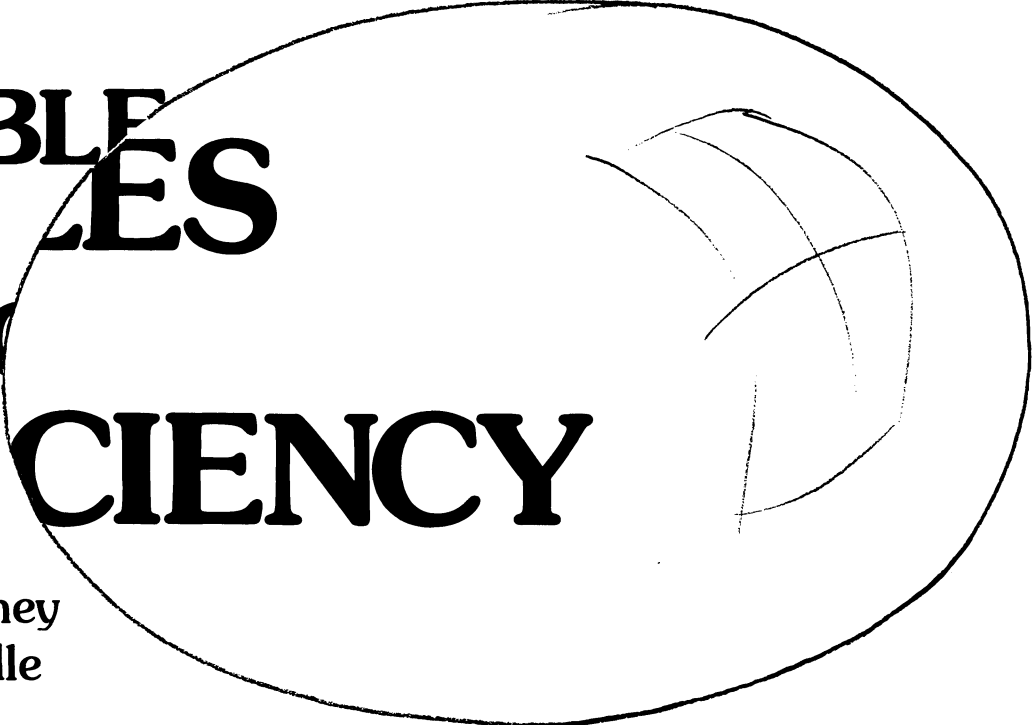


Cleaner Air at Lower Cost

BUBBLES AND EFFICIENCY



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THE REGULATION of air pollution has followed a perplexing path. Theorists have long urged the Environmental Protection Agency (EPA) to adopt principles that would lead to the most efficient ways of achieving cleaner air. The regulators, however, have insisted upon a seemingly more straightforward scheme: if the goal is to improve air quality by, say, 10 percent, the obvious thing to do is to require the use of pollution controls that reduce emissions at each and every source by 10 percent. This approach has formed the basis for national air quality policy for almost a decade. Thus, in accordance with the mandate of the Clean Air Act of 1970, EPA established national standards for six pollutants and required the states to impose so-called technology-based standards to be met uniformly at every smokestack or other emission source, no matter how many of these sources a given facility had.

Finally, EPA came to recognize the inefficiency of the source-standards approach. In December 1979, one year after endorsing an experimental "bubble" policy (see "Blowing Bubbles at EPA," *Regulation*, March/April

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1979), the agency announced two new options for reducing air pollution. For a particular pollutant, (1) the agency will focus on an entire plant—rather than individual sources in the plant—and allow management to meet an overall plant standard in any way it might choose, or (2) the agency will consider a regional grouping of plants and develop a process whereby these plants adjust their emissions so as to achieve the regional goal. In either case, according to the final rule issued by EPA on December 11, 1979:

Sources will have the opportunity to come forward with alternative abatement strategies that would result in the same air quality impact but at less expense by placing relatively more control on emission points with a low marginal cost of control and less on emission points with a high cost. (44 *Federal Register* 71781)

EPA's new cost-effectiveness or "bubble" approach is simple enough to understand when applied to a single plant. If the cost of removing an additional unit of a given pollutant (the incremental or marginal cost) is higher for some sources than for others, the manager can reduce the plant's total cost of achieving the desired air quality by shifting emission control

from the higher-cost to the lower-cost sources until the point is reached at which incremental cost becomes the same at each source. At that point, the total cost of meeting the plant standard is minimized. The practical problems are a bit more complex when this approach is applied to a collection of plants, but the principle is the same. The plant manager whose incremental costs of emission reduction are high will look for opportunities to realize savings by paying neighbors whose costs are low to cut their emissions by the needed amounts.

Given that the theoretical case for the cost-effective bubble approach is simple and compelling, why did EPA take so long? There are many reasons, no doubt—including bureaucratic caution, uncertainty about the monitoring technology that would be needed to police the system and, perhaps most important, the fact that the theory was not solidly buttressed by cost estimates of alternative emission control situations. In the absence of such estimates, decision makers were left to wonder about the extent to which incremental cost really mattered. Were the savings to be gained significant? Were they large enough to offset the possibly higher monitoring costs that might be involved?

The Du Pont and Maloney-Yandle Studies

In the summer of 1979, we carried out a research project that bears upon these questions. The raw material for our work came from a study conducted in 1976 by T. A. Kittleman and R. B. Akell, two engineers of the E. I. du Pont Company, in which they estimated the costs of achieving an 85 percent reduction in hydrocarbon emissions at each source in all of the Du Pont plants within the United States. From their investigation, Kittleman and Akell learned that the differences in average reduction costs among sources were monumental. In short, they found significant economies of scale in the control of hydrocarbon emissions—which is to say, the cost of reducing an additional unit of emissions from a large source (one emitting a large volume of hydrocarbons) was lower than for a small source. Kittleman and Akell did not determine the incremental cost of control on a source-by-source basis, and therefore could not compare the costs of alternative approaches for reducing hydrocarbon emissions. That is what we set out to do.

Du Pont provided us with its data base and support for our investigation. Our objective was to develop a procedure for calculating costs at different levels of control, so as to be able to estimate the cost of achieving a given reduction in hydrocarbon emissions under three different regulatory approaches. They were defined as follows:

Source-by-source standards—in which emissions from each source of a given size (defined as sources emitting more than three pounds an hour or fifteen pounds a day) are reduced 85 percent.

Plant-by-plant standards—in which each plant reduces its overall emission level by 85 percent, with managements being free to determine the degree of reduction at each source.

Multi-plant standards (trade-offs among plants)—in which total emissions in a hypothetical region (composed of all the plants qualifying for our sample) are reduced by 85 percent, with plants being permitted to exchange emission permits.

The first approach is theoretically the most costly, since the percentage reduction is the same at each source, no matter how high or how low the cost of achieving it. Under this approach, cost-effectiveness is swapped for regulatory convenience. The second approach parallels EPA's new plant bubble concept, in which total emissions from a plant are monitored, but variation in percentage reductions from individual sources is permissible. Costs are predicted to be lower here, since emission reduction can be concentrated on sources where it is less costly. Under the third approach, the plant bubble is stretched to cover an entire region and trade-offs are permitted among plants so as to make possible larger reductions in emissions where costs are lower, again within the limitation of the same overall percentage reduction in emissions. From society's standpoint, this approach predictably yields the greatest amount of clean air (emission reduction) at the lowest control cost, since the scope for possible cost-saving adjustments among emission sources is greatest.

In the Du Pont data made available to us there were fifty-two plants having a total of 548 sources of hydrocarbon emissions. The variation in the size of the sources—both within and among plants—suggested significant

possibilities for exploiting economies of scale in emission control. In our econometric analysis, first we estimated the relationships between the costs of emission control and the operating characteristics of the control equipment for each of the 548 sources. From this, we estimated the incremental cost of emission control at each source. Next, we minimized the control costs for an 85 percent reduction in overall emissions, using first a plant bubble and then a multi-plant or regional bubble. This gave us estimates for those two approaches, which we compared with the figures for source standards taken directly from the Du Pont study.

Cleaner Air at Lower Costs

The results of our analysis were dramatic enough to startle even the true believers (see table). Under source standards, the annual total cost of an 85 percent reduction in emissions for all fifty-two plants, as shown in Du Pont's data, was \$105.7 million. When each plant was placed under a bubble and allowed to adjust emission control among sources within the plant, the annual cost for the same reduction in pollution fell to \$42.6 million. In other words, the shift from source to plant standards produced the same amount of clean air at a saving of 60 percent. As would be expected, the savings were greater for some plants than for others—ranging, in fact, from a high of 92 percent to a low of zero. This is explained by the fact that some plants had large emission sources with low incremental control costs, whereas others lacked large sources and other opportunities for cost saving as well.

For the purpose of analyzing trade-offs among plants, we treated all the plants in our sample as if they were located in the same (hypothetical) region. When the fifty-two plants were placed under one so-called regional

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Taking the regional bubble concept one step further, we estimated the costs that would be associated with hydrocarbon reduction standards higher than the 85 percent assumed above. Here we learned that overall emissions of the plants in question could be reduced by 99 percent at an annual cost of \$92.4 million. In other words, the regional bubble yielded significantly more clean air than source standards and still generated cost savings of considerable size.

Some Final Thoughts

Despite the dramatic savings reported here, one should be cautious about lambasting EPA for not having moved years ago toward cost-effective pollution control. Clearly it would not be in the interests of either the polluters or those demanding environmental quality for regulators to rush into schemes whose advantages have not been demonstrated. In the case of the bubble, there were—until quite recently—too many uncertainties. Evidence to indicate the magnitude of the potential savings was largely a matter of conjecture. Moreover, monitoring difficulties, an issue stressed repeatedly by opponents of plant and regional standards, threatened to be a real problem. Whereas technology-based standards have avoided this problem (because they mandate the use of equipment that achieves the required degree of control), under the bubble the emissions themselves become the target and therefore a reliable monitoring capability becomes crucial. Indeed, it probably was the practical appeal of technology-based standards, plus ignorance of how costly they would be, that caused the concept of performance standards, which was central to the Clean Air Act of 1967, to be rejected. For the same reasons, the move to technology-

EMISSION CONTROL COSTS UNDER
THREE APPROACHES

Approach	Millions of 1975 Dollars	
	Annual cost	Savings over source standards*
Source standards	105.7	—
Plant standards	42.6	63.1
Multi-plant standards	14.6	91.1

*Assuming 85 percent reduction in hydrocarbons.

based standards in the 1970 Clean Air Act was heralded as a major breakthrough in pollution control. After all, if the equipment is in place and working, pollution is being regulated, though probably in a very costly manner.

In the years since 1970, as control technologies have been developed and applied on a fixed percentage-reduction basis, industry, government, and private scholars have generated information about control costs, especially incremental costs. Monitoring techniques have also been improved as experience has brought a better understanding of pollutants and how they move when discharged. This learning process, though slow and haphazard, has ultimately filled much of the knowledge gap and led to a growing recognition of the possibilities for more cost-effective regulation.

Two questions remain to be answered. First, while it is clear from the evidence presented here that the savings from plant and regional bubbles are very large, are these savings large enough—in all situations, or some—to offset additional monitoring and administrative costs and still generate net social benefits? What is mostly needed here are specific cost data on the monitoring task. Second, will EPA pursue the new regulatory approaches suggested by the accumulating evidence—will it, in other words, facilitate the development of an emerging market in emission rights—or will it stand in the way? In this connection, the agency's first action on a petition from a state for bubble-approving authority presents cause for concern. On March 11 the EPA rejected New Jersey's request that authority to approve plant bubbles be included in its state implementation plan. Given the nation's urgent need to lower the cost of cleaner air, it is to be hoped that the bubble is an idea that cannot be denied much longer. ■

Selected References

- T. A. Kittleman and R. B. Akell, "The Cost of Controlling Organic Emissions," *Chemical Engineering Progress*, April 1978.
- M. T. Maloney and Bruce Yandle, "The Estimated Cost of Air Pollution Control under Various Regulatory Approaches," a report to the Du Pont Company from the Department of Economics, Clemson University, July 1979.
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Diesel Automobiles (Continued from page 14)

Apart from the question of how diesel particulate-reductions are to be achieved, there is the even more basic question of whether, and to what extent, such reductions are medically, rather than merely aesthetically, desirable. The actual health effects of the diesel are by no means clear. EPA's "White Paper" states:

Extensive research into the health effects [of chemical substances absorbed by diesel particulates] is underway. Many undoubtedly are toxic. Others, such as polynuclear aromatic hydrocarbons, are known to cause cancer in animals and produce mutations in bacteria. Although it is too early to draw definite conclusions . . . , available data suggests that serious concern is warranted.

The automobile industry, on the other hand, points out that work-place exposure studies have failed to find significant negative long-term health effects, even though diesels have been in use for a long time.

In light of the possible health risks, one is inclined to be more sympathetic to EPA's stringent position on permissible overall particulate levels than to its reticence in adopting fleet averaging to achieve those levels. The averaging approach is demonstrably more efficient and has been applied effectively in other regulatory fields. Of EPA's reasons for further study, one suspects that the reason carrying the heaviest weight is the political difficulty of determining what method of averaging to employ, given the widely varying effects of different methods upon particular firms. Yet surely a flat emission level, as contrasted with any of the various averaging approaches, also has a differential effect. That is to say, some companies will be more affected than others by a uniform limit applicable to all diesel vehicles—so evenhandedness is hardly a rational justification for that approach. At most, one can say that the force of established regulatory habit makes the across-the-board limit *appear* less preferential, or makes EPA *appear* to be avoiding the inevitable preferential choice. On an issue that bears appreciably upon our major problems of inflation and energy, concern with appearances is a luxury we can ill afford.