EQUITY DILEMMAS ASSOCIATED WITH
COMMAND-AND-CONTROL
AND MARKET-BASED APPROACHES
TO AIR POLLUTION CONTROL

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INTRODUCTION

While command-and-control regulation has brought about significant improvements in air quality, market incentives are receiving renewed interest in the policy arena, due to the high marginal costs of emission reductions (dollars paid for the last ton of emissions controlled from an operation) required to achieve air quality standards. A number of market incentive policies (mechanisms that employ economic forces to change the behavior of target groups) were either enacted by the Clean Air Act Amendments or will be adopted pursuant to the provisions by the USEPA.

This paper describes the existing command-and-control approach to air quality planning, discusses variations in market incentive implementation, and outlines some of the potential impacts and equity issues associated with each system. Three classes of market incentives are examined: 1) emission fees; 2) production based emission trading (e.g., grams/widget); and 3) marketable emission permits. These three classes of market incentives have the potential to yield very different distributions of costs and benefits for existing industries. The social equity effects of each strategy, in terms of how much is paid for pollution control, who benefits and who ultimately pays, are likely to be distinctly different under each scenario of market incentive implementation.

Based upon the relative uncertainty in determining impacts on social equity, the paper concludes that production-based emission trading offers significantly increased efficiency and industrial productivity compared to the current command-and-control approach, without sacrificing the ability to make equity adjustments in the future.

In this paper, a broad foundation of air pollution control theory and practice is first presented. Some individuals who reviewed draft versions of this paper felt that this framework was necessary to set the stage for the comparisons made later, while others felt it was an unnecessary summation of the existing literature. Readers who are familiar with the positive and negative aspects of the existing command and control approach to air quality planning, and familiar with the general principles of market based strategies, will probably wish to jump ahead to the 'Equity Issues' section of this paper (page 9).

APPROACHES TO AIR QUALITY PLANNING

The following sections discuss the basics of command-and-control, emission fee, marketable emission permit, and production-based trading approaches to pollution control. Each system has a different set of real and potential efficiency losses, ranging from intentional tradeoffs of equity for efficiency, to potential efficiency losses from unintentional market failures.

Command-and-Control

Section 110 of the Clean Air Act (CAA) requires state regulatory agencies to develop air quality management plans (AQMPs), through a public participation process, that are designed to bring the local area into compliance with federal ambient air quality standards. The AQMP, based upon emission inventory analysis and detailed air quality modeling techniques, contains estimates of the emission reductions that must be obtained in order to achieve mandated air quality standards. The AQMP is then translated into a set of source-specific regulations designed to achieve the necessary emission reductions. The plans and regulations are submitted to the U.S. Environmental Protection Agency (USEPA). After the USEPA evaluates the plan and regulations for consistency with the federal Clean Air Act, the submittal is approved by the USEPA as part of the "federally approved State Implementation Plan (SIP)."

New Source Review (NSR) programs in non-attainment areas are a major component of the SIP. NSR regulations are designed to mitigate emissions of non-attainment pollutants from new facilities and from the modification of existing operations. Under NSR, when a facility increases emissions beyond the threshold value established by the regulation, the facility is required to meet federal Lowest Achievable Emission Rate (LAER) requirements. In general, due to the stringency of emission rate requirements, LAER usually translates into a specific control technology requirement. However, if new (presumably lower cost) control technologies can meet the LAER emission rate requirements, they are approved. Depending upon the magnitude of the emission increase, NSR may
also require the facility to provide emission offsets to mitigate the emission increase. Emission offsets are certified reductions of emissions at the same or another facility. In areas of ozone non-attainment, emission increases must usually be offset at a ratio of greater than 1:1. Thus, when new sources are permitted in these areas, offsets requirements will theoretically reduce the net emissions in the basin.

LAER and offset requirements can serve as barriers to entry for new sources and existing source modifications. Capital outlays for LAER control technology in California can run between $10,000.00 and $20,000.00 per annual ton of pollutant abated. This capital outlay is a serious barrier to entry if existing competition in the marketplace has not been required to make similar capital outlays for pollution control. The equity impacts of LAER have been significant, in that the marginal costs of emission control required for new entrants have been much higher than for existing industry. The current command-and-control approach often results in significant variation in the marginal costs of emission control between industries within a source category and between source categories themselves.5

The vast majority of offsets have been provided for existing industry expansions through on-site emission reductions (the required offset ratio is 1:1 for on-site emission increases, making on-site use more attractive). In 1990, for sources that could not provide on-site reductions, the capital cost for emission offsets on the open market for reactive hydrocarbons, carbon monoxide (CO), and oxides of nitrogen (NOx) were about $11,000.00 per annual ton.6 Because most new facilities requiring offsets were LAER controlled, usually by 95% to 98%, the practical barrier to entry presented by the offset requirement alone was high, but not insurmountable.7

Nevertheless, the costs of emission offsets will likely continue to increase over time. Now that California state law requires districts to apply reasonably available control technology (RACT) to all existing sources in moderate non-attainment areas, and best available retrofit control technology (BARCT) to sources in serious and severe non-attainment areas,8 the availability of low cost offsets will decrease, and the barrier to entry provided by offsets will rise significantly (although BARCT will somewhat adjust the intra-source-category equity problems).

An additional problem associated with command-and-control approach is that either the inputs or the outputs of operations are constrained by regulation, in order to constrain emission outputs on both a total mass and emission rate basis.9 This reduces production flexibility and increases marginal costs of production.

The Persistence of the Command and Control Approach. Given the increasing costs of offsets, industries and state and local air quality regulators have been searching for a new approach to air quality planning. As the USEPA, under the urging of both the executive and legislative branches, turns toward increasing use of "market mechanisms" to improve the efficiency of pollution control, there is continued focus on providing economic incentives for pollution control.

Despite vigorous lobbying by industry and economists, the command-and-control approach to regulation has remained the primary regulatory approach. The literature is rife with possible reasons why market-based incentives have failed to fully materialize.10,11,12,5,13 However, one of the most significant obstacles to implementation of marketable permit systems may be the fundamental shift in ownership of emission rights.

The current air quality planning, rule development, and the public and industry participation mechanisms are structured such that no facility is guaranteed of having a right to pollute in the future. Rather, permission to pollute is granted to industry, but never on a permanent basis because future regulations may require additional reductions. Hence, there is a potential shift from the current system where emission rights are controlled by the public (through the local air pollution control agency), to a system where emission rights become a private property. This fundamental change in control, over who decides what reductions should occur and when, may be at the root of the dilemma. The hesitancy in changing ownership rights may result from fundamental differences in value systems of participants in the political process (i.e., industry, regulators, environmental coalitions, and the general public).

Additional certainty in the air pollution control arena is desirable from industry's perspective. Companies need to know whether they will be required to retrofit with emission control equipment five years down the road, before they undertake capital expansion plans in the present. To the extent that certainty can minimize costs to industry, the
public benefits from improved efficiency. From business' perspective, a system of private emission right ownership is preferable, ensuring certainty in future business decisions.

Yet, from the public's perspective, social costs other than air quality are also taken into account during the public regulatory process. Potential failures of marginally profitable businesses means subsequent job loss (and reductions in the local tax base). The social and local economic consequences of these failures are usually cited as the primary outside costs taken into account during regulatory development. When the subsequent social costs of an emission control alternative are perceived to be high, other emission control alternatives with higher marginal costs to industry are often adopted. The public is often willing to accept higher costs of emission control for some sources than for others, due to equity considerations.

Emission Fees

Emission fees are a relatively straightforward market-based incentive; companies are assessed an annual fee that is dependent upon the quantity of pollutant(s) released by the facility. Emission fees can be structured such that the externalities associated with air pollution are internalized by the company (Pigouvian taxes). These social costs are then passed on to the consumers of the polluting goods and services. By causing the social costs of production to be internalized into the final price of the good or service, the correct price signals are sent to the consumer.

Examples of existing fee-based structures include stationary source permit fees used by California air pollution control agencies to generate operating revenues (although these fees are not set high enough to serve as an emission deterrent). The current national strategy for CFC emission reduction also includes emission fees of $1.37/lb for U.S. producers (which will rise to $3.10/lb in 1995) under Public Law 101-239, 103 Stat. 2106, 1989. Fee-based market incentive policies are also under consideration for the control of greenhouse gases, automobile emissions, and perhaps consumer products.

In theory, and under appropriate conditions, emission taxes yield the least-cost method for achieving a standard. Specific conditions include: firms seek to minimize private costs of producing any level of output, firms do not have monopsony power (or control over input prices), and input prices approximate opportunity costs. In response to unit emission taxes, companies will take action to reduce emissions, to the point where the marginal cost of emission reductions equals the avoided emission fees (provided they know the costs of control). Because the tax applies to all industries, the marginal costs associated with control ($/last ton controlled) and the average emission control cost ($/ton controlled) will equalize across activities.

To reduce emissions, firms usually require additional inputs such as operating capital, labor, expertise, etc. Changes in input composition affect the marginal costs of production, and facility outputs will depend upon demand functions. Although Pigouvian tax systems may help guide the decisions of individuals (and thereby direct resources to their best uses), the complex relationships between inputs and outputs and demand functions make it difficult to determine the optimum tax that should be applied. If fees are set too high, unnecessary economic burdens will result (a transfer from private to public). If fees are set too low, pollution reductions will not occur and costs of environmental damage will continue to be paid by the public rather than the consumer (a transfer from public to private). Plus, emission fees must be adjusted on a continuing basis, as economic conditions in the area fluctuate.

Emission fees, unlike conventional taxes, have the tendency to decrease economic distortions while also providing public revenues. One can make an equity argument on the part of fees that the public is still assumed to hold any emission property right, just as currently exists under the command-and-control structure.

To determine the socioeconomic impacts of emission fees, which amount to an excise tax on certain industry activities, the effect of the tax on the price and cost of each commodity and its inputs must first be determined, and then the impacts of cost changes on various socioeconomic groups must be determined. This is a complex task, which involves multiple equilibrium functions.
Production-Based Emission Trading

A production-based emission standard is an emission rate limit per unit of output, e.g., grams of pollutant per widget produced. The federal emission trading policy statement (ETPS) essentially requires that production-based trading be used when trades are conducted under the existing command-and-control approach. The general approach used in production-based emission trading is:

- the regulatory agency sets an emission standard associated with the output of the industry (mass of emissions per unit of production);
- facilities are required to meet the emission standard on the average for their production (i.e., total emissions/total production must be less than the emission standard), and
- if a facility can over-comply with the emission standard (emissions are less than the maximum allowed) the difference may be banked as negative emissions for later use in averaging, or sold to another facility for use in complying with the average emission rate requirement.

For example: an emission rate of 0.001 pounds per gallon of product is established; facility A produces 100,000 gallons of product but only emits 75 pounds of regulated pollutant; a 25 pound emission credit is generated by facility A from over-complying with the emission standard; the 25 pound credit generated by facility A is sold to facility B; facility B may now produce 100,000 gallons of product and emit 125 pounds of the regulated pollutant and remain in compliance with the production-based standard of 0.001 pounds per gallon.

Notice that under the production-based trading system, a company cannot comply with the standard by simply reducing production at the facility. Facilities must generate and consume credits through production.

The unit of production around which trading is conducted can be problematic for some industries. Gallons of product and KWh of electricity are fairly simple, but how do you trade when you manufacture computer components? For surface coating operations, trading has been conducted around the liters of solids applied. Liters of solids is a surrogate for surface area coated, and therefore a surrogate for production. Although not perfect, surrogate trading mechanisms can be developed for many industries.

Under a production-based emission trading system, facilities have the choice of either complying with the emission standard for all production, or controlling the emissions in-house only from the most cost-effective operations. Also, if the marginal costs of in-house control are higher than the costs of credits generated by other facilities, they can purchase these credits and delay control technology purchases until the time when the marginal costs of control equal the market price of credits. Note also, because emissions output from a facility is dependent upon that production, and because credits are generated and sold based upon that production, the average cost of emission control at each facility ($/ton reduction) also tends to equilibrate across facilities. Average emission control costs for those facilities that already have efficient emission controls due to the command-and-control approach will decrease, because costs associated with previous over-control can be recouped through trading (although this may require revision to the ETPS).

Practical experience in the lead trading program, source bubbles, and alternative emission control plans, indicate that production-based standards have the potential for success (contingent upon resolving enforcement issues).

Lead Phasedown. Production-based emission trading was allowed by the USEPA during the phase-down of the lead content in gasoline. The USEPA had established a lead content (i.e., grams/gallon) standard in 1973, which took effect in 1978. In 1982, the USEPA added a market, which allowed parties to trade credits generated by excess reductions. In 1985, USEPA further allowed these credits to be banked for use at a later date. When refiners were able to reduce the lead content of gasoline below the production-based emission rate, they could use the credit to sell gasoline with lead content in excess of that required. The banking provisions of the lead phasedown rule allowed refiners to use early reductions as credits against gasoline that could not meet the final limit in 1986 and later years. Hence, refiners benefited in a number of ways: 1) refiners experienced reduced overall control costs compared to
strict command and control approaches, 2) refiners ensured that the marginal costs of pollution control were spread evenly throughout the industry, 3) refiners achieved individual cost savings associated with planning (gradual reductions and potential for delaying compliance with final limits through trading can yield more time to plan facility modifications that minimize future operating costs), 4) refiners had increased incentive to take advantage of any new technology that could have become available during the phasdown period, and 5) lead content reduction probably occurred more rapidly than was expected to occur under the command and control approach because refiners' costs were lower.

**SCAQMD Utility Regulation.** The South Coast AQMD has implemented a form of production-based trading in the utility industry. Under Rule 1135 (adopted August 4, 1989 and amended July 19, 1991) electric utility systems (e.g., the Southern California Edison (SCE), the Los Angeles Department of Water and Power (LADWP), and the municipal systems of Burbank, Pasadena, and Glendale) would comply with an allowable production-based emission rate, grams of pollutant (NOx) per MWh of electricity production, and an overall daily emission cap. The initial average emission rate for the LADWP was set at 1.6 pounds of NOx/MWh, with a final phasdown emission rate of 0.15 pounds of NOx/MWh set for December 31, 1999. This example of production-based trading also set an emission cap for each of the individual participants in the trading program, and allows for industry growth (i.e., increased electricity production, but at the same emission rate). The emission cap for the LADWP in 1999 is 5,400 pounds of NOx per day, which increases to 7,400 pounds per day in 2009. Rule 1135 is a prime example of how production-based trading within a corporation can be implemented. Plus, the rule allows "municipal bubbles" to be formed, so that multiple power producers can comply by averaging their emissions and output, further improving program efficiency. 20

**California Low Emission Vehicle Regulations.** Recently adopted vehicles emission regulations in California now require manufacturers to meet average emission rates for their vehicle fleets. 21,22 The California low emission vehicle and clean fuels (LEV/CF) program establishes stringent gram/mile vehicle exhaust emission certification standards to be met by each manufacturer on a weighted sales average. Compliance with the lower emission standards can be achieved through the use of advanced vehicle control technologies, cleaner-burning fuels, or any combination of the two. Manufacturers are allowed to carry credits forward to a future year if they over-comply with the annual requirements. Plus, the LEV/CF program allows surplus credits earned by one manufacturer to be sold to another manufacturer that cannot comply directly with the regulation, or that finds it less costly to purchase the credits than to comply directly with the new low emission standards. 22

The flexibility designed into the LEV/CF regulations should help to ensure that low emissions are achieved at a minimum cost to industry, and therefore to the consumer.

**Alternative Emission Control Plans.** Source bubbles, some of which are referred to as alternative emission control plans (AECPs) in California, are designed to average the emissions from more than one operation within a facility subject to a rule. 23 For example, a surface coating that exceeds a required VOC limit may be compensated for by a coating that is below the required VOC limit, provided that the net emissions from the two operations are less than or equal to the emission that would occur if only complying coating were applied. 24

In theory, the nationwide implementation of 132 source bubbles are believed to have resulted in savings of 435 million dollars. 25 However, during the inspection of 22 California AECPs for compliance (although these were not part of the 132 source bubbles reviewed by Hahn and Hester), numerous problems were encountered. The production-based trading approach to reducing emissions in the 22 AECPs was not actually reducing emissions. 23,26 Emission reductions were not achieved by the sources operating under the production-based trading program for paints and coatings, primarily due to lack of sufficient monitoring and enforcement, failure to establish an appropriate trading baseline, and what in some instances appeared to be intentional circumvention. 26 In essence, the failure of these AECPs resulted from failure to comply with the ETPS. The fact that these 22 source bubbles failed to achieve required emission reductions calls into question whether all other source bubbles have actually achieved real projected emission reductions... hence, the source bubble cost savings figures reported by Hahn and Hester can be called into question.
Nevertheless, the fact that the source bubbles in Los Angeles failed to achieve equivalent emission reductions does not mean that these source bubbles can’t work. The problems with enforcement could be overcome with additional industry and regulator training, the allocation of significant additional inspection resources, and improved technology for monitoring and tracking facility emissions and throughput. If properly implemented and monitored, cost savings can be achieved from the emission trading strategy. However, the increased compliance and enforcement costs are also significant and need to be included in any cost savings analysis.

New Forms of Production-Based Emission Trading. Production-based emission trading can be used in concert with source-category emission caps, rather than individual participant emission caps. For example, an emissions cap can be placed on the sum total of NOx emissions for all electricity generating sources in the Los Angeles Basin, such as public and private utilities, cogeneration facilities, and alternative energy suppliers (e.g. solar, wind, geothermal, etc.). An average emission rate requirement can then be implemented, with which all sources must comply. If emission reductions from the source category are needed in the effort to attain air quality standards, a phasedown of the initial source-category cap could be part of the design, with all participants knowing what future effective emission rates will be required. Emission trading, as discussed above, would be conducted around the production standard, ensuring that equivalent marginal costs of control are borne by the industry. Sources could be allowed to freely enter the market. Then, if source-category emissions continue to increase due to growth, the average emission rate requirement could be adjusted downward periodically.

Marketable Emission Permit (MEP) Systems

Throughout the 20 year history of the Clean Air Act, advocates of market incentives have lobbied for the implementation of tradable property rights to reduce the cost of air pollution control. Marketable emission permit (MEP) systems involve the direct allocation of tradable emission discharge permits, or property rights to industry. Theoretically, regulatory agencies would issue discharge allocations to individual firms, identify the emission reductions that will be required to achieve the ambient air quality standards, mandate percentage reduction figures for industry, reclaim a percentage of the discharge permits each year, and allow firms to freely trade emission permits throughout the process.

Allowances, rather than credits, are employed in marketable emission permit systems. Facilities may comply with future emission requirements by simply reducing production at the facility (or even relocating the facility outside of the basin) whereupon their allowance can be sold.

Initial emission permit allocations can be made in any number of ways: by industrial sector or by individual facility, by previous permitted emission limits or actual mass emissions over a given time period, by auction, or by any hybrid system imaginable. Although impractical due to high transaction costs, permits could even be issued to the general public as was once suggested by the American Lung Association. The equivalent least-cost solution to emission fees in the MEP system is where auctions are used to allocate pollution rights. In essence, to retain the right to pollute, a market participant must bid competitively for that right.

The final emissions allocation for each industrial operation in the future (say the year 2010 in Los Angeles) would be established in advance. The final prescribed allocation would be set by the regulatory agency, and would be defined as the percentage of their initial allocation remaining after emission reductions are recalled by the regulatory agency. Final prescribed allocations could be an equal percentage of initial allocation for all industry, could vary by source category, or could even be different for every specific facility.

In the case of the proposed SCAQMD program, the Regulatory Flexibility Group proposal for emission trading (emission trading units) would establish emission allocations for each future operating year, as a function of the required annual reduction for each source category. For example, if a company had a 100 t/yr baseline and 5% annual reductions were required for the source category, the source would be able to emit 95 t/yr in the second year, 90.25 t/yr in the third, and so on. Emission trading would be conducted on an annual basis, so that only the allocated emissions for any year can be traded. This annual emission trading requirement prevents the possibility of sources trading away large percentages of permanent emission allocations in the present, declaring bankruptcy a few
years down the road, and then being unable to provide the full required reductions to the regulatory agency upon close of operations.

Baumol and Oates outline a number of administrative and implementation advantages of MEP systems over emission fee systems, including: fewer market adjustments must be made to achieve a set goal (i.e., fee prices must be adjusted periodically to ensure that reductions occur and to account for inflation), a free distribution of initial allowances avoids the increased costs to industry of fees, and permit systems are inherently more politically palatable than fees/taxes.9

Few studies have attempted to quantify the effects of emission trading. Hahn and Hester chronicle the use of MEPs, and provide a comparative analysis of the application of marketable permits to environmental problems.25 Under MEP systems, cost savings accrue through emission trading, as sources with low marginal costs of control achieve emission reductions and sell excess reductions to an industry that has high marginal costs of control. The initial allocation of emissions will not change the potential for cost savings compared to command-and-control regulation,5 provided that no monopoly or monopsony formation results, and provided that allocations are freely traded (i.e., the opportunity cost roughly equals the control cost, and allocations are not valued by industry for other reasons). That is, two basic assumptions in the marketable-permit framework are: 1) firms minimize their total production costs, and 2) the market for permits is competitive.25 However, we should keep in mind that the farther the initial allocation is from the most efficient allocation, the higher the transaction costs will be on the road to the final efficient allocation.

Under an active market, the marginal costs of emission control will be identical across firms.11 However, it must be noted that it is the marginal cost of additional emission control, above and beyond the emission reductions that have already been achieved by many industries in the past, that will equilibrate across participants. The average costs of reductions for each participant will depend upon their initial and final allocations of permits, and will therefore affect inter-source-category and intra-source-category equity.

The main premise that MEP systems will achieve the same low cost solution as emission fee proposals hinges upon the caveat that all sources face the same price for a permit.9 However, the specific form and function of the marketable permit system will determine whether this premise will be achieved.

While economic theory indicates that MEPs will be an efficient mechanism for reducing air pollution, great care must be exercised to ensure that permits are enforceable. Active enforcement is necessary, as indicated by enforcement review of both the U.S. lead trading program and alternative emission control plans for the aerospace industry in California, to ensure that real emission reductions are achieved.19,26 Emission reductions that occur under a scheme of MEPs become an asset, and potential abuses may be great. Mechanisms that ensure that property rights are based upon certified methods and tight tracking of the ownership of these rights are required if MEP systems are to function as intended.30

The Acid Rain Control Program. The control of acid rain, under Title IV of the Clean Air Act Amendments of 1990, employs the concept of marketable emission discharge permits for sulfur dioxide emissions. The Amendments require that specific reductions in sulfur emissions be met on a nationwide level, and the market will be allowed to determine which facilities will reduce emissions and which facilities will not. Industry, through the use of marketable emission discharge permits, will essentially require the facilities that remain uncontrolled to pay for pollution controls on other facilities (where presumably the installed controls are less costly than providing emission reductions at the uncontrolled facilities). Note, however, that acid deposition is a regional rather than national problem. Reductions of sulfur emissions in California will not achieve acid deposition reductions in the Northeastern states.31 The problem of risk trading and pollution impact shifting will be discussed in more detail later, as a potential equity issue associated with some market incentive programs.

The SCAQMD RECLAIM Program. The South Coast Air Quality Management District has, over a period of two years, been developing a marketable permit system, known as the Regional Clean Air Incentives Market (RECLAIM) program.32 The RECLAIM program is a marketable permits system for emissions of reactive
hydrocarbons and oxides of nitrogen. All permitted facilities (and some non-permitted operations) would be eligible to participate in the program. Under the RECLAIM program, marketable permits would be distributed based upon facility baseline emissions, and a percentage of these permits would be recalled every year. Facilities would be free to trade emission permits once the permits are distributed. The program is in the final planning stages, as evidenced by a recent staff reorganization, but the permit distribution criteria and implementation mechanisms are still being developed.

The nature of the RECLAIM marketable permit system being proposed for the South Coast Air Basin is very different than the marketable permit program employed for acid rain control. Under the acid rain program, emission allocations will be distributed annually through a hybrid system of direct sales, private sales and auction (helping to ensure that trading will occur and that marginal costs are shared more equally by industry), and special provisions are provided for independent power producers that would feel more directly the economic impacts of any potential monopoly over emissions allocations. Furthermore, it must be noted that electric power producers are regulated by both the Public Utility Holding Company Act (PUHCA) and the Public Utility and Regulatory Policy Act (PURPA), which regulate utility ownership and actual power allocation contracts, which should ensure that anti-competitive behavior is avoided. Harrison and Nichols note that public utility commissions will likely have incentives to encourage industry to participate in trading as sellers. But it is not yet clear that this will be the case for other market segments.

EQUITY ISSUES ASSOCIATED WITH MARKET INCENTIVE PROGRAMS

Equity is relative. Individual concepts of what constitutes a fair and equitable distribution of costs and benefits from any action evolve from fundamental philosophical principles. With such wide variation in individual philosophy, it is difficult if not impossible for any two individuals to achieve complete consensus on what constitutes an equitable distribution of a good or service.

The political process, with the participation of multiple players each with different concepts of equity, can be viewed as a forum to balance the equity impacts (real and perceived) of any social action. But complete consensus cannot be achieved, and policy inequities in the eyes of each individual can arise through the process by hook (the final compromise) and by crook (manipulation of the political process).

In this paper, only the potential results of an action are examined. For example, private ownership of emission rights is deemed neither inherently good nor bad, only the effects of that private ownership. However, individuals may (and often do) argue that it is immoral to own an emission right, and their opinion cannot be impugned. The public policy arena and democratic process is the place to undertake that debate.

Distributional Impacts

"By ignoring the redistributive effects of an environmental policy, we may either unintentionally harm certain groups in society, or alternatively, undermine the program politically." Theoretical analyses in the literature of emission fee, production-based trading, and marketable permit approaches indicate that the overall costs to society can be reduced compared to command-and-control approaches. Even if the same emission control results occur over the long term (say, twenty years) under command-and-control as occur under a market strategy, the costs savings over the short term can be significant. However, even if total costs are decreased by a policy, there is often no guarantee that everyone will be better off. Socioeconomic impacts can vary depending upon whether the goods or services with increased costs are consumed by the poor or the wealthy, the young or the old, families or single individuals, etc. In addition, if trading encourages location or relocation of facilities in areas that are inhabited by specific socioeconomic groups, direct risks increase. Determining the effects on socioeconomic groups is far from simple. Primary effects are often followed by secondary or indirect effects.

Distributional Impacts - Socioeconomic Groups. Current air pollution control programs are believed to benefit poorer areas more than wealthy areas, because industry is not usually located in high-income areas (although ozone impacts can be highest in some suburban and rural areas). Yet, the costs of control are shouldered by the consumer
at large (including wealthy and rural residents who may not receive as many direct benefits, but may value these benefits equally). Yet, studies of the distributional costs of command-and-control strategies indicate that they are somewhat regressive, in that poorer individuals must expend greater percentages of their income to derive these benefits. Robinson's study indicates that costs of control, as passed on to the consumer, ranged from 0.76% of income for the poorest groups to 0.16% of income for the wealthiest groups. Baumol and Oates indicate that there is no reason to believe that the impacts of effluent fees will differ in terms of distributional effects.

Under a marketable permits program, specific source categories with large sources of previously un- or under-controlled emissions may benefit at the expense of other previously controlled industrial activities, depending upon how emission allocations are made. Distributional impacts will depend upon the specific consumption patterns of various socioeconomic groups. Given the increased marginal costs of emission control in the future, and the assertion by Dorfman and Snow that the closer one moves toward putting a price on pollution the more regressive the burden generally becomes, it becomes clear that the socioeconomic consequences of any emission control program designed to remove emission control decisions from the public arena must be carefully planned and analyzed prior to implementation.

Determining who is better off under a new system, compared to their welfare under projected command-and-control scenarios, is difficult, if not impossible. First, the command-and-control approach yields uncertainty in terms of which control strategies will be adopted, when and in what order they will be adopted, and what specific exemptions they may contain. Second, the development of innovative emission control technology that may prove feasible for specific sources is difficult to predict. And third, the non-environmental externalities that come into consideration during the emission control strategy development process may yield implementation of regulations that are non-optimal in terms of emission control cost-effectiveness, but may yield lower overall social costs when other non-priced externalities are included in the analysis. Under the existing command-and-control approach to air quality planning, there is some consideration of equity issues during the regulatory process (albeit the system probably requires improvement), which is an advantage over the marketplace systems from this standpoint.

**Distributional Impacts - Industry.** As discussed previously, the distributive effects of MEP programs are dependent upon both the initial allocation of emission permits and the final prescribed allocation. Both the initial allocation and future allocation of emission permits is conducted one time, at the beginning of the program. Hence, once the initial allocations are made, redistribution of the wealth occurs in the marketplace. The extent to which marketable permit systems can produce inequities within a source category, depends upon: the extent of previous emission reductions achieved by facilities within a source category, the allocations of marketable permits to facilities within the source category, and the future controlled baseline allowances provided to industries within the source category.

A prime example of potential equity dilemmas is noted within electric generating industries. Typical cogeneration units are twice as energy efficient as their utility power generation counterparts, consuming half the fuel and emitting one-half the amount of pollution per unit of energy produced. Newer facilities have already controlled their emissions by as much as 98%. If baseline allocations are granted upon historical actual emission levels, these facilities may be required to further control their emissions or purchase reductions on the open market. Thus, the equity impacts upon industry should not be evaluated solely upon the marginal costs of obtaining additional reductions, but upon the relative change in emission control costs compared to what would have been required under the existing command-and-control system. It is unlikely that a facility already achieving 98% control would be required to obtain additional emission reductions under the command-and-control approach.

**Mitigating Distributional Impacts.** It is easy to argue that any socioeconomic inequities that arise from the implementation of market-based control can be mitigated after the fact. Although the distributional effects can be addressed through revenue-neutral fees, subsidies, or changes to tax laws, it may make more sense to attempt to implement air quality planning strategies that attempt to minimize transitional impacts by their nature. Although wealth can be redistributed to yield pareto efficient outcomes, "unfortunately such enlightened textbook transfer policies rarely take place in the real world." As Baumol and Oates attest: "The past performance of redistributive policy does not make us confident that the undesirable redistributive effects of environmental programs will
finally, as Okun notes, the redistribution of wealth after a shift has occurred is neither simple nor efficient: "we can transport money from the rich to the poor only in a leaky bucket." 38

In terms of correcting negative distributional effects that result from environmental policy, avoiding the negative effects at the outset is most efficient and desirable. Providing flexibility in an environmental program to correct negative redistribution effects as they are encountered would be the next most efficient system. And finally, correcting negative distributional effects after they have occurred, through a separate political infrastructure, would be the least efficient approach.

**Barriers to Entry**

The existing regulatory system, which requires source specific standards, serves as a barrier to entry for new industry. 25 Minimizing barriers to entry will increase market contestability, improve competition, and increase consumer surplus.

Emission fees reduce existing barriers to entry, because all new and existing sources are treated equally. MEP programs also decrease barriers to entry because LAER and offsets would no longer be required. 39 However, sources are likely to be required to obtain all of their emission reductions up front (rather than over an extended time period) from existing sources. These new sources would not be able to take advantage of new low-cost emission reduction technologies that may be developed during the next twenty years. With production-based trading, the barrier to entry is also reduced. Sources that can produce equivalent output with minimal environmental impact are rewarded for entering the market by receiving a tradeable commodity based upon their outputs. For example, new, inherently clean power sources (such as wind, solar, and geothermal) might not be allowed to participate in a MEP approach, because they did not pollute in the past.

During the debate over the acid rain provisions of the Clean Air Act Amendments, cogeneration operators expressed a concern that under a marketable emission permit system, large electric utilities would hoard emission reduction credits for their own future consumption (i.e., holding for themselves the rights which entitle others to enter the market and compete). 40 The concern over control or monopoly over emission reduction potentials, in industries where growth in demand is fairly certain, is not to be taken lightly. EPA's analysis "fell far short" of convincing independent utilities that the supply of emission reduction credits for sale in the market would be sufficient to ensure adequate competition. 40 In an effort to address this concern, congress developed special provisions for independent power producers.

It is still unclear, however, how sources will evaluate the opportunity costs of holding emission allocations in reserve under a marketable permit program. Existing facilities with large sources of uncontrolled emissions may hold these permits for their own future expansion. It may be that additional enticements will be necessary if an active permit market is to become viable. Parallels might be drawn from industrial operations that hold in reserve undeveloped land in urban areas for their own future use, given that the real value of the asset is unlikely to decrease. Individual sources will probably evaluate the opportunity costs associated with holding emission allowances in reserve very differently.

**Incentives to Close or Upgrade Inefficient Facilities**

Under command-and-control approaches, it is easy to argue that barriers to entry translate into barriers to upgrade existing facilities. All of the market-based mechanisms, if they function as intended, should provide substantially increased incentives to close, modernize, or control existing high polluting facilities. When these facilities close, or are modified to reduce emission, significant local air quality benefits can accrue. However, if the emission reductions are banked for later use at a 1:1 offset ratio, these benefits can be reduced or eliminated. It might also be argued that air pollution control strategies that foster competition will provide incentives to upgrade existing facilities.
Efficiency Losses Under Monopoly Conditions

"An emission tax rate that is appropriate for the pure competitor will not, in general, induce behavior that is consistent with optimality in the second best world inhabited by a monopolist." A Pigouvian tax on the output of a monopolistic polluter may actually influence the monopolist to further restrict output, falling even lower than "socially optimal levels," and society is subjected to the welfare loss associated with restricted output. In general, the welfare loss is believed to be far outweighed by the welfare gains of improved environmental quality. Thus, Pigouvian taxes are not expected to result in incremental output distortions due to monopoly presence in the marketplace.

The least-cost analysis for emission trading requires that free trading occur and that no entity can gain control over emission rights. Both of these requirements can be met for MEP programs, but they must be designed into the initial permit and final prescribed permit allocations. Under a MEP system, it is unlikely that an existing output monopolist will relinquish any of their emission rights that are associated with the restricted outputs. Should new entrants contest the market, production expansion would be required to maintain profitability. These questions are complex and require additional analysis before permit allocations are conducted. If industrial operations file suit against the implementing agency, claiming that the impacts of a marketable permit policy is discriminatory, or lawsuits are eventually filed against regulatory agencies and industrial operations claiming that an emission monopoly has formed, efficiency gains made by the marketable permits strategy are likely to be significantly eroded.

By contrast, under production-based emission trading, gaining monopoly control over the emission market is difficult if not impossible. Credits must first be generated through production. Then, if there is only one firm with emission credits to sell, as the credit monopolist raises the asking price, credit purchasers simply compare the marginal cost of controlling their own emissions with the monopolist's asking price and take appropriate action. Plus, as the market price of credits increases, other firms have added incentive to install control technologies that will enable them to become credit sellers ... further reducing the risk of monopoly stability.

Secondary Economic Impacts

Aspects such as unemployment, impacts on local economic productivity, local tax revenues, etc., are additional components of microeconomic and macroeconomic analyses that have not historically been included in market incentive impact analyses (not that these concerns are adequately addressed under the command-and-control approach either). Individual businesses cannot be expected to take secondary economic impacts into consideration when making private decisions. However, the participatory process and open forum used in command and control rule development has served as a location for debate on these secondary economic impacts.

As discussed previously, one of the most significant transitional costs associated with pollution control is considered to be the loss of jobs to the local economy. Marketable permit programs which allow credits to be generated from production decreases and facility shutdowns can exacerbate secondary impacts. The pattern of costs due to employment loss depends upon the job classifications that are reduced and the socioeconomic makeup of the employees that fill those job classifications. It may make sense to keep existing industry functional to slow the rate of change, smooth the transition, and minimize transitional costs by extending them over a longer period of time. Hence, policies that encourage businesses to relocate from the region may be socially undesirable.

Emission fees, which can be varied by source category or business size would be established through the public process, leading to increased opportunity for debate over secondary economic impacts. Under an emission fee approach, all industries within a source category have the incentive to lobby for lower (and/or differential) emission fee rates. During the ongoing fee-setting process, numerous avenues for public input will likely exist.

Production-based emission trading standards offer opportunity for public input in determining the "fair" level of emissions associated with a given industrial output. In addition, production standards provide for intra-source equity, in that all similar industries must meet the same production standards and cannot achieve an unfair competitive advantage based upon an initial allocation. Under this system, some facilities actually have an incentive to lobby for
more stringent emission rate requirements, as they will receive monetary compensation for their previous application of pollution control, or because their process is inherently lower polluting. Hence, under this approach, industry cooperation toward a common emission reduction goal is fostered.

Marketable emission permit systems provide one opportunity to take secondary economic impacts into account in setting the initial and final prescribed permit allocation. Because property rights will have been granted, there is likely to be little flexibility to adjust the system if secondary socioeconomic impacts are later quantified. All corrections to these problems must come from outside the system. Under the MEP approach, all businesses have incentive to lobby for the largest share of initial and final prescribed permit allocation possible.

Production Flexibility

Fee-based approaches result in emission reductions without controls being exercised over inputs or outputs. Thus, emission fees yield no production cutoff criteria. That is, daily or year-end emission constraints that result under command-and-control or marketable permit regulation are not imposed. The production-based emission trading approach discussed earlier can also be implemented such that no constraints on outputs are imposed. By monitoring source category emissions growth and periodically adjusting the average emission rate downward to counter emission growth, marginal costs of emission control increase but output production is never controlled. Marketable permit strategies, by allowing facilities to purchase reductions from other source categories, probably increase production flexibility significantly.

Geographical Effects

The relationship between the emission of a pollutant and the social costs of that pollutant are geographically and meteorologically specific. Formation of ozone is dependent upon the local emissions of reactive hydrocarbons and NOx (i.e., the relative concentration ratios), temperature, sunlight, and numerous atmospheric parameters. Least-cost analyses are often based upon the presumption that emission impacts are direct and additive. In a complex ozone setting, this is often not the case. To adjust for the potential formation of hot spots, regulatory agencies are faced with adjusting trading or fee-based approaches so that actual local social costs are reflected in the cost of the product. Ensuring that any market incentive program protect local areas and avoid creating hot spots makes implementation more difficult.

In regional hot spots, emission fees could be increased to achieve the additional reductions that equalize social costs due to emission effects across the entire air basin. In the case of a MEP system, offset trading ratios or restricted emission trading zones can be established, such that if a firm purchases emission rights from distant sources, those reductions are discounted in accordance with their relative geographic emission impact. Similarly, with production-based emission trading, ratios could be applied to emission credits generated when they are used by facilities in other areas.

Protection of Class 1 areas (federal parks and wilderness areas) is mandated by the Clean Air Act and is currently included in NGR regulations through prevention of significant deterioration (PSD) requirements. These regulations affect emissions of both attainment and non-attainment pollutants, and restrict emissions of these pollutants when they may impact Class 1 areas. Keep in mind that when non-attainment pollutants are emitted, they are usually accompanied by the emissions of attainment pollutants. All of the market incentive strategies need to ensure continued protection of these national resources. However, it is still unclear how any of these market incentive programs will be made to conform with PSD requirements. For example, permit transfers under a MEP program may result in emission increases of attainment pollutants that may impact Class 1 areas.

Emission fees would probably need to be implemented such that emission fees are higher in clean air corridors (areas that carry clean air into these Class 1 areas). MEP programs may need to restrict trading in these clean air corridors. Production-based emission trading would also need to address how emission increases (no longer evaluated during the command-and-control permit review process) will avoid significant impacts on Class 1 areas.
Another issue that must be addressed in dealing with geographic effects is the relative reactivity of hydrocarbon emissions. Emissions of one hydrocarbon compound can result in significantly greater ozone formation than equal mass emissions of other hydrocarbon compounds. Hence, cross-source-category or cross-facility trading may result in increases in hydrocarbon reactivity. To address this problem, fee-based approaches could employ the use of differential fees for various emissions. MEP programs could employ discount mechanisms associated with each pollutant trade, based upon reactivity. Production-based trading approaches within source categories may be able to avoid this problem without using discounting mechanisms. If production-based trading occurs within the same source category, it is more likely that similar reactivity group categories will be traded. However, if significant reactivity differences were noted, emission trading discounts based upon reactivity could be applied.

BALANCING EQUITY AND EFFICIENCY

In a democratic society that strives to balance equity and efficiency, removing the emission control approach completely from the public process may be unwise. After the initial allocation of marketable permits, and the transfer of vested rights from the public to private companies, it is unlikely that the public will be able to influence the actual trades that occur. That is, the public cannot put any preference upon which emission reductions should occur first, instead relying solely upon the marginal costs of control as the determining factor. While the current command-and-control program may fail many equity tests, based upon preferential treatment of certain industries in the legislative and rule development process, there is always an avenue for public redress of these inequities when they arise. The advantage of the production-based emission trading control strategy is that the public involvement remains, but is limited to determining the emission reductions that must be achieved by a source category, and does not extend to mandating specific requirements on industry input or limitations on output. Furthermore, in setting the emission rate standards, it can be expected that all industrial operators within a source category itself will have a strong voice in determining appropriate standards through the regulatory negotiation process. Production-based control approaches should yield significant improvement in terms of both equity and efficiency of air pollution control.

All of the equity impacts that arise from MEP systems will result from the initial allocation and final prescribed allocation of the emission permits. However, these distributional effects can probably only be addressed after they occur, due to the creation of property rights. All adjustments must be made by a government infrastructure lying outside of the emission control arena, through inefficient wealth redistribution strategies.

RELATIVE ADVANTAGES OF PRODUCTION-BASED EMISSION TRADING

The use of production-based emission trading should eliminate a number of economic and ideologic problems that might arise if proposed MEP programs are adopted:

- barriers to entry are eliminated by avoiding both the use of offsets and the requirement that businesses purchase credits from existing sources;
- the marginal costs to each industry within a source category are equalized, as are the average costs of emission control, because no initial permit allocation occurs;
- because there is no initial or final prescribed emission allowances, shifts in socioeconomic distributional effects are less likely to occur;
- because vested rights are never created, monopoly control over emission allowances cannot be achieved;
- by allowing transferable credits to be generated only when output production occurs, there is no added incentive for business flight and the transitional socioeconomic impacts that might result;
- because production is encouraged, efficiency and competitiveness is facilitated and consumer surplus in the marketplace should increase;
- because no vested "right-to-pollute" is ever created, the ultimate emission rights remain in the hands of the public (i.e., setting the initial source-wide emission cap, initial average emission rate,
and periodic adjustments of both to accommodate growth in production while achieving emission reductions) while allowing industry complete flexibility in determining their means of compliance;

- shutdown credits remain under the control of the public, can be deposited in a community bank, and could be used to mitigate the secondary impacts of business flight through reallocation to the same or other source categories (in the form of relaxed emission rate requirements that yield a source-category increase equal to the shutdown reduction); and

- as economic impacts of market-based trading are determined, through detailed and comprehensive research into the impacts of the new program, equity adjustments can be made midstream.

The disadvantages of production-based trading include: 1) efficiency losses associated with not allowing emission trading across source categories, 2) enforcement difficulties associated with quantifying production-based trades, and 3) the continued presence of certain political inefficiencies that exist in command-and-control approaches to emission control (because the political process plays a role in establishing initial source category caps, initial emission rates, and reallocations of emissions across source categories).

Trades across source categories are desirable when emission reductions can be achieved at a lower marginal cost outside of the source category being regulated. While production-based trading would introduce a degree of inefficiency by not allowing trades across source categories, the marginal cost of control within each source category will be evident through the actual trades conducted. If the marginal costs are excessive, the public process can be used to reallocate emission reductions from shutdowns to the most heavily impacted source categories, allowing the emission rate per unit of production to rise (or rate reductions to be delayed). In essence, periodic adjustments to source category allocations and average emission rate requirements could also be used to equilibrate the marginal costs of control across various source categories.

That is, if the electric utility industry was achieving emission reductions at a higher marginal cost of control than was the petroleum industry, based upon analysis of the actual trades that had occurred, at the next periodic review, regulators can either allocate shutdown credits and relax emission rate limits for electric generators, or tighten emission rates for petroleum industries, in order to equilibrate the marginal costs of emission control across source categories. Production-based emission trading allows an additional measure of flexibility that will ensure that significant socioeconomic impacts within source categories can be mitigated should they arise.

Enforcement difficulties will arise under any emission control approach that requires knowledge of actual emissions. Rather than simply ensuring compliance with permit conditions (such as checking emission control equipment operating parameters, process throughput, continuous emission monitor data, and occasional source testing or laboratory analysis), market strategies require that mass emission rates, and total mass emissions be known for the averaging period (i.e., daily or monthly) for which a trade will be made. Production-based trading will require quantification of mass emission rates and output, and the same will be needed for both MEP or emission fee approaches. The increase in enforcement resources associated with this new task should not be seen as a negative aspect of market-based approaches, however, because the mass emissions are desperately needed by regulatory agencies if they are to effectively carry out their planning function and determine the emission reductions required to achieve ambient air quality standards. One additional positive impact of production-based trading is the fact that the portion of industry generating emission credits has a vested interest in ensuring that those facilities purchasing their credits are accurately quantifying their emissions and production. Under no other program is industry provided with a monetary incentive to ensure that other facilities are complying with regulations. This means that private emission auditing services may become more feasible than under current approaches.

CONCLUSIONS

The potential advantages and disadvantages of each of the three market-based systems examined in this paper (emission fees, production-based trading, and marketable emission permits) might be expressed qualitatively, such as in Table 1. However, the equity impacts will clearly be dependent upon the specific implementation plan for any market-based approach, such as the initial allocation of tradeable permits in a marketable emission permit system. It makes one pause to think about whether such generalized qualitative comparisons really mean very much.
In theory, all approaches to air quality management, even command-and-control, have as one of their fundamental goals achieving emission standards along a least-cost path. Weitzman notes that it is conceptually irrelevant to the determination of an optimal allocation whether resource allocation is based upon competitive private ownership or upon efficiently organized government public ownership, so long as the problems of income distribution have been abstracted away. Baumol and Oates recommend that an ideal policy package contains a mixture of instruments, "with emission fees, marketable permits, direct controls, and moral suasion."9

All air pollution control programs result in costs and benefits that have distributional effects across various socioeconomic groups. Yet, each approach is likely to have different effects upon equity, in terms of cost and benefit distributions for businesses, consumers, and taxpayers. The economic cause-effect relationships are very complex, and the actual impacts of the programs are difficult if not impossible to predict. Each air pollution control approach discussed in this paper has its own set of intended and unintended, observed and potential, efficiency losses. Policymakers must decide which system, or systems hybrid, should be implemented. Yet, in doing so, the decisions must be made in the face of great uncertainty. There is currently a great deal of support from existing industry toward extremely flexible MEP systems, and therefore increased political determination to undertake such action, although there are few historical precedents from which the impacts of a MEP system can be predicted.

Once detailed studies are conducted to ensure that MEP systems do not result in serious market failure or distributional equity problems, and the production-based emission control program can demonstrate attainment progress, marketable permit programs might then be better implemented. However, until that time, policymakers must weigh the risks of failure and the equity problems associated with MEP programs with the potential for reduced emission control costs.

The implementation of production-based emission standards appears to be a better proposition today, and might be used as a bridge to later MEP systems. Production-based emission standards may avert many of the equity dilemmas raised in this paper, and will ensure active industry and public participation in the rulemaking and overall planning process. Potential market failures (i.e., monopoly control over emission rights) should not occur under the production-based emission trading program. Distributional impacts can be addressed due to the flexible nature of the program. If the implementation of production-based trading pilot programs fail to achieve the expected emission reductions at a lower cost than command-and-control, or if there are practical problems with enforcement that cannot be overcome, the approach is flexible and amenable to ongoing modification.

The significant problems with command-and-control approach must be changed. Offsets and LAER requirements unduly place the burden of control on new and efficient sources, and provide little incentive for existing industry to improve their efficiency. Policymakers must put themselves in a position of cost and benefit risk assessment, and determine which market-based strategies are most likely to achieve air quality goals at an acceptable risk of market failure and mitigated socioeconomic impact.

In determining whether market-based approaches to air pollution control are better than the existing command-and-control approach, two questions must be answered. Is the new approach more efficient? Is the new approach more equitable? If policymakers fail to address one or the other of these questions in their plans, the public pays the price of that failure. In a democratic process, the public needs to be involved in determining the acceptable tradeoff between equity and efficiency. The command-and-control approach has persisted, but production-based emission trading appears to offer an opportunity to increase both the efficiency and equity of air pollution control programs.
REFERENCES AND FOOTNOTES

1. "Command-and-control" is somewhat of a misnomer. Given the public participation in both the planning and regulatory process, a negative connotation of "force" associated with command-and-control is somewhat unwarranted. Market-based incentives still include an element of coercion, in the form of penalties for non-compliance, so a positive connotation of "voluntary" associated with market mechanisms is similarly unwarranted. It may be the absence of a sense of self-determination under the command-and-control approach (i.e., who has the ultimate control over what actions must be taken) that is at issue.

2. In California, these AQMPs are developed by local air quality management districts and coordinated through the state agency.

3. For the purposes of this paper, prevention of significant deterioration (PSD) requirements, which are actually a component of NSR regulations and apply to emissions of attainment pollutants, are considered separately.


6. Based upon the 25 emission offset transactions undertaken in the South Coast Air Basin during 1990, the cost of CO, ROG, and NOx offsets in the same air basin was approximately $2000 per pound per day, or $11,000 dollars per ton per day (ranging from as low as $3,000 dollars per ton per year to as high as $24,000 dollars per ton per year), for emission offsets that extend into perpetuity (J. Margolis; AERX; San Francisco, CA; personal communication; February 28, 1992).

7. For example, a typical 50 MW cogeneration facility with 98% control will emit about 150 tons/year of NOx and must purchase their offsets for about $1.7 million dollars.


10. For example: certainty in emission reductions under command-and-control, the existence of political benefits under command and control, policymaker resistance to admitting existing system failures, tight regulatory control over current trading, legislator and policymaker lack of understanding of the fundamental economic principles, and lack of previous development of adequate emission monitoring and data communication technology. See, in order of topic listed above, references 9, 11, 12, 5, 11, and 13.

11. R.W. Hahn and R.N. Stavins; Market-Based Environmental Regulation: A New Era from an Old Idea? (90-155.7), Proceedings of the 83rd Annual Meeting of the Air and Waste Management Association; Pittsburgh, PA; June 1990.


14. A.P. Loeb; Argonne National Laboratory; Argonne, IL; personal communication; March 1992.

15. Baumol and Oates argue that most taxes in our economy are accompanied by undesirable side effects that distort economic choices. For example, income taxes may discourage work, excise taxes may shift purchases away from the taxed goods (i.e., additional economic burdens are imposed). These types of inefficiencies are not believed to result from emission fee systems. In contrast, emission fees create a "negative excess burden" (see Reference 9, p. 180).
16. Production-based emission trading is essentially required by the federal emission trading policy statement (ETPS). See references 23, 24 and 26.


18. R.G. Rhoads; Director, Control Programs Development Division, U.S. Environmental Protection Agency; Procedure to Calculate Equivalency with the CTG Recommendations for Surface Coating; Memorandum to: Chief, Air Programs Branch, Regions I - IX, Research Triangle Park, NC, May 3, 1980.

19. A.P. Loeb; Three Misconceptions About Emission Trading (90-155.8); Proceedings of the 83rd Annual Meeting of the Air and Waste Management Association; Pittsburgh, PA; June 1990.

20. Rule 1135 was recently submitted to EPA for incorporation into the SIP, but will likely be replaced by the RECLAIM program, (see the marketable emission permits section).

21. California Air Resources Board; Proposed Regulations for Low-Emission Vehilces and Clean Fuels, Staff Report and Technical Support Document; Mobile Source Division and Stationary Source Division; Sacramento, CA; August 13, 1990.

22. R. Guensler, P. Burmich, and A.B. Geraghty; The Role of Transportation Control Measures in California's Air pollution Control Strategy (4,6); Proceedings of the Air and Waste Management Association Specialty Conference on PM$_{10}$ Standards and Nontraditional Particulate Source Controls; Pittsburgh, PA; January 1992.

23. R. Guensler; Evaluating the Effectiveness of State Implementation Plan Strategies (90-93.12); Air and Waste Management Association, 83rd Annual Meeting Proceedings; Pittsburgh, PA; June 1990.

24. Guensler, Randall; Preparation of Alternative Emission Control Plans for Surface Coating Operations; (89-118B.3); Air and Waste Management Association, 82nd Annual Meeting Proceedings; Pittsburgh, PA; June 1989; revised August 1989.


27. W.W. Berry; Testimony of William W. Berry, Chairman, Virginia Power; Hearings Before the Subcommittee on Energy and Power, House Committee on Energy and Commerce; 101st Congress; Serial No. 101-114; October 11, 1989; pp 302-322.

28. Because actual emissions are used in attainment planning, the source potential to emit really meant very little during the original permitting process, until the advent of NSR regulations which used potential to emit as a cutoff point in determining when LAER and offsets applied. In fact, because there were no assumed emission rights being generated when the permit was prepared, actual emission may be significantly lower than permitted emissions (there was no incentive for permit engineers to ensure that actual emissions would approach permitted emission levels). Thus, the actual permitted emission level that exists for two identical facilities can vary, assigned differently be each regulatory agency engineer. In fact, many of the permits in existence today do not even have maximum emission caps associated with them (take for example a paint spray booth permitted before 1979 ... is the permitted emission limit for the booth to be based upon 24 hour per day operation?).

29. Regulatory Flexibility Group; A Marketable Permits Program for the South Coast; Recommendations of the Regulatory Flexibility Group; A Coalition of Southern California Businesses and Associations; Latham and Watkins; Los Angeles, CA; December 20, 1991.
30. Currently, inspection resources are not allocated to ensure compliance with total mass emission limits contained on facility permits ... these checks are usually undertaken only in auditing the accuracy of the source-reported emission inventory. Whereas inspections of paint and coating facilities may typically take 1/4 inspection day, inspection of a comparable paint and coating facility operating under a source bubble (emission trading across coatings, known as an alternative emission control plan) often take more than a full inspection day, due to the time associated with quantifying the total emissions per source for the period in question.

31. C.L. Shaver; presentation at the USEPA NSR/PSD course; Chief, Policy, Planning and Implementation Branch, National Park Service; Denver, CO; May 29, 1991.

32. South Coast Air Quality Management District; Marketable Permit Program; Working Paper 15; El Monte, CA; 1991.

33. U.S. Environmental Protection Agency; Auctions, Direct Sales, and Independent Power Producers Written Guarantee Regulations, Federal Register, Volume 50, Number 242; December 17, 1991.

34. N.S. Dorfman and A. Snow; Who Will Pay for Pollution Control? - The Distribution by Income of the Burden of the National Environmental Protection Program; National Tax Journal; Volume 28, Number 1; March 1975.


39. Some of the existing requirements of the Clean Air Act (e.g., LAER and offset ratios) would not be required under a MEP, provided that the trading program is deemed "equivalent" to the existing command and control program by the USEPA.


41. T. Tietenberg; Spatially Differentiated Air Pollutant Emission Charges: An Economic and Legal Analysis; Land Economics; August 1978, 265-277.

42. If practical problems in enforcement cannot be overcome for production-based emission standards, there is no reason to believe that marketable emission permit systems would fare any better ... both systems require the ability to ascertain and enforce total mass emissions, rather than mass emission rates alone.
Table 1. Potential advantages/disadvantages of market-based approaches relative to command and control.a

<table>
<thead>
<tr>
<th></th>
<th>Emission Fees</th>
<th>Production Based Trading</th>
<th>Marketable Emission Permits</th>
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<tr>
<td><strong>Political Influence</strong></td>
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<td>Decreased</td>
<td>Eliminatedc</td>
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<tr>
<td><strong>Public/Private Coop.</strong></td>
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<td>Higher</td>
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<td>Higher</td>
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<tr>
<td><strong>Compliance Flexibility</strong></td>
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<td>High</td>
<td>Higher</td>
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<tr>
<td><strong>Required Agency Skill</strong></td>
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<td>Higher</td>
<td>Higher</td>
</tr>
<tr>
<td><strong>Barriers to Entry</strong></td>
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<td>Lower</td>
<td>Higher</td>
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<tr>
<td><strong>Monopoly Potential</strong></td>
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<td>Higher</td>
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<tr>
<td><strong>Marginal Control Costs</strong></td>
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<td><strong>Business Flight</strong></td>
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<td>Higher</td>
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<tr>
<td><strong>Competitiveness</strong></td>
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<td>Increased</td>
<td>Decreased?</td>
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<td><strong>Adjustment Capability</strong></td>
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<td><strong>Monitoring Incentive</strong></td>
<td>No Change</td>
<td>Increased</td>
<td>No Change</td>
</tr>
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</table>

a Impacts will clearly be dependent upon the specific implementation plan for any market-based approach. This list should only be used only as a starting point for discussion, and numerous caveats should be attached to the qualitative ratings.

b How much political influence (lobbying) from local and private interest will be inherent in the program?

c High degrees of political influence will, however, be involved in setting the initial and final prescribed emission allowances.

d How great is the incentive for industry to innovate in terms of emission control?

e Does the implementing agency require increased technical skill (e.g. ability to monitor emission reductions, ability to set appropriate emission fees, etc.)?

f Will industrial competitiveness be improved in the basin?

g Given that the distributational impacts are unknown, does the strategy lend itself to making mid-stream equity adjustments?

h Could be mitigated through differential fees, emission limits, or trading ratio requirements.

i Incentive for businesses to monitor the compliance of competing businesses.