REPORT BY THE U.S.

General Accounting Office

A Market Approach To Air Pollution Control Could Reduce Compliance Costs Without Jeopardizing Clean Air Goals

A market approach to air pollution control would allow the purchase, sale, and use of air pollution entitlements consistent with present standards governing outdoor air quality. A market incentive approach can lower the cost of clean outdoor air by allowing firms to find the most efficient way to control pollution without jeopardizing the air quality standards of the Clean Air Act. Problems in implementing such an approach can be overcome.

The committees with jurisdiction over the Clean Air Act should consider rewriting some of the provisions which currently limit the use of market incentives. Also, the committees should encourage the Environmental Protection Agency to emphasize a market approach to air pollution control wherever this system can achieve air quality at less cost and is permissible under the Act.

PAD-82-15
MARCH 23, 1982

UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROGRAM ANALYSIS
DIVISION

B-205035

The Honorable John D. Dingell
Chairman, Committee on Energy
and Commerce
House of Representatives

The Honorable Robert T. Stafford
Chairman, Committee on Environment
and Public Works
United States Senate

The use of market incentives in air pollution control could reduce compliance costs of the Clean Air Act without jeopardizing outdoor air quality standards. Such an approach to air pollution control would provide industry with the opportunity to find cheaper ways to meet our Nation's desire for clean outdoor air. This report provides an evaluation of the feasibility of employing market incentives to bring about greater economy and efficiency in regulating air quality.

Copies of this report are being sent to interested congressional committees; members of Congress; the Administrator, Environmental Protection Agency; the Director, Office of Management and Budget; the Chairman, Council of Economic Advisers; and other interested parties.

Morton A. Myers
Director

REPORT BY THE U.S.
GENERAL ACCOUNTING OFFICE

A MARKET APPROACH TO AIR POLLUTION CONTROL COULD REDUCE COMPLIANCE COSTS WITHOUT JEOPARDIZING CLEAN AIR GOALS

D I G E S T

Establishing a market in air pollution entitlements could be a less costly, more flexible way to meet minimum standards of outdoor air quality. These entitlements allow emissions consistent with present standards governing outdoor air quality. Such a market could save the public millions of dollars relative to the price tag currently imposed by command and control regulations to meet the requirements of the Clean Air Act, estimated at $22 billion in 1979.

GAO undertook this study to explore whether developing such a market is feasible, recognizing that numerous obstacles stand in the way. GAO's purpose is to offer the House Committee on Energy and Commerce and the Senate Committee on Environment and Public Works an assessment of this novel approach to air pollution control at a time when the Clean Air Act is being reauthorized. To the degree that such a market incentive approach could reduce compliance costs by using scarce economic resources more efficiently, a number of important results follow. First, more economic growth could be achieved without sacrificing the benefits of good air quality. Secondly, the individual taxpayer could benefit from more efficient operations of regulatory agencies.

To obtain a general perspective on the feasibility of developing a market in air pollution entitlements, GAO first reviewed relevant literature, Federal legislation and regulations, and Federal policy statements pertaining to the Clean Air Act, command and control regulation, controlled trading, and a market in air pollution entitlements. The review revealed the critical importance of regulatory reforms under way at EPA, known as controlled trading, which could lead to a limited form of a market. In contrast to command and control regulation, controlled trading gives firms considerable flexibility to choose pollution abatement measures to meet an overall emissions limit. Next, GAO studied efforts under way to implement controlled trading, because a full-scale market in air pollution entitlements

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could develop from a workable system of controlled trading. Since much of the trading directly relevant to the feasibility of a full-scale market has occurred in California, GAO field work was conducted there. (See chapter 2.)

Throughout the report, GAO relied heavily on economic analysis. In its field work, GAO made every effort to obtain documented evidence on problems of implementation and on potential cost savings of trading in air pollution entitlements.

ECONOMIC BENEFITS OF A MARKET APPROACH TO AIR POLLUTION CONTROL

The traditional air pollution control system, commonly known as command and control, is characterized by rules dictating specific methods of pollution abatement and limits on the amounts of pollution from each industrial plant and even from each source of pollution within a plant. By contrast, a market approach to air pollution control would allow firms considerable flexibility in choosing ways to meet the air quality mandates of the Clean Air Act. For example, a firm might be allowed to meet an overall limit on pollution from its entire facility by freely choosing where and by how much to control pollution within that plant, provided such choices were consistent with the air quality mandates of the Act. Or, several firms might be allowed to meet an overall limit on pollution from their combined facilities. For instance, a steel firm might find it cheaper to pay chemical companies to control their air pollution, rather than control that same amount of pollution itself. (See pp. 15-18 and pp. 21-22.)

GAO's review of a number of studies suggests that a full-scale market in air pollution entitlements could, in some instances, save industry as much as 90 percent in pollution abatement costs as compared to command and control. In addition, cost data gathered in GAO's field work suggest similar large potential cost savings. (See pp. 24-29 and pp. 71-74.)

EPA's CONTROLLED TRADING IS A LIMITED MARKET APPROACH

EPA's controlled trading approach consists of the "bubble," offset, and emission reduction banking policies. The "bubble" policy allows variation in pollution controls--instead of uniformity--among individual existing sources of pollution

within a single industrial plant. If controlling one smokestack is cheaper than controlling another, this kind of flexibility can yield cost savings. Under some circumstances, the "bubble" policy also permits firms to trade in air pollution entitlements to achieve a less costly solution.

The offset policy allows major new industrial plants to be constructed in areas of the country which do not presently comply with the air quality mandates of the Clean Air Act. The owner of such a new plant must obtain external offsets--emission reductions--from owner(s) of existing plants.

The third component of controlled trading, banking, facilitates the use of bubbles and offsets by creating a central clearing facility, thereby making emission reductions more readily available. (See pp. 16-18.)

Controlled trading is a limited market approach because opportunities to reduce abatement costs without jeopardizing air quality are restricted by certain technology requirements of the Clean Air Act. These requirements include Lowest Achievable Emissions Rate Technology, Best Available Control Technology, and New Source Performance Standards. As a result, a major new industrial plant may have to be equipped with stringent pollution controls, even though it might be cheaper for this plant to adopt weaker controls and, through trading, pay other companies to curtail their pollution. (See p. 42.)

OBSTACLES TO IMPLEMENTING A MARKET IN AIR POLLUTION ENTITLEMENTS

Many of the implementation problems in controlled trading are particularly relevant in assessing the feasibility of a market. This is especially true in arranging external offsets. Transaction costs in the air pollution permit process and search costs are cases in point. In the air pollution permit process, the regulator and regulatee incur transaction costs in negotiating the proper level of pollution abatement to comply with the Clean Air Act. In arranging external offsets, delay and expense can arise in the permit process in determining whether emission reductions at the offsetting sites, usually at existing industrial plants, are large enough to offset the emission

increases at the proposed new plant. The answer depends upon estimates of pollution control efficiency and emissions, and the effect of these emissions upon air quality. Differing estimates may be reconciled only after considerable delay and expense. (See pp. 38-41.)

Search costs pertain to the expense and time of gathering information on the availability and prices of air pollution entitlements. The search for air pollution entitlements can be complicated because air pollution control is so imprecise. For example, uncertainty about the adequacy of current air quality management plans designed to bring certain areas of the country into compliance with the Clean Air Act could lead to tougher regulations in the future to meet any shortfall in compliance. This possible scenario, together with the novelty of trading in air pollution entitlements, could make many reluctant to sell offsets. An individual supplier of offsets might conclude that higher prices are in store, yet have little idea how much higher. This firm might hoard its entitlements until better price information was available. (See pp. 40-41.)

OFFSETS AND BANKING IN SAN FRANCISCO

The basic elements for developing a market in air pollution entitlements are present in the San Francisco Bay Area. An emissions reduction bank, where suppliers of air pollution entitlements receive credit for pollution curtailments not legally required, offers opportunities to reduce transaction costs in future trading. Cost data on retrofitting existing sources in that area suggest large potential savings from such trading and provide an incentive to trade. (See pp. 48-51 and pp. 71-74.)

The Bay Area also appears able to ensure an acceptable level of enforceability in controlled trading. One reason is the precedent set in an offset case in the Bay Area where greater flexibility to achieve cost savings was tied to a regulatory requirement for better information on the emissions inventory of the applicant. (See pp. 74-76.)

As it becomes clear what changes in the air quality management plan are needed to comply with the Clean Air Act and as the novelty of trading wanes, uncertainty and hoarding should become less of a problem in the Bay Area. (See pp. 52 and 77.)

The major problems encountered in the permit process, namely disputes about the efficiency of pollution control equipment, the accuracy of offsetting emission reduction estimates, and the bona fide nature of some offsets, do not appear to be insurmountable. The search for offsets can be facilitated in the future by emission reduction banking in the Bay Area. (See p. 64.)

CONTROLLED TRADING IN LOS ANGELES

Given the severity of air pollution and the stringency of control measures in Los Angeles, that area's offset and banking experience can be considered as controlled trading "under duress." In particular, a greater potential conflict concerning the bona fide nature of offset candidates can be expected in Los Angeles, as the regulator seeks additional regulations to correct Clean Air Act violations. This factor and uncertainty associated with the effectiveness and cost of unusually stringent, state-of-the-art pollution controls there are not likely to make search easy. Yet, external offsets have been negotiated in Los Angeles. (See pp. 83-92.)

Like San Francisco, Los Angeles' offset experience suggests that ownership of air pollution entitlements is being vested in existing firms, at least in a de facto sense. However, the permanency and intactness of these property rights are unclear. So long as that area's air quality management plan is judged deficient in meeting the Clean Air Act, new regulations can be expected to erode the value of these de facto rights. (See pp. 83-92.)

OBSTACLES TO IMPLEMENTATION DO NOT APPEAR INSURMOUNTABLE

Based on GAO's case studies the problems impeding the widespread use of controlled trading and the eventual emergence of a full-scale market in air pollution entitlements do not seem unresolvable. GAO believes that many of these problems are primarily due to the novelty of trading in air pollution entitlements. (See pp. 96-101.)

MATTERS FOR CONSIDERATION BY THE COMMITTEES

The committees should consider rewriting some provisions of the Clean Air Act which currently prevent controlled trading from evolving into—

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a full-scale market capable of achieving our air quality standards at the least cost to society. Specifically, the committees should consider allowing controlled trading in lieu of New Source Performance Standards, Lowest Achievable Emissions Rate Technology (LAER), and Best Available Control Technology (BACT). Where this substitution can yield equivalent air quality at a lower cost, the committees should consider allowing it. (See p. 103.) In addition, the committees should consider replacing case-by-case determination of LAER and BACT with periodic determination of those requirements. The committees should also consider approving interpollutant offsets as they have been used in California. (See p. 104.)

The committees should encourage EPA to devote more effort to implementing controlled trading, particularly its promotion of emission reduction banking. The committees should also encourage EPA to promote a tie-in between cost savings from controlled trading and improvements in enforceability. (See pp. 102-103.)

AGENCY COMMENTS

EPA reviewed a draft of this report and found it "lucid" and "well informed" but drew a conclusion not contained in the report that at present thousands of tons of offsets are "readily available at reasonable prices" in severe nonattainment areas. EPA believes that allowing controlled trading in place of New Source Performance Standards could result in an increase in emissions. GAO believes that this could lead to better air quality. GAO's responses to specific EPA comments are in appendix VII and elsewhere in the report.

A number of industry, environmental, and regulatory officials from the State of California, where GAO's case work was done, also commented on excerpts of the draft. Where appropriate, the report reflects their suggested changes. OMB commented that GAO's report was timely; the Council of Economic Advisers said it was "well done."

TABLES

CHAPTER 1

INTRODUCTION

The Clean Air Act has limited the degree to which outdoor air can be polluted. According to the Council on Environmental Quality (CEQ), $22 billion was spent in 1979 alone to comply with the Act. The benefits of clean air may be achievable at a lower cost by using economic incentive approaches as alternatives to conventional regulation. The principal reason for undertaking this study has been to explore the possibilities of lowering the price tag for clean air through using economic incentive approaches to air pollution control. Such approaches also offer the possibility of saving tax dollars and improving the operations of Government agencies.

One such approach is a market in air pollution entitlements. Such entitlements allow emissions consistent with present standards governing outdoor air quality. Recently, the U.S. Environmental Protection Agency (EPA) promoted a number of regulatory reforms, commonly called "controlled trading," which could culminate in a limited market in air pollution entitlements. Within certain bounds, controlled trading allows firms to find cheaper ways to meet existing air pollution control mandates. Generally, conventional regulation has left little or no room for flexibility necessary for firms to find cheaper or more efficient ways to meet the air quality objectives of the Clean Air Act. This traditional system, commonly known as command and control, is characterized by rules commanding specific methods of pollution control and limits on the amounts of pollution from each industrial plant and even from each source of pollution within a plant.

By contrast, an economic incentive approach such as controlled trading would allow firms considerable choice in complying with the air quality mandates of the Clean Air Act. Flexible rules, rather than rigid requirements, are the hallmark of such an approach. A firm might be allowed to meet an overall limit on pollution from its entire facility by freely choosing where and by how much to control pollution from that plant. Or, firms might be allowed to meet an overall limit on pollution from their combined facilities. If it were cost effective, one firm might pay other companies to control their pollution, rather than control that same amount of pollution itself. And it is in this type of arrangement, where one firm elects to underwrite pollution controls on another, that we have the makings of a market in air pollution entitlements. In effect, one firm buys air pollution entitlements from another. Quite evidently, this kind of market transaction will only occur when it is mutually advantageous to both firms, or trading partners.

Accordingly, an important question is whether the traditional system of rigid controls has created fertile grounds for such a market to emerge. The answer depends on whether command and control has perpetuated sizable differences in

FIGURES

ABBREVIATIONS

APCO	Air pollution control officer
AQCR	Air quality control region
BAAQMD	Bay Area Air Quality Management District
BAC	Bay Area Council
BACT	Best available control technology
CARB	California Air Resources Board
CBE	Citizens for a Better Environment
CEQ	Council on Environmental Quality
CFC	Chlorofluorocarbon(s)
CO	Carbon monoxide
EPA	U.S. Environmental Protection Agency
ERC	Emission reduction credit
HC	Hydrocarbons
LAER	Lowest achievable emissions rate
NAAQS	National ambient air quality standards
NO_2	Nitrogen dioxide
NO_x	Nitrogen oxides
NSPS	New source performance standards
NSR	New source review
PG&E	Pacific Gas & Electric
PM	Particulate matter
PSD	Prevention of significant deterioration
RACT	Reasonably available control technology
RFP	Reasonable further progress
SCAQMD	South Coast Air Quality Management District
SIP	State implementation plan
SO_2	Sulfur dioxide
VOC	Volatile organic compounds

The detailed cost information needed to achieve a least cost solution could be obtained and acted upon in either a market or command and control scheme. In a market, a potential buyer of air pollution entitlements must find out how many entitlements are for sale and at what prices if he wishes to minimize his pollution control costs. This search effort is typical in any market, whether it be in air pollution or peanuts. But, in an unorganized and infrequently used market, these search costs can be very high.

A regulator seeking the same least cost solution through command and control would need the same detailed cost information. However, the regulator's search costs would probably be much higher than in a market scheme. For example, companies would have no incentive to disclose this information in a command and control scheme. In a market, these firms could profit from the use of such information. They could profit from selling or purchasing air pollution entitlements.

In this report, we pay attention to transaction costs in the permit process and search costs. We also investigate a number of other implementation problems which do not fit neatly under the rubric of transaction costs. One is the potential uncertainty troubling a market in air pollution entitlements. On the one hand, this uncertainty is tied to the state of the art in air pollution control and, more generally, to the complex technical and political decisions that must be made in air quality management. Simply put, there may be little assurance that air pollution control measures in place now are adequate to bring various regions of the country into compliance with the air quality objectives of the Clean Air Act. As a result, there may be a good deal of uncertainty about the future supply of air pollution entitlements and a reluctance on the part of companies to sell entitlements now, especially if they have to buy later at higher prices. Similarly, some regulators may fear that controlled trading and a market may somehow limit their options for future controls--if they are needed for compliance--because of market connotations regarding property rights.

More generally, any uncertainty buffeting controlled trading and a full-scale market in air pollution entitlements is also likely to be due to the novelty of the experiment. For instance, a market poses a fundamental challenge to the way in which firms have met their regulatory obligations in the past. Rather than being told exactly what to do by a regulator to comply with the law, controlled trading and a market would leave more of this decision up to the firm. So it would seem that a market would demand a level of private decisionmaking in environmental control which has not yet been made. A market would also make one company possibly rely on another to meet air pollution control obligations. As in the past, when specialization, trading, and markets offered the opportunity for greater economic achievements at the cost of some added risk, so too does a market in air pollution entitlements.

the costs of controlling pollution among different firms. This report addresses these cost differences and the cost savings from a market strategy for meeting the air quality objectives of the Clean Air Act. However, this report focuses on the problems of implementing this novel approach to air pollution control. Such implementation entails extensive reforms of the conventional command and control system. As we noted, EPA has promoted a number of reforms (controlled trading) which represent an important beginning to a possible transition from command and control to a full-scale market. Indeed, a primary premise of this study is that a workable system of controlled trading is necessary for emergence of such a market in air pollution entitlements. Accordingly, we paid special attention to applications of controlled trading and, as a result, witnessed firsthand the types of problems that must be resolved to implement a full-scale market in air pollution entitlements.

Among these implementation problems, we will explore the role of transaction costs and uncertainty in the operation of controlled trading and any subsequent market evolution. These transaction costs are distinct from their more widely recognized "brethren," namely, capital and operating costs of pollution abatement. However, transaction and abatement costs are functionally related. Transaction costs represent the time spent and direct cash outlays in the actual negotiation of the proper level of abatement and, hence, pollution. Under the conventional system of air pollution control, the decision on abatement is made ultimately by the regulator or the court and is the culmination of the air pollution permit process. These transaction costs are imposed and incurred by the regulator to ensure compliance with the Clean Air Act. They are incurred by the firm to facilitate its project's approval and to avoid more pollution abatement than is desired or legally required. In this report, we assume that the traditional permit process and associated transaction costs would be an integral part of a market in air pollution entitlements. This assumption is consistent with the way in which controlled trading is evolving from the conventional system. For example, in controlled trading, if two firms wish to swap air pollution entitlements, both the buyer and seller of these entitlements must obtain permits from the regulator before the buyer can actually use these entitlements. Because of the complexity of air pollution control, a viable market alternative may have to incorporate the traditional permit system in its design. However, it follows, then, that transaction costs incurred in the permit process are not unique to a market, but are generic to air pollution control. If these costs are high enough, they can stymie developing a more efficient system, whether it be a market or an improved version of command and control. Simply put, the practice of completing a transaction must be fairly well developed for a market to work.

In this report, we also consider another type of transaction cost, one which would accompany any attempt to meet the air quality objectives of the Clean Air Act in the least costly way.

importance of these implementation problems are sure to vary from one metropolitan area to another, markets anywhere would be subject to a common set of implementation problems. For these reasons, a case study of California was judged sufficient to meet our objectives. Although Los Angeles has probably the worst air pollution problems of any large metropolitan area in the country and California has some of the most stringent regulations, we believe that these distinctions, on balance, make problems of implementation clearer. And, more importantly, the California experience, because of these distinctions, may be a worst-case scenario for controlled trading in metropolitan areas.

Throughout the report, we rely heavily on economic analysis. In our field work, we made every effort to obtain documented evidence on problems of implementation and on potential cost savings of trading in air pollution entitlements. We also interviewed many participants of trading in California to elicit their judgments about the feasibility of a market. To a limited extent, we also did some statistical analysis using California data.

ORGANIZATION

The following discussion consists of three parts. The first part, chapter 2, provides detailed information on the Clean Air Act and conventional regulation. Strategies adopted by EPA to implement the Act are also discussed. This information is helpful in bringing into sharper focus sources of potential cost savings. The information also shows how those cost savings are most likely to be tapped to a limited extent through controlled trading. In turn, the connection between controlled trading and a possible full-scale market in air pollution entitlements is revealed. As a corollary, this chapter highlights those areas where additional reforms would be needed to facilitate development of a market in air pollution entitlements which could tap all potential cost savings.

The second part, chapter 3, presents basic theoretical arguments for using economic incentives, rather than command and control methods, to meet air quality objectives. It explains two basic ways to incorporate such economic incentives in the Clean Air Act: either through using an emissions fee system or a market in air pollution entitlements, and compares the comparative advantages and disadvantages of each system. Chapter 3 also provides estimates of potential cost savings by employing economic incentives.

The third part addresses problems in implementing controlled trading and an eventual market. Chapter 4 provides a general framework useful for identifying and resolving these problems. Technical, legal, and regulatory issues are analyzed to see in what ways they may obstruct or encourage controlled trading and a full-scale market in air pollution entitlements. In chapter 5, we present the results of a case study of the San Francisco Bay Area's experiment in controlled trading. A wide range of issues are

OBJECTIVES, SCOPE, AND METHODOLOGY

In theory, a market in air pollution entitlements can possibly save society billions of dollars relative to the price tag currently imposed through command and control regulation to meet the requirements of the Clean Air Act. Our objective in this study is to explore whether development of such a market is feasible, recognizing that numerous obstacles stand in its way.

To meet these objectives, we first reviewed the literature, Federal legislation and regulations, and Federal policy statements pertaining to the Clean Air Act, command and control regulation, controlled trading, and a market in air pollution entitlements. This research effort gave us an adequate perspective on the general feasibility of a market, which, in turn, serves as a useful benchmark for judging our findings from a select number of local jurisdictions.

Second, we performed extensive field work in California, in the Los Angeles and San Francisco regions, from July 1980 to February 1981. Much of the controlled trading directly pertinent to a market has occurred in California. So we believed that outstanding transaction costs and other implementation problems were more likely to be apparent there than in other places where little, if any, trading had occurred. We were also able to gather limited information from local air pollution regulators from Louisville, Kentucky, and Puget Sound, Washington, two other areas where emissions reduction banking has occurred. And, our review of the literature included studies which had documented transaction costs and other implementation problems of trading in the rest of the country. 1/ This amalgam comprises the scope of the report.

Our methodological approach consisted of reviewing, at the national level, secondary sources of information, including articles, books, legislation, and regulation. The limited number of controlled trading applications and their scattered incidence across the country, although most frequently in California, meant that statistical analysis would not be fruitful. Furthermore, the nature of the problem suggested that many of the costs and problems of implementation were due to the novelty of controlled trading and a full-scale market, and to the complexity of air pollution control. Although the size and relative

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1/For example, Wes Vivian and William Hall, "An Examination of U.S. Market Trading in Air Pollution Offsets" (Ann Arbor: University of Michigan, Institute of Public Policy Studies, March 1981); William Foskett, "Emission Offset Policy at Work: A Summary Analysis of Eight Cases" (Washington, D.C.: Performance Development Institute, June 1979); and Richard Liroff, "Air Pollution Offsets, Trading, Selling, and Banking" (Washington, D.C.: The Conservation Foundation, 1980).

CHAPTER 2

THE PRESENT APPROACH TO AIR POLLUTION CONTROL

In this chapter, we review major provisions of the Clean Air Act and strategies adopted by EPA to implement the Act. First, this review sheds light on the salient features of command and control regulation, which has been the standard method of air pollution control, and describes the air quality mandates likely to constrain the operation of any market approach. Secondly, it also reveals the evolution now under way, in which economic incentives are grafted onto the conventional system through controlled trading. Our review can serve as a benchmark for comparing command and control and market strategies to meet a common air quality goal. Relatedly, this chapter touches upon problems of implementing a market which are generic to air pollution control and the permit process (a more detailed analysis occurs in chapters 4 through 6).

Our review is necessarily retrospective, given rapid developments in regulatory reform. A retrospective analysis is particularly valuable because it helps to explain the roots of regulatory reform, or controlled trading. It also indicates how much conventional regulation has evolved towards a market.

THE CLEAN AIR ACT OF 1970

Far-reaching amendments to the Clean Air Act of 1963 were enacted in 1970. The resulting Act is the cornerstone for defining and controlling minimum outdoor air quality in the United States. The 1970 Act protects our outdoor air quality in three principal ways. First, national ambient air quality standards (NAAQS), setting minimum standards for outdoor air quality, were established, and a planning mechanism for meeting these standards was introduced. This mechanism, commonly known as the State Implementation Plan (SIP), underscores the States' responsibility for implementing this Act. Secondly, the Act authorized emission standards--typically controlling how much pollution is emitted from a smokestack--for stationary sources of pollution. Thirdly, various measures, such as exhaust standards, were set to control pollution from mobile sources. 1/

The U.S. Environmental Protection Agency established NAAQS for five pollutants in 1971, to protect public health and

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1/S. Blacker et al., "Measurement & the Law: Monitoring for Compliance with the Clean Air Amendments of 1970," Intern. J. Environmental Studies, 1977, vol. 11, p. 169.

addressed, including evidence on potential cost savings from such trading and a market, implementation problems, and a prognosis for a market in that region. Similar evidence is presented in chapter 6 for Los Angeles. Chapter 7 contains a summary, matters for consideration by the committees, and agency comments.

Table 1

National Ambient Air Quality Standards a/

Pollutant	Averaging Time	Standard Levels	
		Primary	Secondary
PM	Annual (geometric mean)	75 ug/m^3	60 ug/m^3
	24 hrs b/	260 ug/m^3	150 ug/m^3
SO_2	Annual (arithmetic mean)	80 ug/m^3 (0.03ppm)	-
	24 hrs b/	365 ug/m^3 (0.14ppm)	-
	3 hrs	-	1300 ug/m^3 (0.5ppm)
CO	8 hrs b/	10 ug/m^3 (9 ppm)	10 ug/m^3 (9 ppm)
	1 hr b/	40 ug/m^3 (35 ppm)	40 ug/m^3 (35 ppm)
NO_2	Annual (arithmetic mean)	100 ug/m^3 (0.05 ppm)	100 ug/m^3 (0/05 ppm)
O_3	1 hr b/	235 ug/m^3 (0.12 ppm)	235 ug/m^3 (0.12 ppm)
HC (non-methane) c/	3 hrs (6 am to 9 am)	160 ug/m^3 (0.24 ppm)	160 ug/m^3 (0.24 ppm)
Lead	3 months	1.5 ug/m^3	1.5ug/m^3

a/The National Ambient Air Quality Standards (NAAQS) are classified as either primary or secondary, and cross-classified according to various time periods of compliance. The primary NAAQS are designed to "protect the public health." The secondary standards are more severe and are designed to "protect the public welfare from any known or anticipated adverse effects...." The functional meaning of a tandem NAAQS can be best described as that of a target and goal relationship; i.e., the primary NAAQS serves as a target with the secondary NAAQS as the goal. The Clean Air Act calls for attaining the primary standard "as expeditiously as practicable" while specifying a reasonable time at which such secondary standard will be attained."

b/Not to be exceeded more than once per year. Previously, this standard governed concentrations of photochemical oxidants, which are approximately 90 percent ozone.

c/A nonhealth related standard used as a guide for ozone control.

Source: Environmental Quality: The 11th Annual Report of the Council on Environmental Quality-1980, p. 172.

welfare. 1/ Table 1 lists the current NAAQS. 2/ Of these pollutants, particulate matter (PM) and sulfur oxides (SO_x) are emitted chiefly from stationary sources. 3/ To control these emissions and other NAAQS pollutants from such sources, the Act provided several measures. The principal way was to incorporate emission standards for new sources of pollution in the SIPs. 4/ Known as new source performance standards (NSPS), they set maximum emission rates for specific categories of new stationary sources. These NSPS are based upon "the best available technology, taking into account the cost of achieving such reduction." 5/ In accounting for costs, the courts instructed EPA to choose those control techniques "which would not render the source's ultimate product noncompetitive." 6/ Secondly, EPA did not have to justify "different standards for different industries." Whether an NSPS can be met by an industry was to be "decided on the basis of information concerning that industry alone." 7/

In contrast to its approach to new sources, the Act's provisions for controlling emissions of existing stationary sources were generally less specific. Rather than mandating specific emission standards, the Act stipulated that for each of 247 air quality control regions (AQCRs), States submit SIPs specifying emission limitations directed to existing stationary sources. 8/ 9/ In setting these limits, EPA assisted the States

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1/36 Fed Reg. 22384 (1971).

2/The five principal criteria air pollutants are: photochemical oxidants, or ozone (O_3), carbon monoxide (CO), sulfur dioxide (SO_2), total suspended particulate matter (PM), and nitrogen dioxide (NO_2). A sixth, nonhealth-related standard applies to nonmethane hydrocarbons (HC). Environmental Quality: the 10th Annual Report of the Council on Environmental Quality--1979, pp. 53-54. See 40 C.F.R. §50.1 - 50.12 (1981).

3/R. Liroff, "Air Pollution Offsets," p. 3.

4/E. Murov, "Environmental Law: Attaining and Maintaining Air Quality Standards Under the 1977 Clean Air Act Amendments," Tulane Law Review, vol. 53, no. 3, April 1979, p. 909.

5/S. Blacker et al., "Measurement and the Law," p. 174.

6/E. Murov, "Environmental Law," p. 912.

7/Background Information for New Source Performance Standards, vol. 3, U.S. EPA, Office of Air & Water Programs, Research Triangle Park, N.C., Feb. 1974, p. 128.

8/42 U.S.C. §7411(d) (Supp. III 1979); R. Liroff, "Air Pollution Offsets," pp. 3, 4.

9/S. Blacker et al., "Measurement and the Law," p. 171.

or NESHAPS are more likely to have emission standards linked to the NAAQS, and these standards reflect the air quality standards philosophy. 1/ In both types of emission standards, however, there is one common element, "some level of control of emissions which is practical to ask all members of a well-defined class of emitters to achieve and that level of control should be achieved by all members of the class...." 2/ 3/

> to use the best system of emission reduction available at a cost and at a time that is reasonable. These standards are not intended to be related to ambient air quality. Attainment and maintenance of national ambient air quality standards is covered by State implementation plans as provided for under section 110 of the Act ("Implementation Plans").

1/To control pollution from new and existing stationary sources, many States have adopted "emission standards, both 'pure' emission standards based directly on their assessment of what is 'best technology', and those based on an overriding application of the air quality standards philosophy" (de Nevers, "Air Pollution Control Philosophies," p. 199). Some of those standards, as mentioned, require no specified emission rate or test: "the operator who installs and operates properly the 'best technology' is deemed to be complying with the regulation." Other emission standards used are prohibitive in nature, for instance, a ban on open burning. Additionally, visible emission standards, fuel sulfur content and olefin content limitations in gasoline, and numerical emission standards are used (de Nevers, "Air Pollution Control Philosophies," p. 198).

2/Ibid., pp. 198-99. In contrast to the NSPS and NESHAPS, but not unlike emissions controls imposed on existing stationary sources, the motor vehicle emission standards, authorized by the Act, were primarily a result of determining what emission limitations were necessary to meet the NAAQS. However, the end result was promulgation of exhaust standards which were "technology-forcing," in the sense that they could not be met by then current best technology.

3/The Council on Environmental Quality has summarized this approach to air pollution control:

> New sources of air pollution were required to meet specific emission standards, which has had the effect of requiring them to adopt particular technologies. But rather than prescribe limits on air pollutants emitted by existing sources..., the Clean Air Act directed EPA to establish national primary and secondary ambient air quality standards for six major pollutants. The individual States were then directed by Congress to prepare plans to assure EPA that these standards would be met according to the schedule established by Congress.

by issuing control technique guidelines containing information on the technology and costs of emission control. 1/

The only emission standards required for existing sources in the Act were the national emission standards for hazardous air pollutants (NESHAPS). Criteria for setting these standards made no reference to potential costs of control and also applied to new stationary sources. 2/ Besides these stationary source controls, the 1970 Act also set emission limits on carbon monoxide (CO), hydrocarbons (HC), and nitrogen dioxide (NO_2) emitted from automobiles manufactured during and after 1975 or 1976. 3/ These exhaust emission standards were supplemented by regulations on the lead content of fuels. 4/

The 1970 Act has been characterized as having both a "pure emissions standards" philosophy and an air quality standards philosophy. 5/ For instance, the NSPS and NESHAPS are pure emission standards "in the sense that [they] were determined on the basis of 'best technology'." 6/ Basic to this philosophy is the notion that "there is some maximum possible or practical degree of emission control." 7/ If each firm is "required to control his emissions to [the] maximum degree possible," society will have the "cleanest possible air." 8/ 9/ Sources not covered by NSPS

1/Ibid., p. 171.

2/Ibid., p. 174.

3/Pub. L. No. 91-604, §6, 84 Stat. 1690, Dec. 31, 1970; R. Liroff, "Air Pollution Offsets," p. 3.

4/E. Murov, "Environmental Law," p. 938.

5/Noel de Nevers, "Air Pollution Control Philosophies," Journal of the Air Pollution Control Association, vol. 27, no. 3, March 1977, p. 198.

6/Ibid., p. 198.

7/Ibid.

8/Ibid.

9/EPA, Background Information for NSPS, 1974, p. 118. The following EPA response to comments during promulgation of the NSPS is instructive of the pure emissions standard philosophy:

> The objective of standards promulgated under section III of the Act ("Standards of Performance for New Stationary Sources") is to prevent new air pollution problems from developing by requiring affected sources

Similarly, in nonattainment areas, with air quality worse than the NAAQS, entry of a major new firm or modification of an existing firm is subject, among other things, to the following requirements: 1/

- procuring emission offsets, or emissions reductions, from established firms, so as to result in an improvement in air quality.

- adopting lowest achievable emissions rate technology (LAER), the most stringent control measure used anywhere.

- demonstrating that pollution control measures (emission offsets plus LAER) are consistent with reasonable further progress, as defined by EPA, towards meeting the NAAQS.

- for photochemical oxidant violations in cases where a 5-year extension has been obtained for compliance with the NAAQS, an analysis of alternative sites and other factors which demonstrate that the benefits of the project significantly outweigh its environmental and social costs.

1/LAER is to be "superior to the advanced technology normally required by New Source Performance Standards" (Liroff, "Air Pollution Offsets," p. 7). In other words, cost is "to be given less weight in a LAER determination than in the NSPS case" (ibid., p. 8). By LAER is meant, "for any source, that rate of emissions based on the following, whichever is more stringent:

- the most stringent emission limitation which is contained in the implementation plan of any state for such class or category of stationary source, unless the owner... demonstrates that such limitations are not achievable; or,

- the most stringent emission limitation which is achieved in practice by such class or category of stationary source." 40 C.F.R. Part 51, Appendix S (1981).

Under the nonattainment provision, a major new firm or modification is defined as "any stationary source which emits, or has the potential to emit, 100 tons per year or more of any air pollutant under the Act." By "potential to emit" is meant "the capability at maximum capacity to emit a pollutant after the application of air pollution control equipment." Maximum annual rated capacity is to be based "assuming continuous year round operation." 40 C.F.R. Part 51, Appendix S (1981).

THE CLEAN AIR ACT AMENDMENTS OF 1977

Far-reaching amendments to the 1970 Act were made in 1977. Important amendments concern prevention of significant deterioration (PSD) in areas with better air quality than the NAAQS require, and address the problem of meeting the NAAQS in nonattainment areas. 1/ The PSD provisions set ceilings on allowable increases of PM and SO_2 concentrations in the air. These ceilings cannot be exceeded, even if the area affected still does not violate the NAAQS after the ceiling has been reached. 2/ The PSD amendments also contain, among others, the following conditions for permitting major new projects in attainment areas: 3/ 4/

- adoption of best available control technology (BACT), an emission control at least as stringent as NSPS.
- ambient air quality impact analysis.
- assessment of effects on visibility, soils, and vegetation.
- public review.

> In addition, the Clean Air Act called for strict limitations on emissions from mobile sources...
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> The Council on Environmental Quality, "Environmental Quality-1979, The 10th Annual Report," Washington, December 1979, p. 670.

1/E. Murov, "Environmental Law," p. 911.

2/This maximum allowable increase in pollution is set relative to a baseline concentration of the relevant pollutant.

3/42 U.S.C. §7475 (Supp. III, 1979); 40 C.F.R. §51.24 (1981). The 1977 amendments and a subsequent court ruling have defined a major new project as any new stationary source of air pollution which is included in any one of 28 industrial categories judged by EPA to cause or contribute significantly to air pollution and which "emits, or has the potential to emit, 100 tons per year or more of any pollutant regulated under the Clean Air Act." In addition, any other new source which discharges or has the discharge potential of 250 tons per year or more of any of the regulated pollutants is also defined as "major." Alabama Power Company v. Costle, 606 F. 2d 1068 (D.C. Cir. 1979).

4/By "potential to emit" is meant "the capability at maximum capacity to emit a pollutant after the application of air pollution control equipment" (40 C.F.R. §51.24 (b)(4)(1981)). Under a previous, contested definition, "potential to emit" was based on the "maximum annual rated capacity of the source, unless the source is subject to enforceable permit conditions which limit the annual hours of operation." Under the current definition, no allowance for limiting hours of operation is permitted.

nonattainment areas violating the ozone (O_3) and/or carbon monoxide NAAQS, SIPs must also contain RACT for mobile sources. 1/

Other major changes to the 1970 Act strengthen enforcement. The 1970 Act relied on injunctions and criminal penalties for enforcement. However, the history of injunctive action suggests that the Act offered no real threat to the noncomplying facility. Similarly, criminal penalties were typically small and required proof of intent to pollute. The 1977 Amendments have retained these sanctions but have "significantly expanded enforcement flexibility by making owners and operators of major sources subject to civil penalties up to $25,000 per day for specified violations." 2/ The principal aim of these civil penalties is to compel the offender to eliminate excessive pollution, and, thus, the size of this penalty should be at least equal to the benefits of noncompliance. Moreover, EPA can "assess and collect from owners and operators...a noncompliance penalty equal to the economic value that a source owner will net from failure to comply..." 3/ What is especially significant about this penalty is that it is "administratively rather than judicially enforced" and may "result in swifter sanctioning and deter noncompliance." 4/ 5/

Economic incentives

The promise of economic incentive approaches, including a market in air pollution entitlements, in the context of the present Clean Air Act has been aptly summarized by the Council on Environmental Quality (CEQ). Two opportunities for direct pollution control cost savings have been foreclosed according to the CEQ. On the one hand, uniform percentage reduction requirements from all dischargers within an industry ignore variations

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1/Examples of measures which may be required are periodic motor vehicle emission inspection and maintenance programs, improved public transit, and bicycle lanes and storage facilities. EPA memo, Feb. 24, 1978, pp. 8-9.

2/E. Murov, "Environmental Law," p. 931.

3/Ibid., p. 936.

4/Ibid., p. 937. EPA has stated that a violator will not be subject to both the civil penalty and the administrative fine.

5/Ibid., pp. 929-937. The administrative noncompliance penalty is required for violations of the NSPS and NESHAPS, whereas the civil penalty appears to be aimed more generally at failure of the State to enforce its SIP. Such civil penalties, together with a possible prohibition by EPA of major new sources and modifications, have been cited as means for assuring enforcement of SIPs.

These PSD and nonattainment provisions will "generally increase the lead time for obtaining required permits to construct." 1/

The 1977 Amendments affect more than just these new projects. For nonattainment areas, these Amendments require of SIPs "implementation of all reasonably available control measures as expeditiously as practicable" and "reasonable further progress, including such reduction in emissions from existing sources in the area as may be obtained through the adoption, at a minimum, of reasonably available control technology (RACT)." 2/ RACT is generally defined as a set of pollution control techniques which are less stringent than the NSPS. 3/ 4/ 5/ Additionally, in

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1/B. Goldsmith, J. Mahoney, "Implications of the 1977 Clean Air Act Amendments for Stationary Sources," Environmental Science and Technology, vol. 12, no. 2, February 1978, p. 144.

2/42 U.S.C. §7502(b) (Supp.III 1979). Reasonable further progress means "annual incremental reductions in emissions of the applicable air pollutant...which are sufficient...to provide for attainment of the applicable NAAQS" in nonattainment areas by Dec. 31, 1982, or, where such attainment is not possible for ozone and/or carbon monoxide, by Dec. 31, 1987.

3/RACT has also been defined in general terms as a standard that represented the lower emission limit that a particular source is capable of meeting by the application of control technology that is reasonably available considering technological and economic feasibility. These RACT requirements were adopted by EPA "because it believed that sources in some States could readily reduce emissions beyond what was required in existing SIPs." These existing SIPs were the product of the 1970 Act. Liroff, "Air Pollution Offsets," p. 9.

To determine whether a particular control measure constitutes RACT, the EPA has advised, "while it is recognized that RACT will be determined on a case-by-case basis, the criteria for SIP approval rely heavily upon the information contained in the CTG (control techniques guideline)," and "deviations from the use of the CTG must be adequately documented." Memo from the Administrator, EPA, to Regional Administrators concerning criteria for approval of 1979 SIP revisions, February 24, 1978, p. 8. CTGs are issued to assist State and local pollution control authorities in devising means for achieving and maintaining the NAAQS through existing source control. 42 U.S.C. §7410 (Supp. III 1979).

4/Liroff, "Air Pollution Offsets," p. 9.

5/Ibid.

EPA expanded its bubble policy to include multi-plant applications not only within but across control technique guideline categories. Thus, a multi-plant bubble, encompassing one or more industries, is now possible. Firms within this bubble are given the flexibility to swap air pollution rights to achieve a less costly solution to an overall emission limit. For example, one firm may be able to curtail a given amount of pollution at one-half the cost of another firm. A multi-plant bubble provides an economic incentive for the high-cost firm to finance additional pollution controls on the low-cost firm.

The bubble policy has not made as many inroads on the other source of inefficiency cited by the CEQ, namely, "the de facto requirement that new sources of air pollution install specific technology to abate their pollution." Multi-plant bubble applications cannot be used in lieu of LAER for nonattainment pollutants and multi-plant bubbles cannot be used as substitutes for BACT or NSPS. However, rules promulgated in 1980 open the door for bubble-type alternatives to BACT in a single-plant application. Under these rules, the definition of "stationary source" for PSD--to which BACT would be applied--is more liberal than under previous regulations. The definition of source is plant-wide. Consequently, an industrial plant may avoid BACT by varying pollution controls on its different polluting activities to bring it under the BACT emissions trigger point. Recently, this type of single-plant bubble application became acceptable for avoiding LAER. 1/

The offset policy

The offset policy originated in a December 1976 EPA interpretative ruling. This policy allows major new firms to enter nonattainment areas, provided they offset their emissions with emission reductions obtained from existing firms. Such reductions are commonly known as external offsets. Additionally, an existing firm contemplating a major modification in a nonattainment area may do so by arranging emission reductions from other firms. The offset policy is more cost-effective than the previous EPA stance which forbade the entry of major new companies in nonattainment areas. Also, prior to this policy, a major modification of a facility required that the owner reduce emissions in other parts of the plant. In some of these cases, external offsets may be cheaper.

Conceptually, EPA's offset and bubble policies are similar. However, there are two important distinctions. The offset policy applies to major new sources in nonattainment areas, and requires

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1/See 45 Fed. Reg. 52680 (1980) and 40 C.F.R. §5124(b)(1)(1981); and 46 Fed. Reg. 50766 (1981).

emission reductions greater than new source emissions, so that a net benefit in air quality results. Generally, the bubble policy only requires emission reductions resulting in equivalent air quality, and multi-firm bubbles do not apply to major new sources.

External offsets are significant in evaluating a market in air pollution rights. Like multi-firm bubbles, these offsets may involve buying and selling air pollution entitlements. For example, one firm may pay other firms to curtail their own emissions. But, unlike multi-firm bubbles, external offsets had occurred at the time of our audit, from July 1980 to February 1981. Application by companies of external offsets has been severely limited by the requirement for LAER, which minimizes the amount of pollution that can be swapped. As in the case of multi-firm bubbles and BACT, external offsets cannot be used in lieu of LAER. In addition, external offsets cannot be used in place of NSPS.

Emission reduction banking

The 1976 emission offset interpretative ruling was modified in January 1979 to permit emission reduction banking. This policy, in a sense, ties together the previous two policies. EPA recognized that emission reduction banking could facilitate the use of both offsets and "bubbling" by having in storage and ready for use emission reduction credits. For example, a firm, anticipating future expansion or growth of itself or of other companies in its area, might find it advantageous to curtail its pollution by more than what the law required. This additional surplus reduction in its emissions could then be banked and kept for its own future use or transfer to others.

Some important banking provisions of the January 1979 interpretative ruling stipulated that States would assume the role of banker and would be "free to govern ownership, use, sale, and commercial transactions in banked emission offsets as it sees fit." 1/

In all of these controlled trading policies, important conditions for their use are that they be enforceable and result in no deterioration of air quality.

IMPLEMENTING A MARKET

Our review of the Clean Air Act and controlled trading points to several reasons for sizable transaction costs in the permit process and for other implementation problems. We believe that a market approach, to be workable, must come to grips with these problems. The conditions of the Act for allowing major new projects in both attainment and nonattainment areas are instructive.

1/40 C.F.R., Part 51, App. S (1981); 44 Fed. Reg. 3282 (1979).

The regulator and permit applicant can expect to incur costs in deciding upon BACT or LAER, determined on a case-by-case basis. Air quality modeling and monitoring may also be necessary. Environmental impact statements, alternative sites analysis, and public review are other sources of potentially major costs. Finding offsets and bubble opportunities represent added costs to achieve a least-cost solution of air quality problems.

CHAPTER 3

AN ALTERNATIVE APPROACH TO AIR POLLUTION CONTROL: USING ECONOMIC INCENTIVES

A central concern in designing environmental policy should include realizing objectives at the least cost to society. In the previous chapter, we identified three important sources of potentially high and unnecessary costs of conventional regulation in meeting air quality objectives of the Clean Air Act. They are: (1) the conventional system's tendency towards uniform percentage reduction requirements for all dischargers within an industry; (2) the de facto requirement that new sources of air pollution install specific technology to abate their pollution; and (3) selecting industry-specific controls on the basis of affordability and on information concerning that industry alone. 1/ 2/ These characteristics of command and control, assuming that firms seek to minimize their costs of pollution abatement, suggest that a properly designed set of policy measures that makes effective use of economic incentives can be expected to attain the NAAQS at less cost than conventional regulation.

HOW ECONOMIC INCENTIVES REDUCE ABATEMENT COSTS

The reason is quite straightforward for expecting economic incentive approaches to be less costly in meeting the air quality objectives of the Clean Air Act than their command and control counterparts. EPA has defined the maximum allowable concentrations of pollutants in the atmosphere--the NAAQS (see table 1). An issue for the policymaker should be how to achieve these standards most effectively. Suppose, for example, that in a certain air shed 3/ the total emissions of a particular pollutant need to be cut in half to meet the prescribed standard. Under a command and control approach, the environmental authority might issue permits to individual polluters limiting their emissions, or alternatively might require specific abatement technologies for the different sources. For example, suppose that since total emissions must be reduced by 50 percent, the regulatory agency requires each polluter to reduce or "roll back" his emissions by 50 percent.

1/Environmental Quality, Council on Environmental Quality, 1979, p. 671.

2/Background Information, U.S. EPA, p. 128.

3/For purposes of air quality management, an air shed is a space within which all or a sizable amount of the regulated pollutant disperses. An air shed can be thought of as a fallout basin.

The inefficiency inherent in such an approach is apparent. The costs of abatement will typically vary among polluters so that an order to reduce emissions by 50 percent will result in considerably more expenditures on abatement by some polluters than others. But to minimize abatement costs, an environmental program should generate the greatest reduction in emissions where it is the cheapest to do so. If a chemical plant can reduce its sulfur emissions more inexpensively than can a steel factory, it follows that the standard for sulfur concentrations in the atmosphere can be achieved at less cost by having chemical plants reduce their sulfur emissions more than steel factories.

It would be extremely difficult for a regulator to amass all the necessary information on relative abatement costs before setting abatement quotas for each polluter. Moreover, since abatement technology and hence costs change over time, any initial set of quotas would soon be out of date. The attraction of the market approach is that it can generate automatically the least-cost pattern of abatement efforts without making heavy demands on the regulator. Suppose, for example, that a steel factory can reduce its sulfur emissions for $.20 per pound, while abatement costs for the chemical plant are $.10 per pound. If there were a price for sulfur emissions (established either in the form of an emissions fee by the regulator or by competitive bidding for pollution licenses among polluters) of, say $.15 per pound, then the cutbacks in emissions would take place where it is cheapest. The chemical plant would find it less expensive to reduce its emissions than to pay for the right to emit, while the steel factory would avoid the relatively costly abatement and pay for the right to continue its emissions.

More generally, the costs of abatement for each polluter are not constant. It is typically relatively inexpensive to make modest reductions in emissions, but increasingly costly to eliminate the remaining vestiges of these emissions. In short, the marginal cost of abatement (i.e., the cost of reducing emissions by one more unit) tends to rise as emissions are reduced. In this more realistic setting, economic incentives can also generate the desired reduction in aggregate emissions at the smallest total abatement cost.

Suppose we find that a price of $.15 per pound of sulfur emissions is sufficient to reduce total emissions to a level consistent with our predetermined environmental standard. In a market setting of cost-minimizing firms, we will find that each polluter has cut back his waste emissions to (and only to) the point where marginal abatement cost equals the price of emissions. In other words, each polluter will have eliminated those emissions for which the abatement cost is less than $.15 per pound. For the remaining emissions, it is cheaper to pay to emit than to abate. The implication is that, from the perspective of the economy as a whole, the environmental goal will have been achieved in the least

costly way (i.e., through eliminating only those emissions for which the cost of abatement was $.15 per pound or less). Note also that this outcome is reached through decentralizing decisions. The environmental authority does not need to know the abatement costs of individual sources; each polluter himself finds the least expensive means to reduce his emissions and determines the proper level of these emissions.

ECONOMIC INCENTIVE APPROACHES CAN DIFFER

There are two basic ways to enlist economic incentives in air pollution control: through a system of either emission fees or marketable air pollution entitlements. In chapter 2, we saw that EPA's controlled trading policies are apt to push us in the direction of the latter system. Under the fee approach, the regulatory authority sets an effluent charge (or price) on emissions, leaving polluters to determine the quantity of emissions. Conversely, under a system of marketable entitlements, the authority directly sets quantity (in the form of a specified amount of pollution entitlements) and allows the bids and offers of polluters to determine the market-clearing price. From the standpoint of air quality, we assume that a system of either emission fees or marketable entitlements would have to meet the same air quality objectives as the present command and control system.

ECONOMIC INCENTIVES IN AN UNCHANGING AND CERTAIN WORLD

In a static world of perfect certainty, emission fees and marketable entitlements are equivalent. Suppose that the regulatory authority must reduce total emissions of a pollutant to some specified level to attain the target level of air quality. With perfect information, the agency can either set the price (the emissions fee) at the appropriate level and allow polluters to establish the requisite level of emissions, or set quantity in the form of a specific amount of pollution entitlements and let the bids of polluters establish the price of these entitlements.

Figure 1 depicts the equivalence of these two policies. The curve DD' is the demand curve of polluters for emissions and indicates the quantity of emissions that will be forthcoming at different prices. 1/ If e* is the target level of emissions (the level consistent with the mandated standards for air quality), and if the regulatory agency knew the relationship indicated by DD', the agency could establish a fee for emissions of f*; polluters would respond with a total level of emissions of e*. Alternatively, regulators could issue e* of emission entitlements and the bids of polluters would establish a market-clearing price

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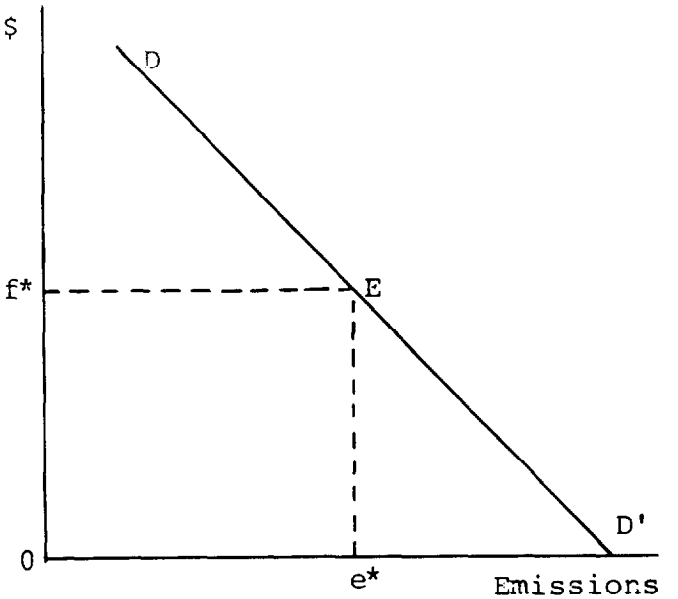
1/The source of the demand curve for emissions is the same as for any other factor input. It is the sum across all firms of the value of the marginal product of emissions.

Figure 1

Emission Fees and Marketable Entitlements



of f*. In either case, the level of emissions could be controlled to yield the same air quality as the current command and control system. Emission fees would have to be set high enough or the quantity of pollution entitlements set low enough to ensure meeting the air quality objectives of the Clean Air Act.

ECONOMIC INCENTIVES IN AN UNCERTAIN AND CHANGING WORLD

The practical concerns of policymakers and administrators, however, relate to imperfect information and flux. Not only are regulators likely to have only a vague notion of the DD' function in figure 1, but the demand curve will shift position over time. From this perspective, a system of marketable entitlements possesses several advantages over fees.

First, using marketable pollution entitlements minimizes the uncertainty and adjustment costs in attaining mandated levels of air quality. Under a system of fees, the environmental authority will be unsure of the response of polluters to a particular level of emission charges. Should the authority set the fee too low, air quality standards will not be met. The fee may have to be raised and then further altered to generate an alternative path converging on the target level of emissions. This means costly adjustments and readjustments by polluters in their abatement technology. The need for repeated changes in the fee is likewise an unattractive prospect for the regulatory agency. In contrast, under a marketable entitlements scheme, the environmental authority establishes the total amount of emissions at the allowable standard; in principle, no problem exists in achieving the target.

Second, in a dynamic economy, complications can result from economic growth and price inflation. Under a system of emission fees, continuing inflation will erode the real value of the fee; likewise, expanding production from both existing and new firms will increase the demand for emissions. Both of these forces will tend to shift the demand curve for emissions outwards; in consequence, pollution levels will rise over time unless the nominal fee is increased. This means that the environmental authority will need to raise the fee periodically to maintain air quality standards. In short, the burden for affirmative action under fees is on environmental officials; the choice could be between unpopular fee increases or nonattainment of standards. Under a system of marketable entitlements, market forces automatically accommodate inflation and growth with no increase in pollution. The rise in demand for permits simply translates directly into a higher price.

Finally, marketable entitlements appear more feasible on grounds of familiarity. Introducing a system of emission fees requires adopting a method of controlling pollution, new both to regulators and polluters. In contrast, permits or licenses are a familiar policy instrument. In many instances, such permits (effectively conferring pollution entitlements) already exist; it would seem less drastic to make these permits or entitlements transferable than to introduce an entirely new approach in the form of emission fees.

On the other hand, emission fees have at least one significan advantage. While a marketable entitlements system minimizes uncer tainty in achieving the target level of air quality, a corollary i that fees reduce the danger of excessive abatement costs from over stringent standards. There exists the threat under a system of marketable entitlements that a zealous regulatory authority might set extremely high standards for environmental quality that impose huge and unjustified abatement costs on society. Fees, in contras establish a ceiling on abatement costs, since firms always have the option of continuing their emissions and paying the fee. 1/

SOME EMPIRICAL STUDIES OF POTENTIAL COST SAVINGS FROM USING ECONOMIC INCENTIVES

Several studies of different pollutants have explored the cost differences associated with various approaches to regulating emissions. These studies typically examine a specific pollutant

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1/One suggested modification to the marketable entitlements propos al to mitigate this shortcoming is the inclusion of a high fee or penalty to serve as an "escape valve" in the event that price of pollution permits threaten to reach exorbitant levels. See M. Roberts and M. Spence, "Effluent Charges and Licenses Under Uncertainty," Journal of Public Economics, 5 (April-May 1976), pp. 193-208.

in a particular Air Quality Control Region (AQCR). Making use of an actual inventory of the emissions of existing sources, information on the abatement costs of each source, and an air quality model that indicates how emissions from the source affect ambient air quality in the region, a typical study determines the least-cost solution for attaining one or more air quality objectives. This solution provides a baseline consisting of the least-cost pattern of emissions among the various sources that is consistent with the attainment of the air quality standard. The patterns of emissions associated with various policy approaches can then be compared with this baseline solution to see how much "excess abatement cost" they entail. We will summarize the findings of three such studies representative of the kinds of results emerging from this literature.

Particulate emissions in the St. Louis AQCR

Atkinson and Lewis have made one such study of particulate emissions in the St. Louis AQCR. 1/ Based on the 27 largest industrial sources in the area, the study accounts for approximately 80 percent of total particulate emissions. Table 2 presents data on the 27 sources. Note, in particular, the wide variation in abatement costs among the different sources. For example, particulate emissions for source number 9, a boiler in a paper products operation, can be reduced by 75 percent at a cost of only $4 per ton; in contrast, a 76 percent reduction for source number 8, a brewer boiler, costs $600 per ton. Even among a group of power plants (sources 19 through 27), costs per ton for roughly equivalent levels of reductions vary quite dramatically. Such differences in abatement costs suggest that a program which is not very sensitive to these differences could generate inordinately excessive levels of total abatement costs.

This is, in fact, what Atkinson and Lewis find. They compare a command and control system consisting of a "representative set of emission regulations" to the least-cost solution for attaining the Federal primary standard for particulate concentrations. They estimate that abatement costs under the command and control system are about 10 times as large as the least-cost outcome. With various pricing schemes in a market, the authors find that an appropriate uniform price for particulate emissions over the whole area will cut costs dramatically as compared with the command and control outcome; the uniform pricing system entails abatement costs that are only 15 percent to 20 percent as large as under the command and control system. Although the savings are considerably less with reference to the secondary standard for particulate concentrations, Atkinson and Lewis conclude

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1/Scott E. Atkinson and Donald H. Lewis, "A Cost Effectiveness Analysis of Alternative Air Quality Control Strategies," Journal of Environmental Economics and Management, November 1974, pp. 237-50.

Table 2

Source Specific Control Cost Estimates for Particulate Emissions in the St. Louis Region a/

Source number	Standard industrial classification	Precontrol emission rate (tons/day)	Low control option		High control option	
			Cost ($/ton)	Emission reduction	Cost ($/ton)	Emission reduction
1	Meat packing, boiler	6.25	16.00	75.0	73.75	99.0
2	Feed and grain mill	5.70	16.00	80.0	57.68	99.0
3	Feed and grain mill	11.37	11.00	75.0	184.25	99.0
4	Feed and grain mill	17.15	15.00	75.0	279.00	99.0
5	Feed and grain mill	5.09	341.00	52.0	1830.20	99.0
6	Wet corn milling, boiler	4.21	19.00	75.0	97.38	99.0
7	Brewery, boiler	2.95	13.00	75.0	41.88	99.0
8	Brewery, boiler	2.67	600.00	76.0	2114.02	95.0
9	Paper products, boiler	21.22	4.00	75.0	20.50	99.0
10	Chemical plant, boiler	3.42	34.00	75.0	1172.50	99.0
11	Inorganic pigments, boiler	7.30	63.00	52.0	79.85	99.0
12	Inorganic industrial chemical plant, boiler	6.00	32.00	68.0	111.84	99.0
13	Inorganic industrial chemical plant, boiler	10.70	4.00	75.0	32.88	99.0
14	Petroleum refinery	6.00	128.00	75.0	1064.38	99.0
15	Petroleum refinery	4.72	58.00	52.0	72.75	99.0
16	Asphalt batching, boiler	2.90	15.00	75.0	321.77	99.7
17	Cement plant, dry process	3.28	2.00	75.0	10.25	99.0
18	Cement plant, dry process	3.68	118.00	97.0	464.50	99.0
19	Power plant	3.72	214.00	93.0	1138.00	99.0
20	Power plant	7.60	251.00	63.0	311.50	99.0
21	Power plant	5.00	86.00	66.0	173.00	99.0
22	Power plant	5.10	909.00	74.0	3138.65	92.4
23	Power plant	11.90	75.00	81.0	201.50	99.0
24	Power plant	80.00	5.00	75.0	17.38	99.0
25	Power plant	6.90	104.00	75.0	4469.77	89.2
26	Power plant	32.50	39.00	75.0	96.75	99.0
27	Power plant	5.60	240.00	93.0	1312.50	99.0

a/Source: Scott E. Atkinson and Donald H. Lewis, "A Cost Effectiveness Analysis of Alternative Air Quality Control Strategies," Journal of Environmental Economics and Management, November 1974, p. 241.

that "...a substantial cost differential exists for a wide range of air quality." 1/ In addition, they find that substantially greater savings can be realized if, instead of a uniform price for emissions, the price can be varied to make it somewhat higher in those parts of the AQCR from which emissions have the most damaging effect on air quality. With this latter modification, abatement costs under the pricing system can approximate the least-cost level.

Nitrogen dioxide emissions in the Chicago AQCR

A similar type of study of nitrogen dioxide (NO_2) emissions, this time for the Chicago AQCR, yields roughly comparable results to the Atkinson-Lewis findings. 2/ In their study, Anderson et al. explored the levels of abatement costs associated with different policy measures to restrict emissions from 797 point sources in the AQCR. Table 3 presents some of their basic data on abatement costs for different sources. Once again, we find quite large differences in these costs. For example, reducing emissions by 40 percent can be achieved for a gas or oil-fired boiler at a cost of 0.28 cents per million Btu; for industrial process furnaces, the cost is over six times greater, 1.9 cents per million Btu.

Taking a standard for NO_2 concentrations of 250 $\mu g/m^3$, Anderson et al. find that the least-cost solution involves annual abatement costs of $21 million. Using the crudest sort of command and control policy, a simple across-the-board rollback of emissions of the same percentage for all polluters results in a large increase in abatement costs. To achieve the NO_2 standard at all receptor points in the AQCR, the rollback strategy would require a 90 percent reduction in emissions from all sources at an annual cost of $254 million--approximately 12 times the costs associated with the least-cost solution.

An alternative command and control policy which involves uniform pollution controls across all firms within broad pollution-source categories was found to be less costly, but still more than four times more expensive than the least-cost outcome.

1/Ibid., p. 247.

2/Robert J. Anderson, Jr., et al., "An Analysis of Alternative Policies for Attaining and Maintaining a Short-Term NO_2 Standard" (MATHTECH, Inc., Princeton, N.J.), 1979.

Recently, the EPA has updated and revised this original study by Anderson et al. 1/ The EPA estimated that a State Implementation Plan (SIP) control strategy without trading--which involves a "uniform level of emission control across similar categories of sources"--has annual control costs of $130 million, to comply with the previous NO_2 standard. By contrast, this SIP strategy with trading of permits could cost as little as $13 million, for a 90 percent savings. Like the study by Anderson and Lewis, this work indicates that a least-cost solution is possible if the pricing scheme in a market strategy reflects the dispersion characteristics of the NO_2 emissions and the marginal control costs of the polluters.

Chlorofluorocarbon (CFC) emissions in the United States

This representative study is a bit different from the preceding two. 2/ It does not involve one of the "criteria pollutants" subject to the NAAQS, but rather a pollutant of more recent concern. Evidence suggests that CFC emissions eventually find their way to the stratosphere where, through a series of chemical reactions, they deplete the ozone layer that protects the earth from harmful ultraviolet radiation. As a result, the United States is considering programs to restrict CFC emissions.

In a recent study, the Rand Corporation evaluated several alternative policy strategies for achieving this reduction. 3/ The first is a program of "mandatory controls" that would place specific technological restrictions on each class of sources of CFC emissions. The Rand study estimates that the abatement (or "compliance") costs under this particular variant of the command and control approach would total $185 million from 1980 to 1990. Alternatively, the Rand group considers a market incentives policy under which the price of CFCs rises to a level sufficient to restrict emissions by precisely the same amount as the program of mandatory controls. The total abatement costs associated with

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1/"An Analysis of Economic Incentives to Control Emissions of Nitrogen Oxides from Stationary Sources," Report of the Administrator of the Environmental Protection Agency to the Congress of the United States in compliance with Section 405(f) of Public Law 95-95, the Clean Air Act, as Amended, January, 1981.

2/Adele R. Palmer et al., "Economic Implications of Regulating Chlorofluorocarbon Emissions From Nonaerosol Applications," prepared for the U.S. Environmental Protection Agency (Rand, Inc., Santa Monica, CA), June, 1980.

3/See chapter IV of the Rand Study: A. Palmer et al., Economic Implications of Regulating Chlorofluorocarbon Emissions from Nonaerosol Applications (Santa Monica, California: Rand, June 1980).

Table 3

Estimates of Emission Control Costs for Existing Plants a/

Control Technique b/	Coal Fired Utility Boilers		Gas, Oil Fired Utility Boilers		Industrial Boilers		Industrial Process Furnace	
	control (%)	unit cost c/	control (%)	unit cost c/	control (%)	unit cost c/	control (%)	unit cost c/
LEA	11 d/	0.2	17 d/	negligible	10 d/	0.29	25 d/	0.4
LEA & FGR	-	-	-	-	-	-	40 d/	1.9
LEA & OSC	22 d/	0.5	40 d/	0.28	16 d/	0.6	-	-
LEA & FGR & OSC	-	-	59 d/	2.8	-	-	-	-
LEA & OSC & NH_3	-	-	70	14.0	-	-	-	-
Advanced design burner retrofit	-	-	-	-	-	-	50	1.1
Retrofit low NO_2 burner	40	0.8	-	-	50	1.1	-	-
Retrofit dry SCR	90	26.0	90	26.0	90	23.0	90	20.0

a/Robert J. Anderson, Jr., et al., "An Analysis of Alternative Policies for Attaining and Maintaining a Short-term NO_2 Standard," prepared for the Environmental Protection Agency (MATHTECH, Inc., Princeton, N.J.), 1979, pp. 2-22 to 2-32.

b/See Anderson for explanations: LEA = Low Excess Air; FGR = Flue Gas Recirculation, OSC = Off-Stoichiometric Combustion, SCR = Selective Catalytic Reduction; NH_3 = Ammonia injection.

c/Costs are stated in terms of 1976 prices, in cents per million Btu.

d/Available as of 1979.

this policy are about $108 million--a savings of roughly 40 percent over mandatory controls. Interestingly, there is no need in this case to consider any spatial distinction among sources, since the mixing processes in the stratosphere effectively make all emissions equivalent irrespective of site.

SOME FURTHER ISSUES

Studies suggest that the potential cost savings of shifting from a command and control strategy for regulating air pollution to one relying on pricing incentives is large. But the discussion is still incomplete; several important issues remain.

Innovation in abatement technology

We stress that the estimates of cost savings in the preceding three studies are static in nature: they are based on existing abatement technology. The savings noted in those studies result

simply from rearranging abatement quotas among polluters to get the largest cutbacks in emissions where control costs are the lowest. What may be of even greater quantitative significance are advances in abatement technology that produce less costly techniques for reducing emissions.

From this more dynamic perspective, economic incentives may stimulate research and development of new abatement technology by making such research and development directly profitable to private firms. A firm faced with paying for its emissions will find that developing more effective control techniques reduces costs and increases profits. In contrast, existing environmental programs, particularly those like NSPS that prescribe control procedures for each source, mute incentives for innovative efforts by polluters. It can even be in the interest of polluters, under some circumstances, to resist the introduction of new control technology.

By harnessing the profit motive, a system of economic--or market--incentives thus has the potential for reducing the costs of achieving our environmental goals in both static and dynamic terms. Cost-savings as the result of technological change are much more difficult to quantify because of the inherent unpredictability of future technological change.

The spatial problem

We noted earlier in this chapter that a system of uniform pricing incentives can achieve any predetermined reduction in total emissions at the lowest possible cost (resulting from equalizing marginal abatement cost across all sources). However, two of the empirical studies reported findings that are apparently at odds with this proposition: they found additional potential savings from varying the price of emissions among sources according to location.

Resolving this apparent inconsistency involves distinguishing between emissions and their effect on air quality. Society's environmental objective is to attain specific levels of air quality; this translates directly into an unambiguous reduction in total emissions only if a unit of emissions is equivalent in its effect on air quality irrespective of the location of its source. Where such an equivalence does not hold, a given reduction in emissions will obviously make a greater contribution to improving air quality if it is located at an especially crucial site (i.e., a site from which emissions have a particularly damaging effect on ambient air quality). Since reductions in emissions from such sites are disproportionately valuable in achieving the ultimate air quality objective, it follows that a larger incentive for abatement (or higher price for emissions) is needed at these locations if the air quality goal is to be realized at the least cost.

We will explore this issue of spatial distinctions among sources in later chapters; here we offer two observations. First, the spatial aspect of pollution policy is obviously not unique to a system of economic incentives; it is an inherent dimension of the pollution problem itself. Whether one adopts a system of prices for emissions or a command and control approach, it remains true that for most pollutants emissions from different locations have different effects on ambient air quality. Any system of pollution control ignoring these differences passes up potential cost savings in achieving society's environmental objectives.

Second, the importance of the spatial issue varies widely among pollutants and geographical areas. We saw, for example, that the study of NO_2 emissions in Chicago found enormous savings by incorporating spatial elements into the control program. In contrast, this issue is of no consequence for CFC emissions.

TRANSFER PAYMENTS AND EQUITY

Economic theory and our previous discussion of empirical results indicate that regardless of which system of economic incentives is adopted, the potential exists for large reductions in abatement costs relative to existing command and control measures. At the same time, however, such a system can increase the cost of environmental programs to polluters. This may seem paradoxical, but the apparent inconsistency is easily resolved. Although a system of prices for emissions will reduce total abatement costs, it will impose a new source of costs on polluting firms, in the form of a tax bill from the regulatory authority (equal to the unit fee times the level of emissions). With marketable entitlements, the added cost is the price the polluter must pay to obtain the entitlements for his allowed emissions. Note that these are not true costs from the perspective of society as a whole. The revenues from emission fees, for example, represent a transfer payment from polluters to the taxpaying public.

While these costs may constitute a transfer payment from the vantage point of society, they are nevertheless a cost of doing business for the polluting firm. Moreover, some recent evidence suggests that in some instances the costs could be quite large. A Rand study of chlorofluorocarbon emissions control found, on the one hand, significant savings in abatement costs from using economic incentives. As elaborated previously, the study estimated abatement costs of $185 million under a realistic system of mandatory controls compared to about $108 million under a system of economic incentives. But juxtaposed to these costs to society of $108 million are revenues collected in an emissions fee scheme or in a marketable entitlements system of $1,500 million. According to figure 1, the $108 million, under a least-cost solution, is represented graphically by the triangle e*ED'. The $1,500 million, as payment for the pollution entitlements, is depicted by the rectangle Of*Ee*, which reflects the value of those entitlements to polluters.

There is no simple way around these transfer payments under a system of emission charges: polluters must pay a tax bill for their emissions in addition to bearing the abatement costs for any cutbacks in emissions. There is, however, an additional degree of freedom under the marketable entitlements approach that can mitigate the problem. The source of this flexibility concerns alternative means for making the initial allocation of the entitlements.

The regulatory authority could choose at the outset to auction off the entitlements to polluters. This would produce results much like those under a system of fees with firms paying for rights in addition to their costs of abatement. Alternatively, a system of marketable entitlements can be set in motion with an initial distribution of these entitlements to existing polluters. This version of the marketable entitlements scheme would effectively eliminate the added source of costs for existing firms without any necessarily adverse consequences for the efficiency properties of the program and with some obvious advantages for its political acceptability. 1/

One apparent criticism of such a scheme, in which existing polluters are vested at no charge with entitlements to pollute, is that a new firm with a higher value of production attributable to the use of some of these air pollution entitlements might be prevented from doing business. In this way, existing polluters impose an opportunity cost on society measured in terms of the output foregone from this new firm. However, this problem is mitigated as existing polluters recognize the foregone profits of not selling pollution entitlements to this newcomer. In other words, the foregone net value of the newcomer's output is an opportunity cost to these existing polluters. Provided that the new firm's value of production from the use of these air pollution entitlements is greater than the corresponding values for the existing polluters, entry of this new firm is made possible through a mutually advantageous market transaction between the parties.

Alternatively, with the regulatory authority as initial owner and auctioneer, new firms would have to compete with existing firms for these scarce air pollution entitlements. The highest bidders can be expected to be those firms with the highest values of production from the use of air pollution entitlements. So, we can

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1/To avoid distortions in economic decisions, it is essential that the distribution of entitlements to polluters be "lump sum" in character. It must be based only upon historical behavior--not on any current or future decision variables or else firms will have incentive to expand emissions to increase their entitlements. See W. Oates and R. Collinge, "Efficiency in the Presence of Externalities: An Issue of Entry and Exit," University of Maryland, Department of Economics Work Paper No. 1980-38 (1980).

expect the same pattern of bidding and the same market-clearing price for these entitlements under either scheme of initial distribution, provided that firms recognize the opportunity costs of holding these entitlements.

On efficiency grounds, there is thus a plausible case for a system of marketable pollution entitlements with an initial allocation of these entitlements at no charge to existing polluters. However, another related objection to this latter provision is based on equity grounds. Since the scheme effectively vests the entitlement to pollute with existing polluters, it represents a wealth transfer to them. One might argue that clean air belongs to the general public and, in consequence, that polluting firms should pay from the very outset of the program for the clean air that they "employ." The issue is, however, somewhat more complicated. In most instances, firms have historically had de facto entitlements to emit at least certain levels of emissions into the environment. Moreover, under existing regulatory programs, most major polluters have already engaged in extensive abatement activity: to give them the (transferable) entitlement to emit their remaining discharges may, in fact, represent a reasonable compromise.

The functioning of markets in pollution entitlements

While the properties of markets in pollution entitlements are impressive in principle, we have not explored in any depth the actual structure and workings of such markets. This will be the subject of later chapters. However, we want to raise one reservation concerning the functioning of these markets, the potential for monopolizing the supply of pollution entitlements as a means to exclude competition. 1/ A single large firm might buy up all the entitlements to emit pollutants and use this control over emission entitlements as a barrier to entry against potential competitors.

In weighing the importance of monopolization, additional factors should be considered. First, firms in a particular area compete with one another for other factors of production including labor, raw materials, and land. Why should we expect the supply of the newly marketable input, namely emissions, to be more susceptible to monopolization for purposes of forestalling competition than the supplies of other inputs? One answer might

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1/See, for example, R. Holcombe and R. Meiners, "Corrective Taxes and Auctions of Rights in the Control of Externalities," Public Finance Quarterly, 8 (July 1980), pp. 345-349. A system of emission fees, incidentally, is not subject to this problem, since any firm is free to pollute so long as it pays the fee.

be that the supply of pollution entitlements is fixed in total. But then the supplies of other factors, such as land, may also be highly inelastic. Second is the recognition that competition in output markets need not come from local production. Even if a firm were to monopolize the entire stock of pollution entitlements in a specific locale (e.g., an air shed), this would not prevent competitors from locating in neighboring (or distant) jurisdictions. Only in the case where production in the particular locale confers substantial cost savings could monopolization of pollution entitlements constitute any sort of barrier to entry. And third, note that under the system where pollution entitlements are distributed initially to existing polluters, there is no way to force existing firms to leave their respective industries; firms need not sell their pollution entitlements unless they find it desirable to do so. Entry of new firms might conceivably be discouraged, but it would be difficult for a firm to eliminate competition from existing local producers.

In the event that monopolization of the supply of pollution entitlements does appear to be a genuine threat, a system of emission fees is likely to prove superior on the grounds of efficiency and equity.

CONCLUSIONS

There are two basic economic incentive schemes for controlling air pollution: emission fees and marketable entitlements. In a changing and uncertain world, marketable entitlements appear to be more effective in realizing and maintaining prescribed standards of air quality in a way that minimizes disruptions to the sources of emissions. And, one version of the marketable entitlements scheme that makes use of an initial allocation of entitlements to existing polluters can alleviate some of the cost burden to polluters. On the other hand, where serious market imperfections--such as the monopolization of the supply of pollution entitlements--exist, an emissions fee system is likely to be superior.

Regardless of which economic incentive approach is chosen, studies suggest that our environmental targets can be achieved at only a modest fraction of the costs under traditional command and control programs. Estimates of the static savings in abatement costs for particular pollutants range from about 40 percent to about 90 percent; to these must be added the further savings of stimulating research and development of new abatement technology.

CHAPTER 4

IMPLEMENTING A MARKET IN AIR POLLUTION ENTITLEMENTS

In chapter 3, we looked at the potential for cost savings in using economic incentive approaches to air pollution control. We also discussed the relative merits of the two major types of economic incentives, emission fees and marketable entitlements, and described our reasons for preferring marketable entitlements. Also, from reviewing previous studies, we found that estimates of static savings in abatement costs range from about 40 percent to 90 percent. To these must be added the dynamic cost savings from improved technology likely to result from substituting economic incentives for command and control. Realizing these savings depends crucially on our ability to overcome a number of obstacles that could inhibit implementing such an economic incentive approach. Accordingly, in this chapter, we present a general framework useful for identifying and resolving implementation problems.

We begin by assuming that any feasible economic incentive approach must be at least as effective as the present regulatory system in meeting the air quality objectives of the Clean Air Act. This assumption, together with arguments presented in chapter 3, suggest that a marketable entitlements scheme is more feasible than a system of emission fees. And, ongoing policies by EPA--i.e., controlled trading--could represent a steppingstone from command and control to a marketable entitlements scheme. Thus, the premise of this study is that a workable system of controlled trading is necessary for a full-scale market in air pollution entitlements.

In this chapter, we investigate technical, legal, and regulatory issues to see how they may obstruct or encourage developing controlled trading and an eventual full-scale market in air pollution entitlements. Particularly, we focus on factors that may impede using external offsets--one of three controlled trading policies being implemented by EPA. In chapter 2, we observed that external offsets are particularly significant in evaluating the feasibility of a market. They involve the swapping of air pollution entitlements between firms and, unlike multi-firm bubbles, they had occurred at the time of our audit. We also investigate the feasibility of emission reduction banking. Its relevance to a market is evident in EPA's 1979 Interpretive Ruling which stipulated that States would be "free to govern ownership, use, sale, and commercial transactions in banked emission offsets." 1/ Several communities have established such banks.

We first discuss what would be traded in such a market. We examine the intrinsic properties of air resources, problems of

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1/See 44 Fed. Reg. 3280 (1979), 40 C.F.R. Part 51, App. S (1981).

measurement and control, and how we should define air pollution entitlements. This discussion helps in understanding the critical nature of transaction costs and uncertainty associated with air pollution control in developing a market for air pollution entitlements. In the second section of this chapter, we examine the role of transaction costs in arranging external offsets: those incurred in the permit process, which are generic to air pollution control, and a market alternative retaining the traditional permit process; and those which are unique to a least cost solution in meeting the air quality objectives of the Clean Air Act. The third section focuses on the regulatory machinery now in place for controlling air pollution, emphasizing how the existing system is likely to encourage or discourage external offsets and evolution of a market. This chapter closes with a discussion of two other implementation issues: enforceability and property rights.

PROBLEMS ARE POSED DUE TO THE INTRINSIC PROPERTIES OF OUTDOOR AIR

Outdoor air can be considered an economic resource. Some degradation of this resource is normally a prerequisite for producing goods and services, but degradation can be excessive, adversely affecting the well-being of other resources, including human health.

Unlike conventional resources such as capital and real estate, air cannot be easily transformed into excludable private property to be parcelled out among competing users. Outdoor air is likely to be less manageable because its quality depends upon complex factors such as weather and chemical reactions. These factors affect the dispersion characteristics of air pollution. Thus, air quality is a better example of a public, nonexcludable good than of a private good. Consumption of a public good is typically characterized by benefits and costs accruing to paying and nonpaying beneficiaries alike.

Another ramification of this difficulty in parcelling out air quality is controlling overall use of the outdoor air. Difficulty in tracking the air quality effects of emissions from different users increases the probability that some pollution will go undetected, and ambient air quality standards will be violated.

To a limited extent, a common tool, called an air quality model, is employed in parcelling out air quality and ensuring compliance with the air quality standards governing overall use. This model traces the movement of a plume of smoke from the stack of a factory, for example, through time and space, showing how the plume spreads with distance from the smokestack by means of a mathematical description of atmospheric diffusion.

This model generally requires two types of input data: plant--or source--data, including emission rates and stack characteristics, and meteorological data. Unfortunately, the lack of

good meteorological and source data has prevented air quality models from being precision instruments. For example, "most experts agree that modeling results may at best be presumed to have a range of accuracy running from minus 50 percent to plus 100 percent" and "it is not uncommon to hear expert opinions that particulate modeling results are inaccurate to a far greater degree." 1/

Other measures for controlling use of air resources

Our present system of air pollution control is not singularly dependent upon the results of air quality models to determine appropriate emission limits. In fact, we have a system consisting of emission limitations based on air quality modeling and, separately, on technology-based criteria, such as New Source Performance Standards (NSPS), Best Available Control Technology (BACT), and Lowest Achievable Emissions Rate Technology (LAER). Previously, we noted that such emission standards were manifestations of the pure emissions standard philosophy of control.

As seen in their role as substitutes for modeling-based emission standards, these technology-based limits can be interpreted as measures to minimize the variance between compliance objectives--such as the NAAQS--and actual use of air resources. Imposing strict technology-based emission controls is a way to reduce our dependence on inexact air quality modeling. As these emission limits are made more stringent, the resulting emissions, whose air quality impact may have to be modelled, are reduced.

On implementing a market

What is the appropriate definition of outdoor air quality to be traded in a market in air pollution entitlements? Within a given air shed, the answer depends on the ease with which emissions from a smokestack translate into effects upon air quality. This can be a function of the accuracy of air quality models and the dispersion characteristics of the pollutants in question.

For widely and evenly dispersed contaminants, the entitlement to emit an air pollutant and the entitlement to pollute the outdoor air are barely distinguishable. The location of polluters is not critical to air quality within a fairly large fallout basin. Accordingly, an appropriate role for air quality modeling may be to set an overall emissions limit consistent with meeting the

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1/U.S. Congress, House, Subcommittee on Health and the Environment of the House Committee on Interstate and Foreign Commerce, statement by John Quarles, chairman of the National Environmental Development Association Clean Air Act Project, 96th Cong., 2nd sess., June 16, 1980.

NAAQS in a fairly broad geographical area. Once this limit has been established, trading in air pollution entitlements would be equivalent to trading in emission entitlements. A prospective buyer who wished to have the right to emit 10 more tons per year would simply negotiate a reduction of 10 tons per year from other firms in the fallout basin. Air quality modeling would not be needed to determine the legal acceptability of this trade.

Conversely, for locally and unevenly dispersed contaminants, emission entitlements and air pollution entitlements are quite distinct. It would be both difficult and impractical to define fallout basins within which emissions from one firm were equivalent to emissions of other firms in terms of effect on air quality. It would be far more important to determine on a case by case basis what determined a legally acceptable trade. For example, a prospective buyer wanting to emit 10 tons more per year might have to arrange a greater than 10 ton per year reduction from other firms to meet the NAAQS. Moreover, the exact tradeoff could be expected to vary with--and be quite sensitive to--distance between the traders and wind direction. Air quality modeling could be critical.

Consequently, the transaction costs of transforming air quality into excludable private property could be minimal for "global" pollutants, and could be sizable for "local" contaminants within a given air shed. Unfortunately, the problem is slightly more complicated. Those "global" air pollutants which happen to be more widely and evenly dispersed are most likely to be transported across air quality control region, State, and even international boundaries. The result is that managing these air resources within their fallout basin--or air shed--can be complicated by jurisdictional disputes. Because these "global" pollutants may not stay within their originating jurisdictions, trading in emission entitlements is bound to be disrupted from time to time as some jurisdictions find that they have to further restrict the supply of these entitlements to meet the NAAQS.

TRANSACTION COSTS CAN SIGNIFICANTLY INFLUENCE FEASIBILITY OF MARKET DEVELOPMENT

The technical problems of converting air quality into excludable private property are fundamentally linked to costs incurred in the permit process to negotiate the proper level of pollution abatement. It is useful to interpret these transaction costs as incurred and imposed primarily to reduce the risk or uncertainty of violating the Clean Air Act.

Assuming that these costs are incurred to ensure good air quality management, two basic pieces of information--accurate data on emissions and their effect on outdoor air quality--are necessary. Providing this information can be a principal cause of sizable transaction costs in the permit process. To see why

this is so, we need only to consider the requisite engineering analysis and data requirements for air quality modeling.

The engineering analysis necessary to estimate emissions may be complicated by several factors. How the product which generates pollution as a byproduct is to be made, including what types of inputs are to be used, and how much of the product will be made, must be addressed. The effect of pollution control technology on emissions must also be gauged. The above analysis is further complicated by decisions on the appropriate control technology, especially when BACT or LAER are mandated, since they are to be determined on a case by case basis (see pp. 12 and 13).

Modeling may play a part in choosing the right control technology. For instance, an air quality model may show that the area in which the proposed project is to be constructed is nonattainment. This finding could trigger the requirement for LAER.

With emission estimates, control technology, and the results of air quality modeling in hand, the regulator must then decide whether to conditionally approve a construction permit. This preliminary decision may then have to be reviewed by other regulatory agencies such as EPA. And the public may have an opportunity to scrutinize the basis for this decision. Appeals and litigation can follow.

Final approval of the construction permit only allows the firm to build the project. Operating the project depends on approval of an operating permit. Before this operating permit may be granted, further engineering analysis may be necessary. Source testing, or measuring actual emissions, may be required.

When an operating permit is granted, the project can be considered "in compliance." However, meeting these permit requirements does not ensure this project's continuing compliance with the Act. Enforcement may entail an annual review of the effectiveness of pollution controls, a periodic check on input use and capacity utilization, and possible air quality and emissions monitoring.

For external offsets, these permit requirements will usually apply to more than one firm because an external offset normally requires air pollution controls at the proposed project and at an offsetting source. Once agreement has been reached on the appropriate control technology and emission estimates for the project, calculating the necessary offsets--or emission reductions from other sources-is possible. Generally, needed offsets increase with distance between the project and offsetting source due to the dispersion characteristics of the pollutants.

In calculating necessary offsets, present EPA offset policy requires that emission offsets provide a positive net air quality benefit in the affected area. The following paraphrase of EPA guidance is instructive.

- Air quality modeling may not be necessary for NO_x and volatile organic compounds (which include hydrocarbons).

- The offsetting source may be located anywhere in the broad vicinity of the proposed new source, if within the same AQCR, for NO_x and volatile organic compounds. It is desirable to obtain offsets from sources located as close to the proposed site as possible. If the proposed offsets would be from greater distances, the offset ratio should be increased and it should be shown that nearby offsets were investigated, and reasonable alternatives were not available.

- Air quality modeling should be considered to ensure a positive net air quality benefit for PM, SO_2 and CO. 1/

After determining necessary offsets, appropriate pollution control measures for the offsetting sources and verification of resulting emission reductions, or offsets, must be made. Operating permits for offsetting sources and enforcement may be necessary.

As indicated earlier, we assume that this traditional permit process and associated transaction costs would be an important part of a market in air pollution entitlements. This assumption conforms with the way in which controlled trading is evolving from the conventional system of air quality management. However, these transaction costs are not unique to a market, but are generic to air pollution control. If these costs are high, they can stymie the development of any pollution control system, whether it be a market or an improved version of command and control.

The other type of transaction costs relevant to the feasibility of a market in air pollution entitlements is search costs. Searching is necessary to achieve air quality standards in the least costly way.

Search costs pertain to the expense and time of gathering information on the availability and prices of air pollution entitlements. These costs are generic to trades in air pollution entitlements between two or more firms. Thus, procuring external offsets involves search. But both the availability and prices of these entitlements depend on our ability to control overall use of air quality and its utilization among different users in a legally acceptable manner. For instance, if air pollution control is fundamentally imprecise, there may be considerable uncertainty and doubt about the adequacy of current air quality management plans to meet the standards in nonattainment areas. This uncertainty may affect the willingness of some firms to sell offsets. For example, a prospective supplier of air pollution entitlements

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1/40 C.F.R. 51, Appendix S (1981).

may expect more stringent regulations to be imposed on other firms in the future to bring a nonattainment area into compliance. Thus, this potential offsetter might judge that it could get a higher price for its entitlements in the future than now. Accordingly, this company might offer offsets only at a higher price which might include some premium for taking the risk of selling now and foregoing the possibility of higher prices later. On the other hand, if some other firms expected the imminent burden of new regulation on their facilities, they might be very eager to sell entitlements.

The cost of searching can also interface with the cost of getting through the permit process. Simply put, the searcher may be saddled with uncertainty about what constitutes a legally acceptable trade. It may be unclear where emission reductions need to be obtained. The vagueness of previously cited EPA guidance and the imprecision of air quality models do not foreclose this possibility.

EMISSION REDUCTION BANKING CAN REDUCE TRANSACTION COSTS

As noted earlier, emission reduction banking is part of EPA's controlled trading policies. Under the banking policy, a State can allow companies to "bank" any of their emission reductions that are over what is legally required. These extra reductions in pollution (called emission reduction credits) result in an extra improvement in air quality as long as they remain "deposited" in the bank, or are not used.

An important aspect of banking relates to our previous discussion of transaction costs. As a depository of actual emission reductions or offsets, a bank can improve information on the availability of air pollution entitlements. This can reduce search costs.

The success of a bank in reducing search costs depends on more than just having deposits. Once again, the technical problem of converting air quality into excludable private property is relevant. Transferring emission reduction credits between firms for use as external offsets must conform with air quality standards. For example, company X may sell company Z a 5-ton emission reduction credit. But, depending on their distance and direction from each other, the use of this credit at its face value by company Z may not comply with air quality standards.

Suppose 90 percent of any improvement in air quality from company X's reduction occurs within a 2-mile radius of its plant site. Company Z's plant is 10 miles away. So, a transfer and use of this 5-ton credit by company Z will not affect the same area as would company X's use of this credit. Consequently, the regulator may disallow all or most of this credit as an offset for company Z's emissions. Consequently, the contribution of a bank in expediting external offsets may depend beforehand

on the nonprice information available on emission reduction credits. In the above example, this information would allow company Z to make an informed judgment on the quality of the asset which it was considering buying.

OTHER ISSUES AFFECTING IMPLEMENTATION AND SIZE OF TRANSACTION COSTS

Technology-based emissions standards pose problems for development of a market

It has been shown that major new sources of nonattainment pollutants must install Lowest Achievable Emissions Rate Technology (LAER). Similarly, major new sources of attainment pollutants must install Best Available Control Technology (BACT). These requirements sharply reduce or preclude altogether using external offsets or multi-firm bubbles by such sources. In nonattainment areas, external offsets cannot be used in lieu of LAER. In attainment areas, external offsets cannot be used in place of BACT. In short, both LAER and BACT artificially restrain demand for air pollution entitlements in a market.

LAER and BACT can also prove troublesome in implementing a market for another reason. These emission standards are supposed to be determined by the regulator on a case-by-case basis, to capture any advances made in air pollution control technology. However, this case-by-case determination of the latest advance in pollution control technology may discourage some companies from buying or selling air pollution entitlements. This could be the case if the market transaction itself serves as a signalling device for finding new or more advanced controls. For example, a dry cleaning plant, in selling air pollution entitlements to another firm, might be retrofitted with a new pollution control measure. If this trade occurred in a nonattainment area and if the retrofit were judged "cost-effective" by the regulator, possibly all other dry cleaners in the air shed could be ordered to adopt this stricter control. If the owner of the previous dry cleaning plant happened to own other establishments in the same basin, he might be very reluctant to sell entitlements if he knew about this link between controlled trading and command and control. Instead, he might prefer to hoard entitlements or sell them at only very high prices. Such behavior would lead to higher search costs incurred by prospective buyers. Finally, for every entitlement traded in a market, where a new control was revealed, the demand for many more entitlements in a market could be precluded, as BACT and LAER became increasingly strict. A firm envisioning a new major project might avoid all possible market opportunities for fear that such transactions might signal tougher controls on its future project.

Enforceability in a market for air pollution entitlements

To compare adequately enforceability between a command and control system and a market entails recognizing that the relevant choice is either command and control regulation that accommodates economic growth or a market, with some common constraint governing acceptable air quality, namely, the NAAQS. The following statement from EPA's interpretative ruling on offsets sums up these choices:

> Under the preconstruction permit requirements in Part D (of the Clean Air Act), States have two basic options for dealing with proposed new major sources within a nonattainment area that cause or contribute to a violation of a NAAQS. The SIP may provide an allowance for growth while assuring reasonable further progress toward attainment, and new sources may be allowed that do not result (individually or in the aggregate) in emissions that exceed the allowance. If the growth allowance is used up, or if none is provided, the State's other option is to allow sources to be constructed only if case-by-case offsets are obtained sufficient to provide for reasonable further progress towards attaining the NAAQS... 1/

This ruling permitting regulators to establish a growth allowance suggests similar enforcement problems for market and nonmarket schemes which accommodate economic growth. For example, suppose a new facility is envisioned for a nonattainment area but it emits nonattainment contaminants. In a nonmarket scheme, the regulator would free up a reserve of clean air for this facility by making emission regulations on established firms more stringent. Enforceable permit conditions on these offsetting firms would be necessary before approving the new project. These conditions might limit the operating capacities of these offsetters. New permits to construct might also be required. Importantly, the same types of control measures and permit conditions would be required in a market scheme using voluntary external offsets. Thus, the enforcement issues under either scheme would be identical. Will new pollution control equipment of existing firms perform as proposed? Are throughput estimates at these offsetting facilities accurate? How can we ensure compliance with these operational limitations?

Finally, in a market for air pollution entitlements, enforceability, rather than hindering the adoption of a market, can be an objective or important by-product of this market. Buyers of valuable assets in such a market have an incentive to prevent encroachment of their property. For instance, if a company purchases

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1/44 Fed. Reg. 3275 (1979).

air pollution entitlements, its interests are served by identifying and preventing "interlopers" from illegally using any part of these entitlements. Such illegal use could violate the NAAQS. Depending upon how the regulator chose to correct this violation, the firm that purchased entitlements could lose some of its investment. This would be unlikely if the identity of the "interlopers" were known.

This incentive to protect one's own property rights, which a market would encourage, is especially significant in light of some statistics from our previous studies which shed light on the enforcement capability of the present system of air pollution control. In one such study, 1/ we found that "few major air pollution sources have been classified 'in compliance' as a result of onsite inspections and source tests, the most reliable methods of determining compliance." We concluded that "only 25 percent of the major sources were found in compliance by the most reliable methods" and "72 percent were certified by the States based on unverified information submitted by the sources." 2/ We also reported that EPA found "out of 921 inspections of sources supposedly in compliance, 200 or 22 percent,...in violation. 3/ Enforcement can be thought of as a process to ensure continuous compliance, and continuous compliance tests are probably no more stringent than the initial compliance tests reported above.

In another study, we reported on the accuracy of monitoring networks employed to measure outdoor air quality in various parts of the country. 4/ The importance of these data for enforcement is dual: to judge the effect of emissions from polluting sources and to determine compliance with the air quality objectives of the Clean Air Act. Our investigation disclosed that 72 percent of the air quality monitors which it evaluated were incorrectly placed; that almost 60 percent of the monitoring equipment in use was not certified by EPA; and, that 81 percent of the monitoring sites had problems which could result in unreliable data. 5/ This report concluded that these deficiencies "raise serious questions about the reliability and representativeness of the air quality

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1/U.S. General Accounting Office, "Improvements Needed In Controlling Major Air Pollution Sources," (CED-78-165, Jan. 2, 1979), U.S. Government Printing Office, p. 7.

2/Ibid., p. 8.

3/Ibid., p. 9.

4/U.S. General Accounting Office, "Air Quality: Do We Really Know What It Is?" (CED-79-84, May 31, 1979), p. i.

5/Ibid., pp. ii-iii.

data." 1/ These two studies of ours suggest that the conventional system is no model of enforcement.

Property rights

As suggested earlier, the issue of who owns the air has arisen in applying EPA's offset and banking policies. But a precise resolution of this issue has not been forthcoming. EPA has stated that "so long as the pollution control requirements under the Act are satisfied, the State is free to govern ownership, use, sale, and commercial transactions in banked emission offsets as it sees fit." 2/

Lack of confidence in pollution control measures adopted to achieve and maintain the NAAQS may be an underlying cause for the concern about vesting companies and individuals with entitlements to pollute. However, one commentator sees section 173(1)(A) of the Clean Air Act as suggesting that regardless of the ownership route taken, the regulator has the authority to "confiscate" these entitlements either partially or entirely to meet the NAAQS:

> Under [this] section...the amount of emission reduction that can be used to offset a proposed new source is calculated by using the SIP baseline in effect when the application for a permit is made rather than when the offsets are created. Tightening the SIP levels applicable to a firm thus has a confiscatory effect on any offsets not yet used in a permit application ...[S]uch SIP revisions are clearly authorized by statute and may be necessary as compliance deadlines draw nearer. 3/

On the other hand, proponents of private property have stressed the need for assurances against such confiscation, and "this need may be given as a justification for granting offsets the status of vested property rights." 4/ But, one commentator has observed that any such assurances do not appear open-ended:

> It is doubtful that treating offsets as private property would necessarily dispose of the confiscation problem or allay investors' fears. Although the law of takings resists simple analysis, constitutional doctrine

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1/Ibid., cover summary.

2/44 Fed. Reg. 3280 (1979).

3/"Emission-Offset Banking: Accommodating Industrial Growth With Air Quality Standards," University of Pennsylvania Law Review, vol. 128, 1980, p. 950.

4/Ibid.

> permits the confiscatory effects of government regulation when necessary to protect public health under the police power. Tightening SIP baselines to adjust for unanticipated increases in pollution would thereby seem a legitimate exercise of police power. 1/

Opposition to vesting companies and individuals with air pollution entitlements may also be rooted in consideration of common property resources and market failure. The public or non-exclusive nature of air quality characterizes common property resources. In turn, this leads to the "free rider" problem which we addressed earlier. Without government intervention, air quality historically was a free-access resource which was over-exploited. However, the Clean Air Act was enacted to correct for this market failure. Firms and individuals legally exploit the air quality resource within the bounds of this Act. These entitlements of legal exploitation appear the issue, not entitlements to pollute in disregard of the NAAQS.

CONCLUSIONS

In this chapter, we have identified the important issues in implementing a market in air pollution entitlements. We discovered that the non-exclusive nature of air quality poses a fundamental challenge to creating a market. This nature, which characterizes a public good, means that transforming air quality into excludable private property has certain technical complications. In fact, it appears that only when this property is defined as part of an area-wide air shed is this technical transformation fairly straightforward. The connection between individual smokestack emissions and their relative effects on air quality is easier to ascertain for pollutants which are more widely and evenly dispersed. If an overall emissions limit can be established which meets the NAAQS, trading in air pollution entitlements reduces to buying and selling emission entitlements. This simplification is significant, given the potential data requirements for accurate air quality modeling.

The legal issue of property rights is inextricably tied to the technical problem of transforming a public good into separate pieces of property for sale. However, it can be argued that the Clean Air Act mitigates legal complications by defining what parts of outdoor air are legally exploitable. Under this theory vesting individuals and companies with entitlements to pollute what is legally exploitable would not appear to threaten the Clean Air Act.

The complexity and imprecision of air pollution control has other important ramifications for any market approach which aims to comply with the air quality objectives of the Clean Air Act in

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1/Ibid., pp. 950-951.

the least costly way. Sizable transaction costs in the permit process are possible. Uncertainty about the adequacy of SIPs could translate into large search costs for prospective buyers of air pollution entitlements. Certain aspects of the existing system of air pollution control affect the magnitude of these costs. For instance, an emissions reduction bank can reduce search costs, while technology-based emission standards such as BACT and LAER tend to have the opposite effect.

Enforceability is another important concern in implementing a market. However, any system for accommodating economic growth and air quality will face a common set of enforcement issues. This fact and other evidence suggest that a command and control system of air pollution control is no model of enforcement.

In the next two chapters, we explore the experience in two metropolitan areas with attempts to overcome the impediments described above to implementing a market in air pollution entitlements. The value of these case studies is that they suggest actual remedies for achieving a workable program, which in turn suggests the direction that public policy should pursue in eliminating obstacles to more widespread development of markets in air pollution entitlements.

CHAPTER 5

OFFSETS AND BANKING IN SAN FRANCISCO

In this chapter we present the results of a case study of the offset and emissions reduction banking program in the San Francisco Bay Area. We chose the Bay Area for a more detailed analysis because at the time of our audit, from July 1980 to February 1981, it was the only region in the country with considerable experience in both banking and offsets.

The Bay Area Air Quality Management District (referred to as BAAQMD), 1/ a local regulatory authority, has primary responsibility for controlling air pollution in this area, except for pollution caused by motor vehicles (see figure 2). The California Air Resources Board (CARB), the State regulatory authority in air pollution control, has responsibility for motor vehicle emissions. CARB also has general oversight responsibilities to ensure the adequacy and enforceability of regulations adopted by BAAQMD to meet the National Ambient Air Quality Standards (NAAQS).

Since 1977, two types of offsets and a limited form of onsite banking have occurred in BAAQMD. External offsets were authorized by EPA's 1976 ruling, and internal offsets, involving emission trade-offs at a single facility, have been allowed by BAAQMD regulations for several years. Tied to the use of internal offsets is BAAMQD's onsite or informal bank. Since December 1977, firms have been able to accumulate emission reductions, not required by laws, rules, or regulations, in this informal bank for their own use as internal offsets.

NEW DEVELOPMENTS IN BANKING

Although an onsite bank has been operating for several years, support for a more versatile emissions reduction bank galvanized in 1979. The Bay Area Council (BAC), a trade association representing several hundred firms in the San Francisco region, advocated this reform because of dissatisfaction with two aspects of the informal bank. Emission reduction credits (ERCs) in this bank were subject to possible confiscation if new regulations imposing more stringent emission standards were levied, and credits in the informal bank could not be used as external offsets.

BAC was also active in lobbying for State legislation on emissions reduction banking. In September 1979, a State law was enacted which authorized local air pollution control districts, such as BAAQMD, to set up formal emission reduction banks. Key provisions of this law are instructive in comparing the new formal bank with its predecessor, the onsite banks. For example,

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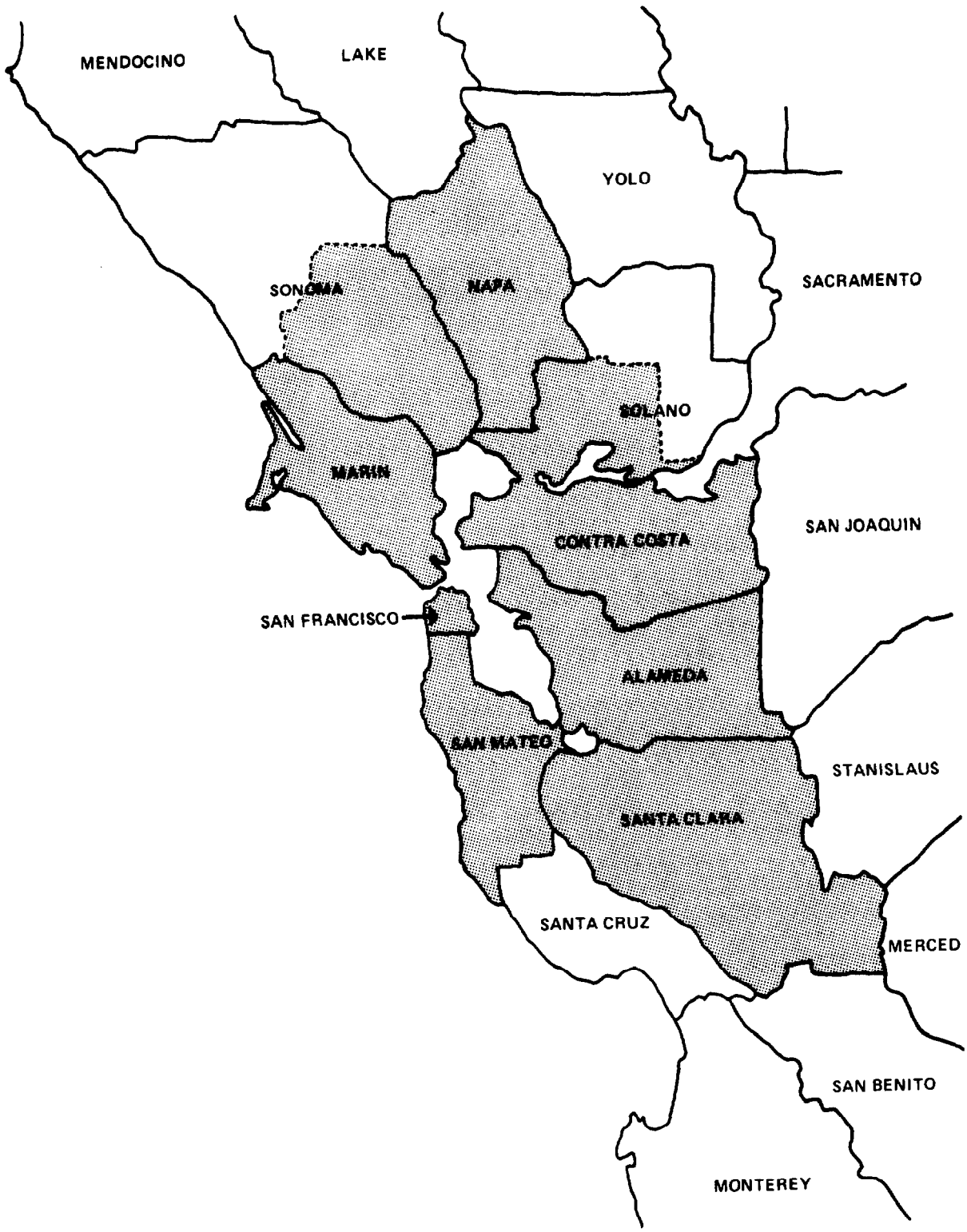
1/BAAQMD will also be referred to as the District.

Figure 2

Bay Area Air Quality Management District



local air pollution control districts could now issue banking certificates--as formal proof of ERCs and their ownership--in the names of the owners of the facility reducing emissions. These certificates would be issued only after the local regulator had approved ERCs. In the informal bank, no certificates were issued. In addition, ERCs could be transferred from one person to another through sales and options agreements, thus making it possible to use ERCs as external offsets. As with the onsite bank, emission reductions can be deposited in the formal bank only if not required by any laws, rules, orders, permits, or regulations.

Striking a balance between regulatory flexibility and investment certainty

In pushing for banking reforms, the Bay Area Council and BAAQMD began designing a formal bank for the Bay Area. The bank, which opened January 1, 1980, was a compromise between the regulator's need for flexibility to change regulations if air quality objectives were jeopardized and industry's need for certainty to protect the value of its deposits from changing regulations.

The following BAAQMD regulations governing formal banking reflect this compromise. First, regulation 2-2-307 states:

> Changes in offset requirements adopted within 3 years from the date reductions are banked shall not be applicable to the use of such reductions. Any such changes adopted 3 or more years after reductions are banked shall be applicable to the use of such banked reductions. 1/

In other words, ERCs in the formal bank are fully protected for 3 years from time of deposit. Second, regulation 2-2-308 stipulates:

> If the APCO [Air Pollution Control Officer] determines that banked emissions, if used as offsets, would interfere with reasonable further progress towards attainment of NAAQS, the APCO may declare a moratorium on emission deposits. 2/

This moratorium provision stemmed from industry's desire for unconditional use of what is banked and from the regulator's concern for meeting the NAAQS. In the unlikely event that withdrawing and using ERCs might threaten air quality standards, a moratorium on deposits could minimize this risk.

1/Bay Area Air Quality Management District, Regulation 2, Rule 2, Section 307, Februrary 20, 1980, p. 2-2-7.

2/Ibid., Section 308, p. 2-2-7.

According to BAC, a variety of other safeguards were accepted by industry in exchange for permanently vested credits. For instance, emission reductions from shutdowns serving "an inelastic basin-wide demand" cannot be credited because these emissions may not cease but simply flow from other sources within the District. Moreover, emission reductions required by BAAQMD's air quality management plan are also not bankable.

Reducing transaction costs of external offsets

The Bay Area Council claimed that delays in searching for offsets would be reduced with a pool of usable offsets in the formal bank. Firms could better synchronize their investment plans and their need for air pollution entitlements. Similarly, the California Air Resources Board concluded that "sources seeking offsets potentially could decrease high search costs by being able to go directly to the bank." 1/ And BAAQMD foresees "more readily accessible information concerning what emission reduction credits are potentially available and where." 2/ Thus, the role of the formal bank in reducing transaction costs and uncertainty associated with external offsets was clearly perceived by its architects.

As we noted in chapter 4, specifying the nonprice characteristics of ERCs, such as their spatial and temporal fallout, can reduce transaction costs of trading in air pollution entitlements. The more specific this information is, the easier it is to determine the substitutability of emissions from the prospective buyer and prospective seller. However, the significance of this specification is likely to depend upon the specificity of the offset program. The Bay Area's external offset program contains some fairly simple trading rules which specify minimum offset ratios under various scenarios. Consistent with these simple rules, the Bay Area's formal bank does not provide readily accessible information on the expected fallout patterns of its ERCs.

Measuring emission reduction credits in the formal bank

To determine how much credit can be deposited in the formal bank, a depositor must compute "actual emission reductions." By this is meant:

1/State of California Air Resources Board, "Public Meeting to Consider Adopting Policy for the Implementation and Review of Systems for the Banking of Reductions in the Emission of Air Contaminants," San Francisco, April 24, 1980, pp. 34-35.

2/D. Goalwin, J. Phillips, BAAQMD, "Practical Aspects of an Emissions Bank," January 1981, p. 10.

> A reduction of emissions . . . from a baseline determined by source tests or other methods approved by the APCO. Baseline and reduced emissions shall be calculated as average daily emissions. If methods other than source tests (such as fuel consumed or solvent used) are used to calculate the baseline, such data must be based on the average of 3 years usage prior to the submission of the complete application, or other time period as approved by the APCO. 1/

This baseline must account for "actual operating emissions from the source subject to reduction." 2/

A community bank proposal

Alongside the formal and informal banks (or "private" banks), the Citizens for a Better Environment (CBE), an environmentalist group, has lobbied for a "community" bank in the Bay Area. Wickland Oil Company, recently engaged in a lengthy and expensive permit application involving external offsets, has supported this proposal. According to CBE, the primary purpose of their proposed community bank is "to make offsets available to new sources." 3/ Major features of CBE's proposal include:

- For major new sources and modifications, 25 percent of calculated emissions would be required as a mandatory deposit in the community bank.
- A percentage of any emission reductions certified for deposit in the formal bank would be placed in the community bank, starting at 10 percent for deposits in 1982 and rising to 50 percent in 1984.
- Firms exempted from offset rules, or owning no permitted sources in the air basin, or using best available control technology (BACT) on all emission points and unable to find offsets could withdraw deposits from the community bank.
- Community bank depositors would be reimbursed by the withdrawer at a price equal to "the average basin-wide cost of achieving ERCs plus 10 percent." 4/

To date, no such community bank exists in the Bay Area.

1/BAAQMD, Regulation 2, Rule 2, Section 201, p. 2-2-4.

2/BAAQMD, "Guidelines for Banking Emission Reductions," p. 4.

3/CBE letter to BAAQMD, October 3, 1980.

4/Ibid.

EXTERNAL OFFSET REGULATIONS

BAAQMD has several simple trading rules to expedite external offsets. Previously, it required a case-by-case analysis to determine needed offsets. Currently, external offsets are triggered by cumulative emission increases of more than 550 lbs. per day for NO_2, and more than 250 lbs. per day for the other NAAQS pollutants, in nonattainment areas. For SO_2, CO, NO_2, and PM, offsets can be avoided if the applicant can show that project emissions will not interfere with meeting NAAQS.

Once a stationary source has triggered the offset requirement, the following offset ratios are applicable:

- A value of 2:1, if the new project uses annual average emissions as the basis for computing needed offsets, provided the offsetting source is no more than 30 miles from the project for organic compounds or NO_2, or more than 10 miles for PM, SO_2, and CO.

- A value of 1.2:1, if other than annual average emissions are used as the basis for calculating needed offsets, provided the offsetting source is no more than 15 miles from the new project for organic compounds or NO_2, or no more than 5 miles for PM, SO_2, and CO.

- Any other value, regardless of distance and location of offsets, if it can be shown to result in a net air quality benefit and if CARB concurs. 1/

The emissions baseline to be used in computing emission reductions from offsetting sources is computed in exactly the same way as the emissions reduction baseline for the formal bank. A new project which triggers any of the offset requirements must also install BACT, equivalent to LAER.

THE PERMIT PROCESS

For a new project, two types of air pollution permits are normally required. Before construction can begin, an authority to construct is needed. After construction is complete, a permit to operate is required. The purpose of the authority to construct is to prevent violations of any rules, regulations, or laws. The permit to operate is a check on the project's emissions estimated during the authority to construct phase of the permit process and is renewable on an annual basis. If the authority to construct contains special limitations on the project's operations--such as a limit on the maximum daily hours of production--the renewable feature of the permit to operate serves as a check on these conditions.

1/BAAQMD, Regulation 2, Rule 2, March 5, 1980, p. 2-2-6.

The time which it takes to get through this permit process depends on the project's evaluation under New Source Review (NSR). NSR applies to all new and modified stationary sources expected to emit more than 150 lbs. per day of organic compounds, NO_2, SO_2, or PM, or CO in an amount which will violate the CO NAAQS. All permit applications for ERCs in the formal bank are also subject to NSR. Besides allowing BAAQMD more time to evaluate an applicant's request for an authority to construct--generally 180 days following the District's acceptance of an application as complete, NSR contains important public comment and inspection requirements. In addition, applications under NSR may be evaluated by CARB and EPA.

MAJOR PARTICIPANTS IN THE OFFSET AND BANKING PROGRAMS

We wish to document obstacles which have been encountered in using the Bay Area's offset and banking program. First, however, it is useful to know the attitudes and general perceptions of regulators, industry, and environmentalists toward this program and a market. This knowledge can help us to understand the problems slowing the use of offsets and banking in the Bay Area.

The regulator (BAAQMD)

Generally, those in policymaking positions at BAAQMD were more receptive to the formal bank and external offsets than staff who are directly engaged in processing permit applications. The majority of BAAQMD's board of directors apparently support the formal bank. For instance, during May 1980 hearings, the board's chairperson stated that "what we're trying to achieve here [is] to give [bank depositors] a property right whose value may appreciate...." 1/

In arguments before the BAAQMD's board in May 1980, industry argued that a moratorium on withdrawal would discourage companies from depositing in the formal bank. The District's Air Pollution Control Officer (APCO) agreed with this assessment, that "it strikes fear in the hearts of investors...." 2/ On CBE's community bank proposal, the APCO testified before the board:

> My feeling, and, I think, our staff's feelings, is let's let the bank open, let's get deposits in the bank, if they're [going to] come, and at some later time, if we think it's a viable incentive for putting emissions aside, discuss the possibility of a community

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1/Public hearing before the BAAQMD hearing board, May 7, 1980, statement of Chairperson Boxer.

2/Public hearing before the BAAQMD hearing board, May 7, 1980, statement of M. Feldstein.

bank. So, the staff would oppose at this time only, until we see what happens with the banking rule, the establishment of a community bank as a deterrent for depositing in the bank. 1/

BAAQMD's counsel expressed similar reservations about the community bank, particularly the idea of having government choose which firms would get entitlements. He also asserted that some entitlements to pollute the air are vested.

In contrast, BAAQMD's director of permit services felt that no one has such a vested entitlement. He also supported a community bank as a mechanism for correcting what he considered an unfair burden on new sources. He thought that the formal bank "wouldn't get off the ground," citing the success of the informal bank as a dominant substitute, and he had a dim view of external offsets, arguing that internal offsets are a lot easier to arrange. 2/ He also advocated the pure emissions standard philosophy, believing that BACT is the cure-all for the Bay Area's air pollution problems. Similarly, another staff member of the permits division felt that firms can afford to use the most technically efficient control equipment and that BACT is the desired tool for meeting the NAAQS.

The business community

We encountered a number of industry officials who announced their intention of hoarding air pollution entitlements. Reasons given for this strategy included uncertainty about the future supply of air pollution entitlements and the need for entitlements to accommodate their own future plant expansion.

Company representatives also expressed little confidence in the safeguards designed to protect the value of ERCs in the formal bank. A spokesman for the Bay Area Council described the issue in this way: "Industry is concerned about long-term access to the formal bank; they fear that the District will find some way to take away their rights." 3/ One company official feared the threat of eminent domain, and of government pressure on his firm to sell entitlements deposited in the formal bank. However, some of these same representatives admitted that the formal bank offers more protection for their ERCs from changing regulations than does the informal bank.

1/Ibid.

2/GAO interview, July 14, 1980, with BAAQMD director of permit services.

3/GAO interview, September 27, 1980, with T. Merle of the Bay Area Council.

Other persistent complaints voiced by business officials are summarized below:

- Ambient air quality standards are so stringent that there are few rights to buy and sell, and regulations so tight that there is little to bank.
- The offset policy is a way to salvage LAER and the existing regulatory framework.
- The regulators allegedly resist trading; "the big fear of regulators is that someone will make a buck out of it," and a claim that BAAQMD's attitude towards external offsets and banking is that they are "not interested in developing another industry."

Environmentalists

As noted previously, CBE has been the main proponent of a community bank in the Bay Area, arguing that the formal bank grants "property rights to emitters of air pollution ... (which is) a far cry from the regional directives of the (BAAQMD) board." 1/ And, according to a CBE spokesman, a major reason for their community bank proposal is to realign property rights. CBE has written:

> Air pollution has suddenly become like private property and can be bought, sold, and banked. Unfortunately, the control of this now valuable commodity is in the hands of existing polluters. But giving air pollution the status of private property, rather than viewing it as a public nuisance, also bestows upon existing polluters the opportunities to control and direct future economic development by controlling the availability of offsets. This enables existing polluters to profit further from their over-exploitation of a public resource--clean air. 2/

Similarly, CBE has testified that: "There is no requirement that anyone sell anything from the private bank. Our community bank is a program to share the filth." 3/

1/Public hearing, May 7, 1980, statement of J. Gabe.

2/J. Gabe, CBE, "Squatter's Rights," September 1980, p. 1.

3/Public hearing, May 7, 1980, statement of J. Gabe.

Transaction costs in the permit process: perceptions of the major participants

In chapter 1, we noted that transaction costs are incurred in the permit process to ensure compliance with the Clean Air Act. We also drew attention to search costs incurred to provide information on the availability and price of air pollution entitlements. Here, we report observations on transaction costs in the permit process as gleaned from numerous discussions with BAAQMD, company officials, and CBE.

All of the major participants in the permit process were concerned about the difficulty of determining BACT. To correct this problem, both CBE and the District thought that a better clearinghouse for BACT is needed. Company officials pointed out that constantly changing definitions of BACT caused uncertainty and delay. Relatedly, disputes about emission estimates were cited as a serious problem in the permit process. CBE told of situations where permit applicants were informed by the District that their applications were complete when in fact they were not, partly because errors in emission estimates had not been caught by BAAQMD. A District spokesman pointed to emission estimate errors, and stressed the importance of submitting accurate presentations of the production process. Company officials cited the difficulty of developing emissions data acceptable to BAAQMD for those situations in which source testing has not been or can not be specific. For small firms, the expense of developing emissions data which supports the use of control measures contrary to District recommendations was described as prohibitive. Disagreements on proper emission factors were also identified as a problem by company officials. Finally, both the District and company officials felt that quantifying offsets and showing that they represent bona fide emission reductions were especially vexing.

USING THE OFFSET PROGRAM

In this section, we focus on the actual use of external offsets in the Bay Area, with an eye towards transaction costs and other obstacles impeding development of a market in air pollution entitlements.

We identified two important external offset cases in the Bay Area. One of these--the Wickland Oil Company (Wickland) case--was successfully completed, but only after considerable delay and expense. The other--the Pacific Gas and Electric Company (PG&E) case--was abandoned by the appellant prior to action by the BAAQMD hearing board.

In our investigation, we were able to link large transaction costs to efforts aimed at minimizing the risk of noncompliance and in determining the availability and price of external offsets. However, in making a prognosis for the Bay Area's external offset program, we caution the reader that the size of these costs

could be exaggerated because they reflect the first such experiments in the Bay Area.

Wickland Oil Company

In 1977, Wickland Oil Company proposed building a petroleum terminal in Contra Costa County. This terminal would receive gasoline and other fuels from tankers visiting its wharf and possibly from pipelines connecting it to nearby refineries. This project was expected to emit HC and SO_2 in amounts which would trigger both BACT and offset requirements.

Wickland submitted its permit application in February 1978. BAAQMD denied this permit 3 months later, ruling that Wickland's proposal did not incorporate BACT and did not contain enforceable offsets. After this denial, Wickland found new offsets and submitted a revised application in October 1978. The District preliminarily approved this new proposal in May 1979. However, a number of environmentalist groups, including CBE, appealed this decision which resulted in public hearings. Nearly a year later, in May 1980, the District's hearing board reversed BAAQMD's earlier approval and denied Wickland a permit. Environmentalists and Wickland then negotiated a number of modifications to the project which the District approved in June 1980, thereby allowing Wickland to begin construction of its terminal.

Problems

Transaction costs in the air permit process were principally due to problems involving HC emissions. Determining BACT and estimating emissions for the terminal proved difficult. In addition, a serious problem arose in estimating emission reductions from an offset site.

To satisfy BACT requirements, Wickland proposed a floating roof with double seals to control HC emissions from the terminal's petroleum storage tanks. But, BAAQMD preferred a fixed roof with a vapor recovery or incineration system. According to BAAQMD's calculations, its control strategy would result in fewer emissions than Wickland's. Wickland disputed these calculations. After reviewing these arguments, a CARB official agreed with Wickland's assessment. As a result, BAAQMD reversed its decision and accepted Wickland's tank design as BACT.

To satisfy HC offset requirements, Wickland originally maintained that its terminal would set in motion market forces which would bring about offsetting emission reductions from nearby refineries. Wickland argued that its demand for refinery output would drop, so these refineries would then produce less gasoline and less pollution. BAAQMD rejected this argument because Wickland had not received enforceable commitments from these refineries to limit their output. CARB agreed with BAAQMD.

In its revised application, Wickland proposed an HC offset at a dry cleaning plant in San Francisco, City of Paris Dry Cleaners, more than 20 miles away from the terminal site. The owner of the dry cleaners agreed to replace dry cleaning equipment using Stoddard solvent with less polluting equipment using perchloroethylene solvent, at Wickland's expense. BAAQMD tentatively approved this offset. However, during the public comment and hearing period, environmentalists argued that HC offsets should have been obtained in Contra Costa County, closer to the project site. BAAQMD countered that the ozone excesses in that county are a result of HC emitted all over the Bay Area, and therefore HC reductions anywhere in the Bay Area will provide a net air quality benefit for ozone. This strategy was accepted by CARB and EPA.

This issue about where to locate offsets was eventually settled by BAAQMD's hearing board in favor of Wickland. Environmentalists argued that before approving the Paris offset, BAAQMD should have required air quality modeling, because the effect of HC emissions on ozone production depends on NO_2 concentrations which differ between the project site and the dry cleaners. The hearing board sided with BAAQMD, concluding that mathematical modeling is not accurate enough to determine the effect of an individual source on ozone formation.

Environmentalists also argued before the board that BAAQMD's calculation of HC offset credit from Paris Dry Cleaners was erroneous. The board agreed. Five years of data for Paris, from 1974 through 1978, were available for estimating emission reductions when BAAQMD evaluated this HC offset. Estimated emissions had declined every year since 1974 and reached a low point in 1978. Based on an average of all 5 years' data, BAAQMD calculated an emission offset of 151.4 tons per year. They justified their 5-year averaging method on the intention of new owners to rebuild the dry cleaning business. The board disapproved this averaging method because for most of the 5-year period the company was under another management with different operating practices.

This HC offset dispute was finally settled after Wickland agreed to scale down the size of its terminal which reduced estimated terminal emissions from 83.2 tons per year to 72.6 tons per year, and, after Wickland and CBE agreed on an estimate of about 73 tons per year as offset credit from Paris Dry Cleaners.

Outside the permit process, Wickland experienced difficulty finding HC offsets. After about 4 months of searching, Wickland's consultant could not find enough HC offsets for sale in Contra Costa County. In conducting this search, Wickland concentrated on dry cleaning offsets, showing owners of these establishments a copy of regulations being considered by BAAQMD to control cleaning equipment using Stoddard solvent. But, 130 out of 136 dry cleaners contacted in the county were already using perchloroethylene, so they would be unaffected by this regulation. The emission offset potential of the remaining six cleaners was

judged too small to meet Wickland's needs. For dry cleaners outside of Contra Costa County, suppliers of Stoddard solvent directed Wickland's consultant to the larger users. According to Wickland's consultant, perhaps half of these approximately two dozen dry cleaners contacted were willing to sell, and in December 1978, Wickland negotiated an agreement with one of them, City of Paris Dry Cleaners. Besides dry cleaners, about a dozen other firms were contacted, including chemical manufacturers, paper manufacturers, and oil companies. Most allegedly refused to sell because they wanted to keep their HC offsets for future expansion. Two willing firms wanted too high a price. In all of these search contacts, it appears that the implicitly understood price for offsets was Wickland's willingness to underwrite any necessary pollution controls.

As mentioned earlier, Wickland also needed SO_2 offsets. When Wickland purchased its terminal site in Contra Costa County, it closed down the Virginia Chemicals, Inc., plant located there and, thereby, met part of its SO_2 offset requirement. In searching for additional SO_2 offsets, Wickland's consultant drew up a list of companies with potential offsets, using BAAQMD's emissions inventory data. Of about two dozen firms initially contacted, none wanted to sell offsets at a price equal to their pollution control costs. Eventually, Wickland was able to meet its SO_2 offset requirement by agreeing to supply low sulfur fuel to ship and motor vehicle operators in the Bay Area.

A Wickland official claims that delays in the permit process may have resulted in an estimated $6 million in additional, inflated construction costs. A number of factors appear to be responsible for this delay. Preapplication discussions between Wickland and BAAQMD took longer than expected due primarily to regulation changes requiring BACT and offsets. Subsequent disagreements regarding BACT and offset credit can be tied to judgmental errors on the part of BAAQMD. Some delay was also caused by Wickland's resistance to acquiring enforceable offset commitments.

Outside the permit process, evidence suggest that prospective suppliers of offsets would rather hoard their entitlements, than sell them, at a bid price just covering pollution abatement costs. Given uncertainty about the adequacy of the Bay Area's implementation plan in meeting the NAAQS, and given the novelty of a market in air pollution entitlements, this hoarding behavior is not surprising. Nevertheless, according to our evidence, as many as 17 firms were willing to sell offsets to Wickland at its bid price.

A detailed account of the Wickland offset case can be found in appendix I.

Pacific Gas and Electric Company (PG&E)

To help meet increasing demand for electricity PG&E proposed to expand its power plant complex on San Francisco Bay. The new project, called Potrero #7, would consist of four combustion turbine generators and one steam turbine generator. As originally proposed, the project was to be fueled with distillate oil. Emissions from this project were expected to exceed the offset trigger points for NO_x, HC, and PM.

PG&E submitted their permit application in March 1979. After reviewing this proposal, BAAQMD informed PG&E in May 1979 that it would have to acquire more offsets before the District could approve the permit. PG&E then revised its application, agreeing to meet a more stringent BACT requirement and to limit the hours of operation of its proposed project. In November 1979, BAAQMD again judged that there were not enough offsets. PG&E then proposed to burn less polluting natural gas, instead of distillate oil, and offered more offsets. However, in July 1980, BAAQMD decided that a number of previously arranged offsets were no longer eligible because of new regulations. In addition, PG&E refused to meet a new, more stringent BACT requirement. In October 1980, PG&E appealed to BAAQMD's hearing board, but withdrew this appeal and the project 2 months later after receiving forecasts of lower demand for electricity.

Problems

As in the Wickland case, major problems in the permit process involved determining BACT and emissions for the project and arranging acceptable offsets. The difficulty with BACT centered on meeting numerical limitations for turbine NO_x emissions. Originally, PG&E had proposed to limit these emissions to 75 parts NO_x per million parts of air (75 ppm NO_x). This numerical limitation was guaranteed by the turbine manufacturer.

However, BAAQMD prevailed upon PG&E to agree to a 50 ppm NO_x limit prior to the District's second evaluation of PG&E's application. Subsequently, BAAQMD changed its mind about BACT, insisting on a still lower limitation because San Diego's air quality management plan stipulated such a limit. PG&E would not agree to meet this new requirement because the turbine manufacturer would not guarantee that low an emissions figure without the use of water or steam injection.

Relatedly, BAAQMD's estimates of NO_x emissions from the project were lower than PG&E's. BAAQMD based its estimates on more stringent BACT while PG&E based its estimates on the turbine manufacturer's guarantees, without the use of water or steam injection. PG&E claims that it wanted to avoid the appearance of being credited with fewer emissions than it was entitled to, and that it expected its permit to be appealed by CBE.

The principal difficulty in arranging offsets acceptable to BAAQMD occurred when PG&E, at the District's urging, decided in 1980 to use natural gas instead of distillate oil to power its generators. Earlier, in 1979, the District had prepared an evaluation of the project using natural gas. But, despite this evaluation, BAAQMD chose in May 1980 to treat PG&E's fuel-switching strategy as a new permit application. The implications of this decision for offset availability were contained in the following language of the District's regulation 2-1-307:

> Emission reductions resulting from requirements of Federal, State, or District laws, rules, or regulations shall not be allowed or banked as emission offsets unless a complete application was filed with the District at least 90 days prior to the adoption date of such laws, rules, or regulations. 1/

Regulation 2-1-307 was critically important because in March 1980 2 months before BAAQMD declared PG&E's application new, the District adopted regulations which would effectively require dry cleaners in the Bay Area to use perchloroethylene instead of Stoddard solvent. But PG&E had negotiated offsets involving such a switch in solvents with five dry cleaners in 1979. Applications for these offsets were apparently judged complete no later than September 1979, or more than 90 days before the newly adopte regulations. However, BAAQMD argued that the "complete application" mentioned in regulation 2-1-307 referred to the Potrero #7 power plant, and not to the dry cleaners. Thus, BAAQMD ruled that the previous offsets were no longer available.

An important factor in this dispute about offset eligibility is the discretionary nature of BAAQMD's decision to declare PG&E's application new. BAAQMD policy is that when a project is changed so as to significantly alter expected emissions, it may treat that change as sufficient cause for a new application to allow more time to conduct its review. But PG&E claims that their decision to use natural gas instead of oil did not significantly change project emissions except to reduce SO_2 and that BAAQMD had already calculated emissions using gas in the November 1979 evaluation, so that no new analysis was required. One PG&E official said that if BAAQMD had needed additional time to conduct its evaluation, PG&E could simply have agreed to another extension of the evaluation period rather than allow the application to be considered new.

Besides obstacles encountered in the permit process, PG&E also incurred substantial search costs. Because the location of the cheapest offsets was not known, PG&E had a study conducted

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1/BAAQMD, Regulation 2, Rule 1, Section 307, p. 2-1-6. Recently, the District added "for such banking or actual emission reductic after the words "complete application"; cf., new Section 306.

costing $56,000. This study estimated amounts and costs of emission reductions potentially available at each of more than 200 major sources in the Bay Area, and in several small source categories such as paint removal services. PG&E claims that only one of the major sources contacted during the study wanted to sell pollution entitlements. Most of these sources wanted to use their potential offset supplies for their own future expansion. Expanding its search, PG&E was eventually able to purchase $70,000 worth of options to purchase offsets from dry cleaners using Stoddard solvent. Exercising these options, according to PG&E, would have cost it $1.3 million, but this was still an estimated $19 million cheaper than the alternative, retrofitting existing PG&E facilities with NO_x controls. In the end, however, BAAQMD disallowed these dry cleaner offsets. Shutting down some of its existing facility at the Potrero site comprised PG&E's offsets for other pollutants.

Two interpollutant tradeoffs were permitted in the PG&E case. First, SO_2 reductions from PG&E shutdowns were allowed to offset Potrero #7 PM emissions. Secondly, PG&E's HC emission offsets (until rejected) were allowed to offset Potrero #7 NO_x emissions.

As in the Wickland case, we found no evidence that air quality modeling determined the location of necessary offsets. However, modeling performed by PG&E and BAAQMD indicated that the project's CO emissions would not interfere with air quality standards, so CO offsets were not required. Offset ratios were apparently governed by NSR regulations presented earlier in this chapter.

A detailed account of the PG&E offset case can be found in appendix II.

Sanitary Fill Company

We also received limited information about a third external offset negotiation in the Bay Area, involving Sanitary Fill Company. In November 1978, that company began searching for external offsets to accommodate its plans for a solid waste disposal facility. Sanitary Fill identified 23 potential offset suppliers of SO_2 and NO_2, using BAAQMD's major-source emissions files. In a letter to these firms, the company expressed its possible interest in installing control equipment at their facilities at its expense. Of 14 documented responses, about 50 percent desired to hoard air pollution entitlements at a bid price covering the expense of retrofitting their facilities.

Some concluding observations about external offsets

In the Bay Area, evidence suggests that prices bi
nal offsets have been below maximum prices which the
ably would have been willing to pay to see their pr
approved. For example, PG&E claims that a $19 mi'
existed between its bid price and the cost of ir
Consider the hypothetical case where PG&E would
to construct its project with internal offsets, as

economical way to meet expected demand for electricity in a world which did not allow external offsets. Then in a world allowing external offsets, it probably would have been willing to pay more than the $1.3 million it offered for the dry cleaning offsets. Accordingly, a prospective buyer of external offsets should weigh the costs of expected delay and possible permit denial against higher prices to elicit the right amount of offsets.

USING THE EMISSIONS REDUCTION BANK

Although the Bay Area's formal bank opened in January 1980, its first ERCs were not approved until nearly one year later. A number of factors are probably responsible for this hiatus. Even after the bank's opening, debate continued on a number of very important issues, including a moratorium on withdrawals, treatment of shutdowns, and the alternative posed by a community bank. Controversy over these issues contributed a great deal to uncertainty about the status and final design of the formal bank, until these issues were settled in May 1980. And, proposals for a community bank represent a continuing source of uncertainty to prospective depositors in the formal bank.

Another crucial factor in reducing demand for the formal bank has been the informal bank. Unlike Louisville, Kentucky, and Puget Sound, Washington--the other two areas with formal bank at the time of our audit--the Bay Area did not allow transfer of credits from the informal to formal bank. Secondly, the informal bank, by disallowing use of its credits for external offsets, may have been perceived as a superior substitute to the formal bank. This can be understood in light of the threat posed to existing firms by the community bank initiative which would "tax" ERCs for deposit in the formal bank. In addition, a more stringent certification process and public disclosure requirements of the formal bank may have made using the informal bank more attractive

Despite these deterrents, four applications for ERCs in the formal bank had been submitted at the time of our review, and one of these--by Hewlett-Packard--had been approved by BAAQMD. Of the remaining three applications, evaluation of one, involving Tri-Valley Growers, Inc., had been delayed by difficulty in establishing an emissions credit baseline. 1/ The other two applications, by Stauffer Chemical, Inc. and Raychem, Inc., had been held up by disclosure that proposed sources of emission reductions did not have required permits.

1/Our original audit began in July 1980 and ended in February 1981. However, we recently received information updating the status of the Bay Area's bank. As of July 22, 1981, Tri-Valley Growers' application for emission reduction credit had also been approved. In addition, four other companies--U.S. Steel, Pacific Gas and Electric, Allied, and Hunt-Wesson Foods--have applied for credit approximately equal to 45 tons per year of PM, 1246 tons per year of NO_2, and 359 tons per year of SO_2.

That these firms opted for the formal bank is probably due to two factors. The first is the formal bank's pledge to protect the value of its ERCs from subsequent changes in regulations for 3 years from time of deposit. A Hewlett-Packard official cited this pledge as the primary reason for its decision to bank formally. A second factor may be the option available in the formal bank to sell ERCs to other firms. For Tri-Valley Growers, the proposed source of ERCs was shutting down an entire facility and the transfer of its business outside the District. Apparently, Tri-Valley will have no internal offset uses for these ERCs in the foreseeable future, so it could become a seller of air pollution entitlements. The other applications also involve shutdowns.

As a depository of ERCs for possible sale, the Bay Area's formal bank could play an important role in reducing transaction costs of future external offsets. Before these ERCs can be approved, applications for these credits must be scrutinized in the NSR review process. Thus, this rigorous certification process could prevent the type of debacle which jeopardized the Wickland case, where an emissions baseline chosen for computing offsets was successfully challenged. The emission baseline originally chosen by BAAQMD for City of Paris Dry Cleaners could have been expected to fail the formal bank's certification test. Had there been an incentive for City of Paris to create ERCs--an incentive now offered by the formal bank--ERCs could have been available when Wickland began its search.

In the PG&E case, it is also interesting to note what could have happened had there been a formal bank. PG&E's offset candidates, namely the dry cleaners, would have had an incentive to apply for ERCs. For a period of 3 years from time of their deposit in the formal bank, the value of these ERCs would have been insulated from changing regulation. The risk of offset forfeiture which beset this case would have been much smaller.

With these points in mind, a detailed account of recent banking activity in the Bay Area is presented in appendix III.

FROM AN OFFSET AND BANKING PROGRAM TO A MARKET

In this section, we explore in more detail some issues raised in our earlier analysis of external offsets and banking which bear directly on the feasibility of a market in the Bay Area.

Supply side of a hypothetical market in the Bay Area

As we have seen, a sizable number of firms in the Bay Area apparently prefer to hoard their entitlements. However, this preference depends on a number of important qualifying factors. First, we found no evidence that prospective buyers offered a price for air pollution entitlements which accounted for more than the suppliers' direct costs of pollution abatement. In

light of the considerable uncertainty facing traders in an embryonic market and the imprecision of air pollution control plaguing most air quality management plans, it is plausible to expect many prospective sellers to insist upon a risk premium before relinquishing their hold on air pollution entitlements. This need for a risk premium can explain why PG&E officials encountered prospective suppliers, who had earlier expressed interest in trading air pollution entitlements, subsequently unwilling to sell them at a price covering the direct costs of pollution control.

Of 207 major sources contacted by PG&E, 97 of these (47 percent) were willing to be considered as potential offset suppliers. However, these initial expressions of interest were not tied to any specific prices offered by PG&E.

In the Wickland offset case, we found similar evidence that some firms preferred to hoard their air pollution entitlements rather than sell them. As with PG&E, we have no evidence to suggest that Wickland offered a price greater than the direct costs of curtailing air pollution.

As mentioned earlier, Wickland's consultant could not find enough HC offsets for sale in Contra Costa County near the project site. Of 136 dry cleaners contacted in that county, 130 were already using perchloroethylene solvent. However, we discovered that these firms could have supplied offsets. A carbon absorption system can be installed to further control emissions from these sources. And, in 1978, one study of the availability of offsets in the Bay Area indicated that 15,000 lbs. per day of such offsets could have been supplied at a capital cost of $3 million. By way of comparison, Wickland's project is expected to emit about 400 lbs. per day of HC. In the South Coast Air Quality Management District, such an HC offset, involving a dry cleaner using perchloroethylene, was approved for use in the Pacific Coast Cement case (see chapter 6). 1/

Unfortunately, it is not possible to estimate the true supply of air pollution entitlements in the Bay Area. However, we do have pollution control cost data for those firms which were interested in PG&E's inquiries about supplying offsets. We assume that these firms have lower risk premiums than those companies expressing no interest in selling air pollution entitlements. The following statistics summarize these pollution control costs and associated offsets:

- 5,985 lbs. per day of PM at an undiscounted capital cost of $15 million, for an average cost of $2,506 per lb. per day.

1/See also, "Environmental Regulations and Technology: The Dry Cleaning Industry," Project Summary, U.S. Environmental Protection Agency, October 1981.

- 64,330 lbs. per day of HC at an undiscounted capital cost of $26 million, for an average cost of $404 per lb. per day.

- 7,860 lbs. per day of NO_2 at an undiscounted capital cost of $2.08 million, for an average cost of $265 per lb. per day.

- 27,640 lbs. per day of SO_2 at an undiscounted capital cost of $6,550,400 for an average cost of $237 per lb. per day.

- 15,600 lbs. per day of CO at an undiscounted capital cost of $200,000, for an average cost of $12.82 per lb. per day.

Using these data, we estimated some supply relationships for HC and PM without risk premiums. 1/ The equation tested for PM was:

$$q_s = a_0 + a_1 \log P$$

where q_s = lbs. of PM supplied per day

P = price per lb. per day of PM, in 1978 dollars.

We found the following:

a_0 = -6,120 lbs. per day, with a t statistic = -9.69

a_1 = 1,064 lbs. per day, with a t statistic = 13.12

R^2 = .852.

In the above equation, dq_s/dP, which measures the change in the quantity of air pollution entitlements supplied for any dollar increase (or change) in the price of these entitlements, equals a_1/P. Table 4 indicates the range in estimated values of dq_s/dP for representative values of P. Thus, for prices of about $500 per pound per day of PM, the increase in the quantity of PM entitlements supplied per dollar increase in price is about 2 lbs. 2/ But for prices of about $30,000 per lb. per day, the supply response is

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1/In estimating the following equations, we had to rely on single points of individual firms' supply curves. The relationships estimated resemble market supply equations in the long run.

2/If we assume a 10 percent discount rate and a life to these rights of perpetuity, then the $500 per pound per day price becomes $50 per pound per day in discounted dollars. Furthermore, this price on a per annum basis becomes about $0.14 per pound per year in discounted dollars.

sharply reduced to only .04 lbs. of PM per $1 increase. Thus, estimated supply of PM takes the classic shape, as depicted in figure 3.

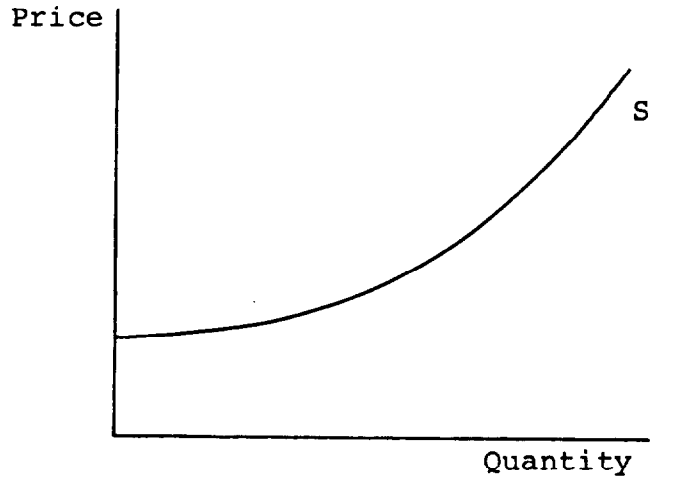
Table 4

Particulate Matter (PM) Supply Response

Price of PM ($ per lb. per day)	Value of dq_s/dP (lbs. of PM supplied per $ change in price)
$ 500	2.1
1,000	1.1
1,500	.7
2,000	.5
3,000	.35
5,000	.2
10,000	.1
30,000	.04

Figure 3

Supply of Particulate Matter (PM)



For HC offsets, results are listed below:

a_0 = -11,083 lbs. per day, with a t statistic = 2.35

a_1 = 4,698 lbs. per day, with a t statistic = 6.80

R^2 = .698

The equation estimated has the form, $q_s = a_0 + a_1 \log P$. Table 5 shows the range in values of dq_s/dP.

Table 5

Hydrocarbon (HC) Supply Response

Price of HC ($ per lb. per day)	Value of dq_s/dP (lbs. of HC supplied per $ change in price)
$ 300	16.0
500	9.4
1,000	4.7
1,500	3.1
2,000	2.3
2,500	1.9
3,000	1.6

Table 6

California Energy Commission Estimates of Offsets in the Bay Area, According to Source
(tons/day)

	PM		SO_2		NO_2		VOC	
County	Major a/	Minor	Major	Minor	Major	Minor	Major	Minor
Alameda	.32	1.3	.36	.42	.65	.40	2.3	3.3
Contra Costa	3.5	3.4	51.5	2.9	36.5	7.2	1.8	.95
Marin	0	0.06	0	0	0	0	0	0
Napa	0	0.09	0	0	0	0	0	0.01
San Francisco	0	.55	2.2	.36	6.1	.5	0	.07
San Mateo	0	.11	0	0	0	0	.45	.37
Santa Clara	.25	.44	1.3	.03	0	.01	2.2	1.2
Solano	.11	.14	10.6	.03	2.6	.45	0	.10
Sonoma	0	0	0	0	0	0	0	0
TOTAL	4.18	6.09	65.96	3.74	45.85	8.56	6.75	6.00

a/Major = Stationary source of 100 tons or more per year.

Source: Statewide Emission Trade-off Inventory, draft, California Energy Commission, November 1980.

More recent estimates on future offset availability were obtained from the California Energy Commission (see table 6). Although these data are not price-specific, they are valuable in another way because they estimate emission reductions available after accounting for the adoption of all recent and future regulations needed to bring the Bay Area into compliance with the NAAQS These reductions result from the application of retrofit control technology on existing stationary sources. Because new regulations will be phased in gradually, the California Energy Commissi estimates in table 6 describe offset availability in the 1990 time frame.

Market power in the Bay Area

Earlier in this chapter, we reported that there had been some concern voiced about the ability of a group of firms to dominate a market in air pollution entitlements and to control the tempo of economic growth in the Bay Area. In chapter 3, we noted that the presence of market power can reduce the cost savings and gains in allocative efficiency which flow from a market in air pollution entitlements.

Using the 1979 emission inventory figures for BAAQMD, we computed the percentage share of emissions accruing to the "top ten" major stationary sources in the Bay Area, on a pollutant-specific basis. We calculated this percentage share for three scenarios (see table 7). In scenario 1, we include only emissions of major sources in the Bay Area and report what percentage of these emissions are due to the "top ten." In scenario 2, we include the emissions of all sources under BAAQMD jurisdiction, which include major and minor stationary sources. Finally, in scenario 3, we account for the emissions of all sources in the Bay Area. In this scenario, mobile sources, such as motor vehicles, are counted. Table 7 shows that, when all sources are accounted for, the "top ten" stationary sources contribute only 3.9 percent of total PM emissions, 9.2 percent of HC emissions, 20.9 percent of NO_2 emissions, and 1.3 percent of CO emissions. Only for SO_2 do the "top ten" control a sizable percentage of all emissions, at 72.4 percent. As a corollary, what table 7 reveals is the considerable contributions by small stationary sources and mobile sources to air pollution in the Bay Area. With the possible exception of SO_2, the potential influence of the "top ten" stationary sources on prices and quantities of air pollution entitlements traded in a Bay Area market appears negligible, based on these data. The fact that the "top ten" SO_2 stationary sources belong to three different industries and in some instances have a vested interest in more growth--and, hence, more business--in the Bay Area makes it less probable that they would exercise much market power.

Table 7

Percentage Distribution of Emissions
By Major Stationary Sources

Top 10 Major Stationary Sources	PM	SO_2	VOC(HC)	NO_2	CO
Scenario 1	64.6	92.7	70.6	77.3	90.9
Scenario 2 (All District Sources)	8.5	79.1	19.8	43.3	17.5
Scenario 3 (All Sources)	3.9	72.4	9.2	20.9	1.3
All Major Stationary Sources					
Scenario 2 (All District Sources)	13.1	85.2	29.5	56.0	19.1
Scenario 3 (All Sources)	5.8	78.2	13.2	26.9	1.4

Using mobile sources in supplying pollution entitlements

Table 8 breaks down 1979 emissions in the Bay Area by type of source. Motor vehicles accounted for almost 50 percent of HC emissions, 50 percent of NO_2, and nearly 91 percent of CO. When all mobile sources are counted, the tally is almost 61 percent of NO_2 emissions and nearly 94 percent of CO.

Given these statistics, the contribution of mobile sources to the supply side of any market in pollution entitlements is likely to be sizable. As these emissions vary, mobile sources could add a great deal of uncertainty to the future supply of air pollution entitlements.

One way to gain better control over mobile sources and reduce uncertainty (about the adequacy of SIPs) is to encourage their use as external offsets. For example, one firm might pay another firm, as a seller, to provide mandatory inspection and maintenance for its employees' motor vehicles and for the company fleet.

Demand side of a hypothetical market in the Bay Area

We can expect the demand for external offsets to be larger as the costs of controlling air pollution vary among firms in the Bay Area. So, an important question is whether or not these treatment costs differ. Table 9 illustrates a wide variance in the capital costs of HC control for 45 companies in the Bay Area. The mean undiscounted capital cost of curtailing HC emissions among the 45 companies sampled is $910 per lb. per day, with a

Table 8

Percentage Distribution of 1979 Emissions By Type of Source in the Bay Area (tons/day)

	Part	Org	NO_2	SO_2	CO
Petroleum Refining	1.0	7.1	7.2	22.1	.1
Refining processes					
Other processes					
Combustion for heat					
Storage & blending					
Loading					
Upsets, breakdowns, flaring					
Chemical Manufacturing	.3	.2	.1	24.0	.8
Sulfur					
Sulfuric acid					
Other chemicals					
Other Industrial/Commercial	38.0	2.7	.5	4.7	.2
Metallurgical					
Mineral					
Construction & demolition					
Other processes					
Fuels Distribution	0.0	1.9	0.0	--	--
Bulk loading					
Filling stations					
Organic Compounds Evaporation	0.0	28.0	0.0	--	--
Storage tanks					
Coating operations					
Degreasers					
Dry cleaners					
Rubber, plastic product mfg.					
Other organics evaporation					
Combustion of Fuels	3.4	3.4	31.0	29.6	4.6
Domestic					
Commercial & institutional					
Utilities--power plants					
Reciprocating engines					
Other combustion					
Burning of Waste Materials	.3	.1	.1	.2	.1
Incineration					
burning					
Off-Highway Mobile Sources	1.1	1.3	9.2	11.1	1.5
Farm tractors					
Construction equipment					
Ships					
Locomotives					
Aircraft	1.1	1.4	1.2	.5	1.6
Air carriers					
General aviation					
Military					
Motor Vehicles	12.1	47.2	50.8	7.8	90.8
Cars and light duty trucks					
Heavy duty trucks					
Buses					
Motorcycles					
Misc. Emission Sources	42.7	6.7	--	--	.3
Accidental fires					
Paved & unpaved roads					
Ocean/bay salt					
Vegetation					
TOTAL	100.0	100.0	100.0	100.0	100.0

standard deviation of $743 per lb. per day. The highest capital cost recorded among any of these companies was $3,300 per lb. per day and the lowest, $80 per lb. per day. These are the costs of retrofitting existing stationary sources to make offsets available. Table 10 provides similar information for PM. The mean undiscounted capital cost of curtailing PM emissions among the 49 companies sampled is $3,761 per lb. per day, with a standard deviation of $4,766 per lb. per day. The highest capital cost recorded among any of these companies was $32,000 per lb. per day and the lowest, $400 per lb. per day.

Table 9

Capital Costs of Hydrocarbon (HC) Control

1978 Capital Costs of Controlling HC (dollars per lb. per day)	Percentage of Companies with This Cost
$80	4
$300-$450	33
$600-$890	27
$1,000-$2,100	29
$2,500-$3,300	7

Table 10

Capital Costs of Particulate Matter (PM) Control

1978 Capital Costs of Controlling PM (dollars per lb. per day)	Percentage of Companies with This Cost
$400-$900	18
$1,000-$1,800	29
$2,000-$3,800	23
$4,000-$6,700	20
$8,000-$10,000	8
$10,000+	2

Using the HC cost data, a 25 percent uniform rollback of emissions would have been 41 percent more expensive than a least cost solution. Such a rollback might characterize a command and control strategy for accommodating economic growth. The cost data on PM suggest that a much larger cost savings would have been potentially forthcoming. For example, a 25 percent uniform rollback of PM emissions was about 180 percent more expensive than a least cost solution.

Another factor affecting the demand for external offsets is District regulation which limits their scope. External offsets cannot be used as a substitute either in part or in total for BACT. Although there is no tradeoff requirement for new sources emitting less than the offset emission trigger points, the sizable cost savings reported previously could make it attractive for these sources to substitute emission reductions from other companies for their own. However, there are no BAAQMD guidelines or regulations which specifically address this possibility. Similarly, there are no specific procedures spelled out which would facilitate the swapping of air pollution entitlements between existing sources. Such multi-firm bubbles could prove attractive even in times of no growth, because they would allow firms to collectively reduce their costs of complying with the Clean Air Act.

AN ENFORCEABLE MARKET

In chapter 4, we addressed the issue of enforceability in a market for air pollution entitlements. We saw that a fundamental issue in the enforceability of external offsets and a market is the basis for comparison. If the alternative to voluntary exchange of rights is a State-mandated offset or growth margin scheme, the same set of enforcement issues would be binding. Another important consideration is the effectiveness of enforcement under the current command and control system.

With these general points in mind, we now investigate the possibility of combining the economic incentives embodied in a market approach with better enforceability. The following account of an internal offset case in the Bay Area illustrates how this can be accomplished.

Cost savings and better enforceability through the use of economic incentives

In June 1979, Shell Oil Company applied for approval of a major modification to its refinery in Martinez. BAAQMD approved this application in March 1980. Shell was required to obtain external offsets. However, it had internal offsets available and elected to use them instead.

An interesting aspect of this project was Shell's desire to have at its disposal a number of alternative production strategies. This flexibility would allow Shell to adjust to changing prices and availability of various energy inputs. Offsets would allow the modification to be built and the flexibility to tap different energy sources could provide significant cost savings in the operation of its refinery. But the District was concerned about enforcing this flexibility in Shell's proposal.

Negotiations between Shell and BAAQMD on these issues extended from October 1979 to February 1980. These negotiations culminated in an agreement under which Shell would establish an environmental auditing scheme to track the emissions of these various energy use alternatives. As part of this auditing scheme, Shell may computerize its audit, so that emissions can be automatically reported to BAAQMD on a daily basis.

A number of permit conditions were stipulated by BAAQMD which combine flexibility with enforceability. One condition limited maximum daily fuel usage, measured as Btus of heat input. Within this constraint, Shell can use different combinations of energy inputs. For purposes of enforcement, Shell must report daily usage of each type of fuel used to BAAQMD. Another permit condition allows Shell to interchange fuel oils of varying sulfur content, within an overall Btu constraint. To satisfy enforcement, Shell must install a continuous emission monitor for SO_2 in one of its boiler stacks.

Flexibility to change the production process also extended to marine operations at Shell's wharf. These operations, which range from gasoline loading to the lightering of crude oil, are limited by a permit condition governing the maximum hydrocarbon emission content of material handled. For instance, more gasoline can be loaded and less crude oil lightered within this overall emission limit. A similar restriction--a cap on hydrocarbon emissions--governs the number of and size of tankers visiting the Shell wharf. Any combination of different sized tankers is allowed within this constraint.

All or any of Shell's permit conditions may be replaced with a system for continuously auditing and reporting emission rates as a running annual average. These data can apply to ship movements, wharf activities, and fuel use. A Shell official told us that the company's intention is to incorporate as much emission data as possible in a computerized audit scheme, providing the District with daily access to these data.

According to BAAQMD's Chief of New Source Review, who oversaw the processing of Shell's permit, the permit conditions set forth and the emissions data to be generated by Shell's environmental auditing scheme are much better than any information and checks which the District previously required of Shell.

Other enforcement issues

As in the Shell internal offset case, BAAQMD attached numerous conditions to Wickland Oil Company's permit to ensure enforcement. The basic constraints which BAAQMD felt were necessary to render Wickland's permit enforceable are listed in appendix IV. Keeping tabs on this information, as in the Shell case, will not be a small task. But this kind of record keeping is essential for any air quality management scheme which intends to comply with the Clean Air Act and accommodate economic growth. Given the magnitude of cost savings that could result from such a scheme, the wherewithal to fund any incremental enforcement expenditures is present. Importantly, such enforceability can dovetail with enforcement of private property rights to pollution in a market. Firms would have a vested interest in protecting the value of these valuable assets, which they owned, from "interlopers" who would violate the Clean Air Act.

CONCLUSIONS

The basic elements for developing a market in air pollution entitlements are present in the Bay Area. The formal bank offers opportunities to significantly reduce transaction costs of future trading. Cost data indicate large potential savings from such trading and provide an incentive to trade.

As an alternative to command and control, a market for air pollution entitlements should safeguard air quality. The Bay Area is well suited to ensure this. One reason has been the active involvement of an environmentalist group in overseeing offset and banking transactions in the Bay Area. Another is the precedent set in an internal offset case in the Bay Area where greater flexibility to achieve cost savings was tied to a regulatory requirement for better information on the emissions inventory of the applicant. This combination of cost savings and environmental auditing could bring better air quality through a market.

Environmentalists have lobbied for an alternative to the current bank, viz., a community bank. A principal reason for this proposal is their belief that new firms will have difficulty locating external offsets. This belief is grounded in their observation that a sizable number of firms prefer to hoard air pollution entitlements. Hoarding can be explained as a reaction to the considerable uncertainty about the future supply of air pollution entitlements and to the novelty of trading in these entitlements. As it becomes clearer what changes in the SIP are needed to meet the NAAQS, this uncertainty should be reduced. It should also become apparent to some firms that hoarding air pollution entitlements may be a counterproductive strategy. If new regulations are imposed, hoarding now may maximize the loss of entitlements through future regulation.

In our investigation, we found that a supply of external offsets was available at the prices bid by Wickland and PG&E. These prices apparently just covered the direct costs of pollution control. An important caveat explaining some of this availability was the threat of imminent regulation on the offset suppliers. A number of other firms indicated an interest in selling offsets, but it is evident that some of these companies wanted a price for their offsets which was greater than the bid price.

Although external offset experience to date in the Bay Area has been cited as discouraging future trades, the major difficulties encountered by Wickland and PG&E in the permit process do not appear to be insurmountable. The problems of emission offset baselines, BACT determinations, and offset eligibility can be corrected. The search for offsets, although not easy, could be facilitated by the advent of the formal bank in the Bay Area.

CHAPTER 6

CONTROLLED TRADING IN LOS ANGELES

In this chapter, we focus on external offsets and emission reduction banking in the Los Angeles metropolitan area. The South Coast Air Quality Management District (referred to as SCAQMD), has primary responsibility for controlling air pollution in that area (see figure 4), except for pollution caused by motor vehicles. As with the Bay Area Air Quality Management District in San Francisco, CARB has general oversight responsibilities over SCAQMD.

THE OFFSET AND BANKING PROGRAM OF THE SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

External and internal offsets and onsite banking have occurred in SCAQMD for several years. Like San Francisco, onsite banking evolved as a result of New Source Review (NSR) regulations requiring firms to calculate cumulative increases in emissions in determining applicability of Best Available Control Technology (BACT). As part of this regulation, firms have been able to accumulate emission reductions not required by laws, rules, or other regulations for use as internal offsets.

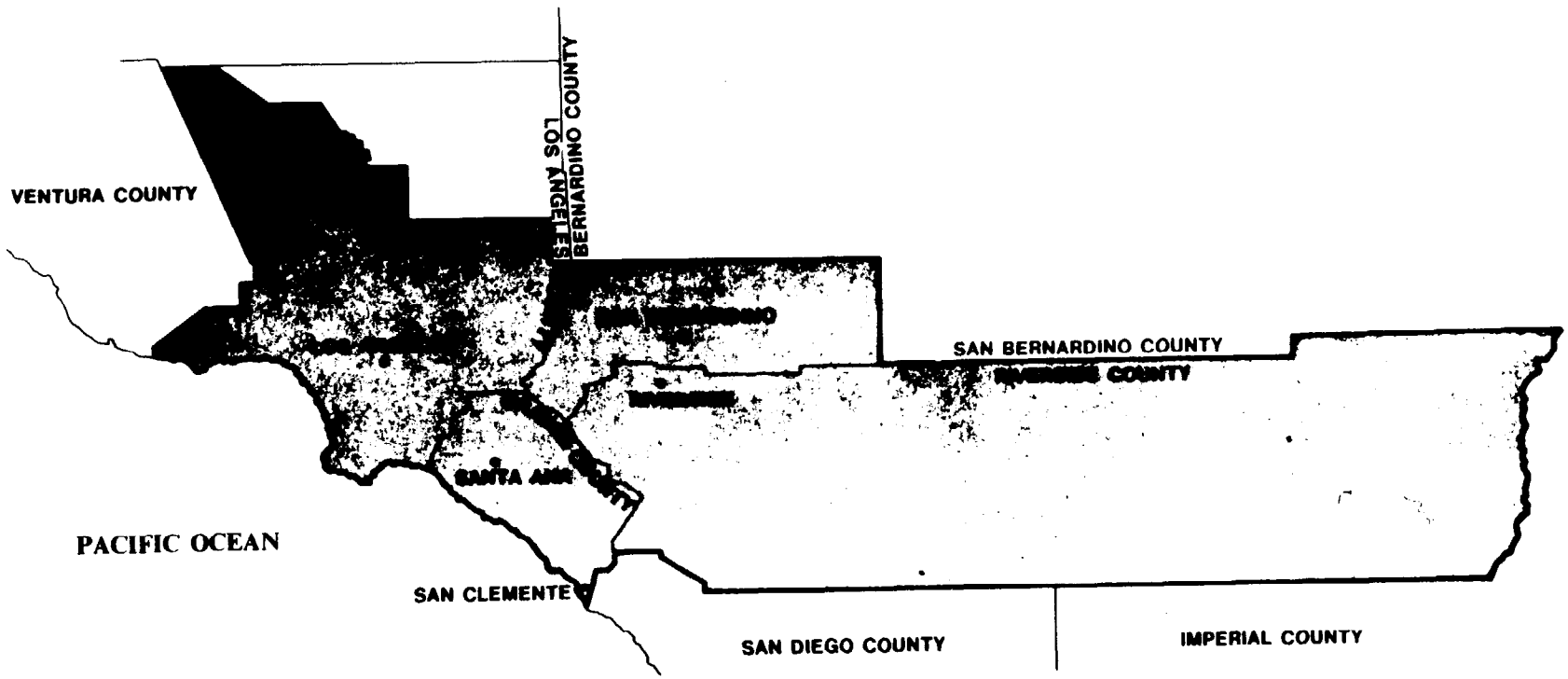
To expedite external offsets, SCAQMD proposed establishing an emissions reduction bank in June 1980. One of the provisions of this proposal would allow ERCs presently in the "informal" bank to be transferred to this new institution. Other important features of this proposal include the following:

- banking is voluntary and ERC use is governed by "any discount factor or offset ratio in effect at the time of surrender of the certificate."
- emission reductions scheduled by a tactic in SCAQMD's Air Quality Management Plan are ineligible for banking unless the tactic is not adopted as a regulation by January 31, 1982, or unless the proposed emission reduction exceeds the tactic's reduction.
- a minimum deposit of 150 lbs./day is required "to open an account."
- there is a registration of title to ERCs and issuance of ERC certificates. 1/

1/SCAQMD, Proposed Rule 1309--Emission Banking, July 8, 1980, pp. 32-37.

Figure 4

South Coast Air Quality Management District



Like the Bay Area's bank, this proposal does not provide for an easily accessible detailed listing of spatial characteristics of ERCs. On the other hand, the need for such information may not be compelling, since SCAQMD's current use of an offset equation provides explicit technical trading terms for exchanges of rights involving distances of 15 miles or less between traders.

A new source expecting to emit 150 lbs. or more per day (250 lbs. per day in San Francisco) of any of the NAAQS pollutants--except CO, with a 750 lbs. per day limit--is required to get offsets. Since October 1979, SCAQMD has provided specific guidance in its NSR regulation (Regulation XIII) regarding acceptable offset ratios. The following equation has been specified:

value of offset ratio = 1.2 + b(x)

where x = distance in kilometers between the new source and offsetting sources(s);

b = 0 for values of x less than 8 km; and

b = 0.01 for values for x greater than or equal to 8 km (5 miles).

To some extent this equation can be used as a substitute for air quality modeling in determining the location and size of acceptable offsets. Normally, for project approval, the applicant must "substantiate with modeling or other analyses that the new source or modification will not cause a violation or make measurably worse an existing violation of any national ambient air quality standards at the point of maximum ground level impact." But modeling is not required "if all offset sources are within a distance of 8 kilometers (5 miles) from the affected permit units." 1/ On the other hand, SCAQMD will disallow an offset which is more than 24 km (15 miles) in the prevailing downwind direction from the affected source unless the applicant "demonstrates, through modeling...that the offsets will result in a net air quality benefit in the area impacted by the affected source." 2/

In meeting the offset requirement, emission reductions arranged at the offsetting sites must outweigh emissions from the new project. For a new source, with no permit conditions limiting its operating rates, SCAQMD's NSR regulation requires that emissions be estimated from its maximum rated capacity, maximum proposed hours of operation, and actual material processed. This provides a worst-case emissions rate for the new project.

1/South Coast Air Quality Management District, Regulation XIII, New Source Review, Rule 1303 (h)(5), March 7, 1980, p. 4.

2/Ibid., Rule 1308(b)(3), p. 11.

Emission reductions from an offsetting source are measured as the difference between its emissions before and after "modification." If there are no operating limits on this offsetting source, emissions before "modification" are to be computed from the sum of its actual annual emissions during the highest 3 years of the last 5, divided by three. Emissions after "modification" are calculated as worst-case, as described above.

Another important aspect of the NSR regulation for SCAQMD is its allowance for interpollutant offsets. For purposes of offsetting PM emissions, SCAQMD accepts reduction in HC, SO_2, and NO_2 emissions as long as the permit applicant shows that PM offsets were not available. The rationale for such offsets is that HC, SO_2, and NO_2 are precursors contributing to PM concentrations in the air.

An earlier NSR regulation for SCAQMD (Rule 213) was much less specific regarding offsets. For permit applications submitted before July 1, 1979, no specific mention of required offset ratios was made. In response to our inquiry, SCAQMD officials stated that either a 1.2:1 offset ratio, using maximum worst-day emissions of the new source, or a 2:1 offset ratio, based on the annual average emissions of the new source, whichever was greater, reflected their policy during this earlier period.

Another important aspect of SCAQMD's offset program is its "emission tradeoff list." In 1978, SCAQMD began offering prospective new sources a list of existing stationary sources which had expressed an interest in selling pollution entitlements in external offset transactions. As of July 1980, approximately 12 percent of these companies had indicated that they would like to be included on the list so that a company seeking offsets will know of their interest. In table 11, the emissions of these prospective suppliers are listed.

Table 11

Emissions of Prospective Suppliers in the South Coast Air Quality Management District

Pollutant	Tons per year	Lbs. per day
Volatile organic compounds (HC)	11,113.1	60,893.7
NO_2	3,585.0	19,643.8
SO_2	1,936.2	10,609.3
CO	339.4	1,859.7
PM	439.2	2,406.6

Table 12 lists the California Energy Commission's tradeoff estimates for SCAQMD, after accounting for current and future regulations needed to meet the NAAQS. These estimates reflect emission reductions available after applying "optimal" retrofit technology.

Table 12

California Energy Commission Estimates of Offsets in the South Coast Air Quality Management District, According to Source
(tons/day)

County	PM		SO_2		NO_2		VOC	
	Major a/	Minor	Major	Minor	Major	Minor	Major	Minor
Ventura	1.8	0.28	16.8	0.09	0.0	0.37	0.0	0.12
Los Angeles	8.6	8.5	48.3	2.6	24.8	12.1	11.8	17.8
Orange	1.1	1.1	3.6	0.3	0.0	1.3	3.6	6.0
Riverside	0.0	0.4	0.0	0.01	0.0	0.07	0.0	0.9
San Bernardino	1.9	3.1	6.7	0.8	5.0	2.4	1.4	2.7
Total	13.4	13.38	75.4	3.8	29.8	16.24	16.8	27.52

a/Major = Stationary source of 100 tons or more per year.

Source: Statewide Emission Trade-off Inventory, draft, California Energy Commission, November 1980.

ATTITUDES OF THE REGULATOR AND BUSINESSES

We interviewed a number of SCAQMD officials regarding their views on banking. Their attitudes toward this institution are as follows:

- "Banking in our area is probably not a useful strategy, because of our nonattainment status. We have serious reservations that any nonattainment area can profitably use emissions reduction banking."
- "In the South coast, if emission reductions are the result of a new control technique, then SCAQMD is required to adopt these controls on everyone, including the depositor.'
- "Our problem with regulatory reform efforts of EPA are:
    - we need every tactic we can get;

- these reforms are fine for areas that do not have the same problems as we do; and

- no one in this area is going to give up rights for external use. They do not want to mortgage their future." 1/

Industry representatives had the following opinions of banking as it has been proposed in Los Angeles:

- The baseline used in regulation, namely, maximum allowable emissions, should also be used in determining emission reductions. Currently, historical average emissions are used for the banking baseline.

- "Unless the whole system can be simplified, banking is not going to work."

- "For emission reductions to be valuable, we must have no more NSR changes. What are they [ERCs] worth? We should be able to know the offset ratios."

- Specific disincentives to use the bank are the hearing and NSR permit processes. 2/

These attitudes can be understood in light of the severe air pollution problems in Los Angeles. Regulators apparently are anxious that an emissions reduction bank not insulate depositors from further regulations if such measures are needed to meet the NAAQS. Industry, on the other hand, is concerned about adequate economic incentives. If the worth of an ERC at time of withdrawal ends up being only a small fraction of its face value (at time of deposit), they wonder who will participate.

OFFSET CASES

In chapter 4, we identified two types of transaction costs expected in arranging external offsets: permit costs to ensure compliance and search costs to strike the best trade. We also indicated that two basic elements for good air quality management are access to accurate data on emissions and their effect on outdoor air quality. Accordingly, obtaining this information could be a major cause of sizable transaction costs in the permit process. In addition, we showed the connection between access to the above data and possible search costs. In chapter 5, we discovered that determining BACT, estimating emission reductions at

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1/GAO interview, September 22, 1980, with SCAQMD officials.

2/GAO interview, September 22, 1980, with Western Oil and Gas Association members.

an offsetting source, search costs, and the encroachment of command and control on the potential supply of offsets hindered negotiations for external offsets in the Bay Area. Furthermore, although our review of offsets in San Francisco suggested that ownership of pollution entitlements was being "grandfathered," or vested in existing firms, this ownership is by no means permanent. Pollution entitlements today could be "confiscated" tomorrow, if the regulator decided that stricter emission limits were needed to meet the NAAQS. With these and other implementation issues in mind, we now examine external offset negotiations in Los Angeles.

Port of Long Beach--
Pacific Coast Cement Company

On January 5, 1979, the Port of Long Beach submitted an application to SCAQMD for permits to construct and operate a cement terminal. The lessee of this terminal was the Pacific Coast Cement Company. Emissions of SO_2, NO_2, PM, and HC were expected from this project. In the initial review, daily NO_2 emissions of more than 150 lbs. triggered the NSR offset requirement. During this review, hydrocarbons, sulfur compounds, and particulate matter eventually were also projected at emission rates greater than 150 lbs./day.

Problems

According to a Port representative, finding an acceptable offset package was the most time-consuming phase of Pacific Coast Cement's permit process. The Port undertook the search for offsets within a few months of the application date. The following two criteria were used in screening offset candidates: (1) Will the candidate's emissions cover Pacific Coast Cement's needs; and (2) Is the candidate located in the vicinity of the Port? In answering the first question, the Port assumed worst-day emissions for Pacific Coast Cement and an offset ratio equal to 1.2:1 in computing needed offsets. Generally, only those candidates with emissions greater than this amount were considered. However, those firms with emissions much greater than desired for offsets were excluded. A Port representative indicated that this exclusion was due in part to the absence of the proposed emissions reduction bank at the time of the search. In answering the second question, the Port primarily considered those companies in Long Beach. The Port made use of SCAQMD's emission tradeoff list in this screening process.

Once offset candidates had been screened, the Port then approached prospects, offering to pay a price covering all pollution abatement costs, including maintenance and capital costs and the expense of getting through the permit process, necessary to bring about offsets. By June, the Port had identified promising offset sources of NO_2 and HC, owned by Long Beach Oil Development, Inc. (Long Beach Oil). By installing catalytic converters on engines of water-injection plants of Long Beach Oil, NO_2 and HC emissions could be reduced. These offsets were in the Port's "own backyard"

and were readily available because Long Beach Oil anticipated future regulations requiring them to retrofit these engines. 1/ Additional HC offsets were located at a Long Beach dry cleaner, which could be accomplished by installing an activated charcoal absorber. Like Long Beach Oil, this dry cleaner was willing to supply offsets because it might have to put on this additional control in any event, due to future regulations.

The Port had much greater difficulty finding PM and SO_2 offsets. To satisfy PM offset requirements, SCAQMD sanctioned the Port's use of an interpollutant tradeoff, substituting NO_2 reductions at Long Beach Oil for PM reductions. By September 6, 1979, the Port found an SO_2 tradeoff at a U.S. Steel plant in Torrance, California, less than 10 miles away. Pacific Coast Cement agreed to underwrite the purchase of low-sulfur (less polluting) fuel for U.S. Steel's plant. However, U.S. Steel subsequently closed this plant and it donated enough of the resulting emission reductions to meet the SO_2 offset needs.

In searching for these offsets, the Port encountered two prevalent responses: either a firm did not want to get involved with the regulator ("a low profile is a less risky way to deal with the regulator") or the company preferred to hoard its pollution entitlements for its own use. 2/ As with NO_2 and HC, the Port was offering to pay all pollution abatement costs.

In appendix V we list documented responses of 43 companies to the Port's offer to pay for SO_2 and PM offsets. About one third of these firms were unwilling to sell their offsets at the offered price, i.e., they chose to hoard their entitlements. Typical of these firms' responses was Proctor and Gamble's reply that it was not in a position to give away its emissions and then be "caught flat"; it needed to keep its "options available." 3/ From the data in appendix V, there is also considerable evidence that many prospective suppliers were "high-priced" because of the stringent controls already in place.

Negotiations between Pacific Coast Cement, Long Beach Oil, U.S. Steel, and the Long Beach dry cleaner were completed by November 1979. An offset ratio of about 2:1 was arranged for SO_2 and HC. With the interpollutant tradeoff between PM and NO_2, the offset ratio was about 4:1 for NO_2. Table 13 summarizes these offset requirements. We found no evidence to suggest that air quality modeling was instrumental in setting these offset ratios or in determining offset locations.

1/Port of Long Beach memo, May 25, 1979, p. 1.

2/GAO interview, September 23, 1980, with Port of Long Beach.

3/Port of Long Beach memo, May 29, 1979, p. 1.

Table 13

Emission Offset Requirements
for Pacific Coast Cement Company

Contaminant	Max. Allowed Emissions lbs./mo.	Max. Allowed Emissions lbs./year	Required Offsets lbs./day	Required Offsets lbs./30.5-day month
SO_2	700	6,000	50	1,525
NO_2	6,000	51,200	800	24,400
PM	1,440	11,400	--	--
HC	600	5,200	40	1,220

The only other problem identified in the Pacific Coast Cement case was whether emissions from ships using the terminal should be included as part of the project's emissions inventory. This matter was settled quickly by deciding that these emissions were part of the project, but the review became quite involved regarding the project emission rates, as well as the ship area which would be included in determining the emission inventory. No particular problems arose in determining BACT and in estimating emissions from the terminal, or in estimating emission reductions from the offsetting sources.

On January 31, 1980, SCAQMD issued a permit to construct the Pacific Coast Cement terminal. Two conditions were required: that pollution control equipment installed at Long Beach Oil and the Long Beach dry cleaner provide 90 percent abatement efficiency, and that U.S. Steel receive and use a specified amount of low-sulfur fuel. Appendix VI contains the full text of these conditions.

The Pacific Coast Cement offset negotiation worked, despite a lengthy search for offset sources. Clearly, finding offsets dwarfed efforts for other phases of the permit process. A Port official estimates that for a project costing $16 million, $50,000 was spent in direct outlays to negotiate the air quality permit and to search for offset candidates. Another $70,000 was spent for an environmental impact report. This official stressed that the offset negotiations were very time consuming, and that offsets, in his judgment, would not be available much longer because "regulators will have to cover all their bets." 1/

1/GAO interview, September 23, 1980, with Port of Long Beach.

Port of Los Angeles harbor dredging project

In 1979, the Port of Los Angeles and the Army Corps of Engineers proposed to dredge the Port's navigation channel to 45 feet and expected to take about 2-1/2 years to complete this project. The principal source of emissions would be diesel-powered dredges. SCAQMD estimated that this project would emit 5,000 lbs. of NO_x per day, and more than 150 lbs. per day of PM, SO_2, HC, and CO.

Problems

A major point of contention between SCAQMD and the Port--and a principal cause of delay and sizable transaction costs--was SCAQMD's unprecedented decision in December 1979 to treat this project as a stationary source of emissions. Given the project's expected emissions, this meant that it would be subject to New Source Review (NSR). Surprised by this judgment, the Port sought an exemption from NSR, going so far as to get special legislation introduced in Sacramento which would have exempted this project from NSR. But, after several months of political wrangling, these efforts failed. During this dispute, SCAQMD initially favored using low-polluting electric-powered dredges, claiming that such an alternative would not require any air pollution permits. However, the Port feared that electric dredging might lead to non-competitive bidding for its project, claiming that few dredging companies were equipped with this kind of dredge. As a second choice, SCAQMD initially urged the Port to investigate the feasibility of using selective catalytic reduction on diesel dredges, suggesting that this control might qualify as innovative technology which could exempt the Port from having to get NO_x offsets.

There was, however, a great deal of uncertainty about the effectiveness and costs of these control strategies. For instance, following on the heels of SCAQMD's initial recommendations, their chief engineer concluded instead that offsets would be more cost-effective than electric dredging. And, a SCAQMD consultant concluded that offets were more cost-effective than selective catalytic reduction of diesel emissions. Amidst this uncertainty and conflicting assessments by SCAQMD personnel, and still resisting the electric dredging option, the Port finally agreed to participate in offset transactions, after more than 15 meetings with SCAQMD.

Playing the same role as the Port of Long Beach had in the Pacific Coast Cement case, SCAQMD spent considerable time and resources searching for offsets. By May 1980, it had identified over 15,000 lbs. per day of potential NO_x offsets. But it was very uncertain about the accuracy of this information. Witness SCAQMD's acknowledgement that "potential use of equipment owned by [one offset candidate]" must await "extensive studies and

design considerations before offset control could be implemented." 1/ At this point in the search, there was evidence that one offset candidate might be willing to sell or lease entitlement at a price just covering pollution control costs, because it expected imminent new regulation.

As the search for offsets proceeded, a number of preferred candidates emerged. On May 20th, the press announced that the Cit of Los Angeles' Department of Water and Power was installing pollution controls on one of its power plants 3 years before it was required and that the entitlements so created might be used to offset the dredging operation's emissions. "...the power company [could] 'bank' pollution reduction credits that could be used when the air quality district demanded future tradeoffs. Instead, the Harbor Department proposes to buy those pollution credits to offset the pollution from its dredging." 2/ The District acknowledged this possibility shortly afterwards:

> While no agreements have been signed, it appears probable that the City of Los Angeles...will have available tradeoffs exceeding 2,600 pounds per day of NO_x by November 1, 1980. This is due to the fact that the Department of Water and Power is ahead of schedule on construction of NO_x control devices...This quantity of NO_x provides approximately half of the emission tradeoffs required. 3/

Offsets from two other plants, shut down by U.S. Steel and Goodyear Tire companies, were also mentioned as leading candidates. At about this time it was also revealed that the Port was willing to pay up to $2 million for needed offsets.

Despite the effort and financial resources committed to an offset strategy, this control option collapsed shortly afterwards over a dispute between SCAQMD and the Port regarding how much offset credit the Port would receive from the Department of Water and Power's facility. This power plant had not been used very much in the past, but once new pollution controls were installed the City planned to use it more. It was this greater future use of the plant which lies at the heart of the controversy. The Port expected to receive offset credit equal to the reduction of a large amount of emissions which would result from extra controls on this plant as it operated at a high utilization rate. SCAQMD had initially concurred. But later, it reversed its position,

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1/Port of Los Angeles memo, May 13, 1980, p. 3.

2/"Tests Show Dredging Pollution Less Than Estimated," J. Davies, News Pilot, May 20, 1980, p. A2.

3/SCAQMD letter to District Board, May 28, 1980, p. 1.

ruling that offset credit must be the difference between the actual historical emissions rate for the plant as it was operating now and future controlled emissions resulting from its greater utilization later. The result was that very little, if any, offset credit would be available from this plant.

A major cause of delay in the Port of Los Angeles dredging project stemmed from the unprecedented application of NSR to this project and the resulting attempts by the Port to obtain an exemption from these rules. An equally important cause of transaction costs was the difficulty encountered by SCAQMD in determining appropriate control techniques and in estimating emissions and costs of various control options. This complicated the search for offsets in two ways. First, uncertainty about project emissions meant uncertainty about the quantity of necessary offsets. Secondly, it was unclear which option was the most cost-effective. This was particularly critical for judging the efficacy of offsets because it was unclear how long it would take to arrange them. But, perhaps the more troubling aspect of this offset case lies in SCAQMD's and the Port's misunderstanding of available offset credit at the Department of Water and Power's tradeoff site. SCAQMD had gone so far as to publicly acknowledge that the Port might be able to acquire a tradeoff from this site exceeding 2,600 lbs. of NO_x per day, when in fact SCAQMD's own rules indicated that little, if any, credit would be available from that site.

Finally, as in the Pacific Coast Cement case, there is no evidence that air quality modeling was used to calculate needed offset ratio values or to determine the location of possible offset candidates. However, before the Department of Water and Power's offset was disallowed, there had been preliminary discussion about an appropriate offset ratio, using the offset equation introduced earlier in this chapter. Given the distance between the dredging site and the power plant, it would appear that modeling would have been required to justify that offset.

Watson Energy Systems, Inc.

In 1974, Watson Energy Systems, Inc., sought to construct a solid waste disposal and steam generation plant in Wilmington, California. This facility would substitute for land-fill methods of disposal and would generate either steam or electricity. The contingent supply of such energy to nearby industries which normally use fossil fuels would result in an incidental external offset. However, as events unfolded, this external offset became a necessary condition for approval of the project.

Watson first submitted permit applications to SCAQMD on December 19, 1974. Over the next 2 years, Watson proposed six modifications to the project. On August 25, 1976, SCAQMD denied Watson's applications. About 4 months later, on January 5, 1977, SCAQMD's hearing board reversed the earlier decision to deny Watson Energy its permit. Shortly after this reversal, CARB

notified SCAQMD that Watson Energy's proposal would have to be reviewed under Rule 213, a recently promulgated New Source Review (NSR), "since the hearing board reversal occurred after the effective date of that rule." 1/ A significant, new requirement of Rule 213 was the need for a formal air quality impact analysis. However, about one year later, CARB reversed itself, exempting Watson from Rule 213. But EPA decided that Watson's project would be subject to its December 1976 offset interpretative ruling.

On March 8, 1978, SCAQMD issued Watson 10 permits to construct. But Watson was apparently still unsure of the best means for controlling its pollution. On April 18, it submitted two new applications, to replace a common exhaust stack and to use a larger baghouse than originally proposed. On May 30, 1979, EPA announced its intent to approve the project, based "on the forthcoming finalization of a steam sales contract between Watson Energy Systems, Inc. and the Atlantic Richfield Company." 2/ And, on September 20, 1979, a contractual agreement between these two companies was finalized. On December 12, 1979, and January 3, 1980, a Watson official requested an extension for its permits, reportedly citing funding problems as a cause of delay in the construction start-up date. On January 17, 1980, the Watson project was approved by EPA.

As late as March 31, 1980, SCAQMD was considering a request by Watson to review new developments in baghouse control technology for Watson's possible use.

Problems

According to SCAQMD's chief engineer, the major hurdle in the Watson case was coming to an agreement about the project's estimated emissions. A major cause for disagreement about these estimates was the unique and innovative character of the project. The resulting delay and transaction costs can be understood in the context of SCAQMD's engineering evaluation process.

Typically, a SCAQMD engineer reviews an application, relying "in part on his experience as an engineer, in part on information obtained from the literature, from calculations, and from observations of similar devices in operation if that is possible." 3/

1/SCAQMD letter to California Air Resources Board, May 20, 1977, p. 1.

2/U.S. EPA letter to Watson Energy Systems, Inc., May 30, 1979, p. 2.

3/"Before the Hearing Board of the Air Pollution Control District of Southern California," in the matter of Watson Energy Systems, Inc., January 5, 1977, p. 4.

But, in this case, the proposal's unique and innovative character meant that there were few projects of this type anywhere with which to compare the proposal and generally little information on which to judge emission estimates. As a result, SCAQMD recommended that Watson build a pilot project from which to obtain reliable emission estimates. Watson declined.

A number of problems ensued. First, SCAQMD denied Watson a permit, based largely on the opinion of one staff member who had "recently toured plants in the eastern part of the United States and Canada, observing incinerators." Watson appealed this decision and SCAQMD's hearing board sided in its favor, after concluding that the resemblance of the eastern plants with Watson's project was questionable. However, in making this ruling, the board stipulated that Watson waive all rights to further experimentation if, once constructed, its project failed to comply with the rules of SCAQMD. This waiver underscored the fact that considerable uncertainty still remained about compliance of the project. Simply put, Watson would not know whether its project was viable until after it was constructed! Thus, there was a strong incentive for Watson to make doubly sure that its proposal was sound. Watson's subsequent requests for permission to use different pollution controls than initially proposed and for information on new developments in control technology can be appreciated in light of the novelty of its project.

As noted earlier, by the time Watson had won the appeal, a new problem arose in the form of new regulations. This resulted in additional requirements for an air quality impact analysis and enforceable--as opposed to incidental--offsets. Given this offset requirement, it was agreed that "[Watson would] obtain a letter from the adjacent refineries agreeing to purchase all steam generated by the Watson facility," and that "the letter was also to state that the refineries will reduce steam production at their facility by the same amount purchased from the Watson Company and that the refineries will not exceed their present maximum steam-generating capacity by purchasing steam from Watson ...." 1/ Such an agreement was reached with Atlantic Richfield in September 1979.

According to the air quality report submitted to EPA, a 1.2 offset ratio for NO_2 was to be used. We found no evidence that air quality modeling was used to determine this ratio or the location of the offsetting site.

As late as March 30, 1980, Watson officials were suggesting possible changes in the project. A district engineer overseeing this project wrote:

1/SCAQMD memo, May 18, 1976, p. 1.

> [SCAQMD] maintains the position that approval or denial of [permits] will depend on source tests.... [S]ince there are so many unknown variables involved in this operation, the only way to determine compliance with the rules is by actual testing. 1/

These latest facts typify the major source of transaction costs and delay in the Watson project, i.e., an inability to tie down project emissions, short of a costly pilot demonstration. Unlike the Pacific Coast Cement and the Port of Los Angeles offset cases, search for offsets was not a major source of transaction costs in the Watson negotiations. 2/

The Watson offset had to be approved through a SIP revision process expressly required by EPA to ensure enforceability. Terms of this SIP revision include overall limits on steam generated by both Atlantic Richfield and Watson Energy to be used at the Atlantic Richfield refinery and constraints on the amount of fuel oil that could be burned at the refinery. Continuous and written records of steam and oil consumption are to be kept for compliance checks. Appendix VI contains the full text of these conditions.

CONCLUSIONS

Los Angeles has probably the most severe air pollution problem and the most stringent air pollution controls of any area in the country. If these facts translate into a limited supply of air pollution entitlements available for external offsets, transaction costs and other implementation problems are likely to be unusually burdensome. Thus, if external offsets can work in Los Angeles, it is probable that their potential is greater in other metropolitan areas.

Quite simply, we believe that Los Angeles' offset and banking experience is properly interpreted as controlled trading "under duress." A greater potential conflict between a market and the current system of command and control is to be expected in Los Angeles. It is also plausible to expect a greater emphasis there on ensuring compliance and enforceability of individual permits. These factors and the uncertainty associated with the effectiveness and costs of unusually stringent, state-of-the-art pollution controls are not likely to make search easy. Because of these considerations, we think it significant that external offsets have been negotiated in Los Angeles.

1/SCAQMD memo, March 31, 1980, p. 5.

2/A recent update on the Watson project indicates continuing problems with New Source Review.

As in San Francisco, some prospective suppliers in Los Angeles preferred to hoard while others were eager to sell entitlements when offered prices just covering their pollution control costs. In part, this dual response seems to be rooted in a common fear of future regulation. Those who hoard rationalize their action as prudent in the face of an ever tightening supply of entitlements. Why sell at a low price and then have to buy dearly later? However, for those firms facing imminent new regulation, the incentive is clearly to sell now. Critics of EPA's offset policy point to these "paper offsets" as proof that there are no corresponding air quality benefits. But this criticism begs the issue in the sense that regulators are free to reduce emissions elsewhere to improve air quality.

Like San Francisco, offset experience in Los Angeles strongly suggests that ownership of air pollution entitlements is being vested in existing firms, at least in a de facto sense. However, the permanency and intactness of these property rights are by no means clear. So long as the air quality management plan of SCAQMD is judged deficient in meeting the NAAQS, new regulations can be expected to erode these de facto rights. The discount rate incorporated in the proposed emissions reduction bank exemplifies the fluid nature of these rights. However, SCAQMD's tolerance of hoarding and its sanctioning of payment to existing firms for offsets, and its proposed issuance of a certificate of title to depositors of ERCs, suggest that although not permanent in the sense of being left totally intact, these rights are vested with existing firms.

CHAPTER 7

SUMMARY, MATTERS FOR CONSIDERATION BY THE COMMITTEES, AND AGENCY COMMENTS

An important premise of this study is that a working system of controlled trading is necessary for a full-scale market in air pollution entitlements to evolve. Accordingly, we focused on implementation of controlled trading, and particularly emission reduction banking and external offsets. We devoted less effort to the bubble policy, the third component of controlled trading, because no "bubbles" had occurred as of the time of our research, from July 1980 to February 1981. Since our audit, however, EPA has approved its first "bubble," a multi-plant transaction between two Narragansett Electric power stations in Providence, Rhode Island. Reportedly, cost savings of $3 million and a 30 percent reduction in SO_2 emissions are expected to result from this "bubble." EPA approved its second "bubble" in March 1981, for an Armco Steel plant in Middletown, Ohio. Cost savings of $14 million to $16 million have been estimated. From these and other "bubbles" expected in the near future, EPA has predicted cost savings of over $100 million. 1/

This upsurge in "bubbling" is significant in developing a market in air pollution entitlements for two principal reasons. First, it indicates that conventional air quality management has passed up important economies in pollution abatement. These potentially huge cost savings are the principal driving force behind a market. Secondly, this upsurge may reflect progress toward maturation of controlled trading. It may mark a turning point in which the private sector gains confidence that controlled trading is "here to stay" and begins exploring opportunities offered by this policy. For EPA, this event may provide the impetus for widespread use of controlled trading and usher in a full-scale market in air pollution entitlements. Already, there are signs that regulatory reforms necessary for emergence of a full-scale market are happening. Multi-firm "bubbles" are now allowed across control technique guideline categories for HC. These changes can greatly expand the possibilities for market transactions. EPA has also approved a so-called "generic bubble" for New Jersey which eliminates Federal review of each "bubble" application. And EPA has proposed simpler modeling requirements for "bubbles" with smaller air quality impacts. EPA has opened the door even wider by allowing firms to use internal offsets to escape the requirement for LAER in nonattainment areas. These reforms should mean easier trading in the future and better prospects for a full-scale market.

1/As of June 5, 1981, EPA had approved additional bubbles for Coors Container Company, McDonnell-Douglas, and Green River Station, and had proposed approving five others. EPA estimates a savings of at least $30 million from these bubbles.

SUMMARY

Previous studies suggest that, in theory, a market in air pollution entitlements could lower pollution abatement costs, in some cases, from about 40 percent to 90 percent to meet our society's outdoor air quality objectives. Cost data which we obtained from California point to potential cost savings of a similar magnitude. Indeed, we discovered one offset case in the San Francisco Bay Area with potential cost savings estimated at $19 million. In addition, we have presented theoretical arguments which suggest that a market would stimulate technological change in air pollution control, something which apparently has not happened with much success under the conventional system of air pollution control. Though cost savings are the driving force behind controlled trading and an eventual full-scale market, establishing a workable system to realize these savings is critical. Thus, implementation problems must be addressed.

With this emphasis in mind, we have taken the hypothesis that a workable market alternative must retain much of the existing air pollution permit process. As a result, our analysis was directed at identifying trouble spots in the permit process which result in sizable transaction costs. For several external offset cases in California, we examined how difficult it was to get through this process--it involves time and direct cash outlays on the part of both regulator and regulatee. First, the regulator and regulatee negotiate the proper level of pollution abatement, leading to an exchange or transaction. The regulator grants the regulatee a right--or permit--to pollute, in exchange for assurances that the regulatee will not violate the Clean Air Act. These costs associated with this process are quite separate from the more widely known compliance costs--namely, the price of pollution control equipment and the expense of maintaining that equipment. If getting through the permit process is costly, the prospects for controlled trading and an eventual full-scale market are diminished, because any potential cost savings from such trading are reduced by these transaction costs.

Search costs are also germane to the feasibility of a market in air pollution entitlements. Typically, in an external offset case, one firm, possibly with the help of the regulator, must find other companies which can satisfy its need for emission reductions. The first firm--the prospective buyer--may also be interested in finding the cheapest offsets. Getting information on the price and availability of offsets and "striking the right deal" can be costly and occurs largely outside the permit process. Afterwards, these offset agreements must be validated by the regulator in the permit process to ensure compliance with the Clean Air Act.

We also explored the effects other issues had on transaction costs occurring both within and without the permit process: emission reduction banking, and possible conflicts between elements of command and control and controlled trading. In addition, we analyzed implementation problems centering on enforceability, property rights, and market power.

External offsets

Table 14 summarizes major implementation problems in the five California external offset cases which we examined. That all of these offset experiments were staged with little or no precedent is important. This suggests that transaction costs incurred in arranging these offsets could be high. For instance, with time, better information on the availability and prices of offsets may be developed in response to potential profits from trading, and can be expected to reduce search costs, all other things being equal.

The novelty of these experiments also has behavioral implications which suggest resolution over time. Witness the fundamental change in the way that firms meet their air pollution control obligations under controlled trading. For instance, with externa offsets, a company can rely on other firms to meet its own obliga tions. Perhaps due to this novelty, we found no evidence that prospective buyers offered to pay a price which covered more than the direct pollution abatement costs of offsets, even though ther are good reasons to expect a higher minimum price asked by the seller. From the seller's standpoint, uncertainty regarding the adequacy of SIPs to meet the NAAQS suggests a more restricted supply of entitlements in the future. Thus, a seller can be expected to ask for a risk premium, above the direct costs of pollu tion control. Reinforcing this is the dearth of information on what the market-clearing price is. Simply put, until a prospecti seller has a better idea of what price to offer, demanding a risk premium seems plausible. On the buyer's side, this bidding behavior may reflect a reluctance to treat air pollution control as an investment in a market context. Buyers appear reluctant to pa more than what it costs the seller to abate, even though buyers may have to pay much more than that to curtail the pollution by their own means. The resulting hoarding problem and low bid pric will diminish over time, if brokers and exchanges respond to the opportunity for profit in such a market and if firms begin to thi in terms of profit or cost savings from a market in offsets.

Some transaction costs in the permit process aimed primarily at ensuring compliance with the Clean Air Act can be similarly categorized as transient. Specifically, the problem of conflicting opinion about BACT, which hindered both the Wickland and PG&E cases, could be ameliorated by replacing case-by-case determination with a periodic definition of these standards. The need for case-by-case determination of BACT or LAER is also questionable when increasingly stringent controls become less reliable.

Other problems in the permit process, such as calculating offset credit (in the Port of Los Angeles and Wickland negotiations) and determining necessary offsets (in the PG&E case) also appear not to be insurmountable. In the case of offset credit, a simply understood rule is needed to identify real emission reductions from offsetting sources. Although a problem in the PG&E case, calculating necessary offsets has generally not been

Table 14

Implementing External Offsets

Problem Type	Company: Pacific Coast Cement	Port of Los Angeles (aborted)	Watson	Wickland	PG&E (aborted)
Transaction costs in permit process		**	**	**	**
Estimating project emissions	*	*	**	**	*
Determining project controls		**	**	**	**
Determining necessary offsets				*	**
Estimating offset emission reductions		**		**	
Determining offset controls		*			
Offset eligibility					**
Search costs outside permit process	**	**		**	**
Hoarding	D			D	D
Likely price bid equal to direct pollution control costs	D			D	D
Fear that trade would signal further regulation	D				
Uncertainty about adequacy of SIP	D			D	D
Little or no precedent	D	D	D	D	D
Enforcement				*	
Questions raised about				*	
Special permit conditions	D		D	D	
Property rights					
Existing sources "grandfathered"	D	D	D	D	D

Note: D = the corresponding issue described the negotiation.
* = the corresponding problem impeded negotiations.
** = the corresponding problem was a major impediment.

troublesome. The evidence from California suggests that there has been a reliance on an emissions basis with fixed offset ratios as opposed to an air quality modeling basis for determining needed offsets.

There are, however, other problems in arranging offsets which seem more deep-seated. The conflict between offsets and other air pollution control strategies is an example. In the Pacific Coast Cement Company case, evidence suggests that some firms were reluctant to sell offsets because they thought doing so might trigger additional, uncompensated regulation. In a related way, offsets initially approved for PG&E were subsequently declared ineligible because of new regulations. Unless offsets can be made to work as substitutes for other control strategies and not as mutually preemptive measures, this conflict is likely to deter offsets.

Another entrenched problem in the permit process appears to be the basic calculation of emissions. The seriousness of this problem seems to depend on how innovative the project is, as in the Watson case. Similarly, in the Port of Los Angeles case, uncertainty about the feasibility of both offset and project controls and resulting emissions was apparently linked to the innovativeness of the abatement measures being considered.

Significantly, none of the offset negotiations described in table 14 involved using emissions reduction banking and offsets in tandem. However, in all but the Watson case, the potential importance of banking--had a bank been there--is evident. In the Pacific Coast Cement case, a Port of Long Beach official acknowledged that a number of prospective suppliers were eliminated from consideration because what emission reductions they could have supplied were greater than what Pacific Coast Cement needed. Had there been a bank, this official stated that the company might have been willing to negotiate a trade with these suppliers and bank the rest. Thus, absence of a bank may have increased Pacific Coast Cement's search costs. In the Port of Los Angeles dredging case, the confusion that developed with regard to eligible offset credit could have been avoided if a bank had been in place. The City's Department of Water and Power, as prospective depositor of emission reduction credits, would have discovered that it had nothing to bank. Similar problems encountered by Wickland Oil and PG&E could also have been avoided had a bank with the needed credit been in place. As a depository of emission reduction credits ready for use, banking can reduce transaction costs in the permit process and search costs that are incurred when two or more firms decide to swap air pollution rights.

Unlike banking, the sanctioning of interpollutant offsets is one policy adopted by California regulators which probably reduced search costs in the Pacific Coast Cement and PG&E cases. Besides banking and certain kinds of interpollutant offsets, another possible way to reduce search costs which has an

economic and public health rationale is to allow trading in air pollution entitlements according to population densities affected by corresponding emission reductions and increases. For example, using emission reductions in a heavily populated area to offset emission increases in a less populated area may improve public health while making offsets easier to locate.

Enforceability, property rights, and market power have also been examined as possible impediments to controlled trading and a market in air pollution rights. In the offset negotiations which we investigated, there seems to be a pattern of "grandfathering" these rights, i.e., vesting ownership of offset credit with existing firms. These companies appear to have had the prerogative to sell or hoard these rights at the bid price. Evidence which we have from the San Francisco Bay Area does not point to market power as a threat.

Enforcement was a minor problem in the Wickland case. Environmentalists questioned the enforceability of SO_2 offsets supplied by marine vessels. In judging the enforceability of these offsets, the conventional system's apparently poor record on enforcement and its emphasis on initial compliance as opposed to continuous compliance should be kept in mind. Upon closer examination, the issue of enforcement appears more transparent than real. In fact, the same set of enforcement concerns are operative under either a command and control or market scheme, provided that each has a common goal of accommodating economic growth, without compromising air quality objectives of the Clean Air Act. Finally, enforcement can be enhanced through a market by requiring firms to report better emissions inventory data as the price for being given the opportunity to achieve sizable cost savings through controlled trading. This kind of linkage has been included in a permit approved in the San Francisco Bay Area.

Emission reduction banking

The second component of controlled trading scrutinized in this report is banking. As with offsets, we focused on California. Table 15 summarizes our findings. Although "grandfathering" of property rights seems to have gone largely unchallenged in the external offsets which we examined, the case is not so clear in banking. In Los Angeles, language in a proposed regulation that "this (banking) rule does not recognize any pre-existing right to emit air contaminants" and in San Francisco the motion that an alternative community bank be established bear witness to this issue of property rights. 1/ On the other hand, the emissions reduction bank operating in San Francisco apparently intends to vest ownership with existing users of rights. In the Los Angeles proposal, the intent is unclear, given the dis-

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1/SCAQMD, Proposed Rule 1309-Emission Banking, July 8, 1980, p. 32.

Table 15

Implementing Emission Reduction Banks

Problem Type	San Francisco Bay Area Bank	Los Angeles Proposed Bank
How to handle value of ERCs when reasonable further progress in jeopardy.	3-year grace period from time of deposit--full face value. Thereafter, value determined by regulations at time of withdrawal. Possible moratorium on deposit.	Continuous discounting, i.e., value determined by regulations at time of withdrawal.
- Industry position	Wanted at least 10-year grace period; no moratorium on deposits or withdrawals.	Want to be sure of the value of ERCs.
- Regulator position	3-year grace period; moratoria on deposits and withdrawals.	Need every reduction to meet RFP.
Which emissions baseline to use in measuring emission reductions.	Actual, historical	If no permit conditions exist which govern capacity utilization, the difference between actual historical (before modification) and maximum allowable (after modification).
- Industry position	Maximum allowable	Maximum allowable before modification.
- Regulator position	As stated	Unclear, apparent conflict with CARB.
How to handle shutdowns	No shutdowns for inelastic demand. All other shutdowns use at least RACT baseline.	
- Industry position	Full credit for all shutdowns	
- Regulator position	As stated	
Property rights	Vest with existing firms	Apparent vesting with existing firms.
- Industry position	As stated	Vest with existing firms.
- Regulator position	As stated	Conflicting internal view.
- Environmentalists	No vesting with existing firms; community bank.	

claimer about pre-existing rights. More important, in both jurisdictions the intactness of any property rights is not sacrosanct. The Bay Area has a 3-year grace period, followed by possible discounting of any credits in the bank as new regulation is needed to meet the NAAQS. In Los Angeles, discounting from the day of deposit has been proposed. So, apparently what we have in these regions are banks which effectively recognize limited property rights.

As we indicated in chapter 5, the Bay Area bank had one ERC deposit on record and three applications being processed at the time of our audit. Little difficulty was experienced in approving the first ERC deposit. The other three applications have been delayed by poor documentation of emission baselines.

Although the Bay Area bank officially opened its doors in January 1980, considerable uncertainty has persisted about its final design. Specifically, a moratorium on withdrawal was rescinded in May 1980, and environmentalists are still urging the regulator to establish a community bank. A small rate of participation in the bank can also be attributed to the regulator's decision not to allow transfers of credit in its "onsite bank" to the formal bank.

REPRESENTATIVENESS OF OUR FINDINGS

California's controlled trading experience is probably unique when compared to similar experiments in other parts of the United States. But most of the problems which we have recounted are probably generic to air pollution control and to an embryonic market. Thus, being unique would seem to be a matter of degree. Perhaps Los Angeles' supply of available offsets is more restricted than most other metropolitan areas, suggesting that search may be a greater problem there. And the severity of air pollution in Los Angeles may mean greater emphasis on compliance and, correspondingly, larger transaction costs in the permit process. It is also plausible to think that conflicts between controlled trading and command and control and disputes over property rights would be more likely in Los Angeles. Pursuing this logic, the same may be true for San Francisco, but to a lesser extent because of its less severe air pollution problem. In summary, then, if California's experience is at all unusual, one manifestation of this would probably be that its implementation problems are more serious than in most other parts of the country. This possible, conservative bias is important, because controlled trading has worked in California, albeit sporadically. This bias is also significant because it means that implementation problems are less likely to remain latent there and escape our attention.

The results of three earlier studies of nine external offsets in Louisiana, Oklahoma, Pennsylvania, Virginia, Texas, and California--including our report on an external offset case involving a Sohio pipeline in Los Angeles--support our assertion that the implementation problems uncovered in this study are

representative and generic to air pollution control and to an embryonic market. 1/ And our review of the other two emission reduction banks in existence at the time of our audit in Louisville, Kentucky, and Puget Sound, Washington, also indicates important parallels with their counterparts in San Francisco and Los Angeles.

MATTERS FOR CONSIDERATION BY THE COMMITTEES

Our review of existing theoretical studies of the potential cost savings from applying market incentive approaches to air pollution control, evidence from California suggesting a potentially wide variation in pollution abatement costs, and information from EPA on cost savings expected from using its bubble policy, point to the possibility of meeting air quality objectives at a fraction of current abatement costs.

Whether this promise of theory becomes a reality hinges on implementation problems facing the greater use of controlled trading and the eventual emergence of a full-scale market in air pollution entitlements. Based on our findings from case studies of external offsets and emission reduction banking in California, we believe that significant, but not insurmountable, implementation problems currently impede the spread of controlled trading and the evolution of a full-scale market.

In light of the implementation problems identified in California and the potential cost savings of a market approach to air pollution control, the committees should consider allowing controlled trading in place of New Source Performance Standards (NSPS), Lowest Achievable Emissions Rate Technology (LAER), and Best Available Control Technology (BACT). These requirements are contained in Sections 111, 165, and 173 of the Act. Specifically allowing external offsets to be used in place of these rigid requirements can save industry money and can enhance air quality, especially in cases where regulators have required the use of highly stringent, but unreliable pollution controls. Where this substitution can yield equivalent air quality at a lower cost, the committees should consider allowing it. The committees shoul also consider replacing case-by-case determination of LAER and BACT with periodic determination of those requirements. As we found in two offset cases in California, a major cause of delay in the permit process has centered on disputes of what constituted BACT, without any clear indication that the delay resulted in a better solution.

1/See R. Liroff, "Air Pollution Offsets"; W. Foskett, "Emission Offset Policy at Work"; U.S. General Accounting Office, "The Review Process for Priority Energy Projects Should be Expedited," EMD-80-6, November 15, 1979.

Finally, the committees should consider approving the use of interpollutant offsets as they have been used in California. New sources in that State have been able to locate offsets more easily using this method.

The committees should encourage EPA to emphasize a market approach to air pollution control whenever this system can achieve air quality at less cost and is permissible under the Clean Air Act. Specifically, the committees should urge EPA to step up its promotion of emission reduction banking. As revealed in our case studies, this institution has the potential to reduce the sizable transaction costs and uncertainties which have beset external offset negotiations. To promote emission reduction banking, the committees should encourage EPA to focus on those factors which have impeded development of banking in San Francisco and Los Angeles. The committees should also urge EPA to promote a tie-in between cost savings from controlled trading and a requirement for improved information on emission inventories, to facilitate enforcement.

AGENCY COMMENTS

The Environmental Protection Agency (EPA) formally reviewed a draft of this report. EPA stated that the draft was a "lucid and generally well-informed analysis of how emissions trading can reduce the costs and rigidity of the Clean Air Act." However, EPA's statement that "the report concludes that tens of thousands of tons of offsets are readily available at reasonable prices" in severe nonattainment areas is a serious misinterpretation of our findings. More accurately, the severity of air pollution and the stringency of control measures in Los Angeles--a severe nonattainment area--have led to our characterization of that area's offset and banking experience as controlled trading "under duress." We state that uncertainty associated with the effectiveness and cost of unusually stringent, state-of-the-art pollution controls there are not likely to make search for offsets easy (see p. v).

EPA believes that our draft report's recommendation, that the Congress consider allowing controlled trading in place of New Source Performance Standards (NSPS), could result in an increase in emissions. EPA's basis for this belief is its statement that the "existing source [the offsetting source under our recommendation] is likely to shut down while the new, non-NSPS facility keeps operating...." Unfortunately, EPA does not adequately compare its hypothetical scenario against the status quo. To the degree that new NSPS sources are currently subject to more expensive pollution controls than existing sources, our recommendation is likely to lead to at least equivalent air quality. Relatively expensive controls on new sources could forestall the shutdown of older, more polluting sources. By contrast, our recommendation would allow new sources to find cheaper ways to meet environmental requirements. Our recommendation would make it more economically attractive to open new plants and, as a corollary, would reduce the current incentives to keep older plants open beyond their

otherwise useful lives. Consequently, our recommendation could lead to fewer, older dirtier plants than under the status quo. Another important consideration, the widely held judgment that market-incentive approaches are likely to stimulate technological improvements in pollution control, suggests that our recommendation could lead to better long-term air quality.

Relatedly, EPA notes that our NSPS recommendation "must address workable mechanisms for assuring the permanence of offsetting reductions for the life of the new facility..." [their emphasis]. Although we do not believe this issue is as crucial as does EPA, nonetheless, permanence of offset reductions can be handled in a straightforward manner. As presented in appendix IV, in the Wickland Oil case, that firm's permit to operate would be suspended in the event of the offsetter's noncompliance. For the sake of argument, EPA's concern with permanence of offsetting reductions could be handled in the following way. The permit to operate of the new source wishing to substitute offsets for NSPS would be valid so long as the offsetting source's permit to operate was in effect. If the offsetting source were to shut down, its operating permit would be rescinded. The new source would be obligated to find another offsetting source to retain its permit to operate. Presumably, under our recommendation, and with this arrangement for assuring permanence of offsets, a new source would include in its calculations some estimate of the remaining life of the offsetting source before negotiating for that offset.

A number of industry, environmental, and regulatory officials from the State of California, where our case work was done, also commented on excerpts of the draft. Where appropriate, the report reflects their suggested changes. OMB commented that our report was timely; the Council of Economic Advisers said it was "well done."

Our responses to specific EPA comments are in appendix VII.

WICKLAND OIL COMPANY

BACKGROUND

Wickland Oil Company proposed to build a petroleum terminal and wharf in Selby, California. The terminal would receive gasoline, diesel oil, and other fuel either by tankship from distant locations or else by pipeline from nearby refineries. These petroleum products would then be stored in tanks prior to being shipped by pipeline or by tank truck.

The project required permitting or reviewing by 14 major Federal, State, regional, and local regulatory agencies in addition to the Bay Area Air Quality Management District (BAAQMD), and preparation of an environmental impact report.

It was the first project in the Bay Area requiring external offsets to be evaluated under the District's New Source Review Rule (NSR). As noted before, this rule permits construction of large projects in nonattainment areas as long as Best Available Control Technology (BACT) is used and enough offsets are obtained to produce Demonstrable Air Quality Benefits (DAQB). The maximum daily emission rates of two pollutants, hydrocarbons (HC) and sulfur dioxide (SO_2), were calculated by BAAQMD and found to exceed the NSR trigger points for both BACT (150 pounds per day) and offsets (250 pounds per day). Tankship and terminal emissions were included in the calculations.

HC emissions

HC emissions originate from both the terminal and the ships. The major terminal sources are the tanks. The other terminal sources are the truck loading racks and fugitive emissions from pumps, valves, and waste water. The major tankship source of HC emissions is ballasting, in which water pumped into the unloaded cargo tanks forces fuel vapors into the atmosphere. Small amounts of HC are also produced during tankship engine combustion.

Wickland will offset annual HC emissions at Selby through emission reductions at a dry cleaning plant, City of Paris, in San Francisco. For a price, the owner of the plant agreed to replace dry cleaning equipment using Stoddard solvent with less polluting equipment using perchloroethylene solvent. Before the hearing board revoked Wickland's conditional authority to construct, the Air Pollution Control Officer (APCO) had required a 1.8:1 offset ratio of annual emission reductions to annual project emissions to satisfy the requirements for demonstrable air quality benefits.

SO_2 emissions

Sulfur dioxide emissions originate from engine combustion, mainly in the tankships but also in the tugboats which assist in tankship berthing.

Wickland will offset annual SO emissions by selling low sulfur fuel to Bay Area ship and motor vehicle operators at about the same price as the high sulfur fuel which they are now using, by purchasing and closing down Virginia Chemicals, Inc., an onsite company which emitted SO_2. BAAQMD required a 1.2:1 offset ratio for SO_2 emissions.

Timetable

For projects requiring offsets, BAAQMD advised applicants for the authority to construct to allow a maximum of 150 days after BAAQMD received a completed application before the final decision to grant or deny the authority to construct. Of this, up to 60 days was allowed for BAAQMD's application evaluation and completeness check, and, after publication of the APCO's preliminary decision, 30 days for public comment and review by the California Air Resources Board (CARB) and EPA. Either CARB or EPA could then request a 60-day extension. This 150-day maximum could be extended by the applicant's written consent. Moreover, appealing BAAQMD's decision could further delay issuing the authority to construct. If appealed, 10 days were allowed after publication to notify the hearing board, which was then required to call a public hearing within 30 days to consider the appeal.

PROBLEM SURVEY

Wickland's authority to construct was approved more than 2 years later than expected, resulting in an estimated $6 million in additional, inflated construction costs for a currently estimated $25 million to $30 million project.

Preapplication discussions with BAAQMD officials and development of the original application took 3-1/2 months longer than expected due mainly to regulation changes requiring BACT and offsets. Disagreements between Wickland and BAAQMD over BACT and offset requirements resulted in the denial of the first application after a 3-month evaluation period and led to 5-1/2 months of further discussion and development of a revised application. In part, the problem was caused by the judgmental element in determining BACT. The public comment period lasted 1 month longer than usual because of strong public interest in the project. Issues brough forth during the public comment period led to an appeal of Wickland's authority to construct and resulted in intermittent hearings which lasted 13 months. In part, this was caused by BAAQMD's judgmental errors in determining the HC offset and by BAAQMD's failure to review Wickland's final environmental impact report prior to approving the authority to construct.

There were other problems. To end the hearings, Wickland negotiated a settlement with the appellants which required in part the conversion of nearly 350,000 barrels of storage capacity from gasoline to a lower vapor pressure product such as fuel

oil. Because emission estimates were so judgmental, Wickland acquired perhaps 30 tons per year more HC offsets than needed.

CHRONOLOGY

Wickland purchased the project site and began project planning in mid-1977. From September 1977 through mid-February 1978, Wickland discussed authority to construct application procedures and requirements with BAAQMD and developed an application. Despite disagreement with BAAQMD over Wickland's BACT and offset proposals, Wickland submitted its application on February 15, 1978, which BAAQMD denied May 12, 1978, about 1 month beyond the expected 60-day period for evaluation and completeness check. In denying the authority to construct, the APCO ruled first that Wickland's tank design of floating roofs with double seals was not BACT and second that Wickland's proposed offsets were merely theoretical, i.e., not enforceable.

Wickland appealed this denial to the BAAQMD hearing board May 25, 1978, but had the hearings postponed while discussing permit matters with BAAQMD and CARB. CARB agreed with BAAQMD that Wickland's offset proposal was unsatisfactory. However, CARB disagreed with BAAQMD about BACT on the tanks, concluding July 31, 1978, that floating roofs and double seals were indeed BACT. With the offset matter settled, Wickland withdrew its appeal and sought acceptable offsets. The company submitted a revised application, which BAAQMD accepted October 30, 1978.

BAAQMD completed its evaluation on March 14, 1979, 2-1/2 months beyond the expected 60 days, and the next day gave public notice of its intention to grant Wickland an authority to construct. BAAQMD estimated annual HC emissions of 83.2 tons and annual SO_2 emissions of 24.7 tons.

There was considerable public interest during the comment period from March 15, 1979, to May 9, 1979. Those in favor of the project generally felt the new terminal would add to the tax base, stimulate employment, and provide more gasoline to the Bay Area. Those opposed expressed concern that project emissions might be carcinogenic and that the HC offset was not in Contra Costa County near the project but rather in San Francisco, more than 20 miles away. These and other issues were later put before the hearing board.

On May 21, 1979, within a week after the APCO approved Wickland's conditional authority to construct, environmentalists appealed this decision. The BAAQMD board began public hearings on June 14, 1979. Almost a year later, May 1, 1980, the board revoked Wickland's conditional authority to construct, ruling first that in violation of the California Environmental Quality Act (CEQA) the APCO had not reviewed Wickland's final Environmental Impact Report (EIR) prior to approving the authority to construct and second that in violation of a BAAQMD regulation,

the APCO had not demonstrated that Wickland's HC offset arrangement would cause City of Paris Dry Cleaners to reduce emissions more than Wickland's new terminal would emit.

On June 19, 1980, just over a year after the hearings began, the hearing board approved a modified conditional authority to construct negotiated between Wickland and the appellants and approved by the APCO. Both Wickland and the appellants decided to negotiate the appeal, Wickland because they believed the hearing board was partial to the appellants, and the appellants because their limited funds were needed for other matters. Wickland had obtained additional data to demonstrate that the HC offset resulted in a net emission reduction. The appellants disputed this but withdrew their objections after negotiating design changes in Wickland's project which resulted in a HC emission reduction from 83.2 to 72.6 tons per year.

PROBLEMS

Permit denial

BAAQMD disapproved Wickland's idea of BACT on the company's tanks until a CARB official judged otherwise. BAAQMD also disagreed with Wickland's lower estimates of tank emissions until the experiments on which they were based were confirmed. The confirmation came too late for Wickland's application evaluation. So according to Wickland, they may have offset about 30 annual tons of HC above the probable true value of project emissions.

These disagreements call attention to the judgmental element in determining BACT and calculating emissions. In part, this is because the BAAQMD engineers have no one source to turn to for guidance. Possible sources include BAAQMD experience; contact with other districts, EPA, CARB, and equipment manufacturers; and EPA publications. The director of permit services suggested that looseleaf, frequently updated versions of EPA's BACT and emissions publications, by giving BAAQMD a single source, would reduce the judgmental element in determining BACT and calculating emissions, and reduce the possibility of overlooking relevant information sources.

The APCO ruled that BACT for petroleum product tanks is a fixed roof with a vapor recovery or incineration system and not a floating roof with double seals as in Wickland's design. The BAAQMD engineer came to this conclusion from an emission comparison between the currently accepted BACT in the BAAQMD and Wickland's tank design. From his recent evaluation of an authority to construct application for another oil company, Urich Oil Company, the engineer considered BACT to be a fixed roof with a vapor recovery system. He calculated its emissions using the formulae for fixed roofs in EPA's emissions publication, "Compilation of Air Pollutant Emission Factors" (AP-42), and the known efficiency of Urich's vapor recovery system. AP-42 had no emission formulae for floating roofs with double seals, so

the engineer adjusted the AP-42 formulae for floating roofs with single seals to allow for the second seal. Comparing the two results, he found the emissions from Urich's fixed roof design lower than those from Wickland's floating roof design and, therefore, determined that Urich's system was still BACT.

Wickland disagreed with BAAQMD's calculations, citing recent experiments by Chicago Bridge and Iron Company, a tank manufacturer. They argued that BAAQMD had overestimated both the standing and withdrawal losses, two components of floating roof tank emissions:

- Standing losses were said to be as much as 2-1/2 times true value because BAAQMD had made an incorrect adjustment for the second seal in the AP-42 formula.
- Withdrawal losses on gas tanks were said to be as much as 4 times the generally accepted value and 10 times the probable true value because BAAQMD did not adjust the AP-42 formula for the second seal.
- Withdrawal losses on diesel tanks were said to be as much as 300 times true value because the AP-42 formula BAAQMD used holds only for gasoline, which evaporates much more rapidly than diesel oil.

BAAQMD engineers defended their calculations, arguing that in the formulae for gasoline losses, Wickland overestimated the effect of the second seal. They said the main cause of losses was because the tank shell was not perfectly round, causing leaks between the roof seals and the tank shell, regardless of the number of additional roof seals. They argued that Wickland overestimated the effect of diesel oil's slower rate of evaporation on diesel tank withdrawal losses. These losses, caused by evaporation of fuel product from the portion of the tank shell exposed to the atmosphere, depends significantly on how soon the tank is refilled so that the exposed area is covered again.

BAAQMD reversed its decision and accepted Wickland's tank design as BACT after the CARB's chief of the Stationary Source Division, citing the recent Chicago Bridge experiments, took this position July 31, 1978. However, BAAQMD did not accept Wickland's lower tank emissions calculations. Because Wickland's calculations were so much lower than BAAQMD's own, BAAQMD wanted further confirmation. Acceptable confirmation did not come until February 1980, 9 months after Wickland's application was approved on May 15, 1979. Based on a test program and review of previous experiments, American Petroleum Institute published new formulae confirming the lower emissions claimed by Wickland. These estimates were about 30 tons per year less HC than BAAQMD's estimates. So, using the HC offset ratio negotiated in Wickland's final modified authority to construct, Wickland would have needed perhaps 30 tons per year fewer offsets.

Offset proposal

BAAQMD disapproved Wickland's first offset proposal because Wickland's offsets could not be enforced. Wickland held that its new terminal would create market forces which would reduce emissions in the Bay Area, thereby insuring demonstrable air quality benefits.

Wickland argued that every barrel of finished product brought into Wickland's new terminal represents one barrel of finished product that Wickland would no longer be purchasing from a local refiner and, therefore, 1-1/2 barrels of crude oil that will no longer have to be delivered by tankship to that refiner for processing.

BAAQMD would not accept Wickland's proposed offsets because they were not enforceable commitments from Wickland's suppliers to limit refinery output, tanker unloading, and truck loading. To make the offset enforceable would require placing a restriction in the refineries' operating permits, limiting annual production to previous years' production less an amount equal to Wickland's purchases. Without such an agreement, BAAQMD argued that the refineries might find other markets to replace Wickland or make more of some other product.

Public comments

Because of strong interest and numerous issues raised, the 30-day period for written public comment was extended 1 week to April 25. More than 400 written comments were received. Specific issues identified during the comment period included the following:

- The HC offsets should have been in Contra Costa County, not in San Francisco, and were insufficient to improve air quality.
- Perchloroethylene emissions pose a carcinogenic health hazard in the vicinity of City of Paris Dry Cleaners.
- BAAQMD should not issue an authority to construct until environmental impact report studies are complete.
- HC emissions may pose a carcinogenic health hazard in the vicinity of the terminal.
- Wickland's offset proposal to supply low sulfur fuel to ships in the Bay Area is not enforceable.

Some of these issues were later appealed to the hearing board even though the APCO had responded to them during the public comment period. The ACPO's responses were:

- The ozone excesses in Contra Costa County are a result of HC emitted all over the Bay Area, and therefore HC reductions anywhere in the Bay Area will provide a net air quality benefit for ozone. This strategy is accepted by CARB and EPA.

- Perchloroethylene emissions will be controlled more than 99 percent. And modeling shows downwind concentrations are 100 times less than OSHA standards.

- BAAQMD's evaluation of emissions and offsets is the significant part of the air quality analysis of an environmental impact report, and if the report identifies any other adverse air quality impacts, BAAQMD will mitigate them by placing additional conditions on the operation of the project.

- There is no evidence that any alleged cancer increase in Contra Costa County is related to air pollution. And modeling showed that concentrations for benzene and aromatic compounds are no more than one-twentieth of OHSA's standards.

- Conditions will be imposed on Wickland as will insure enforceability of the low sulfur fuel offset.

Public appeal

The board revoked Wickland's conditional authority to construct May 1, 1980, ruling that the APCO did not show that the City of Paris offset would provide demonstrable air quality benefits as required by BAAQMD regulation and, in violation of CEQA, did not review Wickland's final environmental impact report prior to approving the authority to construct. Public hearings led to a delay of over a year in issuing Wickland's authority to construct and to a negotiated settlement with the appellants to reduce plant emissions. The settlement in part required Wickland to eliminate 20,000 barrels of storage capacity and to convert almost 350,000 barrels of storage capacity from gasoline to some lower vapor pressure product, such as fuel oil.

Demonstrable air quality benefits

According to the hearing board, information on City of Paris' past emissions data was too unreliable to estimate accurately the emission reductions from Wickland's HC offset. Therefore, BAAQMD could not prove that the Wickland project would result in demonstrable air quality benefits. The cause of this problem was that the new owner of the offset facility, City of Paris, had not yet established a clear pattern of business practices, types of customers, and volume.

Five years of solvent usage data, from 1974 through 1978, were available when the BAAQMD evaluated Wickland's City of Paris

HC offset. Usage had declined every year since 1974 and reached a low point in 1978, the first full year of new ownership. The new owners purchased Paris in 1977 with the intention of reversing the trend of declining business volume. A rapid decrease in business then occurred from 1977 to 1978 because the new owners discontinued several unprofitable wholesale accounts before they began building up the retail business in 1978.

Averaging all 5 years' data, BAAQMD converted solvent usage to HC emissions and calculated an emission offet of 151.4 tons per year. They based their 5-year averaging methodology on the new owners' intention to rebuild the Paris business. The board disapproved this methodology because part of the 5-year period included operations under another management. The board implied that averaging only the period of new ownership would also have been unsatisfactory because a pattern of business practices, type of customers, and customer volume had not yet stabilized.

The appellants argued that the best estimate of future Paris emissions is not past solvent usage but the amount of Stoddard solvent eliminated, based on the plant's new capacity. They estimated an offset of either 35.7, 39.3, or 50.1 tons per year based on three different solvent usage factors, which are values of the amount of solvent used per 100 pounds of clothes cleaned, and the capacity of the new perchloroethylene equipment. Wickland countered that a published industry-wide factor should be used. The board disagreed with both suggestions, saying that a site specific factor should be used for weight of clothes cleaned at Paris per gallon of Stoddard solvent used. As an alternative, the appellants suggested using the 57.1 tons per year emissions figure for 1978, the low volume point and the only complete year that City of Paris had been operated by the new owners prior to BAAQMD's evaluation.

CEQA

Part of the CEQA issue concerned whether or not BAAQMD was a responsible agency for the Wickland project. If it was, then it was required to comply with CEQA. The appellants argued that it was. BAAQMD argued that it was not.

CEQA requires each responsible agency for a project to consider the lead agency's final environmental impact report before acting on the project. A responsible agency according to CEQA is one with discretionary rather than ministerial approval power over a subject. It exercises judgment, deliberation, or decision rather than fixed standards or objective measures without personal judgment.

BAAQMD argued that even if some of BAAQMD's activities are not exempt, the approval of Wickland's authority to construct is exempt because it was a ministerial activity. The board disagreed,

ruling that approval of Wickland's authority to construct was a discretionary activity. The board cited the following examples of APCO's exercise of judgment:

- Selecting the appropriate averaging period for comput ing the baseline for Paris' offsetting emissions.
- Choosing to compute emission offsets on an emission reduction basis rather than an air quality modeling basis.
- Deciding that Paris was not improperly distant from Wickland in view of the type of pollutants involved.

BAAQMD argued that delays would result if it had to wait for final environmental impact reports before permit approval.

In substance, if not literally, BAAQMD seems to have complied with CEQA in the Wickland case. The APCO testified that he reviewed the draft environmental impact report prior to approving authority to construct, and having reviewed the reports, he did not need to make any changes in his original decision. In addition, major parts of the report's air quality section were contributed by BAAQMD.

Other contentions

The hearing board dismissed several other contentions: for example, that perchloroethylene is carcinogenic and that the HC offset should have been nearer the project than Paris. The adequacy of the HC offset ratio to produce demonstrable air quality benefits with respect to ozone was also questioned. The appellants argued that modeling should have been performed because the effect of HC emissions on ozone production depends on NO_2 concentrations, which differ between Selby and Paris. The board sided with the APCO, concluding that mathematical modeling is not sufficiently accurate to determine the effect of an individual source on ozone formation and that the APCO's interpretation of demonstrable air quality benefits as an HC offset ratio greater than 1:1 is consistent with CARB's and EPA's strategy for achieving the ozone standard.

Offset availability

Wickland paid a consultant for 3 to 4 months to search for HC and SO_2 offsets. He could not find enough HC offsets for sale in Contra Costa County, near the project site, so Wickland purchased the offsets in San Francisco, more than 20 miles away. This led to some otherwise avoidable confrontations with environmentalists and other citizens at the public meeting and during the appeal. The consultant did not find SO_2 offsets for direct sale at a price equal to the costs of curtailing such emissions, so Wickland will become a vendor of low sulfur fuel in order to satisfy their SO_2 offset requirement.

HC offsets

According to the director of permit services the cheapest offsets will be those at firms for which new control regulations are being considered, because if they are not sold, the firm's owner will have to bear the entire cost of compliance. Consistent with this claim, when Wickland's consultant was searching out HC offsets, he showed dry cleaner owners a copy of regulations being considered to control cleaning equipment using Stoddard solvent. According to Wickland's consultant, 130 out of 136 dry cleaners contacted in Contra Costa County were already using perchloro ethylene and had no HC reductions available. And the emissions of the other six were judged too small for Wickland's needs. For dry cleaners outside of Contra Costa County, suppliers directed the consultant to the larger users in the Bay Area. According to the consultant, perhaps half of the approximately two dozen dry cleaners contacted were willing to sell, and on December 11, 1978, Wickland negotiated an agreement with one of them, City of Paris, according to which City of Paris would, for a price, install and maintain perchloroethylene equipment and assign the resulting offsets to Wickland. Besides dry cleaners, about a dozen other firms were contacted including chemical manufacturers, paper manufacturers, and oil companies. Most allegedly refused to sell because they wanted to keep the offsets for future expansion. Two willing firms wanted too high a price.

SO_2 offsets

When Wickland purchased the Selby site, it obtained a 7.4 ton-per-year SO_2 emission reduction from a Virginia Chemicals, Inc. plan located there. This would be applied at an offset ratio of 1.2:1 against 24.7 tons per year project emissions from tankship combustion. The additional 22.2 tons per year had to be acquired from other sources.

From BAAQMD's inventory of stationary source emissions Wickland's consultant obtained a list of Bay Area companies with potentially available SO_2 offsets. According to a Wickland official, of about two dozen firms contacted, mainly oil companies and chemical companies, none wanted to sell at a price equal to the cost of curtailing their emissions. A broker informed Wickland that an apple drying plant was willing to sell SO_2 offsets. This turned out to be an unacceptable offset, first because being an open-air operation, the emissions would be difficult to control and second, because the plant operated only 6 months per year whereas BAAQMD wanted less seasonal offsets. As a result, Wickland has decided to contract with local firms currently using high sulfur fuel to provide them with the more expensive low sulfur fuel at a competitive price.

Permit evaluation

On Wickland's original application, BAAQMD completed its application completeness check and evaluation on May 12, 1978,

3 months after the application was submitted. On the revised application it took about 4-1/2 months. According to the director of permit services, this amount of time is not unusual for projects as large and complex as Wickland's. If an evaluating engineer worked on one case instead of the six he usually works on or if more than one engineer worked on large cases, time could be reduced.

The second application evaluation could have been avoided if disagreement between Wickland and BAAQMD over BACT and acceptable offsets had been resolved at the time the first application was submitted. The disagreement, which also caused the 5-1/2 months of discussions between the original and revised applications, was due in part to the judgmental element in determining BACT for tanks and Wickland's resistance to acquiring enforceable offset commitments.

Pre-application discussion

According to the deputy APCO, the 5-1/2 months Wickland spent in pre-application discussion and developing its first application was about 3-1/2 months more than usual for a project of comparable size and complexity. It was caused in part by the change in BAAQMD regulations on December 20, 1977. The new regulations, implementing CARB's New Source Review rule, required BACT and offsets for large emitters. Figuring out how to determine BACT caused the biggest delay.

Offset ratio

The APCO imposed on Wickland a higher offset ratio than the NSR rule required. If the BAAQMD had not overestimated City of Paris' emission reductions this factor alone would have resulted in Wickland's having purchased almost twice as many HC emission reductions as it needed.

The NSR rule under which Wickland fell required large projects to achieve demonstrable air quality benefits but did not specify the offset ratio required to do this. However the APCO and director of permit services interpreted this to be any offset ratio greater than 1:1. And the board agreed that this was a proper interpretation. But the APCO and director of permit services said that their policy was to obtain as high an offset ratio as possible to maximize the improvement in air quality.

For Wickland's City of Paris HC reductions the offset ratio they initially calculated was 2:1, the same as that preferred by CARB's chairman. However, an error in determining Wickland's HC emissions resulted in an actual offset ratio of 1.8:1. When applied to the project's estimated 83.2 tons per year of HC emissions this offset ratio required 151.4 tons per year in HC offsets. This is in fact the BAAQMD's estimate of the City of

Paris offsets that Wickland acquired, and is nearly 68.2 tons per year more than what BAAQMD interpreted as required by NSR.

However, the board rejected BAAQMD's 151.4 tons per year estimate of City of Paris offsets concluding that BAAQMD had calculated Paris' emission reductions incorrectly. And in Wickland's later modified authority to construct, this offset estimate was negotiated between Wickland and the appellants down to 73+ (instead of 151.4) tons per year. This was higher than the new project emissions of 72.6 (instead of 83.2) tons per year, thereby satisfying the NSR rule with slightly more than a 1:1 ratio.

The APCO applied a 1.2:1 ratio to the estimated project SO_2 emissions of 24.7 tons per year, which required Wickland to obtain 29.6 tons per year in emission reductions, or nearly 4.9 tons per year more than the regulations required.

PACIFIC GAS & ELECTRIC COMPANY

BACKGROUND

To help meet increasing demand for electricity in northern and central California, PG&E proposed to build Potrero unit #7, a 414 megawatt (mw) electricity generating plant burning natural gas and fuel oil. However, 21 months later (December 17, 1980) after new projections of a smaller increase in demand, the project was deferred indefinitely. It did not get beyond the application for authority to construct evaluation phase of the air quality permit process.

The plant would have been built on San Francisco Bay at the existing Potrero power plant complex consisting of six electricity generating units. Units 1, 2, and 3 consist of conventional oil or gas fueled boilers which produce steam to drive steam turbine generators, whereas units 4, 5, and 6 consist of oil or gas combustion turbine generators which, like jet engines, are driven directly by the expanding combustion gases.

Potrero unit #7, consisting of four combustion turbine generators (282 mw) and one steam turbine generator (132 mw), would have been more efficient than Potrero units #1 through #6. According to a PG&E spokesman, Potrero unit #7 would have been the most efficient power plant in the PG&E system. Normally wasted exhaust heat from the combustion turbines would be made to produce steam to drive the steam turbine generator. During exceptionally cold weather the natural gas would be replaced by oil. The oil would be delivered by barge and stored in a 200,000 barrel tank constructed on the site.

Most emissions originate in exhaust gases from the turbines. Most PM, HC and NO_x result from natural gas combustion and most SO_2 from oil combustion. Minor emission sources include the oil storage tank, barge engines, and auxiliary boiler.

Prior to the cancellation, PG&E had not met the offset requirements. Proposed HC offsets at several dry cleaners were disallowed and the proposed onsite shutdown of Potrero units #1 and #2, two obsolete plants, were inadequate. PG&E and BAAQMD modeling showed that project CO emissions would not interfere with National Ambient Air Quality Standards at the point of maximum ground level impact so in accordance with BAAQMD regulations CO offsets were not required. Cumulative emission increases were above the offset trigger points for NO_x (550 pounds/day), HC (250 pounds/day), and PM (250 pounds/day).

Two interpollutant tradeoffs were permitted: because sulfate contributes to PM pollution, that portion of Potrero's #1 and #2 SO_2 reduction converted in the atmosphere to sulfate was allowed to offset Potrero #7 PM emissions. And because both NO_x and HC

interact to produce ozone pollution PG&E's HC emission offsets (until rejected) were allowed to offset Potrero #7 NO_x emissions.

Although, according to the evaluation engineer, PG&E met most BACT requirements, including proposed use of low-sulfur fuel oil, installation of a floating roof with double seals on the storage tank, and "efficient combustion" in the turbines, they failed to meet BACT numerical conditions for turbine NO_x emissions prior to the cancellation.

Besides BAAQMD, 9 State and Federal agencies would have had to grant 16 permits or approvals for the project. One of them, the California Energy Resources Conservation and Development Commission, which has sole authority to approve thermal electric power plants, was the lead agency. They began their review and approval process September 1976 and except for several postponements continued it throughout the BAAQMD's air quality review until PG&E cancelled the project. Under the Commission a draft EIR was being prepared.

PROBLEM SUMMARY

PG&E's authority to construct was not approved because they failed to meet either offset or BACT requirements, and PG&E suspended the processing of the application. Because the BAAQMD adopted rules requiring emission reductions at dry cleaners, PG&E's offsets were disallowed. This caused PG&E to lose offset options worth $70,000. Because their turbine manufacturer would not guarantee it without the use of water or steam injection, PG&E would not accept a permit condition on BACT for turbine NO_x emissions.

A preliminary decision on a complete application is expected to take only about 60 days but after more than 21 months the Potrero #7 application had still not been officially approved or denied. Most delays in the process resulted from the following activities of PG&E and the BAAQMD:

- In order to meet BACT and offset requirements PG&E considered alternatives, and discussed them with BAAQMD.
- Because of application changes the BAAQMD conducted three evaluations and amended one.
- PG&E awaited a Department of Energy ruling on Potrero #7 fuel use and prepared a petition for an exemption to burn gas.
- Prior to cancelling, PG&E reconsidered the need for the project.

CHRONOLOGY

May 1979 evaluation

PG&E submitted their authority to construct application on March 15, 1979 for Potrero #7, a distillate oil fueled power plant. Natural gas would have been cleaner and required fewer offsets but, according to one official, appeared to be unavailable in the amounts needed. The project was to be built in two stages: first, the four combustion turbine generators, and later, the steam turbine generator. Until the second stage start-up in June 1982, the combustion turbine generators, starting June 1981, were to operate only during periods of peak electricity demand for a limited number of hours per year. After second stage start-up all five generators were to operate together 24 hours per day to meet base-level electricity demand.

Although the BAAQMD had not yet specified BACT for NO_x emissions, the turbine manufacturer had guaranteed 75 parts NO_x per million parts air when the exhaust contains 15 percent O_2 (75 ppm NO_x).

As offsets PG&E proposed offsite HC reductions at three dry cleaners and one printer and shutdown of Potrero #1 and #2 at second stage start-up. In their first preliminary evaluation, May 1, 1979, the BAAQMD concluded that PG&E would have to acquire more offsets before approval would be granted.

November 1979 evaluation

Between the May and November evaluations two changes in PG&E's proposal reduced second stage emissions estimates for all pollutants. On August 15, 1979, following negotiations throughout the period with the turbine manufacturer and the BAAQMD, PG&E agreed to meet 50ppm NO_x by the second stage start-up now scheduled for June 1983. The director of permit services had tentatively determined this to be BACT after conversations with two turbine manufacturers. PG&E also agreed to an authority to construct condition limiting second stage operations from full-time (24 hours per day) to 80 percent full-time. This reduction, encouraged by the BAAQMD, was based on the observed downtime of other full-time base-load plants.

After allowing for four approved dry cleaner offsets, the second preliminary evaluation, November 14, 1979, showed that PG&E still needed offsets in both stages, so that approval could not yet be granted.

Based on indications that natural gas availability was increasing, the BAAQMD, in discussions throughout the period, encouraged PG&E to switch from oil to gas to further reduce emissions. And BAAQMD prepared an evaluation of the project using gas showing that in both stages PG&E would need additional NO_x offsets only.

July 1980 evaluation

On December 12, 1979, PG&E asked the BAAQMD to postpone a preliminary decision until the Department of Energy ruled on PG&E's request to classify Potrero #7 an "existing" unit rather than a "new" unit. The Power Plant and Industrial Fuel Use Act (PIFUA) had provided that without an exemption from the Department of Energy a power plant classified as "new" could not burn oil or gas as a primary fuel whereas an existing one could. And because Energy's ruling would affect plant fuel, and therefore emissions, it would therefore affect PG&E's approach to meeting offset requirements.

But Energy denied PG&E's request February 4, 1980, so PG&E applied for a temporary exemption to burn gas until synthetic fuels became available about 1990. Using gas now and synthetic fuels later had become an alternative because the availability of gas for power plants had increased, and Federal policy had developed favoring gas over oil in the near term and synthetic fuels over others in the long term. The main purpose of switching to gas was to reduce offset requirements.

Between the November and July evaluations PG&E made several changes to reduce offset requirements:

- Fuel would be switched from oil to gas.
- First stage start-up would be delayed, making 50ppm NO turbines available in the first as well as the second stage.
- Potrero #1 and #2 would be shut down early and would therefore offset emissions in the first as well as the second stage.
- Five instead of four dry cleaner offsets would be provided.

But the BAAQMD imposed two further BACT and offset requirements on PG&E, which in part prevented authority to construct approval. First, because the BAAQMD considered the switch from oil to gas a significant change from PG&E's original application they declared this to be a new application and considered it complete May 23, 1980. This action resulted in PG&E's losing their dry cleaner offsets because regulations requiring the emission reductions PG&E wanted to use as offsets had recently been adopte by the BAAQMD. Second, the BAAQMD concluded that BACT for turbi would probably be 42ppm, not the 50ppm suggested earlier, becaus San Diego's SIP limits NO_x to 42ppm.

Thus, in their third preliminary evaluation, July 21, 1980, the BAAQMD again withheld authority to construct approval. PG&E would have to acquire more offsets and guarantee lower NO_x emissions.

PG&E's appeal

Several extensions of BAAQMD's 60-day decision deadline avoided a denial of the project, allowing PG&E to consider alternatives to remove the BACT and offset deficiencies and to postpone action amid growing indications that the project would be cancelled.

On October 14, 1980, PG&E appealed to the hearing board BAAQMD's denial of PG&E's dry cleaner offsets, arguing that BAAQMD misinterpreted rule 2-1-307, but cancelled the appeal 2 months later when the project was cancelled. Based on PG&E's lower forecasted growth in electricity usage the project was no longer needed.

PROBLEMS

Dry cleaner offsets: regulations

BAAQMD disallowed PG&E's dry cleaner offsets, which in part prevented approval of the May 23, 1980, application, and caused PG&E to appeal BAAQMD's decision to the board. Had the project not been cancelled, BAAQMD's ruling would have required PG&E to seek and purchase other, probably more costly offsets.

BAAQMD would not accept PG&E's dry cleaner offsets. BAAQMD regulation 2-1-307 read "Emission reductions resulting from requirements of Federal, State, or District laws, rules, or regulations shall not be allowed or banked as emission offsets unless a complete application was filed with the District at least 90 days prior to the adoption date of such laws, rules, or regulations." 1/ BAAQMD argued that the "complete application" referred to in 2-1-307 is that of the new or modified source, the Potrero #7 power plant. Therefore, BAAQMD would not allow PG&E's proposed dry cleaner offsets because PG&E's application, considered complete by the District as of May 23, 1980, had not been completed more than 90 days prior to BAAQMD regulations 8-17 (adopted May 21, 1980) and 8-27 (adopted March 5, 1980). Regulations 8-17 and 8-27 require the emission reductions which PG&E proposed to use as offsets.

PG&E disagreed with BAAQMD, arguing that the "complete application" is that of the source of the emission reductions, the dry cleaners, and that application for five dry cleaners was complete no later than September 17, 1979, more than 90 days before BAAQMD's regulations 8-17 and 8-27 were adopted. Therefore, they contended these dry cleaner offsets should be allowed.

1/Subsequent to the PG&E case, language in this regulation was changed.

PG&E appealed BAAQMD's ruling to the board on October 14, 1980, but the appeal was never adjudicated because PG&E cancelled the project and, on December 18, 1980, the case was dismissed. Because the board did not have the opportunity to make a ruling a similar appeal could arise again. Future appeals would be avoided if BAAQMD were to specify in regulation 2-1-307 to which "complete application" the regulation refers. 1/

Dry cleaner offsets: new application

PG&E and BAAQMD disagreed on the date that the Potrero #7 application was complete and whether or not the May 23, 1980, application had changed significantly from the previous application. With the adoption of the new dry cleaner regulations BAAQMD's viewpoint caused them to disallow PG&E's dry cleaner offsets.

BAAQMD legal counsel told PG&E that its application was not complete prior to May 23, 1980, because PG&E did not have enough offset data for BAAQMD to make a preliminary decision on the authority to construct. (However, the director of permit services has said recently that PG&E was told this erroneously.) And even if the original application had been complete, according to BAAQMD legal counsel, the switch to gas fuel from oil (and a few other changes) significantly altered expected project emissions. BAAQMD policy was that when a project is changed so as to significantly alter expected emissions BAAQMD may treat that change as a new application to allow BAAQMD staff time to conduct its review.

PG&E responded that its original application submitted March 15, 1979, had been complete because BAAQMD had calculated emissions; and that according to BAAQMD's "Lists and Criteria" an application is complete when it provides enough information for BAAQMD to calculate emissions. In letters to PG&E on May 1, 1979, and November 14, 1979, BAAQMD had indeed calculated emissions and had told PG&E that the preliminary evaluation was complete.

PG&E argued that their April 15, 1980, decision to use gas instead of oil did not significantly change project emissions except to reduce SO and that BAAQMD had already calculated gas emissions in the November 14, 1979, evaluation so that no new analysis was required. One PG&E official said that if BAAQMD had needed additional time to conduct its evaulation PG&E could simply have agreed to another extension of the evaluation period rather than allow the application to be considered new.

1/Recently, after our audit, the District added the words, "for such banking or actual emission reductions," after "complete application"; cf., new regulation 2-1-306.

PG&E did not pursue this disagreement further. To regain their disallowed offsets, PG&E decided instead to appeal BAAQMD's interpretation of regulation 2-1-307 to the board.

Turbine BACT

In part because PG&E did not agree to meet BACT for turbine NO_2 BAAQMD could not approve the May 23, 1980, application. The evaluation engineer concluded that PG&E's gas turbines did not meet BACT requirements. Regulation 2-2-202 defined BACT as the most stringent of the following three specifications:

- The most effective emission control device or technique which has been utilized for at least one year, for the equipment comprising such stationary source.
- Any other emission control device or technique determined to be technologically feasible and cost-effective by the APCO.
- The most effective emission control limitation for the equipment comprising such stationary source which the EPA certifies, during the public comment period, is contained in an approved implementation plan of any State, unless the applicant demonstrates to the satisfaction of the APCO that such limitations are not achievable.

In July 1980, BAAQMD concluded, in accordance with the third specification of regulation 2-2-202, that Rule 68 of San Diego's approved SIP contained an emission limitation for gas turbines that represented BACT. A review of turbine test data and field performance convinced the evaluation engineer that the limitation was attainable.

PG&E would not accept the San Diego Rule 68 emission limits as a permit condition because without water or steam injection the turbine manufacturer would not guarantee that low an emissions figure.

The BACT deficiency was never removed because PG&E did not reach an agreement with the turbine manufacturer before the project was cancelled.

Emissions

Although some of the BAAQMD's emissions estimates were more advantageous to PG&E than PG&E's own, concern over possible inaccuracy prevented PG&E from accepting them without negotiation.

BAAQMD estimated 64.5 tons per year of PM emissions from Potrero #7 based on source tests whereas PG&E estimated 142 tons per year, or about 80 tons per year higher. BAAQMD's estimate was more favorable to PG&E because it would have required fewer offsets. BAAQMD estimated 1,848 tons per year of HC emissions

from Potrero's #1 & #2 based on AP-42 whereas PG&E estimated 1,435 tons per year, or over 400 tons per year less based principally on source tests. BAAQMD's estimate was more favorable to PG&E since it represented more offsets.

But PG&E wanted to avoid the appearance, publicly, of being credited with either fewer emissions or more offsets than they were entitled to. They expected their authority to construct to be appealed by CBE based upon CBE's appeal of the Wickland authority to construct and their interest and participation in the Commission hearings and the air quality evaluation for Potrero #7. Therefore, PG&E believed that the BAAQMD's evaluation would have been subjected to public scrutiny. A senior engineer at PG&E said that had the project not been cancelled, instead of accepting BAAQMD's estimates, PG&E intended to discuss both its own and BAAQMD's calculation methodologies and negotiate with BAAQMD mutually agreeable estimates. The purpose of this negotiation would have been to strengthen the justification for the finally agreed upon estimates. However, the project was cancelled before the estimates could be negotiated

Offsets

Because the location of the cheapest offsets was not known, PG&E had a study conducted costing $56,000 and requiring 10 months to complete. But, according to a PG&E spokesman, most offsets recommended by the study were unavailable so PG&E had to locate other offset sources.

The study estimated amounts and costs of emission reductions available at each of more than 200 major sources in the Bay Area, and in several small source categories such as paint removal services. It was conducted to aid in the planning of three electricity generating plants in the Bay Area including the Potrero #7 plant.

Only one of the major HC sources contacted, a dry cleaner, wanted to sell. So, remembering Wickland's experience, PG&E sought and purchased from Stoddard dry cleaners $70,000 worth of options and extensions thereof to purchase offsets. Installing the control equipment, thereby exercising the options, would have cost PG&E an additional $1.3 million, but this was still estimated to be $19 million cheaper than the alternative, retrofitting existing PG&E facilities with NO_x controls. In the end, PG&E received no value for the $70,000 option money because BAAQMD disallowed the dry cleaner offsets and the project was cancelled.

The shutdown of Potrero's #1 & #2 comprised PG&E's only offsets for other pollutants. According to a PG&E spokesman, none of the major sources contacted from the study wanted to sell. They intended to use their offsets for their own future expansio

BANKING ACTIVITY IN THE BAY AREA

HEWLETT PACKARD

On July 22, 1980, Hewlett Packard, Inc. submitted its application for ERCs. The company chose the formal bank because of its superior protection against regulatory change. Hewlett Packard proposed to bank emission reductions resulting from a change in the way that printed circuit boards are produced at its Palo Alto plant. It has been using two chemicals--1,1,1 trichlorethane and methylene chloride, and was now proposing to substitute aqueous solutions for these chemicals, which by its estimates could reduce organic solvent emissions by 219 tons per year. Hewlett Packard estimated this reduction after evaluating the last 3 years of purchase and recovery records for the two chemicals which were to be no longer used. However, BAAQMD, after examining these same records, approved credit for only 159.4 tons per year. This disparity in estimates was due primarily to BAAQMD's use of 260 actual days of operation, rather than Hewlett Packard's use of 365 days per year for the facility.

Hewlett Packard officials were pleased with the way in which their application was handled. On October 10, 1980, BAAQMD preliminarily approved an ERC of 159.5 tons per year. A certificate will be granted after the production change is completed and a permit to operate has been issued.

TRI-VALLEY GROWERS

On August 18, 1980, Tri-Valley Growers, Inc., applied for ERCs from a forthcoming shutdown of its canning plant, S&W Fine Foods in Redwood City, California. Operations of this plant are to be moved outside the District. No particular use for the requested credit has been planned. Interestingly, S&W inquired about ERCs shortly after BAAQMD notified it that facilities emitting 2.5 tons or more per year of any criteria pollutants would now require an operating permit.

In its estimates of emission reductions, S&W assumed operation of its four boilers at maximum capacity, but did not submit any emission factors or calculations. The District engineer evaluating this application estimated much smaller emission reductions, based on fuel use records of S&W for 1975-76 and on EPA-approved emission factors. The District preferred more recent data on fuel use but a company fire had destroyed these records.

On October 8, 1980, S&W's application, with these revised estimates, was submitted by the permits division of BAAQMD to the Air Pollution Control Officer for preliminary approval. However, it was decided that the missing fuel data would have to be obtained. On October 28th, BAAQMD asked S&W to get this information from its fuel suppliers. In February 1981, a company official

told us that these data would be sent, shortly, to BAAQMD. He also agreed with the District's estimates of their emission baseline.

However, BAAQMD's Director of Permit Services questioned any approval of ERCs unless it could be shown that S&W's operations will not be merely transferred to another cannery in the District.

STAUFFER CHEMICAL

On October 21, 1980, Stauffer Chemical, Inc., applied for ERCs, to result from shutting down its boric acid plant in San Francisco. Stauffer has no specific use in mind for these proposed credits.

On November 7, 1980, BAAQMD notified Stauffer that its appli cation was incomplete and cited the requirement for documentation of actual emissions. Based on the company's estimated emission reductions, BAAQMD also asked why this plant had no operating per mits. In addition, BAAQMD requested that the company certify tha its other sources are in compliance. But, in response to our in- quiry, a District official stated that this request for certifica tion was in error.

By January 17, 1981, the District still had not received the requested information and did not know why Stauffer has no operat ing permits. A company representative alleged that such permits were not required until just prior to the plant's shutdown, so they were not obtained. He also said that Stauffer is preparing the requested data.

RAYCHEM

Like Stauffer Chemical, Raychem, Inc., applied for ERCs, on March 12, 1980, only to learn that its proposed sources did not have the required permits to operate. Raychem planned to shut down one of its manufacturing facilities in Redwood City.

On April 22, 1980, BAAQMD notified the company that it coul not approve the requested credit, and that its enforcement divi- sion had been alerted to Raychem's lack of necessary operating permits. About 3 months later, the company submitted informatic for the needed permits. However, the District did not look at these data until October 1980, because it was too busy with othe matters. BAAQMD then notified Raychem that this information wa not suitable, so it could not proceed with an evaluation. In January 1981, a District official informed us that he thought the company would get most of its originally proposed credit because the necessary operating permits would not be very stric

With the exception of Raychem, the District's processing o banking applications has been expeditious. In the Raychem case it is unclear why this company's bid for ERCs has been delayed

almost 1 year. We find this delay especially curious in light of BAAQMD's admission that needed operating permits will eliminate very little of the originally proposed ERCs.

PERMIT CONDITIONS IN THE WICKLAND OFFSET

Listed below are the basic constraints which the District felt were necessary to render Wickland's permit enforceable:

1. Before Wickland's startup, the issuance of a permit to operate to City of Paris (Paris) dry cleaners--an offsetting source--ensuring necessary offsets.

2. Suspension of Wickland's permit to operate in the event of Paris' noncompliance, unless Wickland can correct this offset inadequacy.

3. Constraints on maximum throughputs at the Wickland terminal and on truck shipments from the terminal.

4. Limitations on maximum ship deliveries to Wickland's terminal and on ship ballasting.

5. Wickland's regular reporting to the District of ballasting information.

6. Wickland's provision of specified minimum quantities of low sulfur content fuel to marine vessels operating in District waters, and Wickland's annual reporting to the BAAQMD of data on such fuel provision and its use, and Wickland's demonstration that burning such fuel provide a specified minimum annual net reduction of SO_2.

7. Fail-safe instrumentation to prevent truck loading at Wickland's terminal in the event of abatement system failure.

8. A dedicated maintenance plan at Wickland's terminal, entailing periodic checks for emission leaks and their prompt repair, and including annual reports to the District regarding these matters.

9. Wickland's annual report to BAAQMD on tanker deliveries and tanker sizes and total terminal throughput by class of organic material.

10. Wickland's compliance with NSPS and BACT requirements, compliance (by marine vessels serving Wickland) with S emission limits, and Wickland's refusal to offload any vessels not complying with the above constraints.

PACIFIC COAST CEMENT COMPANY
POSSIBLE TRADEOFF CANDIDATES
WITHIN A 10-MILE RADIUS

Company	SO_2/Particulates (tons/year) (Company inventory)	Responses (Why tradeoffs were not feasible)
ARCO (Refinery)	4,073.4/478.4	"Saving tradeoffs for future projects."
Bethlehem Steel	0/74.0	Intermittent source. 1/
Canners Steam Co.	29.0/13.0	"Natural gas--interruptible schedule."
Can Containers Co., Div. LHB Foods	0/14.0	--
Champlin Petroleum Company	702.7/32.8	"Saving tradeoffs for future projects."
Edgington Oil Refineries	66.0/35.0	"...have no interest in such an arrangement [elaborated that they began working with the District 3 years ago to establish their own bank]...that in light of possible expansion...no excess emissions to give to the Port."
Flecher Oil and Refinery Co.	69.0/14.0	2/
Golden Eagle Refinery Company	1.0/9.0	2/
Great Lakes Carbon Corporation	3,144.0/130.0	"Source too large. Not interested...on SO_2 attainment schedule."

APPENDIX V

Company	SO_2/Particulates (tons/year) (Company inventory)	Responses (Why tradeoffs were not feasible)
Kaiser Gypsum Co., Inc.	0/43.0	"...due to our past dealings with them on this project wherein their opposition... was made quite clear, it is advisable that they remain uncontacted." [Kaiser had opposed the Pacific Coast Cement Company project in the EIR on the grounds that the company "would be dumping its product."]
Los Angeles Dept. of Water and Power--Haynes	17,224.0/17,289.0	2/
Los Angeles Dept. of Water and Power--Harbor	401.0/56.0	2/
Martin-Marietta Aluminum, Inc.	.6/28.0	"Presently using BACT. Couldn't obtain firm response."
Martin-Marietta Carbon, Inc.	2,360.0/93.0	"Presently using BACT; increase in controls may reduce productivity. Poor prospect ..."
Mobil Oil Corp.	2,286.0/338.0	
Monsanto Co.	1.0/30.0	"Using BACT; addtional controls would hinder productivity. Not interested."
National Gypsum	0.0/49.0	"Intermittent Source." "Possible use of baghouse." Local plant reps "positively interested" but Port official indicated that national headquarters nixed the idea. Also, firm preferred a low profile.

APPENDIX V

Company	SO_2/Particulates (tons/year) (Company inventory)	Responses (Why tradeoffs were not feasible)
National Supply Co.	.5/8.0	"Intermittent Source"
Pacific Smelting Co.	1.0/9.1g	"Saving for future projects." "Low emitter for SO_2 but interested."
Proctor & Gamble	26.0/37.0	"Currently meeting BACT limits; not in a position to give away their emissions and then be 'caught flat' themselves; in future...needed to keep their options available...thus planned to keep their own emissions."
Rachelle Labs	0/2.0	
Shell Oil Corp.	3,156.0/219.0	2/
Shell Oil Corp.	75.0/82.0	2/
Southern California Edison - Alamitos - Long Beach	11,180.0/2,323.0 124.0/153.0	"In light of the Sohio experience, we're hesitant to get involved." Also, "Edison needs the tradeoffs for its own customers as well as for its own future facilities."
Stauffer Chemical Co.	527.0/9.0 36.0/113.0	"Initially, positive response, will forward to Corp. management." According to Port official, corp. headquarters nixed the idea; also scrubber technology was judged too costly and unreliable.

APPENDIX V

Company	SO_2/Particulates (tons/year) (Company inventory)	Responses (Why tradeoffs were not feasible)
Texaco, Inc.	1,188.0/256.0	2/
Todd Pacific Shipyards	0.0/67.1	"Intermittent Source."
U.S. Borax & Chemical	1.8/352.0	"Possibly willing to allow use of bag-house" - initial response. "Unable to obtain firm response."
U.S. Steel	90.0/182.0	Obtained SO_2 tradeoff via fuel-switching agreement. Later, shut down; U.S. Steel gave banking credit.
Union Carbide	1.0/23.0	2/
Union Chemicals Division	284.0/9.0	"Sulfur acid stack emitting less than 500 ppm sulfur with ammonia stack scrubber installed in 1974. Any further reduction unfeasible or at least uneconomic."
Union Oil	3,714.0/346.0	"Saving tradeoffs for future modifications."
Western Dyeing & Finishing	25.0/8.0	"Natural gas--interruptible schedule (diesel backup)."

1/Intermittent sources are not desirable tradeoffs if their emission profiles are not coincident with project's.

2/Direct port contact not made due to general knowledge that tradeoffs are being saved, and/or because source is so large that control is not feasible for small tradeoffs, and/or source is intermittent.

APPENDIX V

PACIFIC COAST CEMENT COMPANY
POSSIBLE TRADEOFF CANDIDATES
BEYOND A 10-MILE RADIUS

Company	SO_2/Particulates (tons/year) (Company inventory)	Responses (Why tradeoffs were not feasible)
W. R. Grace approx. 12 miles	4.0/63.0	Initial contact: "possible interest in baghouse to control emissions from materials transfer." "Reaffirmed interest in being [TSP] tradeoff candidate..." "Presently controlled by wet scrubbers." "Assuming baghouse would be more efficient device..., tradeoff possible."
Firestone Tire approx. 12 miles	44.0/0.0	"Natural-gas interruptible service." "Diesel as backup in winter."
Philadelphia Quartz approx. 12 miles	3.7/10.4	"Saving for future projects."
U.S. Gypsum approx. 12 miles	53.0/50.0	"Using BACT; no room for cost-effective controls."
Owen-Illinois, Inc. approx. 16 miles	143.0/12.5	"Saving tradeoffs for future projects." "BACT for particulates. Saving SO_2 for future projects."
Glass Containers Corp. approx. 16 miles	16.5/20.5	"New scrubbers - '78 or late '77[;] no available emissions for cleanup."
Bethlehem Steel approx. 16 miles	6.0/54.0	"Natural gas--interruptible service. Weak response regarding particulates." "Interested in particulate control, need letter."

APPENDIX V

POSSIBLE TRADEOFF CANDIDATES BEYOND A 10-MILE RADIUS

Company	SO_2/Particulates (tons/year) (Company inventory)	Responses (Why tradeoffs were not feasible)
Container Corp. of America approx. 16 miles	54.0/14.3	"Saving tradeoffs for future projects."
Crown Zellerbach approx. 16 miles	6.0/3.0	"Natural gas - interruptible service." "Particulates already BACT." BACT with baghouses.

NOTE: The companies listed in the above table were described as "backup tradeoff candidates."

APPENDIX V

THE PACIFIC COAST CEMENT COMPANY CASE

Condition #

16. Pacific Coast Cement Company shall provide emission reductions of at least 800 lbs./day of NO_2 and 20 lbs./day of HC from Long Beach Oil Development Company (Long Beach Oil). The following shall be sufficient to satisfy this requirement:

    a. Pacific Coast Cement shall provide to Long Beach Oil four NO_2 reduction catalysts with oxidizing stages to be installed on four continuously operating, natural-gas fired, 500 horsepower internal combustion engines which catalysts will achieve a minimum 90 percent reduction of NO_2 and HC emissions from those engines. NO_2 reductions from installation and operation of these catalysts shall also be deemed to be sufficient to offset the emissions of PM from the terminal.

    b. The catalysts shall operate under valid Permits to Operate issued by SCAQMD.

17. Pacific Coast Cement Company shall provide emission reductions of 50 lbs./day of SO_2 from U.S. Steel Corporation in Torrance. The following steps shall be sufficient to satisfy this requirement:

    a. Pacific Coast Cement shall provide U.S. Steel with 12,350 barrels/year of fuel oil having a sulfur content of not more than 0.5 percent by weight;

    b. U.S. Steel's Permits to Operate for open hearth furnaces shall be revised to require burning of 1,420 gallons/day of the 0.5 percent sulfur fuel oil or an amount of lower sulfur fuel oil which would result in equivalent reductions of sulfur compounds amounting to 50 lbs./day.

18. Pacific Coast Cement Company shall provide emission reductions of 20 lbs./day of HC from one or more of the dry cleaners listed in Exhibit "A" attached hereto and incorporated herein by this reference. The following steps shall be sufficient to satisfy this requirement:

    a. Pacific Coast Cement Company shall provide one or more of such dry cleaners with activated carbon absorption unit which achieve a minimum of 90 percent reduction in HC emissions from that source;

b. The Permit to Operate held by such dry cleaner(s) shall be modified to require installation and maintenance of the carbon absorber.

THE WATSON ENERGY CASE

1. The total steam load comprised of the steam purchased from Watson Energy Systems and the amount generated by boilers #31, #32, #33, #42, #51, and #52 at the ARCO Watson Refinery shall not exceed 1,355,000 pounds per hour at 680°F, 600 psig.

2. Continuous records of steam purchased from Watson Energy Systems and of the steam produced by boilers #31, #32, #33, #42, #51, and #52 at the ARCO Watson Refinery, during the receipt of steam from Watson Energy Systems, shall be maintained and made available for inspection by the EPA and the South Coast Air Quality Management District. These records shall be kept in terms of pounds per hour of steam at 680°F, 600 psig.

3. The steam purchased from the Watson Energy Systems facility shall be used as a "first-on, last off" source of steam for the ARCO Watson Refinery, except for steam produced by waste heat or as part of the refining process, or as required to maintain fired boilers in service for emergency use.

4. Any proposed changes in equipment that would increase the oil fired steam generating capacity or decrease oil fired steam generating efficiency of boilers #31, #32, #33, #42, #51, or #52 at the ARCO Watson Refinery must be reviewed and approved by the EPA prior to implementation of the proposed changes.

5. ARCO shall maintain written records of oil consumption at boilers #31, #32, #33, #42, #51, and #52 during receipt of steam from Watson Energy Systems. These records shall be available for inspection by the South Coast Air Quality Management District and the EPA. The total oil consumption of these boilers shall not exceed a monthly average of 226,000 gallons per day when receiving steam from the Watson Energy Systems plant at a rate of 350,000 pounds per hour. When receiving steam at a lower rate, ARCO shall be allowed to increase its boiler fuel oil consumption to achieve a total steam load not to exceed the limit of condition one (1).

APPENDIX VII

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

NOV 16 1981

OFFICE OF
POLICY AND RESOURCE MANAGEMENT

Mr. Henry Eschwege
Director
Community and Economic
Development Division
U.S. General Accounting Office
Washington, D.C. 20548

Dear Mr. Eschwege:

The Environmental Protection Agency (EPA) has reviewed the General Accounting Office (GAO) draft report, "A Market Approach to Air Pollution Control Could Reduce Compliance Costs Without Jeopardizing the Goals of the Clean Air Act." The Agency's comments on the draft report are attached, in fulfillment of Public Law 96-223.

This report supports EPA's efforts to relieve States and industry of unnecessary regulatory burdens while continuing to achieve statutory goals. It presents a lucid and generally well-informed analysis of how emissions trading can reduce the costs and rigidity of the Clean Air Act. Its empirical findings show that offset policies and related trading steps can be useful tools for states facing attainment problems.

1 We also welcome the report's focus on practical implementation rather than economic theory. Despite contentions that external offsets are too expensive or problematic to obtain in severe nonattainment (NA) areas, the report concludes that tens of thousands of tons of offsets are readily available at reasonable prices in these areas, even assuming the most stringent future control scenarios.

2 We note that the draft report's recommendation that Congress allow New Source Performance Standards (NSPS) bubbles between new and existing facilities raises serious issues which the report does not address. Bubbles which let new facilities avoid NSPS in exchange for compensating increased controls on existing sources can produce short-term air quality equivalence. However, because the existing source is likely to shut down while the new, non-NSPS facility keeps operating, this approach could result in a long-term increase in emissions over what traditional NSPS on the new facility would produce. Since NSPS is regarded as an effective

3 and easily-administered new source program, any recommendation for NSPS bubbles must address workable mechanisms for assuring the permanence of offsetting reductions for the life of the new facility before Congress could responsibly effect this change.

Although other specific problems and comments are provided in the attachment, we generally find the report to be a coherent and balanced review of the evidence. It is especially timely during this period of shrinking resources at all levels of government and industry. EPA agrees with and has for some time been implementing the report's general recommendation that trading opportunities be expanded within the current Clean Air Act to achieve cost-effectiveness and relieve waste and over-rigidity in air pollution control. We intend to continue to extend opportunities to the states to make existing-source bubbles and other voluntary emissions trades easier, quicker and more predictable to use.

We appreciate the opportunity to comment on this report prior to its publication and request that this letter be made an integral part of the enclosed comments.

Sincerely yours,

Joseph A. Cannon

Joseph A. Cannon
Acting Associate Administrator
for Policy and Resource Management

Enclosure

EPA Comments to the GAO Draft Report, "A Market Approach to Air Pollution Control Could Reduce Compliance Costs Without Jeopardizing the Goals of the Clean Air Act"

GENERAL COMMENTS

4 1. The report's title misleadingly sugggests that full market- or incentive-based approaches -- e.g., marketable permits or emissions fees -- are being recommended to replace the current regulatory system established by the Clean Air Act and the States. Yet its exclusive focus is on implementing controlled trading (broadly defined as use of inexpensive surplus reductions created at one point and time to meet or avoid expensive regulatory requirements applicable to other points) as a supplement to the current system, and especially on past implementation of offsets and banking in California. The title should be changed to "Controlled Trading Supplements to Air Pollution Control..." or "Emission Trading Supplements to Air Pollution Control..."

5 2. The report's concluding summary notes the significance of the recent "upsurge in bubbling" which "may mark a turning point in which the private sector gains confidence that controlled trading is 'here to stay' and begins [actively] exploring opportunities" (pp. 7-1-2). But its text does not adequately document this upsurge and glosses over the importance of bubbles, which are more significant than offsets because existing sources comprise over 95% of current nonattainment inventories. As of November 1, 1981, EPA had approved or proposed to approve 16 bubbles saving applicants an estimated $50 million over the cost of conventional controls. At least 80 more bubbles averaging $2 million in savings were being actively developed. Many of these bubbles will produce overall emission reductions and energy savings; a significant number involve multiplant or interfirm trades. (In two recent bubbles effected through the operating Louisville bank, for example, GE and Borden Chemical leased or bought VOC emission reduction credits (ERCs) and used them to meet state reasonably available control technology (RACT) requirements at savings averaging over 90% of the cost of conventional controls). Sixteen states were developing "generic" rules to avoid time-consuming state implementation plans (SIP) revisions for individual bubbles; many of these rules included banking components. More extensive banks than San Francisco's were operating in Louisville and Seattle, with at least a dozen others in state or local rulemaking. EPA was preparing a policy statement which would let States substantially expand opportunities for bubbles consistent with the Clean Air Act, and provide clear decision principles on when ERCs can be created, stored, and used for any trade. (See attachments).

6 3. The report similarly skimps the significance of banks for netting and bubbles. Netting --- the applicability of which was expanded in nonattainment areas on October 14, 1981, (46 FR 50766) --- would let plants expanding or modernizing in such areas use a bubble approach to avoid new source review and associated requirements (preconstruction permits, lowest achievable emissions rate (LAER) control technology, the offset requirement, and any applicable ban on new construction) so long as plant-wide emissions do not significantly increase. While NSPS would still apply to the new facility, this approach, if adopted by States, would substantially reduce the barriers to trades noted by the report.

Even where the industrial base is stable or declining, banking can facilitate interfirm bubbles to meet existing-source control requirements, increase bubble savings, and open up bubble opportunities to sources which have single stacks or for other reasons cannot benefit from single-plant trades. Banking can also speed permit approvals and smooth workloads by letting state pollution agencies certify surplus emission reductions in advance of their use in permit applications. EPA supports state or local banking systems which provide ERCs maximum protection consistent with the Clean Air Act. EPA's Region IX is working with Bay Area Air Quality Management District (BAAQMD) at its request to broaden participation in the Bay Area bank (see attachment 1, an excerpt from the Region's FY 1982 Section 105 agreement with BAAQMD).

7 4. The report does not recognize that emission trading or any other successful change in the complex, two-tiered air quality management system must be implemented incrementally. Instead it tends to assume direct "before and after" comparisons between the past system and an ideal system characterized by full-fledged market trades to meet any regulatory requirement. It is important to recognize that offsets, banking, the bubble and nonattainment-area netting have been incremental steps which let states open more regulatory requirements to emissions trading within the current system, without creating large new uncertainties or compelling local governments to redo their air pollution programs before any trades can take place. While these steps may evolve into active markets, their scope is for the States to determine, consistent with the Clean Air Act. EPA's approach has been to make more trading options available to States, to avoid overloading the current system, and to recognize that these approaches can provide substantial cost-savings and compliance flexibility over traditional command-and-control regulation, even if relatively few interfirm trades for cash are made.

8 5. Chapter 3's background discussion concludes that trading approaches which could lead to marketable permits are more compatible with the current system than emission fees. However, some of its reasons against fees (e.g., the impact of inflation on fee levels) could be corrected by properly designed systems, while others not mentioned (e.g., the technological infeasibility of measuring precisely quantities of emissions from zero through maximum capacity) seem more intransigent. Moreover, possible uses of fees as narrower "safety valve" supplements to trading may have been dismissed too quickly. For example, use of mobile-source nonconformance penalties based on the degree engine standards are exceeded and the marginal cost of coming into compliance could allow domestic automobile makers to exceed certain standards instead of halting production, without removing incentives to comply. Where offsets for major new sources or modifications are too difficult or expensive to obtain, sources might be allowe to pay a fee (based on the area's estimated cost of producing surplus reductions) to the relevant pollution control agency, which could use

these funds to secure such reductions itself. (cf. p. 3-8 n. 1). A similar "offset fee" was recommended by the National Commission on Air Quality, and could accelerate trading by assuring potential offset producers both a ready buyer and a ready supply of offsets should future need arise.

9 6. Finally, some of the draft report's recommendations raise major issues which are not adequately addressed. EPA supports expanded use of the bubble and more efficient offset approaches as important tools in the arsenal of states experiencing nonattainment problems. That choice, however, is for the states, and important issues relating to the proper extent of EPA's role have not been addressed. Subject to the same proviso, EPA would also support state use of best achievable control technology (BACT)/LAER determinations to establish baselines for emissions trading and generally agrees more certain and predictable substitutes should be found for such case-by-case technology determinations. However, the report's recommendation (p. 7-17) that Congress allow NSPS to be met through controlled trading with existing sources addresses only immediate air quality equivalence, not the long-term ambient improvement which is one of the main goals of Section 111. This recommendation would create a substantial danger of long-term ambient degradation unless implementation issues relating to long-term effects are adequately addressed. See our more detailed comments on the report's recommendations below.

Detailed Comments

-- We suggest that the following revisions be made in the report's Glossary:

10 • Lowest Achievable Emission Rate (LAER): This definition should be consistent with the definition provided in Section 171(3) of the Clean Air Act. LAER is generally more stringent than new source performance standards.

11 • The definitions of "major new stationary source" and "source" should be made consistent with the definitions provided in 40 CFR Part 52 as published on October 14, 1981, (46 FR 50766). This particular Federal Register discusses the latest EPA policy concerning these particular definitions and their ramifications. In particular, it approves "netting" for plants expanding or modernizing in nonattainment areas, and details some of the implications of this major change.

12 • Define "netting" as use of a bubble approach by expanding or modernizing plants to avoid New Source Review (NSR) and associated requirements (including preconstruction permits, BACT or LAER

the requirement for greater than 1-1 offsets in nonattainment areas, and construction moratoria where applicable) so long as plant-wide emissions do not significantly increase. NSPS would continue to apply to the new "affected facility," and the state would still have to demonstrate Reasonable Further Progress (RFP).

13 • Reasonably Available Control Technology (RACT): This definition should be revised as follows: "Emission limitation that represents the lowest limit that a particular source . . . ." This definition is found at 45 FR 59199 (September 8, 1980). Under EPA's bubble policy as currently being applied, sources are generally free to meet state-defined RACT by securing equivalent emission reductions through bubbles within or between plants or industrial process (CTG) categories, rather than by installing specific control technology on identified emission points.

-- We suggest that the following revisions be made in the text of the report:

14 • The report refers throughout to emission "rights". While this is common in the economic literature, a better term for a government report would be emission "entitlements". This is because of criticism by legal authorities that references to the conferring of emission rights is incorrect and that even a phrase suggesting granting of "entitlements" should be qualified so as not to imply government appropriation of the air resource.

15 • The report should recognize the significance of EPA's October 14 change expanding the applicability of "netting" in nonattainment areas. Our best estimate indicates that this change, if adopted by States, would exempt over 90% of major new sources from the Emission Offset Interpretative Ruling and parallel state new source review provisions. This estimate is based on the fact that very few new plants or modifications appear to have been abandoned due to the offset requirement, and that well over 90% of 1500 documented successful offset transactions were "internal."(f., e.g., Wes Vivian and William Hall, "An Examination of U.S. Market Trading in Air Pollution Offsets" (University of Michigan Institute of Public Policy Studies, March 1981). These "internal" trades would generally "net out" under EPA's October 14 change, provided they were within the same plant rather than just within the same firm. Widespread availability of such "netting" opportunities would both expand controlled trading opportunities and substantially reduce some of the implementation barriers noted in the draft report. Entirely new "greenfield" plants would still be subject to NSR, since they could not "net out" due to the statutory definition of "source."

16 • Proper accreditation to the "bubble" and "offset" policies on pages iv, 1-2 should be made. Specifically, the first full sentence on p. iv should read "For example, as with EPA's "bubble policy," a firm might..."; the third, fourth and sixth sentences in the first full paragraph on p. 1-2 should respectively read "As with EPA's bubble policy, a firm might..."; "Or, several firms might..."; "Such an approach is included in EPA's emission offset and bubble policies. And it is in this type of arrangement..." We parenthetically note that the bubble policy has from the beginning allowed trades between two or more existing plants for TSP and SO_2 as well as VOC, and that EPA has progressively been taking steps to make such interfirm bubbles easier to obtain.

17 • The savings of 90% from market approaches cited from the study by Mathtech of the Chicago Air Quality Control Region (AQCR) (see pp. v, 3-11, 7-2) misinterprets the study's results a bit. The 90% savings result from source-by-source controls that account for differences in sources' marginal control costs and their marginal contributions to ambient air quality. In theory, such savings could be achieved by "enlightened regulation" as well as by other means (though, admittedly, traditional regulation tends to be more restrictive in practice). It is not unlikely that, for practical reasons, economic incentives would be applied uniformly across similar "clusters" or source categories of polluters rather than on a source-by-source basis. Hence, the savings from incentive approaches, while substantial, are likely to be somewhat less than the 90% figure.

18 • On page 2-5, the secondary ambient air quality standard for total suspended particulate (TSP) is 150 ug/m^3. The value for the annual geometric mean (60 ug/m^3) is used as a guide in assessing implementation plans to achieve the 24-hour standard (40 CFR 50.7).

19 • On pages 2-8 and 2-9, the references and discussions provided in footnotes 2, 3, and 4 on page 2-8 and 1 and 2 on 2-9 should be updated to reflect the most recent requirements on prevention of significant deterioration (PSD), LAER, and offsets.

20 • On page 2-11, the definition of RACT, as discussed earlier, should be repeated in footnote 1. State options to allow "RACT bubbles" should also be referenced.

21 • On page 2-11, the control technique guidelines (CTGs) discussed in footnote 1 should refer to sources of VOC emissions only. No such documents have been generally prepared for other pollutants.

22 • On page 2-11, it should be noted that motor vehicle inspection

and maintenance programs are not required for all areas violating ozone and/or carbon monoxide ambient air quality standards. Such control measures were required only for those areas where it was determined that such standards could not be achieved on or before December 31, 1982.

23 • On page 2-15, the discussion of netting (bubbling) with respect to sources subject to BACT and LAER should be made consistent with the most recently revised EPA policy. Essentially, the new policy, discussed in the October 14, 1981, Federal Register (46 FR 50766), expands the applicability of netting to avoid LAER in addition to BACT requirements. The text should be clear that these are "bubbles" to avoid BACT or LAER, not bubbles to meet BACT or LAER through less expensive equivalent reductions elsewhere within the plant. So long as the plant-wide increase in emissions from an expansion, modernization or replacement is not significant, the new facility does not constitute a "source" to which BACT or LAER requirements apply.

24 • The discussion on pp. 2-15-16 seems to confuse major new sources, major modifications, and the effect of the Clean Air Act and EPA/state offset policies on both. Firms contemplating major modifications in NA areas could do so "by arranging surplus emission reductions from other firms or from their own existing facilities" in the area. The "previous EPA policy" which forbade new plants or major modifications in such areas was the Clean Air Act itself, which EPA's offset policy (and the 1977 Amendments confirming that policy) ameliorated. The offset policy requires major new sources, modifications, or expansions to apply LAER technology and secure more reductions from existing sources than the new facility will add.

If the general point of this passage is that most industrial growth comes from modifications rather than entirely new "greenfield" plants, and that external offsets can be much cheaper than internal offsets from within the same plant, that point should be made explicitly. Where offsets are still required because a plant cannot "net out" or is entirely new, the point remains powerful. Where a firm can "net out", it is likely to prefer the certainty and speed of avoiding NSR, even if internal offsets are relatively expensive. However, some potential "netters" may still prefer external offsets, if the price spread of $19 million between internal and external offsets suggested by the report's discussion of the Pacific Gas and Electric (PG&E) case is any guide.

25 • On pages 3-2 through 3-4, care should be taken when discussing trades among pollutants which impact different places. The overriding concern of EPA is attainment and maintenance of ambient air quality standards. For pollutants, such as TSP and sulfur dioxide (SO_2), it is necessary that dispersion modeling be done to analyze the impact that trades involving such pollutants will have on ambient air quality levels. EPA has, however, developed several modelling screens and other techniques to avoid adverse ambient effects without having to conduct either modelling, or detailed site-specific modelling, for every trade. These steps can substantially reduce the uncertainty and transactions costs of bubbles or other trades.

26 • In comparing marketable permits and emission charges (pages 3-6 to 3-8), the following should be recognized in the text:

-- The uncertainty that occurs with emission charges in achieving an environmental goal is basically a short-run phenomenon; in the long run, charges can be adjusted sufficiently so that a particularly desired response from polluters can be achieved. This should also be recognized on page 4-1.

-- If, to promote efficiency, the initial allocation of entitlements under a marketable permits scheme is by auction, there may be considerable uncertainty over the prices to be paid for emission reduction entitlements.

-- Inflation can be accommodated under a system of emission charges by an annual adjustment in the charge rate that is tied to the GNP deflator. Economic growth cannot be so easily accommodated; however, where the level of pollution allowed can be established on a cost-benefit basis, charges can be used to keep the cost-benefit ratio in balance. This concept suggests that, in accommodating growth, the level of emissions should be allowed to grow if necessary to keep a given cost-benefit ratio in balance. This is a somewhat different point, but may be worth mentioning.

27 • On page 3-9, the emission inventory for the St. Louis AQCR does not include emissions from nontraditional sources such as roads, parking lots, and storage piles. These emissions represent a significant portion of TSP and, hence, should be factored into any discussions involving controls of TSP.

28 • The last sentence in the final paragraph on page 3-13 should be amended to add the following to the end of the sentence: "and the marginal control costs of the polluters".

29 • The discussion on pages 3-19 and 3-20 regarding the "transfer payment problem" should be amended to note that there may be relatively simple means of alleviating the problem. If a charge is to be paid (or permits are to be required) only for those emissions that are in excess of a given level, the amount of transfer payments can be minimized. A firm that abates pollution sufficiently need not pay additional monies (for either charges or permits). Hence, the extent of the transfer payment problem depends on the particular structure of the incentive system. This transfer payment problem is more unique to chlorofluorocarbons, which are used in production (rather than created as a by-product of a production process) and are eventually released into the atmosphere regardless of control technique.

30 • On page 4-9, the citation for the offset policy should be updated to reflect the most recent changes.

31 • On p. 4-11, the report should note that banked reductions produce an "extra improvement in air quality" not just for the time they remain in the bank, but for the period between their withdrawal for use in a state new source permit and that source's commencement of operations. For many major new "sources" this period can be 2 years or more.

32 • On page 4-13, the policy, with respect to LAER netting, has been revised (see 46 FR 50766, October 14, 1981).

33 • On page 4-17, the data discussed in the referenced report unfairly represent the status of the ambient air quality monitoring program. The location criteria and monitoring procedures used in this survey were based on proposed monitoring regulations rather than promulgated regulations. Many sites GAO assumed to be improperly located are now in compliance with the promulgated requirements (see attached memorandum for more information concerning this comment). This paragraph should be updated to reflect current situations. It should also be noted that GAO is currently evaluating the ambient air quality monitoring program to determine overall effectiveness and compliance with promulgated criteria.

34 • Suggestions on p. 4-18 and elsewhere that state regulators have authority under the Clean Air Act to confiscate banked ERCs to assure RFP and attainment are legally correct but misleading. As the subsequent discussion of San Francisco's 3-year guarantee indicates, the more important point is that states have other, equally legal options to meet RFP and attainment which are not counterproductive. These include, but are not limited to, guaranteeing that deposits will be discounted no more than the percentage control required of their source category if and when further reductions are required. They could also include an absolute guarantee for deposited reductions, if the state were prepared to

impose more stringent control requirements (or use its growth margin) to make up the difference. While EPA encourages non-confiscatory alternatives, the choice is for the State or local pollution agency, since under the Clean Air Act EPA must approve any SIP which assures RFP and attainment. The important point is that affected sources should participate in development of local banking systems to assure reasonable investment certainty, and that banking rules must specify in advance how they will deal with future reductions to avoid taking issues or other legal problems.

35 • The report did not discuss the SIP process for such trades. Until a state's controlled trading regulations are approved as part of the SIP, many trades must be submitted as case-by-case SIP revisions. EPA has already approved one such "generic" controlled trading rule to let New Jersey approve industrial hydrocarbon (ozone) bubbles without case-by-case SIP revisions. Sixteen other states are developing generic bubble rules. Most of these rules cover TSP and SO_2 as well as hydro-carbon trades, and many contain banking provisions.

36 • Trading has also begun to be used in other air pollution areas and to change past regulatory attitudes. Agency approved use of a bubble approach which lets can manufacturers average plant-wide emissions on a daily basis to determine RACT compliance instead of having to meet uniform emission limits for each can-coating line throughout the day, will produce the same air quality while saving that small industry about $107 million in capital and $28 million/year in operating costs, chiefly because energy-intensive incinerators will not have to be installed or used. EPA has determined that bubbles can be used to meet section 111(d) requirements and some BPSER requirements under section 113(d)(5) and (7). Most important, making the bubble and other trading steps work has led to changes under which SIP revisions are sharply reduced or streamlined (see 46 FR 44477, Sept. 4, 1981), simple algorithms can be substituted for costly, uncertain diffusion modelling in many instances, and EPA is becoming a manager auditing state programs instead of a regulator directly involved in every changed emission limit or case.

Report's Recommendations

37 The report recommends EPA devote increased emphasis to promoting both banking and private brokerage activities in emission reduction credits. Such activities can be initiated at the Federal level or left up to the individual decisions of state and local governments without further promotional activity at the Federal level. The advantages and disadvantages of each approach should be addressed.

38 Also, GAO recommends "that the Congress consider allowing controlled trading in place of New Source Performance Standards (NSPS)..." to reduce industry's compliance costs and enhance air quality (page 7-17). Unfortunately, the report does not examine the pros and cons of this

APPENDIX VII

legislative change. While "NSPS offsets" or bubbles may offer potential cost savings while achieving equivalent or greater pollution control, their administrative complexity and risk to improved air quality are significantly greater than with existing-source controlled trading approaches. The report does not recognize nor analyze the fundamental differences mandated by law between pollution control programs for new sources and existing sources. We believe that this matter requires considerable analysis before Congress can reponsibly decide whether to authorize such a policy.

EPA COMMENTS AND GAO'S RESPONSE

1. The report does not conclude that "tens of thousands of offsets are readily available at reasonable prices" in severe nonattainment areas. In the San Francisco Bay Area, the report concludes that search for offsets, although not easy in the past, could be facilitated in the future by emission reduction banking (p. v). The report also concludes that because of hoarding, offsets may be difficult to find (p. iv). However, as it becomes clear what changes in that area's air quality management plan are needed to comply with the Clean Air Act and as the novelty of trading wanes, uncertainty and hoarding should become less of a problem (p. iv). In the Los Angeles area, the report concludes that offset and banking experience there can be considered as controlled trading "under duress." A large potential conflict concerning the bona fide nature of offset candidates and uncertainty associated with the effectiveness and cost of unusually stringent, state-of-the-art pollution controls are not likely to make search easy there. In light of these factors, it is worth noting that external offsets have been negotiated in Los Angeles (p. v). Based on the experiences of Los Angeles and San Francisco, we conclude generally--i.e., not specific to Los Angeles--that the problems impeding the widespread use of controlled trading and eventual emergence of a full-scale market in air pollution entitlements are resolvable. We note that California experience may be a worst-case scenario for controlled trading in metropolitan areas (p. 5).

2. The draft report's recommendation, that controlled trading be allowed in place of New Source Performance Standards (NSPS), should yield at least long-term air quality equivalence. The present system of air pollution control generally imposes more stringent requirements on new sources than on older sources. Where these new source requirements are more expensive than old source requirements, the present system encourages the operation of older, more polluting, plants longer than otherwise. Our draft report's recommendation would lower the costs of pollution control requirements for new plants, thereby reducing the incentive to continue operating older, dirtier, plants. Thus, our draft report's recommendation should lead to fewer older plants and more new plants than under the status quo. Since it is widely belived that market incentives stimulate technological improvements, our draft report's recommendation can be expected to lead to better air quality than the status quo. More generally, how effective the new source program is certainly is debatable. 1/

1/For an excellent account of how the NSPS system can forestall the shutdown of older, more polluting plants, see B. Ackerman and W. Hassler, Clean Coal/Dirty Air (New Haven: Yale University Press, 1981).

3. Developing a workable mechanism to assure the permanence of offsetting reductions is straightforward. It simply entails tying the legality of the new source's operating permit to the legality of the offsetting source's operating permit. Using EPA's example, if the offsetting source were to shut down, its permit to operate would be rescinded. The regulator would alert the new source that it needed to obtain additional offsets. These subsequent offsets could be arranged externally or internally. With improved efficiency of pollution control equipment, resulting from technological change, the new source could even find it attractive to retrofit its facility, to meet its obligation. From the standpoint of air quality, retrofitting the new source could be far superior to an alternative, status-quo situation in which the "new" source, 20 years later, is still "operating" an obsolete control device. 1/ From an economic standpoint, our recommendation gives the firm the choice to use that strategy which it calculates is most cost-effective.

4. We do not believe that the report's title is misleading. Our objective in this study was to explore whether developing a market approach to air pollution control was feasible (p. i). EPA's controlled trading policies are a limited market approach (p. ii), and we assume that the traditional permit process would be an integral part of a full-scale market (p. 2). For these reasons, it follows that we would have considerable interest in studying the feasibility of controlled trading, and particularly those forms of it allowing market transactions between two or more firms (p. iii). Indeed, a primary premise of this study is that a workable system of controlled trading is necessary for emergence of a full-scale market approach (p. 2). Simply put, we believe that EPA's controlled trading policies represent an important beginning to a possible transition from command-and-control to a full-scale market (p. 2). So, we studied implementation problems which have hindered such trading (p. 2), seeing in them obstacles to emergence of a full-scale market. As a result, we witnessed first-hand the types of problems which we believe must be resolved to implement a full-scale market approach (p. 2). In analyzing problems troubling controlled trading--and with its transition to a full-scale market in mind, we concluded that EPA should promote controlled trading as an alternative, rather than as a complement (supplement), to command and control (p. 103). We also determined, as a result of both our findings regarding potential cost savings and our analysis of problems impeding the wider use of controlled trading and, hence, the greater attainment of these savings, that the committees should consider rewriting some provisions of the Clean Air Act, so that controlled trading does not remain a curious adjunct in air pollution control.

1/Ibid., p. 73.

5. Given our objective, to explore whether developing a market approach to air pollution control was feasible, external offsets, involving trades between two or more firms, are more important than single-plant bubbles. As we note in our report, no interfirm bubbles had occurred at the time of our audit. Moreover, the problems of implementing an interfirm bubble are similar--and certainly not different in any generic sense--from the problems in implementing external offsets. Our reason for focusing on the San Francisco region was the important distinction that both external offsets and banking, directly relevant to the feasibility of a full-scale market, had occurred there at the time of our audit (p. ii).

6. We agree that netting is an important development (pp. 17, 94). Netting was approved after our draft was sent to EPA for its comment. Netting reduces barriers to interfirm trades by making such trades no longer necessary, in some cases. We believe that firms should be given the maximum degree of flexibility consistent with air quality objectives. Consequently, we believe that firms should be given the choice of using external offsets--or external netting--to avoid unnecessarily expensive pollution controls. Accordingly, we have recommended that the committees consider allowing controlled trading in place of NSPS, BACT, and LAER.

7. We agree that incrementalism is important. As we note in our report, controlled trading could develop into a full-scale market capable of minimizing the compliance costs of firms (pp. i, 21).

8. As EPA notes in point #26, the effect of inflation on fee levels could be handled by indexing the fee, through an annual adjustment in the charge rate tied to the GNP deflator. However, since the effect of inflation is unlikely to be uniform across all polluters and since the full effect of inflation is unlikely to be borne by the polluters, the indexing scheme could be quite complicated.

   An emission fee scheme--as well as its counterpart, marketable entitlements--can be calibrated to account for every last pound emitted. In that case, the measurement problem could be serious for either system.

   The price of offsets is a function of their demand and supply. Where offsets for major new sources are too expensive to obtain, despite the community's decision that it wants these sources, air quality standards--not offsets--are the issue. If the market for offsets is characterized by genuinely acute scarcity, there is no way to escape that fact. For example, suppose a regulator agrees to secure

Q offsets for a prospective buyer for a fee. To accomplish this feat, suppose the regulator offers a prospective supplier the following deal: "sell me Q offsets at price P and I'll guarantee you Q offsets later at price P to accommodate your plans for future expansion." Such a guarantee could reduce the risk premium in this supplier's asking price. Such a premium reflects perceptions about the future scarcity of offsets. To the degree that these perceptions are correct, the regulator does not eliminate the need for such a premium by offering this guarantee. The guarantee simply means that the regulator now bears the risk. If the regulator ignores the need for such a premium, its promise to supply Q offsets later at price P raises the danger that air quality standards will be violated. Simply put, the issue for our hypothetical community is scarcity set by air quality standards. The issue will not disappear through "sleight of hand."

9. The issue of federalism is complex and not subject to simple solution. We agree with EPA that the choice among alternatives is for the States. This is not to say, however, that EPA's role in overseeing state implementation plans should be diminished.

   To use "best achievable control technology (BACT)/LAER determinations to establish baselines for emissions trading" is not compelling. In some areas, using such a baseline may constitute regulatory "overkill." Taking a literal definition of LAER, what offsets would be available after setting such a baseline? We give our reasons for recommending controlled trading in place of NSPS on p. 151.

10. The definition has been changed, as suggested.

11. The definitions have been changed, as suggested.

12. The concept of netting is not an important one for this report.

13. The definition has been changed, as suggested.

14. We have defined air pollution rights as entitlements to contaminate a certain portion of the outdoor air.

15. The significance of netting is addressed in point #6.

16. Proper accreditation is economic theory. The suggested change regarding SO_2 and TSP (total suspended particulate) has been made.

17. We note the possibility--and the reasons why we believe it unlikely--that "enlightened regulation" could bring about a least cost solution (p. 3). We do not agree that economic incentives are likely to apply only to "clusters"

of sources. We recognize no practical considerations relating to air quality which necessitate such a balkanization. Moreover, the driving force of a market--namely, the opportunity for mutual gain--is likely to push the use of economic incentives beyond narrow "clusters."

18. We agree.

19. Changes have been made, as suggested.

20. Changes have been made, as suggested.

21. This comment does not effect the accuracy of our statement.

22. This comment does not effect the accuracy of our statement.

23. Change has been made regarding update. Netting can result in air quality equivalent to what would have resulted from use of LAER or BACT. It depends on the efficiencies of pollution controls applied in either case.

24. No change is necessary (cf. pp. 17, 48, 78). We don't believe that our discussion is confusing. The general point of this passage is not what EPA supposes.

25. We agree but don't believe any change is necessary (cf. p. 94).

26. The uncertainty associated with emission charges is due to the lack of knowledge regarding how individual polluters will respond to a given charge level. In a static world, over time through a process of trial and error, the regulator would be able to reduce this uncertainty. Unfortunately, the world is not static. Technological changes effect production and pollution over time, adding to the demands for information placed on the regulator by an emissions fee system. The uncertainty is long-term.

As defined, uncertainty associated with prices in the initial auction is short-term. Furthermore, the effects of such uncertainty on air quality and compliance costs are unclear. Inflation has been addressed in point #5 in response to EPA's general comments.

Either charges or marketable entitlements can be used in a system which ties air quality standards to cost/benefit considerations. See point #5 of our response to EPA's general comments.

27. Because the presence of nontraditional sources does not effect in a substantive way what we report, no change is necessary.

28. Changes have been made, as suggested.

29. We have in mind only a charge on emissions. We believe the transfer issue remains a major factor to be incorporated in the design of a market approach.

30. Change has been made, as suggested.

31. Change has been made, as suggested.

32. The latest revisions do not eliminate the problems that LAER and BACT pose for a market approach.

33. We believe that our work on the status of air quality monitoring is accurate. We are currently evaluating EPA's air quality monitoring system.

34. We do not believe that our suggestions are misleading.

35. See p. 94, where we note the development in New Jersey.

36. Page 94 discusses these developments.

37. See our reply in point #9.

38. See our responses to points #2 and #3 of EPA's letter.

APPENDIX VIII

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

NOV 14 1981

Mr. William Anderson
Director, General Government Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Anderson:

Thank you for the opportunity to review and comment on your draft report: "A Market Approach to Air Pollution Control Could Reduce Compliance Costs Without Jeopardizing the Goals of the Clean Air Act".

We are always interested in receiving analyses of any approach that reduces the costs and burdens caused by federal regulations. Your report comes at an excellent time. As I am sure you know legislative changes to the Clean Air Act are currently being debated in the Congress. The Administration has already proposed several major goals to reduce the costs of meeting air quality control while continuing the progress towards cleaner air. I'm sure you will agree with many of the changes being proposed.

Our preliminary review of your report indicates that the approach and potential beneficial impacts you identified warrant a detailed review. I have asked my staff to contact your office directly and arrange for a meeting to discuss your proposal after they have had a chance to conduct an indepth analysis.

OMB appreciates the time and effort you have taken to develop this alternative and always is anxious to review innovative concepts concerning regulatory policy.

Sincerely,

Edwin L. Harper
Deputy Director

APPENDIX IX

THE CHAIRMAN OF THE
COUNCIL OF ECONOMIC ADVISERS
WASHINGTON

November 30, 1981

Dear Mr. Myers:

The staff of the Council of Economic Advisers has reviewed the GAO draft report, "A Market Approach to Air Pollution Control Could Reduce Compliance Costs Without Jeopardizing the Goals of the Clean Air Act", that you transmitted to Mr. Weidenbaum on October 13, 1981.

We believe that the report is well done. It will be useful to illustrate how markets and property rights can be used to solve environmental problems.

Yours sincerely,

James B. Burnham
Special Assistant
to the Chairman

Mr. Morton A. Myers
Director
United States General
Accounting Office
Washington, DC 20548

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