will be used to cover both economic incentives (e.g., tolls, product charges) and market-based economic instruments (e.g., emissions fees and trading programs).

2. For a good or service to be "private" in economic terms, and thus have its value effectively expressed in the market, it must exhibit the following characteristics. First, if one individual consumes a particular good or service then he reduces the amount available for others to consume (this does not hold for a view of the wilderness, the use of air, etc.). Second, if a person has a particular good or service in his possession he can exclude other people from using it (which implies that he can charge them for its use if he wishes).

3. This is traditionally referred to as "the tragedy of the commons".

4. In addition, no individual feels enough damage to effectively pay the polluter to reduce his emissions to an efficient level where the incremental damages and benefits from the pollution are equated.

5. "Excessive pollutant emissions" is defined in terms of the environmental medium's (i.e., the air, water, soil, etc.) ability to assimilate the pollutants we emit. Pollutant emissions are "excessive" if they surpass the assimilative capacity of the environment which, in turn, results in the degradation of the resource.

6. In practice, the burden of control is often not shared equally. For instance, new sources of air pollutants often face more stringent control requirements than older, existing emitters. In addition, while in certain jurisdictions such as the United States, and to varying degrees in the European Community, command-and-control regulations are rather uniformly applied to new sources, in Canada the application of regulations have traditionally been more a function of negotiation between regulators and industry.

7. Pearce, D.W. and Turner, K.R. (1990).

8. The environmental effectiveness of enforceable restrictions on the use of certain substances in the production of goods and services will depend on whether economical alternatives to the restricted substances can be found.

9. The Lower Mainland is in a rather unique position in this regard as it does monitor emissions from light duty vehicles under the AirCare program, and this can be used as a basis for developing new emission management measures. We will return to this point in Section 3.3.2 below, and in Section 6.0 where we discuss tradeable permits for mobile sources.

10. Concerns about the ability of the regulatory planning process to accurately complete these tasks is the source of many of the objections to command-and-control environmental regulation, and is the basis for many challenges by industry of standards and regulations.

11. By efficient we mean that the incremental costs of achieving a reduction is equal to the incremental benefits of that reduction. Thus, if something is not "efficient" then resources of value to society are being wasted.

12. In addition, it would be doubtful whether the information collected would be of much value as firms would have an incentive to overstate their abatement costs and exaggerate their problems in the hopes of receiving more lenient regulatory treatment.

13. This incentive only exists if the penalties are effective and substantial and there is a credible threat of detecting non-compliance.

14. West Coast Environmental Law (1993), pg. 52.

15. The reductions specified by the regulator may or may not represent efficient reductions in terms of equating the marginal (i.e., incremental) benefits of the reductions with the marginal costs of achieving the reductions. As a consequence, achieving the stipulated reductions may lead to a waste of resources. In this regard, the role of economic instruments is to minimize the costs.

16. Subsidies and tax allowances are essentially different sides of the same coin. Hence, the discussion that follows could equally be interpreted in terms of tax allowances as opposed to subsidies.

17. The discussion here applies equally to an emission reduction tax allowance.

18. The generation of revenue to fund air quality management programs is more the role of user fees, which are described below.

19. Other forms of transportation demand measures (TDMs) that have been proposed -- such as increased parking charges -- also operate in much the same way as tolls in influencing the behaviour of motorists. They act to increase the cost of using private automobiles and, therefore, provide an incentive to avoid private vehicle use and use substitutable transportation alternatives, or to avoid transportation use (e.g., work at home).

20. Of the product charges, carbon taxes have been promoted as an emissions management measure for a number of years. They have been implemented in a number of European countries (e.g., Finland, the Netherlands, Norway, Sweden, etc.) and have been discussed in Canada and the United States. A carbon tax is a tax on the carbon content of fuels. As certain fuels (e.g., coal, diesel) have a higher carbon content then other fuels (e.g., natural gas), the tax provides an incentive to reduce fuel consumption and substitute less carbonaceous fuels for fuels with higher carbon contents. As an incentive, a carbon tax can be highly effective; however, as a tool for *regional* air quality management, it may be difficult to implement for (at least) two reasons. First, while such a tax would fall on the mobile sector and, therefore, would help to balance the control burden in the GVRD/ELFV, mobile sources are politically and socially more difficult to affect than point sources. Hence, it may be politically difficult to implement an *effective* carbon tax. Second, if unilaterally imposed as a regional measure under the AQMP, it could put the region at a competitive disadvantage relative to neighbouring jurisdictions. To avoid this latter problem, carbon taxes would need to be applied over multiple jurisdictions or nationally. As a consequence of the broader jurisdictional nature of this measure, it will not be considered further in this paper.

21. Bylaw 725 authorizes the GVRD to collect fees from "every Person who discharges an Air Contaminant." However, these charges are currently only levied on permitted stationary point sources (Barr, E. (1994), pg. 28.).

22. The fees levied under *Bylaw 725* cover 40% of the management costs; the balance currently comes from property taxes.

23. GVRD (1992), pgs. 40-41.

24. Pearce, D.W. and Turner, K.R. (1990).

25. B.C. Ministry of Environment, Lands and Parks (1992).

26. This proposal is partially based on the advantage that AirCare offers -- light duty vehicles are subject to annual emission inspections and the data necessary to implement a mobile emissions fees are collected during inspections.

27. Even if the regulator is lucky, the fee will only be correct in a static sense; i.e., if nothing else changes. If the distribution of sources change, economic growth occurs, or sources experience differing rates of technological change, then the "correct" fee will also change.

28. Scott, Anthony (undated), UBC.

29. As noted in the literature, this is a common feature in most applications of emission fees and taxes. See: OECD (1989), Pearce, D.W. and Turner, K.R. (1990), Hahn, Robert W. (1989), among others.

30. The coupons can be distributed by auction, in accordance with historical emission patterns, or by other means. The issue of initial allocation is discussed in Appendix A.

31. The later sections in Appendix A provide more detailed explanations of each of these elements and describe the potential variations in design for each of these general categories.

32. "Paper" reductions occur when a facility which is permitted to discharge at a level greater than its actual discharge level attempts to obtain a emission reduction credit for the difference between its actual and permitted emissions. No actual reduction occurs, only a "paper trade".

33. Offset or growth credits come in two forms: internal and externally transferable credits. Internal credits are issued when a source finds a means to reduce emissions below that required by the regulatory policy at that time. These credits can later be used by that facility to offset any expansion they might have. External credits are generated in much the same way, but they can be transferred to new sources to offset the emissions that the new source produces.

34. A description of the role of offsets in this regard is provided in Appendix A.

35. It should be noted that the most significant cost savings in the RECLAIM program in California will likely be attributed to the establishment of these facility bubbles.

36. See Appendix A for a discussion of alternative banking options.

37. It is worth noting that one of the common objections to emission trading is that such programs provide a "right" or "licence" to pollute. However, this "licence" exists under tradeable credit programs, emission fee programs and command-and-control programs. The difference is that, under an emissions trading program, the "license" is more visible and they are easier to control.

38. If emission reductions are desired by the regulator, the cap can be structured to decline by a predetermined rate over a specific time period, which is equivalent to a scaled reduction in the annual allowable emission coupons issued.

39. Faced with the requirement to purchase the control equipment specified by regulators under a traditional command-and-control approach, emitters have demonstrated the ability to frequently and effectively avail themselves of a variety of alternative courses of action to compliance. These include administrative appeals on the grounds of compliance costs and capabilities, etc.; political appeals on the grounds of regional development, job losses, etc.; protraction of decisions through the vigorous use of court challenges; and the acceptance of nominal penalties for violations. Many of these options are effectively removed by providing emitters with the

ability to define how they will comply with required reductions; and by providing them with an alternative to expensive abatement measures -- the purchase of credits (CCME (1992), pg. 15).

40. It has been argued that performance standards also provide sources with the flexibility to determine the most cost-effective control measures; however, they do not provide the same incentives. Furthermore, uniform standards require all emitters to apply control measures to meet the standards which, for some firms, may be quite costly.

41. As pointed out by Tietenberg, this is a problem faced by firms in any type of market that face a fixed resource supply constraint. However, since "... they seem to handle it in these other markets, there is reason to believe they can handle it in this one too." (Tietenberg (1980), pg. 254).

42. In the case of localized air pollution, differences in source location and seasonal factors mean that not all emission reductions are of equal value in terms of improving air quality. The problems posed by local pollutants are common to all regulatory approaches, including command-and-control.

43. Trading zones are more fully discussed in Appendix A.

44. The arguments for BACT and new sources performance standards are easier to support in areas of non-attainment, which is not the case in the GVRD.

45. The stringency of regulatory standards is not an issue, its the manner in which they are specified and imposed. What economic instruments offer is not less regulatory control but rather a greater incentive to comply with the regulations and a mechanism for achieving compliance at substantially lower costs.

46. Any regulatory approach grants emitters "access" to environmental resources. The difference is one of visibility which, in turn, leads to different perceptions. For instance under the permit-fee system, emitters are allocated an amount of pollution to emit; under a trading system with a cap, the allocation is explicit, more visible and easier to control.

47. See Appendix A.

4.0 Emissions Management Alternatives for the Lower Fraser Valley: Assessment and Recommendations

The development of regional emissions management policy requires the completion of two principal tasks: the selection of the goals that regulatory intervention is meant to achieve; and the selection of the means or instruments to achieve those goals. In Section 3.0 we provided a sketch of the range of alternative emissions management measures that regulators in the GVRD could consider in executing this second task, and we reviewed their relative merits. As the discussion indicated, there are a wide variety of potential measures that could be used to address air quality concerns and achieve regional emission reduction goals. However, irrespective of whether one chooses to select management measures on the basis of a command-and-control approach, an economic instruments approach, or an integration of the two, given the range of measures available it can be difficult to determine which measure, or combination of measures, might represent the best package of options for achieving cost-effective emissions management in the LFV.

In this section of the report we attempt to screen the range of management measures available in order to narrow the range of choices and provide an indication of what type(s) of measure(s) may hold the most promise as a means of achieving the emission reduction objectives of the AQMP. To this end, we begin with a review of some of the possible criteria available to assess and compare the various management measures described in Section 3.0. The selection of management measures almost inevitably involves trade-offs between objectives, and these criteria can make those trade-offs more apparent. However, in order for these criteria to be meaningful as assessment tools, an understanding of what the goals are that the regulator is trying to achieve through the application of particular management measures, and the potential trade-offs they imply, is needed. Thus, we continue the discussion by outlining some the goals and objectives that the AQMP is striving to achieve, our interpretations of those goals, and our assumptions concerning the manner in which the AQMP will be implemented.

We then provide a preliminary assessment of how each of the control measures discussed in Section 3.0 which are relevant to the region may rank relative to these criteria. On the basis of this preliminary assessment, and the goals and assumptions that underlie it, we then proceed to provide some general recommendations concerning possible choices of management measures. As part of the discussion, we outline some of the reasons why the GVRD might want to consider economic instruments, and particularly emissions trading (transferable emissions limits), as a supplement to, or an alternative to, a command-and-control approach to the implementation of the AQMP. In addition, as part of the discussion we introduce a variety of issues that regulators would have to address in order for economic instruments to be effective. As part of this discussion, we also outline our assumptions concerning these issues that, in turn, underlie the choice of design features presented in Section 5.0 of this report.

4.1 Assessment Criteria

The performance characteristics of different management measures can vary substantially, both between different measures and across different program designs. For example:

- in order to achieve an environmental objective, some measures would imply that the "public pays" as opposed to the "polluter pays";
- different measures have implications for "how much" the polluter or the public will pay in terms of abatement measures, monitoring and administrative costs, and enforcement costs;
- some measures provide continuing incentives to abate, others provide one-time or only periodic incentives to abate, and still others are only meant to generate revenues to fund emissions management activities without explicitly providing an abatement incentive; and
- different measures provide regulators with differing degrees of control over emissions and, therefore, the ability to affect specified environmental improvements.

In selecting certain measures, then, regulators need to understand how the performance characteristics of a given measure line up with policy goals, as well as the sorts of trade-offs that may have to be made between measures (e.g., between revenue generation and incentives, degree of environmental effectiveness and monitoring/administrative costs) to ensure that policy goals are met. To facilitate the comparison and selection of emission management measures, a variety of screening and assessment criteria can be employed. Some of the possible criteria that could be used to aid in the screening and assessment of alternative control measures are illustrated below.

Policy Objectives and Goals

- Revenue generation/cost recovery/reinvestment
- Aggregate emissions reductions
- Ambient air quality goals (targeted emission reductions)
- Avoidance of health/environmental risks
- Accommodation of economic growth
- Polluter Pays

Environmental Effectiveness

- Meet environmental goals
- Offer environmental benefits beyond specified goals
- Incentives for on-going abatement
- Encouragement of R&D into environmental management technology and processes
- Time element of meeting goals (e.g., seasonality, speed with which environmental impacts are realized)
- Ability to address local environmental issues/impacts (e.g., "hotspots")
- Flexibility with respect to managing growth in emission sources and changing environmental goals
- Linkages with or incorporation of non-targeted pollutants

Experience

- Existence of similar policies using similar measures in other jurisdictions
- Successes and failures of those applications

Cost Effectiveness, Equity and Other Cost Considerations

- Cost of compliance (both short-term and long-term) for emitters
- Cost of administration (including monitoring, reporting, etc.) for emitters and regulators
- Overall cost-effectiveness
- Overall impact on competitiveness of firm/industry
- Fairness and equity in distribution of compliance/management costs
- Ability to capture static and dynamic economic efficiencies
- Stimulate on-going, cost-effective abatement

Acceptability

- Support for the measure amongst all stakeholder groups (public, emitters, government, etc.)
- Predictability (e.g., scope, administration, longevity of the measure)
- Impacts on domestic and international competitiveness and market structures
- Distributional impacts, including distribution across players and use of revenues generated through (for example) environmental charges, user fees, permit fees

Administration and Management Considerations

- Consistency with government policy
- Jurisdictional compatibility (e.g., legislative constraints and overlapping and/or preexisting regulations)
- Coordination with the application of measures/instruments in other jurisdictions
- Legal support
- Enforceability to ensure environmental goals are achieved
- Administrative constraints and complexities
- Feasibility of tracking and monitoring the impact of the measure
- Understanding of data requirements
- Understanding of programs design requirements (e.g., market architecture requirements, trading market design and impacts for economic instruments)

As indicated, there are a variety of criteria that could be taken into consideration when assessing alternative management measures. If the purpose here were to compare and contrast alternative detailed regulatory program designs (e.g., a fully defined BACT policy or performance standards versus a fully designed emissions trading program or an emissions fee program), then each of the specific criteria outlined above may need to be considered in some detail.

However, our purpose is to provide an assessment of alternative emissions management measures at a more conceptual level. More to the point, while some of the measures outlined in Section 3.0 are currently being utilized in the LFV (e.g., user fees in the form of *Bylaw 725* and the *Waste Management Permit Fee Regulation*, environmental levies on tires and batteries, transportation subsidies), many have not been (e.g., a tradeable emissions coupon or transferable emissions limits program, dual instruments). To be able to properly compare and contrast the full suite of available management measures on the basis of the more detailed criteria presented above, well defined designs and implementation plans for those measures that have already been implemented, as well as those that are not currently employed in the region, would be required. Thus, to facilitate an assessment of the relative effectiveness of alternative measures in achieving air quality management goals at a broader, more conceptual level, we will consider a somewhat narrower and more general set of assessment criteria that includes:[1]

- ***Environmental Effectiveness:*** to what degree is the measure capable of achieving the environmental goals and/or other social objectives of an air quality management program.

- ***Cost Effectiveness:*** does the measure lead to the achievement of the designated environmental goal(s) at the lowest cost to emitters, the government and the public.

- ***Equity:*** are the costs of compliance fairly distributed across emission sources (e.g., are the costs distributed across sources in proportion to their relative contributions to emissions).

- *Administrative Simplicity:* are the rules clear and predictable and are the administrative monitoring and enforcement burdens borne by government, the regulated and the public "reasonable".

- *Polluter Pays:* is the instrument consistent with the polluter pays principle; i.e., are those who emit pollutants responsible for the costs imposed by their discharges.

- *Acceptability:* is there support for the measure amongst the regulated, the regulators and the public.

While these criteria will suffice for our analysis, they are not operationally meaningful in the absence of some defined set of "objectives". For instance, the question as to whether a particular measure is "environmentally effective" or "cost-effective" depends on what the goals are of a given environmental policy and what role a particular measure is meant to undertake in meeting those goals. For example, a user fee may seem to be environmentally ineffective in terms of creating an incentive for abatement, but that is not what a user fee is designed to do. Similarly, an offset policy may not lead to earlier emissions reductions than anticipated by the regulator and, therefore, the offset policy may be deemed "environmentally ineffective". However, this may be an invalid criticism since this is not the role that offsets are meant to play. Thus, in order to make these criteria meaningful as an assessment tool within the context of the LFV and the AQMP, the operational goals of the AQMP, and by extension the roles that specific management measures such as economic instruments are to play in achieving those goals, must be specified. These issues are addressed below.

4.2 Policy Goals and Implementation Assumptions

We begin by noting that the Plan has been designed and will be implemented in a manner consistent with the following objectives:[2]

- achievement of the required pollutant emission reductions;

- attainment of the most cost-effective reductions;

- an equitable distribution of management costs amongst sources; and

- availability -- or potential availability -- of the data and monitoring information necessary for effective implementation of reduction measures.

The objectives listed above, while necessary in order to render a meaningful assessment of alternative management measures, may seem rather generic. However, they have an important bearing on the roles of specific measures in achieving the goals of the AQMP, and the merits of any given management measure have to be assessed within the context defined by these objectives. A further examination of the meaning and implications of these objectives is provided below.

4.2.1 Required Reductions

The general intent of the GVRD's AQMP is clearly outlined its Mission Statement:

> The GVRD Air Quality Management Program will work cooperatively with the community to shape regional land use and transportation, encourage clean air lifestyles, and manage emissions from human activity so as to protect human health and ecological integrity both within the region, in neighbouring jurisdictions in the Lower Fraser Valley airshed, and globally.[3]

However, the specific objective of the AQMP which provides guidance for a meaningful assessment of alternative management measures is to "achieve the GVRD Creating Our Future 1993 strategic policy for 'Clearing the Air' to reduce by 50 percent (from 1985 levels) the overall emissions of five major contaminants -- carbon monoxide, volatile organic compounds, nitrogen oxides, sulphur oxides and particulate matter -- by the year 2000."[4] Whether or not this aggregate emissions goal is appropriate or that it ensures "... that maximum air quality and public health benefit is achieved ..."[5] is not supposed to be of concern here: this study is not meant to evaluate the merits of this or alternative emission reduction goals (that is best handled within the context of a cost-benefit analysis).[6] What is more relevant in terms of investigating the feasibility and benefits of potential economic instrument applications is whether the 50% reduction is treated in practice as a "desired goal" (i.e., this is what we would like to achieve) or as an absolute requirement (i.e., this is what we *must* achieve); and whether we are to assume that this 50% reduction in aggregate emissions is the single environmental goal (such that, for example, particulates may be allowed to increase as long as CO emissions decline sufficiently so that the required, overall reductions objective is not violated), or are there additional goals such as limits on how much specific contaminants may increase, if at all.

In this assessment, we assume that the 50% reduction objective is an absolute requirement.[7] Furthermore, since the aggregate 50% reduction is apportioned across the priority contaminants in the AQMP, we assume that pollutant-specific reductions are required, not simply an aggregate 50% reduction. While these interpretations of the AQMP's emissions reduction goal may seem trite, they can have a significant bearing on the type of management measure (e.g., a price or a quantity-based measure) that is most effective in reaching the stated policy objective, as well as the sources to which the measures should be applied.

4.2.2 Cost Effective Reductions

The emission reduction measures to be applied under the AQMP "... must ensure that maximum air quality and public health benefit is achieved at the least economic cost and disruption to the economic viability and livability of the region."[8] That management measures should impose the least economic cost is a rather simple consideration, and apparently straightforward in nature. Those reductions of each pollutant that cost the least per tonne to abate should not be dissuaded, and the program should persuade sources and entrepreneurs alike to develop better methods for controlling emissions.

However, a goal of attaining least cost reductions has two implications. First, it is important to take into account all facility costs when considering any measure. The total of abatement costs, fees and taxes, legal costs, administration and monitoring costs often represent a significant burden to facilities participating in control programs. Second, in searching for least-cost measures, regulators need to be open to all possible management alternatives (not simply those that are the most acceptable to the public), and each measure must be able to be evaluated on a level playing field (e.g., both command-and-control and economic instruments approaches are equally acceptable).

4.2.3 Equitable Distribution of Management Costs

Perhaps one of the greatest difficulties with implementing a comprehensive air quality management plan comes from participants' concerns about equitable cost distribution. This equity includes costs in monitoring requirements, required rates of reductions on emissions, control measures/technologies, and their distribution across source sectors. In our assessment, we assume that distributional equity is a key goal in selecting emission reduction measures; i.e., that the associated control costs be distributed across sources in approximate proportion to a source's contribution to emission loadings.

4.2.4 Data Requirements

As noted in Section 3.0, some management measures, while theoretically optimal, require data and monitoring information that regulators may not reasonably be expected to have (e.g., facility by facility abatement cost data, facility by facility continuous monitoring data). We will assume that, regulators in the GVRD will not have access to information that is far in excess of that which is currently (or expected to be) available.

4.2.5 Some Further Considerations

The objectives outlined above take us some distance in rendering the criteria outlined in Section 4.1 meaningful as an assessment tool. However, the objectives indicated in the terms of reference for this study include:[9]

- review the applicability, feasibility and economic effectiveness of the application of economic instruments as a component of the air quality management strategies to improve air quality in the LFV airshed; and

- provide a detailed assessment of the feasibility, the effectiveness and the legislative and administrative elements of a program for marketable permits and/or higher permit fees in the LFV.

In order to make any headway with respect to these objectives, and provide an assessment of economic instruments and incentives, one must first begin with an understanding of the role that these instruments and incentives are to be assigned within the context of the AQMP, where and how they are anticipated to be applied, and the operational objectives that they will be implemented to achieve.

For certain economic incentives, such as bridge and road tolls, parking charges, etc., their roles are defined in the AQMP. However, with respect to emission fees and, more importantly, marketable permit programs, these issues have not been addressed and, therefore, it is difficult to provide any meaningful assessment of these instruments. For example, an assessment of the compliance cost savings realized, and the administrative costs incurred, through the application of a trading program will depend on the selection of the program's objective(s); e.g., is the program meant to act more as an offsets policy to accommodate economic growth, or is it meant to provide the primary means of achieving the emissions reduction goal. In addition, the degree to which the advantages of a trading program (or any other economic instruments) will be realized will depend on whether this instrument would be implemented as an alternative to traditional command-and-control measures (e.g., specification of technology or performance-based standards, etc.), as part of a integrated program of complimentary command-and-control and market-based initiatives, or grafted on to the existing/planned command-and-control structure.

While these issues have yet to be resolved, in order to facilitate a broader understanding of the applicability, feasibility and effectiveness of economic instruments (such as transferable emissions limits and emission fees), and to provide a basis on which to make preliminary recommendations concerning the choice of instruments and the design of such programs, we have had to make assumptions concerning the manner in which the GVRD could apply instrument programs. In making our assumptions, we considered three possible objectives for economic instruments (and particularly emissions trading/transferable emissions limits program applications):

- *Case 1:* In this case it is assumed that the objective of an economic instruments program is to provide the *primary means* of achieving the emission reductions specified in the AQMP (for at least some contaminants/source sectors) at the greatest speed and least cost. Under this case, the possibility of realizing the full advantage of instruments such as trading programs is maximized. However, it should be noted that instrument applications under this case may have broad implications for other air quality programs and initiatives.

- *Case 2:* In this case it is assumed that the emission reduction measures outlined in the AQMP will be fully implemented and the objective of an economic instruments program is to provide emitters with an incentive to achieve emission reductions in excess of those achieved through the application of the AQMP emission reduction measures alone. Essentially, this case assumes that economic instruments will be utilized primarily to fill the gap between the 38% reduction in annual emissions achievable under the AQMP and the 50% reduction goal.

- *Case 3:* In this case it is assumed that the objectives of the AQMP will be achieved through the application of the emission reduction measures outlined in the AQMP and through the retention of new source performance requirements. The principal objective of an economic instruments program in this case will be largely limited to providing a means of accommodating economic growth (as opposed to achieving improved cost-effectiveness and/or greater/earlier reductions).

The assessment provided below, and our recommendations concerning the choice and, to a minor degree the design, of economic instruments, is based on the Case 1 assumption. The merits of this case, as opposed to the others, lies in the fact that it provides a clear basis for assessment. In contrast, while the Case 2 assumption may more closely approximate reality in terms of how economic instruments would likely be applied in the GVRD, any assessment based on this assumption would require more detailed information as to the implementation plan for the AQMP, as well as detailed decisions concerning how and to what sources economic instruments (such as emissions fees and transferable emissions limits programs) would be applied and how they would be integrated with the AQMP and other existing/proposed regulatory measures. Since many of these decisions have yet to be made by the GVRD, the number of assumptions that the Study Team would have had to make to conduct an assessment of economic instruments under Case 2 would render the assessment practically meaningless.

With respect to the Case 3 assumption, this too was rejected in favour of Case 1, as it would not provide a particularly enlightening assessment of the applicability, feasibility and economic effectiveness of the application of economic instruments, as called for in the terms of reference.

As will be noted in Section 7.0, instrument applications under both the Case 2 and Case 3 assumptions warrant further study. However, regulatory decisions with respect to the anticipated role of economic instruments and the manner in which they will be integrated into existing regulatory structures will be required both before such further studies could be usefully undertaken.

4.3 Preliminary Assessment of Emissions Management Alternatives for the Lower Fraser Valley

Our assessment of the main categories of management measures described in Section 3.0, relative to the assessment criteria outlined above, is summarized in Exhibit 4.1 below. The assessment is based on the Study Team's understanding of the theoretical and practical roles and capabilities of various measures; the goals of the AQMP; our interpretations and assumptions concerning those goals; the contaminants that the AQMP is meant to address; our assumptions concerning the potential role that economic instruments could be assigned within the context of the AQMP; and the views of the residents/stakeholders in the LFV as expressed in a variety of consultation reports.[10]

By its nature, the assessment provided below is subjective: there are few clear right or wrong answers, and the answers will vary with the design of the measure and the regulatory context within which it will be integrated. In addition, the assessment is not truly consistent since some measures already exist (e.g., user/emission fees in the form of *Bylaw 725* and the *Waste*

Management Permit Fee Regulation, transportation subsidies), and are partially evaluated on the basis of their existing designs, while other measures (e.g., tradeable emissions coupons/transferable emissions limits programs, a comprehensive emissions fee program, bridge tolls and other transportation demand measures) are not fully in place, and they are assessed more on the basis of their theoretical or expected properties. Finally, each of the measures listed in the Exhibit is assessed in terms of their *general characteristics and applications* -- a given measure can be designed and implemented in a variety of ways and this, in turn, can lead to different relative rankings.

For each of the measures listed in Exhibit 4.1, key considerations regarding the assessment are discussed in more detail below. It should be noted that, in this assessment, environmental effectiveness is being interpreted as the ability to effectively achieve a specified emissions reduction. This criterion should ideally be interpreted in terms of achieving a certain ambient air quality objective; however, there is often uncertainty in the scientific linkages between emissions and ambient air quality. Thus, for the purpose of this assessment, we are confining our interpretation of environmental effectiveness to a more directly linked and measurable outcome: specified emission reductions.

Enforceable Restrictions

As a tool for regional air quality management, enforceable restrictions, by prohibiting the use of a pollutant, can be quite environmentally effective.[11] Such restrictions may be more applicable as a management tool for a small number of easily identifiable, toxic pollutants (such as CFCs, certain benzene compounds), as opposed to some of the broader priority pollutants addressed by the AQMP. However, enforceable restrictions could be useful in mandating the use of certain "clean" fuels in transportation. In terms of cost-effectiveness, this measure may not score well, since substance restrictions are generally made on a scientific basis without full consideration of the costs of substitutes (unless they are prohibitively high), the cost of changing production processes, the cost of retro-fitting equipment, etc.

Uniform Emission Standards

For the reasons given in Section 3.2, uniform emission standards (either technology-based or performance-based) do not rank highly against most criteria, especially when they are applied to existing sources.[12] Their environmental effectiveness is compromised by the fact that the restrictions differ between new and old sources; they are subject to negotiation; they do not impart an upper-bound on emissions; and they are not easily related *directly* to defined emission reduction goals, except in a static sense.

The rankings against both cost-effectiveness and administrative simplicity reflect the short-comings associated with command-and-control generally (which are discussed in Section 3.2). Uniform emission standards can perform well in terms of acceptability among existing facilities in so far as they act as a barrier to entry for new, competing firms. Also, even if the regulated may not appreciate the standards, the general public will, since they represent a visible sign that

Exhibit 4.1: Assessment of Alternative Emission Management Measures

Alternative Management Measures	Criteria					
	Environmental Effectiveness	Cost-Effectiveness	Polluter Pays	Administrative Simplicity	Equity	Acceptability
Enforceable Restrictions	✔	✔	✔✔	✔✔	✔✔	✔✔
Uniform Emission Standards	✔	✔	✔✔	✔	✔	✔✔
Subsidies for Public Transportation/ Carpools	✔	✔	✘	✔✔	✔✔	?
Emission Reduction Subsidies	✔	✔	✘	✔	✘	✔
Emission Fees/Taxes	✔✔	✔✔	✔✔	✔	✔	✔
User Charges	?	?	✔✔	✔✔	✔	✔✔
Bridge and Road Tolls	✔✔	✔	✔✔	?	✔✔	?
Product Charges/Tax Differentiation (e.g., disposal levies on batteries and tires)	✔✔	✔✔	?	✔✔	✔✔	✔✔
Transferable Emissions Limits	✔✔✔	✔✔✔	✔✔	?	?	?
Dual Coupon/Fee Programs	✔✔✔	✔✔✔	✔✔	?	?	?

Compliance with Criteria:

- ✔ Low
- ✔✔ Medium
- ✔✔✔ High
- ✘ Violates Criteria
- ? Uncertain as criteria does not generally apply or the effect is uncertain

the government is "controlling" the behaviour of emitters. Equity is not usually achieved among existing facilities because these facilities have differing characteristics and, therefore, the financial burden from installing any control measures deemed necessary to comply with a standard will also differ. In addition, those small facilities that wish to expand usually find themselves having to meet more stringent requirements than the existing facilities that are already of a larger size.

Subsidies for Public Transportation and Carpools

As with all subsidies, the main problem with these measures (at least on the surface) is that they violate the polluter pays principle (although in the case of subsides for public transportation, the taxpaying transit riders eventually foot the resulting tax bill). In terms of environmental effectiveness, the results are not clear. For example, in the absence of subsidies for public transportation, this transportation alternative might not represent a cost-effective choice for many individuals. In the case of other types of subsidies (e.g., subsidies for carpools) the problem is that they generally offer an *all-or-nothing* proposition. In this case their effectiveness is unclear since they target individuals not simply on behaviour (i.e., the "wealth effect" of the subsidy has bearing). In this same sense, subsidies are often considered inequitable since the wealth impacts will affect an individual's decision to alter behaviour. In general, it is often unclear what level of subsidy is necessary to achieve the substitution toward public transit or carpools; and by extension it is unclear what emission reductions will be achieved at each level of subsidy.[13] The argument for the low ranking against cost-effectiveness is based on the same reasoning: monies are spent with unclear environmental consequences.[14] In terms of acceptance, the effect is unclear: it may depend on the level of subsidy; the availability of the subsidized transportation mode; and whether taxpayers realize that they, and not the government, are footing the bill for the subsidy.

Emission Reduction Subsidies/Tax Allowances

Again, as with all subsidies, these measures violate the polluter pays principle. In terms of environmental effectiveness, this measure can achieve some environmental gains (by motivating emitters to adopt abatement technologies); however, it suffers from the same shortcomings associated with emissions fees/taxes (i.e., it is not clear what level of subsidy is required to achieve a given reduction). In terms of cost-effectiveness, the low ranking also results from the same shortcoming associated with emissions standards, and from the fact that this measure is open to possible abuse. By extension, it could also be argued that the equity principle is likely also violated: the general taxpayer is footing the bill for the industrial emitter and it is unclear whether the emitter *truly* needs the subsidy.[15]

Emission Fees/Taxes[16]

Assessing emission fees is a rather subjective activity due to the fact that, on a theoretical level, they can be effective both from an environmental standpoint and in terms of cost-effectiveness (if sources are given the freedom to develop their own abatement strategies). However, they are not particularly effective from an environmental standpoint (for the reasons noted in Section

3.3.2). The features that are more certain include the fact that, as discussed in Section 3.3.2, in practice emission fees are not administratively simple to apply (if they are to be used as an effective emission reduction measure as opposed to a user fee). In addition, the necessary continual manipulation of the fee and the fact that the fees may be viewed as a "tax grab" may render this measure unacceptable.[17] Finally, unless emission fees in the GVRD are eventually extended to the mobile sector, they will fare poorly in terms of equity.

User Charges

User charges are a useful and often necessary means of *financing* air quality management program activities. However, as noted in Section 3.3.2, their primary role is to raise revenues, not to provide an effective abatement incentive (hence the ambiguous ranking noted in Exhibit 4.1 concerning environmental and cost-effectiveness). Where this measure may rank poorly, at least in terms of its current application in the GVRD (e.g., *Bylaw 725*), is in terms of equity. These charges are currently only levied on permitted stationary point sources, which are the minority emitters in the LFV on a total, regional emissions basis.[18] However, the GVRD is waiting for the Province to grant authority to assess fees for automobile use.

Bridge Tolls, Road Tolls and Other Charge-Based TDMs

Many of the transportation demand measures (TDMs) recommended under *Transport 2021* and incorporated within the AQMP will be of benefit as they start to bring the costs of polluting activities closer to home for the major emissions-contributing source in the LFV: the mobile sector. However, we have assigned a relatively low rating to environmental effectiveness and cost effectiveness for two reasons. First, since charge-based TDMs constitute an *all-or-nothing* proposition, it is unclear what degree of substitution away from private vehicle use toward public transit, carpools, etc., will occur at any given level of charge. By extension, as with all charge-based measures, while emission reductions can be modelled, it is unclear what emission reductions will actually be realized at each level of charge. The argument for the low ranking against cost-effectiveness is based on similar reasoning (the government may collect revenues with uncertain reductions in emissions). The second potential problem with charge-based TDMs is that if they are to be effectively used to reduce emissions, the charges will need to be varied as a "searching tool" in an effort to find the correct setting, and to adjust to the dynamics of a rapidly growing region. The resulting setting may be quite high and prove to be unacceptable from the public's point-of-view (hence the ambiguous rating assigned to acceptability). The ambiguous rating assigned to administrative simplicity also stems from the role assigned to these measures. If tolls are implemented more as a user fee, then they are relatively simple to administer. However, if they are used as an effective emission reduction tool, then they can become more complex to administer.

Product Charges/Tax Differentiation

This type of management measure can be a useful adjunct to the AQMP. By driving a wedge between the costs of "environmentally friendly" and "environmentally unfriendly" production inputs and consumer products, producers and consumers are provided with the incentive to substitute towards the more "friendly" products. The potential problems with this measure surround the size of the levy and the degree to which economical substitutes can be found for the "unfriendly" products/inputs. These issues can affect the environmental effectiveness of the measure, the cost-effectiveness and the degree of acceptability. Whether the "polluter pays" under this measure will depend on the products that receive the levy and how the costs are passed down through the market.

Emission Trading/Transferable Emissions Limits Programs

As with emission fees, any assessment of emission trading programs at this stage is unavoidably subjective. This is due to the fact that, within the context of the LFV and the AQMP, the assessment is largely based on the theoretical or expected properties of these programs; it will vary according to the trading components adopted (e.g., offsets, bubbles, fully tradable programs, etc.); it can vary *dramatically* with specific program designs; and it can vary *dramatically* according to the manner in which instruments are integrated into existing/planned regulatory policies. However, despite these problems, in assessing emission trading programs, some general conclusions and remarks concerning the sensitivity of those conclusions can be made.

First, from an environmental effectiveness point-of-view, tradable emissions coupon/transferable emissions limits programs are ranked higher than any of the alternative management measures. This is due to the fact that emissions trading systems are *quantity* measures. However, the extent to which the environmental effectiveness of these programs will be realized will depend on the definition of the emissions reduction goal. If the goal is to cap the aggregate regional emissions of a pollutant, then the degree to which the environmental effectiveness will be realized will depend on whether all sources of the pollutant are enrolled in the program (this also assumes that the emissions inventory incorporates all sources) and on whether the emissions can be effectively monitored. It may not be practical to achieve these conditions, in which case the environmental effectiveness of trading may deteriorate. Alternatively, if the goal is to cap aggregate emissions of a pollutant for a given source sector (e.g., point) or sectors (e.g., point and mobile), then the theoretical environmental effectiveness of trading is more likely to be realized in practice.

Second, in theory tradeable emission coupon programs can be highly cost-effective. In practice, however, this conclusion is sensitive to the climate within which the programs are implemented. If emitters are required to comply with BACT policies and/or performance standards, if new sources are subject to new source performance standards, or if emitters have to comply with excessive monitoring requirements and administrative activities, then the cost-effectiveness of tradeable coupon programs can be substantially reduced.

Third, these programs can be administratively complex, depending on how they are integrated with existing policies (hence the ambiguous rating). However, they are likely no more so than existing command-and-control programs. In fact, they are likely to be less complex since the task of developing standards no longer falls on the regulator. However, while this may raise the question of whether one is just changing the distribution of administrative costs, emitters are likely able to discharge this task in a more cost-effective manner, because of their understanding of their own facilities.

Fourth, these programs may not be very equitable for the same reasons associated with many other measures: the difficulty of effectively addressing the mobile sector. However, the mobile sector could be brought into the trading program through measures such as vehicle scraping programs or, given the particular situation in the GVRD, more directly as full trading partners (Section 5.0 describes a possible design for a mobile sector trading program). Whether or not the mobile sector can be effectively brought into the program is a subject that requires further study (this is one of the reasons for the ambiguous rating for equity).

The initial allocation of the coupons also represents one of the areas with the greatest potential for a non-equitable situation. If the coupons are freely allocated, then facilities with more influence may receive more than their "fair share". If the coupons are auctioned, then as long as capital markets are imperfect (i.e., small businesses have less access to equity or borrowed funds) larger firms have a substantial advantage. The issue of allocations is a subject that requires further study and is one of the reasons for the ambiguous rating for equity.

Finally, the acceptability of emission trading programs is difficult to accurately assess, both because it can vary significantly with program design and because of the misconceptions that surround such programs. At one level, industry is quite accepting of tradable coupon/transferable emissions limits programs if they are given the freedom to determine the abatement strategies that best apply to their facilities. However, the public may not "trust" industry, and they may harbour a variety of misconceptions concerning trading programs (e.g., that they imply a "right" to pollute, that they mean less regulation, that they use public resources to enrich emitters) that render such solutions unacceptable or acceptable only if a variety of constraints are placed on the program (e.g., excessive monitoring requirements, uniform emission standards, new source performance standards). Of course the imposition of these constraints may render the programs unacceptable to industry (such programs end up having form but no substance) and to government (since it drives up administrative costs while reducing environmental benefits).

While a system of tradable emission limits can be quite flexibly designed to highlight or priorize various social, economic, or industrial requests and benefits, several areas almost certainly can cause such a program to falter and perhaps be retracted. These "showstoppers" must obviously be avoided with great assurance. What follows is a listing and description of these potential problems.

- ***Lack of sufficient monitoring.*** Because facilities are financially responsible for their emissions under this system, the ability to deceptively report emissions must be minimized. If not, the facilities are not likely to accurately report emissions, the cap will be exceeded, trades will not occur in any significant amount, and the program will be less effective than a command-and-control program where facilities are at least required to install certain equipment. Several types of monitoring suffice. The first is a continuous or semi-continuous type of actual emissions monitor. The second is an accounting of products used (e.g., fuel, paint and other evaporative emissions) and an assumption on the part of the regulator and facility that all of the pollutants in these products are eventually released into the atmosphere, barring the installation of highly specialized equipment to remove vapours from a venting area.

- ***Pre-approval of all trades.*** Facilities and others interested in transferring emission limits must know that as long as they abide by the rules of trade, all trades are valid. Further, they must also know that as long as they abide by the rules of use, all transferred emission limits must be valid. The transfers cannot be of a "buyer beware" type, but rather the "selling" facility must be made accountable if they have transferred away credits or limits that they need in that year. In such a case, the selling facility is required to purchase or find unused emission limits to make up the shortfall, or the facility is out of compliance and is levied with a stiff fine. That fine includes a direct financial penalty, a decrease equivalent to the excess from the following year's emission limit, and perhaps a civil penalty against the facility owner. The rules for use must therefore be well thought out and defined.

- ***Continual alteration of program goals or emission limit values.*** While the use of callable credits reduces the economic and equity impacts of altering the program should new information (e.g., health effects, air chemistry, biogenic emissions, etc.) become available, frequent changes will be at the least disruptive and more likely will lead to a distrust of the regulators' support or definition of the program. Facilities make their abatement decisions based upon what they believe to be the program definition at the time, and if they believe that the program will change often over a short time period, then the facilities are likely to hold off making the most cost-effective emission reductions and, perhaps even worse, request to withdraw from the program by leaving the area. Along those same lines, companies wishing to locate in the GVRD or LFV will be dissuaded from doing so, believing that they will be entering a highly uncertain regulatory atmosphere.

- ***Lack of a database of emission limit holdings.*** Without a database that accurately accounts for facility and other entities' holdings, the regulator cannot accurately assess whether a facility is in compliance with the rules, and facilities are not able to verify their holdings and thus adjust their behaviour accordingly, hindering the establishment of an efficient market or transfer system in which facilities can transfer their limits and create the cost savings likely from a well-designed program. Such a database is not difficult to develop, and in fact several U.S. jurisdictions already have designed and worked through the difficulties with such a database, but this database must be available from the beginning of the program implementation.

- ***No well-defined baseline of facility emissions.*** The regulator must attempt to establish the emissions, or a relatively accurate proxy of emissions from facilities before the program begins. Without this, the regulator will not know from what level emissions must be reduced. The "mix" of ozone precursor emission (e.g., VOC and NO_x) are especially important in determining the most effective amounts of each precursor to reduce in order to affect ozone formation. Further, without a baseline improvements in air quality are more difficult to accurately attribute to emission reductions versus other factors.

- *New facility purchases 1:1 for new emissions.* New facilities entering the regulated region must be required to hold emission limits to cover their emissions. Without this requirement, the cap cannot be maintained, and equity between new and existing facilities is destroyed. More specifically, these new facilities should be required to hold emission limits in a manner similar to existing facilities, meaning that for every unit of emission released the new facility must hold equivalent emission limits (a 1:1 ratio).

Dual Coupon/Fee Programs

The assessment of dual coupon/fee programs at the conceptual level is not markedly different from the assessment of an emissions trading programs. Hence, the comments noted above apply equally well here and will not be reiterated with one exception -- the issue of acceptability. The advantage of such a system is that it may be more publicly acceptable: the public and the government are more likely to agree with a system that generates revenues and explicitly appears to include the "polluter pays principle".

4.3.1 Summary

As the assessment provided above indicates, there are advantages and disadvantages associated with each of the management measures. There are few clear answers as to what measure or combination of measures is most appropriate: some measures rank relatively high against certain criteria while not against others. In selecting management measures, then, priorities have to be established among the criteria, and trade-offs made on the basis of these priorities. The willingness to make trade-offs between the criteria, and the climate in which those trade-offs have to be made, will affect the choices that regulators make in selecting certain instruments over others. While we recognize these influences, in Section 4.4 below we draw on the assessment provided in order to make some of the choices clearer. Specifically, we outline some of the reasons why the GVRD might want to consider economic instruments, and particularly transferable emissions limits, as a supplement or an alternative to a command-and-control approach to the implementation of the AQMP. In addition, we outline our general recommendations concerning transferable emissions limits as a possible measure to facilitate the attainment of the goals and objectives of the AQMP. Finally, we introduce a variety of issues that regulators would have to address concerning the characteristics that an emissions reduction program containing transferable emissions limits programs would need to exhibit in order for this instrument to be effective. As part of this discussion, we also outline our assumptions concerning these issues that, in turn, underlie the choice of design features presented in Section 5.0.

4.4 A Recommended Role for Economic Instruments in the GVRD

As noted earlier, a number of regulator issues are outstanding and would need to be resolved before a more detailed assessment of alternative management measures can be made. However, the preliminary assessment provided in Section 4.3 does provide an indication of the relative merits of various measures as tools for accomplishing the goals of the AQMP (as per the discussion of the goals and assumptions provided in Section 4.2). While some measures appear to outperform others in terms of environmental effectiveness, cost-effectiveness, etc., with the exception of emission reduction subsidies (which violates the polluter pays principal), we would not necessarily recommend that any of these measures be abandoned outright. No one single measure will suffice for all pollutants and all sources: to achieve the goals of the AQMP combinations of the various measures assessed in Section 4.3 will be required.

A feature of interest in the assessment is that, on the face of it, one might recommend against further large scale applications of command-and-control; however, the outright dismissal of such programs would be naive. For certain priority contaminants (at least in the short to medium term) command-and-control measures may serve as the only practical means of management. What the assessment would indicate is that, while we do not suggest that any of the command-and-control measures should be rejected out of hand, regulators in the GVRD should broaden their range of choices to include economic instruments and, more specifically, transferable emissions limits.[19]

In terms of the choice of economic instruments, as a general rule, any measure that offers emitters a financial incentive (that goes beyond legal sanctions and penalties) to reduce emissions will serve a useful role in achieving the AQMP goals. Similarly, any measure that is *directly* linked to financing the costs of administrating air quality management in the region, and that makes the costs of air quality management more apparent to industry and the public, will also serve a useful role in advancing the AQMP goals. Thus, we would recommend that bridge and road tolls, other charge-based TDMs, and user fees (e.g., *Bylaw 725*, *Waste Management Permit Fees*) be applied to reach the goals of the AQMP, subject to three qualifications.

First, the manner in which each of these measures will be ultimately applied will depend on the overall package of management measures (including economic instruments, economic incentives and command-and-control based policies) selected for the region. Choices as to which measures are necessary, which are redundant, and which need modification, would need to be evaluated during the development of an implementation plan an AQMP which incorporates a broader range of economic instruments.

Second, in applying these incentives, their limitations have to be recognized; i.e., these incentives are largely applied to provide a "signal" to industry and the public as to the costs of polluting and to generate revenue to finance emissions management in the LFV. While it is incorrect to trivialize the emission reduction incentives associated with these incentives, it would be equally incorrect to exaggerate their role.

Third, the cumulative impact of these charges must be taken into account. For example, if a program of transferable emissions limits is instituted then the existing *Bylaw 725* and *B.C. Waste Management Permit Fees* could be re-dedicated to financing the trading system. Similarly, parking charges, bridge/road tolls, etc., could be used to finance transportation alternatives and/or mobile sector transferable limits programs. The point is, if instruments such as trading programs are implemented as the primary management measure for a given priority contaminant (our Case 1 assumption), then permit fees and other charges should not be used as an additional *emission reduction incentive* for that pollutant. Unless these fees are integrated with the transferable limits program (such as a dual coupon/fee system), to continue to treat them as some sort of separate reduction incentive serves only to increase the cost of compliance. Attempts to implement overlapping and redundant "incentives" could jeopardize the acceptability and viability of the air quality management program, as these additional measures would have no incremental incentive effect and, therefore, no incremental environmental purpose. Rather, they would likely be seen as a "tax grab".

While we would generally recommend most of the economic instruments that provide a "signal" to industry and the public as to the costs of polluting and/or that generate revenue *explicitly* to finance emissions management in the LFV, we would recommend against full-fledged *emissions fees* as a principal management measure. This recommendation may seem counter-intuitive; however, it is made for practical reasons. Specifically, as discussed in Section 3.3.2, the difficulties associated with the practical application of emission fees as a means of regional emissions control render this instrument cumbersome and largely ineffective from an environmental, cost-effectiveness and administrative simplicity point-of-view. However, such fees could be retained to fund the administration of emissions management (i.e., a user fee), or to fund and enhance a transferable emissions limits program (e.g., a dual coupon/fee system).

4.4.1 Transferable Emission Limits as a Management Measure

As a principal management measure (at least for some contaminants/source sectors) we would recommend that regulators in the GVRD consider adopting transferable emissions limits programs. As a *quantity-based* instrument, these programs provide regulators with a more direct means of affecting changes in industrial, sectoral and regional emissions.

In making a recommendation to consider transferable emissions limits, it must be recognized at the outset that a variety of factors will need to be considered in order to structure the economic instrument to fit into the GVRD's air quality management policy, as well as provincial and federal policies; and that a number of issues and questions will have to be debated and settled upon by regulators before any such programs can actually be rigorously designed or implemented. For instance, the role of trading, whether the instrument will substitute for some existing AQMP measures or be implemented in addition to the AQMP as defined, the specific contaminants and source sectors to which the instrument will apply, the seasonal dimensions of those contaminants, the targeted emissions levels, etc., will have a bearing on the design of an instruments program. Thus, before we proceed to a description of the alternative potential program designs recommended by the Study Team, the specific issues that regulators would need to address before implementing a transferable emissions limits program are presented for consideration.

Setting Program Goals: Understanding the Advantages of Transferable Emissions Limits

While the Study Team recommends that regulators in the GVRD consider broadening their range of management measure choices to include transferable emissions limits, before such a such a choice could be acted upon, regulators would need to define the goals for the program (e.g., to achieve earlier/greater emission reduction, more cost-effective reductions, to only accommodate economic growth). However, in determining these goals, the advantages of adopting transferable limits programs must be clear to the regulator: program expectations must be realistic at the outset.

As argued earlier, a key advantage of a trading or transferable limits program is that it has the potential to provide regulators with a greater degree of control over the quantity of allowable emissions (through the setting of an aggregate emissions limit or cap, an industry cap, etc.), and more certainty of achieving emission reduction goals. However, the possibility that the implementation of such programs will allow for greater and/or earlier emission reductions is also seen as a potential advantage. These features and the expectations that may accompany them, must be carefully examined.

By way of example, we can take the stated AQMP goal of a 50% reduction in emissions (with the 50% reduction allocated across the priority contaminants) as the basis for contaminant-specific emission caps. If these caps are held constant over time (a fixed cap), then it is unlikely that emitters will reduce aggregate emissions below that cap. As a rule, one should assume that collectively emitters will operate at the cap and, on average, will not abate below the cap.[20] However, under a declining cap, sources may achieve greater and/or earlier reductions in some periods in order to have bankable coupons available at a latter period when the required reductions are tight and expensive. In the aggregate, earlier reductions than expected may occur; however, ultimate reductions in overall airshed emissions greater than those implied by the cap are not likely to be made. Emitters may abate more now, but this is so they can emit more latter when the costs of additional reductions are high.

Another advantage associated with transferable emissions limits programs is that the potential exists for the emission reduction goals to be achieved at a lower overall cost, as compared to command-and-control. However, in realizing this goal, regulators have to be aware of the fact that the ability to achieve cost-effective reductions is quite sensitive to the command-and-control provisions attached to the instrument program. Thus, care must be taken to ensure that the program is effectively integrated with the AQMP and other regulatory policies in order to ensure that existing/planned command-and-control requirements do not serve to minimize the scope for trading and the cost savings that can be realized from trading.

Required Emission Reduction

While the role of a transferable emissions limits program in achieving a given emission reduction goal will need to be defined, the definition of these reduction goals may also require further exploration before a transferable limits program can be fully designed and implemented. For example, while the definition of required reductions in term of tonnes seems adequate as a basis for program design, it is not. Some considerations with respect to the definition of emission reduction goals include:

- *Emission Levels:* Transferable emissions limits programs begin with the definition of an emissions cap; thus, prior to full program design, the regulator will have to decide what contaminants should be capped, whether the current emissions of the particular contaminants should be capped, or whether the caps should be reduced over time. In addition, if the choice is to implement a declining cap, then the regulator will have to determine the rate of decline and the time period over which the reductions are to take place.

- *Spatial Equity:* In terms of spatial equity, a number of issues may need to be addressed which may affect instrument design. For example, based on air quality modelling and observation, it may become apparent that there are geographical areas that needs to be protected more than other areas. In addition, there may be questions as to whether all local areas need to experience relatively equivalent protection from emissions increases, or whether some can tolerate incremental pollutant loadings. Another regulatory consideration is whether or not there are pollutants that should always be protected against increases at *any* location. Decisions with respect to these issues can affect the program design, the scope of eligible trades under the program, and the cost reductions realized.

- *Temporal Distributions:* On the basis of a contaminant's characteristics, air quality modelling and observation, particular time periods during the year may be identified when a contaminant causes the most damage (as is the case with ozone in the ELFV). However, this may bring up further questions such as do the health effects worsen non-linearly as pollutant peaks increase? Specific design parameters in economic instruments can control for many of these effects, while additional regulation is required to control others.

- *Efficient Economic Growth:* The division of emissions regulation among stationary, area, and mobile sources may be an artificial one and may need reconsideration. In addition, since some sources are difficult and costly to monitor, while others represent a seemingly insignificant portion of emissions, the question can arise as to whether these source emissions justify the additional administrative burden required to include them in a transferable limits program. However, if sources are not distinctly different with respect to these issues, then cost-effectiveness might improve if sources were controlled with a linked program. Finally, questions concerning whether or not any one sector's growth can be increased at the "expense" of another, or whether sectors should be independently limited while allowing for "trading" between them, will have to be addressed.

Contaminant/Source Sector Coverage

In the discussion above, a number of issues touched on the question of what sources and pollutants should fall under the umbrella of a transferable emissions limits program. This is a difficult issue to resolve as it depends directly on whether the reduction goals of the AQMP have been appropriately defined. For example, the draft AQMP cost-benefit analysis raises some questions concerning whether public health risks warrant CO controls; whether the Plan is sufficiently focused on pollutants such as PM_{10}; and whether there is sufficient scientific evidence to support the reductions specified.

In this study, we have taken a rather pragmatic approach to the definition of contaminant and source sector coverage. Specifically, while on theoretical grounds one could recommend the application of transferable emissions limits programs (as either a substitute for some measures in the AQMP or as an addition to the Plan) for most, if not all, priority contaminant and source sectors, such a recommendation would not be practical. Technical reasons aside, one could not expect that regulators, the public and industry would easily accept a wholesale change in the way that environmental regulation is viewed and implemented. As noted repeatedly in the report of the Economic Instrument Collaborative (1993), the more appropriate approach is to implement a limited number of programs, make sure they are working properly, and *then* expand the system. The question remains, however, which limited number of contaminants/source sectors should be incorporated within the instruments program.

The approach taken in this report is that a transferable emissions limits program will have a greater chance of being accepted (and therefore of being a success) if it is first implemented in "problem" areas; i.e., to address the Priority 1 air quality issues in the LFV. As noted in Section 2.0, the Priority 1 issues are ozone (primarily NO_x for the reason noted in Section 2.4.1) and PM_{10}. In the balance of this report, then, our focus will be on the design of a transferable emissions limits programs for NO_x and PM_{10} in the point and mobile source sectors.[21]

Interpollutant Trading

A consideration that regulators may have to address is the issue of interpollutant trading. Again, from a theoretical standpoint, we would recommend interpollutant trading as it broadens the range of viable trades and, therefore, the opportunity for cost-effective reductions. However, from a practical point-of-view, we would recommend against interpollutant trading *at this time*. As noted in the report of the Economic Instrument Collaborative (1993), a scientific basis for interpollutant trading does not exist as yet in the GVRD for pollutants such as PM_{10}, NO_x and VOCs.

Equitable Distribution of Costs

Perhaps one of the greatest difficulties with implementing a comprehensive air quality program that regulators will have to address stems from the participants' concerns about equitable cost distribution. In this regard, to a large extent the mobile source sector is often "overlooked" for charges and large reductions. Other times, when reductions in the mobile source sector are desired, the costs for these reductions are borne by the business sources in the area, rather than directly by drivers. When businesses undertake these costs, the costs are spread too evenly among drivers and other employees and consumers. Rather, the drivers generating the greatest emissions should bear the largest costs.

In addition, if an industry has recently made great strides in reducing its emissions, presumably at some expense, then requiring it to make the same reduction (percentage) as other industries is not considered equitable by many. It appears that "the good guys" are punished in these scenarios. A system can be crafted to take differing past abatement efforts into account. While this *initially* requires more work for regulators, after the initial program design is completed, no additional work is required.

Efficient Implementation and Transaction Processes

Finally, in market-based systems implementation requires more data, more tracking, and more knowledge of economics and markets. The initial system needs to lend itself to market transactions, price discovery if coupons are traded, and non-monopolistic coupon holding in addition to many other issues.

These issues are well beyond the scope of this study, and require a detailed understanding of market operations. On the other hand, the regulators need not completely understand the nuances of the market, but they do have to design a system that works well within typical business decision processes. This is the juncture where business and regulators need to listen to the needs of the other and attempt to create an efficiently working system -- one that reduces emissions without overburdening regulators or sources.

4.5 Summary

One can assess the merits of economic instruments and other management measures at an objective, conceptual level. On the basis of the preliminary assessment provided, and given the goals and assumptions that underlie the assessment, we would recommend that regulators in the GVRD broaden their range of choices to include transferable emissions limits. However, as the material presented above indicates, a wide range of practical issues and concerns need to be addressed and regulatory decisions made before one can effectively select and design the "best" management measure for a given set of circumstances. For example, questions regarding the goals and objectives of both instrument programs and command-and-control strategies need to be understood before an instrument program can be effectively designed and assessed. Similarly, questions as to whether the instruments program will be implemented in addition to, or instead of existing air quality management measures, and whether the program will be effectively integrated with other command-and-control based initiatives in a complimentary way, will affect the merits of an instrument program and its desirability. These issues and concerns take on even greater importance when it comes to the question of instrument design and implementation. Many design features are in fact implemented to address concerns in the airshed such as local hotspots, strategic behaviour by firms, seasonal problems, etc. In the section that follows we provide some *potential* program designs to address PM_{10} and NO_x emissions from the mobile and point source sectors. These designs are premised on our assumptions concerning many of the issues raised above. As regulators begin to address the questions raised, the program designs may indeed change.

Endnotes

1. With certain exceptions, the criteria presented here are equivalent to those employed by the British Columbia Ministry of Environment, Lands and Parks, and Environment Canada in the assessment of regulatory measures.

2. While not explicitly stated, we will assume that the GVRD has or can obtain the legal authority to implement any of the measures outlined in Section 3.0. While this assumption may not hold for certain measures, we are trying to focus more on the environmental effectiveness and cost effectiveness of alternative measures: laws can be changed, less so the inherent characteristics of a given management measure.

3. GVRD (1994e), pg. S-2.

4. GVRD (1994e), pg. S-2.

5. GVRD (1992), pg. 27.

6. The types of issue that would be of more concern at this level of analysis relate to issues of whether the connection between the stated emission reduction goals, and air quality and environmental/human health benefits, is firmly grounded in science. Such a basis is necessary in order for the goals to be credible and for any selected management measure to gain acceptance amongst stakeholders and the public.

7. Without putting to fine a point on it, much regulatory action in Canada and elsewhere has, in practice, become more of a "this is the goal that we want but we will live with what we can get", rather than "this is what we will attain." We recognize that the negotiated regulatory process that has existed in Canada, and the fact that trade-offs do exist between environmental improvement, compliance costs, employment, regional development, etc., can impinge on the ability of a regulator to achieve the stated objective. However, it should be noted that many of these constraints can be mitigated by the choice of regulatory approach.

8. GVRD (1992), pg. 27.

9. GVRD RFP #93106, pg. 16.

10. For example: B.C. Ministry of Environment, Lands and Parks (1993a), GVRD (1993c), etc.

11. The final consequences on the environment will depend on what is substituted for the restricted substance.

12. It should be noted that this conclusion may not hold for uniform emission standards for new sources such as motor vehicle emission standards, standards for new woodstoves, and gas-fired boilers.

13. While models exist that can be used to gauge demand and substitution elasticities, most are static in nature and may not accurately reflect dynamic consumer choices and/or the characteristics of transportation alternatives. For example, a transit subsidy may be entirely useless as a tool to encourage someone to take a bus to work if, in fact, the bus goes no where near their workplace.

14. This occurs regardless of whether the subsidy is an all-or-nothing type or a per-unit type.

15. It is worth noting that, for non-subsidy programs, consumers also always foot a portion of the bill through higher product prices; in many cases the same portion of the bill necessary to implement an effective subsidy.

16. The discussion here also applies to the use of vehicle registration fees in the form of emission fees.

17. Both of these issues were noted in B.C. Ministry of Environment, Lands and Parks (1993a). Specifically it was suggested that the "ministry should commit to long-term price stability; enabling permittees to plan and budget" and that the "regulation was seen more as a tax grab than a pollution prevention initiative." (pg. 6).

18. Barr, E. (1994), pg. 28.

19. In making this recommendation, however, if the benefits offered by economic instruments are to be realized, regulators may ultimately have to re-think the manner in which command-and-control measures are currently implemented.

20. In the presence of economic growth and/or technological change, some emitters will operate below "their caps"; however, on average emitters will collectively operate at the overall cap.

21. In Appendix B, however, emission trading program designs are provided for every source sector and pollutant.

5.0 Recommended Economic Instrument Designs for the GVRD

This section of the report develops a number of alternative program designs that are likely to work well in controlling the subset of GVRD priority contaminants that are potentially amenable to economic instruments (at least at this time) and that will aid in the achievement of the goals of the AQMP. In conducting this analysis, a variety of factors that must be considered when choosing an economic instrument to fit into an air quality management policy have been assessed. For instance, the specific contaminant, its targeted levels, its sources, and its health effects all have bearing on the design of an instruments program. In addition, the GVRD has both seasonal and year-round contaminants, and contaminants with thresholds and those without. Each of these different categories works best with specific instrument designs.

The goal of this project was not to design the final instrument. Rather, it was to highlight both the design features of an instruments program that are likely to work best and which hold promise for application in the GVRD; and the regulatory issues, design parameters and trade-offs that would have to be addressed before a final design could be reached and an implementation plan developed.

This section of the report is organized as follows. Section 5.1 provides a summary of the key assumptions (previously discussed in Section 4.0) that are utilized in the analysis.

Section 5.2 provides an overview of the recommended instruments programs for the point and mobile sectors and describes the design elements recommended by the Study Team.[1] The program features described in this section have been developed on the premise that the operational objective assigned to an economic instruments program under the AQMP is to provide the primary mechanism necessary to achieve the emission reductions specified in the draft AQMP at the greatest speed and least cost (our Case 1 assumption).[2] This section concludes with a presentation of the specific issues that would need to be addressed for each design element before the recommended designs could be carried forward.

Section 5.3 provides a detailed description of the program components, and possible variations, for controlling PM_{10} and NO_x emissions from stationary and mobile sectors.[3]

Section 5.4 provides some illustrative examples of how the recommended program designs *could* work in practice for controlling PM_{10} and NO_x emissions from stationary and mobile sectors.

Section 5.5 extends the discussion of the instruments design recommendations by looking at how the recommendations might vary across different assumptions concerning the operational objectives assigned to an economic instruments program under the AQMP.

Section 5.6 summarizes some outstanding issues that we have not been able to address in this study but that regulators in the GVRD would need to consider before proceeding with the implementation of an economic instruments program or the next phase of an instruments analysis..

5.1 Summary of Assumptions

The GVRD AQMP provides a suite of control measures to address air quality in the LFV. However, the AQMP does not stipulate an implementation plan.[4] Even so, in order to provide recommendations concerning possible instrument program designs, a number of implementation issues would need to be addressed and certain parameters defined. Many of the questions were initially raised in an earlier memo (Sholtz, (1993)) to the Steering Committee, which discussed the importance of some of the issues and the reasons why some assumptions are necessary.

In lieu of information pertaining to these issues, and to allow for the definition of alternatives, several assumptions had to be made in order to make any real recommendations. The assumptions on which the instrument program design recommendations presented below are based include:

- Attainment of the emission reductions specified in the AQMP is an absolute requirement (i.e., not just a "desired goal").
- Pollutant-specific reductions are required, not simply an aggregate 50% reduction.
- The operational role assigned to an economic instruments program under the AQMP is to provide the primary means to achieve the emission reductions specified in the AQMP at the greatest speed and least cost (our Case 1 assumption).
- Source sectors participating in the transferable emission limits program, as well as new sources, would not be subject to specific control equipment or process requirements, but rather subject to emission limits[5] as defined by the program.
- Banking of coupons is only allowed where specifically noted in our recommendations.
- Transferable emission limits have reasonable guarantees against confiscation and devaluation unless otherwise so stated in our recommendations, such as in the case of callable coupons.
- Based largely on the results of the draft cost-benefit analysis, the contaminants that have priority for the application of transferable limit programs are PM_{10} and NO_x, and the source sectors to focus on include the point and mobile source sectors.
- Monitoring of actual emissions from sources will be required where technologically feasible.

- The GVRD has the legal ability to carry out any recommended fee or coupon allocation systems.

- Any recommended fee or coupon program would be administered by one central governing body (e.g., the GVRD our some other regulatory body).

- Any penalties required in the programs can be assessed by a governing body.

- An accurate emissions baseline for the airshed, source sectors and individual contaminants can be determined, upon which an accurate emissions cap can be defined.

- Air quality modelling can be (has been) performed to determine the NO_x/VOC relationship in the relevant airshed(s), and to determine whether NO_x or VOC should be the focus of an instruments program for ozone control.

- Air quality modelling can be (has been) performed to determine the mixture of and proportion of secondary particulates, and to allow for the identification of secondary particulate emission sources that should be brought into the program as participants.

- A permitting or registration system exists or will exist for all new sources (including mobile sources) that will participate in the program.

5.2 General Program Design

Given these assumptions, we recommend that *for the most part* a program utilizing transferable emissions limits for stationary and mobile source emissions of PM_{10} and NO_x should be considered. It is not particularly "earth-shattering" that we would recommend a transferable emissions limits program, nor may it seem particularly unique. However, while it is a comparatively easy task to recommend such programs (for the reasons outlined in Section 4.0), not so the specification of the design characteristics that would render such programs workable within the Lower Fraser Valley airshed and within the context of the AQMP. The difficulty with defining such programs is even greater given that the vast majority of emissions stem from the mobile sector -- a source sector that has been infrequently addressed as a candidate for economic instruments beyond the application of economic incentives such as bridge and road tolls, gasoline taxes, and parking charges.

5.2.1 Overall Instruments Program

In this section we describe the elements of the overall emissions trading program we recommend. As noted earlier, the program design elements will vary by contaminant and sector; thus, not all of the same elements described below may be incorporated in the PM_{10} program, the NO_x program, or the programs designed for the remaining priority contaminants as described in Appendix B.

In brief, we recommend a program of transferable emission limits that utilizes the new ***dual coupon-fee system*** (a transferable limit with an emissions fee) with ***additional regulatory permit constraints*** (such as point of impingement limits and other maximum allowable emission rates that would be built into a facility's operating permit). For certain contaminants and source sectors one of the ***flexible limit*** designs (***staggered coupons*** or ***limited banking coupons***) is recommended for the instrument design. Within this design some contaminants need the additional imposition of a ***seasonal cap system*** with an ***off-season constraint***, while others are fine using the purely ***annual cap system***. Within these types of systems, either a steady or declining balance cap can be implemented. Which type of cap will in fact be necessary is a choice that is subject to the regulators' desired goals. In addition to these design features, the program would include an ***emissions offset*** component. Furthermore, to provide regulators with the flexibility to make adjustments once the program is up and running, a portion of the coupons issued would be ***callable***.

While terse, this description is a mouthful of jargon and it is rather confusing. Hence, to begin to understand the design features we are recommending, it would be useful to describe the purpose and role of each of the design components (highlighted in bold type) that are being recommended (more detailed explanations of these components are provided in Appendix A). In addition, since some program design elements will be needed for some contaminants/source sectors and not others, a schematic which relates when certain design elements are appropriate and should be selected is provided below (see Exhibit 5.1).

Dual Coupon-Fee System

This system was discussed in Section 3.3.4 (and is elaborated on further in Section 3.4 of Appendix A). It is in essence a combination of a transferable emissions limit program and an emissions fee program, where the fee generates revenue for the administration of air quality management programs.

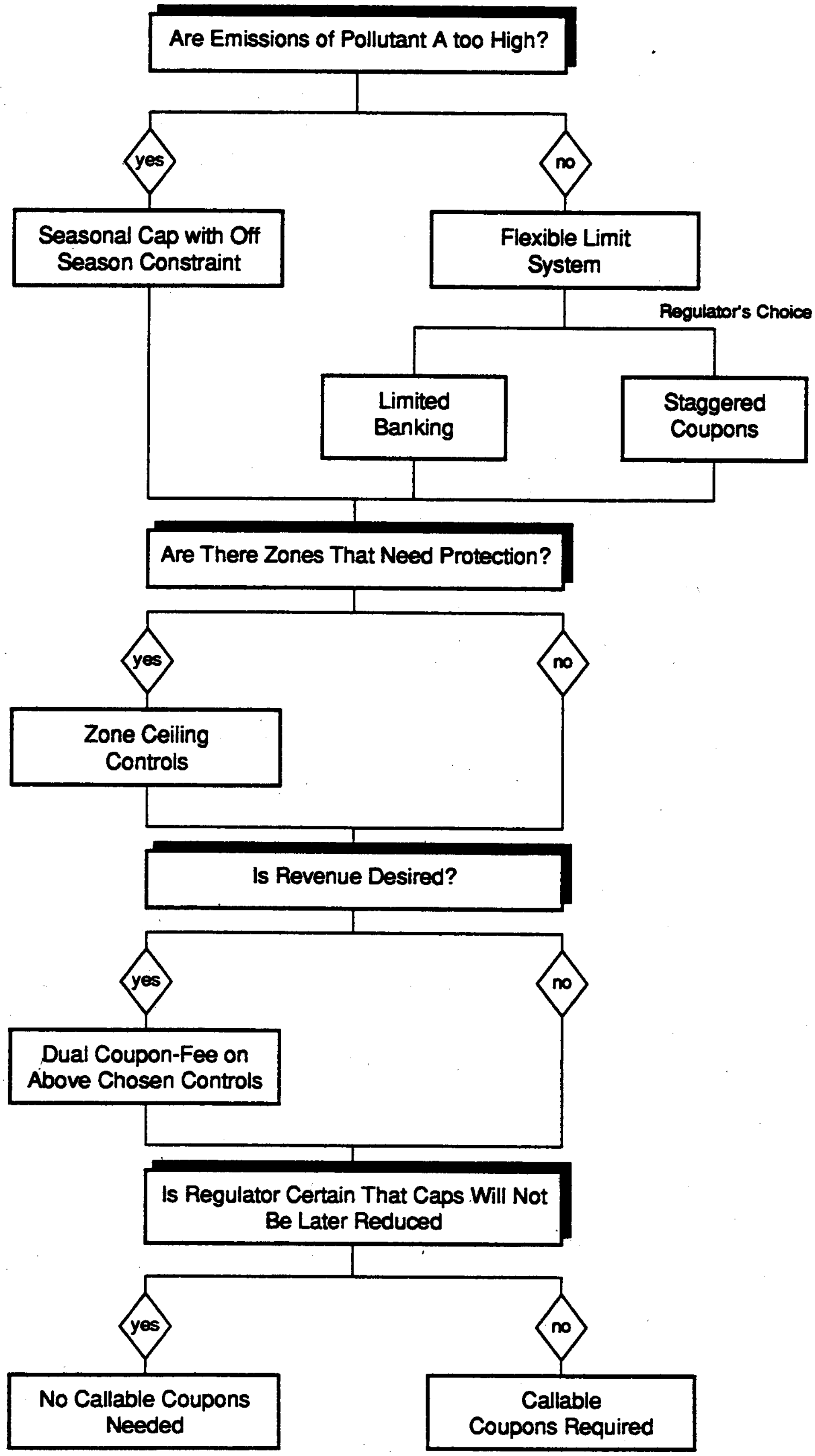
It is assumed under this system that the initial allocation of coupons was neither auctioned nor charged to the facilities, but rather was given to them (see Section 3.5.10 in Appendix A for a discussion of auction issues and alternatives). Given the allocation of coupons, the fee portion then acts essentially as an emissions fee, or a rental fee for the *use* of the coupon. The fee can be set at any level by the regulator as long as that level fulfils the following:

- It is not higher than the market price of the coupons that would result if there were no fee.[6]

- It is set at a flat fee per unit (e.g., tonne, kilogram, etc.) of emissions, and the per-unit fee does not depend upon facility size or emissions over the year.

- The fee is determined before trading of coupons begins, including future fee schedules, perhaps with an inflation adjustment.[7]

Exhibit 5.1: Schematic for Selecting Instrument Design Options



- The fee schedule contains an adjustment scenario relevant to the case where coupons are called (the issue of callable coupons is discussed below).

Flexible Limits

There are two types of flexible limit designs: *staggered coupons* and coupons with *limited banking*.

- ***Staggered Coupons***: This variant on the dual coupon/fee system is an overlapping coupon system (see Appendix B). It provides a cap on emissions with that cap either remaining steady or declining at a regulatorily prescribed rate. (Whether the cap is set for aggregate emissions, for the emissions of a particular sector, or for individual contaminants is a regulatory choice and will largely be driven by the extent to which economic instrument programs are eventually applied.) Under this form of flexible limit system, the coupons are issued with *staggered* dates, meaning that half the "annual" coupons are good to cover emissions from January through December, while the other half of the "annual" coupons are good to cover emissions from July through June of the following year. The staggered design of the instrument is used to avoid the difficulties with emissions uncertainty in a coupon market (as discussed in Appendix A).

- ***Limited Banking of Coupons***: If a facility did not use its actual emissions limit, banking allows the facility (or mobile source sector) to carry forward or "bank" the unused portion (or some of that portion) for use in future years. Limited banking comes in several forms (described in detail in Appendix A) that restrict the movement of emissions over a particular period of time. These forms of banking provide a regulatory check on emissions while still allowing some flexibility for businesses and mobile sources.

Both of these flexible limit designs provide the necessary measure of flexibility that is needed to avoid extreme disruptions in both facility abatement costs and emission peaks which can occur if strict annual limits are imposed and facilities have *any* delay in knowing their emissions. Both designs avoid inducing end-of-year emissions spikes and cost swings for the most part. The absolute predictability of average emissions is greater with the staggered coupon system, as is the flexibility it brings in the early years of the program. On the other hand, the limited banking system offers a slight incentive to reduce emissions earlier if possible, but initial emission limits must be set more carefully since excess limits can be carried through the program for a longer period of time.

Annual Cap System

The annual cap system defines the maximum emissions that can be released on an annual basis (whether the year is defined on a calendar year or some other consecutive twelve month period) and is the more commonly depicted form of a cap. With respect to the AQMP, the cap could be defined by subtracting the annual emission reductions expected from the implementation of the AQMP from the forecasted emissions expected in the absence of the AQMP. Alternatively, the cap could be based on estimates from air quality modelling as to the annual allowable emissions associated with the maintenance, on average, of an ambient air quality standard. How the cap is defined is a regulatory (and scientific) choice.

The cap can be imposed for a specific contaminants, for a number of contaminants, for an industry, a source sector or the region. Whether the cap is set for aggregate emissions, for the emissions of a particular sector, or for individual contaminants, is a regulatory choice and can be fit into this design choice as well. Further, within the annual cap system both types of flexible limit systems are practical to apply. Whatever the regulatory choice, however, once the cap is defined, each facility's emissions limit (i.e., the number of coupons it is allocated) is set with reference to the overall cap on an annual basis without regard to the season.

It should be noted that, given the international dimensions of the LFV airshed, it would not be possible to place a cap on the entire airshed without integrating American sources in Washington State into the program. Rather, the best that regulators in the GVRD could achieve is a cap on the Canadian portion of the airshed. This has implications for the connection between the emission reduction goals of the AQMP and its ambient air quality objectives. Specifically, while a program can be designed to effectively meet the emission reduction goals of the AQMP, ambient air quality is a function of emissions on both sides of the border. Issues concerning the joint implementation of air quality management programs between the GVRD and Washington State and issues concerning trans-boundary contaminant transport could not be addressed within the scope of this study; however, they warrant examination.

Seasonal Cap System with an Off-Season Constraint

This system is a variation of the annual cap and portions of the staggered coupon system. It is adapted for control of contaminants which have the potential to do the most damage (or react) during only a part of the year (such as is the case with ozone and by extension NO_x and VOCs). The system requires more apparent complexity because of the desire for stricter controls during a season while providing for some flexibility so as to avoid the difficulties presented by traditional (non-overlapping) coupon systems.

With this type of system, a seasonal and an off-season cap are established. The seasonal cap may remain steady at current emission levels, or it could begin at those levels and then decline, in which case as the program continues this cap would likely represent a binding constraint to facility emissions. On the other hand, the off-season cap is set as a protective measure, meant to both protect against excessive emissions shifting and to provide a means for facilities to obtain offset coupons during the off-season.

The off-season cap is set at levels consistent with protecting air quality during the non-ozone season, and these levels are almost certainly higher than the cap level set during the ozone season. Like the seasonal cap, it is possible for this off-season cap to also decline over time, perhaps at a rate different than that of the seasonal cap, to achieve some improvement in air quality as new technologies arise.

To maintain flexibility, one of the limited banking options combined with a special form of staggered coupon is preferable. One alternative allows both the seasonal and off-season coupons to be banked using one of the available options discussed in Appendix A.[8] In addition, under this alternative facilities are allowed to borrow coupons from the following off-season,[9] up to an allowable maximum percentage of the *seasonal* coupons they have used in that season. However, as an option, the regulator may want to (and this action is *highly recommended*) apply a "backward" discounting rule that strongly devalues coupons brought back in this manner. For example, it may take two off-season units to cover one unit's worth of seasonal emissions. The schedule is in fact a regulatory decision and one reflecting the overall flexibility of the allowable emissions in future periods.

Emissions Offset Program

For new sources moving into the region, even if their inclusion into the trading program is not feasible, (as explained in the specifics for the various contaminants in Appendix B), they should be included in an **emissions offset program** in order to keep aggregate emissions for the airshed under a defined limit. Thus, any new facilities that wish to move into the regulated airshed must obtain coupons to cover their emissions each year. If the facility has monitorable emissions and is the type of source already included in the trading program, then the facility must effectively "join" the program, beginning with purchasing enough coupons (from existing facilities that produce excess reductions) to cover its emissions. If the facility has other emissions, it must obtain "offsets" in the form of coupons to cover its estimated emissions to the satisfaction of the regulator. This insures that any aggregate emission cap is maintained, yet new business is not precluded from entry. Without a transferable emissions limits program, these coupons are analogous to growth coupons.

It should be noted that, under our Case 1 assumption, for those sources participating in the trading program, additional command-and-control measures such as uniform emissions standards are assumed not to apply. The validity of this assumption rests on the existence of the offset requirement. Thus, irrespective of whether the regulator does or does not chooses to implement uniform emissions standards, or other command-and-control measures, on new and old sources that are participating in the program, the new/expanding sources must offset their emissions. The presence of command-and-control requirements simply serves to limit the source's choices of control measures.

Callable Coupons

As noted in Section 3.3.3, once a market is up and running it may be necessary to alter the aggregate number of coupons (either temporarily or permanently) in order to respond mid-course to increased needs to reduce emissions. At the same time, to provide an effective incentive, the coupons have to represent a "property right" in a *market sense*; however, if that right is too firmly entrenched, regulators can have difficulty making the necessary mid-course adjustments.

There are several ways to accomplish such reductions. For example, one way to do this is a simple proportional reduction in current endowments; however, as noted in Appendix A, there are problems with this approach in terms of cost-effective adjustment. There is a market solution for this problem that we recommend that would create two distinct types of coupons: callable coupons and regular coupons (or not so easily callable coupons). In the event of revisions in emission allocations, callable coupons would be taken from their owners first. The market price of callable coupons would be less than the price of the regular coupons because of the latter's higher certainty value. Callable coupons would be held by flexible facilities (i.e., those that can easily and cheaply respond to changes in allowable emission levels) and by facilities that would be willing to bear the risk of mid-course reductions. In early years, the two types of coupons might almost be interchangeable if there is little chance of any adjustments; in later years there may be significant differences in the risks and, therefore, in the prices.

The issuance of these two types of coupons imparts an asset value to the coupons, thus maintaining the integrity of the instrument, and allows regulators the ability to maintain flexible control over emissions. The level of flexibility could be improved by creating more types of coupons; thus, allowing for more levels of callability. However, these two coupon types are probably an adequate number of distinctions. Additional coupon types would thin the market. The number of coupons determined as *first callable* is a regulatory decision. It should reflect a conservative estimate of how "far off" the emission allocations in the aggregate may be to achieve air quality objectives.

Further Considerations

With an understanding of the basic components of the program in hand, there are a number of further design features to consider. These are discussed below.

We believe that in general **all relevant source sectors should be linked**, although specific caveats need to be recognized (and are in the following subsections for PM_{10} and NO_x, and in Appendix B for the remaining priority contaminants). The allocation of emission coupons should be **set per source (facility)** at the onset for stationary sources (including point sources and possibly many area sources that can be monitored) and **as a sector** for mobile sources.[10] The linking of sectors should provide sufficient liquidity and trading opportunities for all facilities in the program.

Mobile sources represent a large portion of the emission increases in the future; thus, integration of these sources is especially important for any system aimed at capping emissions. The mobile sector program is described in Section 5.2.2 below. However, at this stage it is worth noting that while the implementation of a mobile source linked program may be completed over a few years, beginning with a *differentiated fee system* (see Appendix A), the program should be designed to accommodate the eventual **inclusion of mobile sources into the dual coupon-fee system**. In addition, the program must allow innovative transportation approaches to be rewarded through the coupon system.

As discussed in Section 4.0, **inter-pollutant trading is not recommended at this stage**. Given the uncertainty of the baselines and mobile source emissions program, revisions in one contaminant area would affect all others. Also, monitoring uncertainties make trading across contaminants difficult for regulators to track, and predicting air quality trends is extremely difficult and most likely inaccurate.

5.2.2 Mobile Source Sector Cap System

Although this system actually falls under the general program design, it is quite a significant part of the design leading to the most effective program for the GVRD. Therefore, this strategy has been given its own subsection in this report. Because of a limited number of sources in some sectors (not only for PM_{10} and NO_x, but for the remaining priority contaminants addressed by the AQMP), the inclusion of mobile sources adds degrees of flexibility for all other sources both within and outside the program.

While mobile sources are traditionally considered as a single source, the control methods for this source are so varied and allow for such creativity for individuals and companies alike that any single control cost is likely to be misrepresentative. Some controls might include combustion process innovations, but many more are likely to include behavioral changes that facilities promote and that individual drivers find rewarding. The actual methods adopted to reduce emissions are irrelevant to the design of the mobile sector program.

Program Overview

The GVRD is in a rather unique position from other jurisdictions (for example, the U.S.) for it has access to a centralized vehicle registration database in association with a centralized insurance administration. In addition, it helps to administer a comprehensive vehicle emissions testing program (AirCare). These three components may allow the GVRD to integrate motor vehicles into a dual coupon/fee system with much greater ease than would be possible in other areas. It would be a first to fully include this sector in a market-based incentive system.

The system works in general as it does with the dual instrument and offset programs already discussed in Section 5.2.1. A vehicle emissions cap is set based upon previous or current emissions testing and miles driven in a year, or on the basis of modelling (e.g., Mobile 5). For example, the cap could be defined by subtracting the annual emission reductions expected from the implementation of the AQMP from the forecasted mobile source emissions expected in the absence of the AQMP. With this cap as a reference, each vehicle already registered is "issued" coupons (in reality no coupons are physically issued, but each owner is credited with a particular emissions limit). The sum of the emission limit coupons must therefore equal the portion of the baseline inventory attributable to mobile sources. This action places mobile sources and facilities/emitters on a level playing field for the incentive to reduce emissions. For a contaminant where a declining cap is instituted, then the vehicle allocation also declines in an equitable fashion.

In order to register the vehicle each year the driver's vehicle account must have been electronically credited sufficient coupons to cover the vehicle's emissions. If the vehicle has created emissions in excess of its allocated (or credited) amount, then the owner, or person to whom the vehicle is registered, must purchase additional coupons. If instead the vehicle has been prudently driven, or the owner has otherwise reduced the emission from his/her vehicle, then excess coupons in their account can be sold to any other motor vehicle or facility.[11]

In addition to having sufficient coupons in their vehicle registration account, the owner must pay the same fee per unit of emissions that the facilities are paying. New vehicles are essentially treated as new sources as far as entering the program. They must obtain coupons from other sources *in any valid sector* (later subsections provide more detail on the actual mechanism involved). Similarly, sources in any sector may obtain coupons originally issued in the mobile source sector. Of course, in order to generate these coupons the total emissions from a mobile source(s) must also be cut.

Obtaining Coupons

Recall that vehicle owners must hold (or obtain) coupons equal to their emissions for the past year (or equal to an expected annual amount for new vehicles) in order to register a vehicle.[12] There are many possible entities that could aid in this process; hence, individuals are not necessarily required to go to the large scale market to obtain coupons.

Most likely, "brokers" would obtain coupons and resell what the individual needed based on market prices for the coupons. In addition, employers might give employees a certain number of coupons, perhaps generated by reducing emissions in other areas. On the other hand, employers might make especially good agents to buy coupons from employees for use in the facility. This process is discussed below.

Generating Coupons

Just as with other sources, if emissions from mobile sources are reduced, then coupons are available for the market and, therefore, for other drivers and for other emitters in other source sectors. The ability for the individual to generate his or her own subsidy for reducing emissions is an especially appealing attribute of the mobile sector cap system.

In fact, there are two main ways to reduce emissions: installation of technology that reduces the emission per mile rate or a reduction in the number of miles driven (e.g., substitution to public transportation). In the case of the former, if the driver retires a dirty car before it "dies" or has it retrofitted to burn a less polluting product (e.g., propane), then presumably emissions are reduced and coupons can be generated. The monetary value of these coupons, when sold, represents a subsidy to the individual. The purchaser of the coupons, presumably another mobile source or a facility in another source sector who does not find further reductions economically or technologically feasible, essentially provides the funding for the subsidy. No public money is required.

Integration with Transport 2021

If the coupons are generated by a reduction in miles driven, then both emission reductions and congestion reductions are achieved, as are improvements in visibility. The ability of this system to promote the goals of *Transport 2021* is important.

Emission tailpipe standards do not promote these program goals with real incentives. However, the ability to also generate coupons when alternative transportation methods are utilized, or when miles needed to drive to work, school, etc., are reduced provides incentives for these measures. In fact, employers who are also facilities may find the ability to create these coupons a great benefit and may find it in their best interest to provide employees with the incentives to generate coupons for the facility to then use.

Along these same lines, because employees will have to pay for their emissions, they may finally ask for employers to help provide alternative transportation measures. Without this system, employees have largely resisted participation in these measures since they have paid very little to pollute.[13]

Initial Caps

The setting of the initial sector cap will require work, but is very important to the success of the system. With both new and old vehicles in the fleet, some will pollute more than others; hence, the baseline will have to account for this differential and for turnover at some rate. This measure need not be perfect and may be set at whatever estimates the GVRD used to predict future emission reductions as a result of the tighter tailpipe emissions.

The difficult part is determining what initial allocation is due each vehicle. Presumably, the model that the GVRD used to predict aggregate reductions also estimated vehicle lives and emissions, and this may be a sufficient measure. One alternative would be to provide each vehicle registered in the GVRD with an equal number of coupons. However, while this might appear equitable it would not be, since individuals have very different motivations for using their vehicles (distance from work, availability of transportation alternatives, etc.). Thus, an individual who rarely drives a car could find windfall gains from a system that allocated coupons equally, while an individual that must use a vehicle frequently would suffer a loss. Another, more likely alternative would be to base the initial allocation on the AirCare tested emissions rate times the miles driven between AirCare tests. This would represent the starting point for the allocation, but the vehicle's lifetime is needed to determine the reduction rate of coupons generated.[14]

This alternative might not appear equitable since it implies an unequal distribution of coupons. However, since a mobile coupon system has not been announced, past driving patterns likely reflect true driving behaviour since drivers would have no reason, prior to the announcement of the program, to engage in strategic behaviour in order to alter their coupon allocations.

Finally, once this additional allocation is made, it may be the case that an additional sector decline is desired. This is relatively simple to implement. It is instituted by decreasing the allocation by some predetermined percentage schedule for some or all years. It should be noted that, if this program is to be used to achieve reductions over time, the schedule for reduction should mirror the planned provisions for transportation alternatives.

Additional Considerations

Participation in the mobile program is based on the existence of a vehicle registration system and a mandatory emission testing requirement. The vehicle must be subject to both requirements to be eligible to participate in the program.

When this report discusses designing a mobile source program, it is true that many issues are left unresolved. Complete resolution of these details is beyond the scope of the report; however what follows is a discussion of several of the key difficulties to be resolved and some suggestions that may be discussed in future work to design the implementation details of such a plan.

Types of Vehicles

First, the designation of sources as "mobile" and therefore part of the separate mobile source program is misleading. More accurately, traditional mobile sources can be placed into several categories that include:

- fleet vehicles;
- heavy-duty vehicles;
- passenger vehicles;
- airplanes;
- trains; and
- boats and ships.

These various components can be included in an overall economic instruments program separately, depending upon the specific attributes of the sources within the category. Fleet vehicles are easy to include as a source of emissions for a company or facility. Heavy-duty vehicles owned by a facility can be included as a source in the non-mobile source part of the program. Other heavy-duty vehicles need to be included as separate sources. Finally, passenger vehicles, if part of AirCare, can be included as described already in previous subsections.

The idea is to develop a program where approximate emissions can be measured and the owners of the vehicles take the costs of their polluting activities into account. For passenger vehicles availability of AirCare represents an existing infrastructure that can be utilized to lower the cost of monitoring. In addition it provides an important central location for collecting a large amount of data. Heavy-duty vehicles, especially diesel, while not now a part of AirCare can nevertheless be treated as emission sources. Many options could be explored, as would be required by an implementation plan.

One option would be to make heavy-duty vehicles subject to mandatory AirCare testing. Another option is described below:

1) Heavy-duty vehicles not part of a facility must begin emission testing and mileage recording each year for registration.

2) Facilities that are part of the program must include their vehicles' emissions in their total, and thus they must hold emission limits sufficient to cover these emissions. They can include these emissions either by having vehicles tested for emissions or by the regulator specifying average emissions for categories of these heavy-duty vehicles (such categories include age, condition, make and model). The regulator must establish which protocol will be required for use.

Heavy-duty vehicles therefore can be incorporated as sources within a facility. To reduce emissions, the facility can decrease use of the vehicle, retrofit the vehicle to reduce its emissions per mile, or retire the vehicle and replace it with a cleaner alternative.

Establishment of Vehicle Emission Limits

A vehicle's initial emission limit is a function of its mileage and emissions as tested in grams per mile. This initial limit needs to be equitably set, and many would argue that a measure of past use would be a good proxy for this equity. This may be so because the initial allocation should neither reward nor punish for past mileage, and aside from altering their driving habits, commuters and drivers in general will require the same emission limit to continue driving the same vehicle. Only by altering their behaviour will they feel a financial change.

Still, the setting of the initial mileage may be contentious, but we have a suggestion for remedying this situation, which involves a rather simple calculation, yet it is likely to represent each vehicle's average. When a vehicle is purchased and initially registered to a new owner, its mileage is recorded as well as the date of transfer. By reading the odometer at the time of implementation the average mileage *for that vehicle for the current owner* is calculated by dividing the mileage since initial registration to the current owner by the number of years since the vehicle's acquisition by the current owner. The regulator, in conjunction with other government programs may wish to provide some credits as subsidies to owners who previously made otherwise un-subsidized changes on behalf of the environment, for example purchasing an electric or compressed natural gas vehicle before the emission limit program is announced and implemented.

Vehicles registered outside the zone present another difficulty, but one that can largely be contained. In order to park or commute into the area, an employee who regularly commutes into the region must have their vehicle tested for emissions and must pay a separate fee equal to the last year's market price of credits times the product of (the commute distance expected to be covered by that employee) and (the vehicle's tested emissions). This fee is paid upfront, after the first year of the program. If it turns out that the employee makes a change so that these calculations are incorrect, they can apply for a credit. This is not a perfect solution but should capture a large portion of the mobile source emissions from vehicles commuting into the region. As for other vacation, shopping, or sight seeing vehicles, the regulator is likely to not be able to take control of these emissions. On the other hand, the other programs that assess bridge taxes and other parking fees add some cost to these drivers. Another alternative for this group of drivers is to add a parking surcharge for vehicles not displaying a "tag" from the regulated region. If business owners do not like to discourage this transport, then they can put a sticker on the vehicle's parking stub or issue a credit ticket and in-turn pay the fee themselves.

In all the above cases, odometer tampering would have to be considered. The specific methods to identify such tampering have been developed in other areas of regulation and should be dealt with accordingly. All cases of tampering should carry a substantial penalty.

Seasonal Emissions

Unless the vehicles are tested twice a year, seasonal emissions are not controlled more strictly than non-seasonal emissions for this program. If trades are going to be allowed between pollution sectors, and they should be, then some discount factor must be attributed to mobile source emissions that are converted to credits for the more strictly controlled season. This should be a simple transformation and should present no difficulty for the regulator. Again, the importance of a well-run database is imperative.[1]

Alternative Transportation

The program as discussed above creates the appropriate incentives for alternative travel. By decreasing the use of their emitting vehicles, or switching to lower emitting vehicles, the vehicle owner receives a financial benefit. By not switching, the owner pays a penalty. As already discussed, if owners already took such an action they may be allocated a subsidy in their number of credits issued, which they can sell.

5.2.3 Summary of Remaining Regulatory Decisions

While specific design features for NO_x and PM_{10} emissions are described in Section 5.3 below, (and Appendix B for the balance of the priority contaminants addressed by the AQMP), in summary the basic design elements recommended for a tradeable emissions limits program begin with a dual coupon-fee system. This system places a cap on emissions (at either an aggregate airshed level and/or for individual sources/contaminants), and the allocation of the capped emissions (i.e., the coupons) is generally done on a staggered basis. The coupons would be bankable (except where noted below) and would be subject to reasonable guarantees against confiscation and devaluation. The program would require all new sources to acquire emission offset coupons in order to maintain the integrity of the cap. Finally, in order to provide

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1 See Plott, Charles and Anne Sholtz, "Property Rights Support and Associated Informational Data Bases for Environmental Markets," February 1994, unpublished mimeo, California Institute of Technology, Division of the Humanities and Social Science.

regulators with the ability to make on-going program adjustments (in light of air quality modelling data, etc.) part of the coupons issued would be callable.

In order to further the design and implementation of this (or an alternative) program, aside from the obvious, broader decisions (the extent of application, the level at which the caps will be set at, the method of distributing coupons, etc.), and in addition to the issues raised in Sections 5.2.1 and 5.2.2, a number of additional regulatory issues will also need to be resolved. These are presented below for consideration and are organized by program element.

- ***Dual Coupon/Fee System - Remaining Decisions***:

  - Determine an appropriate rate of average aggregate reduction to achieve the particular contaminant's target objective.

  - Determine individual source (facility) allocations of the baseline.

  - Decide whether there are certain facilities that need no further reduction in their allocation because of past "goodwill" reductions in emissions.

  - Reach agreement on an appropriate fee schedule for the particular contaminants.

  - Decide: (1) whether the fee should be gradually implemented, meaning that it begins low and has a defined increase over time; (2) the relative market-value of the coupons, and hence which fees are to be the highest; and (3) whether all sources, even those not in the program, should pay some fee for estimated emissions -- presumably to keep the playing field level and not to dissuade facilities from joining the program merely because of fees.

  - The time that the fee is collected.

- ***Seasonal Cap System with an Off-Season Constraint - Remaining Decisions:***

  - Determine the appropriate rate of reduction in seasonal emissions that will achieve the targeted objectives for ozone (not the precursor itself).

  - Determine the off-season limits that will assure no exceedances of either ozone or the precursor in the program in the off-season.

  - Determine the acceptable percentage carry-back for short-term flexibility into the season.

  - Determine the devaluation rate for those special, limited coupons brought into the season from the off-season.

- Determine a banking devaluation schedule. It is acceptable for the regulator to merely determine a maximum off-season limit and allow consultants to calculate the necessary schedule.

■ *Callable Coupons - Remaining Decisions:*

- Estimate the appropriate proportion of the emissions baseline that should be callable.

- Determine a set of procedures for establishing that coupons should be called (e.g., so many exceedances of such a level at a particular number of monitoring stations triggers a call of some specified amount).

5.3 Specific Program Designs

In this section we move from the general discussion of the program to specific descriptions of how they would be applied at the source level. In what follows we assume that economic instruments are applied as the primary tool for reaching the emission reduction objectives (i.e., no uniform performance standards for program participants, new source performance requirements, etc.). Furthermore, while the variables in these designs are described, most are *not* assigned actual values because that is a regulatory decision to be made based on the Steering Committee's decisions regarding the integration of economic instruments into the AQMP.

In order to place our recommendations in context, we begin with a discussion of program guidelines for ozone generally. We then go on to discuss recommended program guidelines for NO_x and PM_{10}. It should be noted that the recommended program guidelines are variations on the dual coupon-fee and mobile source systems discussed above.

5.3.1 Program Guidelines for Ozone

Overview

The proposed program goal includes a reduction of ozone (smog), and thus the program must ultimately control emissions of ozone precursors. Due to the geographic location of the GVRD, the meteorological conditions appear to be most conducive to *seasonal* ozone formation from May through September.[15] While seasonal controls may appear adequate, and perhaps economically beneficial, if designed improperly they can create incentives for emission shifting and worsening air quality in the off-season months, in addition to other problems.

Given that ozone levels during the ozone season already exceed the Level A NAAQO more than 1 percent of the time, exceed Level B objectives on occasion, and exceed level C objectives only in very rare circumstances, ozone levels *may* be considered somewhat too high.[16] This determination is solely a regulatory decision.

If this is deemed to be the case, a **declining balance seasonal cap** in one or both of the precursors (NO_x and VOCs) seems necessary. This cap would decline over the time frame of the AQMP goals, eventually ending at the targeted reduction.[17] Alternatively, if declining levels are not warranted, then the design is the same, but without a decline in coupons over the program lifetime. In either case, we recommend setting an additional **off-season cap** on the regulated precursor(s) to protect against the difficulties delineated in Appendix C.

While we recommend setting an off-season cap, the level of this cap is more controversial. Since ozone is a seasonal contaminant, presumably this off-season cap should be set at or near current levels to *insure no increase or shifting* of significant amounts of precursor emissions into the off-season. In addition, the NAAQO for the *precursors* themselves must be considered, as is done in the following discussion for NO_x (and for VOCs in Appendix B). On the other hand, the ultimate level of this cap is a regulatory decision, and does *not* affect the instrument design or choice.

The spatial distribution of ozone is an additional regulatory consideration. The highest levels and frequency of ozone exceedances has occurred in the eastern parts of the GVRD and other regions in the ELFV, while the emissions are greatest in the western half of the GVRD. This pattern occurs as the western precursor emissions are transported eastward before they significantly react to form ozone, while they form ozone in the eastern regions. Therefore, it appears that the best interest of the GVRD will be served if a form of zonal control is implemented, where no source in the western zone can increase its emissions above some level using coupons from the eastern zone. This type of **zoned ceiling control** can be built into an emissions trading program for ozone precursors and is recommended (see Section 3.5.9 in Appendix A for a detailed description.)

The method to regulate ozone (i.e., its precursors) for point and mobile sources is discussed in more detail in Section 5.3.2.[18]

5.3.2 Program Guidelines for NO_x

Overview

NO_x in and of itself has largely remained below the annual average Level A objective, but some sites have experienced exceedances of this objective.[19] The short-term objective, on the other hand, is very rarely violated, usually from facility breakdowns rather than intended emissions.[20] Therefore, current levels are most likely *slightly* too high, and a small decline in the cap may be prudent. Again, however, this is a regulatory decision.

While NO_x is a seasonal ozone precursor, it may also contribute to TSP and PM_{10} levels. The analysis to determine the extent to which this occurs is not yet complete, but the results of the analysis are extremely important. If NO_x emissions turn largely into PM, then a **declining balance, staggered coupon system** is most likely best. On the other hand, if these emissions contribute more to ozone, then stricter seasonal controls may be desired, with an off-season cap set at adequate levels of public health protection; thus, leading to a recommendation of a **declining balance seasonal cap system with an off-season constraint.**

Mobile Sources

Mobile sources clearly contribute the majority (77%) of NO_x emissions, with light duty vehicles contributing about 35% of the aggregate emissions. Therefore, we recommend inclusion of mobile sources using the **mobile sector cap system** described in Section 5.2.2. Marine vessels, which have been left out of this system, represent 18% of the aggregate emissions, and therefore should be controlled in some way. The ability to monitor these emissions must be determined before they could be included in the mobile sector cap system, but perhaps a **differentiated fee system for marine vessels** could be applied. Whether or not the GVRD has the ability to levy and enforce such a fee is unknown if the vessels are of international origin.

In addition, not all vehicles are subject to AirCare testing. To bring heavy duty vehicles, for example, into the mobile program, these vehicles would have to be made subject to mandatory AirCare testing requirements.

Point Sources

Point sources contribute about 17% of NO_x emissions. To the extent that these emissions can be effectively monitored, all relevant sources should be allowed to participate in the program.[21] The type of system recommended is the **declining balance, staggered coupon system with a seasonal cap system and an off-season constraint**. The actual type of cap may depend upon the ozone and particulate issues raised in the overview above.

5.3.3 *Program Guidelines for Particulates*

Overview

As indicated in the State of the Environment Report for British Columbia,[22] the problems associated with particulate matter occur throughout the year. In this case, a program aimed at controlling annual emissions is likely to be best. In addition, in terms of the health effects noted in the cost-benefit analysis of the AQMP,[23] it is clearly shown that reductions in this contaminant are desired. Even more so, the study shows that regulatory policy should not allow increases in particulates.

It therefore appears that a **declining balance, staggered coupon system** for annual emissions is desired to control particulate emissions in the stationary and mobile sectors.[24] To the extent that the particulates are primary particulates,[25] the cap would be on actual releases of primary particulates, and this action would provide a control on the particulate levels. On the other hand, if secondary particles[26] are large contributors to total particulates, then regulation of those gaseous emissions that act as particulate "precursors" would be required. A preliminary report on visibility prepared for GVRD discusses some of these distinctions.[27]

Mobile Sources

Mobile source contributions to primary particulates are measured in two broad categories, *road dust* and *emitted particulates*. Excluding road dust, these emissions are significant, but not major, with light-duty and heavy duty vehicles comprising only 7.1% and 10.3% of the emissions respectively. On the other hand, if road dust is included in the total, then the mobile source category contributes 78% of the primary particulate emissions.[28]

Information on the control measures for, and measurability of, road dust was not available at the time this report was written. Therefore, this emissions category is considered outside the scope of the analysis, and emitted particulates will be considered. With this caveat in mind, mobile sources should be controlled using the **mobile sector cap system** described in Section 5.2.2.

In addition, as discussed above, in order to bring vehicles which are not subject to AirCare testing into the mobile program to address secondary particulate emissions, these vehicles would have to be made subject to AirCare.

Point Sources

Point sources clearly represent the majority of sources releasing emitted particulates. In addition, there are quite a few industrial categories within this sector that produce significant particulate quantities -- bulk shipping terminals, wood products, paper products, and non-metallic processing to name a few. This provides a probable range of control costs that elevates the economic savings potential from trading under a declining balance emissions cap.

To the extent that these emissions can be measured, all sources should be allowed to participate in the program.[29] The type of system applied is the **declining balance, staggered coupon system**. This is recommended rather than a system that allows banking of emissions coupons because we *assume* that the regulator desires that particulate emissions show a steady, irreversible decline.

5.4 Applying the Recommended Programs: Some Illustrative Examples

In this section we provide some illustrative examples of how the recommended program designs (dual coupon-fee and mobile source system) discussed in Section 5.3 *could* be introduced in practice and *could* work for controlling PM_{10} and NO_x emissions from stationary and mobile sectors. These examples also demonstrate how the programs would address certain situations (e.g., imposition of controls that threaten competitiveness, entry of a new source) and what the outcome of the program's operation might be.

5.4.1 Example 1: Simple Transfers and Permitted Daily Emission Limits

Assume that there are only four facilities who release NO_x emissions, say A, B, C and D. In addition, assume that before any new emissions program is instituted, these facilities have been operating under maximum allowable *rate-based* limits of 1 tonne per day specified in their operating permits (it is further assumed that these limits cannot be changed without some sort of administrative regulatory hearing and/or environmental impact study). For our purposes, think of these as fixed for the purpose of protecting health and welfare of the area adjacent to the facility. Even though the facilities have these maximum limits, their emissions do not always run at this rate-based limit (as is the case for a number of permittees under the *B.C. Waste Management Permit-Fee Regulations*), and in fact the actual facility-wide emissions for facility A, B, C and D are 150, 200, 300 and 350 tonnes per year respectively.

At the beginning of the implementation of a transferable emission limit program, these facilities are allocated a two-part emission limit by the regulator. They keep the 1 tonne/day rate-based limit to avoid allowing local air quality to deteriorate. This sets an upper bound limit on daily emissions that they cannot exceed irrespective of the number of coupons held (this limit is one of the additional regulatory permit constraints noted in Section 5.2.1). In addition, annual emission limits initially equal to each facility's *actual* annual emissions are imposed to create a cap on emissions (the facilities must determine actual emissions as a condition of entry into the program).

Each of these annual emission limits allocated to the facilities is accounted for by a "coupon" for each tonne in the annual emission limit for each facility, such that Facility A has 150 coupons, B has 200 coupons, etc. To monitor activity, the regulator has set quarterly compliance periods, which means that at the end of each quarter,[30] these facilities must have enough coupons remaining in their account to cover (equal) their emissions for that past quarter. These emissions are usually reported and verified through a continuous or semi-continuous monitoring system installed at the facilities' sources (alternative estimation procedures are permitted but, depending on their accuracy, the facilities coupons may be discounted).

The regulator who maintains the listing of facility accounts then removes, or retires, the number of coupons equal to a facility's reported emissions from that facility's account. For example, suppose that facility A had initially 150 coupons for 1995 in its account. After the first quarter its emissions were 40, and after removing 40 coupons it has a remaining balance of 110 coupons. Suppose that its second quarter emissions were 50, then the number of coupons remaining for the next two quarters is 60, unless the facility makes a transfer (discussed below). In addition, of course, during no day may the facility exceed one tonne of emissions, as stipulated by its maximum daily rate, regardless of the number of coupons it holds in its account.

Suppose further that the regulators wish to decrease the amount of emissions by 50 percent over the next 10 years, and after that have emission levels stay at that decreased level. Depending upon whether the rate of reduction in emission is constant (suppose a constant 5% of the initial baseline per year) the facilities' annual emission limits must also decrease by that rate. Facilities A through D would have limits for the first 11 years of the program as follows:

	Program Year											
Facility	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
A	*150*	*143*	*135*	*128*	*120*	*113*	*105*	*98*	*90*	*83*	*75*	*75*
B	*200*	*190*	*180*	*170*	*160*	*150*	*140*	*130*	*120*	*110*	*100*	*100*
C	*300*	*285*	*270*	*255*	*240*	*225*	*210*	*195*	*180*	*165*	*150*	*150*
D	*350*	*333*	*315*	*298*	*280*	*263*	*245*	*228*	*210*	*193*	*175*	*175*

Assume that Facility A can install one type of equipment to meet the prescribed emission reductions and can do so in a cost-effective manner, raising its product prices only slightly. Similarly, assume that Facility B can install one type of equipment to meet the required emission reductions and can also do so in a cost-effective manner. On the other hand, Facility B also thinks that it may be able to reduce its emissions by an *additional* 50 tonnes per year if it invests $1 million in new research and equipment. However, the value of its product is such that raising the prices to accommodate such an increase would put the facility out of business. It does not have to make these additional reductions anyway since it can install the traditional abatement equipment and meet the 50% reduction cost-effectively.

Suppose also that Facility C will have to spend $500,000 to reduce the first 100 tonnes of emissions, but it would have to spend an additional $2 million to reduce the next 50 tonnes to stay within its declining annual emission limits in future years. While it can afford to make the first 100 tonne reduction, its profit margin is too low to absorb the additional costs necessary to make the next 50 tonne reduction. In fact, it can afford (including remaining in business from price raises) no more than $1.25 million for the additional 50 tonne reduction, for a total maximum of no more than $1.75 million.

With transferable emission limits two positive things happen. First, Facility B agrees to undertake the additional research and 50 tonne reduction if Facility C pays for it plus gives B some compensation for its effort, say $200,000, thus making B Better off. Further B agrees to transfer the excess coupons that result to Facility C, who then meets its annual emission limit since it adds 50 coupons to its annual holdings. Facility C is able to remain in the region because its total abatement costs (including the equipment paid for in Facility B) are below the $1.75 million maximum its product market can handle. (The cost is $500,000 for the first 100 tonnes annual reduction plus $1.2 million for abatement at Facility B.)

Facility B conducted research into and installed new abatement equipment it could not otherwise afford, and Facility C also was able to remain in the region. Further, the emission in the region fell by 50%, and no daily rates were exceeded. The total cost savings was, in accounting terms, $800,000 (or 32%) for C, but in reality the savings was much greater. Had Facility C not been able to add equipment at B and transfer the coupons, it would have left the region, resulting in the release of its workers and a loss to the corporate tax base.

In order for this system to work, the regulator must require that all transfers be recorded and verified in a central database. This same database maintains the remaining balances of coupons in each facility's account.

Suppose that Facility D wished to increase its emissions by 50 without making reductions. In this system it would not be allowed, no matter how much it compensated Facility B, to transfer these coupons into its account. If it did, its daily-rate limits would be violated. Running at the maximum daily rate every day would result in emissions of 365 tonnes, which is clearly below those that would occur if D were to transfer and use the coupons from B. Therefore, local health is protected and D must make real reductions in order to expand.

5.4.2 *Example 2: A New Facility*

Assume that the same four facilities are in existence, all with declining balances. Suppose that a new profitable industry wished to locate in the GVRD, but that it will produce emissions of 10 tonnes per year even with the best control equipment. Under this program it cannot simply move into the region and release these emissions. It must open an account with the regulator who maintains the central database of annual emission limits and thus coupon holdings. Its opening balance is zero over all years, and since its emissions will be 10 tonnes, it cannot operate. In order to operate it must have a balance of at least 10 coupons each year that it operates.

The new facility must obtain those coupons from other facilities. However, in order to transfer those coupons without themselves violating their annual emission limits, an existing facility must find a way to decrease emissions even further and free up some coupons. The cost associated with these additional abatement controls may be too high for the reducing facility to stay in business, but if it receives adequate compensation for installing the additional equipment, then it is not adversely affected. Also, the new industry is the one compensating the facility to make these additional, costly reductions.

Suppose that Facility D makes additional reductions of 10 tonnes per year and does so with compensation from the new facility. The regulator records the decrease in coupons from D's account and simultaneously records a positive balance of 10 tonnes per year in the new facility's account. The cap on emissions is maintained, meaning that the 50% reduction is still met, yet business can expand in a more cost-effective manner.

For the sake of discussion, let's observe what would have happened in the case where the regulator used only emission fees as his economic instrument. Suppose also that before the new facility entered, the fee was set perfectly so that emissions were reduced as desired. The cost of abatement for the new facility is, say, $1,500 per tonne across the board. Suppose further that the fee is $500 per tonne. In this case the new facility can enter, release emissions of 10 tonnes from the new facility, and no other facilities will decrease their emissions by more than the 50% they were previously planning -- the cap is broken.

In order to maintain emission within this cap, the regulator would have to increase the emissions fee for all facilities, thus penalizing them for the entry of a new facility. The increased fee would also mean that the existing facilities were no longer reducing their emission in a cost effective manner, and if they could they would attempt to install additional equipment. However, it is more likely that they would fight the emissions fee increase, or the source of it, resulting in either higher emissions or decreased economic growth.

5.4.3 Example 3: PM Reductions With the Mobile Source Sector

In this example, suppose that there are several facilities that emit particulate matter (PM) in addition to the mobile source sector. As with any control program, the regulator must establish a baseline of emissions, and in this case it must include the mobile source sector. Section 5.2.2 examines how this baseline is set, but essentially the records of each vehicle's representative mileage and average emissions per mile are likely to be a sufficient starting point (in this example, we have assumed that AirCare testing has been expanded to cover particulate emissions). In an account maintained by the appropriate government agency, presumably AirCare, each vehicle is allocated coupons that equal the average emissions for that vehicle on an annual basis. As discussed in Section 5.2.2, some estimate of the vehicle's remaining lifetime is also made, and the coupons are adjusted so that after that point the account contains coupons for an emission limit equal to the new vehicle standards, rather than the higher emission from the current vehicle.

On an annual basis (as a minimum) the driver must have the vehicle's emissions rate checked at AirCare, and in order to receive the certification to take to ICBC, coupons equal to the vehicle's emissions must be turned in to the AirCare representative. These emissions are equal to the product of the vehicle's emission rate, determined at the *past year's* AirCare emissions rate check, and the miles driven over the past year, as recorded by the oedometer or an alternative, tamper-proof monitoring device installed in the vehicle.[31] Most simply, these coupons are deducted from the vehicle's account electronically. A positive balance in the account is treated in the same manner that the program for non-mobile sources specifies excess coupons may be handled (e.g., banked in some limited fashion or transferred to another mobile source, facility, broker, or any other entity that wishes to hold coupons). If the account has a negative net balance the account must be brought up to date before registration by AirCare can be completed.

This account updating might occur in several ways. First, the vehicle owner may transfer coupons from another vehicle where he or she is also the registered owner. Second, another holder of coupons may authorize the transfer of coupons to the vehicle's account. Several potential transfers are likely to be prevalent. AirCare may maintain a Central Motor Vehicle Coupon Account with unused coupons in it, and it may charge vehicle owners for each coupon transferred from this central account to their vehicle's account. Presumably, this charge reflects AirCare's cost of obtaining these coupons. Second, brokers may maintain accounts with unused coupons, and they may transfer coupons from their account to another vehicle's account, but they cannot transfer the coupons the other way for security reasons. In either case, once the vehicle's account has sufficient coupons to cover its emissions, registration can be completed and the new AirCare emissions rate is recorded for use in determining the coming year's emissions when the vehicle owner returns in a year.

In the case that the owner has reduced emissions, perhaps by taking public transit, carpooling, etc., there will be excess coupons in the vehicle's account. Similarly to the above, AirCare may compensate the owner for these excess coupons and then transfer the coupons from the vehicle's account or that of a broker or facility. Most likely, for ease, AirCare will initially maintain only vehicle accounts and those of designated brokers. Facilities will likely receive any transferred motor vehicle coupons through one of the designated brokers.

The idea here is to give motor vehicle owners the appropriate incentive to create fewer emissions. This system essentially charges for each mile driven, and charges more the dirtier the vehicle's emissions. In order to let vehicle owners know what their behaviour is likely going to cost them, they should be supplied with the AirCare emissions rate determined at their last inspection. They can then calculate their miles times this rate as the year progresses to know how they are doing versus their coupon holdings. By observing the price that AirCare, or any other entity, charges for the coupons, the vehicle owner can essentially calculate the cost of driving versus taking alternative transportation or driving a cleaner vehicle.

When a new vehicle is registered it must obtain coupons, just as in the example for a newly entering facility, to cover its emissions. Of course, if the owner has retired an older vehicle exactly at the end of its expected lifetime, the account will contain some coupons set at the new vehicle standards. If the owner has purchased a car that does not meet these standards, then he will obviously have to purchase more coupons that are generated by some other source making extra reductions. On the other hand, if the new vehicle is cleaner than these standards, then the owner can sell the excess coupons; thus receiving a monetary benefit to cover part of the cleaner vehicle's cost. The nice thing about this system is that the dirtier sources are the ones providing the subsidies for cleaner vehicles, rather than the general public purse.

5.4.4 Example 4: Implementing the Dual-Coupon Fee System

In this example, we begin with the same four facilities discussed in Section 5.4.1. Therefore, we skip to the declining balance allocation for these facilities as reported below. As before, the GVRD would establish the appropriate limits just as it has had to do in the development of its AQMP.

	Program Year											
Facility	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
A	*150*	*143*	*135*	*128*	*120*	*113*	*105*	*98*	*90*	*83*	*75*	*75*
B	*200*	*190*	*180*	*170*	*160*	*150*	*140*	*130*	*120*	*110*	*100*	*100*
C	*300*	*285*	*270*	*255*	*240*	*225*	*210*	*195*	*180*	*165*	*150*	*150*
D	*350*	*333*	*315*	*298*	*280*	*263*	*245*	*228*	*210*	*193*	*175*	*175*

The regulator first calculates the appropriate declining emission limit just as with all transferable emissions limits programs. In addition to these allocations, however, the regulator also establishes a fee that each facility will pay for each unit of emissions released. This fee must not be higher than the fee that would, by itself (in theory), reduce the quantity of emissions to the same level as those depicted by the total of the declining balance limits shown above. Only a single government entity need establish both the declining balance limits and the emissions fees, perhaps the GVRD would be the appropriate agency to oversee this task. These fees will not be the instrument that ultimately controls the emissions; rather, the cap established by the coupons attached to the transferable portion of the emission limits is what acts as that regulatory mechanism.

Most likely the emissions fees should begin modestly and grow proportionally as the emissions limits fall (with an adjustment for inflation). Also, the fees should not begin at too high a level because of the adverse impact on the facilities who have not had time to adjust their financial planning accordingly. Therefore, there are two issues that can ultimately affect the fees.

First, just to keep the total fees received constant as emissions fall, the regulator must proportionally increase the fees per unit of emissions as the emissions limit falls. Below is such a fee schedule.

Table 1 of Real Emissions Fees (1994$/tonne)

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Fee	*0*	*42.1*	*44.4*	*47.1*	*50*	*53.3*	*57.1*	*61.5*	*66.7*	*72.7*	*80*	*80*

For example, Facility B would pay $8,000 in total annual emissions fees if its emissions were equal to the emission limits established in the table above.

Second, the administrator may feel that the fees should begin low and increase more than proportionally up to some point. The following schedule illustrates combining this feature with the need to increase fees because of the declining balance. Note that years 1 through 3 of the program represent the gradual increase in fees, and after that point, the fees increase proportionally as in Table 1.

Table 2 of Real Emissions Fees (1994$/tonne)

Year	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*
Fee	*0*	*25*	*35*	*45*	*50*	*53.3*	*57.1*	*61.5*	*66.7*	*72.7*	*80*	*80*

This fee would most likely be paid on a semi-annual basis to keep revenues flowing, but an annual basis is equally efficient from an economic point of view. The fees would be paid as a tax to the GVRD, and could then be distributed to the appropriate agencies to cover administrative costs. In addition, if the fees are in excess of the administrative costs, the excess fees could be placed into a fund for use in education and research, developing bicycle paths or other public transportation, improving parks and forested areas, or a host of other environmentally related issues.

5.5 Design Variations for Alternative Program Objectives

The discussions in the preceding sections have addressed the type of program and design elements that could aid in the achievement of the AQMP under the assumption that a transferable emissions limits program (or any economic instruments program) serves as the primary management measure (our Case 1 assumption). However, as initially discussed in Section 4.0, the GVRD could apply emissions trading in one of (at least) two other alternative ways, i.e., our Case 2 and Case 3 implementation alternatives as presented in Section 4.2.5.

5.5.1 Case 2 Design Variations

The Case 2 alternative assumes that the emission reduction measures outlined in the AQMP will be fully implemented, and the objective of an economic instruments program would be to provide emitters with an incentive to achieve emission reductions in excess of those achieved through the application of the AQMP emission reduction measures alone. Essentially, this case assumes that economic instruments will be utilized primarily to fill the gap between the 38% reduction in annual emissions achievable under the AQMP and the 50% reduction goal. The program we recommend would allow for these additional reductions to be met without any variation in design. What could be lost, however, is many of the cost savings and opportunities for trading that would arise under the implementation of an economic instruments program under the Case 1 assumption. In fact, depending on how the instruments program is integrated into the AQMP and other federal/provincial regulatory policies, it is possible that the reductions in cost-effective abatement and trading opportunities could render the program non-viable.

As noted in Section 4.0, the Case 2 assumption is likely a closer approximation of reality in terms of how economic instruments would likely be applied in the GVRD, and the merits of economic instruments under the Case 2 assumption warrant further study. However, as was noted earlier, more detailed information as to the implementation plan for the AQMP and other regulatory issues will be required before such further studies could be usefully undertaken.

However, one possible variation (not in design but in implementation) that could be considered (and one adopted and approved for use in the SCAQMD) is to meet not only the additional reductions with a transferable emissions limits program, but meet the initial uniform emission standards with the program as well. This is accomplished by assigning coupons based generally on the emission levels associated with the BACT or other technology that underlie the standard. By the compliance deadline (say the year 2000) sources would have to hold coupons sufficient to cover their emissions. In essence, the requirements of the uniform emissions standard are tied more to emissions than technology in the sense that the sources determine what is the appropriate technology. The end result is that the cost-effectiveness of reductions is improved by allowing all reductions to meet cost-effectiveness criteria, rather than restricting cost saving reductions to those beyond the technology that explicitly/implicitly underlies the standard, and this increases cost savings.[32] Giving everyone the opportunity to find the cost-effective solution is also more equitable.

Finally, under this variation, meeting standards with trading induces sources to undertake R&D for more efficient abatement. While trading on post-compliance emissions also induces technological advancement, this advancement is not likely to be as great or lead to as cost-effective strategies. The abatement technologies developed are likely to be designed as "add-on" controls or temporal controls that account for facilities already having installed the control measures that explicitly/implicitly underlie the standard. This is in contrast with development of abatement technologies that are efficient as an entire system, without the waste resulting when two-part abatement is installed.

5.5.2 Case 3 Design Variations

The Case 3 alternative assumes that the objectives of the AQMP will be achieved through the application of the emission reduction measures outlined in the AQMP and through the retention of new source performance requirements. The principal objective of an economic instruments program in this case would be largely limited to providing a means of accommodating economic growth (as opposed to achieving improved cost-effectiveness and/or greater/earlier reductions). This assumption affects both the type of instruments program and its design. Specifically, under this case the program design recommendations would be narrowed to include only the **emissions offset** component.

5.6 Some Outstanding Issues

This section summarizes some outstanding issues that could not be addressed in this study but that regulators in the GVRD will need to consider before proceeding with the implementation of an economic instruments program or the next phase of an instruments analysis.

The first issue relates to whether the GVRD and/or the province has the legal authority to implement an economic instruments program. In our assessment we have assumed that the legal authority exists. However, a recent study by the West Coast Environmental Law Research Foundation[33] demonstrates that, while the legal authority may exist, special care is needed in developing the enabling legislation and draft regulations for implementing economic instrument programs. While we will not reiterate the findings of the West Coast study here, we would encourage readers to review the study.

Another legal issue that is involved when developing tradeable coupon/transferable emissions limits programs is the legal definition of what is traded. There are substantial questions involved in the treatment (or lack thereof) of environmental coupons as property rights, and these would have to be reflected in an emissions trading plan.

A further issue relates to the fact the Lower Fraser Valley airshed is shared between British Columbia and Washington State; hence, the possibility exists that joint action may be undertaken by Washington State and the GVRD/provincial government to address air quality issues. This in turn could involve the integration of both Canadian and U.S. sources in a trading program. If this is a possibility then the design of an instruments program, and the specification of the associated trading rules, may have to be undertaken jointly. The design process would also have to take into account the fact that the Washington State Department of Ecology currently allows for facility bubbles, the creation of emission reduction credits, and offsets.[34]

Another issue relates to monitoring. An assessment of the economics of monitoring emission sources in the LFV was beyond the scope of this study. However, the ability to institute some form of reliable monitoring is essential to program operation. In fact, the program should eventually require the regulated sources to install monitoring equipment where feasible. Where not feasible, and where an adequate proxy for emissions is not available, coupons generated from sources likely should be discounted before they are offered for sale.

In addition, depending on the monitoring requirements imposed, the economic merits of an instruments program can change dramatically. In this regard it is worth noting that, in making any recommendations for monitoring, it may not be reasonable to require monitoring equipment with a level of accuracy well in access of the emissions inventory (which has an accuracy of within +/- 35%).[35]

Finally, in this study we have not specified the types of trading rules that would be most appropriate, nor would it have been possible at this stage of development. The rules that will guide the program cannot be defined until most of the regulatory issues raised in this and the previous two sections are resolved. However, to provide the reader with a feel for the types of issues that will be encountered if and when a full economic instruments design and implementation study is initiated, we have attached as Appendix D the trading rules for the Regional Clean Air Incentives Market (RECLAIM) program in southern California.

Endnotes

1. The program design elements presented in this Section apply equally to all priority pollutants addressed by the AQMP, and the specific applications are described in Appendix B.

2. This is our Case 1 assumption for the operational objectives of an economic instruments program. Variations on the general program design for alternative operational objectives are discussed in Section 6.4.

3. Instrument designs for all sources and all pollutants addressed by the AQMP are provided in Appendix B.

4. A command-and-control strategy was implicitly assumed for the cost-benefits analysis (ARA/Bovar-Concord (1994)).

5. These limits consist of both a transferable element and a maximum allowable, non-transferable emission rate set to protect local human health and inserted into a facility's operating permit.

6. It is worth noting that the market price of the coupon in this system will be lower than in a pure tradeable coupon system.

7. Such a system would allow facilities who were initially allocated the coupons the time to plan cash flow to cover these fees, even though the same abatement strategies are efficient under the pure coupon system and the dual system.

8. The simplest option is a banking devaluation schedule, where the value of banked coupons declines the longer they are banked.

9. The designation of "following off-season" is actually irrelevant here because excess off-season coupons from the previous season are banked in the next off-season.

10. The sector designation is rather misleading here. Individual ownership of the mobile source coupons is not likely feasible, but individual ownership of the *ability to generate* the coupons is feasible. Various options are discussed in the relevant section on mobile sources.

11. The exact mechanisms involved in this transaction will not be developed in this report, but it would require significant interaction between ICBC, AirCare and the GVRD air quality regulators. One simplified way that this might be achieved, however, is for the licensing bureau to sell/buy coupons at the going market rate (or some average market rate).

12. Total emissions are the product of an emissions per mile rate for that particular vehicle and the number of miles the vehicle is driven.

13. Although gasoline taxes represent some payment to pollute, efficiency in burning gasoline (miles per gallon) is not necessarily a good measure of a vehicle's emissions. In addition, with more fuel efficiency, the cost of driving falls, doing little for congestion and perhaps making it worse.

14. For example, suppose that a particular current vehicle emits 100 units of a particular pollutant in a year, and that vehicle has an expected remaining lifetime of 5 years. New emission standards would yield emission of 40 units for the same miles driven. In the best case, the driver should have an allocation for 100 units for each of the next five years and 40 units after that, until some later date near 2005.

15. GVRD (1993b), Figure 3.5.

16. GVRD (1993b) Section 3.2.

17. It is important to keep in mind that ozone is not an emitted pollutant. Rather, its precursors (NO_x and VOC) are what is emitted and ultimately regulated. Because of the highly non-linear interaction of NO_x and VOC, a 50% reduction in NO_x will not likely have the same.effect as a 50% reduction in VOC or a 25% reduction in both pollutants. Therefore, some consideration of the reduction amounts of the precursors necessary to reduce the ozone level a specified amount is vital to designing a complete program goal.

18. With respect to area sources, since only space heating appears to be a significant contributor, adding nearly 6% to the aggregate NO_x emissions (GVRD, (1994b) Table 2), command-and-control style measures on this one category may be more cost effective when monitoring costs are considered. If the heating is included in a facility, then perhaps if that facility changes its heating type, and can prove significant emission decreases that are permanent, it may be granted coupons for the difference. The idea is to provide facilities with an incentive to adopt new technologies.

19. GVRD (1993b), Figure 3.13.

20. GVRD, (1993b) Table 3.1.

21. The actual factors affecting whether facilities should be allowed to participate are delineated in Section 3.5.8 in Appendix A.

22. B.C. Environment, (1993).

23. See ARA/Bovar-Concord, (1994).

24. Area sources appear to contribute to emitted particulates, and the industrial sectors included within this sector individually contribute significantly as well. This variety creates the potential for inclusion into a trading program, however, some of these sources appear to present extremely difficult monitoring and enforcement problems as well as the potential to produce local emissions increases that are undesirable if they are included in a trading program (see Appendix B for a further discussion).

25. Primary particulates are released as particulate matter directly into the atmosphere.

26. Secondary particulates form when gaseous emissions are converted to particulates in the atmosphere. Such gaseous emissions include SO_2, NO_x, NH_3, and VOCs.

27. See Senes, (1994).

28. Calculated from GVRD, (1994b) Table 2.

29. The actual factors affecting whether facilities should be allowed to participate are delineated in Section 3.5.8 in Appendix A.

30. In reality, the facilities are given a period (*a reconciliation period*) to settle their books and adjust their accounts. Often this period is 30 days.

31. For new vehicles, one might take the product of the owner's previous mileage history and the expected emissions rate for the vehicle.

32. In addition, their are savings that arise when sources are now able to implement dynamic abatement plans.

33. West Coast Environmental Law Research Foundation (1993).

34. See Washington State Department of Ecology Chapter 173-400 WAC: General Regulations for Air Pollution Sources, sections WAC 173-400-120 through WAC 173-400-136.

35. GVRD (1994b), pg. 6.

6.0 Analysis of Potential Compliance Cost Savings From The Application Of A Transferable Emissions Limits Program

In considering the implementation of a transferable emission limits system, it seems natural to ask whether the potential cost savings of such a program are likely to be significant, or at least apparent. While cost savings are often touted as the main reason for adopting such systems, in actuality the ability to set and maintain a cap on emissions (be it at the regional, source sector or industrial level) may present a larger benefit for some jurisdictions. Nevertheless, this section attempts to present evidence that the *potential* cost savings associated with the implementation of a transferable emission limits program, for at least point sources of NO_x and PM_{10}, would indeed be positive.

6.1 Methodological Issues

In order to estimate the potential cost savings, as a starting point one would have to know the cost-effectiveness and potential emission reductions that could result from applying any of the suite of potential abatement technologies available (*not* just those identified in the GVRD's AQMP), or reasonably expected to be available in the future, for controlling emissions ***at each*** source. Unlike in the GVRD's AQMP, where there is some restriction of potential control technologies to those that are (reasonably) economically viable for a given source or facility, the list of potential technologies that would be used in the cost savings calculation would need to include all applicable control measures without regard to a facility's or industry's ability to absorb the associated control costs. The relevant economic number associated with these control technologies which would be used in the cost analysis is simply cost-effectiveness (i.e., $/tonne reduced). Below we review why this is the case.

Recall that a transferable emissions limits program allows a facility to subsidize the development and/or installation of abatement controls at another facility (i.e., by purchasing the emission limit coupons made available by further abatement). Recall further that this will occur, in general, if one facility faces a relatively high per tonne cost of reducing emissions and can subsidize the installation of *additional* controls at another facility. These additional controls must be more cost-effective than the controls available to reduce emissions directly at the subsidizing facility (otherwise there would be no gain from trading), even though the additional controls may be too expensive for the facility where they are being installed (in the absence of the subsidy). Example 1 in Section 5.4 provides a numerical example of why this subsidization is beneficial using four hypothetical facilities in such a program. The important point to remember is that the cost-effectiveness of each potential control measure, regardless of whether a facility could reasonably be expected to *internally* afford the measure is the basis for determining potential cost savings for a transferable emission limits program.

After the list of potential technologies and their cost-effectiveness is determined, then the least cost mix of these available technologies (taking into account payments made and received for transferring emission limits coupons) that would achieve the required emission reductions must then be calculated. This cost is then compared to the estimated cost associated with having each facility only implement those control measures that the regulator has determined (implicitly or explicitly) are *internally* economically viable for the facilities in the regulated airshed, i.e., the measures indicated in the GVRD's AQMP.

While these calculations may appear straightforward, they are extremely data intensive. Most regions simply do not have the additional data necessary to conduct these calculations, since such data is not needed when designing a command-and-control program. In this regard, the GVRD is no exception and only has the data for measures expected to be required by the AQMP. In fact, since the use of economic instruments is relatively new, there is only one region that has developed this extensive data set at a level acceptable for performing the cost savings calculations required here: the South Coast Air Quality Management District (SCAQMD). It developed this data set as a result of implementing the Regional Clean Air Incentives Market (RECLAIM) program. By law, regulators in the SCAQMD had to show what, if any, impact the implementation of the RECLAIM program might have on jobs (e.g., type, employees versus capital) and the economies of local areas within the region.

Although the SCAQMD in Southern California represents a clearly different distribution of industries and manufacturing scale, some of the cost savings calculated for the RECLAIM program can provide insight into potential savings for the GVRD. In the absence of this data, the potential cost savings to the GVRD that would be associated with the implementation of the transferable emissions limits program could not be calculated without going through the same process that was required for the RECLAIM calculations. Therefore, we have devised a method to use this data in an appropriate fashion, while retaining the actual emissions and facility costs from the GVRD in large part.

6.2 Potential Cost Savings at a Source Level: An Example

In order to show that there is the *potential* for cost savings, we have calculated the cost effectiveness for the NO_x point source controls in the GVRD and ELFV. We then picked one source -- cement kilns -- whose potential abatement costs are low relative to the average for the region, but high relative to that industry's operating costs. In addition, the facilities appear similar to those included in RECLAIM. We then calculated the cost effectiveness of *all* the potential controls that could be installed, as well as the emission reductions that could be achieved, regardless of whether the cement industry could afford the much stricter controls. These numbers are presented below.

Source	Measure	Control Levels	Reduction	Cost-Effectiveness (1993$/tonne)	Included In AQMP
Cement kilns	P-CMT-1	50%	30,819	$917.32[1]	Yes
	SCAQMD-1	80%	49,310[2]	$1,956[3]	No
	SCAQMD-2	84%	51,776	$2,119	No
	SCAQMD-3	89%	54,858	$2,771	No

1. ARA/Bovar-Concord (1994), *Clean Air Benefits and Costs in the GVRD, Appendix C*, Table C-2.1.
2. Reductions figured by applying control level to emissions previously controlled with the P-CMT-1 technology.
3. RECLAIM cost data spreadsheets.

The only control required in the GVRD's AQMP is the first control (P-CMT-1) with a 50% reduction rate. The other controls (which are taken from SCAQMD data), however, are available to a facility *if it could afford* to add them. This would occur if the facility was subsidized by another facility that needed to achieve a similar control level to that associated with the stricter controls listed, but had higher per tonne control costs (on a cost-effectiveness basis). Again, this is true because in a program of transferable emission limits, facilities can subsidize other facilities which could otherwise not afford it to install *additional* control equipment (i.e., equipment beyond that required for the facility to comply with its permits) whose cost-effectiveness is better than that available in their own facility. In the GVRD, given the differences in the cost-effectiveness of abatement between different sources, this potential does seem to exists. To demonstrate this, consider the following example.

Under the AQMP, Gas-Fired Boilers and Heaters using the stricter control option (P-BLR-1b) with an emissions reduction rate of 70%, have cost-effectiveness numbers of approximately $6,091/tonne reduced.[1] In comparison, the installation of the more stringent controls *available* at the cement kilns in the GVRD (the SCAQMD-3 measure for example) reduces as many if not more tonnes of emissions as is reduced when boilers use the more expensive P-BLR-1b control option. Furthermore, the cost-effectiveness of the SCAQMD-3 measure is $2,771 per tonne. The difference in the cost-effectiveness numbers ($2,771 versus $6,091 per tonne) is the basis for trade (the cost of the P-CMT-1 measure recommended under the AQMP does not even enter the calculation). Therefore, the application of the stricter controls at the cement facility (e.g., either of the SCAQMD measures) would reduce an equivalent number of tonnes of emissions as that associated with the application of the P-BLR-1b measure on Gas-Fired Boilers and Heaters (thus keeping the emissions cap intact) at a much lower cost. Since the P-CMT-1 measure is all that is required under the AQMP, the SCAQMD measures would only be installed on cement kilns if the installation of the control measures was subsidized by the Gas-Fired Boilers. Given the differences in the cost-effectiveness numbers, it is cheaper for the SCAQMD measures to be subsidized by the Gas-Fired Boilers; thus, a trade such as this under the emission limits transfer program results in a significant cost savings for facilities utilizing either cement kilns or gas-fired boilers.

Given the differences in the cost-effectiveness of abatement across different sources in the LFV, with comparable data for various alternative control measures (i.e., not just those indicated in the AQMP) similar examples of potential cost-effective trades could be demonstrated. Whether trades like that indicated in the example above would in fact occur is not in the regulators' control -- it is up to the sources to determine when and with whom they wish to trade.

6.3 Potential Cost Savings at the Point Source Sector Level for NO_x and PM_{10}

Using the cost-benefit cost tables for NO_x point source emission controls, the average cost-effectiveness *overall* for sources in the LFV are from $7,615 to $10,775 per tonne reduced.[2] This range takes into account the high and low ranges of the estimated costs of abatement for sources within the LFV. Due to the fact that this average cost per tonne is above that of many alternative abatement choices that could be feasible under an emissions limits transfer program (for example the advanced technologies on cement kilns indicated in the SCAQMD data), it is reasonable to assume that the potential cost savings indicated in the example above, as well as others, could also be felt by many of the point sources currently in the LFV or expected to enter as the region experiences economic growth. This high average cost per tonne reduced indicates that many alternative control technologies which are not economically feasible to the industries within which they are applied (unless their installation is subsidized through the sale of coupons) are nevertheless economically feasible on the whole. This opens the door for economic benefits under a program of transferable emissions limits.

When the mobile source sector is included in the program, the cost savings are expected to be even greater. This is true because there are alternative controls available to the mobile source sector other than those indicated in the AQMP with more favourable cost-effectiveness than those available to point and area sources at this time (e.g., early vehicle retirement or scrap programs, conversion of vehicles to compressed natural gas, conversion of fleets to alternative fuels). This fact is also true in the South Coast Air Basin, where the average cost effectiveness for the controls that would have been required in the Air Quality Management Plan *if there were no RECLAIM program* was estimated at $31,979/ton.[3] Keep in mind that even at this cost level, the reductions in emissions necessary to achieve the Federal standards were not predicted to be achieved for the South Coast Basin.

Using total suspended particles as a proxy for PM_{10}, the story is likely to be the same. Unfortunately there is no suitable or comparable control technology data available, from RECLAIM or another program, for this pollutant. In order to provide some estimate of the possible savings, one can look across the controls to see whether greater implementation of some technologies could be economically subsidized to reduce the cost of implementing the most expensive technologies. For example, compare the cost of PM controls to the petroleum refining industry (using stage 2 measure P05P) with those alternatives available in the mobile source sector. One alternative appears to be even quicker retirement of old diesel vehicles in favour of more fuel efficient vehicles (emission measure M-HDV-1)[4], which would become viable with the refining industry footing the bill for the substitution rather than the general tax base. This would be possible by virtue of the fact that the refineries could subsidize the early vehicle retirement and then transfer the coupons to their account; thus reducing the need to implement the exceedingly expensive alternatives for PM controls.

Implementing the RECLAIM program for NO_x and SO_x in the SCAQMD is estimated to result in a cost savings of approximately 55% over that of command and control.[5] It is important to note that this savings includes the costs of monitoring and record-keeping that are estimated for the RECLAIM program. While a direct comparison of the facilities in the GVRD and the SCAQMD is not accurate, it can provide some idea of the potential magnitude of overall cost savings. While the South Coast facilities are clearly much higher on the "abatement cost curve," their cost savings as a percentage of overall control costs is not necessarily biased by this fact. It may be true that because the GVRD facilities have not yet installed the majority of abatement controls that have previously been installed in the South Coast (due to the fact that this level of control has not been necessary for the GVRD), the GVRD facilities may have an advantage in their ability to save an even greater proportion of control costs. By not having the same wealth of existing abatement equipment installed, the GVRD's facilities have an added level of flexibility that allows them to implement the best mix of cost-effective technologies. For example, if a facility already has installed an expensive piece of equipment, the costs of removing and replacing that equipment with equipment partially subsidized by another facility may render such a subsidy non-viable.

Alternatively, the GVRD may find that they are able to achieve the 50% reduction in emissions desired, rather than the 38% predicted by the AQMP. This is possible because it may be cost-effective overall to meet the 50% reduction as long as facilities can subsidize control equipment installation at other facilities, if that equipment represents a more cost-effective choice of abatement. Also, the attribute of economic instruments that encourages technological development makes it much more likely that facilities will develop new methods to further reduce emissions in a cost-effective manner.

The specific examples of real cost savings that would be available to the GVRD facilities clearly show that cost savings are estimated to be positive and likely significant. Due to the fact that the GVRD data on all the potential control technologies, reduction efficiencies, and all source monitoring capabilities is not available for this study, to arrive at an estimate of the potential cost savings we apply the RECLAIM cost savings (i.e., 55% over that of command-and-control) proportionately to the point source facilities in the GVRD, taking into account the same cost of record-keeping and monitoring as a percentage of control costs. Thus, if the proportionate savings from trading realized under RECLAIM are realized in the GVRD under an AQMP with a transferable emissions limits program (which as argued above is a reasonable assumption), then such a calculation shows that the GVRD may save $352 million for point source NO_x controls and $686 million for PM_{10} (TSP) point source controls, for a combined total of over one billion dollars.[6] The application of a mobile sector trading program would improve the cost-savings estimate. However, the data required to produce such an estimate is not available.

While significant, it must be kept in mind that this is merely a potential expected cost-savings. The actual savings may exceed this estimate because the composition of sources is more diverse, the program is implemented before significant resources have been allocated to pollution abatement through other programs, or mobile source emissions add significant savings. On the other hand the savings may be smaller because of inferior program design (including items already mentioned in previous chapters) or the sources are not diverse in abatement costs.

Also, as pointed out in Sections 3.0 and 4.0 above, the actual magnitude of realized cost savings will depend on the operational objectives assigned to the transferable emissions limits program by the regulator (e.g., the Case 1 through 3 assumptions); whether the program is implemented as a substitute for, a compliment to, or on top of a command-and-control regulatory framework; whether specific uniform emission standards and new source performance standards are retained; etc. Once regulatory decisions are made with respect to these issues, then a more accurate estimate of potential savings can be made.

6.4 Monitoring, Enforcement and Administrative Cost Impacts

The monitoring, enforcement and administration costs associated with the GVRD's AQMP were not calculated as part of the recent AQMP cost-benefit analysis, and accurately calculating both these costs and those that would be associated with the instruments program, are beyond the scope of this part of the study . However, we can use the RECLAIM program to understand the order of magnitude of these costs.

Under a program of transferable emissions limits, the initial administrative costs may appear high; however, because the program does not require the regulators to attempt to estimate what technologies are likely to be developed in the future and then write rules that (implicitly or explicitly) require the implementation of these technologies, administrative workloads will likely decline, or at least be transferred to other uses such as planning growth controls, rapid transit, and permitting new sources. Monitoring and enforcement costs may also decline because site inspections are not the only way that the regulator can oversee a facility's emissions. Site inspections can be quite cumbersome and less frequent than the information gained from monitoring systems in place at a site. Record-keeping/administrative costs likely will increase, at least at first, since the regulator must keep account of the current standings of the facilities' emission limits and coupon holdings. However, the establishment of a computerized, central database should reduce this impact in the longer run.

One of the key sensitivities with trading programs involves monitoring costs. As noted earlier, the type of monitoring required by regulators can significantly affect the net savings realized from such programs. In the South Coast, the SCAQMD staff estimated the number of major and large sources based on their protocols for defining and identifying sources. Major sources were assumed to install continuous emission monitoring systems (CEMS), and it was also assumed that two pieces of permitted equipment would share one CEMS. Therefore, the required number of CEMS for each facility was calculated based on a count of equipment in that facility. Large facilities were assumed to install a less stringent type of monitoring system called a continuous process monitoring system (CPMS). The number of CPMSs required for each facility was assumed to be equivalent to the number of permits for each facility. The costs included electrical cables, fuel meters, source testing, calibration and maintenance. It was also assumed that each facility would install no more than one remote terminal unit (RTU). The average RTU cost was assumed to be US $25,000 for installation with an annual inspection and maintenance cost of US $2,500. When the costs of record-keeping are also included, and if all these costs are placed solely on the NO_x reductions (therefore establishing a conservative estimate that does not take into account that facilities often emit more than one contaminant) these costs are about 14% of the RECLAIM-based abatement costs for NO_x.[7]

The RECLAIM cost-effectiveness numbers employed in our analysis already take into account the expected costs of monitoring at the respective facilities. On the other hand, the GVRD cost-effectiveness numbers do not include such costs. Therefore, the RECLAIM numbers are again conservative from this aspect, yet cost savings are *still* apparent.

Endnotes

1. Calculated using Table C-2.1 with 4% discounting from ARA/Bovar-Concord (1994), Appendix C.

2. Calculated using all individual source sections from ARA/Bovar-Concord (1994), Appendix C, Table C-2.1.

3. SCAQMD (1992), *RECLAIM Summary Recommendations*, Appendix, Table H.

4. ARA/Bovar-Concord (1994), Appendix C, Table C-7.4.

5. SCAQMD (1993), *Volume III, Socioeconomic and Environmental Assessments*, July, Chapter 6, pg. 2.

6. Calculated from ARA/Bovar-Concord (1994), Appendix C, Table C-2.1 (0% interest) total NPV costs.

7. SCAQMD (1993), *Volume III, Socioeconomic and Environmental Assessments*, July, Chapter 6, pg. 7.

7.0 Conclusions and Further Work

From an air quality management point-of-view, the task for regulators in the GVRD appears to be one of minimizing air quality episodes and preventing a decline in the generally good air quality experienced in the LFV. In terms of specific contaminants, the concentrations of CO, NO_x, SO_x and total suspended particulate matter (TSP) currently pose a limited risk to environmental quality and human health, as indicated in the draft cost-benefit analysis.[1] The Priority 1 contaminants in the LFV that pose the greatest risks at present to environmental quality and human health include fine particulate matter of less than ten microns in diameter (PM_{10}), a component of TSP; and ground-level ozone, which is often referred to as photochemical smog and is the result of chemical reactions between NO_x and VOCs.

The implementation of the GVRD's AQMP recommended emission reduction measures will make a significant contribution to improving air quality in the Lower Fraser Valley and reducing the risks to the environment and human health. However, relative to its 1985 baseline, the implementation of the AQMP (and the federal vehicle emission standards) does not reach the goal of an overall 50% reduction from 1985 levels in aggregate emissions. Rather, the implementation of the AQMP will result in a 38% decline in overall annual emissions by the year 2000. The reductions will stem from significant declines in CO (by 45%), VOCs (by 33%) and SO_x (by 50%); however, NO_x declines only marginally (by 2%), while particulates -- the contaminant likely to cause the most damaging health effects -- shows a 3% increase from 1985 levels (excluding road dust).[2] This would suggest that Priority 1 contaminants will require additional regulatory action in order to achieve the AQMP's air quality goals.[3]

In this study we have examined the two-part question of whether the additional regulatory actions needed to achieve the 50% emission reduction goal, and to reduce NO_x and PM_{10}, should come in the form of command-and-control style additions to the AQMP or through the application of economic instruments; and/or whether the implementation of an economic instruments program would allow the emission reductions required under the AQMP to be achieved at a reduced cost to society. In order to conduct this analysis we have made a number of assumptions, which include:

- attainment of the emission reductions specified in the AQMP is an absolute requirement (i.e., not just a "desired goal");
- pollutant-specific reductions are required, not simply an aggregate 50% reduction;
- economic instruments would be applied as the primary measure for achieving the required emission reductions (our Case 1 assumption);

- the 50% emission reduction goal will be apportioned across the priority contaminants and the resulting contaminant-specific reduction goals are binding (e.g., particulates will not be allowed to increase even though CO emission reductions are attainable and are sufficient to ensure that the required, overall reductions objective is not violated);

- source sectors participating in the transferable emission limits program, as well as new sources, would not be subject to specific control equipment or process requirements, but rather subject to emission limits as defined by the program;

- banking of coupons is only allowed where specifically noted in our recommendations;

- transferable emission limits have reasonable guarantees against confiscation and devaluation unless otherwise so stated in our recommendations, such as in the case of callable coupons;

- based largely on the results of the draft cost-benefit analysis, the contaminants that have priority for the application of transferable limit programs include PM_{10} and NO_x, and the source sectors to focus on include the point and mobile source sectors;

- monitoring of actual emissions from sources will be required where technologically feasible;

- the GVRD has the legal ability to carry out any recommended fee or coupon allocation systems;

- any recommended fee or coupon program would be administered by one central governing body (e.g., the GVRD or some other regulatory body);

- any penalties required in the programs can be assessed by a governing body;

- an accurate emissions baseline for the airshed, source sectors and individual contaminants can be determined, upon which an accurate emissions cap can be defined;

- air quality modelling can be (has been) performed to determine the NO_x/VOC relationship in the relevant airshed(s), and to determine whether NO_x or VOC should be the focus of an instruments program for ozone control;

- air quality modelling can be (has been) preformed to determine the mixture of and proportion of secondary particulates, and to allow for the identification of secondary particulate emission sources that should be brought into the program as participants; and

- a permitting or registration system exists or will exist for all new sources (including mobile sources) that will participate in the program.

On the basis of these assumptions, we considered a wide range of management measures under both an economic instruments and a command-and-control regulatory approach. On the basis of our review we concluded that *for the most part* a program utilizing transferable emissions limits for stationary and mobile source emissions of PM_{10} and NO_x, would provide a viable policy option and would aid in achieving the desired air quality objectives in the GVRD in a cost-effective fashion. We have focused on these two contaminants both for air quality reasons (as noted above) and for practical reasons; namely, it may be easier to accept a change in regulatory strategy if one implements a limited number of programs for the Priority 1 contaminants, make sure they are working properly, and *then* expand the system.

It is not particularly "earth-shattering" that we would recommend consideration of a transferable emissions limits program, nor may it seem particularly unique. Given the assumptions noted above, and particularly the assumptions pertaining to the achievement of emission reductions, it is a comparatively easy task to recommend such programs (as they are quantity instruments as opposed to price instruments). However, this study has also been concerned with the specification of the design characteristics that would render such programs workable within the Lower Fraser Valley airshed and within the context of the AQMP. Program design is not a simple and straightforward task, and the difficulty with defining such programs is even greater given that the vast majority of emissions in the LFV stem from the mobile sector -- a source sector that has been infrequently addressed as a candidate for economic instruments beyond the application of economic incentives such as bridge and road tolls, gasoline taxes, and parking charges. Given the dominance of the mobile sector, we have also provided a *mobile source sector cap system*. This approach to reducing vehicle emissions could, perhaps for the first time, allow a significant part of the environmental cost of vehicle emissions to be directly incorporated into consumer decisions.

While this study defines a variety of design characteristics for a transferable emissions limits program and the mobile source sector cap system, the objective here was not to provide the full design specifications for the instrument program; define an implementation plan; specify monitoring, enforcement, administrative and legislative requirements; comprehensively cost the fully designed instruments; or assess the compliance, administrative and monitoring costs associated with the implementation of the fully designed instruments. Before these sorts of questions can be resolved, a number of issues will have to be considered and resolved by regulators in the LFV.

To begin, the validity of our assumptions has to be determined. This will require that regulators determine what the practical goals and objectives are for air quality management (e.g., the Case 1, 2, or 3 implementation assumptions), what trade-offs are acceptable, and what role economic instruments can/should play in that regard (e.g., to achieve greater/earlier reductions, to achieve greater cost-effectiveness, to facilitate economic growth, etc.). In addition, contaminants should be priorized on the basis of their health effects so that a program can be developed and implemented in a timely and smooth fashion. The desired type of reduction also needs to be clarified (i.e., is it assumed that the 50% reduction in aggregate emissions is the single environmental goal or are there additional goals such as limits on how much specific contaminants may increase, if at all). The desired type of reduction also needs to be identified for each contaminant -- peak versus aggregate reductions -- to maximize the incentive for proper technological development and to insure the most beneficial reductions are made. The type of monitoring that the GVRD is willing to require, and that facilities find feasible, is of utmost importance, and this issue must be resolved before one can identify with accuracy those sources that are best left out of a trading program. Finally, several air chemistry and modelling issues should be settled before any program can be fully designed or implemented (e.g., does NO_x or VOCs drive ozone formation).

If these and other issues raised throughout the report are resolved, then a program for the GVRD and the ELFV can be more completely discussed, designed, and evaluated. In tandem, further study should begin on a number of additional issues, but in light of the answers provided to the regulatory issues we have brought forth in this report. For example, more study of the instruments aimed at reducing seasonal ozone is likely to be needed. Currently, several jurisdictions in the U.S. are considering similar programs that the consultants are helping to design. Nevertheless, not all the issues surrounding the final design of this program, particularly monitoring protocols and their effects upon trading strategies, have been resolved. In addition, further work is needed to uncover the best design parameters for the GVRD. The transferable emissions limits program incorporating a dual coupon/fee system that we are recommending regulators in the GVRD should consider has not been implemented in other regions in a manner that is optimal (e.g., due to concerns over property rights and issues of public acceptability the constraints placed on the trading programs have often tended to limit trading opportunities). Further work on the correct design of the program and the manner in which it will be integrated into the AQMP and other provincial/federal regulations will be beneficial. Along these same lines, the full scale inclusion of mobile sources, while certain to yield large benefits, also requires more work on the design of the rules and regulations governing this program. Additionally, the data that the GVRD has gathered in the past should be analyzed in detail to uncover any potentially surprising individual behaviours. Finally an integrated study with the goals of *Transport 2021* may be helpful, especially if previous studies have estimated driver responses to emissions taxes.

It is important to highlight that much of the analysis in this report that bears on the relative merits of alternative management measures can be particularly sensitive to our Case 1 assumption concerning the role that would be assigned to economic instruments under the AQMP. Our Case 2 assumption concerning the implementation of instruments is likely a more realistic reflection of how instruments would be applied in the LFV, and once regulators in the region have addressed the various issues presented in this report and the trade-offs they imply, the potential application of instruments under this Case 2 assumption can be assessed. Depending on the regulatory decisions that would define the Case 2 analysis, the assessment of the relative merits of alternative management measures may change (e.g., for some of the reasons presented in Section 4.0); however, the design features recommended in this report for a trading instrument would not change in any material way.

Further Work

In order to extend the analysis provided in this report and construct a fully designed instruments program and implementation plan a number of steps will need to be undertaken. A general approach to fully designing the instruments recommended in this study is outlined below. However, before executing this approach it is important to stress that, first and foremost, there are a host of issues (noted throughout this report) that the regulatory bodies in the LFV must settle. Unresolved, these issues stand in the way of fully designing a program that utilizes economic instruments and incentives, particularly the market based variety we have suggested.

The general approach we recommend would begin with a clear statement of the goals for the regulation. These goals can be expressed in terms of environmental objectives, abatement costs, revenue generation, and/or other socioeconomic issues. With respect to environmental objectives, it must be clearly outlined whether the regulation is to address aggregate emission reductions or specific contaminant emission reductions, peak or aggregate exposure, as well as elements of the distribution of pollution and environmental impacts (e.g., spatial, temporal, cross-contaminant). The second step would be to priorize different goals, recognizing that as with any policy, a particular economic instrument may satisfy one or some -- but not all -- objectives. Although the priorizing of goals need not imply a strict ranking of specific objectives, it should offer sufficient guidance to both assess relative strengths and weaknesses of different designs and then identify the important areas for design revisions or further research.

Given a clear definition of the goals of the regulation, and after reviewing the baseline conditions (with respect to emissions, sources, spatial issues, etc.), the next step would be to determine the role that economic instruments would be assigned vis-à-vis the goals and baseline conditions (e.g., is a Case 1, 2, or 3 implementation assumption appropriate). Having defined both the role for economic instruments and the goals and objectives these instruments are the achieve, the next step would be to formalize and expand the design of the instruments recommended in this study in light of the regulatory decisions regarding the various issues raised in this report. Essentially, formalizing the design would involve a refinement of this study and would enable a more accurate assessment of the merits of alternative control measures (since the roles of each measure would be clearly defined) and provide an improved basis for comparing and selecting among alternative measures and designs. As part of this study, the full feasibility of the mobile sector trading program introduced in this study should be examined, as well as its relationship to the Transport 2021 measures. The purpose of formalizing the design elements would be to provide a starting point for refinement; it is not necessarily intended to be the final instrument. Formalizing and expanding the basic design of the instruments recommended in this study would first address the parameters of the transfer program, followed by a basic design of the process for implementing or operating any instrument. Key design components in both these areas are indicated in the boxes on the following page.

The fourth step in the full design of an economic instrument would then be to identify potential problems and constraints to reaping the full cost-effectiveness and efficiency gains of economic instruments. It is at this stage that one would move fully from general principles into practice and recognize the indirect economic and behavioural implications of introducing an economic instrument. As pointed out by Carlson and Sholtz (1993), current theories underlying emissions trading assume perfect knowledge. However, significant sources of uncertainties related to emissions, regulations, prices, etc. do exist and will affect behaviour.

Instrument Parameters

- pollutant(s) to cover
- cross-pollutant trading
- types of sources (point, mobile, area, combinations, provisions for opting-in)
- geographic parameters (e.g., area of trading, zones and subzones)
- level of emissions cap (e.g., regional, sectoral, industrial)
- level of trading (e.g., inter vs. intra-facility trading)
- treatment of new sources
- number of coupons and units for trading
- expiration of coupons and/or banking options
- callable coupons and stagger periods

Process Design Components

- initial allocation of permits/coupons (e.g., auction vs. free allocation; by sector or individual source; determination of emissions baseline)
- transfer/trading rules
- tracking (e.g., design of information base; responsibility for maintenance; periodicity of reporting requirements)
- monitoring requirements
- non-compliance penalties (e.g., linkage with market value of coupons; fines vs. coupon purchases; opportunities to retire coupons; combination of revenue generation and emission control objectives)
- financing provisions for the administration of the instrument
- role of regulatory bodies and other government agencies (e.g., ICBC, AirCare)

Based on the identification of problems and constraints and development of some solutions to those challenges, the basic instrument design would be revised and alternatives developed. In some cases, the revisions may involve an adjustment of one component of the design, or a revision of the scope of the instrument. For example, the distinction between inter- and intra-facility trading may become important.

The next step in the design component of the study would also include development of alternative designs. Alternatives are especially important when the instruments are intended to satisfy multiple objectives. Developing alternatives also provides an opportunity for regulators to compare single-instrument approaches and combinations of control measures.

The development of alternative designs would also allow regulators to explore possibilities for instrument programs to address air quality issues not directly addressed in the AQMP. One particular example involves greenhouse gases. The Intergovernmental Panel on Climate Change (IPCC) is currently evaluating potential management alternatives to reduce greenhouse gases, and the possibility exists for a trading instrument to be employed. By developing and reviewing alternative designs, the GVRD will be well placed to respond to the recommendations of the IPCC. In addition, methods may be found by which an instruments program could be more closely linked to ambient air quality monitoring data that, in turn, could directly influence program operations.

The general approach described above to further design an instruments program for the LFV does not have to be implemented as a package. Rather, we recommend the GVRD look at, and act on, this approach incrementally. To begin, we would recommend that regulators in the GVRD begin a detailed review of the issues raised in this report, and the trade-offs they imply. This review will allow for a clearer vision of whether trading instruments are acceptable and what they should be designed to achieve.

It should be noted that, in reviewing alternative instrument programs, it is not necessary to determine the exact cost savings from an instruments program such as transferable emissions limits in order to design such a system. However, if such a study is desired, this will require the collection of data pertaining to the cost effectiveness and potential emission reductions that could result from applying any of the suite of potential control measures available (not just those identified in the GVRD's AQMP), or reasonably expected to be available in the future, for controlling emissions ***at each*** source in the LFV. In addition, the economics of monitoring will have to be understood. Furthermore, a trading model for sources in the LFV will have to be constructed (or time on existing models will need to be purchased). Finally, depending on the results of the cost analysis, alternative designs and further refinements may be necessary.

To conduct the studies necessary to complete the design approach outlined above is not a minor undertaking. Undertaking the cost analysis alone would likely involve resource commitments of upwards of $200,000 to $300,000. The complete study could well cost upwards of $500,000.

Finally, as has occurred in other jurisdictions, once regulators in the GVRD have a clear image of the type of instruments program they desire and the role it will play within the context of the LFV, the AQMP, and other environmental regulations, the decision to go forward with the program may be conditional on the result of a modelling exercise or a pilot program. In essence, modelling exercises generally revolve around the calculation of potential cost savings, and our remarks in this regard have been noted above.

We would not necessarily recommend for or against a modelling study—that is a regulator's choice and an issue of regulatory comfort. However, with respect to pilot programs, we would recommend against them if for no other reason than they do not work with trading programs. Trading programs function because the coupons have the characteristics of an asset—they are of value to firms. In a pilot project, there is no certainty at the outset that the project will continue and, therefore, no certainty as to whether the coupons have any value. Thus, firms are unlikely to invest money in control measures that provide emission limits coupons that potentially have no value. In fact, a pilot program was proposed for NO_x trading in Illinois and was rejected due to unwillingness of firms to participate.

Endnotes

1. Concentrations of CO rarely, if ever, exceed the Maximum Acceptable Objective (the Level B standard has not been exceeded since 1985); however, in recent years it has exceeded the Maximum Desirable Objective (the Level A standard) 5% of the time in downtown Vancouver during rush hour periods. Concentrations of NO_x also rarely exceed the Maximum Acceptable Objective (the Level B standard). In certain parts of the northwestern and southwestern GVRD, exceedences of the Level A standard have occurred in some years; however, average concentrations over the LFV have remained below the Level A standard. Concentrations of SO_x have been about constant over the period from 1982 to 1992 and are well below the Maximum Desirable Level (the Level A standard). Finally, overall, geometric mean TSP concentrations have remained below the annual Level A concentration. (Source: GVRD (1993b)).

2. ARA/Bovar-Concord (1994).

3. The focus on NO_x is partially as a result of the fact that only marginal reductions are achieved under the AQMP, and partially a result of the fact that NO_x is suspected to be the driver behind ozone formation. However, as noted in endnote 12 above, economic instrument designs will also be considered for VOCs in Section 6.0.

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POTENTIAL ECONOMIC INSTRUMENT APPROACHES TO AIR QUALITY MANAGEMENT IN THE GVRD: VOLUME 2

APPENDIX A: **Market And Non-market Based Economic Instruments and Incentives for Controlling Emissions**

APPENDIX B: **Economic Instrument Design Alternatives for the GVRD**

APPENDIX C: **Potential Difficulties with Seasonal Ozone Controls**

APPENDIX D: **Example of Trading Rules from RECLAIM**

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February, 1995

APPENDIX A

MARKET AND NON-MARKET BASED ECONOMIC INSTRUMENTS AND INCENTIVES FOR CONTROLLING EMISSIONS

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Appendix A

Market and Non-Market Based Economic Instruments and Incentives For Controlling Emissions

1.0 Introduction

The potential approaches to controlling emissions fall into two general categories: command-and-control, and economic instruments. With respect to economic instruments, however, it is important to differentiate between *non-market based economic incentives*, and *market based economic instruments*. This distinction is vital to understanding the usefulness of each. Non-market based economic incentives merely incorporate some monetary (economic) terms into the regulated entities' decisions regarding some, but not all of its polluting activities. By contrast, properly constructed market based economic instruments incorporate monetary decisions for all polluting activities pertaining to the regulated pollutants; thus, these instruments provide for a more efficient allocation of resources for meeting a particular regulatory goal.

The Greater Vancouver Regional District's (GVRD) Air Quality Management Plan (AQMP) includes numerous goals, and the policies aimed at meeting these goals in the most cost-effective manner are likely to include elements of market based economic instruments, non-market based economic incentives, and command-and-control measures. For example, a primary AQMP goal is a reduction in the emissions of several pollutants including sulphur oxides (SO_x), nitrogen oxides (NO_x), particulates (PM), carbon monoxide (CO), and volatile organic compounds (VOCs). These pollutants have distinct characteristics that may make the components of an optimal regulatory policy differ across pollutants and sources in the Lower Fraser Valley (LFV).

Another primary goal of the AQMP is to reduce the growth in mobile source emissions by discouraging the use of private automobiles as the primary mode of transportation in the LFV, and encouraging the use of alternate transportation modes, including public transit. A similar goal of increasing bicycle commuters is also stated. Both these goals are largely aimed at altering individuals' behaviours rather than industrial choices which may necessitate different incentives and control measures. While profit should be the goal of the industrial sources, such a clearly defined goal is difficult to establish for individuals. Therefore, some policies that work well for industrial sources may not work well if applied at the individual level without corporate coordination.

The primary purpose of this Appendix is to extend the discussion of both the non-market and market based economic instruments, presented in Section 3.0 in the main body of the report, and provide a more detailed listing and explanation of the attributes of many of the specific economic instruments discussed in Section 3.0, that *could* be implemented in the GVRD and the Eastern Lower Fraser Valley (ELFV). In addition, this Appendix attempts to suggest which policy tools might be more effective in achieving the goals of the AQMP in various situations. Consequently, the way that non-market based economic incentives interact with the AQMP goals is also discussed, and the distinction between the way that these incentives operate as opposed to market based instruments is highlighted.

2.0 Non-Market Based Economic Incentives

Non-market based economic instruments or incentives have been included in regulatory policies for many years. To name a few, they include items such as:

- penalties for emitting more than permitted pollutant levels;
- lump-sum tolls on roads and bridges;
- registration fees for vehicles (where the fees are not linked to the vehicles' total emissions);
- stationary source permit fees;
- carpool subsidies; and
- subsidies for public transport usage.

While incentives such as these are clearly capable of altering behaviour, the modifications in behaviour that they engender only occur at "trigger levels" where the incentive takes effect. Specifically, these non-market incentives typically represent an *all-or-nothing* choice to firms and consumers, as opposed to a continuing incentive to reduce pollution. The fees and charges associated with these incentives represent a one time increase in the relative cost of polluting activities, and firms and consumers will either make a one time substitution to cheaper, less polluting activities, or they will simply pay the charge and carry on as before. At some level of pollution or level of charge (i.e., the trigger level) the incentive may effect a substitution; otherwise, the incentive has little direct effect on behaviour. The following subsections describes the likely effect of a variety of non-market based incentives on pollutant emissions, and discusses the positive and negative aspects of each of the incentives.

2.1 Vehicle Registration Fees

Automobiles in British Columbia are charged a fee for registration, and this fee can be used as an incentive to reduce emissions. In general, if the fee is high enough, their is an economic incentive to reduce the number of vehicles registered. Those people who find the registration fee greater than the value of their usage of the vehicle will not register. Assuming that the lack of registration is equivalent to removing the car from usage for that registration period, then the fee will have some impact on the emissions coming from automobiles. However, for those who elect to register, the fee will not decrease their driving frequency and, therefore, their emissions.

Several variations on the vehicle registration fee have consequences for the specific effects on emissions, total vehicle miles travelled, and total vehicle registrations. These variations include:

(1) flat fees not differentiated by age or any other proxy for emissions per mile; (2) a fee that is a function of the emissions per vehicle mile (the dirtier the vehicle the higher the fee); and (3) a fee based on total emissions from the vehicle over the year. Each variation is discussed below.

- ***Flat, non-differentiated fees:*** The flat, non-differentiated fee has the least amount of potential for reducing emissions. Clearly, there is substitution to alternate travel "methods" from the vehicles retired from registration. Unfortunately, in addition to substituting to public transit, bicycles, motorcycles or mopeds, car pools, or "telecommuting", this substitution includes options for existing vehicles -- regardless of those vehicles' emissions per mile. For example, a family with several cars may elect not to keep extra vehicles and to use the remaining vehicles more frequently. As a consequence, vehicle registration will go down but congestion and emissions do not decrease in this case. In fact, because other vehicles have been removed from service, and those that remain registered are used more intensively (i.e., instead of registering and driving three different cars, the driver only uses the one car), it may be the case that the average annual emissions from the registered vehicles actually increase. The possibility for a rather perverse incentive exists with this type of fee. The more that any vehicle is driven, the more likely that it will not be retired from service (since the owner has not registered the alternative vehicles), a fact that holds for the dirtiest vehicles as well as the cleanest. This is true assuming that frequent usage is a proxy for the benefit the driver receives from having a vehicle.

- ***Differentiated fees:*** Differentiating a fee based upon the "cleanliness" of the vehicle, or its average emissions per mile travelled, creates different incentives. While there is still an incentive to substitute usage to alternate travel methods, there is an additional incentive to replace dirtier vehicles with cleaner ones. This increases the probability that emissions per vehicle will fall, although the extent of the realized decline is uncertain. What we do know at least is that emissions per vehicle should be below that resulting from the flat fee. On the other hand, the substitution to cleaner vehicles also means that the decline in congestion is likely to be less under the differentiated fee than under the flat fee.

- ***Vehicle emission fees:*** A fee based on total emissions actually falls into the category of *market based economic incentives or instruments*; hence, later sections will elaborate on the particulars of this variation. In short, however, there is *no* incentive to merely increase usage of existing, dirty vehicles as long as the fee is the same for each unit of emissions. There is an incentive to substitute to cleaner vehicles, and even more so if the vehicle is driven often. This latter attribute is not found in either of the non-market based fees described previously, and begins to relay the important distinction between market based instruments and non-market based incentives. Finally, the effect on congestion depends upon how much of the substitution is to cleaner automobiles rather than to other travel mode alternatives.

2.2 Bridge and Road Tolls

Bridge and road tolls have been recommended as part of a package of *transportation demand management measures* recommended under the *Transport 2021* program, and incorporated in the GVRD-AQMP.[1] These are flat, per vehicle fees levied per bridge crossing or per segment of highway travelled. These fees increase the cost of travel per vehicle, but are unrelated to a vehicle's emissions per mile. Accordingly, they create an incentive to decrease the usage of the toll bridge or road, perhaps by the use of public transit, increasing vehicle ridership, or by adopting other transportation or work alternatives.[2] Therefore, they provide incentives to reduce private vehicle use, decrease congestion, and reduce total mobile source emissions. However, the degree to which these reductions will occur is dependent on the level of the toll. For those who elect to pay the toll, their driving frequency will not decline and, therefore, their emissions will not decline. In addition, since tolls apply to the specific usage of a vehicle (e.g., crossing a bridge), they do not create incentives for substitution to newer, cleaner vehicles or fuels.

2.3 Subsidies for Public Transportation and Carpooling

These subsidies serve to lower the cost of a particular travel mode relative to alternative, non-subsidized travel choices and, therefore, provide an incentive for users to substitute the subsidized travel modes for non-subsidized methods. In cases where the subsidy occurs on a per unit basis (miles travelled, for example), subsidies are analogous to negative taxes, and are actually a form of market based incentive. On the other hand, as they are often applied (e.g., per carpool regardless of miles travelled) subsidies act more like the uniform vehicle registration fees discussed previously.

In evaluating the usefulness of subsidies (under either case) as an emissions management measure, several considerations are worthy of note. First, since subsidies are intended to alter people's transportation choices, they are only effective if they provide an incentive large enough to make the desired (subsidized) behaviour more appealing than the alternative, non-subsidized choices. The subsidy required to achieve this change may be quite high; therefore, a funding source becomes an important consideration. Combining the subsidy with a tax on the non-subsidized behaviour, which acts as the funding source, can be a particularly effective tool. It not only funds the subsidy but lowers the amount of the subsidy necessary to make it effective since the tax raises the cost of the non-subsidized behaviour.

Second, subsidies are often viewed as short-term price changes, and therefore using them as the tool to modify behaviour that requires individuals to invest or make long-term plans is likely to fail. Even if the long-term payback is positive, the perceived risk in such systems is likely to be too great to induce people to make long-term behavioral modifications based upon future payoffs.

2.4 User Fees

With respect to emissions management, user fees are levied to cover regulatory costs, as opposed to providing an explicit emissions reduction incentive. For example, under Bylaw 725, the GVRD levies a permit fee on stationary point sources of air pollution.[3] The purpose of this fee is to recover the costs of GVRD's emissions monitoring system; the development, implementation and enforcement of the AQMP; and inventory development. The GVRD's permit fee (and it is argued, the provincial permit fee as well),[4] is not designed to providing an incentive for achieving reductions in the emissions of priority pollutants.[5] However, these fees can be interpreted as a partial incentive in so far as, while they are meant to generate revenues for regulatory activities, the hope is that they will achieve whatever emission reductions are possible.

2.5 Penalties

Penalties are an integral part of most regulatory programs, be they command-and-control or economic instrument based. They impose a cost on those who do not follow the rules; thus, they provide an incentive to encourage compliance. Penalties are a good example of economic incentives that are not market based. They only are applied if a regulated entity does not follow the rules, and at all other times they do not affect emissions. As long as the expected penalty is greater than the expected financial gain from violating the rules, then the penalty is sufficiently severe. In fact, increasing the penalty above this amount will not result in any decrease in emissions. This latter fact illustrates a very important trait of non-market based incentives. Penalties in and of themselves serve only as an enforcement mechanism. They neither give incentives for technological development, or other long-term changes in behaviour, nor do they provide incentives for shorter-term reductions beyond those mandated by the other policies already in place.

3.0 Market Based Economic Instruments

As opposed to the non-market variants described in Section 2.0, market based economic incentives or instruments establish trade-offs for *each* unit of pollution that a facility may release. The standard incentives in this category include emission fees, emission reduction subsidies, growth credits (emission reduction credits), internal "bubbles" with and without banking, fully tradable emission coupons/transferable emissions limits, and dual emission fee/tradable coupons systems. This section is divided into several subsections. The first provides a brief description of each of these market based instruments, primarily to provide differentiation from the non market incentive alternatives described in Section 2.0. Later sections provide detailed explanations of each of the market based instruments and describe the potential variations in design for each of these general categories. It is important to note that these variations can produce drastically different outcomes in air quality, costs of emissions abatement, and flexibility for economic growth.

3.1 Emission Fees

3.1.1 Overview

Emission fees are a common feature of many, existing regulatory policies. In fact, the integration of an emissions fee into current regulations was one of the key elements called for in the revision of the provincial *Waste Management Permit Fee Regulation*.[6] In essence, emission fees are taxes levied on each unit of a particular pollutant that a facility releases, and they generally vary with the toxicity of the pollutant. Emissions fees are not supposed to be designed as revenue generators (especially of the revenues required to fund an air quality management program).[7] Rather, they are levied to provide a continuing incentive for emitters to abate. Specifically, since each unit of pollution emitted by a facility costs the facility the per unit charge, it has an incentive to always reduce its pollution, and avoid the out-of-pocket charge, as long as the cost of abating one more unit of a pollutant is less than the financial "penalty" or fee for releasing that same unit. The emissions fee, in essence, defines the long-run, per unit cost of abatement that all emitters face. However, as long as a facility pollutes they will have a continuing incentive to find more efficient methods to reduce its emissions, substituting cleaner production methods whenever economically feasible.

Emission fees will result in decreased pollutant levels as long as the fees are greater than the costs of abatement for some amount of emissions currently being released. In addition, since they are levied on a per unit of pollutant basis, they can be applied to most sources of emissions (e.g., point and mobile sources). For example, in terms of mobile sources, if registration fees are levied as a flat tax for every unit of emissions released (or estimated to be released based upon emission tests of the vehicle), then the registration fee is essentially an emissions tax. Such a tax provides an incentive to substitute from dirty vehicles to cleaner vehicles. In fact, a proposal to apply per unit fees to the emissions of light duty vehicles in the GVRD is currently being reviewed.[8]

One of the disadvantages of emission fees, however, is that they do not establish a guaranteed upper limit on the amount of emissions facilities may find economically beneficial to release. For example, if a new, highly profitable industry develops whose abatement costs are above the emission fee, then that facility will produce new emissions and elect to pay the fee. The only way to prevent such increases in emissions is to increase the fee each time such new developments occur.

3.1.2 Setting emission fees

Before emissions fees are set, the regulator must decide the goal of the policy. If the goal is to reduce pollution to socially optimal levels, then the fee must be set equal to the marginal (i.e., incremental per unit) damage from an additional unit of pollution at that level of pollution where the benefit from releasing that unit of pollution is equal to the social damage (cost) of releasing that unit of pollution. Setting a flat fee equal to this monetary amount will result in facilities reducing their pollution emissions to the socially optimal level. Setting fees greater than that amount would result in further reductions in emissions, but at costs to society higher than the benefits. Setting fees lower than that amount would result in fewer resources devoted to abatement activities, but the higher emissions would cause damages greater than the costs of abatement.

Note that zero pollution, or near zero pollution, while a seemingly desirable goal in and of itself, is not likely to be the optimal use of resources for society.[9] This potentially troubling statement is perhaps best explained with a more familiar example. Consider the damage and loss of life caused by automobile accidents. It should be very apparent that this damage is quite significant. However, despite this damage, we do not reduce it to zero, simply because the cost of doing so would be prohibitively high. We could just eliminate automobiles altogether, but we choose not to because the benefits we feel we receive from the use of automobiles are higher than our perception of the costs. Instead, we reduce the risks through seat belts, child car seats, better bumpers, continual head lights, and airbags, to the point where the (marginal) costs of accident prevention actions equals the (marginal) benefits of the prevention measures.

In the case of setting emissions at socially optimal levels, determining the correct fee is extremely problematic. First, the damage caused by the pollution must be determined, not just for one level of emissions, but for many levels of emissions -- enough levels to develop a marginal damage function. Second, facilities' abatement costs for each unit of (or many levels of) abatement must be known by the regulator. While facilities may know this information, they have no incentive to truthfully reveal this to the regulator. In fact, they have every incentive to significantly over-state their abatement costs.

Given that the determination of socially optimal emission levels and fees is so problematic, regulators often are wise to set their goals on merely achieving some level of emissions reductions or setting a ceiling on allowable emissions, perhaps based on studies that suggest effects of various emission levels in the aggregate.[10] However, even if a pre-defined level of emissions is the goal, the regulator still must know the abatement cost curves for each regulated emissions source. If no new technology or industries develop, setting the fee where the cost of abating one unit less than the desired emissions level is less than the fee, but abating one unit more is greater than the fee, will result in emissions equal to the desired level. On the other hand, if any new profitable industries develop then emissions levels will rise since these sources will release emissions to the point where the fee is greater than the cost of abatement for the next unit of emissions. In order to prevent such emission increases, the regulator would have to raise the fee, increasing the costs for all sources.

Those who advocate emissions fees argue that problems such as those described above are over-blown. The regulator does not need all of these intricate pieces of information because the fee itself can be used as a searching device; i.e., the fee can be raised or lowered until the right level is found (at least theoretically). However, there are a couple of problems with this. First, the purpose of an emissions fees is to motivate emitters to *change* their activities and behaviours. However, from a practical point-of-view, it is unlikely that individuals and firms will react to continual iterations of the fee as the regulator searches for the setting the brings the marginal cost of pollution damage to society into equality with the marginal costs of abatement; nor are the regulators likely to be indulged in experiments with continually differing fee settings.[11]

Secondly, even if emitters respond to the fee or tax, it is not transparently obvious how, or at what point in time, the regulator will know if the fee is too high, too low or just right.

3.1.3 Improving Cost-Effectiveness

Using emission fees rather than the standard command-and-control or non-market based incentive methods of regulation allows for the potential to increase cost-effectiveness and efficiency.[12] This means that the costs of meeting a particular air quality goal are lower, or that a greater reduction in emissions released by sources can be achieved with the same amount of resources.

The aggregate savings from such a system vary depending on the variety of sources within a facility and across facilities. However, aggregate savings will occur because emissions fees allow a given facility to equate abatement costs at the margin across all the sources within the facility. In addition, these same marginal abatement costs are equated across all facilities (that emit the same pollutant), as all facilities face the same emission fee level (for a given pollutant). The distribution of savings will also vary depending on the variety of facilities. Those facilities whose abatement costs at the margin greatly exceed the fee are subject to the largest cost savings, while those with low abatement costs may actually spend more than under command-and-control rollback regulations.

When new industry develops in the regulated area, emissions will increase if the emissions fee is kept the same. In order to keep the emissions constant, the fee must increase. Of course, the regulator is almost certain not to know the abatement costs for the new facilities' sources. Therefore, setting the fee may require trial and error, perhaps throughout the program. However, as noted earlier, such uncertainty does not allow facilities to make long-term efficient abatement decisions. In addition, such trial and error experiments may not be politically tolerable.

3.1.4 Revenues

How and to whom the tax revenues raised by such a policy are to be distributed is another matter for regulators. In theory, those whom the pollution has damaged should receive the compensation. In reality, such a provision is practically impossible. Instead, the revenues can be spent on reducing other public health risks, which spreads the monetary reimbursement evenly, but may not spread the actual benefits evenly. On the other hand, the tax revenue can be used to reduce the taxes collected from citizens, and the distribution of these monetary benefits depends upon the progressive nature of the tax schedule. More often than not, however, imposition of such taxes results in increased tax revenue without reductions in other taxes.

3.1.5 Political Issues for Implementation

Many political issues are likely to arise when policy makers attempt to implement emissions fees as part of a regulatory program. First, existing sources may see such a program as merely an additional tax on industry. The introduction of such a system of fees almost always involves large increases in costs to polluters relative to *existing* regulatory programs. Therefore, regional or provincial programs can create potential incentives for businesses to move out of the regulated area, or not to consider expanding into that area.

The increase in cost to existing sources presents obvious conflicts to implementing a program. To ease such conflicts, fees are usually differentiated between new and existing sources, with any new sources paying much higher fees than existing sources. This fee scale provides a benefit to existing sources called a *barrier to entry*. Such a barrier places new firms at a competitive disadvantage if they enter the regulated area. The result is less competitive pressure on existing sources, and, unfortunately, fewer of the benefits of competition for the residents of the regulated area.

3.2 Emission Reduction Subsidies

Emission reduction subsidies are similar to taxes, but they are per unit monetary awards paid *to* facilities for each additional unit of pollution they abate, rather than paid *by* facilities who release emissions. They are set in a manner virtually identical to emission fees (or taxes on emissions) described above. While emitters may favour such subsidies -- most people, when given the chance, would prefer to spend other people's money -- they are not a truly viable alternative in many industrial cases. In applying these subsidies, and using public monies, the regulator is, in effect, requiring the public to "buy" the right to cleaner air from the emitter -- not something many politicians would want to suggest to their constituents.

A second problem with subsides is that they are open to abuse. In an effort to receive more lenient regulatory treatment, firms have an incentive to overstate their abatement costs and exaggerate their difficulties. This creates problems when one looks at subsidies since it is difficult to determine whether they are *actually* required by a particular firm in order for it to adopt the pollution abatement measures the regulator requires. As noted above, most people, if given the chance, would rather spend someone else money rather than their own. Hence, given the opportunity to receive a subsidy, many polluters would actively try to build a case for why they should receive a subsidy, irrespective of whether they actually need it. The end result is that monies are often wasted by providing unnecessary subsidies.

The third problem with the use of subsidies as an emissions management measure is they violate the "polluter pays principle" (which is the basis on which the GVRD-AQMP, and most environmental regulations in the province and elsewhere are built). The transgression of this principle can take on even greater significance when the possibility for abuse is considered.

3.3 Offset or Growth Credits

Offsets are based on the notion of an *emissions reduction credit* (which is also the basic element of emission trading programs). These credits are created when a firm controls to a greater degree than the law requires either by changing process inputs (e.g., fuel switching), process changes, installation of pollution control technologies, curtailing production, or by shutting down an emission source.[13]

With the concept of emission reduction credits as a base, offset or growth credit programs serve to keep new or expanding sources from increasing the total amount of emissions released in a given airshed by requiring the purchase of emission reduction credits from existing sources in the same area. Specifically, rather than allowing new facilities that set-up in a regulated airshed to only implement the specified control technologies and other regulatory measures to reduce emissions (as defined by command-and-control or another regulatory option) and then release pollutants, offset programs require that, in addition to meeting the existing regulations, new facilities must *offset* their remaining, additional emissions by obtaining growth or offset credits from existing facilities in the airshed. By its nature, this instrument must be used in conjunction with other regulatory options such as limited emission rates, emissions fees, or some form of emissions trading program.

Offset or growth credits come in two forms: internal and externally transferable credits. Internal credits are issued when a source finds a means to reduce emissions below that required by the regulatory policy at that time. These credits can later be used by the facility to offset any expansion they might have. External credits are generated in much the same way, but they can be transferred to new sources to offset the emissions that the new source produces.

While originally designed as a means for allowing economic growth while insuring no further degradation of air quality, in the U.S., such offset programs are used as a method to slowly decrease emissions. In cases where the program is designed to create a decrease in emissions, the new facilities must obtain growth credits at a ratio greater than one-to-one; i.e., for every unit of pollution they will emit, the new facilities must acquire more than a unit of growth credits. Recalling that these growth credits are created only by a facility decreasing its emissions more than required, the total effect is a decrease in aggregate emissions.

3.4 Facility Bubbles

3.4.1 Overview

Facility bubbles are a policy tool that establishes a cap on total emissions and allows facilities to meet the reductions prescribed by the regulator in the most "efficient" and cost-effective manner, where efficiency is defined only for allocations of resources *within the facility*. In simple terms, the regulator establishes a legal limit (a *cap*) on total allowable emissions for each facility, but the facility is allowed to design its own portfolio of abatement technologies to stay within that emissions cap. In other words, a facility may trade emissions between its individual sources (e.g., a boiler, a furnace). It can increase abatement at sources where the costs per unit of emissions reduction are low to compensate for less abatement at the most expensive sources of the same pollutant; thus, saving the facility's resources for other uses.

3.4.2 Improving Cost-Effectiveness

Perhaps the most significant cost savings in the Regional Clean Air Incentives Market (RECLAIM) program will be attributed to the establishment of these facility bubbles. In the past, such bubbles have lead to highly visible savings.

In their purest form, facility bubbles remove the control guidelines from specific equipment and allow each facility to determine the most cost-effective way to meet these same emission levels or reductions. For example, a facility may be prohibited from using a particular solvent, both because it releases VOCs, and because a cleaner, alternative technology is available; however, little consideration may be given to the alternative's costs. Under a bubble program, the facility could resume use of the solvent if corresponding reductions were made elsewhere in the facility. The ability to make trade-offs such as these provides facilities with the financial incentive to research and develop new emissions abatement technologies. In other words, the monetary gain from developing additional, cost-effective emission reductions funds technological innovation. When combined with inter-facility trading, new technologies will have even more value since they allow the creation of credits that can be sold to facilities with higher abatement costs, allowing all abatement costs to be equated at the margin -- a requirement for economic efficiency. The savings generated by internal trading are greatest, of course, if individual facilities have multiple sources with differing marginal abatement costs. If facilities' emissions originate primarily from a single source, such as a furnace, they have little potential to make internal trades; thereby, reducing the potential for cost savings from the bubble portion of an emission trading policy.

While overall cost-effectiveness is not achieved across facilities (an attribute of flat, per-unit emission fees) the establishment of a bubble program has several positive attributes. First, it establishes a cap on aggregate emissions; that cap being the sum of the individual facility caps. Second, as long as it is implemented with an offset program for new sources, that aggregate cap remains binding while allowing flexibility for new source growth. In addition, the entry of new sources does not impose an increased fee on all other existing sources, which would be required if the regulator wishes to maintain a continuous emissions cap. With emissions fees, the increased fee is passed on to all sources. Finally, in order to achieve a particular level of emissions, the regulator does not need to know the facilities' abatement costs. Instead some share of the desired, total emissions level is allocated to each facility that, in turn, determines the most appropriate compliance strategy.

3.4.3 Monitoring

Facility bubble programs require a different type of monitoring than do command-and-control programs where individual equipment is specified rather than overall emissions limits. The level of monitoring depends upon the program; however, several options exist. The regulator can require the facility to establish, through testing, emission rates for its equipment, and then keep track of the usage of the equipment to come up with total emissions. In addition, inspectors can visit facilities to check that the equipment is operating according to the facility's permit specifications, even thought those specifications were developed by the facility as it developed its plan to meet the emissions limit.

3.5 Tradable Emission Coupons/Transferable Emissions Limits

3.5.1 Overview

Tradeable (or transferable) emission coupon/transferable emissions limits programs offer regulators the ability to design a policy that institutes an emissions cap, achieves greater certainty of environmental effectiveness, and potentially achieves least cost emissions control, without the regulator having to know the abatement cost curves of each facility, and without having to continuously manipulate an emissions fee. Theoretical proposals for tradeable emission coupon/transferable emissions limits programs (i.e., environmental markets) are aimed at providing pollution sources with the flexibility and economic incentive to make additional, cost-effective reductions, and to allow all facilities to meet emission reduction standards at a substantially reduced cost relative to traditional command-and-control.

The basic goal of these programs is to achieve a given level of emissions (or emission reductions), over some period of time, in a manner that encourages polluters with relatively low abatement costs to incur the associated costs and reduce emissions more than would be required under command-and-control. The incentive offered to the low cost emitter is that they will be economically rewarded for taking such actions since they can sell the additional emission reductions (which represent the emissions they otherwise would have been permitted to emit), in the form of emission reduction coupons, to facilities with higher abatement costs. The net result is that the burden of control is distributed across emitters according to their ability to abate cost-effectively -- those that can abate cheaply will bear the greatest share of the control but not the cost burden. As a consequence, while the "polluters still pay" (the low cost emitter has to incur abatement costs while the high cost emitter has to purchase the privilege to emit in the form of coupons), the overall cost of control is reduced.

The benefits of tradeable/transferable coupon programs do not only accrue to the regulated in the form of greater latitude to define abatement strategies and reduced abatement costs. From a regulatory point-of-view, tradeable coupon programs offer a number of potential advantages. First, these programs allow regulators to effectively cap total emissions from all sources in the program. A portion of the capped, allowable emissions is then allocated to each facility in the form of coupons. However, since emitters must hold coupons equal to (or greater then) their actual emissions, the regulator is able to gain more direct control over the quantity of pollutants emitted in the airshed. In addition, if emission reductions are desired, the cap can be designed to decline by a predetermined rate over a specific time period. As the cap declines, aggregate emissions will fall to target levels. Furthermore, with such a cap, a portion of the regulatory burden is eased. With facility allocations declining over time, predictions of future technology are no longer necessary. The control burden is allocated by the market, and the task of finding the "best available control technology" is shifted to the regulated.

A Hypothetical Example

In order to provide a clearer understanding of the benefits of a tradeable coupon/transferable emissions limits system, consider the following hypothetical example. Suppose that a facility (say, Facility 1) initially released 100 tonnes of emissions into the air, but was required to make a mandatory reduction of 10% (i.e., 10 tonnes). Assume a second plant (Facility 2) in the same airshed emits 50 tonnes per year and must meet the same standard; i.e., it must reduce pollution emissions by 10%, or five tonnes. Assume further that both plants can use the same abatement technology; however, the per unit abatement cost to Facility 1 is $10/tonne, while the cost to Facility 2 is $15/tonne (i.e., Facility 2 faces a higher marginal cost of abatement).

Facility	**Existing Emissions**	**Required Reductions**	**Command-and-Control Reduction**	**Command-and-Control Cost**	**Tradeable Coupons Reduction**	**Tradeable Coupons Cost**
Facility 1:	100	10	10	$100	15	$150
Facility 2:	50	5	5	$75	0	--
Total:	150	15	15	$175	15	$150

Under a command-and-control approach, each facility would make the required 10% reductions in emissions at a total cost of $175. Under an emissions trading program, Facility 1 would install the equipment and reduce its emissions by 15 tonnes, at a total cost of $150, while Facility 2 would not install the equipment and reduce its emissions. Facility 1 would, in effect, "over-control" its emissions and the "excess" five tonne reduction would be sold to Facility 2 as emissions coupons at a price less than $15 dollars per tonne but more than $10 per tonne (the actual price would be determined in the market). Total emissions from the two facilities would fall from 150 tonnes to 135 tonnes under either the command-and-control approach or the emissions trading program. However, under the emission trading program, air quality goals would still be met; however, the overall cost of the reductions are less.

This simplistic example illustrates a basic concept of environmental economics: the structure of the regulatory program can provide incentives for low-cost abaters to make reductions in addition to those required by law -- reductions that in a competitive industry environment would prove economically harmful. With tradable coupons/emissions limits, such facilities have the opportunity to at least recover the costs of the additional reductions; that is, they can sell the additional reductions to sources which face higher costs for that same reduction.

An Empirical Example

The U.S. Environmental Protection Agency (EPA) in the United States is the executive branch of the government mandated to enforce and implement the *Clean Air Act* and its subsequent amendments. As part of its mandate, the EPA commissioned a study that evaluated the economic consequences of four scenarios: implementing two different air quality standards for NO_2, and achieving each of these goals using two policy options -- a least cost (fully tradable emissions coupons) option and the standard "equal-percentage reduction" approach. The latter is merely a requirement that all sources reduce emissions by a fixed percentage; i.e., a command-and-control strategy.

The study used available cost data for 797 sources in the Chicago metropolitan area. In addition, a state-of-the-art model relating ambient air quality at 100 receptors to the emissions from the included sources was developed and tested. This model was able to then predict air quality under the various policy options.

The study showed that the costs of achieving the 500 micrograms per cubic meter standard for NO_2, were $US1 million. The incremental cost of achieving the much tighter standard of 250 micrograms per cubic meter depended upon which policy option was chosen. Using the standard percentage rollback approach, the cost jumped to $US254 million! A staggering increase. In order to meet the tighter standard, the sources would have to reduce their emissions by about 90%.

The alternative policy was a tradable emissions policy designed to achieve the least cost solution. Under such a policy, the greatest reductions were made at the sources that faced the lowest costs in making the reductions. In economics terms, the cost of making the reductions was equated at the margin across all sources. Under this scenario, the cost of meeting the tighter standard was $US24 million, less than one-tenth the cost of the command-and-control type policy.

As the public interest desires tighter air quality standards, studies such as this have shed some light on the potential cost savings from designing policies with economic, market based incentives. The ability to achieve much tighter standards with less economic displacement makes these incentive programs tools that both environmentalists and industry agree is worthy of consideration. Incidentally, Chicago is currently planning to implement an emissions trading program to reduce ozone (smog).

3.5.2 *Controlling Peaks Versus Aggregates*

There are several important distinctions among pollution types that should be considered when designing a tradable emissions coupon/transferable emissions limits system that will:

- keep compliance costs as low as possible; and
- control emissions and ambient pollution levels so they do not exceed desired "short-term" peak levels (such as those included in the Air Quality Index system used by the GVRD).

Controlling the aggregate emission level through the trading/transfer of emissions coupons, that are issued for some amount of emissions per coupon period (e.g., kilograms or tonnes per year), will reduce aggregate emission levels as long as the number of kilograms or tonnes allowed by the total coupons allocated does not exceed current emissions baseline levels. In the case of ozone (O_3) these reductions do not necessarily mean that the ambient levels of ozone will decrease; however, in the case of NO_x, SO_x, and particulates this relationship is more clear-cut and tractable.

Nevertheless, controlling aggregates says very little about controls on peaks. Because of the non-linear health effects (i.e., the effects become much worse as ambient levels increase) associated with peaks of pollutants such as SO_x, NO_x and O_3, additional standards are often eventually set with hourly, eight-hour, or daily limits for these pollutants. In Canada, the National Ambient Air Quality Objectives (NAAQOs) for these pollutants are set with hourly and daily (24 hour) limits for O_3, and hourly, daily and annual limits for NO_x and SO_x. In the U.S., the Federal standards for these pollutants are set with hourly limits for O_3, and daily eight-hour limits for NO_x and SO_x. Therefore, by not controlling peaks, declines in aggregate levels may occur; however, the maximum benefits from these declines may not be realized, and one potentially runs the risk of more frequent peaks. As a consequence, regulators may need to consider systems that are designed to either control peaks or limit the potential for gross peaking of emissions.

One solution actually results in two markets, each necessary for business operation, but one that controls aggregates (the "typical" trading coupon) while the other controls peaks. The idea seems simple, one instrument in kilograms or tonnes per year (or quarter, etc.) and the other as a continuous emissions flow constraint. The latter must be used at each point in time while there is some latitude in the future use of the former.

For simplicity, assume that each firm has a *pollution profile*. This profile tracks pollution emission levels at each point in time within the time frame of the aggregate limit. For the aggregate kilogram per year market, a facility must hold the coupons to pollute for the integral from t=0 to t=end of quarter (i.e., the area under the curve in Figure 1 below) if it wishes to follow its profile. For the peak market, the firm must hold the license to pollute its peak at time equals t. In Figure 1, the firm would have to hold the peak of 8 at time=a, 11 at time=b, and 15 at time=c. Of course, holding a peak instrument that is good for more than these peak emissions is certainly permissible.

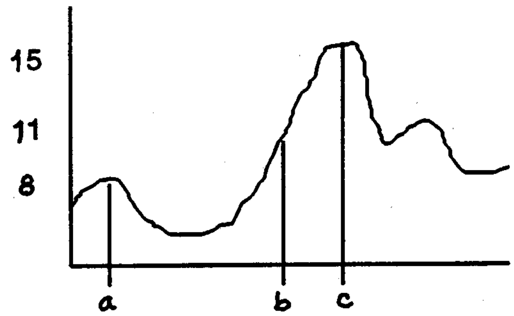

Figure 1

3.5.3 *Assigning Baselines: The First Step in Coupon Allocation*

Before a tradeable emissions coupon program can begin, the emissions cap has to be defined and, more importantly the share of that cap which is to be allocated to the various sources needs to be determined. The first step in this process is to establish a baseline for emissions. How should a regulator assign a baseline in the market? The compromise often reached with industry in that initially no firm in existence should have a baseline allocation that forces it to participate (buy) in the market before reductions in emissions are required. The particular firm may choose to do so, but such immediate action to purchase market instruments should not be initially necessary.

In defining a baseline in a pure system of tradable emission coupons (without peak instruments), there are several important issues to consider. The first is the availability of past emissions data from facilities or good proxies for past emissions. Without this data, using past activity may be obviously problematic. On the other hand, using some future data is equally problematic since facilities can alter their allocation by increasing their reported emissions over the time period used to determine the emissions baseline. This process provides incentives for facilities to manipulate emissions in order to secure a larger allocation (share) of coupons. Sources may either report more emissions than they release or they may actually increase emissions during the periods when baseline and allocation share are determined. If that action proves to be the case, real emission reductions in the early years of the program will be less than planned. The "over-allocation" of coupons, based on unrealistic emission rates or productivity measures, will delay meaningful reductions.

In any case, as experience with the initial allocation process for SO_2 allowances and RECLAIM Trading Credits (RTCs) has demonstrated, the allocation of coupons will not be a straight forward procedure. In fact, this is likely to be the single most contentious issue faced in the implementation of a trading program, and the one most prone to manipulation, especially in the absence of very good data on historic emission rates and patterns.

In the development of the U.S. Acid Rain and RECLAIM programs, specific individual sources (called facilities in the language of these programs) were given special dispensation -- "extra allowances and coupons"-- after arguing that historic, reported emissions were somehow not representative of their "normal" operating patterns. Indeed, in public hearings on RECLAIM, it was perceived that most of the regulated community's negative comments on the later drafts of the proposal were based on the insufficiency of their initial allocations. In many cases, adjustments to allocations mooted the opposition. The GVRD, if it considers implementing a emissions trading program, can expect to come under the same kinds of pressure.

3.5.4 Alternative Allocation Procedures

Setting aside the problem of baseline definition, there are three standard procedures for achieving an initial allocation of coupons. The first is called the fixed percentage approach. This approach assigns each facility a percentage of the total baseline. In order to use this approach the regulator must have extremely accurate data on past emissions. Adjustments to any one facility's total will affect the size of the entire allocation and, therefore, require adjustments to all facilities' allocations.

For that reason, a simple, fixed percentage approach to apportioning coupons may not be prudent. If it becomes desirable during the course of program development to adjust upward one source's allocation, either the universe of coupons expands, with all sources increasing their allocation (to keep the shares constant), or all sources' shares are adjusted downward (to keep the emission universe at the same, initial size).

The second approach allows facilities to somehow represent their past emissions through a regulatory procedure. Each individual case can be scrutinized and adjusted. The final, total allocation is simply the sum of all facilities' allocations. If this total is too high, perhaps a uniform reduction from all facilities' allocations can be applied across the board. In this way, adjustments to any individual allocation does not mean a requisite adjustment of all facilities' allocations.

The third allocation method is quite different. The regulator determines an acceptable total (aggregate) allocation. After this is completed, an auction is held and facilities must bid for the coupons or for each share of the total. This potentially creates difficulties because facilities are suddenly required to come up with large quantities of funding to continue their operations. They may elect to close or there may be scale effects that make it more difficult for some small businesses to continue operating.

To remedy this problem, a fourth allocation method, known as a *revenue neutral initial auction*, can be used. In simple terms, each facility is given an initial allocation of coupons *on paper,* and then it is required to bid in the auction. If the facility buys exactly the number of coupons it was given, then it owes nothing. If the facility buys more coupons, it must pay for the extra coupons at the market clearing auction price. On the other hand, if it buys fewer coupons than its initial allocation, it receives compensation (from other purchasing facilities) at the market clearing auction price. Notice, however, the regulator still must come up with the initial paper allocation of coupons.

What is different about any auctioning of coupons is that facilities have the incentive to accurately reveal their desire for the coupons. On the other hand, an after market in coupons, if it is active, achieves the same result if preceded by a free initial allocation.

3.5.5 Exclusion of Sources

As part of market design and definition, the question will arise as to whether or not all emitters within an airshed will be required to hold coupons. The major concern is whether emitters, who individually represent very small contributions to emissions in an airshed, ought to be forced to purchase coupons. On the one hand, many would argue that some emitters should be excluded if the cost of monitoring, administrating and enforcing the coupon program for these (predominantly small) emitters outweigh the benefits derived from their inclusion in the program.

On the other hand, relatively small sources often face higher marginal abatement costs than do larger sources. Therefore, there are sound economic reasons to allow all sources, regardless of size, the *opportunity* to participate in an emissions trading program. While their participation need not be mandatory, prohibiting voluntary compliance with program requirements may result in significant, lost opportunities to reduce emissions at less cost.

While there certainly can be political risks in trying to force small businesses onto the same playing field with large emitters, there is no cost in allowing them to make that choice for themselves. Indeed, significant benefits can be realized: remember, a basic objective in using economic instruments as a regulatory tool is to achieve emission reductions at less cost than under command-and-control policies. In a similar vein, greater emission reductions are economically feasible when reductions are made efficiently. Therefore, closing the door on potential cost-effective emission reductions is unwarranted and unnecessary.

3.5.6 Opt-In Provisions

Opt-in provisions are simply rules to allow sources who are not required to be in the program the opportunity to join. It is perhaps best to have some defined window of opportunity to avoid strategic behaviour and protect the stability of the coupon market(s). If the number of coupons is rather limited, it may be possible to cause price fluctuations when new coupons are issued. On the other hand, if the coupons are issued based on emissions (no greater than perhaps the U.S. RACT or some other rate-based standard) and required reductions levels, then there is not an effective increase in available coupons. Only if the opted-in source reduces emissions further is there an increase in coupons.

3.5.7 Seasonal Trading Issues

Background

The proposed AQMP includes goals to control ozone (smog) formation which, in turn, necessitates controlling emissions of NO_x and/or VOCs that serve as ozone precursors. Due to the geographic characteristics of the Lower Fraser Valley Airshed, the meteorological conditions appear to be conducive to ozone formation during a limited season, perhaps from May through September. Therefore, the GVRD may want to propose the control of precursor emissions during a season within that time period. On the surface, this simple control method seems fine, but it creates the potential for undesirable, and unplanned, effects.

Potential Difficulties: Emissions Shifting

Perhaps the most obvious change that occurs when a seasonal system of regulations is implemented is a change in incentives for control. If possible, a source may find it favourable to move its emissions out of the ozone season and into the off-season; however, several issues may arise.

- With this shifting behaviour, regulators may find that the previous definition of the ozone season is no longer valid. Looking at past data, when emissions were higher, may indicate whether meteorology is as limiting a factor on ozone formation when precursor emission concentrations rise.

- This shifting behaviour likely will alter the peak NO_x emissions as well. It may be the case that the new peaks that result, when emissions are moved out of the ozone season and into the off-season, create the potential for greater NO_x peaks.

- Finally, the changing of peak NO_x emission levels also can alter the NO_x/VOC ratio during certain times. That ratio in part determines the effectiveness of NO_x reductions on ozone formation. Multi-day episodes, which are more common than random single-day episodes, may change in frequency and severity. Airshed modelling is necessary to predict this effect.

Along the same lines, even if sources do not shift emissions from the ozone season to the off-season, the additional costs imposed on sources for emitting ozone season NO_x likely will effect a sources' choice to install continuous versus temporal controls. This potential exists in two basic forms. First, rather than installing equipment to create year-round reductions, if it is more cost effective, facilities may simply use temporal controls to achieve the seasonal reductions. Examples of such controls include fuel switching and temporary mobile source reductions. Also, if operating costs exist, then facilities may simply turn off their add-on abatement equipment during the off-season.

Second, the movement to emission limits (total emissions during the ozone season) from emission factors (emissions per unit of production) establishes production reduction as a potential, new control option. As emission rates are essentially averaged only over the season, reduced production over that season may be accompanied by increased production in the off-season. In addition, production reductions may come disproportionately from the "edges" of the ozone season, without similar reductions during the parts of the season most prone to ozone episodes. Again, whether or not this type of emission shifting poses a problem depends on both the intent of the program, and on the results of air quality modelling.

New Source Entry

A feature common to attainment or maintenance policies in the U.S. that are governed by command-and-control is the practice of requiring new sources to acquire offsets. A new source must essentially purchase emission reductions from other facilities at some ratio greater than one. With only seasonal trading they would have to acquire two types of offsets: off season offsets at a ratio greater than one, and seasonal offsets at a ratio presumably of 1:1. This requirement does increase existing sources' incentives to make continuous reductions beyond those required by the regulator, but if existing sources find that emissions shifting is most cost-effective, then ratios such as 1.3:1 during the off-season may not be sufficient to avoid peaking difficulties (for example, with NO_x) during the off-season. Increasing this ratio also puts the burden of reduction on new sources, perhaps discouraging new business entry.

Alternatives to the Simple Trading Season

The above proposal institutes an emissions cap only during the ozone season, with trading during that time and, perhaps, banking of emissions from one ozone season to the next. However, there are alternatives.

It is clear that, for ozone (smog) reductions, constraints on seasonal emissions need to be tighter than off-season emissions, but for the reasons highlighted in the previous sections, this strategy may create unintended effects as emissions shift into the off-season. An alternative approach involves setting essentially two "caps" on emissions: one for the ozone season and one for the off-season. The ozone season cap would, of course, be tighter to reflect to seriousness of the meteorological conditions during the season; while the off-season cap serves as a safety mechanism to prevent excessive emissions shifting. The additional cap reduces the chance of greater peaks during the off-season for ozone, and anytime for NO_x. Finally, the imposition of two caps allows the offset ratio to be set at one-to-one for all new sources covered under the trading program.

There are several methods to institute this cap and design instruments to work within this proposed framework. We expect that more research is needed to address this specific solution, but we outline several alternatives below.

- *Alternative 1*: Two caps with two types of coupons whose usage dates overlap. The ozone season coupons overlap, for a relatively short period (one month perhaps), at each end of the ozone season with off-season coupons. In addition, the off-season coupons can be banked, perhaps for one year, for usage on the next off-season. No banking of seasonal coupons would be permitted, but the overlap gives them additional value, sources additional flexibility, and reduces the chance of price volatility as their expiration date approaches.

- *Alternative 2*: Two caps with two types of coupons only designated for use within their specific season. These coupons could be banked for a limited period, but could only be used in the same type of season as their issue.

- *Alternative 3*: Two caps, three coupon types -- seasonal coupons, off-season coupons, and year-round coupons. Their usage dates are analogous with their names, but which coupon types might be banked remains an open issue.

3.5.8 Monitoring Requirements

For any emissions management program to be effective -- be it based on command-and-control or economic instruments -- effective monitoring of source behaviour is required. There are several monitoring techniques that are applicable to various pollutants and sources -- continuous, semi-continuous and functional monitoring. Once emission trading programs are implemented, they result in the creation of an asset, and the type of monitoring available to the regulator is extremely important. The strategic behaviour of firms in each of these monitoring categories diverges unless enforcement is perfect, which is equivalent to continuous monitoring.

Continuous monitoring systems accurately record the emission from a source at frequent time intervals per day. Semi-continuous monitoring encompasses a large set of monitoring techniques that allow several sources within a facility to "share" the monitor, using it at different times during the day. Functional monitoring accepts current engineering-based beliefs about machinery emissions, these beliefs are functions that relate production processes and aggregate emissions for each piece of machinery.

Under command-and-control type regulatory systems, the benefits of deviating from the permit may include productivity increases and reductions in compliance costs. When coupons are tradable, the benefits of not reducing pollution as much as claimed, in addition to the above two benefits, include the *gaining of an asset*. A facility now has an additional financial gain resulting from the sale, or lack of purchase, of coupons it rightfully needed to remain in compliance. For functionally monitored firms, without changes in enforcement, one should expect increased numbers of polluters to attempt to hide emissions in order to generate coupons. In other words, the benefits of strategic behaviour increase. Even if violations of the system are met with draconian penalties for the firm, one might argue that those firms in financial trouble will have little downside risk.[14]

Along these same lines, a regulator could never allow *ex-post* selling of coupons claimed to be unused if the firm was merely functionally monitored. If the firm was allowed to say, "Oh, by the way, we did not operate as much yesterday as planned so we are selling those leftover coupons or using them later", the resulting strategic behaviour could be severe. For example, a firm could wait to see if it was inspected, if not then it could lie about the decrease and sell the generated asset without the threat of discovery. On the other hand, continuously monitored firms could be allowed the freedom to sell coupons *ex-post* since all emissions are verifiable after the fact. In addition, allowing continuous monitors firms more flexibility may give other firms incentive to install continuous monitoring (or semi-continuous) equipment.

The important point to remember is that monitoring requirements in part determine whether a fully tradable emissions coupon/transferable emissions limits system is feasible. Also, even if the monitoring is available, unless the cost savings are great, the additional costs of monitoring may not justify such programs. Finally, the regulator needs to decide whether these monitoring systems are desirable, especially on large sources, for other reasons such as baseline determination and prediction.

3.5.9 Trading Zones

Certain areas within an airshed may be more sensitive to emissions; hence, trading zones are sometimes established to assure that emissions do no increase in the protected area as a result of trading. In and of themselves, designated trading zones are not a difficulty, but the restrictions on transfers of coupons can pose difficulties. If the restriction is on transfers of coupons among and between zones, market liquidity can be harmed and price disparities created. Many issues affect market liquidity. If liquidity is an issue, then to the largest extent possible, the tradeable coupons should be standardized. In financial and commodities markets, standardized instruments are "fungible"; i.e., one share of a particular corporation's stock is as good as another (but not the same as a preferred share), one pork belly from the same delivery point is equal to one from a second approved source. When traded instruments are standardized, buyers and sellers are left only to negotiate the price.

With trading zones and zone restrictions, the trading instruments are no longer equivalent. For example, assume that two zones -- A and B -- are established, and zone A is the protected zone. In such a case, one alternative is to allow coupons issued in zone A to be used by sources in either zone, but coupons issued in zone B must only be used by the zone B sources. There are now two instruments, rather than one, and two markets as well.

Since zone A coupons can be used in either zone, they will likely command a price higher than the zone B coupons.[15] The zone B coupons are less flexible, have less usefulness and, therefore, they are less valuable. Furthermore, market liquidity suffers because trading activity has been fragmented by the creation of the two separate markets. Liquidity in the market is enhanced by bringing all buyers and sellers to a central marketplace: zone restrictions artificially divide buyers and sellers.

Blanket provisions, such as the above, are the least desirable and efficient alternative. If it is necessary to establish a protected zone, several less intrusive options exist. The first is the creation of a *net transfer* restriction. As long as a trade does not result in an increase in emissions in the protected zone (in other words there are no net transfer into the protected zone), then the coupons can be used by sources in either zone. This alternative requires keeping track of settlement times of trades in case several trades occur at close to the same time, and the net transfer trigger is reached, thus disallowing some coupons from use in the protected zone. A second alternative is the establishment of a *trading ratio*, but this does not ensure emissions will not increase in the protected zone, only that they are traded across the zones in a certain proportion. A final alternative (and the one enacted under RECLAIM) is to allow free trading as long as the coupons are not used to allow a source to increase its emissions above preset, initial levels (a form of point of impingement requirement). This alternative sets a lower cap on the protected zone's emissions; however, unlike the "no net increase" alternative, that cap is not likely to be reached unless all sources choose to buy coupons to increase emissions to the preset, initial program levels.

3.5.10 Market Issues

This discussion of market operations and transactions begins to identify some of the problems and challenges that regulators face in developing emissions trading/transferable emissions limits programs (and environmental markets generally). Indeed, many of the issues presented are critical to the success of a program. While this section introduces many of the issues, it can only begin to reflect on how significantly the entire program can be affected if the sensitivities of these issues are not properly taken into account.

Trading Unit Denomination

An important issue in program design and operation is to provide market participants with standardized trading units (i.e., coupons). In addition, the specific terms defining the instruments have to be carefully considered. Before considering this question further, we would argue that the market ought to be open to any interested party -- brokers, speculators, investors, environmental groups, labour unions, etc. There is no economic justification for limiting participation and, in fact, the more participants the better: liquidity is enhanced. Also, consideration needs to be given to the appropriate coupon denominations (e.g., coupons denominated in tonnes, kilograms, etc.). Smaller denominations mean that relatively small sources will have an easier time participating, as will non-source participants (such as environmental groups). A smaller trading unit means a lower price for the smallest unit of trade. While a seemingly negligible environmental effect, smaller denominations encourage public participation. If individuals wish to reduce emissions and purchase a coupon, they are more able to do so.[16]

Let us now consider the affect of the choice of denomination on maximizing the gains from trade. Suppose that a 100 kilogram trading unit is designed. If abatement technologies and techniques yield standard, 100 kilogram incremental reductions, then this figure is appropriate. However, if reductions of, say, 25, 50, or 75 kilograms are feasible, then it is unlikely sources will incur the costs of making those reductions because the resulting emission reductions are not marketable. This represents a lost opportunity for reductions and efficiency. Along the same lines, changes in production most likely does not result in these 100 kilogram increments of emissions. Therefore, small sources who have small reductions in production are not likely to be able to market the excess coupons. Again, this provision imposes more hardship on small sources.

In addition, if monitoring capabilities are limited at 100 kilogram increments, then allowing trades in smaller increments than 100 kilograms would induce incentives for facilities to alter their emissions to take advantage of the information gap. At this point it is impossible to determine the appropriate denomination. It is, however, an issue requiring careful thought and analysis.

Area-Wide Market Assurance: Auctions in General

Many proposals begin with some concern about market assurance. The Illinois EPA NO_x trading system proposal,[17] for example, initially called for a two percent set-aside of total emissions for "area-wide market assurance" and "to ensure liquidity". Half of these coupons would be saved for a "crisis assurance pool", and the other, set aside coupons, would be auctioned off periodically, providing some price discovery signals to the larger market. In practice, experience has demonstrated that this approach has little if any merit or benefit.

First, it is commendable to be concerned about liquidity in the design of new markets. However, liquidity refers to the ability to easily find a trading partner and to quickly execute a trade at a price close to that of previous trades. Liquidity implies that transaction costs are low and market prices are reasonably stable. There is no evidence to suggest that a set-aside auction has a positive affect on market liquidity or performance.

Second, prices from an auction market may not be reliable. If the auction is held early in the year, it will not necessarily reflect the demand for coupons later. From experiments run in the Caltech Laboratory, it was observed that the potential for price volatility is greatest as the coupon or compliance period nears expiration. Facilities' emission information becomes more accurate as the period progresses, as does their ability to predict their need for additional coupons (or ability to sell their excess coupons).

When would the auction be held? This seems to be a simple question, yet the implications of its answer are telling of its complexity. For example, in the case of ozone, if the auction is held during the ozone season then, depending on its design, it may only provide price discovery for coupons *at that time*. Unfortunately, this timing is too early to provide relief from market squeezes. On the other hand, if the auction is held during the reconciliation period (i.e., the period when emitters must reconcile their actual emissions for the year with their coupon holding), then it is too late to provide any meaningful price discovery. It is precisely the correct knowledge of coupon prices that allows sources to decide whether to install additional abatement equipment, remain where they are, or purchase coupons. An auction during this time, however, can help aid liquidity.

In addition to liquidity and price discovery issues, the hoarding of coupons is often cited as one of the reasons for including an auction. Contrary to popular belief, hoarding is not prevented by the auction. In fact, if there are a fixed number of coupons offered in the auction it is theoretically easier to hoard, but it is economically nonsensical to do so. In the actual market, there can be no absolute monopolist unless all initial holders of coupons sell all of their coupons to a single entity, even those coupons they know they will need. When coupon prices rise as a condition in the market lead to a demand for coupons, sources are more willing to sell their coupons at that higher price; hence, quantity supplied increases.

Not only does economic theory support an absence of need for the auction, experimental evidence concurs. In experiments run at the Caltech Laboratory, an open market following the initial allocation of coupons outperformed the revenue-neutral auction, even when the initial allocation of coupons was highly skewed toward a few individuals. Not only were prices more stable, but the market's efficiency was higher. This efficiency measures the gains from trade realized by market (or auction) participants.

Finally, the crisis assurance pool is not likely to be beneficial. If facilities exceed their coupon holdings, then the penalty should be applied. Sources must self-insure and bear their own costs of excessive risk-taking. Along these same lines of ambiguity, the crisis pool could be difficult to manage because of the abundance of administrative procedures and legal issues (and costs) that are bound to arise in refining the usage rules. A crisis assurance pool would lead to "leakages" from the market. They are not in the spirit of a market based system, and can lead to perverse incentives. It is usually better to allow sources to be responsible for creating appropriate compliance strategies and, if they fail, to penalize them accordingly. In cases where true system crises occur, *callable coupons* are a more efficient solution (see Section 3.5.13 for a discussion of these coupons).

The Auction: Other Issues

In addition to the difficulties discussed in the previous section, the provision of a set-aside auction raises a plethora of issues. As noted, it matters when the auction is held. Since the need for coupons is most likely to be acute at the end of the season, an early auction will be of little benefit. The choice of auction market is also important. Several market mechanisms or architecture's are known rather generically as "auction markets," yet they are all very different, and all yield different outcomes, both in terms of allocation and price discovery.

If a regulator elects to insert this type of provision, it must understand that in doing so it is opening the door to a wide range of additional operational requirements and problems that will have to be addressed before the program is implemented. How will the auction be designed? Who will run it? When will it be held? If there is a need or desire for this feature, the regulator might consider leaving these questions to potential market sponsors to sort through and resolve.

Serialization and Market Sponsorship

Coupons should have serial numbers that include an issuance (or expiration) date and trading zone designations if needed. It is also important to track the ownership of each instrument.

Many question arise when governmental agencies begin to create markets. Among the questions that the GVRD would need to address is whether it "envisions" establishing and administering the "market exchange system". How far into the issues of market operations is the GVRD willing to wade? It may want to consider further whether this role is one that is necessary and appropriate for it to assume. For example, there are financial risks involved with directly sponsoring a market that the GVRD would need to assume. Issues such as these would have to be addressed.

Reconciliation Periods

Facilities often obtain information about past emission only after a time lag, and they may not realize that they may have too few or too many coupons, in relation to actual emissions, until after the trading instruments' expiration date. RECLAIM and the Acid Rain Program in the U.S. both provide limited reconciliation periods so that facilities can act on the most precise information available and adjust their holdings to match current, updated emissions estimates. Both programs also allow excess instruments to be traded and used after their expiration dates, provided any emission covered by the instruments occurred while they were valid.

Reconciliation with an open market can be helpful, but the length of the period is important. If the period is too short, it is useless. It must be long enough to allow facilities to collect and assess more precise emissions information.

The additional flexibility of a properly defined reconciliation period reduces facilities' uncertainty; yet, there is no possibility of increasing emissions beyond levels that otherwise would be allowable in a given period. While it reduces the incentives to hold extra coupons or report higher-than-actual emissions to avoid non-compliance penalties, reconciliation does not address the problems of emission peaks and price volatility discussed earlier. In fact, with a textbook annual coupon, price volatility will simply shift from the final days of the compliance year to the reconciliation period, because there is no substitute instrument available.

3.5.11 Property Rights

Among the issues involved with developing tradeable emission coupon/transferable emissions limits programs (and environmental markets generally), is the legal definition of what is traded. The South Coast Air Quality Management District (SCAQMD) examined the applicability of the definition of commodities and securities to RECLAIM trading coupons. In the event that the GVRD implements a trading program, then it might be worth consulting the SCAQMD's legal staff on their findings. There are substantial questions involved in the treatment (or lack thereof) of environmental coupons as property rights, and these would have to be reflected in an emissions trading plan.

In the theoretical literature studying the benefits of tradable emissions coupon systems, the traded coupon is treated as a property right. Ownership of the coupon is guaranteed with certainty, as is its use by the owner. Coupons for future year emissions can be purchased in advance, thus allowing regulated facilities to make long-term plans for the installation of abatement equipment and the choice of production process.

In practice, however, uncertainty over the "property right" and its use is prevalent. Both the EPA and the SCAQMD have dictated that the emissions credits/coupons in each of their credit systems are not property rights, but rather *limited licenses*. Similarly, in a study by the West Coast Environmental Law Research Foundation (1993), it was suggested that coupons in a Canadian market be given the status of a *revocable license*. The rights that these licenses convey can be altered by the regulator at their initiative, without requiring the implementation of Federal "takings" laws, and they avoid the problems of compensation.

Whether a "full property right" is assumed by coupons holders, or a "revocable licence" status is given to coupons, quite clearly, from the perspective of environmental regulators and environmental advocacy groups, it is essential that certain safety nets exist in the program to allow regulators to "correct" the program if the air quality goals are not achieved as planned. In addition, future health and science findings may result in additional changes in standards and air quality objectives.

Several options exist for the regulator to reduce the number of coupons in a trading system in the event that some sort of market "correction" is required. To maintain the property right, however, the regulator would essentially have to buy back the coupons. Recent experience shows that this is most likely not an acceptable option for the public regulator. The revenue required to purchase these coupons often would involve taxing the regulated facilities or taxing the public. Another option is some form of coupon devaluation or proportional confiscation. For example, the Emission Reduction Credit (ERC) market that has provided offsets to facilities under the jurisdiction of the SCAQMD, experienced an extreme reduction in the value of coupons in the mid-1980s. Even though these coupons had already been created or purchased by facilities, each coupon was essentially devalued eighty percent, leaving its owners with an economic loss.[18]

The possibility that coupons may be devalued or confiscated in the future adds uncertainty to the user's ability to receive full future value from the coupon; thus, lowering the market value of the coupons. Facilities may be reluctant to purchase coupons in advance, electing to delay purchases until the coupons are needed and, therefore, retarding the development of forward markets. On the other hand, if facilities expect an across-the-board devaluation, then they may purchase more coupons than they expect to need, in anticipation of the reduction. Of course, they discount the value of each of these coupons, so that they offer no more for all of the coupons than they would for fewer certain coupons. Therefore, the value of the uncertain coupons falls, and retards potential increases in efficiency.

Because of the significant economic losses apparent from devaluation, regulators may find that reductions in coupons are difficult to achieve. The organization of the coupon holders versus those who would benefit from the reduction in the number of coupons, may mean that the most socially beneficial option does not occur. If the instrument could be designed to reduce the economic costs of removing coupons, regulators might not find program revision as difficult.

3.5.12 Mid-Course Corrections

Environmental markets carry a great deal more uncertainty than is generally appreciated or discussed in the theoretical or policy literature. The sources of uncertainty are many; they are real; and they will significantly affect market participation and behaviour. Certainly, regulators need to retain the right and the authority to adjust policies in light of program experience and new developments in understanding the effects of pollution. Regulators should, on the other hand, also be sensitive to the affects their future actions (regardless of probability), can carry.

A common initial reaction is to return to prescriptive regulatory controls, which is perhaps the most draconian backstop provision once a market has been established. Facilities would not only face the costs of installing command-and-control technologies, but also the confiscation of the economic value of any coupons purchased or otherwise acquired. There are other alternatives to abandoning market incentives.

By way of example, a mid-course correction may require a permanent reduction in the total coupons from some point of time onward. One way to do this is a simple proportional reduction in current allocations. There are at least two inefficiencies associated with this approach. In the short-run, immediately after the reduction, firms may have to adapt to the increased requirements for abatement by reducing output. There is no reason to believe that a proportional reduction in output is the efficient solution. In fact, one would expect those firms who could react expeditiously and cheaply to sell coupons to those who cannot in a manner that would rescue much of the instantaneous efficiencies. The following examples indicate the potential economic consequences of simple proportional reduction in current allocations.

	Firm 1	Firm 2	Firm 3	Firm 4
Emission Level	60	40	100	200
Credits	60	40	100	200
Reduction Required (=30)	9	6	15	30
Credits	51	34	85	170
Emissions	51	34	85	170
Per Unit Cost of Reduction	180	300	450	930

In this example, presumably Firm 1 would be willing to sell coupons to firm 2 and 3 for a price above 20. That would act to blunt the cost of the cost of the reduction somewhat. The final result after a trade might look like the following:

Emission Level	60	40	100	200
Coupons	60	40	100	200
Reduction Required (=30 tonnes)	9	6	15	30
Coupons Remaining	51	34	85	170
Traded Coupons	-15	6	9	0
Traded $	25x15=375	25x-6=(300)	25x-9=(225)	
Emissions	36	40	94	170
Per Unit Cost of Reduction	20	50	30	
Reduction Cost	20x24=480	50x0=0	30x6=180	
Net Cost to Firm	105	150	405	660

Note that all firms are better off after the trade.

If the firms can correctly anticipate the mid-course correction (either the timing or the extent) they will be able to install an efficient constellation of capital equipment that would give them the appropriate flexibility to react to the mandatory reductions. If they cannot correctly anticipate the mid-course correction -- as is likely -- then there will be a permanent efficiency loss due to the incorrect expectations. There is a market solution for this problem which is a mixture of futures and insurance contracts: a callable coupon.

3.5.13 *Callable Coupons: Fitting Change into a Market*

As explained above, once a market is up and running it may be necessary to alter the aggregate number of coupons in order to respond to increased needs to reduce emissions. One way of doing this is with callable coupons. The idea is similar to callable financial instruments. For pollution regulation a viable system would create two distinct types of coupons: callable coupons and regular coupons. Callable coupons would be taken from their owners first in the event of an objective program revision. Regular coupons (or not so easily callable coupons) would also be issued. The market price of callable coupons would be less than the price of the regular coupons because of the latter's higher certainty value. Callable coupons would be held by flexible facilities (i.e., those that can easily and cheaply respond to changes in allowable emission levels), and by facilities that would be willing to bear the risk of mid-course reductions. In the early years, the two types of coupons might almost be interchangeable if there is little chance there will be any adjustments; in later years there may be significant differences in the risks, and, therefore, in the prices.

An example of the economic consequences of a mid-course correction (i.e., a required 15% reduction in emissions) with callable coupons is provided below. In this example, the regulator determined at the program's outset that mid-course corrective coupon reductions will not exceed 20% of the total allocation. When it is determined, at some date after the program has been in place, that a correction is indeed necessary, the regulator determines that a 15% reduction is needed. The firms in the example have traded with each other prior to knowing that a correction of 15% was going to surely occur. Presumably, these firms exchanged the future year callable and non-callable coupons sometime near the beginning of the program. The reductions shown, therefore, occurred well after the trades.

As indicated by holding a sizeable portion of callable coupons, Firm 1 has borne most of the costs of the reduction. This is exactly what is required for efficiency. Relative to Example 2 above, where an after market was relied on, Firm 1 is also rewarded for bearing this risk. If events requiring reductions do not occur, Firm 1 gets to keep the $400 received through trading. The advantage is that firms can do these reallocations far in advance of the reduction events and, therefore, coordinate any equipment purchases for abatement with their coupon transactions. This will allow more efficient abatement planning and lower cost pollution avoidance.

The real issue is whether or not callable coupons should be provided by the regulator. The advantages and disadvantages are relatively straightforward, and are summarized below:

	Firm 1	Firm 2	Firm 3	Total
Emission Level	60	40	100	200
Regular Coupons	48	32	80	160
Callable Coupons	12	8	20	40
Traded Regular Coupons	-20	8	12	0
Traded Callable Coupons	20	-8	-12	0
Traded $	20x20=400	20x-8=(160)	20x-12=(240)	0
Reduction Required (=30 tonnes)	(3/4)x32=24	(3/4)x0=0	(3/4)x8=6	30
Regular Coupons	28	40	92	160
Callable Coupons	8	0	2	10
Emissions Level	36	40	94	170
Per Unit Cost of Reduction	20	50	30	-
Cost of Reduction	480	0	180	660
Net Cost of Reduction	80	160	420	660

Advantages:

- Allows firms to plan ahead and to assess the costs and benefits of preparing (or not) for possible mid-course corrections.
- Allows firms to insure against mid-course contractions (by buying the more expensive regular coupons).

- Reduces the necessity for the firm to predict what the market price might be after a correction.

- Allows the regulator to first reduce the coupons of those that have "voluntarily" expressed their willingness to bear that risk.

- Rewards the firms who are willing to bear the risk of reduction (by allowing them to purchase coupons at a lower price).

Disadvantages:

- Dilutes the coupon market by creating two markets where there was originally only one

- Provides a convenient target for regulators who want a mid-course correction (i.e., it is politically easier to reduce coupons after the fact, if there are a number of callable coupons already identified).

3.5.14 Banking of Coupons

There are a host of reasons to consider banking of emissions coupons. *Banking* is a general term used to convey the ability to carry *forward* unused emissions coupons. In other words, banking permits movement of emissions forward in time. Extra reductions made today may be used in the future. Banking has many uses and can affect the market, air quality, and regulatory control over the program. In fact, depending upon how banking is instituted, an emissions trading program can achieve very different results.

If the goal of the program is to make quick reductions but allow for future growth, without requiring a definite, continual decrease in emissions, then *unlimited banking* is an option. Such unlimited banking is allowed in the U.S. Acid Rain program for SO_2 emissions. While banking provides incentives to make extra reductions early in the life of the program, this incentive arises because the facility values the banked coupons future use more than their use at present. Therefore, the facility is likely to use the coupons in the future, increasing its emissions above that level allowed without the banking provision. Since aggregate rather than peak emissions appear to govern the ability of acidic precipitation to decrease the buffering capacity of lakes, such an unlimited banking provision may not be detrimental to the environment. On the other hand, to the extent that snow melt, and the associated rapid dumping of large quantities of water into lakes and streams, is a function of yearly aggregate emissions rather than long-term emissions, such a banking scheme may not be optimal for an analogous pollutant.

Banking decreases some abatement costs in programs where allowable emissions decline over time. A facility that can reduce emissions early in the program will have a reserve of instruments available in later years, when coupons offered in the markets might be more scarce and expensive. Banking thus encourages sources to reduce emissions faster that they might otherwise, but it also allows facilities to carry forward potential, significant pollution to later years, effectively delaying the attainment of future reductions.[19]

Another banking option, *limited banking*, allows some movement of emissions but does provide for a ceiling on the amount of emissions that can be carried forward into any particular year. We have designed four general design alternatives to implement limited banking -- percentage forward limits, percentage use limits, coupon devaluation schedules, and coupon expiration dates. The attributes of each of these alternatives varies, so the goals of the program are important to establishing which of these is most appropriate. In addition, some of these variations can be combined to create other forms of banking, potentially incorporating the positive aspects of the combined designs.

- *Percentage forward limits:* Banking of only a fixed percentage of coupons is allowed for each year. This design feature reduces the number of coupons that could be banked and, therefore, also reduces the potential emission increase that could result from the use of banked coupons. In addition, this type of banking reduces the incentive to hold unused coupons rather than sell them to other facilities, reducing the potential for "hoarding" of capacity. By itself, however, this design still allows coupons to accumulate, therefore, if emissions increases are not desired, it may need to be combined with another banking design.

- *Percentage use limits:* This design prohibits facilities from using more than a fixed percentage of banked coupons to cover emissions. These coupons include coupons purchased from other facilities and subsequently banked; coupons banked by other facilities and then purchased by the facility for compliance; and internally banked coupons. This provides a more direct means of capping the potential future emissions increase that can result from banking in any single period. In other words, no matter how many coupons have been banked, no more than a certain number can be used in any period; thus, creating a secondary emissions cap. On the other hand, while this potentially reduces the profitability of banking coupons, it does not provide a limit to the number of coupons that can be banked. Therefore, this alternative may not discourage the banking of unused coupons as much as that prohibited by the percentage forward limit.

- *Coupon devaluation schedule:* This design alternative reduces the substitutability of banked coupons with current period coupons. Each period that a coupon is banked its emissions value is reduced, either by a fixed percentage of the original amount or by some other percentage reduction schedule. For example, suppose that coupons are issued for each year, and that a current year coupon is valid to cover 100 emission units (kilograms perhaps). The first year that the coupon is banked it is worth only 80 emission units, the second year 60, and so on. In such a program, it is helpful to set up the program not to trade "coupons" *per se*, but rather emission units. The coupons serve as credits whose redemption value decreases if they are banked, and it decreases by a fixed schedule determined at the onset of the program. Like the above alternatives, this decreases the tendency for emission to increase in the future because of banked coupons. The effect on the actual number of coupons banked, however, remains unclear. On one hand, the number of coupons banked may actually increase because it more banked coupons will need to be redeemed for the same amount of emissions. On the other hand, the number of coupons banked may decrease because the value of the emissions the coupon covers today exceeds the value of the emissions the coupon covers in the future (devalued by the schedule) .

- ***Coupon expiration dates:*** This is actually a slight variation on the above design. Rather than devalue coupons by some amount each year, the coupons are devalued 100% after a fixed number of years (i.e., they expire), but zero percent before that time. In other words, the devaluation schedule is zero percent each year until the expiration year, at which time it becomes 100%. This alternative should reduce the incentive to bank more coupons simply because more will be needed to cover the same emissions in the future (as is the case in the percentage devaluation schedule design). On the other hand, it increases the value of a coupon banked for use in the near future, since that coupon is not devalued.

Other Issues in Banking

While banking has its own positive features, it is not an effective alternative for addressing the problems of price volatility in the early years of the program. Banking allows extra, unused coupons to be carried forward for later use, but not carried back to cover emissions in an earlier period. Facilities cannot "borrow" future coupons for use in the current year. Banking does, however, reduce the potential for year-end emission peaks and price crashes when facilities hold excess coupons at year-end, but if facilities are short coupons, banking offers no relief.

One difference with banking is that it may provide incentives to speed the rate of technological development. The opportunity cost of a coupon this year is not the marginal cost of abatement this year, but rather the greater of that cost or that cost in later years. The relevant marginal cost, however, depends upon the supply of coupons (banked plus newly issued) for these future years.

Banking, however, also appears to present the same difficulties associated with the common definition of *hoarding*. That is, facilities hold onto their coupons rather than release them into the market. In fact, hoarding of coupons is observationally equivalent to the actions of facilities operating under a program with unlimited banking.

Facilities state that they want banking to provide an insurance that they will be able to secure coupons in future years if there is a need. One measure that should reduce uncertainty at least as much as banking is a forward or futures market. This market allows participants to ensure sale or delivery of future year coupons (either today or at a future date) for a predetermined market price, and is a standard operating feature of most traditional markets for commodities. Facilities who would bank to ensure coupons can effectively do so by buying coupons in these markets and selling coupons today to generate income. While the equilibrium prices in these markets are not the same, this system also provides a guarantee to regulators that the cap will not be exceeded in future years.

3.5.15 Overlapping Coupons

Banking, as described above, can reduce compliance costs in programs where emissions reductions increase through time. However, as also discussed above, it has the potential to delay reductions in the final years of the program, as banked coupons are pulled out of the bank for use.
Emission coupons have a tangible economic benefit. They are factors of production for regulated facilities, for the facility cannot operate without holding sufficient coupons to cover emissions. In the short run they have no substitute. An annual coupon that cannot be banked has a limited life; it cannot be used to cover emissions beyond its expiration date. Taken together, these factors represent economic incentives for facilities to capture the full value of the coupons before the expiration date. As the end of the year approaches, those facilities that hold excess coupons (facilities that are *long* in coupons) face a use-it-or-lose-it proposition. In order to recover some of the value of the coupon, the facility can increase production (and emissions), sell the coupons to another facility, or pursue some combination of the two. In programs that include it, banking is also an option, but it comes at an environmental cost in some cases.

In addition, if facilities find themselves short, banking cannot smooth out the market, especially in the initial stages of a program where few coupons have had an opportunity to be banked. For example, a sudden improvement in economic activity could leave facilities in need of additional coupons in the short run at year end. Turning to the market, they might find a shortage that drives prices up, perhaps to the levels of non-compliance penalties. This too will increase pressure on regulators to provide additional flexibility to program participants, possibly to the detriment of the environment.

The probability that the number of coupons held by long facilities equals the number of coupons held by short facilities is quite small; therefore, increasing the risk of both market price volatility and emissions volatility. Why emissions volatility? Given the nature of many businesses, they do not know the exact amount of their emissions at the beginning of the year. Therefore, facilities may pursue an insurance strategy to avoid the cost of year-end coupon shortages and penalties. Simply, they will hold more coupons than they expect to need. As the year progresses, the facilities have a better understanding of their annual emissions, and although they may sell some of their extra coupons, it is not likely that they will sell all of them. At year-end, with facilities pursuing this insurance strategy, it is likely that there will be excess coupons, and lost economic opportunity. On the other hand, if any facilities can increase production easily, then they would be wise to do so, using the cheaper coupons available in this circumstance. The result may be increases in emissions at year-end; thereby, also increasing emission spikes -- an undesirable consequence.

Both increased market price volatility and emissions spikes can be avoided using a type of design created for the RECLAIM program in Southern California. This design alteration costs virtually nothing to implement, and should not increase transactions costs to facilities either. The concept is termed *staggered coupons*, or *overlapping coupons*. The idea is simple, the issue and expiration dates of the coupons are staggered so that a short-term substitute is available and so that the coupons held for insurance can be those that do not expire at the end of a compliance year.

For example, in RECLAIM, there are two coupons: those that are good for the calendar year (January to December) and those good from July to the following June. Either type may be used by any facility, as long as the coupon is used to cover emission between its issue and expiration dates. Because of the staggering, there are always two types of coupons that could be used in any period, provided that not all of one type has already been used. More than two stagger periods is possible, but it increases the amount of emissions that could occur in any six month period. Staggering is an option to banking that provides a tighter cap on emissions and also provides a short term substitute, an attribute perhaps important at the beginning of a program, when facilities have the most uncertainty.

3.5.16 Shutdown Provisions

Shutdown provisions were hotly debated in the development of RECLAIM, driven largely by labour unions' desires not to see firms leave Southern California while profiting from the sale of coupons. Their fear was that RECLAIM offered new incentives to firms already considering relocation options. We do not believe these anxieties are completely founded, though we appreciate the sincerity of concern, and there is little if any economic justification for including shutdown provisions in a market based program. If a firm ceases operations, for whatever reasons, and sells its coupons, the purchaser obviously has economic use for the newly acquired instruments. In fact, transferring that asset to a more economically productive enterprise is desirable in and of itself.

3.6 Dual Instruments

While traditional analyses have explored some of the properties of individual market-based approaches to pollution regulation, actual implementation of such programs often results in a policy combining an emissions coupon with an emission fee.

Fees and tradable coupons/transferable emissions limits each have positive features and drawbacks. Each has been proposed as a policy instrument, based on their positive features. Both equate facilities' abatement costs at the margin. Tradable coupons place a cap on emissions within some specified time period. In addition, because facilities treat coupons as an asset, coupons induce technological development aimed at decreasing emissions. Emission fees raise revenue and induce some innovation, limited by the size of the fee.

The negative effects of each instrument are often used to delay or prevent their implementation as a policy solution. Since tradable coupons create a new asset for existing sources, they can provide the impetus for marginal facilities to leave the regulated area -- by selling their coupons and taking the "cash". In addition, a pure coupon system raises no revenue for the regulator or the public. On the other hand, emission fees do not provide a cap on emissions. Indeed, without perfect knowledge of facilities' current and future abatement costs, a regulator cannot determine the correct fee to achieve a given level of emissions. Further, no matter how large the fees, any growth of business influx will usually result in increased emissions.

The inherent limitations of each of these policy instruments may be largely mitigated if a dual instrument is implemented. If properly designed, such an instrument will provide an emissions cap and generate revenue. The design is not very different from a tradable coupon system, in fact the same allocation of coupons is necessary for the dual instrument. Sources must still hold the same number of coupons to cover emissions as in the pure coupon system, but they also must pay a flat fee (tax) for every unit of pollution released. A facilities least-cost abatement choices should be the same under this and the pure coupon system.

The advantage of such a system is that it may be more "publicly" (and therefore politically) acceptable: the public is more likely to agree with a system that generates revenues and appears to include the "polluter pay principle". From the emitters point-of-view, the coupon price should fall by the amount of the fee; therefore, this instrument does not result in an increase in regulatory costs when compared to a pure tradable emissions coupon/transferable emissions limits system. From the regulators point-of-view, the benefits of a pure emission coupon system are retained; however, the dual instrument can be designed to regulate peak emissions better than any instrument alone.

Endnotes

1. Transportation demand management measures (TDMs) involve any strategy to reduce vehicle trips, vehicle use, vehicle miles travelled, vehicle idling or traffic congestion for the purpose of reducing motor vehicle emissions. Travel time and marginal cost are the two most important factors that a person considers in making a decision to drive a car or use public transit, and the role of TDMs is to influence these variables and alter the balance between the use of the automobile (which is currently favoured by the residents of the GVRD) and other modes of transportation (GVRD (1992), *Let's Clear the Air: Air Quality Management Plan Discussion Paper*).

2. Other forms of TDMs that have been proposed -- such as increased parking charges -- also operate in much the same way as tolls in influencing the behaviour of motorists. They act to increase the cost of using private automobiles and, therefore, provide an incentive to avoid transportation use (e.g., work at home) or use substitutable transportation alternatives.

3. Bylaw 725 authorizes the GVRD to collect fees from "every Person who discharges an Air Contaminant." However, these charges are currently only levied on permitted stationary point sources (Barr, E. (1994), "Polluter Pay, Polluter Profit or Emission Taxes?", *Policy Options*, March, pg. 28.).

4. The fees levied under the provincial permit fee system are largely set to fund regulatory costs (with some variation for relative environmental impact), as opposed to providing a means of accurately communicating the priorities that should be attached to controlling various emissions (Barr, E. (1994), "Polluter Pay, Polluter Profit or Emission Taxes?", *Policy Options*, March, pg. 28). In addition, given that the fees levied under the B.C. permit fee system and Bylaw 725 are on permitted as opposed to actual emissions, it is unlikely that these fees would offer emitters much incentive to abate. The permits and, therefore, the fees are based on "maximum permitted emissions" and not actual emissions; hence, reductions in actual emissions generally would not be reflected in reduced fees.

5. Barr, E. (1994), "Polluter Pay, Polluter Profit or Emission Taxes?", *Policy Options*, March, pgs. 28-29.

6. B.C. Ministry of Environment, Lands and Parks (1992), *Revising British Columbia's Waste Discharge Permit Fee System: A Discussion Paper.*

7. The generation of revenue to fund air quality management programs is more the role of user fees, which are described in Section 2.4 above.

8. This proposal is partially based on the advantage that AirCare offers -- light duty vehicles are subject to annual emission inspections and the data necessary to implement a mobile emissions fee program are collected during inspections.

9. Achieving zero pollution is also a physical impossibility -- that is one of the immutable laws of physics (specifically, the laws of thermodynamics).

10. The goals of the GVRD-AQMP are, in fact, based on an aggregate emissions reduction targets.

11. Scott, Anthony, *Economic Incentives: The Problem of Getting Started*, undated discussion paper, UBC.

12. Whether economic instruments render an "efficient" solution depends on whether the policy goal is defined as the level of pollution at which the costs of abatement are balanced, at the margin, with the damages that society incurs from the remaining uncontrolled pollution. Economic instruments will render the most cost-effective control solution irrespective of whether the policy goal is based on an efficiency criteria or on some other decision rule (see: Tietenberg, Thomas H. (1980), Transferable Discharge Permits and the Control of Stationary Source Air Pollution", *Land Economics*, Vol. 5).

13. Under the U.S. *Emissions Trading Program*, an emission reduction credit can be granted for any emission reduction that meets certain criteria established by the U.S. Environmental Protection Agency (EPA). Specifically, to qualify as a valid credit, emission reductions must be real, surplus (i.e., the result of an actual reduction and not a "paper" reduction), quantifiable, enforceable and permanent.

14. If they are headed for a form of bankruptcy, there is virtually no such risk.

15. They will not, in equilibrium, command a lower price because they would be substituted for zone B coupons, thus driving up their price, until the prices were at least equated.

16. Incidentally, RECLAIM coupons are denominated in single pounds, while SO_2 allowances are denominated in U.S. tons.

17. Illinois EPA (1993), *Design for NOx Trading System*, Draft Proposal, September 22.

18. The uncertainty in the availability of coupons need not originate from a program directly regulating the coupon. Other regulatory actions may indirectly force an amendment to the coupons' redemption value. For example, the U.S. *Endangered Species Act* is likely to mandate protection of the Delta smelt and the winter run of Chinook Salmon around the Sacramento-San Joaquin Delta. As a result it is expected that reductions in Delta water exports are likely to be mandated. Thus, U.S. Federal government actions may affect the tradable water entitlements developed in individual states (e.g., California). Additional uncertainty exists because the specific reductions that will be required are not known at this time, adding uncertainty over new purchases as well.

19. Banking was available in EPA's lead market and is allowed under the Acid Rain program. The EPA introduced banking in the lead market several years after the program began -- it was not originally an option. When banking became available, market prices for lead allowances rose, indicating that facilities indeed found the additional flexibility to be more valuable.

APPENDIX B

ECONOMIC INSTRUMENT DESIGN ALTERNATIVES FOR THE GVRD

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Appendix B

Economic Instrument Design Alternatives for the GVRD

1.0 Introduction

This Appendix describes the economic instrument designs that apply not only to PM_{10} and NO_x emissions from the point and mobile source sectors, but also to the remaining priority pollutants and source sectors addressed by the AQMP.

2.0 General Program Design

In this section the assumptions underlying the selection of the instrument program and a brief description of the overall program is provided (a more detailed description of the instrument program and its application to the mobile sector and to the control of priority pollutants is presented in Sections 3.0 through 9.0 below).

2.1 Assumptions

The Draft, Stage 2 AQMP provides a suite of control measures to address air quality in the GVRD/ELFV. However, the Draft AQMP does not stipulate an implementation plan (rather a command-and-control strategy was implicitly assumed). However, in order to provide recommendations concerning possible instrument programs, a number of implementation issues would need to be addressed and certain parameters defined.

In lieu of this information, and to allow for the definition of design alternatives, several assumptions had to be made in order to make any real recommendations. The assumptions (initially raised in an earlier memo to the Steering Committee (Sholtz, (1993)) that the instrument program recommendations presented in Sections 3.0 through 9.0 are based on include:

- Attainment of the emission reductions specified in the AQMP (for a given pollutant, source sector or the region as a whole) is an explicit priority.
- The operational role assigned to an economic instruments program under the AQMP is to provide the mechanisms necessary to achieve the emission reductions specified in the draft AQMP at the greatest speed and least cost.

- Existing source sectors participating in the transferable emission limits program, as well as new sources, would not be subject to specific control equipment or process requirements, but rather subject to emission limits[1] as defined by the program.

- Banking of coupons is only allowed where specifically noted in our recommendations.

- Transferable emission limits have reasonable guarantees against confiscation and devaluation unless otherwise so stated in our recommendations, such as in the case of callable coupons.

- Monitoring of actual emissions from sources will be required where technologically feasible.

- The GVRD has the legal ability to carry out any recommended fee or coupon allocation systems.

- Any recommended fee or coupon program would be administered by one central governing body.

- Any penalties required in the programs can be assessed by a governing body.

- An accurate emissions baseline for the airshed, source sectors and individual pollutants can be determined.

- Air quality modelling can be (has been) performed to determine the NO_x/VOC relationship in the relevant airshed(s).

- Air quality modelling can be (has been) performed to determine the mixture of and proportion of secondary particulates.

- A permitting system exists or will exist for new sources including mobile sources.

2.2 Overall Instrument Program

Given the aforementioned assumptions, and having considered a wide range of instruments, we recommend that *for the most part* a program of transferable emissions limits that utilizes the new ***dual coupon-fee system*** (a transferable limit with an emissions fee) with ***additional regulatory permit constraints*** (such as point of impingement limits and other maximum allowable emission rates that would be built into a facility's operating permit) will achieve the desired air quality objectives in the GVRD in a cost-effective fashion. For certain pollutants and source sectors one of the ***flexible limit*** designs (***staggered coupons*** or ***limited banking coupons***) is recommended for the instrument design. Within this design some pollutants need the additional imposition of a ***seasonal cap system*** with an ***off-season constraint***, while others are fine using the purely ***annual cap system***. Within these types of systems, either a steady or declining balance cap can be implemented. Which type of cap will in fact be necessary is a choice that is subject to the regulators' desired goals. In addition to these design features, the program would include an ***emissions offset*** component. Furthermore, to provide regulators with the flexibility to make adjustments once the program is up and running, a portion of the coupons issued would be ***callable***.

We believe that in general **all source sectors should be linked**, although specific caveats need to be recognized (and are in the following subsections for specific pollutants). The allocation of emission coupons should be set per source (facility) at the outset for stationary (including point sources and many area sources that can be monitored), and as a sector for mobile sources.[2] The linking of sectors should provide sufficient liquidity and trading opportunities for all facilities in the program. Toxic emissions are handled distinctly differently, as is covered in the VOC guidelines in Section 7.0 below.

Because mobile sources represent a large portion of the emission increases in the future, integration of these sources is especially important for any system aimed at capping emissions. The implementation of a mobile source linked program may be completed over a few years, beginning with a *differentiated fee system* (see Appendix A for a discussion), but the program should be designed to accommodate the eventual **inclusion of mobile sources into the dual coupon-fee system**. In addition, the program must allow innovative transportation approaches to be rewarded through the coupon system.

Because of the uncertainty in such a program, the ability to take corrective actions should be built into the program as much as possible. These allow the regulator to decrease the number of coupons in the system more efficiently because facilities are able to create and utilize long-term abatement strategies and pass along the associated cost savings to consumers. Such a system allows the issuance of **callable coupons** (two coupon types, one that can be more easily recalled by the regulator) for future years.

Interpollutant trading is not recommended at this stage. Given the uncertainty of the baselines and mobile source emissions program, revisions in one pollutant area would affect all others. Also, monitoring uncertainties make trading across pollutants difficult for regulators to track, and predicting air quality trends is extremely difficult and most likely inaccurate.

For new sources moving into the region, even if their inclusion into the transferable emissions limits program is not feasible, (as explained in the specifics for the various pollutants in the sections that follow), they should be included in an **emissions offset program** in order to keep aggregate emissions for the airshed under a defined limit.

Finally, sources must, in many cases, install monitoring equipment in order to trade coupons. In fact, the program should eventually require the regulated sources to install monitoring equipment where feasible. Where not feasible, and where an adequate proxy for emissions is not available, coupons generated from sources likely should be discounted before they are offered for sale.

Each aspect of the recommended, overall instrument program (presented in bold type) is elaborated on in the main text of the report (Section 6.0) and will not be reiterated here. The application of the program elements to specific pollutants/source sectors is described in Section 3.0 through 8.0 below. In addition, Figure B.1 below illustrates which components of the program apply to particular priority pollutants.

3.0 Specific Program Guidelines for Ozone

3.1 Overview

The proposed program goal includes a reduction of ozone (smog); thus, the program must ultimately control emissions of ozone precursors. Due to the geographic location of the GVRD, the meteorological conditions appear to be most conducive to *seasonal* ozone formation from May through September.[3] While seasonal controls may appear adequate, and perhaps economically beneficial, if designed improperly they can create incentives for emission shifting and worsening air quality in the off-season months, in addition to other problems.

Because ozone levels during the ozone season already exceed the Level A NAAQO more than 1 percent of the time, exceed Level B objectives on occasion, and exceed level C objectives only in very rare circumstances ozone levels *may* be considered somewhat too high.[4] This determination is solely a regulatory decision.

If this is the case a **declining balance seasonal cap** in one or both of the precursors (NO_x and VOCs) seems necessary. This cap would decline over the time frame of the AQMP goals, eventually ending at the targeted reduction.[5]

If declining levels are not warranted, then the design is the same, but without a decline in coupons over the program lifetime. In either case, we suggest setting an additional **off-season cap** on the regulated precursor(s), to protect against the difficulties delineated in Appendix C.

The level of this cap is more controversial. Since ozone is a seasonal pollutant, presumably this off-season cap should be set at or near current levels to *insure no increase or shifting* of significant amounts of precursor emissions into the off-season.

In addition, the NAAQO for the *precursors* themselves must be considered, as is done in the relevant following discussions for NO_x and VOCs. On the other hand, the ultimate level of this cap is a regulatory decision, and does *not* affect the instrument design or choice.

The spatial distribution of ozone is an additional regulatory consideration. The highest levels and frequency of ozone exceedances has occurred in the eastern parts of the GVRD and other non-GVRD regions further east, while the emissions are greatest in the western half of the GVRD. This pattern occurs as the western precursor emissions are transported eastward before they significantly react to form ozone. Instead the precursors form ozone in the eastern regions.

Exhibit B.1: Economic Instrument Program Components for the GVRD

Economic Instrument	Primary Pollutant				
	VOC	CO	PM	SOx	NOx
Offsets	✔		✔	✔	✔
Seasonal coupons with off season constraint	✔				✔
Staggered coupons (annual)			✔	✔	
Single source control		✔			
Mobile sources included	✔	✔	✔	✔	✔
Trading zones	✔				✔

It appears therefore that the best interest of the GVRD is a form of zonal control, where no source in the western zone can increase its emissions above some level using coupons from the eastern zone. This type of **zoned ceiling control** can be built into a transferable emissions limits program for ozone precursors, and is recommended (see Appendix A for a detailed description).

3.2 Mobile Sources

Regardless of whether control of NO_x, VOCs or both is the chosen control strategy for ozone, mobile sources contribute a significant portion of total emissions. The method to regulate these emissions for mobile sources is included in the subsequent sections on NO_x and VOC controls.

3.3 Point Sources

Although point sources do not include a majority of either NO_x or VOC emissions, they nevertheless contribute to both. The method to regulate these emissions for point sources is included in the subsequent sections on NO_x and VOC controls.

3.4 Area Sources

If the chosen regulatory path includes VOC controls for ozone reductions, area sources are a significant contributor and would likely be included in the program. If NO_x is the chosen route, however, areas sources contribute almost insignificant amounts. The method to regulate these emissions for area sources is included in the subsequent sections on NO_x and VOC controls.

4.0 Specific Program Guidelines for Particulates

4.1 Overview

As indicated in the State of the Environment Report for British Columbia,[6] the problems associated with particulate matter occur throughout the year. In this case, a program aimed at controlling annual emissions is likely to be best. In addition, in terms of the health effects noted in the cost-benefit analysis of the AQMP,[7] it is clearly shown that reductions in this pollutant are desired. Even more so, the study shows that regulatory policy should not allow increases in particulates.

It therefore appears that a **declining balance, staggered coupon system** (declining balance cap on annual emissions) is desired. To the extent that the particulates are primary particulates,[8] the cap would be on actual releases of primary particulates, and this action would provide a control on the particulate levels. On the other hand, if secondary particles[9] are large contributors to total particulates, then regulation of those gaseous emissions that act as particulate "precursors" would be required. A preliminary report on visibility prepared for GVRD discusses some of these distinctions.[10]

4.2 Mobile Sources

Mobile source contributions to primary particulates are measured in two broad categories, *road dust* and *emitted particulates*. Excluding road dust, these emissions are significant, but not major, with light-duty and heavy duty vehicles comprising only 7.1% and 10.3% of the emissions respectively. On the other hand, if road dust is included in the total, then the mobile source category contributes 78% percent of the primary particulate emissions.[11]

Information on the control measures for and measurability of road dust was not available at the time this report was written. Therefore, this emissions category is considered outside the scope of the analysis, and emitted particulates will be considered. With this caveat in mind, mobile sources should be controlled using the **mobile sector cap system**.

4.3 Point Sources

Point sources clearly represent the majority of sources releasing emitted particulates. In addition, there are quite a few industrial categories within this sector that produce significant particulate quantities, bulk shipping terminals, wood products, paper products, and non-metallic processing to name a few. This provides a probable range of control costs that elevates the economic savings potential from trading of a declining balance emissions cap.

To the extent that these emissions can be measured, all sources should be allowed to participate in the program.[12] The type of system applied is the **declining balance, staggered coupon system**. This is recommended rather than a system that allows banking of emissions coupons because we *assume* that the regulator desires that particulate emissions show a steady, irreversible decline.

4.4 Area Sources

Area sources appear to contribute to emitted particulates, and the industrial sectors included within this sector individually contribute significantly as well.[13] This variety creates the potential for inclusion into a transferable emissions limits program; however, some of these sources appear to present extremely difficult monitoring and enforcement problems as well as the potential to produce local emissions increases that are undesirable if they are included in the program.

For example, "burning" is such a category. Unless a long-term permit has been granted to individuals to burn, and others have been excluded from doing so, determining who should be allocated the coupons that represent these emissions is likely to be impossible. In addition, determining the actual emissions from each instance of burning is likely to be difficult and expensive given the many factors that potentially affect the emissions from these sources.

For such sources a different form of regulation may be preferred, perhaps utilizing a prescribed control along with a set fee or a fee based on a general proxy of some sort. In general, if an area source can reasonably quantify its emissions, and if that source is considered a facility-based source, then the regulator may decide to include that source in the coupon program. As and if monitoring technology for these sources improves, then the program may be expanded to include more area sources.

5.0 Specific Program Guidelines for NO_x

5.1 Overview

NO_x in and of itself has largely remained below the annual average Level A objective, but some sites have experienced exceedances of this objective.[14] The short-term objective, on the other hand, is very rarely violated, usually from facility breakdowns rather that intended emissions.[15] Therefore, current levels are most likely *slightly* too high, and a small decline in the cap may be prudent. Again, however, this is a regulatory decision.

While NO_x is a seasonal ozone precursor, it may also contribute to TSP and PM_{10} levels. The analysis to determine the extent to which this occurs is not yet complete, but the results of the analysis are *extremely* important. If NO_x emissions turn largely into PM, then a **declining balance, staggered coupon system** is most likely best. On the other hand, if these emissions contribute more to ozone, then stricter seasonal controls may be desired, with an off-seasonal control set at adequate levels of protection to public health, thus leading to a recommendation of a **declining balance seasonal cap system with an off-season constraint.**

5.2 Mobile Sources

Mobile sources clearly contribute the majority (78%) of NO_x emissions, with light duty vehicles contributing about 35% of the aggregate emissions. Therefore, we recommend inclusion of mobile sources using the **mobile sector cap system**. Marine vessels, which have been left out of this system represent 18% of the aggregate emissions, and therefore should be controlled in some way. The ability to monitor these emission must be determined before they could be included in the mobile sector cap system, but perhaps a **differentiated fee system for marine vessels** could be applied. Whether or not the GVRD has the ability to levy and enforce such a fee is unknown if the vessels are of international origin.

5.3 Point Sources

Apply the same reasoning as with particulates. The actual type of cap depends upon the ozone and particulate issues raised in the overview above.

5.4 Area Sources

Since only space heating appears to be a significant contributor, adding nearly 6% to the aggregate NO_x emissions,[16] regulatory controls on this one category may be more cost-effective when monitoring costs are considered. If the heating is included in a facility, then perhaps if that facility changes its heating type, and can prove significant emission decreases that are permanent, it may be granted coupons for the difference. The idea is to provide facilities with an incentive to adopt new technologies.

6.0 Specific Program Guidelines for VOCs

6.1 Overview

As with NO_x, VOCs are an ozone precursor and therefore may be controlled using the **declining balance, seasonal cap system with an off-season constraint**. Unlike other pollutants, however, some VOCs also are toxic. Although we propose a trading system, within this program *toxic emission reductions cannot be increased, transferred, or traded.* This is a departure from traditional analyses, but is important. On the other hand, quicker reductions are likely if the program provides incentives for facilities and entrepreneurs to find new, better methods to reduce toxic emissions.

The solution is a trading system where *additional* toxic VOC reductions earn VOC coupons, but toxic emissions reductions cannot be forgone using VOC coupons. In other words, if a facility invests additional funds to reduce toxic emissions more than required, then to the extent that those emission are also VOCs the facility is allocated VOC coupons for the decrease. VOC coupons cannot, however, be used to allow toxic emission increases or to forgo required toxic emission decreases.

6.2 Mobile Sources

Light duty vehicles are clearly the largest contributor to VOC emissions. They should be included using the **mobile sector cap system**. Other vehicles are much smaller contributors, and may be included subject to the regulators ability to monitor. Perhaps, as with NO_x, a differentiated fee system could be imposed for the rest of this sector.

6.3 Point Sources

As is typically the case with VOCs, there is only one major point source category -- petroleum refining -- that contributes at least 1% to the VOC aggregate.[17] To the extent that it is a declining industry and to the extent that source testing and monitoring is difficult, this category may be best exempted from the cap and regulated by another means. On the other hand, if that industry might linger, then including it in the cap is potentially beneficial.

6.4 Area Sources

While area sources are significant contributors to VOC emissions, the specific type of source is extremely important when considering inclusion into a trading program because of monitoring difficulties. Solvent evaporation, such as out of drums of paint, can be determined using several methods that essentially assume all the VOCs in the solvent are eventually emitted into the air. This type of source is rather easy to include in a trading program. On the other hand, leaking flanges are not monitored *per se*, but must be discovered by inspection in most cases. Allocating coupons for these sources seems unrealistic. If a mass balance approach for determining a facility's VOC losses is used, on the other hand, then the facility could be included in such a program. If the facility can prove it has decreased these losses, perhaps by retrofitting or replacing valves and flanges, it will need fewer coupons.

There are many unresolved issues for monitoring and establishing protocols for area source VOCs, and several regions in the United States are working on these difficulties at this time. As these issues are clarified and resolved, such sources would be beneficial to a trading program aimed at reducing emissions.

7.0 Specific Program Guidelines for SOx

7.1 Overview

Annual averages for SO_x emissions are well below the Level A Objective,[18] and short term objective exceedances have occurred rarely and as a result of upsets at petroleum processing facilities. Therefore, it is likely that a **staggered coupon system** is appropriate. Whether or not this has a declining balance is a regulatory choice since the Level A Objective a met, but the cap system with offsets would insure against increases in SO_x emissions above whatever cap level is set. On the other hand, if SO_x emission are found to be significant contributors to secondary particulates then a declining balance cap analogous to that for emitted particulates is prudent. Since SO_x emission are not ozone precursors, there is no need for a seasonal program at this time.

7.2 Mobile Sources

While the mobile source sector as a whole contributes nearly half of the SO_x emissions,[19] light duty motor vehicles are responsible for about 10% of the total for 1990.[20] This statistic alone might suggest that including these vehicles in a SO_x mobile source cap program would be costly if SO_x is not already a standard item for emissions testing.

Unfortunately, this sector is expected to produce real growth in these emissions, with projections of baseline increases of an additional 41% from 1990 levels by the year 2005.[21] With this in mind, inclusion of these sources seems prudent, and we recommend a **mobile sector cap system** for SO_x to insure against these increases and to give financial incentives to research and develop better controls. The cost for testing may in part determine the type of system eventually implemented.

7.3 Point Sources

The same recommendation as for NO_x.

7.4 Area Sources

The same recommendation as for NO_x.

8.0 Specific Program Guidelines for CO

8.1 Overview

Virtually *all* the CO originates from mobile sources, and within that sector from light duty vehicles. In fact motor vehicles contributed 92% of the CO for 1990 and are projected to contribute 90% in 2005.[22] New vehicle standards are projected to decrease emissions from these sources by 24% by 2005.[23]

8.2 Mobile Sources

This is perhaps the clearest case where only a single source category apparently needs regional control. CO does not contribute in any significant way to ozone; therefore, only if additional reductions are desired would additional controls be necessary.

Perhaps an emissions fee would be the simplest way to decrease emissions further. Most likely, however, the controls on other emissions from motor vehicles, including transportation changes will decrease the emissions of CO even further. This in conjunction with tailpipe standards and required repair of faulty vehicles should be most cost-effective.

8.3 Point and Area Sources

Do nothing except dictate maximum emissions rates to protect against local degradation of air quality.

Endnotes

1. These limits consist of both a transferable element and a maximum allowable, non-transferable emission rate set to protect local human health and inserted into a facility's operating permit.

2. The sector designation is rather misleading here. Individual ownership of the mobile source coupons is not likely feasible, but individual ownership of the *ability to generate* the coupons is feasible. Various options are discussed in the relevant section on mobile sources.

3. GVRD (1994a), Figure 3.5.

4. GVRD (1994a) Section 3.2.

5. It is important to keep in mind, however, that ozone is not an emitted pollutant. Rather, its precursors (NO_x and VOC) are what is emitted and ultimately regulated. Because of the highly non-linear interaction of NO_x and VOC, a 50% reduction in NO_x will not likely have the same effect as a 50% reduction in VOC or a 25% reduction in both pollutants. Therefore, some consideration of the reduction amounts of the precursors necessary to reduce the ozone level a specified amount is vital to designing a complete program goal.

6. B.C. Environment, (1993b).

7. See ARA/Bovar-Concord, (1994).

8. Primary particulates are released as particulate matter directly into the atmosphere.

9. Secondary particulates form when gaseous emissions are converted to particulates in the atmosphere. Such gaseous emissions include SO_2, NO_x, NH_3 and VOC.

10. See Senes, (1994).

11. Calculated from GVRD, (1994b) Table 2.

12. The actual factors affecting whether facilities should be allowed to participate are delineated in Appendix A, Section 3.5.8.

13. GVRD, (1994b) Table 2.

14. GVRD (1993b), Figure 3.13.

15. GVRD, (1993b) Table 3.1.

16. GVRD, (1994B) Table 2.

17. GVRD, (1994b) Table 2.

18. GVRD (1993b).

19. GVRD, (1994b), Table 2.

20. GVRD, (1994b), Table 2.

21. Calculated from GVRD, (1994b), Table 6c.

22. GVRD, (1994b), Figure 10a.

23. GVRD, (1994b), Table 6c.

APPENDIX C

POTENTIAL DIFFICULTIES WITH SEASONAL OZONE CONTROLS

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Appendix C

Potential Difficulties With Seasonal Ozone Controls

1.0 Emissions Shifting

Perhaps the most obvious change that occurs when a seasonal system of regulations is implemented is a change in incentives for control. If possible, a source may find it favourable to move its emissions out of the ozone season and into the off-season. Several issues arise.

- With this shifting behaviour regulators may find that the previous definition of the ozone season is no longer valid. Looking at past data, when emissions were higher, may indicate whether meteorology is as limiting a factor on ozone formation when precursor emission concentrations rise.

- This shifting behaviour likely will alter the peak emissions of the *traded* precursor pollutants (NO_x, VOCs, etc.) as well. It may be the case that, rather than ozone peaks, the peaks of the precursors that can occur when emissions are moved out of the ozone season and into the off-season create the potential for worsened health effects from these emissions (from NO_2 or the resulting PM for example).

- Finally, this changing of peak precursor emission levels also can alter the NO_x/VOC ratio during certain times. That ratio in part determines the effectiveness of whatever reductions are made. Multiday episodes, which are rather common, may change in frequency and severity. Airshed modelling is necessary to predict this effect.

2.0 Temporal Versus Continual Controls

Along the same lines as point 3 above, even if sources do not shift emissions from the ozone season to the off-season, the additional costs imposed on sources for emitting ozone season precursors likely will impact sources' choice to install continuous versus temporal controls. This potential exists in two basic forms.

First, rather than installing equipment to create year-round reductions, if facilities find it more cost effective they may simply use temporal controls to achieve the seasonal reductions. Examples of such controls include fuel switching and temporary mobile source reductions. Also, if operating the abatement equipment generates variable costs, then facilities may simply turn off their add-on abatement equipment during the off-season.

econd, the movement to emission limits (total emissions during the ozone season) from ission factors (emissions per unit of production) establishes production reduction as a tential, new control option. With emission rates essentially averaged only over the season, reduced production over that season may be accompanied by increased production in the off-season. In addition, production reductions may come disproportionately from the "edges" of the ozone season (May and, if included as a trading month, September), without similar reductions during the parts of the season most frequented by ozone episodes. Again, whether or not this type of emission shifting poses a problem depends on both the intent of the program and the results of air quality modelling.

3.0 Market Volatility and Productivity Losses

Emission credits have a tangible economic benefit. They are factors of production for regulated facilities, for the facility cannot operate without holding sufficient credits to cover emissions. In the short run they have no substitute. An annual credit that cannot be banked has a limited life; it cannot be used to cover emissions beyond its expiration date.

Taken together, these factors represent economic incentives for facilities to capture the full value of the credits before the expiration date. As the end of the year approaches, those facilities that hold excess credits (facilities that are *long* in credits) face a use-them-or-lose-them proposition. In order to recover some of the value of the credit, the facility can increase production (and emissions), sell the credits to another facility, or pursue some combination of the two. In programs that include it, banking is also an option, but it comes at an environmental cost in some cases.

In addition, if facilities find themselves short, banking cannot smooth out the market, especially in the initial stages of a program where few credits have had an opportunity to be banked. For example, a sudden improvement in economic activity could leave facilities in need of additional credits in the short run at year end. Turning to the market, they might find a shortage that drives prices up, perhaps to the levels of non-compliance penalties. This too will increase pressure on regulators to provide additional flexibility to program participants, possibly to the detriment of the environment.

The probability that the number of credits held by long facilities equals the number of credits held by short facilities is quite small, therefore increasing the risk of both market price volatility and emissions volatility. Why emissions volatility? Given the nature of many businesses, they do not know the exact amount of their emissions at the beginning of the year. Since there is no flexibility and facilities may find themselves short a few credits, facilities may pursue an *insurance strategy* to avoid the cost of year-end credit shortages and penalties. Simply put, they will hold more credits than they expect to need. Either a production decrease or over control of emissions will generate the insurance credits. As the year progresses, the facilities have a better understanding of their annual emissions, and although they may sell some of their extra credits, it is not likely that they will sell all of them. At year end, with facilities pursuing this insurance strategy, it is likely that there will be excess credits, and lost economic opportunity. On the other hand, if any facilities can increase production easily, then they would be wise to do so, using the cheaper credits available in this circumstance. As evidenced by work done for the SCAQMD,[1] this type of incentive can lead to increased price and emissions volatility near the end of the credit term and can reduce both the productivity and economic efficiency of the trading system.

In sum, the difficulties that can occur with a strictly seasonal trading system include, or are a result of, the following:

1. Potential short-term credit shortages.
2. Excessive emissions shifting into the off-season.
3. Movement forward of emissions so future-year caps fail.
4. "Use-them-or-lose-them" use of excess credits.
5. Difficulty including new source requirements.

In sum, without banking, expired credits are worthless. If banking were allowed, near the program beginning, facilities might find themselves short credits, but later in the program the seasonal cap may be greatly exceeded, although the "expiration" of credits would no longer represent a full economic loss since they could be carried forward. So the proposed trading system with banking alleviates problem #4, but continues to carry the remaining difficulties.

Endnotes

1. See Carlson, Dale, C. Forman, J. Ledyard, N. Olmstead, C. Plott, and A. Sholtz (1993), *An Analysis and Recommendation of the Terms of the RECLAIM Trading Credit*, Report submitted to the SCAQMD.

Appendix D

RECLAIM Trading Rules: An Example

REGULATION XX

REGIONAL CLEAN AIR INCENTIVES MARKET (RECLAIM)

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(Adopted October 15, 1993)

RULE 2000. GENERAL

(a) Program Objective

RECLAIM is a market incentive program designed to allow facilities flexibility in achieving emission reduction requirements for Oxides of Nitrogen (NO_x), and Oxides of Sulfur (SO_x) under the Air Quality Management Plan using methods which include, but are not limited to: add-on controls, equipment modifications, reformulated products, operational changes, shutdowns, and the purchase of excess emission reductions.

(b) Purpose

This rule provides the definitions for terms found in Regulation XX - RECLAIM. Any identical term found elsewhere in District Rules and Regulations with a conflicting definition shall be superseded, for the purposes of this regulation, by the definition provided in this rule.

(c) Definitions

(1) ALLOCATION is the number of RECLAIM Trading Credits (RTCs) [as defined in paragraph (c)(53)] a RECLAIM facility holds for a specific compliance year, as referenced in the Facility Permit.

(2) ALTERNATIVE EMISSION FACTOR is a SO_x emission value in units of pounds per million standard cubic feet or pounds per thousand gallons derived using the methodology specified in Appendix A, Protocols for Monitoring, Reporting, and Recordkeeping for Oxides of Sulfur (SO_x) Emissions, Chapters 3 and 4.

(3) ANNUAL PERMIT EMISSIONS PROGRAM (APEP) is the annual Facility Permit compliance reporting, review, and fee reporting program.

(4) BASIN means the South Coast Air Basin as defined by the California Air Resources Board.

(5) BEST AVAILABLE CONTROL TECHNOLOGY (BACT) means the most stringent emission limitation or control technique which: (A) has been achieved in practice for such category or class of source; (B) is contained in any state implementation plan (SIP) approved by the Environmental Protection Agency (EPA) for such category or class of

source; or (C) is any other emission limitation or control technique, including process and equipment changes of basic or control equipment which is technologically feasible for such class or category of source or for a specific source, and cost-effective as compared to AQMP measures or adopted District rules. A specific limitation or control technique shall not apply if the Facility Permit holder demonstrates that such limitation or control technique is not presently achievable.

(6) BREAKDOWN means a condition caused by circumstances beyond the Facility Permit holder's control which result in fire, or mechanical or electrical failure causing an emission increase at a RECLAIM facility in excess of emissions under normal operating conditions, determined pursuant to Rules 2011 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) Emissions, and 2012 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions, and Appendices A of Rules 2011 and 2012. In order to be considered a breakdown, the excess emissions shall not have resulted from operator error, neglect or improper operation or maintenance procedures. Malfunctions in monitoring equipment shall not be considered to be a breakdown.

(7) BUYER is any person who acquires RTCs from another person through purchase, lease, trade or other means of transfer.

(8) CEMENT KILN is a device for the calcining and clinkering of limestone, clay and other raw materials, and recycle dust in the dry-process manufacture of cement.

(9) CERTIFIED REPORT means there has been a reasonable and diligent inquiry into the accuracy of the report by the certifying official and that the contents of the report are true and accurate to the best of his or her knowledge.

(10) CLINKER is a mass of fused material produced in a cement kiln from which the finished cement is manufactured by milling and grinding.

(11) COMBUSTION EQUIPMENT is any equipment that burns fuel, including but not limited to natural gas or fuel oil in order to operate. Combustion equipment includes, but is not limited to, boilers, turbines, heaters, engines, kilns, furnaces, ovens, dryers, flares, and afterburners.

(12) COMPLIANCE YEAR is the twelve-month period beginning on January 1 and ending on December 31 for Cycle 1 facilities, and beginning on July 1 and ending on June 30 for Cycle 2 facilities.

(13) CONCENTRATION LIMIT is a value expressed in ppmv, is measured over any continuous 60 minutes, is elected by the Facility Permit holder for a large NO_x source, and is specified in the Facility Permit.

(14) CONTINUOUS EMISSIONS MONITORING SYSTEM (CEMS) means any system of equipment that continuously measures all parameters necessary to directly determine mass emissions of a RECLAIM pollutant, and which meets all performance standards for CEMS set forth in the Protocols for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) and Oxides of Nitrogen (NO_x) Emissions.

(15) CONTINUOUS PROCESS MONITORING SYSTEM (CPMS) is equipment that measures process parameters including, but not limited to, fuel usage rate, oxygen content of stack gas, or process weight, and meets all performance standards for CPMS set forth in the Protocol for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions. Such CPMS data will be used in conjunction with the concentration limit or emission rate, as stated in the Facility Permit, to determine mass NO_x emissions.

(16) CONTINUOUSLY MEASURE means to measure at least once every 15 minutes except during periods of routine maintenance and calibration, or as otherwise specified in the Protocols for Monitoring, Reporting, and Recordkeeping Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x) Emissions.

(17) DAILY means occurring once between 12 midnight and 24 hours later at midnight.

(18) DIRECT MONITORING DEVICE is a device that measures the emissions of NO_x or SO_x or fuel sulfur content and all other variables as specified in Rules and Protocols for Monitoring, Reporting, and Recordkeeping for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x) Emissions.

(19) DISTRICT CENTRAL NO_x STATION is the District's designated computer system for NO_x emission monitoring.

(20) DISTRICT CENTRAL SO_x STATION is the District's designated computer system for SO_x emission monitoring.

(21) ELECTRIC UTILITY is all in-Basin facilities which generate power and are owned or operated by any one of the following: Southern California Edison, Los Angeles Department of Water and Power, City of Burbank, City of Glendale, City of Pasadena, or any of their successors.

(22) ELECTRONICALLY REPORT means transmitting measured data between the point of measurement and the point of receipt of the transmission, as specified in Rules 2011 and 2012 and their Appendices.

(23) EMERGENCY EQUIPMENT is equipment solely used on a standby basis in cases of emergency, defined as emergency equipment on the Facility Permit; or is equipment that does not operate more than 200 hours per year and is not used in conjunction with any voluntary demand reduction program, and is defined as emergency equipment in the Facility Permit.

(24) EMISSION FACTOR is the applicable value specified in Tables 1 or 2 of Rule 2002.

(25) EMISSION RATE is a value expressed in terms of NO_x mass emissions per unit of heat input, is derived using the methodology specified in the Protocol for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions, and is used to calculate NO_x mass emissions on an average basis.

(26) EMISSION REDUCTION CREDIT (ERC) means the amount of credit for emission reductions verified and determined by the Executive Officer pursuant to Regulation XIII - New Source Review.

(27) ENTRY is the process by which a facility not included in the RECLAIM program pursuant to Rule 2001 - Applicability, can enter the program pursuant to conditions established in Rule 2001.

(28) EXTERNAL OFFSET means an emission reduction determined pursuant to Rule 1309(b)(1) and approved by the Executive Officer for use to mitigate an emission increase, where the emission reduction is made at a facility other than the facility creating the emission increase.

(29) EXISTING EQUIPMENT is any equipment operating at a RECLAIM facility for which there was a District Permit to Construct, temporary Permit to Operate, or Permit to Operate, or equipment which existed but was exempt pursuant to Rule 219 - Equipment Not Requiring a Written Permit Pursuant to Regulation II, before October 15, 1993.

(30) EXISTING FACILITY is any facility that submitted Emission Fee Reports pursuant to Rule 301- Permit Fees, for 1992 or earlier years, or with valid District Permits to Operate issued prior to October 15, 1993, and continued to be in operation or possess valid District permits on October 15, 1993.

(31) EXPIRATION DATE is the last date a pollutant can be emitted under the authority conveyed by a Facility Permit specifying allowable emissions based upon the amount of RTCs held by a Facility Permit holder.

(32) FACILITY means any source or grouping of sources or other air contaminant-emitting activities which are located on one or more contiguous properties within the Basin in actual physical contact, or separated solely by a public roadway or other public right-of-way, and are owned or operated by the same person (or by persons under common control) or an Outer Continental Shelf (OCS) source as defined in 40 CFR Section 55.2. Such above-described groupings, if on noncontiguous properties, connected only by land carrying a pipeline, shall not be considered one facility. Equipment or installations involved in crude oil and gas production in Southern California Coastal or OCS waters and transport of such crude oil and gas in Southern California Coastal or OCS waters shall be included in the same facility which is under the same ownership or use entitlement as the crude oil and gas facility on-shore.

(33) FACILITY PERMIT is a permit which consolidates permits for existing equipment, a permit for previously non-permitted NO_x and/or SO_x emitting Rule 219 equipment, and permits for any new equipment, into a single permit. A Facility Permit shall serve as a Permit to Operate, pursuant to Rule 203, for all equipment at a RECLAIM facility. Requirements for non-RECLAIM pollutants shall also be included in the Facility Permit.

(34) FUNCTIONALLY IDENTICAL SOURCE REPLACEMENT is the replacement of an existing source with another source that performs the same function, and has a maximum rated capacity less than or equal to the source being replaced.

(35) GASEOUS FUELS include, but are not limited to, any natural, process, synthetic, landfill, sewage digester or waste gases with a gross heating value of 300 Btu per cubic foot or higher, at standard conditions.

(36) HIGH EMPLOYMENT/LOW EMISSIONS FACILITY (HILO) is a new facility which has a high employment to pollution ratio. A HILO Facility has an emission rate for NO_x, SO_x, ROC, and PM_{10}, per full-time manufacturing employee, that is equal to or less than one-half (1/2) of any estimate stated in the AQMP for emissions per full-time manufacturing employee by industry class in the year 2010.

(37) ISSUE DATE is the first date a pollutant can be emitted under the authority conveyed by a Facility Permit specifying allowable emissions based upon the amount of RTCs held by a Facility Permit holder.

(38) MAJOR STATIONARY SOURCE means any facility which emits, or has the potential to emit 10 tons per year or more of NO_x or 70 tons per year or more of SO_x.

(39) MANUFACTURING EMPLOYEES are those full-time employees directly involved in the manufacture or sale of the product created by a RECLAIM facility.

(40) MODIFICATION means any physical change or change in the method of operation of a source. The following shall not be considered a modification: (A) routine maintenance and repair; (B) any change in operator or ownership of the facility; (C) use of an alternative fuel as required by District rule or federal or state statute, regulation or law; and, (D) an increase in the hours of operation or in the production rate, unless a permit condition limiting hours of operation, throughput or mass emissions would be exceeded.

(41) MONTHLY EMISSIONS REPORT is a report which takes inventory of all RECLAIM pollutant emissions at a facility during a calendar month, submitted by the Facility Permit holder to the Executive Officer, within 30 days of the close of each month.

(42) NATURAL GAS is a mixture of gaseous hydrocarbons, with at least 80 percent methane (by volume), and of pipeline quality, such as the gas sold or distributed by any utility company regulated by the California Public Utilities Commission.

(43) NEW FACILITY is any facility which has received all District Permits to Construct on or after October 15, 1993.

(44) NON-RECLAIM POLLUTANTS are those pollutants other than RECLAIM NO_x and SO_x.

(45) NORMAL OPERATING CONDITION means the condition that conforms with the established norm or standard prescribed in Rule 2011 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) Emissions and Rule 2012 - Requirements for Monitoring, Reporting, and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions, and the Appendices thereto.

(46) NO_x EMISSIONS means the sum of nitric oxides and nitrogen dioxides emitted, calculated as nitrogen dioxide.

(47) ON-SITE, OFF-ROAD MOBILE SOURCES means non-stationary devices powered by an internal combustion engine or motor of 50 horsepower or greater, used off public roads and solely at the facility to propel, move, or draw persons or property. Such devices include, but are not limited to: forklifts, aerial lifts, pumps, generators and compressors, motor graders, backhoes, excavators, dozers, trenchers, and tractors.

(48) QUARTER is a three-month period from January 1 to March 31, April 1 to June 30, July 1 to September 30, or October 1 to December 31, inclusive.

(49) QUARTERLY CERTIFICATION OF EMISSIONS is a certified report inventorying all RECLAIM pollutant emissions at a facility during a quarter.

(50) RATED BRAKE HORSEPOWER (bhp) is the maximum rating specified by the manufacturer and listed on the nameplate.

(51) RECLAIM is the Regional Clean Air Incentives Market established by this Regulation.

(52) RECLAIM POLLUTANTS are oxides of nitrogen (NO_x) and oxides of sulfur (SO_x), excluding any NOx emissions from on-site, off-road mobile

sources and any SO_x emissions from equipment burning natural gas exclusively.

(53) RECLAIM TRADING CREDIT (RTC) is a limited authorization to emit a RECLAIM pollutant in accordance with the restrictions and requirements of District rules and state and federal law. Each RTC has a denomination of one pound of RECLAIM pollutant and a term of one year, and can be held as part of a facility's Allocation or alternatively may be evidenced by an RTC Certificate.

(54) RECLAIM TRADING CREDIT LISTING is maintained by the Executive Officer and is the official and controlling record of RTCs held by any person.

(55) REMOTE TERMINAL UNIT (RTU) is a data collection and transmitting device used to transmit data and calculated results to the District Central Station Computer.

(56) RENTAL EQUIPMENT is equipment which is rented or leased for operation by someone other than the owner of the equipment.

(57) REPORTED VALUE, for the purpose of developing Allocations, means the emissions data provided to the District by the facility representative, pursuant to Rule 301.

(58) RTC CERTIFICATES are issued by the District and constitute evidence of RTCs held by any person and are used for information only. The official and controlling record of RTCs held by any person is the RTC listing maintained by the Executive Officer.

(59) RESEARCH OPERATIONS are those operations the sole purpose of which is to permit investigation of experimental research to advance the state of knowledge or state-of-the-art technology.

(60) SELLER is any person who transfers RTCs to another person through sale, lease, trade or other means of transfer.

(61) SOURCE is any individual unit, piece of equipment or process which may emit an air contaminant and which is identified, or required to be identified, in the RECLAIM Facility Permit.

(62) SO_x EMISSIONS means sulfur dioxides emitted.

(63) STANDARD INDUSTRIAL CODE (SIC) is the classification number assigned to a facility based on its primary economic activity as specified in

the "Standard Industrial Classification Manual," published by the Office of Management and Budget, dated 1987.

(64) THROUGHPUT means a measure of activity including, but not limited to: weight of glass pulled for a glass melting furnace, weight of clinker for cement kilns, amount of nitric acid used in metal stripping processes, amount of nitric or sulfuric acid manufactured for nitric or sulfuric acid manufacturing processes, weight of aluminum produced for aluminum production and/or fuel usage for all other sources as reported pursuant to Rule 301.

(65) TRADING ZONE is one of two areas delineated in Rule 2005 - New Source Review for RECLAIM, Map 1.

(66) ZONE OF ORIGINATION is the trading zone or Regulation XIII zone in which an RTC is originally assigned by the District.

(Adopted October 15, 1993)

RULE 2001. APPLICABILITY

(a) Purpose

This rule specifies criteria for inclusion in RECLAIM for new and existing facilities. It also specifies requirements for sources electing to enter RECLAIM and identifies provisions in District rules and regulations that do not apply to RECLAIM sources.

(b) Criteria for Inclusion in RECLAIM

The Executive Officer will maintain a listing of facilities which are subject to RECLAIM. The Executive Officer will include facilities, unless otherwise exempted pursuant to paragraph (i)(1), if emissions fee data for 1990 or any subsequent year filed pursuant to Rule 301 - Permit Fees, shows four or more tons per year of NO_x or SO_x emissions where:

(1) NO_x emissions do not include emissions from:

(A) any NO_x source which was exempt from permit pursuant to Rule - 219 Equipment Not Requiring A Written Permit Pursuant to Regulation II;

(B) any NO_x process unit which was rental equipment with a valid District Permit to Operate issued to a party other than the facility; or

(C) on-site, off-road mobile sources.

(2) SO_x emissions do not include emissions from:

(A) any SO_x source which was exempt from permit pursuant to Rule - 219 Equipment Not Requiring A Written Permit Pursuant to Regulation II; or

(B) any SO_x source that burned natural gas exclusively; or

(C) any SO_x process unit which was rental equipment with a valid District Permit to Operate issued to a party other than the facility; or

(D) on-site, off-road mobile sources.

The Executive Officer will not include a facility in RECLAIM if a permit holder requests exclusion and demonstrates through the addition of control equipment, the possession of a valid Permit to Construct for such control equipment, or a

Permit to Operate condition that the emissions fee data received pursuant to Rule 301, which shows emissions equal to or greater than four tons per year of a RECLAIM pollutant, is not representative of future emissions.

(c) Amendments to RECLAIM Facility Listing

(1) The Executive Officer will amend the RECLAIM facility listing to add, delete, change designation of any facility or make any other necessary corrections upon any of the following actions:

(A) Approval by the Executive Officer pursuant to Rule 2007 - Trading Requirements, of the permanent transfer or relinquishment of all RTCs applicable to a facility.

(B) Approval by the Executive Officer of a change of Facility Permit holder or change of facility name.

(C) Approval by the Executive Officer of a Facility Permit for a new facility if such new facility would, under RECLAIM, have a starting Allocation equal to or greater than four tons per year of a RECLAIM pollutant NO_x or SO_x, unless the facility would be exempt pursuant to paragraph (i)(1).

(D) Approval by the Executive Officer of a Facility Permit for an existing non-RECLAIM facility, which reports NO_x or SO_x emissions pursuant to Rule 301 - Permit Fees, for any year which are equal to or greater than four tons, as specified in subdivision (b), unless the facility would be exempt pursuant to paragraph (i)(1).

(E) Approval by the Executive Officer of the election of a facility to enter the RECLAIM program pursuant to subdivision (f).

(F) Upon delegation of authority from EPA to the District for Outer Continental Shelf (OCS) sources and inclusion of RECLAIM in 40 CFR Part 55 pursuant to the consistency update process, such OCS sources shall be a RECLAIM facility. The OCS sources' starting Allocation for the year of entry and Allocations for the years 2000 and 2003 and interim years, shall be determined pursuant to Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x), except that fuel usage and emissions data reported to the Minerals Management Service of the Department of the Interior be utilized where emissions data reported pursuant to Rule 301 is not available, provided that the permit holder substantiates the accuracy of such fuel usage and emissions data. The starting Allocation shall be adjusted to reflect the rate of reduction which would have been applicable to the facility if it had been in the RECLAIM program as of October 15, 1993.

(2) The actions specified in this subdivision shall be effective only upon amendment of the Facility Listing

(d) Cycles

(1) The Executive Officer will assign RECLAIM facilities to one of two compliance cycles by computer-generated random assignment which, to the extent possible, ensures an even distribution of RTCs. The Facility Listing will distinguish between Cycle 1 facilities, which will have a compliance year of January 1 to December 31 of each year, and Cycle 2 facilities, with a compliance year of July 1 to June 30 of each year.

(2) The issue and expiration dates of the RTCs allocated to a facility shall coincide with the beginning and ending dates of the facility's compliance year.

(3) Within 30 days of October 15, 1993, facilities assigned to Cycle 2 may petition the Executive Office or the Hearing Board to change their cycle designation. Facilities assigned to Cycle 1 may not petition the Executive Officer or Hearing Board to change their cycle designation. Facilities entering the RECLAIM program after October 15, 1993 will be assigned to the cycle with the greatest amount of time remaining in the compliance year.

(e) High Employment/Low Emissions (HILO) Facility Designation

A new facility may, after January 1, 1997 apply to the District for classification as a HILO Facility. The Executive Officer will approve the HILO designation upon the determination that the emission rate for NO_x, SO_x, ROC, and PM_{10} is less than or equal to one-half (1/2) of any target specified in the AQMP for emissions per full-time manufacturing employee by industry class in the year 2010.

(f) Entry Election

(1) A non-RECLAIM facility may elect to permanently enter the RECLAIM program, provided that:

(A) the owner or operator files an Application for Entry;

(B) the facility is not listed as exempt under paragraph (i)(1);

(C) the facility is not operating under an Order for Abatement or in violation of any District rule; and

(D) the facility is not subject to a compliance date in an existing rule within six months of the date of Application for Entry.

(2) Upon approval of an Application for Entry, the Executive Officer will issue a Facility Permit. The facility's starting Allocation for the year of entry and Allocations for the years 2000 and 2003 and interim years, shall be determined pursuant to Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x). If necessary, the Allocation shall be adjusted to equal the Allocations which would have been applicable to the facility if it had been subject to the RECLAIM program as of October 15, 1993.

(3) Entry into the RECLAIM program will be effective upon issuance of a Facility Permit pursuant to Rule 2006 - Permits, and publication of the addition of the facility to the Facility Listing.

(g) Exit from RECLAIM

No facility, on the initial Facility Listing or subsequently admitted to RECLAIM, may opt out of the program.

(h) Non-RECLAIM Facility Generation of RTCs

Non-RECLAIM facilities may not obtain RTCs due to a shutdown or curtailment of operations which occurs after October 15, 1993. ERCs generated by non-RECLAIM facilities may not be converted to RTCs if the ERCs are based on a shutdown or curtailment of operations after October 15, 1993.

(i) Exemptions

(1) The following sources, including those that are part of or located on a Department of Defense facility, shall not be included in RECLAIM and are prohibited from electing to enter RECLAIM:

(A) dry cleaners;

(B) fire fighting facilities;

(C) construction and operation of landfill gas control, processing or landfill gas energy recovery facilities;

(D) facilities which have converted all sources to operate on electric power prior to October 15, 1993;

(E) police facilities;

(F) public transit;

(G) restaurants;

(H) potable water delivery operations;

(I) facilities located in the Los Angeles and Riverside County portions of the Southeast Desert Air Basin; and

(J) facilities that have permanently ceased operations of all sources before January 1, 1994.

(2) The following sources shall not be initially included in RECLAIM but may enter the program pursuant to subdivision (f):

(A) electric utilities (exemption only for the SO_x program);

(B) equipment rental facilities;

(C) facilities possessing solely "various location" permits;

(D) hospitals;

(E) prisons;

(F) publicly owned municipal waste-to-energy facilities;

(G) portions of facilities conducting research operations;

(H) schools or universities;

(I) sewage treatment facilities which are publicly owned and operated consistent with an approved regional growth plan; and

(K) electric power generating systems owned and operated by the City of Burbank, City of Glendale or City of Pasadena or any of their successors.

(j) Rule Applicability

Facilities operating under the provisions of the RECLAIM program shall be required to comply concurrently with all provisions of District rules and regulations, except the provisions listed in Tables 1 and 2 shall not apply to NO_x and SO_x emissions from RECLAIM facilities after the later of the following:

(1) December 31, 1994 for Cycle 1 facilities and June 30, 1995 for Cycle 2 facilities; or

(2) the date the facility has demonstrated compliance with all monitoring and reporting requirements of Rules 2011 or 2012, as applicable.

Additionally, RECLAIM facilities shall not be required to comply with provisions of the listed District rules which have initial implementation dates in 1994.

Table 1

EXISTING RULE PROVISIONS NOT APPLICABLE TO RECLAIM FACILITIES FOR NO_x

RULE	DESCRIPTION	NON-APPLICABLE PROVISIONS
218	Stack Monitoring	Entire Rule
429	Start-up & Shutdown Exemption Provisions for NO_x	Entire Rule
430	Breakdown Provision	Entire Rule
474	Fuel Burning Equipment - NO_x	(a); (b); (c); (d); & (e)
476	Steam Generating Equipment	(a) and (b)
1109	Emis. of NO_x Boilers & Proc. Heaters in Petroleum Refineries	(a); (b); (c); (d); & (e)
1110	Emis. from Stationary I. C. Engines (Demo.)	(b)(1), (3), (4), (5), (6), (7); & (c)
1110.1	Emis. from Stationary I. C. Engines	(c)(1)(A); (c)(2); NO_x part of (f)(2)(A)(i); & (f)(2)(B)
1110.2	Emis. from Gaseous and Liquid-Fueled I. C. Engines	NO_x part of (c)(2)(A); (c)(2)(B); (d)(2); & (f)
1112	Emis. of NO_x from Cement Kilns	(a); (b); (c); (d); & (e)
1117	Emis. of NO_x from Glass Melting Furnaces	(a); (b); (c); (d); & (e)
1134	Emis. of NO_x from Stationary Gas Turbines	(a); (b); (c); (d); (e); (f); & (g)
1135	Emis. of NO_x from Electric Power Generating Systems	(a); (b); (c); (d); (e); (f); (g); & (h)
1146	Emis. of NO_x from Boilers, Steam Generators, and Proc. Heaters	(a)(6); (c)(4); (e)(1), & (4); & NO_x part of (c)(1); (c)(2)(C)
1146.1	Emis. of NO_x from Small Boilers, Steam Generators, and Proc. Heaters	(a)(4); (c)(4); (d)(1), & (5); & NO_x part of (c)(1); (c)(2)(C); & (d)(4)
1159	Nitric Acid Units - Oxides of Nitrogen	(a) & (b)
Reg. XIII	New Source Review	Entire Regulation

Table 2

EXISTING RULE PROVISIONS NOT APPLICABLE TO RECLAIM FACILITIES FOR SO_x

RULE	DESCRIPTION	NON-APPLICABLE PROVISIONS
53	Sulfur Compounds - Concentration - L.A. County	all
53	Sulfur Compounds - Concentration - Orange County	all
53	Sulfur Compounds - Concentration - Riverside County	(a)
53	Sulfur Compounds - Concentration - San Bernardino County	(a)
53A	Specific Contaminants - San Bernardino County	(a)
218	Stack Monitoring	Entire Rule
430	Breakdown Provisions	Entire Rule
407	Liquid and Gaseous Air Contaminants	(a)(2)(A)
431.1	Sulfur Content of Gaseous Fuels	(a); (b); (c); (d); (e); & Attachment A
431.2	Sulfur Content of Liquid Fuels	(a); (b); (c);(d); (e); & (f)
431.3	Sulfur Content of Fossil Fuels	(a); (b); & (c)
468	Sulfur Recovery Units	(a); & (c)
469	Sulfuric Acid Units	(a)
1101	Secondary Lead Smelters/Sulfur Oxides	(a) & (b)
1105	Fluid Catalytic Cracking Units SO_x	(a); (b); & (c)
1119	Petroleum Coke Calcining Operations - Oxides of Sulfur	(a); & (b)
Reg. XIII	New Source Review	Entire Regulation

(Adopted October 15, 1993)

RULE 2002. ALLOCATIONS FOR OXIDES OF NITROGEN (NO_x) AND OXIDES OF SULFUR (SO_x)

(a) Purpose

The purpose of this rule is to establish the methodology for calculating facility Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x).

(b) RECLAIM Allocations

(1) RECLAIM Allocations will begin in 1994.

(2) An annual Allocation will be issued to each facility for each compliance year from 1994 to 2010, inclusive. All Allocations will be established by the Facility Permit issued pursuant to Rule 2006 - Permits.

(3) Allocations for each year after 2003 are equal to the facility's ending Allocation, as referenced on the initial Facility Permit unless, as part of the AQMP process, and pursuant to Rule 2015 (b)(1), (b)(3), (b)(4), or (c), the District Governing Board determines that additional reductions are necessary to meet air quality standards, taking into consideration the current and projected state of technology available and cost-effectiveness to achieve further emission reductions.

(c) Establishment of Starting Allocations

(1) The starting Allocation for RECLAIM NO_x and SO_x facilities initially permitted by the District prior to October 15, 1993, shall be determined by the Executive Officer utilizing the following methodology:

Starting Allocation = Σ [A X B_1] + ERCs + External Offsets, where

A = the throughput for each NO_x and SO_x source or process unit in the facility for the maximum throughput year from 1989 to 1992, inclusive; and

B_1 = the applicable starting emission factor for the subject source or process unit, as specified in Table 1 or Table 2.

(2) (A) Use of 1992 data is subject to verification and revision by the Executive Officer to assure validity and accuracy.

(B) The maximum throughput year will be determined by the Executive Officer from throughput data reported through annual emissions reports submitted pursuant to Rule 301 - Permit Fees, or may be designated by the permit holder prior to issuance of the Facility Permit.

(C) To determine the applicable starting emission factor in Table 1 or Table 2, the Executive Officer will categorize the equipment at each facility based on information relative to hours of operation, equipment size, heating capacity, and permit information submitted pursuant to Rule 201 - Permit to Construct, and other relevant parameters as determined by the Executive Officer. No information used for purposes of this subparagraph may be inconsistent with any information or statement previously submitted on behalf of the facility to the District, including but not limited to information and statements previously submitted pursuant to Rule 301 - Permit Fees, unless the facility can demonstrate, by clear and convincing documentation, that such information or statement was inaccurate.

(D) Throughput associated with each piece of equipment or NO_x or SO_x source will be multiplied by the starting emission factors specified in Table 1 or Table 2. If a lower emission factor was utilized for a given piece of equipment or NO_x or SO_x source pursuant to Rule 301 - Permit Fees, than the factor in Table 1 or Table 2, the lower factor will be used for determining that portion of the Allocation.

(E) The fuel heating value may be considered in determining Allocations and will be set to 1.0 unless the Facility Permit holder demonstrates that it should receive a different value.

(3) All NO_x and SO_x ERCs held by a RECLAIM facility permit holder shall be reissued as RTCs. RECLAIM facilities will have these RTCs added to their starting Allocations. RTCs generated from the conversion of ERCs shall have a zero rate of reduction for the year 1994 through the year

2000. Such RTCs shall have an annual rate of reduction for the year 2001 and subsequent years, equal to the percentage inventory adjustment factor applied to 2000 Allocations pursuant to paragraph (d)(4) of this rule.

(4) Non-RECLAIM facilities may elect to have their ERCs converted to RTCs and listed on the RTC Listing maintained by the Executive Officer pursuant to Rule 2007 - Trading Requirements, so long as the written request is filed before July 1, 1994. Such RTCs will be assigned to the trading zone in which the generating facility is located. RTCs generated from the conversion of ERCs shall have a zero rate of reduction for the year 1994 through the year 2000. Such RTCs shall have an annual rate of reduction for the year 2001 and subsequent years, equal to the percentage inventory adjustment factor applied to 2000 Allocations pursuant to paragraph (d)(4) of this rule.

(5) External offsets provided pursuant to Regulation XIII - New Source Review, not including any offsets in excess of a 1 to 1 ratio, will be added to the starting Allocation pursuant to paragraph (c)(1) provided:

(A) The offsets were not received from either the Community Bank or the Priority Reserve.

(B) External offsets will only be added to the starting Allocation to the extent that the Facility Permit holder demonstrates that they have not already been included in the starting Allocation or as an ERC. RTCs issued for external offsets shall not include any offsets in excess of a 1 to 1 ratio required under Regulation XIII - New Source Review.

(C) RTCs generated from the conversion of external offsets shall have a zero rate of reduction for the year 1994 through the year 2000. These RTCs shall have an annual rate of reduction for the year 2001 and subsequent years, equal to the percentage inventory adjustment factor applied to 2000 Allocations pursuant to paragraph (d)(4) of this rule.

(D) Existing facilities with units that have Permits to Construct issued pursuant to Regulation II - Permits, dated on or after January 1, 1992, or existing facilities which have, between January 1, 1992 and October 15, 1993, installed air pollution control equipment that was exempt from offset requirements pursuant to Rule 1304 (a)(5), shall have their starting Allocations increased by the total external offsets provided, or the amount that would have been offset if the exemption had not applied.

(E) Existing facilities with units whose reported emissions are below capacity due to phased construction, and/or where the Permit to Operate issued pursuant to Regulation II - Permits, was issued after January 1, 1992, shall have their starting Allocations increased by the total external offsets provided.

(6) If a Facility Permit holder can demonstrate that its 1994 Allocation is less than the 1992 emissions reported pursuant to Rule 301 - Permit Fees, and that the facility was, in 1992, operating in compliance with all applicable District rules in effect as of December 31, 1993, the facility's starting Allocation will be equal to the 1992 reported emissions.

(7) For new facilities initially totally permitted on or after January 1, 1993 but prior to October 15, 1993, the starting Allocation shall be equal to the external offsets provided by the facility to offset emission increases at the facility pursuant to Regulation XIII - New Source Review, not including any offsets in excess of a 1 to 1 ratio.

(8) The Allocation for new facilities initially totally permitted on and after October 15, 1993, shall be equal to the total RTCs provided by the facility to offset emission increases at the facility pursuant to Rule 2005- New Source Review for RECLAIM.

(9) The starting Allocation for facilities which enter the RECLAIM program pursuant to Rule 2001 - Applicability, shall be determined by the methodology in paragraph (c)(1) of this rule. The most recent two years reported emission fee data filed pursuant to Rule 301 - Permit Fees, may be used if 1989 through 1992 emission fee data is not available. For facilities lacking reported emission fee data, the Allocation shall be equal to the external offsets provided pursuant to Regulation XIII - New Source Review, not including any offsets in excess of a 1 to 1 ratio. The Allocation shall not include any emission offsets received from either the Community Bank or the Priority Reserve.

(10) A facility may not receive more than one set of Allocations.

(11) A facility that is no longer holding a valid District permit on January 1, 1994 will not receive an Allocation, but may, if authorized by Regulation XIII, apply for ERCs.

(12) Clean Fuel Adjustment to Starting Allocation

Any refiner who is required to make modifications to comply with CARB Phase II reformulated gasoline production (California Code of Regulations, Title 13, Sections 2250, 2251.5, 2252, 2260, 2261, 2262, 2262.2, 2262.3, 2262.4, 2262.5, 2262.6, 2262.7, 2263, 2264, 2266, 2267, 2268, 2269, 2270, and 2271) or federal requirements (Federal Clean Air Act, Title II, Part A, Section 211; 42 U.S.C. Section 7545) may receive (an) increase(s) in his Allocations except to the extent that there is an increase in maximum rating of the new or modified equipment. Each facility requesting an increase to Allocations shall submit an application for permit amendment specifying the necessary modifications and tentative schedule for completion. The Facility Permit holder shall establish the amount of emission increases resulting from the reformulated gasoline modifications for each year in which the increase in Allocations is requested. The increase to its Allocations will be issued contemporaneously with the modification according to a schedule approved by the Executive Officer (i.e., 1994 through 1997 depending on the refinery). Each increase to the Allocations shall be equal to the increased emissions resulting from the modifications solely to comply with the state or federal reformulated gasoline requirements at the refinery or facility producing hydrogen for reformulated gasoline production, and shall be established according to present and future compliance limits in current District rules or permits. Allocation increases for each refiner pursuant to this paragraph, shall not exceed 5 percent of the refiner's total starting Allocation, unless any refiner emits less than 0.0135 tons of NO_x per thousand barrels of crude processed, in which case the Allocation increases for such refiner shall not exceed 20 percent of that refiner's starting Allocation. The emissions per amount of crude processed will be determined on the basis of information reported to the District pursuant to Rule 301 - Permit Fees, for the same calendar year as the facility's peak activity year for their NO_x starting Allocation.

(d) Establishment of Year 2000 Allocations

(1) (A) The year 2000 Allocations for RECLAIM NO_x and SO_x facilities will be determined by the Executive Officer utilizing the following methodology:

Year 2000 Allocation $= \Sigma [A \times B_2]$ + RTCs created from ERCs + External Offsets, where

A = the throughput for each NO_x or SO_x source or process unit in the facility for the maximum throughput year from 1987 to 1992, inclusive, as reported pursuant to Rule 301 - Permit Fees; and

B_2 = the applicable Tier I year Allocation emission factor for the subject source or process unit, as specified in Table 1 or Table 2.

(B) The maximum throughput year will be determined by the Executive Officer from throughput data reported through annual emissions reports pursuant to Rule 301 - Permit Fees, or may be designated by the permit holder prior to issuance of the Facility Permit.

(C) To determine the applicable emission factor in Table 1 or Table 2, the Executive Officer will categorize the equipment at each facility based on information on hours of operation, equipment size, heating capacity, and permit information submitted pursuant to Rule 201 - Permit to Construct, and other parameters as determined by the Executive Officer. No information used for purposes of this subparagraph may be inconsistent with any information or statement previously submitted on behalf of the facility to the District including but not limited to information and statements previously submitted pursuant to Rule 301 - Permit Fees, unless the facility can demonstrate, by clear and convincing documentation, that such information or statement was inaccurate.

(D) Throughput associated with each piece of combustion equipment or NO_x or SO_x source will be multiplied by the Tier I emission factor specified in Table 1 or Table 2. If a factor lower than the factor in Table 1 or Table 2 was utilized for a given piece of equipment or NO_x or SO_x source pursuant to Rule 301, the lower factor will be used for determining that portion of the Allocation.

(E) The fuel heating value may be considered in determining Allocations and will be set to 1.0 unless the Facility Permit holder demonstrates that it should receive a different value.

(F) The year 2000 Allocation is the sum of the resulting products for each piece of equipment or NO_x or SO_x source multiplied by any inventory adjustment pursuant to paragraph (d)(4) of this rule.

(2) For facilities existing prior to October 15, 1993 which enter RECLAIM after October 15, 1993, the year 2000 Allocation will be determined according to paragraph (d)(1). The most recent two years reported emission fee data filed pursuant to Rule 301 - Permit Fees, may be used if 1989 through 1992 emission fee data is not available. For facilities lacking reported emission fee data, the Allocation shall be equal to their offsets provided pursuant to Regulation XIII - New Source Review, not including any offsets in excess of a 1 to 1 ratio.

(3) No facility shall have a year 2000 Allocation [calculated pursuant to subdivision (d)] greater than the starting Allocation [calculated pursuant to subdivision (c)].

(4) If the sum of all RECLAIM facilities' ending Allocations differs from the year 2000 projected inventory for these sources under the 1991 AQMP, the Executive Officer will establish a percentage inventory adjustment factor that will be applied to adjust each facility's year 2000 Allocation. The inventory adjustment will not apply to RTCs generated from ERCs or external offsets.

(e) Allocations for the Year 2003

facilities' 2003 Allocations will equal the 1991 AQMP projected inventory for RECLAIM sources for the year 2003, corrected based on actual facility data reviewed for purposes of issuing Facility Permits and to reflect the highest year of actual Basin-wide economic activity for RECLAIM sources considered as a whole during the years 1987 through 1992.

(2) No facility shall have a 2003 Allocation (calculated pursuant this subdivision) greater than the year 2000 Allocation [calculated pursuant to subdivision (c)].

(f) Annual Allocations for NO_x and SO_x

(1) Allocations for the years between 1994 and 2000, for RECLAIM NO_x and SO_x facilities shall be determined by a straight line rate of reduction between the starting Allocation and the year 2000 Allocation. For the years 2001 and 2002, the Allocations shall be determined by a straight line rate of reduction between the year 2000 and year 2003 Allocations. Allocations for each year after 2003 are equal to the facility's ending Allocation, as referenced on the initial Facility Permit, unless as part of the AQMP process, and pursuant to Rule 2015 (b)(1), (b)(3), (b)(4), or (c), the District Governing Board determines that additional reductions are necessary to meet air quality standards, taking into consideration the current and projected state of technology available and cost-effectiveness to achieve further emission reductions.

(2) New facilities initially totally permitted, on and after October 15, 1993, shall not have a rate of reduction. The Facility Permit for such facilities will require the Facility Permit holder to, at the commencement of each compliance year, hold RTCs equal to the amount of RTCs provided as offsets pursuant to Rule 2005.

(3) Increases to Allocations for permits issued for Clean Fuel adjustments pursuant to paragraph (c)(12), shall be added to each year's Allocation.

(g) High Employment/Low Emissions (HILO) Facility

The Executive Officer will establish a HILO bank funded with the following maximum total annual emission Allocations:

(1) 91 tons per year of NO_x

(2) 91 tons per year of SO_x

(3) After January 1, 1997, new facilities may apply to the HILO bank in order to obtain non-tradeable RTCs. Requests will be processed on a first-come, first-serve basis, pending qualification.

(4) When credits are available, annual Allocations will be granted for the year of application and all subsequent years until the year 2010.

(5) HILO facilities receiving such Allocations from the HILO bank must verify their HILO status on an annual basis through their APEP report.

(6) Failure to qualify will result in all subsequent years' credits being returned to the HILO bank.

(7) Facilities failing to qualify for the HILO bank Allocations may reapply at any time during the next or subsequent compliance year when credits are available.

(h) Non-Tradeable Allocation Credits

(1) Any existing RECLAIM facility with reported emissions pursuant to Rule 301 - Permit Fees, in either 1987, 1988, or 1993, greater than its starting Allocation, shall be assigned non-tradeable credits for the first three years of the program which shall be determined according to the following methodology:

Non-tradeable credit for NO_x and SO_x:

$$\text{Year 1} = (\Sigma\,[A \times B_1]) - \text{1994 Allocation;}$$

Where:

A = the throughput for each NO_x or SO_x source or process unit in the facility from the single maximum throughput year from 1987 or 1988; and

B_1 = the applicable starting emission factor, as specified in Table 1 or Table 2.

Year 2 = Year 1 non-tradeable credits X 0.667

Year 3 = Year 1 non-tradeable credits X 0.333

Year 4 and subsequent years = Zero non-tradeable credit.

(2) The use of non-tradeable credits shall be subject to the following requirements:

(A) Non-tradeable credits may only be used for an increase in throughput over that used to determine the facility's starting Allocation. Non-tradeable credits may not be used for emissions increases associated with equipment modifications, change in feedstock or raw materials, or any other changes except increases in throughput. The Executive Officer may impose Facility Permit conditions necessary to ensure compliance with this subparagraph.

(B) The use of activated non-tradeable credits shall be subject to a non-tradeable RTC mitigation fee, as specified in Rule 301 subdivision (n).

(C) In order to utilize non-tradeable credits, the Facility Permit holder shall submit a request to the Executive Officer in writing, including a demonstration that the use of the non-tradeable credits complies with all requirements of this paragraph, pay any fees required pursuant to Rule 301 - Fees, and have received written approval from the Executive Officer for their use. The Executive Officer shall deny the request unless the Facility Permit holder demonstrates compliance with all requirements of this paragraph. The Executive Officer shall, in writing, approve or deny the request within 3 business days of submittal of a complete request and notify the Facility Permit holder of the decision. If the request is denied, the Executive Officer will refund the mitigation fee.

(D) In the event that a facility transfers any RTCs for the year in which non-tradeable credits have been issued, the non-tradeable credit Allocation shall be invalid, and is no longer available to the facility.

Table 1

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
Afterburner (Direct Flame and Catalytic)	Natural Gas	mmcf	130.000	39.000
Afterburner (Direct Flame and Catalytic)	LPG, Propane, Butane	1000 Gal	RV	3.840
Afterburner (Direct Flame and Catalytic)	Diesel	1000 Gal	RV	5.700
Agr Chem-Nitric Acid	Process-Absrbr Tailgas/Nw	tons pure acid produced	RV	1.440
Agricultural Chem - Ammonia	Process	tons produced	RV	1.650
Air Ground Turbines	Air Ground Turbines	(unknown process units)	RV	1.860
Ammonia Plant	Neutralizer Fert, Ammon Nit	tons produced	RV	2.500
Asphalt Heater, Concrete	Natural Gas	mmcf	130.000	65.000
Asphalt Heater, Concrete	Fuel Oil	1000 gals	RV	9.500
Asphalt Heater, Concrete	LPG	1000 gals	RV	6.400
Boiler, Heater R1109 (Petr Refin)	Natural Gas	mmbtu	0.100	0.030
Boiler, Heater R1109 (Petr Refin)	Fuel Oil	mmbtu	0.100	0.030
Boiler, Heater R1146 (Petr Refin)	Natural Gas	mmbtu	0.045	0.045
Boiler, Heater R1146 (Petr Refin)	Fuel Oil	mmbtu	0.045	0.045
Boiler, Heater R1146 (Petr Refin)	Refinery Gas	mmbtu	0.045	0.045
Boilers, Heaters, Steam Gens Rule 1146 and 1146.1	Natural Gas	mmcf	49.180	47.570
Boilers, Heaters, Steam Gens Rule 1146 and 1146.1	LPG, Propane, Butane	1000 gals	4.400	4.260
Boilers, Heaters, Steam Gens Rule 1146 and 1146.1	Diesel Light Dist. (0.05% S)	1000 gals	6.420	6.210

- * RV=Reported Value
- ** Process upset emissions are not included in emissions cap
- *** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
Boilers, Heaters, Steam Gens Rule 1146 and 1146.1	Refinery Gas	mmcf	51.520	49.840
Boilers, Heaters, Steam Gens	Bituminous Coal	tons burned	RV	4.800
Boiler, Heater, Steam Gen (Rule 1146.1)	Natural Gas	mmcf	130.000	39.460
Boiler, Heater, Steam Gen (Rule 1146.1)	Refinery Gas	mmcf	RV	41.340
Boiler, Heater, Steam Gen (Rule 1146.1)	LPG, Propane, Butane	1000 gallons	RV	3.530
Boiler, Heater, Steam Gen (Rule 1146.1)	Diesel Light Dist (0.05%)	1000 gallons	RV	5.150
Boiler, Heater, Steam Gen (Rule 1146)	Natural Gas	mmcf	47.750	47.750
Boiler, Heater, Steam Gen (Rule 1146)	Refinery Gas	mmcf	50.030	50.030
Boiler, Heater, Steam Gen (Rule 1146)	LPG, Propane, Butane	1000 gallons	4.280	4.280
Boiler, Heater, Steam Gen (Rule 1146)	Diesel Light Dist (0.05%)	1000 gallons	6.230	6.230
Boiler, Heater, Steam Gen (R1146, <90,000 Therms)	Natural Gas	mmcf	RV	47.750
Boiler, Heater, Steam Gen (R1146, <90,000 Therms)	Refinery Gas	mmcf	RV	50.030
Boiler, Heater, Steam Gen (R1146, <90,000 Therms)	LPG, Propane, Butane	1000 gallons	RV	4.280
Boiler, Heater, Steam Gen (R1146, <90,000 Therms)	Diesel Light Dist (0.05%)	1000 gallons	RV	6.230
Boiler, Heater, Steam Gen (R1146.1, <18,000 Therms)	Natural Gas	mmcf	RV	39.460
Boiler, Heater, Steam Gen (R1146.1, <18,000 Therms)	Refinery Gas	mmcf	RV	41.340
Boiler, Heater, Steam Gen (R1146.1, <18,000 Therms)	LPG, Propane, Butane	1000 gallons	RV	3.530

* RV=Reported Value

** Process upset emissions are not included in emissions cap

*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
Boiler, Heater, Steam Gen (R1146.1, <18,000 Therms)	Diesel Light Dist (0.05%)	1000 gallons	RV	5.150
Boiler, Heater R1109 (Petr Refin)	Refinery Gas	mmbtu	0.100	0.030
Boilers, Heaters, Steam Gens, (Petr Refin)	Natural Gas	mmcf	105.000	31.500
Boilers, Heaters, Steam Gens, (Petr Refin)	Refinery Gas	mmcf	110.000	33.000
Boilers, Heaters, Steam Gens, Unpermitted	Natural Gas	mmcf	130.000	32.500
Boilers, Heaters, Steam Gens, Unpermitted	LPG, Propane, Butane	1000 gallons	RV	3.200
Boilers, Heaters, Steam Gens, Unpermitted	Diesel Light Dist (0.05%)	1000 gallons	RV	4.750
Catalyst Manufacturing	Catalyst Mfg	tons of catalyst produced	RV	1.660
Catalyst Manufacturing	Catalyst Mfg	tons of catalyst produced	RV	2.090
Cement Kilns	Natural Gas	mmcf	130.000	19.500
Cement Kilns	Diesel Light Dist. (0.05% S)	1000 gals	RV	2.850
Cement Kilns	Kilns-Dry Process	tons cement produced	RV	0.750
Cement Kilns	Bituminous Coal	tons burned	RV	4.800
Cement Kilns	Tons Clinker	tons clinker	RV	0.980
Ceramic and Brick Kilns (Preheated Combustion Air)	Natural Gas	mmcf	213.000	170.400
Ceramic and Brick Kilns (Preheated Combustion Air)	Diesel Light Distillate (.05%)	1000 gallons	RV	24.905
Ceramic and Brick Kilns (Preheated Combustion Air)	LPG	1000 gallons	RV	16.778
Ceramic Clay Mfg	Drying	tons input to process	RV	1.114
CO Boiler	Refinery Gas	mmbtu		0.030

* RV=Reported Value

** Process upset emissions are not included in emissions cap

*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
Cogen, Industr	Coke	tons burned	RV	3.682
Electric Generation, Commercial Institutional Boiler	Distillate Oil	1000 gallons	6.420	6.210
Composite Internal Combustion	Waste Fuel Oil	1000 gals burned	RV	31.340
Curing and Drying Ovens	Natural Gas	mmcf	130.000	32.500
Curing and Drying Ovens	LPG, Propane, Butane	1000 gals	RV	3.200
Fiberglass	Textile-Type Fibr	tons of material processed	RV	1.860
Fluid Catalytic Cracking Unit	Fresh Feed	1000 BBLS fresh feed	RV	6.040
Fugitive Emission	Not Classified	tons product	RV	0.087
Furnace Process	Carbon Black	tons produced	RV	38.850
Furnace Suppressor	Furnace Suppressor	unknown	RV	0.800
Glass Fiber Furnace	Mineral Products	tons product produced	RV	4.000
Glass Melting Furnace	Flat Glass	tons of glass pulled	RV	4.000
Glass Melting Furnace	Tableware Glass	tons of glass pulled	RV	5.680
Glass Melting Furnaces	Container Glass	tons of glass produced	4.000	0.240
ICE - Large Bore Engine	Diesel	1000 gals	RV	31.340
ICEs, Permitted (Rule 1110.1 and 1110.2)	Natural Gas	mmcf	2192.450	217.360
ICEs Permitted (Rule 1110.2)	Natural Gas	mmcf	RV	217.360
ICEs, Permitted (Rule 1110.1 and 1110.2)	LPG, Propane, Butane	1000 gals	RV	19.460

* RV=Reported Value

** Process upset emissions are not included in emissions cap

*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
ICEs, Permitted (Rule 1110.1 and 1110.2)	Gasoline	1000 gals	RV	20.130
ICEs, Permitted (Rule 1110.1 and 1110.2)	Diesel Oil	1000 gals	RV	31.340
ICEs, Emergency Standby	Natural Gas	mmcf	RV	RV
ICEs, Emergency Standby	LPG, Propane, Butane	1000 gals	RV	RV
ICEs, Emergency Standby	Gasoline	1000 gals	RV	RV
ICEs, Emergency Standby	Diesel Oil	1000 gals	RV	RV
In Process Fuel	Coke	tons burned	RV	24.593
Incinerators	Natural Gas	mmcf	130.000	104.000
Industrial	Propane	1000 gallons	RV	20.890
Industrial	Gasoline	1000 gallons	RV	21.620
Industrial	Dist.Oil/Diesel	1000 gallons	RV	33.650
Inorganic Chemicals, H2SO4 Chamber	General	tons pure acid produced	RV	0.266
Inorganic Chemicals, H2SO4 Contact	Absrbr 98.0% Conv	tons 100% H2S04	RV	0.376
Iron/Steel Foundry	Steel Foundry, Elec Arc Furn	tons metal processed	RV	0.045
Metal Heat Treating Furnace	Natural Gas	mmcf	130.000	104.000
Metal Heat Treating Furnace	Diesel Light Distillate (.05%)	1000 gallons	RV	15.200
Metal Heat Treating Furnace	LPG	1000 gallons	RV	10.240
Metal Forging Furnace (Preheated Combustion Air)	Natural Gas	mmcf	213.000	170.400
Metal Forging Furnace (Preheated Combustion Air)	Diesel Light Distillate (.05%)	1000 gallons	RV	24.905
Metal Forging Furnace (Preheated Combustion Air)	LPG	1000 gallons	RV	16.778
Metal Melting Furnaces	Natural Gas	mmcf	130.000	65.000

* RV=Reported Value

** Process upset emissions are not included in emissions cap

*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
Metal Melting Furnaces	LPG, Propane, Butane	1000 gals	RV	6.400
Miscellaneous		bbls-processed	RV	1.240
Natural Gas Production	Not Classified	mmcf gas	RV	6.320
Nonmetallic Mineral	Sand/Gravel	tons product	RV	0.030
NSPS	Refinery Gas	mmbtu	RV	0.030
Other Bact Heater (24F-1)	Natural Gas	mmcf	RV	RV
Other Heater (24F-1)	PSA Gas	mmcf	RV	RV
Ovens, Kilns, Calciners, Dryers, Furnaces***	Natural Gas	mmcf	130.000	65.000
Ovens, Kilns, Calciners, Dryers, Furnaces***	Diesel Light Dist. (0.05% S)	1000 gals	RV	9.500
Paint Mfg. Solvent Loss	Mixing/Blending	tons solvent	RV	45.600
Petroleum Refining	Natural Gas, Flare	1000 bbls crude processed	RV	RV
Petroleum Refining	Asphalt Blowing	tons of asphalt produced	RV	45.600
Petroleum Refining, Calciner	Petroleum Coke	Calcined Coke	RV	0.610
Plastics Prodn	Polyester Resins	tons product	RV	106.500
Process Specific	ID# 012183	(unknown process units)	RV	240.000
Process Specific	SCC 30500311	tons produced	RV	0.140
Process Specific	ID 14944	(unknown process units)	RV	0.512
Reported Value			RV	RV
SCC 39090003			RV	170.400
Sec. Aluminum	Sweating Furnace	tons produced	RV	0.300
Sec. Aluminum	Smelting Furnace	tons metal produced	RV	0.323
Sec. Aluminum	Annealing Furnace	mmcf	130.000	65.000

* RV=Reported Value

** Process upset emissions are not included in emissions cap

*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factor	Ending Ems Factor
Sec. Aluminum	Boring Dryer	tons produced	RV	0.057
Sec. Lead	Smelting Furnace	tons metal charged	RV	0.110
Sec. Lead	Smelting Furnace	tons metal charged	RV	0.060
Sodium Silicate Furnace	Water Glass	Tons Glass Pulled	RV	6.400
Steel Hot Plate Furnace	Natural Gas	mmcf	213.000	106.500
Steel Hot Plate Furnace	Diesel Light Distillate (.05%)	1000 gallons	31.131	10.486
Steel Hot Plate Furnace	LPG, Propane, Butane	1000 gallons	20.970	10.486
Surface Coal Mine	Haul Road	tons coal	RV	62.140
Tail Gas Unit		hours of operation	RV	RV
Turbines	Butane	1000 Gallons	RV	5.700
Turbines	Diesel Oil	1000 gals	RV	8.814
Turbines	Refinery Gas	mmcf	RV	62.275
Turbines	Natural Gas	mmcf	RV	61.450
Turbines - Peaking Unit	Natural Gas	mmcf	RV	RV
Turbines - Peaking Unit	Dist. Oil/Diesel	1000 gallons	RV	RV
Utility Boiler	Digester/Landfill Gas	mmcf	52.350	10.080
Turbine	Natural Gas	mmcf	RV	61.450
Turbine	Fuel Oil	1000 gallons	RV	8.810
Turbine	Dist.Oil/Diesel	1000 gallons	RV	3.000
Utility Boiler Burbank	Natural Gas	mmcf	148.670	17.200
Utility Boiler Burbank	Residual Oil	1000 gallons	20.170	2.330
Utility Boiler, Glendale	Natural Gas	mmcf	140.430	16.000
Utility Boiler, Glendale	Residual Oil	1000 gallons	20.160	2.290

* RV=Reported Value
** Process upset emissions are not included in emissions cap
*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 1 (Cont.)

RECLAIM NO_x Emission Factors

Nitrogen Oxides Basic Equipment	Fuel	Units	Starting Ems Factors	Ending Ems Factors
Utility Boiler, LADWP	Natural Gas	mmcf	86.560	15.830
Utility Boiler, LADWP	Residual Oil	1000 gallons	12.370	2.260
Utility Boiler, LADWP	Digester Gas	mmcf	52.350	10.080
Utility Boiler, LADWP	LPG	1000 gallons	37.760	6.910
Utility Boiler, Pasadena	Natural Gas	mmcf	195.640	18.500
Utility Boiler, Pasadena	Residual Oil	1000 gallons	28.290	2.670
Utility Boiler, SCE	Natural Gas	mmcf	74.860	15.600
Utility Boiler, SCE	Residual Oil	1000 gallons	10.750	2.240
Waste Gas Flare	Landfill Dump	mmcf gas burned	RV	RV

* RV=Reported Value
** Process upset emissions are not included in emissions cap
*** Does not include ceramic, clay, cement or brick kilns. Does not include metal melting, heat treating or glass melting furnaces.

Table 2

RECLAIM SO_x Emission Factors

Sufur Oxides Basic Equipment	Fuel	Thruput Units	Starting Emission Factor	Ending Emission Factor
Air Blown Asphalt		hours of operation	RV	RV
Asphalt Concrete	Cold Ag Handling	tons produced	RV	0.032
Calciner	Petroleum Coke	Calcined Coke	RV	0.000
Catalyst Regeneration		hours of operation	RV	RV
Cement Kiln	Distillate Oil	1000 gallons	RV	RV
Cement Mfg	Kilns, Dry Process	tons produced	RV	RV
Claus Unit		pounds	RV	RV
Cogen		hours of operation	RV	RV
Non Fuel Use		hours of operation	RV	RV
External Combustion Equipment / Incinerator	Natural Gas	mmcf	RV	0.830
External Combustion Equip/Incinerator	LPG, Propane, Butane	1000 gallons	RV	4.600
External Combustion Equip/Incinerator	Diesel Light Dist. (0.05% S)	1000 gallons	7.00	5.600
External Combustion Equip/Incinerator	Residual Oil	1000 gallons	8.00	6.400
External Combustion Equip/Incinerator	Refinery Gas	mmcf	RV	6.760
Facility Surveyed Emissions Inventory		lbs	RV	RV
Fiberglass	Recuperative Furn, Textile-Type Fiber	tons produced	RV	2.145
Fluid Catalytic Cracking Units		1000 bbls refinery feed	RV	13.700
Glass Mfg, Forming/Fin	Container Glass		RV	RV
Grain Milling	Flour Mill	tons Grain Processed	RV	RV
ICEs	Natural Gas	mmcf	RV	0.600
ICEs	LPG, Propane, Butane	1000 gallons	RV	0.350
ICEs	Gasoline	1000 gallons	RV	4.240
ICEs	Diesel Oil	1000 gallons	6.24	4.990

*RV = Reported Value
**Process upset emissions are not included emissions cap

Table 2 (Cont.)

RECLAIM SO_x Emission Factors

Sufur Oxides Basic Equipment	Fuel	Thruput Units	Starting Emission Factor	Ending Emission Factor
Industrial	Cogeneration, Bituminous Coal	tons produced	RV	RV
Industrial (scc 10200804)	Cogeneration, Coke	tons produced	RV	RV
Inorganic Chemcals	General, H2SO4 Chamber	tons produced	RV	RV
Inorganic Chemcals	Absrbr 98.0% Conv, H2SO4 Contact	tons produced	RV	RV
Inprocess Fuel	Cement Kiln/Dryer, Bituminous Coal	tons produced	RV	RV
Iron/Steel Foundry	Cupola, Gray Iron Foundry	tons produced	RV	0.720
Melting Furnace, Container Glass		tons produced	RV	RV
Mericher Alkyd Feed		hours of operation	RV	RV
Miscellaneous	Not Classified	tons produced	RV	0.080
Miscellaneous	Not Classified	tons produced	RV	0.399
Natural Gas Production	Not Classified	mmcf	RV	527.641
Organic Chemical (scc 30100601)		tons produced	RV	RV
Petoluem Refin (scc30600602)	Column Condenser		RV	1.557
Petoluem Refin (scc30600603)	Column Condenser		RV	1.176
Petroleum Refng Blowdown Systems	Vapor Rec/Flare	1000 bbls refinery feed	RV	RV
Refinery Process Heaters	LPG fired	1000 gal	RV	2.259
Sec. Lead	Reverberatory, Smelting Furnace	tons produced	RV	RV
Sec. Lead	Smelting Furnace, Fugitiv	tons produced	RV	0.648
Sour Water Oxidizer		hours of operation	RV	RV
Sulfur Loading		1000 bbls	RV	RV

*RV = Reported Value
**Process upset emissions are not included emissions cap

Table 2 (Cont.)

RECLAIM SO_x Emission Factors

Sufur Oxides Basic Equipment	Fuel	Thruput Units	Starting Emission Factor*	Ending Emission Factor*
Sour Water Oxidizer		1000 bbls fresh feed	RV	RV
Sour Water Coker		1000 bbls fresh feed	RV	RV
Sodium Silicate Furnace		tons of glass pulled	RV	RV
Sulfur Plant		hours of operation	RV	RV
Tail gas unit		hours of operation	RV	RV
Turbines	Refinery Gas	mmcf	RV	6.760
Turbines	Natural Gas	mmcf	RV	0.600
Turbines	Diesel Oil	1000 gal	6.24	4.990
Unit 24 PSA		pounds	RV	RV

*RV = Reported Value
**Process upset emissions are not included emissions cap

(Adopted October 15, 1993)

RULE 2004. REQUIREMENTS

(a) Purpose

The purpose of this rule is to establish the requirements for operating under the RECLAIM program. The rule includes provisions pertaining to permits, Allocations, reporting, variances, and breakdowns.

(b) Compliance Period and Certification of Emissions

(1) The compliance year shall be divided into four quarters for emission reporting and certification purposes. The 30 calendar days after the conclusion of each of the first three quarters shall be a reconciliation period. During the reconciliation period, the Facility Permit holder shall calculate the facility's total emissions for the quarter, acquire and have credited to the facility, pursuant to Rule 2007 - Trading Requirements, any RTCs necessary to reconcile the Allocation to the emissions, and submit to the Executive Officer a Quarterly Certification of Emissions.

(2) The Quarterly Certification of Emissions shall be made in the manner and form specified by the Executive Officer and shall be certified for accuracy by the highest ranking management official with responsibility for operation of equipment subject to the Facility Permit. The Quarterly Certification of Emissions shall be calculated as required by Rules 2011 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) Emissions, and 2012 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions, and Facility Permit conditions applicable to the facility.

(3) Upon receipt of the certified Quarterly Report, the Executive Officer will debit the RTC Listing for the submitting facility by the amount certified in the report.

(4) The 60 calendar days following the last day of each compliance year shall be the reconciliation period for the last quarter. On or before the last day of such reconciliation period, the Facility Permit holder shall calculate the facility's total emissions for the last quarter, acquire and have credited to the facility, pursuant to Rule 2007 - Trading

Requirements, any RTCs necessary to reconcile the Allocations to the emissions, and submit an Annual Permit Emissions Program (APEP) report, as prescribed by the Executive Officer, for the purpose of compliance reporting, permit review, and determination of fees. As part of the APEP report, the Facility Permit holder shall accurately report the information specified in Rule 2015 subparagraph (b)(1)(C), (b)(1)(D), and (b)(1)(H) for the District's annual audit.

(5) Except as provided in subdivision (c), the reconciliation period following the end of a quarter shall be used to reconcile the Allocation only with emissions from that quarter.

(c) Correction of Quarterly Certification of Emissions

(1) The Facility Permit holder may, at any time prior to the end of the reconciliation period for the last quarter of the compliance year, make corrections to any quarterly certification of emissions, provided that the Facility Permit holder demonstrates that:

(A) emissions were inaccurately certified due to an error caused by conditions beyond the reasonable control of the Facility Permit holder; and

(B) the corrected information is accurate; and

(C) the Facility Permit holder has made the correction within thirty days of discovering the error necessitating the correction or within thirty days of when the error reasonably could have been discovered, whichever is earlier.

(2) If a correction is made to a Quarterly Certification of Emissions:

(A) the certification requirements set forth in paragraph (b)(2) shall apply to the correction; and

(B) the RTC Listing will be amended to show the corrected amount.

(C) the Facility Permit holder shall, within 30 days of the amendment to the RTC Listing, but no later than the end of the reconciliation period for the last quarter, acquire any RTCs necessary to reconcile the Allocation to the revised certification.

(d) Prohibition of Emissions in Excess of Annual Allocation

(1) Emissions from a RECLAIM facility from the beginning of a compliance year through the end of any quarter shall not exceed the annual emissions Allocation in effect at the end of the applicable reconciliation period for such quarter. Except as provided in paragraph (d)(2), any such emissions in excess of the Allocation shall constitute a single, separate violation of this rule for each day of the compliance year (365 days).

(2) In the event of a violation of paragraph (d)(1), the Facility Permit holder may, pursuant to this paragraph, establish a number of violations less than that set forth in paragraph (d)(1) above. The number of violations under this paragraph shall be the number of days or portion thereof, during which any source of the subject RECLAIM pollutant operated after the Allocation was exceeded, plus one violation for each 1,000 pounds, or portion thereof, emitted in excess of the Allocation. In order to establish the number of violations under this paragraph, the Facility Permit holder shall have the burden of establishing the number of days, or such lesser period as can be established, that the cumulative facility emissions were less than the annual emission Allocation. If the Facility Permit holder is not able to establish the number of days or period during which the cumulative facility emissions were less than the annual emission Allocation, the facility shall be in violation pursuant to paragraph (d)(1) of this rule.

(3) Subject to Rule 2015 (b)(6), if the average price of RTCs exceeds $8,000 dollars per ton, then for purposes of paragraph (d)(2), one violation per 500 pounds, or portion thereof, of excess emissions shall be used in lieu of one violation per 1,000 pounds or a portion thereof, of excess emissions. The average price of RTCs will be the price most recently determined pursuant to Rule 2015 (b)(1)(E).

(4) For purposes of this rule, emissions from the facility shall be determined solely pursuant to methods and procedures specified in Regulation XX and the Facility Permit, if applicable.

(e) Prohibition of Submission of an Inaccurate Quarterly Certification of Emissions

(1) Any Quarterly Certification of Emissions determined by the Executive Officer to be inaccurate, shall constitute a violation of this rule, unless the report was corrected by the Facility Permit holder in accordance with the requirements of paragraph (c)(1).

(2) A violation of this subdivision shall constitute a single, separate violation of this rule for each day in the quarter.

(f) Permit Requirements

(1) The Facility Permit holder shall, at all times, comply with all rules and permit conditions applicable to the facility, as specified in the Facility Permit.

(2) A person shall not build, erect or install a new source or a modification as defined in Rule 2000 - General, without first complying with Rule 201 - Permit to Construct.

(g) Emissions in Excess of a Concentration Limit

(1) In the event emissions exceed a concentration limit, as established by a source test, the days of violation shall be presumed to include the date of the source test and each and every day thereafter until the Facility Permit holder establishes that continuous compliance has been achieved, except to the extent the Facility Permit holder can prove that there were intervening days during which no violation occurred or that the violation was not continuing in nature.

(2) In the event emissions exceed a concentration limit, as established by a source test, the emissions from the source to which the concentration limit applies shall be calculated using the higher concentration for purposes of determining compliance with the facility's Allocation until the Facility Permit holder demonstrates that it is in compliance with the concentration limit set forth in the Facility Permit.

(h) Federal Requirements for the Use of Clean Fuels or Advanced Control Technology

Effective November 15, 1998, each new, modified, and existing electric utility and industrial and commercial boiler which emits more than 25 tons per year of Oxides of Nitrogen shall:

(1) burn as its primary fuel natural gas, methanol, or ethanol (or a comparably low polluting fuel); or

(2) use advanced control technology, such as catalytic control technology or other comparably effective control methods, for reduction of emissions of Oxides of Nitrogen.

For purposes of paragraph (h)(1), the term "primary fuel" means the fuel which is used 90 percent or more of the operating time. This subdivision shall not apply during any natural gas supply emergency as defined in Title III of the Natural Gas Policy Act of 1978.

(i) Breakdown Provisions

(1) The Facility Permit holder shall report a breakdown by telephone or facsimile to the Executive Officer within one hour of such breakdown or within one hour of the time the Facility Permit holder knew or reasonably should have known of its occurrence. Such report shall identify the time, specific location, equipment involved, responsible party to contact for further information, and, to the extent known, the causes of the breakdown and the estimated amount of the emissions resulting from it. The estimated time for repairs shall be reported as soon as possible thereafter. No breakdown may be claimed pursuant to paragraph (i)(3) if a breakdown report is not made in accordance with this paragraph.

(2) Emissions in excess of those occurring under normal operating conditions ("excess emissions") caused by a breakdown shall not be counted in determining compliance with the annual Allocation provided that within seven (7) days of the breakdown, a Breakdown Emissions Plan is submitted to the Executive Officer which contains all of the following:

(A) an identification of the equipment involved in causing or suspected in having caused or been affected by the breakdown;

(B) the duration of time during which the emissions resulting from the breakdown occurred or are expected to continue;

(C) to the extent known, an identification of the types of emissions resulting from the breakdown;

(D) to the extent known, a quantification of the emissions resulting from the breakdown and the method used to quantify the emissions, consistent with the requirements of Rules 2011 and 2012 and Appendix A for each rule;

(E) the names of all operators of the identified equipment, their immediate supervisors, and the managers responsible for the operation and/or maintenance of the identified equipment;

(F) the names of any witnesses to the breakdown;

(G) evidence substantiating that the emissions resulting from the breakdown did not result from operator error, neglect or improper operation or maintenance procedures;

(H) evidence substantiating that steps were immediately taken to correct the condition causing the breakdown and to minimize the emissions resulting from the breakdown;

(I) evidence substantiating that it was beyond the RECLAIM Facility Permit holder's reasonable control to correct the breakdown condition within 24 hours; and

(J) evidence substantiating that the RECLAIM Facility Permit holder was unable to provide on-site offsets for the excess emissions resulting from the breakdown.

(3) Mass emissions under normal operating conditions shall be calculated using concentration limits, emission factors, emission rates or fuel sulfur content specified in the Facility Permit, and throughput, monitored as required by Rules 2011, 2012, and the Appendices thereto. If such throughput data is not available, throughput determined pursuant to the missing data provisions of the Appendices to Rule 2011 and 2012.

(4) Excess emissions occurring within the first 24 hours after the breakdown shall not be counted in determining compliance with the RECLAIM facility's annual Allocation, if the Breakdown Emissions Plan meets the requirements of subparagraphs (i)(2)(A) through (H).

(5) Excess emissions occurring beyond the first 24 hours and up to thirty (30) days after the breakdown shall not be counted in determining compliance with the RECLAIM facility's annual Allocation if the Breakdown Emissions Plan meets the requirements of subparagraphs (i)(2)(A) through (J).

(6) Excess emission fees shall be assessed pursuant to Rule 301 Permit Fees.

(7) The Executive Officer will notify the RECLAIM Facility Permit holder, in writing, within thirty calendar days of submission, regarding whether the plan is approved or disapproved. If approved, the notification shall specify the duration during which the excess emissions resulting from the breakdown shall not be counted in determining the RECLAIM facility's annual Allocation, and the type and amount of emissions so exempt. If the Executive Officer does not respond within thirty days, the Facility Permit holder may deem the plan denied for appeal purposes.

(j) Tampering

A person shall not tamper or interfere with, alter or adjust any monitoring or other equipment used to detect the amount, concentration, rate or other characteristic of emissions emanating from any source in a RECLAIM facility in any way which conceals or disguises the type and quantity of any such emissions.

(k) Compliance Dates

The failure to comply with any requirement in this regulation within the time specified shall constitute a separate violation for each day until such requirement is satisfied.

(l) Variances

(1) No variance may be granted from the following provisions of this regulation:

(A) any provisions which require Permits to Construct or which set forth requirements for Permits to Construct;

(B) the missing data provisions of Appendices A to Rules 2011 and 2012;

(C) subdivisions (b) and (d) of Rule 2004, and any permit conditions which state annual Allocations.

(2) The appeal and variance rights regarding permit conditions for non-RECLAIM pollutants shall be pursuant to Regulation V - Procedure Before the Hearing Board.

(3) In the event that a variance from any monitoring requirement is issued, emissions shall be determined pursuant to the missing data provisions of the applicable Rule 2011 or 2012 Appendices A for purposes of determining compliance with Rule 2004 (d)(1).

(m) Emergencies

In the event that responses to national, regional, or local emergencies require increased emissions in excess of Department of Defense (DoD) facility Allocations, such emissions shall not be counted for purposes of determining compliance with Rule 2004 (d)(1). The DoD facility will notify the Executive Officer, in writing, within one week after the start of increased emissions caused by emergency operations as listed above.

(n) Missing Data Provisions for Recordkeeping and Reporting

In the event the Executive Officer determines that the emissions data developed or reported by the Facility Permit holder are inaccurate or incomplete or not derived in the manner required by this regulation or the Facility Permit, the mission data provisions set forth in Rules 2011 and 2012, Appendices A shall be used for the purpose of calculating emissions for recordkeeping, reporting, certification, and compliance with Allocations.

(Adopted October 15, 1993)

RULE 2005. NEW SOURCE REVIEW FOR RECLAIM

(a) Purpose

This rule sets forth pre-construction review requirements for new facilities subject to the requirements of the RECLAIM program and for modifications to existing RECLAIM facilities. The purpose of this rule is to ensure that the operation of such facilities does not interfere with progress in attainment of the National Ambient Air Quality Standards, and that future economic growth within the South Coast Air Basin is not unnecessarily restricted.

(b) Requirements for New or Relocated RECLAIM facilities

(1) The Executive Officer shall not approve the application for a Facility Permit to authorize construction or installation of a new or relocated facility unless the applicant demonstrates that:

(A) Best Available Control Technology (BACT) will be applied to every emission source located at the facility; and

(B) the operation of any emission source located at the new or relocated facility will not result in a significant increase in the air quality concentration for NO_2 as specified in Appendix A. The applicant shall use the modeling procedures specified in Appendix A.

(2) The Executive Officer shall not approve the application for a Facility Permit authorizing operation of a new or relocated facility, unless the applicant demonstrates that:

(A) the facility holds sufficient RTCs to offset the total facility emissions for the first year of operation, at a one to one ratio; and

(B) the RTCs procured to comply with the requirements of subparagraph (b)(2)(A) were obtained pursuant to the requirements of subdivision (e).

(c) Requirements for Existing RECLAIM Facilities

(1) The Executive Officer shall not approve an application for a Facility Permit Amendment to authorize the installation of a new source or

modification of an existing source which results in an emission increase as defined in subdivision (d), unless the applicant demonstrates that:

(A) BACT will be applied to the source; and

(B) the operation of the source will not result in a significant increase in the air quality concentration for NO_2 as specified in Appendix A. The applicant shall use the modeling procedures specified in Appendix A.

(2) The Executive Officer shall not approve an application for a Facility Permit Amendment to authorize operation of the new or modified source which results in an emission increase as defined in subdivision (d), unless the applicant demonstrates that the facility holds sufficient RTCs to offset the annual emission increase for the first year of operation at a one to one ratio.

(3) The Executive Officer shall not approve an application to increase an annual Allocation to a level greater than the facility's starting Allocation plus non-tradeable credits, unless the applicant demonstrates that:

(A) each source which creates an emission increase as defined in subdivision (d) will:

(i) apply BACT;

(ii) not result in a significant increase in the air quality concentration for NO_2 as specified in Appendix A; and

(B) the facility holds sufficient RTCs acquired pursuant to subdivision (e) to offset the annual increase in the facility's starting Allocation plus non-tradeable credits at a one to one ratio for a minimum of one year.

(d) Emission Increase

An increase in emissions occurs if a source's maximum hourly potential to emit immediately prior to the proposed modification is less than the source's post-modification maximum hourly potential to emit. The amount of emission increase will be determined by comparing pre-modification and post-modification emissions on an annualized basis by using: (1) an operating schedule of 24 hours per day, 365 days per year; or (2) a permit condition limiting mass emissions.

(e) Trading Zones Restrictions

Any increase in an annual Allocation to a level greater than the facility's starting plus non-tradeable Allocations, and all emissions from a new or relocated facility must be fully offset by obtaining RTCs originated in one of the two trading zones as illustrated in the RECLAIM Trading Zones Map. A facility in Zone 1 may only obtain RTCs from Zone 1. A facility in Zone 2 may obtain RTCs from either Zones 1 or 2, or both.

(f) Offsets

Any facility which was required to provide offsets pursuant to paragraphs (b)(2), (c)(2) or subparagraph (c)(3)(B) shall, at the commencement of each compliance year, hold RTCs in an amount equal to the amount of such required offsets. The Facility Permit holder may reduce the amount of offsets required pursuant to this subdivision by accepting a permit condition limiting emissions which shall serve in lieu of the starting Allocation plus non-tradeable credits for purposes of paragraph (c)(3). Unused RTCs acquired to comply with this subdivision or with paragraphs (b)(2), (c)(2), or subparagraph (c)(3)(B) may be sold only during the reconciliation period for the fourth quarter of the applicable compliance year. The Facility Permit for a new or modified facility shall require compliance with this subparagraph, if applicable.

(g) Additional Federal Requirements for Major Stationary Sources

The Executive Officer shall not approve the application for a Facility Permit or an Amendment to a Facility Permit for a new, relocated or modified major stationary source, as defined in the Clean Air Act, 42 U.S.C. Section 7511a(e), unless the applicant:

(1) certifies that all other major stationary sources in the state which are controlled by the applicant are in compliance with all applicable federal, state and local emission limitations or standards (42 U.S.C. Section 7503(a)(3)); and

(2) submits an analysis of alternative sites, sizes, production processes and environmental control techniques for the proposed source which demonstrates that the benefits of the proposed source significantly

outweigh the environmenta nd social cost imposed as a result of its location, construction, or moaification (42 U.S.C. Section 7503(a)(5)).

(h) Public Notice

The applicant shall provide public notice, if required, pursuant to Rule 212 - Standards for Approving Permits.

(i) Rule 1401

All new or modified sources shall comply with the requirements of Rule 1401 - New Source Review of Carcinogenic Air Contaminants, if applicable.

(j) Compliance with State and Federal New Source Review Requirements

By May of each year, beginning in 1995, the Executive Officer will report to the District Governing Board regarding the effectiveness of Rule 2005 in meeting the federal New Source Review (NSR) requirements for the preceding year. The Executive Officer may impose permit conditions to monitor and ensure compliance with such requirements.

(k) Exemptions

(1) Functionally identical source replacements are exempt from the requirements of subparagraph (c)(1)(B) of this rule.

(2) Physical modifications that consist of the installation of equipment where the modification will not increase the emissions rate of any RECLAIM pollutant, and will not cause an increase in emissions above the facility's current year Allocation, shall be exempt from the requirements of paragraph (c)(2).

(3) Increases in hours of operation or throughput for equipment or processes permitted prior to October 15, 1993 that the applicant demonstrates would not violate any permit conditions in effect on October 15, 1993 which were imposed in order to limit emissions to implement New Source Review offset requirements, shall be exempt from the requirements of this rule.

APPENDIX A

The following sets forth the procedure for complying with the air quality modeling requirements. An applicant must either (1) provide an analysis, or (2) show by using the Screening Analysis below, that a significant increase in air quality concentration will not occur.

Table A-1 of the screening analysis is subject to change by the Executive Officer, based on improved modeling data.

SCREENING ANALYSIS

Compare the emissions from the equipment you are applying for to those in Table A-1. If the emissions are less than the allowable emissions, no further analysis is required. If the emissions are greater than the allowable emissions, a more detailed air quality modeling analysis is required.

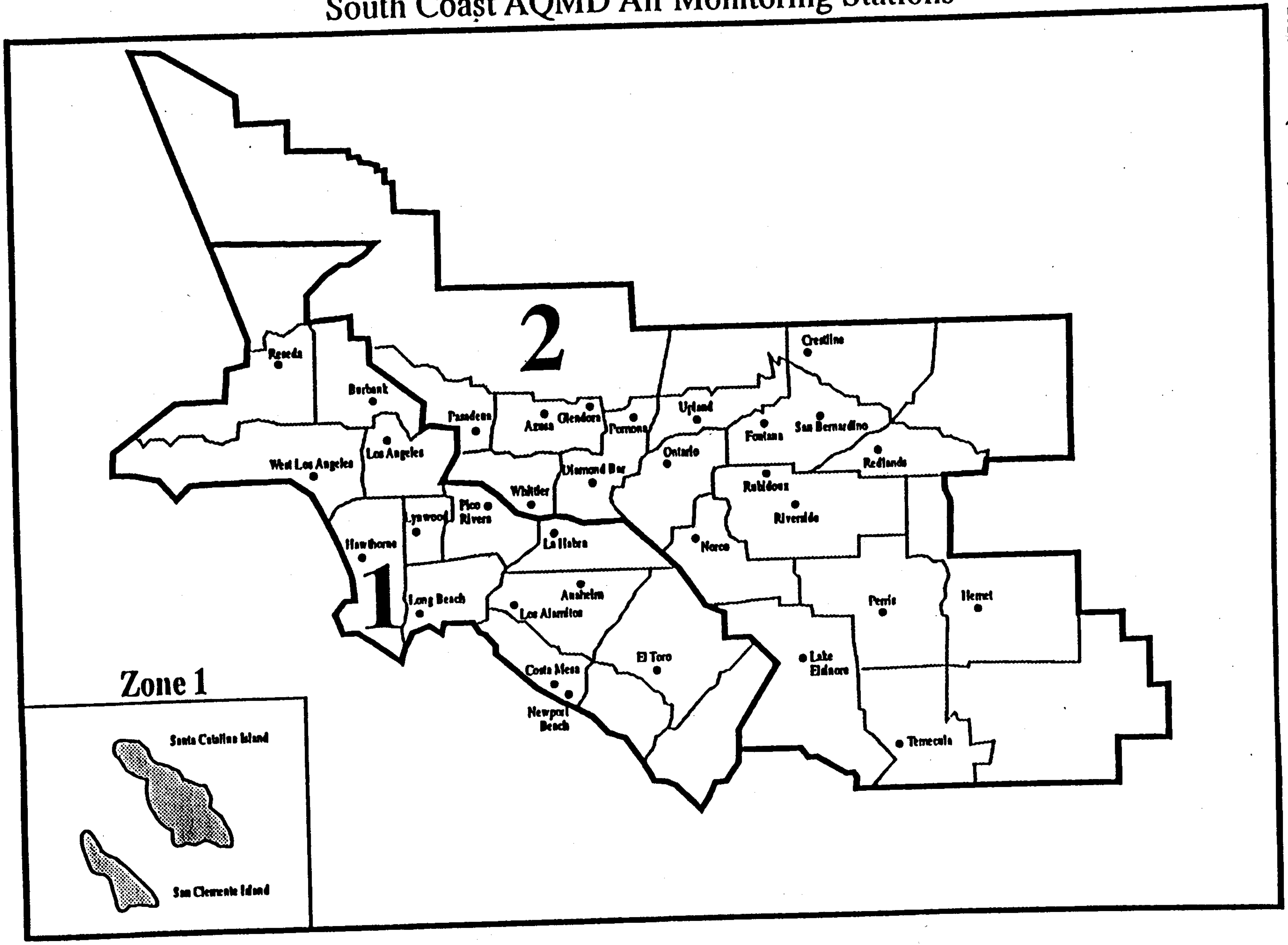
Table A-1
Allowable Emissions
for Noncombustion Sources and for
Combustion Sources less than 40 Million BTUs per hour

Heat Input Capacity (million BTUs/hr)	NO_x (lbs/hr)
Noncombustion Source	0.068
2	0.20
5	0.31
10	0.47
20	0.86
30	1.26
40	1.31

Table A-2
Most Stringent Ambient Air Quality Standard and
Allowable Change in Concentration
For Each Air Contaminant/Averaging Time Combination

Air Contaminant	Averaging Time	Most Stringent Air Quality Standard		Significant Change in Air Quality Concentration	
Nitrogen Dioxide	1-hour	25 pphm	500 ug/m^3	1 pphm	20 ug/m^3
	Annual	5.3 pphm	100 ug/m^3	0.05 pphm	1 ug/m^3

RECLAIM Trading Zones
South Coast AQMD Air Monitoring Stations



PLACEMENT OF REGULATION XIII EMISSIONS OFFSET ZONES INTO RECLAIM TRADING ZONES

	RECLAIM Trading Zone 1	RECLAIM Trading Zone 2
REGULATION XIII EMISSION OFFSET ZONES	1	8
	2	9
	3	10
	4	11
	5	
	6	15 (In Part)
	7	22
	12	23
	13	24
	16	25
	17	26
	18	27 (In Part)
	19	28
	20	
	21	32
		33
		34
		35
		36
		37
		38

(Adopted October 15, 1993)

RULE 2006. PERMITS

(a) Purpose

The purpose of this rule is to set forth the procedures for issuing and amending Facility Permits.

(b) Issuance of Facility Permit

(1) The Executive Officer will compile a draft inventory of sources at each Cycle 1 RECLAIM facility and provide the draft inventory to the prospective Facility Permit holder of each such facility. No later than six months after providing the draft inventories to the Cycle 1 facilities, the Executive Officer will compile a draft inventory of sources at each Cycle 2 RECLAIM facility and provide the draft inventory and to the prospective Facility Permit holder of each such facility.

(2) Within 30 days of receipt of the draft inventory, the prospective Facility Permit holder shall submit inventory corrections to the Executive Officer. At a minimum, the prospective Facility Permit holder shall identify each source of RECLAIM pollutants located at the facility, and shall submit equipment descriptions and operating parameters for such sources if required by the Executive Officer. Equipment previously exempt pursuant to Rule 219 - Equipment Not Requiring a Written Permit Pursuant to Regulation II, shall be listed by category. Inventory corrections shall be submitted in a form and manner specified by the Executive Officer.

(3) After receiving the corrected list of emission sources from the facility, the Executive Officer will, based on the corrected list and any other relevant information, issue a Facility Permit for each RECLAIM facility. The Facility Permit will be issued by January 1, 1994 for Cycle 1 facilities and by July 1, 1994 for Cycle 2 facilities.

(4) Each Facility Permit shall include the following terms and conditions:

(A) a description of each source or process unit and emission control device located at the facility, including sources of non-RECLAIM pollutants. Equipment previously exempt pursuant to Rule 219 - Equipment Not Requiring a Written Permit Pursuant to

Regulation II, shall be listed by category and updated annually with the submittal of the APEP Report.

(B) a starting Allocation for the initial compliance year, which shall be calculated pursuant to Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x);

(C) an Allocation for each compliance year through the year 2010, determined pursuant to Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x);

(D) emission rates, or concentration limit, if applicable, and emission monitoring, recordkeeping and reporting conditions for each emission source in accordance with Rules 2011 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) Emissions, 2012 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions;

(E) applicable federal Clean Air Act Title V requirements;

(F) conditions, other than concentration limits, appropriate to ensure that the source is operated within the applicable range of any emission rate specified for the source pursuant to Rules 2011 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) Emissions, 2012 - Requirements for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions;

(G) all permit conditions applicable to sources at the facility which were in effect immediately prior to issuance of the Facility Permit and which relate to toxics and other non-RECLAIM pollutants;

(H) conditions necessary to ensure continued compliance with BACT requirements imposed prior to issuance of the Facility Permit;

(I) all permit conditions applicable to sources at the facility immediately prior to issuance of the Facility Permit, provided that, unless the conditions are otherwise required by this regulation, such conditions will be in effect only until December 31, 1994 for Cycle 1 facilities and June 30, 1995 for Cycle 2 facilities, or until such earlier date as of which the Executive Officer determined in writing that the facility has complied with all monitoring and reporting requirements of Rule 2011 or 2012, as applicable;

(J) permit conditions to ensure enforceability of, and compliance with, all applicable District rules and state and federal statutes and regulations which the District has jurisdiction to enforce;

(K) the term of the Facility Permit; and

(L) any other provisions necessary to assure compliance with District rules or state or federal statutes or regulations.

(5) For facilities identified after January 1, 1994 as being subject to RECLAIM pursuant to Rule 2001 (c)(1)(D), the Executive Officer will issue a Facility Permit which will contain those provisions specified in paragraph (b)(4) of this rule.

(6) For facilities which enter RECLAIM pursuant to Rule 2001 (f), the Facility Permit will contain those provisions specified in paragraph (b)(4) of this rule.

(7) The Facility Permit shall serve as the Permit to Operate within the meaning of Rule 203 - Permit to Operate, for all equipment and sources at the facility. All valid preexisting Permits to Operate and Permits to Construct will be incorporated into the Facility Permit. An amendment to a Facility Permit may constitute both a Permit to Construct a modified source within the meaning of Rule 201 - Permit to Construct, and a Permit to Operate the modified source.

(8) Operation of any source that is not listed in the Facility Permit in the manner described in subparagraph (b)(4)(A) shall constitute a violation of this rule.

(9) The terms and conditions of the Facility Permit may be appealed to the Hearing Board. Such an appeal shall be filed within 10 days of the issuance of the permit or amendment thereto. The pendency of an appeal shall not stay the effect of the permit.

(c) Amendments to Facility Permits and the RTC Listing

(1) The Executive Officer will decrease an Allocation when the Facility Permit holder is a seller of RTCs and has complied with Rule 2007 - Trading Requirements.

(2) The Executive Officer will decrease a facility's Allocation pursuant to Rule 2010 (b)(1) when the Facility Permit holder has been found to be in violation of Rule 2004 (d).

(3) The Executive Officer will increase an Allocation when:

(A) the buyer of RTCs has an approved Facility Permit;

(B) the Facility Permit holder has complied with Rule 2007 - Trading Requirements, and with Rule 2005 - New Source Review for RECLAIM, if applicable; and

(C) the buyer of RTCs has not requested an RTC certificate.

(4) The Executive Officer shall deny any application for permit amendment unless the applicant demonstrates that operation of the facility, pursuant to the proposed revised permit will comply with all applicable District rules, and state and federal statutes and regulations which the District has jurisdiction to enforce.

(5) The Executive Officer may, upon annual renewal and after 30-day notice to the Facility Permit holder, add or amend written conditions on the Facility Permit to assure compliance with, and enforceability of, any applicable District rule, or state or federal statute or regulation which the District has jurisdiction to enforce.

(Adopted October 15, 1993)

RULE 2007. TRADING REQUIREMENTS

(a) Purpose

The purpose of this rule is to define the RECLAIM trading unit and to establish trading requirements for RECLAIM.

(b) Nature of RECLAIM Trading Credits (RTCs)

(1) An RTC is a limited authorization to emit RECLAIM pollutants in accordance with the restrictions and requirements of District rules and state and federal law.

(2) An RTC may be bought, sold, traded or otherwise transferred or acquired in accordance with the provisions of this rule.

(3) An RTC shall not constitute a security or other form of property, but may be used as collateral or security for indebtedness.

(4) The District reserves the right to amend the RECLAIM rules in response to program reevaluations pursuant to Rule 2015 - Backstop Provisions, or at other times. Nothing in District rules shall be construed to limit the District's authority to condition, limit, suspend or terminate any RTCs or the authorization to emit which is represented by a Facility Permit.

(c) Term of RTCs

(1) An RTC shall be denominated in terms of one pound of a RECLAIM pollutant and shall have a term of one year. Cycle 1 facilities, representing approximately half of the total RTCs allocated in each trading zone, will receive RTCs that have an issue date of January 1 and an expiration date of December 31. The remaining Cycle 2 facilities will receive RTCs that have an issue date of July 1 and an expiration date of June 30.

(2) A Facility Permit holder may acquire and use RTCs issued in either cycle regardless of the facility's initial RTC allocation cycle. However, the expiration date of an RTC is not affected by trading for use in the other cycle.

(3) A Facility Permit holder may acquire and use expired RTCs to reconcile emissions during a quarter in which the annual Allocation was exceeded, if the following conditions are met:

(A) such transaction and use occurs during the reconciliation period immediately following the quarter during which the subject emissions occurred; and

(B) the RTCs are used to reconcile emissions that occurred during the RTC term.

(d) RTC Listing

The Executive Officer will maintain an RTC Listing specifying all RTCs held by each facility or person. The listing is the official and controlling record of RTC holdings. The Executive Officer will amend the RTC Listing upon any of the following actions:

(1) RTC transfer;

(2) change in name of an RTC holder;

(3) expiration of unused RTCs;

(4) a reduction of a facility's annual emission Allocation pursuant to Rule 2010 (b)(1)(A); or

(5) at the end of each quarter's reconciliation period.

(e) Acquisition of RTCs

RTCs may be acquired only as follows:

(1) Initially, the Facility Permit holder is granted, pursuant to Rule 2002, RTCs for each year equal to the facility's annual Allocation for that year.

(2) Any person may acquire RTCs through purchase, trade or other means of transfer from any person who holds RTCs. The following requirements shall govern the transfer of RTCs:

(A) The transfer of RTCs shall be effective only upon amendment by the Executive Officer of the RTC Listing.

(B) The Executive Officer shall not amend the RTC Listing unless the seller and the buyer have jointly filed a Registration of RTC Transfer. The Registration of RTC Transfer shall include, but not be limited to, the following information:

(i) identification of the seller and buyer;

(ii) RTC issue date;

(iii) the amount and type of emissions;

(iv) the transaction date and the date on which the transfer is to be effective;

(v) the Regulation XIII zone and the RECLAIM trading zone from which the RTCs originated;

(vi) the price per pound of emissions, if sold;

(vii) if the RTCs for transfer are for the current compliance year, the seller shall indicate one or more of the following four causes for the generation of RTCs:

(I) process change;

(II) addition of control equipment;

(III) production decrease;

(IV) equipment or facility shutdown; or

(V) if the seller is not a RECLAIM facility, and cause for generation has been previously reported, no cause need be indicated.

(viii) if the RTCs for transfer are valid for a subsequent compliance year, the seller shall comply with clause (vii) or may alternatively indicate that the manner of generating the RTCs has not yet been determined;

(ix) the buyer shall indicate one or more of the following three uses of the RTCs:

(I) issuance of RTC Certificate;

(II) increase of Allocation to satisfy annual compliance or increased production; or

(III) use under Rule 2005 - New Source Review for RECLAIM.

(C) Joint registration may be submitted by an agent, broker, or other intermediary representing the buyer and seller. Such parties, upon approval by the Executive Officer, may report summarized price information, such as daily or weekly volumes with closing prices.

(D) The Executive Officer shall not amend the RTC Listing to identify a new holder of RTCs, or to add RTCs to an existing RTC holder, until an equivalent amount of RTCs are debited from the seller.

(E) When RTCs are transferred from an Allocation, the debit shall result in an automatic amendment of the Allocation.

(F) When the buyer is a RECLAIM facility, the Executive Officer shall amend the buyer's Allocation or issue an RTC certificate in the name of the buyer, as requested pursuant to subparagraph (e)(2)(G).

(G) When the buyer is not a RECLAIM facility the Executive Officer will issue an RTC certificate in the name of the buyer.

(f) Date of Eligibility for Trading of RTCs

(1) RTCs issued as part of an Allocation are eligible for transfer upon approval of the Facility Permit;

(2) RTCs credited pursuant to Rule 2008 - Mobile Source Credits, are eligible for transfer upon issuance; and

(3) RTCs to replace existing ERCs held by non-RECLAIM facilities pursuant to Rule 2002 (c)(5) are eligible for transfer upon issuance.

(g) RTC Certificates

(1) RTC Certificates may only be issued by the Executive Officer for RTCs which are not part of an Allocation.

(2) RTC Certificates shall designate the name of the holder, the Regulation XIII zone and RECLAIM trading zone from which the RTC originated, the issue date, the expiration date, and an annual emissions value.

(3) RTC Certificates may be acquired by transfer as set forth in subdivision (e). In addition, a Facility Permit holder may elect to reduce the Allocation and, upon such amendment to the Facility Permit by the Executive Officer, shall be issued an RTC Certificate. The value of the certificate shall be equivalent to the reduction in the Allocation in the year for which the certificate is issued.

(4) RTC certificates may be surrendered for application to create or increase an Allocation.

(h) Retirement of RTCs

RTCs may be surrendered to the District for retirement from the market. All RTC retirements will be documented annually through the annual program audit, and used to provide further progress for clean air. RTCs retired to their issue date shall be exempt from the RTC Allocation Fee specified in Rule 301 - Permit Fees.

(i) RTC Trading Prohibition

No person shall, in connection with any agreement or proposed agreement for the transfer of any RTC, knowingly make or cause to be made to any other person any false report or statement regarding RTCs.

(Adopted October 15, 1993)

RULE 2008. MOBILE SOURCE CREDITS

(a) Purpose

The purpose of this rule is to establish criteria for and requirements on utilizing emission reductions generated from 1600 series rules as RTCs.

(b) Requirements

(1) RTCs may be issued based on emission reductions which comply with all requirements of any 1600 series rule, except that any person may generate and receive such RTCs. RTCs may only be generated from vehicles registered in the Basin.

(2) In order to receive RTCs pursuant to Rule 1610 as specified in this rule, a minimum of 100 vehicles shall be scrapped, subsequent to the adoption of this rule.

(3) The first annual issue date of RTCs shall be the scheduled RTC issue date immediately following the date on which the reductions were deemed eligible for use pursuant to Regulation XVI - Mobile Source Offset Programs, or the current compliance year, if requested. Zone 1 shall be the zone of origination for all RTCs obtained pursuant to this rule.

(c) Limitations

The Executive Officer will approve plans for scrapping vehicles pursuant to Regulation XVI, for no more than 30,000 vehicles per year.

(Adopted October 15, 1993)

RULE 2010. ADMINISTRATIVE REMEDIES AND SANCTIONS

(a) Purpose

This rule specifies provisions to ensure that RECLAIM facilities which exceed their Allocation provide compensating emission reductions. This rule also provides for administrative penalties for RECLAIM rule violations.

(b) Emissions in Excess of Allocation

(1) Upon determining that a Facility Permit holder has violated Rule 2004 (d), the Executive Officer will:

(A) reduce the facility's annual emissions Allocation for the subsequent compliance year by the total amount the Allocation was exceeded;

(B) revise the Facility Permit to impose any conditions the Executive Officer determines to be appropriate to prevent future violations of Rule 2004 (d).

(2) If the Executive Officer petitions for a permit revocation pursuant to Health and Safety Code Section 42307 due to a violation of Rule 2004 (d), and the Hearing Board finds that Rule 2004 (d) was violated, it may revoke the Facility Permit pursuant to Health and Safety Code Section 42309 and invalidate all RTCs held for the facility's use. Any subsequent application for a Facility Permit filed for that facility shall be subject to all requirements of Rule 2005 - New Source Review for RECLAIM.

(c) Administrative Penalties

(1) For any violation of RECLAIM, the Executive Officer may seek an administrative penalty up to $500 per violation, per day, pursuant to Health and Safety Code Section 42402.5. If administrative penalties are sought, the Executive Officer will:

(A) provide written notice of the administrative penalty to the Facility Permit holder, including a written explanation of the basis for the penalty;

(B) provide an opportunity for a hearing by the Executive Officer or designee(s) within thirty (30) days of the date of the notice. The hearing shall include the right to call and examine witnesses under oath, the right to introduce exhibits, and the right to a record of the hearing.

(C) The hearing shall not be conducted according to technical rules of evidence. The rules of privilege shall be effective to the same extent that they are recognized in civil actions, and irrelevant evidence shall be excluded.

(D) Within thirty (30) days after the hearing, the Executive Officer or designee(s) will mail to the Facility Permit holder a notice of final decision including a statement of reasons therefore.

(E) In determining the amount of administrative penalty to be assessed, the Executive Officer or designee(s) will take into account all relevant circumstances, including but not limited to, the factors specified in Health and Safety Code Section 42403.

(2) The Facility Permit holder shall pay any administrative penalty within thirty (30) days after receipt of notice pursuant to subparagraph (c)(1)(A), or if a hearing has been held, within thirty (30) days of the date of receipt of notice pursuant to subparagraph (c)(1)(D). If the penalty is not paid when due, the Executive Officer may petition the Hearing Board to revoke the Facility Permit. If the Hearing Board finds that the penalties have not been paid, it shall revoke the Facility Permit.

(d) Other Remedies and Sanctions

The remedies and sanctions provided in this rule are in addition to any sanctions, penalties, actions or other remedies available under law.

(Adopted October 15, 1993)

RULE 2011. REQUIREMENTS FOR MONITORING, REPORTING, AND RECORDKEEPING FOR OXIDES OF SULFUR (SO_x) EMISSIONS

(a) Purpose

The purpose of this rule is to establish the monitoring, reporting, and recordkeeping requirements for SO_x emissions under the RECLAIM program.

(b) Applicability

The provisions of this rule shall apply to any RECLAIM SO_x source or SO_x process unit. The SO_x sources and process units regulated by this rule include, but are not limited to:

Boilers	Fluid Catalytic Cracking Units
Internal Combustion Engines	Dryers
Heaters	Fume Incinerators/Afterburners
Gas Turbines	Test Cells
Furnaces	Tail Gas Units
Kilns and Calciners	Sulfuric Acid Production
Ovens	Waste Incinerators

(c) Major SO_x Source

(1) Major SO_x source means any of the following SO_x sources:

(A) any petroleum refinery fluid catalytic cracking unit;

(B) any tail gas unit;

(C) any sulfuric acid production unit;

(D) any equipment that burns refinery, landfill or sewage digester gaseous fuel, except gas flares;

(E) any existing equipment using SO_x CEMS or equivalent monitoring device, or that is required to install such monitoring device under District rules to be implemented as of October 15, 1993;

(F) any SO_x source or process unit elected by the Facility Permit holder or required by the Executive Officer to be monitored with a CEMS or equivalent monitoring device;

(G) any SO_x source or process unit for which SO_x emissions reported pursuant to Rule 301 - Permit Fees, were equal to or greater than 10 tons per year for any calendar year between 1987 to 1991, inclusive, excluding any SO_x source or process unit which has reduced SO_x emissions to below 10 tons per year prior to January 1, 1994.

(2) The Facility Permit holder of a major SO_x source shall:

(A) install, maintain, and operate a direct monitoring device for each major SO_x source to continuously measure the concentration of SO_x emissions or fuel sulfur content and all other applicable variables specified in Table 2011-1 and Appendix A, Chapter 2, Table 2-A; or

(B) install, maintain, and operate an alternative monitoring device which has been determined by the Executive Officer to be equivalent to CEMS in relative accuracy, reliability, reproducibility and timeliness according to the requirements set forth in Appendix A, Chapter 2.

(3) The Facility Permit holder of a major SO_x source shall:

(A) install, maintain, and operate a reporting device to electronically report to the District Central SO_x Station for each major SO_x source: total daily mass emissions of SO_x and daily status codes. Such data shall be transmitted by 5:00 p.m. of the following day. If the facility experiences a power, computer, or other system failure that prevents the reporting of total daily mass emissions of SO_x and daily status codes, the Facility Permit holder shall be granted 12 hours to submit the required report; after the 12-hour extension, emissions shall be calculated pursuant to the missing data requirements set forth in Appendix A, Chapter 2; and

(B) submit Monthly Emissions Report aggregating SO_x emissions from all major sources within 10 days following the end of each calendar month. In its Monthly Emissions Report, the Facility Permit holder may correct daily transmitted data for that month, provided such corrections are clearly identified and justified.

(d) SO_x Process Unit

(1) SO_x process unit is one or more pieces of SO_x emitting equipment which are not major SO_x sources or equipment designated in Rule 219 - Equipment Not Requiring a Written Permit Pursuant to Regulation II, provided that each piece of equipment in a process unit is subject to an identical emission factor as specified in paragraphs (d)(3) through (d)(5).

(2) The Facility Permit holder of a SO_x process unit shall comply with paragraphs (c)(2) and (c)(3) for any SO_x process unit, or elect to comply with the following:

(A) install, maintain, and operate a totalizing fuel meter and/or timer, or any device approved by the Executive Officer to be equivalent in accuracy, reliability, reproducibility and timeliness, for the SO_x process unit, to measure quarterly fuel usage or other applicable measured variables specified in Table 2011-1, and Appendix A, Chapter 3, Table 3-A; and

(B) report the calculated quarterly SO_x emissions, for each SO_x process unit as part of the Quarterly Certification of Emissions required by Rule 2004 - Requirements; and

(C) accept the emission factor as specified pursuant to paragraphs (d)(3), (d)(4), or (d)(5) in the Facility Permit, as the sole method for determining mass emissions for all purposes, including, but not limited to, determining:

(i) compliance with the annual allocations;

(ii) excess emissions;

(iii) the amount of penalties; and

(iv) fees.

(3) Starting January 1, 1994 for Cycle 1 facilities, and July 1, 1994 for Cycle 2 facilities, calculations of mass emissions from each process unit shall be based upon the emission factor specified in Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x). The emission factor for each process unit will be specified in the Facility Permit and

will remain valid unless amended by the Executive Officer pursuant to paragraphs (d)(4) or (d)(5).

(4) A Facility Permit holder may apply to the Executive Officer to amend the emission factor in the Facility Permit for a SO_x process unit at any time. If the applicant demonstrates to the Executive Officer that the alternative emission factor is reliable, accurate, and representative for the purpose of calculating SO_x emissions, the Executive Officer will amend the Facility Permit to incorporate the alternative emission factor. The alternative emission factor shall take effect prospectively from the date the Facility Permit is amended.

(5) The Executive Officer may amend the Facility Permit at any time to specify an alternative emission factor for a SO_x process unit if the alternative emission factor is determined to be more reliable, accurate, or representative of that unit's emissions than the previous emission factor stated in the Facility Permit. The alternative emission factor shall take effect prospectively from the date the Facility Permit is amended.

(e) General Requirements

(1) A Facility Permit holder shall at all times comply with all requirements specified in subdivisions (c), (d), (e), (f) and (g) for monitoring, reporting and recordkeeping, including but not limited to, measuring, reporting, timesharing, determining mass emissions, and installing, maintaining or operating monitoring, measuring, and reporting devices, in accordance with the applicable requirements set forth in Appendix A.

(2) The monitoring system and the applicable method for determination of mass emissions for each SO_x source or process unit will be specified in the Facility Permit, in accordance with the applicable requirements set forth in Appendix A.

(3) The time-sharing of CEMS or equivalent devices among SO_x sources may be allowed by the Executive Officer in accordance with the requirements for time-sharing specified in Appendix A. In such cases, the Executive Officer will specify conditions in the Facility Permit upon which time-sharing may occur.

(4) Any monitoring system certified prior to October 15, 1993 requiring a change to its full scale span range in order to meet the certification requirements set forth in Appendix A, shall be recertified by the District in accordance with the recertification requirements specified in Chapter 2, Section B.15, in Appendix A.

(5) The Executive Officer may at any time require a Facility Permit holder to use a specific monitoring and reporting system if the Executive Officer determines that the elected system is inadequate to accurately determine mass emissions.

(6) The sharing of totalizing fuel meters may be allowed by the Executive Officer if the process units served by the fuel meters have the same emission factor.

(7) A Facility Permit holder of any SO_x major source, process unit, or piece of equipment which is exempt from permit requirements pursuant to Rule 219 - Equipment Not Requiring a Written Permit Pursuant to Regulation II, shall determine SO_x emissions according to the methodology specified in Appendix A. Process units, or pieces of equipment exempt from permit requirements pursuant to Rule 219 shall report such SO_x emissions in the Quarterly Certification of Emissions required by Rule 2004 - Requirements.

(f) Compliance Schedule

(1) Facilities with existing CEMS and fuel meters as of October 15, 1993 shall continue to follow recording and reporting procedures required by District rules and regulations in effect immediately prior to October 15, 1993 until December 31, 1994 for Cycle 1 facilities and June 30, 1995 for Cycle 2 facilities.

(2) Between January 1, 1994 and December 31, 1994 for Cycle 1 facilities and between July 1, 1994 and June 30, 1995 for Cycle 2 facilities, interim emission reports shall be submitted to the District by the Facility Permit holder. The interim reports shall comply with all of the data requirements of this rule and Appendix A, except that the reporting frequency shall be monthly for major sources, and quarterly for process

units. Such reports shall be subm:tted by the tenth day of each month for major sources, and as specified in paragraph (b)(2) of Rule 2004 - Requirements, for process units.

(3) A Facility Permit holder shall install, maintain and operate a totalizing fuel meter for each major source and a totalizing fuel meter and/or timer or any device approved by the Executive Officer to be equivalent in accuracy, reliability, reproducibility, and timeliness for each process unit by January 1, 1994 for Cycle 1 facilities, and July 1, 1994 for Cycle 2 facilities, except that sharing of such devices may be allowed, pursuant to paragraphs (e)(3) and (e)(6).

(4) All required or elected monitoring and reporting systems specified in subdivision (c) and (d) shall be installed no later than December 31, 1994 for Cycle 1 facilities and June 30, 1995 for Cycle 2 facilities. Monitoring, Reporting, and Recordkeeping (MRR) Forms will be provided by the Executive Officer by November 15, 1993 for Cycle 1 facilities and April 15, 1994 for Cycle 2 facilities. The information required on such MRR forms shall be submitted no later than December 31, 1993 for Cycle 1 facilities and June 30, 1994 for Cycle 2 facilities.

(5) The Facility Permit holder of an existing facility which elects to enter RECLAIM or a facility which is required to enter RECLAIM shall install all required or elected monitoring, reporting and recordkeeping systems no later than 12 months after entry into RECLAIM. During the 12 months prior to the installation of the required or elected monitoring, reporting and recordkeeping systems, the Facility Permit holder shall comply with the monitoring requirements of paragraph (f)(3) of this rule.

(g) Recordkeeping

The Facility Permit holder of a major source or SO_x process unit shall maintain all data required to be measured or reported pursuant to this rule and Appendix A for three years after each APEP report is submitted to the District. All records shall be made available to the District staff upon request.

(h) Source Testing

(1) All required source testing shall comply with applicable District Source Test Methods 1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 4.1, 6.1, 100.1 and 307-91; ASTM Methods D3588-91, D4891-89, D1945-81, D4294-91, and D2622-82, and EPA Method 19.

(i) Exemption

The provisions of this rule shall not apply to gas flares.

(j) Appendix A

All provisions of Appendix A are incorporated herein by reference.

Attachment: Appendix A - "Protocol for Monitoring, Reporting and Recordkeeping for Oxides of Sulfur (SO_x) Emissions."

Table 2011-1

MEASURED VARIABLES AND REPORTED DATA FOR SO_x SOURCES

SO_x SOURCES	MEASURED VARIABLES	RECORDING FREQUENCY	REPORTED DATA	TRANSMITTING/ REPORTING FREQUENCY
All sources subject to Paragraphs (c)(2) and (c)(3)	Stack SO_x concentration, Exhaust flow rate, and Status codes OR SO_x concentration, Stack O_2 concentration, Fuel flow rate and Status codes OR Fuel sulfur content, Fuel flow rate, and Status codes	Once every 15 minutes	Total daily mass emissions from each source Daily status codes	Once a day for transmitting/ once a month for reporting
SO_x Process units subject to Paragraph (d)(2)	Fuel usage OR Operating time and Production/Processing/ Feed rate	Quarterly	Total quarterly mass emissions	Once a quarter for reporting

(Adopted October 15, 1993)

RULE 2012. REQUIREMENTS FOR MONITORING, REPORTING, AND RECORDKEEPING FOR OXIDES OF NITROGEN (NO_x) EMISSIONS

(a) Purpose

The purpose of this rule is to establish the monitoring, reporting and recordkeeping requirements for NO_x emissions under the RECLAIM program.

(b) Applicability

The provisions of this rule shall apply to any RECLAIM NO_x source or NO_x process unit. The NO_x sources and process units regulated by this rule include, but are not limited to:

Boilers	Fluid Catalytic Cracking Units
Internal Combustion Engines	Dryers
Heaters	Fume Incinerators/Afterburners
Gas Turbines	Test Cells
Furnaces	Tail Gas Units
Kilns and Calciners	Sulfuric Acid Production
Ovens	Waste Incinerators

(c) Major NO_x Source

(1) Major NO_x Source means any of the following NO_x sources:

(A) any boiler, furnace, oven, dryer, heater, incinerator, test cell and any solid, liquid or gaseous fueled equipment with a maximum rated capacity:

(i) greater than or equal to 40 but less than 500 million Btu per hour and an annual heat input greater than 90 billion Btu per year; or

(ii) 500 million Btu per hour or more irrespective of annual heat input;

(B) any internal combustion engine with rated brake horsepower (bhp) greater than or equal to 1,000 bhp and operating more than 2,190 hours per year;

(C) any gas turbine rated greater than or equal to 2.9 megawatts excluding any emergency standby equipment or peaking unit;

(D) any petroleum refinery fluid catalytic cracking unit;

(E) any petroleum refinery tail gas unit;

(F) any kiln or calciner with a rated process weight greater than or equal to 10 tons per hour and processing more than 21,900 tons per year;

(G) any equipment burning or incinerating solid fuels or materials;

(H) any existing equipment using NO_x CEMS or that is required to install CEMS under District rules to be implemented as of October 15, 1993;

(I) any NO_x source or process unit elected by the Facility Permit holder or required by the Executive Officer to be monitored with a CEMS;

(J) any NO_x source or process unit for which NO_x emissions reported pursuant to Rule 301 - Permit Fees, were equal to or greater than 10 tons per year for any calendar year between 1987 to 1991, inclusive, excluding NO_x sources or process units listed under subparagraphs (d)(1)(A) through (d)(1)(E), and (e)(1)(A) through (e)(1)(D) and excluding any NO_x source or process unit which has reduced NO_x emissions to below 10 tons per year prior to January 1, 1994.

(2) The Facility Permit holder of a major NO_x source shall:

(A) install, maintain and operate a direct monitoring device for each major NO_x source to continuously measure the concentration of NO_x emissions and all other applicable variables specified in Table 2012-1 and Appendix A, Chapter 2, Table 2-A; or

(B) install, maintain, and operate an alternative monitoring device which has been determined by the Executive Officer to be equivalent to CEMS in relative accuracy, reliability, reproducibility and timeliness according to the requirements set forth in Appendix A, Chapter 2.

(3) The Facility Permit holder of a major NO_x source shall:

(A) install, maintain and operate a reporting device to electronically report total daily mass emissions of NO_x and daily status codes to the District Central NO_x Station for each major NO_x source. Such data shall be reported by 5:00 p.m., of the following day. If the facility experiences a power, computer, or other system failure that prohibits the reporting of total daily mass emissions of NO_x and daily status codes, the Facility Permit holder shall be granted 12 hours to submit the required report; after the 12 hour extension, emissions shall be calculated pursuant to the missing data requirements set forth in Appendix A, Chapter 2; and

(B) submit Monthly Emissions Reports aggregating NO_x emissions from all major sources within 10 days following the end of each calendar month. In its Monthly Emissions Report the Facility Permit holder may correct daily transmitted data for that month provided such corrections are clearly identified and justified.

(d) Large NO_x Source

(1) Large NO_x Source is one or more of the following NO_x sources, provided that each piece of equipment in a large NO_x source is subject to an identical equipment-specific emission factor, concentration limit, or emission rate as specified in subdivision (f):

(A) any boiler, furnace, oven, dryer, heater, incinerator, test cell and any liquid or gaseous fueled equipment with a maximum rated capacity:

(i) greater than or equal to 40 but less than 500 million Btu per hour and an annual heat input of 90 billion Btu per year or less; or

(ii) greater than or equal to 10 but less than 40 million Btu per hour and an annual heat input greater than 23 billion Btu per year.

(B) any internal combustion engine with rated brake horsepower:
 (i) greater than or equal to 1,000 bhp and operating 2,190 hours per year or less; or
 (ii) greater than or equal to 200 but less than 1,000 bhp and operating more than 2,190 hours per year;

(C) any gas turbine rated greater than or equal to 0.2 but less than 2.9 megawatts, excluding any emergency standby equipment or peaking unit;

(D) any kiln or calciner with rated process weight less than 10 tons per hour;

(E) any sulfuric acid production unit;

(F) any NO_x source or process unit elected by the Facility Permit holder or required by the Executive Officer to be monitored with a CPMS;

(G) any NO_x source or process unit for which NO_x emissions reported pursuant to Rule 301 - Permit Fees, were equal to or greater than 4 tons per year but less than 10 tons per year for any calendar year from 1987 to 1991, inclusive, excluding NO_x sources or process units listed under subparagraphs (c)(1)(A) through (c)(1)(H), and (e)(1)(A) through (e)(1)(D).

(2) The Facility Permit holder of a large NO_x source shall either comply with paragraphs (c)(2), and (c)(3) for any large source or elect to comply with the following:

(A) install, maintain and operate a totalizing fuel meter and any other device specified by the Executive Officer as necessary to determine monthly fuel usage, and all other applicable variables specified in Appendix A, Chapter 3, Table 3-A; and

(B) install, maintain and operate a modem or any reporting device approved by the Executive Officer to be equivalent in accuracy, reliability, and timeliness, to report total monthly mass emissions of NO_x to the District Central NO_x Station for each large NO_x source. Such data shall be reported within 10 days following the end of each calendar month; and

(C) accept the emission factor, equipment-specific emission rate or concentration limit, as specified pursuant to subdivision (f) in the Facility Permit, as the sole method for determining mass emissions for all purposes, including, but not limited to, determining:

(i) compliance with the annual Allocations;

(ii) excess emissions;

(iii) the amount of penalties; and

(iv) fees; and

(D) monitor one or more measured variables as specified in Appendix A in order to ensure the applicability and accuracy of any equipment-specific emission rate specified in the Facility Permit; and

(E) comply with all applicable provisions of subdivision (f).

(e) NO_x Process Unit

(1) NO_x Process Unit means one or more of the following NO_x emitting equipment, provided that each piece of equipment in a process unit is subject to an identical emission factor or equipment-specific or category-specific emission rate as specified in subdivision (f):

(A) any boiler, furnace, oven, dryer, heater, incinerator, test cell and any liquid- or gaseous-fueled equipment with maximum rated capacity:

(i) greater than or equal to 10 but less than 40 million Btu per hour and an annual heat input of 23 billion Btu per year or less; or

(ii) greater than or equal to 2 but less than 10 million Btu per hour.

(B) any internal combustion engine with rated brake horsepower:

(i) greater than or equal to 200 but less than 1,000 bhp and operating 2,190 hours per year or less; or

(ii) greater than or equal to 50 but less than 200 bhp.

(C) any portable combustion equipment which is not a major or large source;

(D) any emergency standby equipment or peaking unit ;

(E) any other NO_x source that is not a large or major NO_x source or equipment designated in Rule 219 - Equipment Not Requiring a Written Permit Pursuant to Regulation II.

(2) The Facility Permit holder of a NO_x process unit shall comply with paragraph (c)(2), and (c)(3), or paragraph (d)(2), for any process unit, or elect to comply with the following:

(A) install, maintain and operate a totalizing fuel meter and/or timer or any device approved by the Executive Officer to be equivalent in accuracy, reliability, reproducibility, and timeliness for the NO_x process unit, to measure quarterly fuel usage or other applicable variables specified in Table 2012-1, and Appendix A, Chapter 4, Table 4-A; and

(B) report the calculated quarterly NO_x emissions for each NO_x process unit as part of the Quarterly Certification of Emissions required by Rule 2004 - Requirements; and

(C) accept the emission factor or equipment-specific or category-specific emission rate, as specified pursuant to subdivision (f) in the Facility Permit, as the sole method for determining mass emissions for all purposes, including, but not limited to, determining:

(i) compliance with the annual Allocations;

(ii) excess emissions;

(iii) the amount of penalties; and

(iv) fees; and

(D) comply with all applicable provisions of subdivision (f).

(f) Permit Conditions for Large Sources and Process Units

(1) Starting January 1, 1994 for Cycle 1 facilities and starting July 1, 1994 for Cycle 2 facilities, calculations of mass emissions from each large source or process unit shall be based upon the emission factor specified in Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur

(SO_x). The emission factor for each large source or process unit will be specified in the Facility Permit, and will remain valid unless amended by the Executive Officer pursuant to paragraphs (f)(2), (f)(3) or (f)(4).

(2) On and after January 1, 1995 for Cycle 1 facilities and July 1, 1995 for Cycle 2 facilities, the Facility Permit holder of a large source shall:

(A) comply at all times with an equipment-specific NO_x concentration limit in ppm measured over any continuous 60 minutes as specified in the Facility Permit for that source; according to the requirements specified in Appendix A, Chapter 3 (large sources); or

(B) establish an equipment-specific emission rate that is reliable, accurate and representative of that source's emissions, according to the requirements specified in Appendix A, Chapter 6.

(3) A Facility Permit holder may apply to the Executive Officer to amend the concentration limit or equipment-specific emission rate for a large source, or emission factor or category-specific emission rate for a process unit, in the Facility Permit, at any time. If the applicant demonstrates to the Executive Officer that the alternative equipment-specific or category-specific emission rate is reliable, accurate and representative for the purpose of calculating NO_x emissions, the Executive Officer will amend the Facility Permit to incorporate the alternative equipment-specific or category-specific emission rate. No demonstration will be required to amend the Facility Permit to incorporate the alternative concentration limit, provided the large source complies with that limit in ppm over any continuous 60 minutes. The alternative concentration limit or equipment-specific emission rate for a large source, or the alternative emission factor or category-specific emission rate for a process unit, shall take effect prospectively from the date the Facility Permit is amended.

(4) The Executive Officer may amend the Facility Permit at any time to specify an alternative equipment-specific emission rate for a large source, or an alternative emission factor or category-specific emission rate for a process unit, if the alternative emission rate or emission factor is determined to be more reliable, accurate, or representative of that

source's or unit's emissions than the previous emission factor, or concentration limit or emission rate specified in the Facility Permit. The alternative concentration limit or equipment-specific emission rate for a large source, or alternative emission factor or category-specific emission rate for a process unit shall take effect prospectively from the date the Facility Permit is amended.

(g) General Requirements

(1) A Facility Permit holder shall at all times comply with all requirements specified in subdivisions (c), (d), (e), (f), (g), (h), and (i) for monitoring, reporting and recordkeeping, including but not limited to, measuring, reporting, time-sharing, determining mass emissions, and installing, maintaining or operating monitoring, measuring and reporting devices, in accordance with the applicable requirements set forth in Appendix A.

(2) The monitoring system and the applicable method for determination of mass emissions for each NO_x source or process unit will be specified in the Facility Permit, in accordance with the applicable requirements set forth in Appendix A.

(3) The time-sharing of CEMS among NO_x sources may be allowed by the Executive Officer in accordance with the requirements for time-sharing specified in Appendix A. In such cases, the Executive Officer will specify conditions in the Facility Permit upon which time-sharing may occur.

(4) Any monitoring system certified prior to October 15, 1993 requiring a change to its full scale span range in order to meet the certification requirements set forth in Appendix A, shall be recertified by the Executive Officer in accordance with the recertification requirements specified in Chapter 2, Section B.15, in Appendix A.

(5) The Executive Officer may at any time require a Facility Permit holder to use a specific monitoring and reporting system if it is determined that the elected system is inadequate to accurately determine mass emissions.

(6) The sharing of totalizing fuel meters may be allowed by the Executive Officer if the fuel meter serves large sources or process units which have the same emission factor or concentration limit or emission rate. The

sharing of totalizing fuel meters shall not be allowed if the fuel meters measure annual heat input as specified in clauses (d)(1)(A)(i) and (e)(1)(A)(i).

(7) A Facility Permit holder of any NO_x source, process unit, or piece of equipment which is exempt from permit requirements pursuant to Rule 219 - Equipment Not Requiring A Written Permit Pursuant to Regulation II, shall determine NO_x emissions according to the methodology specified in Appendix A. Process units or equipment exempt from permit requirements pursuant to Rule 219 shall report such NO_x emissions in the Quarterly Certification of Emissions required by Rule 2004 - Requirements.

(h) Compliance Schedule

(1) Facilities with existing CEMS and fuel meters as of October 15, 1993 shall continue to follow recording and reporting procedures required by District rules and regulations in effect immediately prior to October 15, 1993, until December 31, 1994 for Cycle 1 facilities and June 30, 1995 for Cycle 2 facilities.

(2) Between January 1, 1994 and December 31, 1994 for Cycle 1 facilities and between July 1, 1994 and June 30, 1995 for Cycle 2 facilities, interim emission reports shall be submitted to the District by the Facility Permit holder. The interim reports shall comply with all of the requirements of this rule and Appendix A, except that the reporting frequency shall be monthly for major and large sources and quarterly for process units. Such reports shall be submitted by the tenth day of each month for major and large sources and as specified in paragraph (b)(2) of Rule 2004 - Requirements, for process units.

(3) A Facility Permit holder shall install, maintain and operate a totalizing fuel meter for each major source and a totalizing fuel meter and/or timer or any device approved by the Executive Officer to be equivalent in accuracy, reliability, reproducibility, and timeliness for each large source or process unit by January 1, 1994 for Cycle 1 facilities and July 1, 1994

for Cycle 2 facilities, except that sharing of such devices may be allowed pursuant to paragraph (g)(6).

(4) All required or elected monitoring and reporting systems specified in subdivisions (c), (d), (e), (f), and (g) shall be installed no later than December 31, 1994 for Cycle 1 facilities and June 30, 1995 for Cycle 2 facilities. Monitoring, Reporting, and Recordkeeping (MRR) Forms will be provided by the Executive Officer by November 15, 1993 for Cycle 1 facilities and April 15, 1994 for Cycle 2 facilities. The information required on such MRR forms shall be submitted no later than December 31, 1993 for Cycle 1 facilities and June 30, 1994 for Cycle 2 facilities.

(5) The Facility Permit holder of an existing facility which elects to enter RECLAIM or a facility which is required to enter RECLAIM shall install all required or elected monitoring, reporting and recordkeeping systems no later than 12 months after entry into RECLAIM. During the 12 months prior to the installation of the required or elected monitoring, reporting and recordkeeping systems the Facility Permit holder shall comply with the monitoring requirements of paragraph (h)(3) of this rule.

(i) Recordkeeping

The Facility Permit holder of a major or large NO_x source or NO_x process unit shall maintain all monitoring data required to be measured or reported pursuant to this rule and Appendix A for three years after each APEP report is submitted to the District. All records shall be made available to the District staff upon request.

(j) Source Testing

(1) All required source testing shall comply with applicable District Source Test Methods 1.1, 1.2, 2.1, 2.2, 2.3, 3.1, 4.1, 7.1, 100.1, and EPA Method 19.

(2) Every large NO_x source shall be source tested no later than December 31, 1996 for Cycle 1 facilities and June 30, 1997 for Cycle 2 facilities, and every three years thereafter. Such source test results shall be submitted

according to the schedule prescribed by APEP. In lieu of submitting the first source test report, the Facility Permit holder may submit the results of a source test not more than three years old which meets applicable requirements of this rule when conducted.

(3) An alternative emission rate for process units shall comply with source testing guidelines to be established by the Executive Officer by March 31, 1994.

(k) Exemption

The provisions of this rule shall not apply to gas flares.

(l) Appendix A

All provisions of Appendix A are incorporated herein by reference.

Attachment: Appendix A - "Protocol for Monitoring, Reporting and Recordkeeping for Oxides of Nitrogen (NO_x) Emissions."

Table 2012-1

MEASURED VARIABLES AND REPORTED DATA FOR NO_x SOURCES

NO_x SOURCES	MEASURED VARIABLES	RECORDING FREQUENCY	REPORTED DATA	TRANSMITTING/ REPORTING FREQUENCY
All sources subject to Paragraphs (c)(2) and (c)(3)	Stack NO_x concentration, Exhaust flow rate, and Status codes OR Stack NO_x concentration, Stack O_2 concentration, Fuel flow rate, and Status codes	Once every 15 minutes	Total daily mass emissions from each source Daily status codes	Once a day for transmitting/ once a month for reporting
Large sources subject to Paragraph (d)(2)	Fuel usage	Monthly	Total Monthly mass emissions from each source	Once a month for reporting
NO_x Process units subject to Paragraph (e)(2)	Fuel usage OR Operating time and Production/Processing/ Feed rate	Quarterly	Total quarterly mass emissions	Once a quarter for reporting

(Adopted October 15, 1993)

RULE 2015. BACKSTOP PROVISIONS

(a) Purpose

This rule specifies RECLAIM program auditing requirements and backstop provisions.

(b) Program Audits

(1) Annual Audits

The District will conduct an annual program audit. The annual audit will assess:

(A) emission reductions;

(B) per capita exposure to air pollution;

(C) facilities permanently ceasing operation of all sources;

(D) job impacts;

(E) average annual price of each type of RTCs;

(F) availability of RTCs;

(G) toxic risk reductions;

(H) New Source Review permitting activity;

(I) compliance issues;

(J) emissions trends/seasonal fluctuations; and

(K) emission control requirement impacts on stationary sources in the program compared to other stationary sources identified in the AQMP.

As part of the first three annual program audits, the Executive Officer will review the effectiveness of enforcement and protocols and recommend revisions to the protocols to achieve improved measurement and enforcement of RECLAIM emission reductions while minimizing administrative cost to the District and RECLAIM participants. The first audit will be presented to the Governing Board in a public hearing on or before January 1996, and included henceforth in the District annual performance report to the California legislature.

(2) Mapping of Emissions

The Executive Officer will maintain, on an quarterly basis, a District-wide map indicating the most current sum of certified emissions. The information used to maintain the map will be obtained from the Quarterly Certification of Emissions and APEP required of Facility Permit holders pursuant to Rule 2004 - Requirements.

(3) Three-Year Audit

In 1997, at the close of the third year of trading, the District will conduct or commission a comprehensive audit to evaluate the performance of RECLAIM. This comprehensive audit will be presented to the Governing Board in a public hearing in the year 1998. The Governing Board will evaluate the performance of the program against the following criteria:

(A) RECLAIM has produced the emission reductions required;

(B) public health exposure to criteria air pollution has been significantly reduced, and public health exposure to toxics has not significantly increased as a result of RECLAIM;

(C) RECLAIM has not accelerated business shutdowns, job loss or shifts in the occupational structure of the region;

(D) the price of credits and the trading activity in each market has demonstrated adequate supply and demand;

(E) the emission monitoring, recordkeeping, and penalty provisions of RECLAIM have produced a strong compliance program and adequate deterrence of violations;

(F) RECLAIM is consistent with the provisions of the Federal Clean Air Act and the California Clean Air Act;

(G) the emission factors listed in Rule 2002 - Allocations for Oxides of Nitrogen (NO_x) and Oxides of Sulfur (SO_x), Tables 1 and 2 are consistent with and appropriate for any recent technology advancements;

(H) RECLAIM has not resulted in disproportionate impacts measured in terms of required emission reductions, on stationary sources in the program, compared to other stationary sources identified in the AQMP;

(I) whether RECLAIM should include a broad spectrum of sources, including mobile, area and stationary; and

(J) control technology has advanced as much as projected under the AQMP.

(4) Reports to the Governing Board

The Hearing Board will present a written report every March to the District Governing Board regarding any increases in annual Allocations issued pursuant to permit appeals. The Executive Officer will report, every March, to the District Governing Board, any recommendations necessary to maintain equivalency. The Executive Officer will propose to the Governing Board, any AQMP amendments necessary to make up for any shortfall resulting from adjustments to Allocations issued pursuant to Hearing Board appeals. In addition, the Executive Officer will propose to the Governing Board rule amendments to adjust RECLAIM Allocations if the Hearing Board issues Allocation adjustments that create a shortfall and are of a type which, if made by the Executive Officer during the issuance of initial Facility Permits, would have resulted in altered Allocations and rates of reduction for RECLAIM facilities.

(5) Program Amendment

The District reserves the right to amend the program pursuant to program evaluations. Nothing in District rules shall be construed to limit the District's authority to condition, limit, suspend or terminate any RTCs or the authorization to emit which a Facility Permit represents.

(6) Should the average RTC price be determined, pursuant to Rule 2015 (c)(1)(E), to have exceeded $15,000 per ton, within six months of the determination thereof, the Executive Officer shall submit to CAL-ARB and USEPA the results of an evaluation and review of the compliance and enforcement aspects of the RECLAIM program, including the deterrent effect of Rule 2004 paragraphs (d)(1) through (d)(4). This review shall be in addition to the audits to be preformed pursuant to Rule 2015. The evaluation shall include, but not be limited to, an assessment of the rates of compliance with applicable emission caps, an assessment of the rate of compliance with monitoring, recordkeeping and reporting requirements, an assessment of the ability of the South Coast

Management District to obtain appropriate penalties in cases of noncompliance, and an assessment of whether the program provides appropriate incentives to comply. The Executive Officer shall submit, with the results of the evaluation, either a recommendation that paragraphs (d)(1) through (d)(4) be continued without change, amendments to the RECLAIM rules setting forth revisions to paragraphs (d)(1) through (d)(4) of Rule 2004, if the District's Governing Board determines that revisions are appropriate in light of the results of the evaluation.

(c) AQMP Revisions

(1) In conjunction with the preparation of future AQMP revisions, the Executive Officer shall evaluate the relative potential emission reductions between RECLAIM and non-RECLAIM sources. Said evaluation shall include consideration of technology advancements and cost-effectiveness. The Executive Officer will propose to the Governing Board, AQMP revisions which ensure that any increases in Allocations which occur based on any adjustments made pursuant to Rule 2002 (c)(12), Rule 2015 (c)(2), and Rule 2015 (e) shall be offset in the AQMP.

(2) In conjunction with the preparation of future AQMP revisions, the Executive Officer will quantify additional energy demand and the potential need for increased Allocations resulting from implementation of the AQMP. In accordance with the results of the evaluation, the Executive Officer will propose amendments to Rule 2002, if appropriate, and if amendments are adopted, the Executive Officer will recalculate the Allocations for the year 2003 and subsequent years, and will issue these Allocations to affected electric generating and natural gas distribution facilities. The Executive Officer's evaluation will establish a need for any such increase in Allocations.

(3) Evaluation of Emission Factors

(A) In conjunction with the preparation of the 1994 AQMP revision, the Executive Officer will complete the evaluation of the ending emission factors found in Tables 1 and 2 of Rule 2002 for the source categories listed in subparagraph (c)(2)(B) of this rule.

The Executive Officer shall take into account the environmental, energy, and economic impacts by each source category in evaluating the achievability of NO_x emission reduction technologies for each source category. In accordance with the results of the evaluation, the Executive Officer will propose amendments to Rule 2002, if appropriate, and if amendments are adopted, the Executive Officer will recalculate and reissue all affected Allocations for RECLAIM facilities in the source categories found in subparagraph (c)(2)(B). The Executive Officer will propose that any increases in Allocations which occur based on any adjustments made pursuant to this provision shall be offset in the AQMP.

(B) The Executive Officer will reevaluate the ending emission factors for the following source categories in accordance with subparagraph (c)(3)(A):
- (i) glass melting furnaces;
- (ii) gray cement kilns;
- (iii) steel slab reheating, flat rolled product annealing and flat rolled product galvanizing furnaces;
- (iv) metal melting furnaces;
- (v) hot mix asphalt operations; and
- (vi) petroleum coke calciners (NO_x only).

(C) The Executive Officer will reevaluate the accuracy of emission factors for SO_3 emissions from petroleum refineries. In accordance with the results of the evaluation, the Executive Officer will propose amendments to this Regulation, which may include, but are not limited to:
- (i) enhanced monitoring requirements; and
- (ii) revision of Allocations.

(d) Program-Specific Backstops

(1) Based on annual and three-year audits conducted pursuant to paragraphs (b)(1) and (b)(3), or upon discovery by the Executive Officer, the Executive Officer will propose that the Governing Board amend the

program to address any specific program problems. In addition, upon discovery that actual emissions from RECLAIM sources exceeded Allocations for any annual period by five percent or greater, the Executive Officer will propose amendment to the RECLAIM program to the Governing Board. Recommendation may include, but are not limited to:

(A) restricting trading;
(B) requiring pre-approval of trades;
(C) enhanced monitoring;
(D) increasing rates of reduction;
(E) implementing technology-specific emission reductions;
(F) increased penalties.

(2) If such program adjustments are determined to have failed to correct the specific program problems, the Executive Officer shall recommend that the Governing Board, after holding a Public Hearing, consider reinstating all or a portion of the source category-specific emission limits or control measures contained in the then current AQMP in lieu of the RECLAIM program.

(e) Severability, Effect of Judicial Order

In the event that any portion of this regulation is held by judicial order to be invalid or inapplicable with respect to any source or category of sources, such order shall not affect the validity or applicability of this regulation to any other sources. In such event, all emission limitation provisions listed in Rule 2001 Table 1 and Table 2, which in the absence of Rule 2001 would be applicable to such source or category of sources, shall become effective immediately; or if the emission limitation provisions require the installation of control equipment, one year after such order. In addition, the Executive Officer will, as expeditiously as possible, propose rules for adoption by the Governing Board which will require that each source or source category affected by the order comply with emission limitations representing Best Available Retrofit Control Technology, as defined in Health and Safety Code Section 40406.