MEDIA-QUALITY, TECHNOLOGY, AND COST-BENEFIT BALANCING STRATEGIES FOR HEALTH AND ENVIRONMENTAL REGULATION*

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I.
INTRODUCTION

The new wave of "social" regulation that Congress enacted in the early 1970's struck the chemical industry with particular force. Untouched by the economic regulation that constrained the transportation, communications, and utilities industries, the chemical industry's contact with the federal regulatory establishment was limited to clearing products such as drugs and pesticides with old-line federal agencies. By the end of the 1970's, the chemical industry was laboring under a wide variety of regulatory constraints on its emissions of chemical byproducts into the workplace and the environment, and further limitations on the ultimate disposal of hazardous chemicals were still germinating.1 At the same time that Congress imposed substantial new requirements on the chemical industry, it created new regulatory agencies to administer the new statutes.2 As a result, the chemical industry is rapidly becoming one of the most heavily regulated industries in the United States.

The new health and environmental statutes generally adopt one or both of two...
approaches toward the content of regulations that the implementing regulatory agencies must promulgate. The "media-quality-based" approach focuses upon the quality of the receiving media (usually air or water) and requires the agency to promulgate and enforce regulations capable of rendering the media acceptably "safe" or "clean" without regard to the costs or technological feasibility of reaching that goal. The "technology-based" approach focuses upon the control technologies that are available to industrial entities and requires the agency to promulgate and enforce regulations capable of ensuring that regulated firms adopt the appropriate cleanup technology without regard to the quality of the receiving media.\(^3\) Between these two extremes is a "balancing" approach that weighs media-quality considerations against technological and economic considerations in determining the amount of pollutant a source may discharge into the environment or the workplace. The balancing approach is usually associated with product licensing statutes such as the Food, Drug and Cosmetic Act,\(^4\) the Federal Insecticide, Fungicide and Rodenticide Act,\(^5\) and the Toxic Substances Control Act,\(^6\) that require an affirmative governmental decision before society can be exposed to the risks of a product or its by-products. Although the major environmental statutes do not often prescribe a balancing approach, many policy analysts (especially from the economics profession) strongly advocate broadening the role of cost-benefit balancing beyond the product licensing context. Nevertheless, Congress has until now rejected the balancing approach in favor of media-quality-based and technology-based approaches, both of which reduce cost considerations to a secondary or even less consequential status.\(^7\)

This article will examine these three fundamental regulatory techniques in the context of health and environmental regulation. The article will argue that Congress has wisely rejected the balancing approach for a host of practical reasons and because the approach, as applied by most practitioners, is fundamentally flawed as a theoretical matter. Briefly, when applied to matters of intense personal interest, such as credible risks to life or risks to very highly valued environmental entities, the Kaldor-Hicks formulation of the balancing approach, which is almost exclusively relied upon by balancing proponents, cannot yield a "correct" answer to the question how much risk is too much. The "willingness to purchase safety" test for

\(^3\) A statute can, of course, mandate a combination of approaches. For example, the Clean Water Act adopts a technology-based approach but backs it up with a media-quality-based approach. Under the first approach, the agency prescribes technologies without regard to the quality of the receiving media. States, however, may promulgate water quality-based standards that must be met in addition to the technology-based standards. Hence, if implementation of the technology-based standards does not produce water of sufficient quality, the media-quality-based standards take precedence.


\(^7\) Similarly both approaches may be implemented by a variety of regulatory tools, including the traditional standard-setting tools and more esoteric tools such as effluent fees and marketable permits. This article will examine the comparative merits of the two approaches within the context of traditional standard-setting since that is the universal implementation tool adopted by Congress in the existing statutes. However, when one approach may be more effectively implemented through some alternative tool, such as marketable permits, it will be considered with the appropriate caveat concerning the political feasibility of enacting that tool into existing statutes.
the value of safety-enhancing technologies is not on theoretical grounds preferable to the "willingness to sell risks" test for the value of those technologies. Yet, policy analysts almost invariably adopt the former test, which is, as the article will show, biased strongly against the adoption of health and environmentally-oriented technologies.

While both the media-quality-based and technology-based alternatives to the balancing approach are heavily weighted with problems of their own, this article will suggest that the general preference of Congress and especially of implementing agencies for the technology-based approach in the context of the chemical industry is warranted by an almost universal recognition that citizens of this country have a "right" to a healthy environment and workplace, at least insofar as the societal pursuit of that right is not technologically impossible or prohibitively expensive. Finally, this article will suggest a mixed strategy that rejects the balancing approach but attempts to arrive at an acceptable (if not "optimal") level of health and environmental protection and to encourage research on protective control technologies.8

II

THE CHEMICAL INDUSTRY

For purposes of health and environmental regulation, three characteristics of the chemical industry distinguish it from other manufacturing industries. These three characteristics might impel the policymaker to treat the chemical industry differently from other industries in promulgating health and environmental regulations.9

The chemical industry is extraordinarily varied and complex. A glance at the Standard Industrial Classifications for the chemical industry reveals an enormous variety of finished products ranging from soap deodorizers to acetone.10 Not surprisingly, the chemical industry produces an equally heterogeneous variety of unwanted by-products.11 A given plant may manufacture dozens of different

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8. This article will focus upon only one dimension of health and environmental regulation—viz, the nature of the immediate regulatory goal. It will examine some of the advantages and disadvantages of a regulatory focus on technology, media quality or some combination of these two considerations, in pursuing health and environmental objectives. The problem can be viewed along other dimensions as well. For example, one can focus on the nature of the regulatory statement. On one extreme of that dimension is the regulatory command; on the other extreme is the economic incentive. One could likewise focus upon whether the regulatory statement is source-oriented or receptor-oriented and whether it is promulgated on a generic or case-by-case basis. See McGarity & Bayer, Federal Regulation of Emerging Genetic Technologies, 36 VAND. L. REV. 461 (1983).

9. For example, some of the writers on "charges" as alternatives to standards seem to sidestep the problem of toxics, pointing out that strict prohibitions may be more appropriate for such discharges. See F. ANDERSON, A. KNEESE, P. REED, R. STEVENSON & S. TAYLOR, ENVIRONMENTAL IMPROVEMENTS THROUGH ECONOMIC INCENTIVES 17 (1977) [hereinafter cited as F. ANDERSON]. At other times, charge proponents have maintained that the toxic problem is solvable if the charge is merely set at a high enough level. See, e.g., U.S. Environmental Protection Agency, Development Document for Proposed Effluent


11. See, e.g., U.S. Environmental Protection Agency, Development Document for Proposed Effluent
products and generate hundreds of different by-products. This bewildering complexity can easily hamstring any strategy of health and environmental regulation that requires a detailed understanding of the industry being regulated.

Many of the products and by-products that the chemical industry produces are hazardous at relatively low exposure levels. While some chemical products, such as pesticides, are intended to be toxic to living organisms, toxicity is an undesirable but inevitable characteristic of most chemical products. Some chemical products and by-products are quite acutely toxic to man and environmental organisms, while others pose long term carcinogenic, mutagenic, or reproductive hazards. The toxicity of many by-products of the chemical industry is, therefore, quantitatively and often qualitatively different from the toxicity of conventional by-products given off by other manufacturing processes. Moreover, large uncertainties often cloud attempts to assess the long term risks that the products and by-products of the chemical industry pose to humans and the environment. Thus, while the costs of regulatory mistakes are likely to be higher for the chemical industry, the probability of making mistakes is also higher.

Finally, the sources of any individual toxic product or by-product of the chemical industry are not likely to be ubiquitous. Most of the very toxic products and by-products of that industry come from very few sources at discrete locations. Hence, monitoring of complex waste streams is simplified by the fact that the waste stream for a particular toxic chemical from an individual plant will rarely overlap with the waste stream for the same chemical from another plant. Like all generalizations, this characteristic has its limitations for some chemicals, such as the phenols, and some sites, such as hazardous waste disposal facilities serving heavily industrialized areas. But, nevertheless, it is a worthwhile simplifying generalization.

III

MEDIA-QUALITY, TECHNOLOGY, AND BALANCING

Nearly all of the regulatory provisions in the more recent occupational health and environmental statutes can be classified as media-quality-based, technology-based, or balancing approaches to pollution control. A media-quality-based approach focuses primarily upon the quality of the receiving media. Society first articulates some overall goal for the receiving media. This goal could be specified with great particularity (for example, no more than 150 dead fish or cases of human cancer per year), but more often it is expressed in more hortatory terms


12. See infra notes 37-39 and accompanying text.
13. See Rose-Ackerman, Market Models for Water Pollution Control: Their Strengths and Weaknesses, 25 PUBLIC POLICY 383, 401 (1977); Implementation of the Federal Water Pollution Control Act: Summary of Hearings on the Regulation and Monitoring of Toxic and Hazardous Chemicals Under the Federal Water Pollution Control Act Before the Subcomm. on Investigations and Review of the House Comm. on Public Works and Transportation, 95th Cong., 1st Sess. 599 (Comm. Print 1977) (testimony of Dr. Charles Schultze). This is, of course, always true of the workplace where waste streams from different plants never interact.
such as “fishable/swimmable water.”\textsuperscript{14} The regulatory entity then determines the level of pollutant in the receiving medium that will just meet the external goal by estimating the environmental and health effects of the pollutant at various concentrations in the receiving medium.\textsuperscript{15} A pollution allocation load (for locations meeting the standard) or pollution reduction load (for locations not meeting the standard) can then be calculated with a model that relates discharges from individual facilities to overall media quality.\textsuperscript{16} Finally, the regulatory entity must apportion the load among the existing sources, perhaps saving some portion of the available load for future sources.\textsuperscript{17}

The allocation formula that the regulatory entity uses is of very little consequence to media quality, but it is of great importance to pollution sources. A reasonably comprehensive list of load allocation techniques includes first-come-first-served, a lottery, uniform percentage reduction for all sources, an auction and a subsequent market in pollution “rights,” effluent charges set at a level that would induce the degree of control just adequate to use up the load, technology-based effluent limitations for all sources just adequate to use up the load, and allocation in accordance with other unspecified “political” factors. If the entire load in a relevant media-quality region is attributable to a single source, as is the case with many sources of toxic substance discharges into air and water and all discharges into workplaces, then no allocation is necessary. The regulatory entity can simply use its reduction model to work backwards from the desired level of media quality to an effluent or emission limitation for the source. After allocating the available load, the regulatory entity then monitors the sources and the receiving media to detect violations and to determine whether the model functioned properly.

Under the technology-based approach, the legislature specifies in vague terms, such as “best available technology,” or “lowest achievable emissions rate,” the degree of pollution control technology\textsuperscript{18} that it expects regulated industries to implement.\textsuperscript{19} The legislature typically distinguishes between new and old sources


\textsuperscript{18} In using the term “pollution control technology,” I do not intend to limit the discussion to “end-of-pipe” technologies aimed exclusively at pollution controls. Changes in the design and operation of the basic units of production and in the way that employees perform their tasks can reduce pollution as well as (and often more cheaply than) end-of-pipe technologies. See A. Kneese & C. Schultzze, Pollution, Prices and Public Policy 24 (1975).

\textsuperscript{19} Very often the statute will specify criteria that the agency must apply in identifying the specified level of pollution control technology. For example, the Clean Water Act specifies that:

Factors relating to the assessment of best available technology shall take into account the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, the cost of achieving such effluent reduction, non-water quality environmental impact (including energy requirements), and such other factors as the Administrator deems appropriate. . . .

in articulating these broad requirements. The regulatory entity then divides the various regulated industries into categories and subcategories in accordance with the production processes they employ, the nature of the waste streams, the age of the facilities, the cost of pollution control, and other factors that appear to be relevant to the standard setter and its engineers.\(^2\) The regulatory entity next surveys the pollution control technologies in use in the regulated industry and in industries with similar waste streams and searches for technologies that may be in use in pilot plants or that may be at even less mature developmental stages. It then picks the technology that best meets the statutory criteria. Since cost is invariably one of those criteria, the standard setter must consider economic feasibility as well as technological feasibility. Finally, the standard setter must specify the degree of effluent or emissions reduction achievable by the specified technology within each category and subcategory and write an effluent or emissions limitation expressed in units of pollution per unit of production, input, or discharge, that mandates that degree of reduction.\(^3\)

Statutes nearly always allow an individual source the freedom to meet the promulgated limitation with any technology it desires; the standard setter is only very rarely given the authority to mandate the use of particular technologies.\(^4\) A technology-based regime could, however, assume an even less direct approach by requiring the standard setter to establish a "charge" or "tax," rather than a limitation, that would induce the relevant sources to adopt the desired technology.\(^5\) In either case, the regulatory entity would establish the limitation or charge without regard to the quality of the receiving media.

Congress has frequently adopted a mixture of both media-quality-based and technology-based approaches for regulating health and safety. The Clean Air Act, for example, takes a predominantly media-quality-based approach. The core of the Act is the primary and secondary national ambient air quality standards for ubiquitous pollutants, which must be set at a level which protects the public health and welfare with an "ample margin of safety."\(^6\) Standards for less ubiquitous toxic air pollutants must protect public health with an "ample margin of

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\(^2\) A technology-based standard need not be promulgated on an industry-wide or even a subcategory-wide basis. In principle a technology-based standard could be promulgated for each individual source of pollutant. The standard setter would then act very much like a court, adjudicating the economic and technological feasibility of various suggested pollution control alternatives for each source. This approach would, however, entail enormous administrative costs. Congress has required the EPA and the states to make case-by-case "best available technology" determinations in granting permits to major emitting facilities under Part C of Title I of the Clean Air Act, 42 U.S.C. §§ 7475(a)(4), 7479(3) (Supp. V 1981).

\(^3\) E.g., 40 C.F.R. §§ 400-460 (1980).


\(^5\) Despite strong support among academicians, this approach has not been adopted in the United States. F. ANDERSON, supra note 9; W. IRWIN & R. LIROFF, ECONOMIC DISINCENTIVES FOR POLLUTION CONTROL: LEGAL, POLITICAL AND ADMINISTRATIVE DIMENSIONS (1974) (EPA Socioeconomic Environmental Studies Series, EPA 6005-74-026).

safety." 25 In addition to these media-quality-based standards, however, the Environmental Protection Agency (EPA) must also promulgate technology-based new source performance standards that require the implementation of the "best available demonstrated" technology. 26

The Clean Water Act also takes a mixed approach. The EPA has focused its efforts on promulgating technology-based standards for new and existing sources of ubiquitous "conventional" pollutants. 27 The Act does, however, provide for water-quality-based standards 28 and effluent limitations. 29 The Act, as amended in 1977, also provides for both technology-based effluent limitations 30 and media-quality-based effluent standards 31 for discharges of toxic substances.

The Occupational Safety and Health Act and the Safe Drinking Water Act prescribe a feasibility-limited media-quality-based approach. The Occupational Safety and Health Administration (OSHA) must promulgate occupational safety and health standards, 32 and the EPA must promulgate National Primary Drinking Water Standards 33 capable of protecting worker and public health (a media-quality-based approach) insofar as that is feasible (a technology-based concept).

As an alternative to focusing primarily upon media quality or upon technology, Congress occasionally requires the regulatory agency to combine both considerations in a balancing process. Typically, Congress mandates balancing in product licensing statutes that require a product's proponent to demonstrate that a product's benefit outweighs the risks that it poses to the public. 34 A balancing approach could with somewhat greater administrative difficulty be implemented for controlling process and by-product risks as well, although Congress has seldom done so. For example, Congress could mandate that the EPA set media-quality standards at precisely the level at which the costs of meeting the standards equalled the benefits of the standard. This would, of course, necessitate an inquiry into the availability and costs of pollution control technologies in addition to the risks of various levels of pollutant to humans and the environment and the value of the threatened consequences. Alternatively, Congress could require that the regulatory entity set technology-based standards at precisely the point at which the pollution reduction benefits derived from the standard equalled the cost of implementing the standard. Again this would require an examination of both media-quality and technology considerations. The balancing approach is therefore in the middle of a spectrum of pollution control approaches ranging from pure media-quality-based standards to strict technology-based standards.

BALANCING AND THE FAILURE OF THE MARKET PARADIGM

The weltanschauung of the policy-oriented economist has come to dominate the intellectual analysis of the pollution control and worker health policy problems. At the heart of the policy-oriented economist's conceptual framework is a commitment to utilitarianism—society should strive to achieve the greatest good for the greatest number of its citizens. From a pure utilitarian perspective, governments and markets should strive for Pareto efficiency—a policy or exchange should be undertaken if it makes a least one person better off and leaves no persons worse off. When this ideal cannot be achieved, a policy is still appropriate under the utilitarian analysis if the "good" (or utils) that it produces for its beneficiaries is greater than the "bad" (or loss of utils) that its victims suffer. Many utilitarians would stop the analysis here without attempting to reduce utils to a more common unit of exchange such as money. Others might attempt to measure gains and losses in monetary terms, but weigh those preferences in accordance with some function that recognizes that when wealth is unevenly distributed people do not convert utils to dollars at the same rate.

To the policy-oriented economist and his fellow travellers in the legal profession, however, pure utilitarian analysis is viewed as impractical. The starting point for the analysis should not be a poll where persons are asked to hypothesize about the pain they would suffer or the satisfaction they would derive from the implementation of a public policy. Rather, the policy analyst should look to the real world for surrogate measures of the value that people attribute to goods and bads. The real world is, of course, the marketplace. Government policies, in this view, should strive to achieve that allocative result which the marketplace would itself reach were it not hindered by some unfortunate market defect. An ideological corollary to this "practical" application of utilitarianism is the proposition that the unregulated marketplace is the norm, and it should not be disturbed absent some demonstrable and correctable failure.

35. In using the term "policy-oriented economist" I mean to identify a subcategory of neoclassical economists that are concerned with the practical applications of microeconomic theory in the public policy arena. The intellectual product of this group of economists is not highly mathematical or theoretical. Rather, the policy-oriented economist concerns himself with the application of various well-developed paradigms to concrete problems of private firm strategy or public policy. Examples are too numerous to mention but include R. DORFMAN & N. DORFMAN, ECONOMICS OF THE ENVIRONMENT: SELECTED READINGS (1977); A. KNEESE & C. SCHULTZE, supra note 18; D. NORTH & R. MILLER, THE ECONOMICS OF PUBLIC ISSUES (1976). While this approach to problem solving is predominant in the nation's business schools, it is by no means confined to those institutions. It also dominates many graduate schools of public policy and undergraduate economics courses. See E. STOKEY & R. ZECKHAUSER, A PRIMER FOR POLICY ANALYSIS (1978). Indeed, it has even achieved a strong foothold in the law schools. See R. MILLER, ECONOMICS TODAY: THE MICRO VIEW 355-75 (1982); R. POSNER, TORT LAW: CASES AND ECONOMIC ANALYSIS (1982); R. STEWART & J. KRIER, ENVIRONMENTAL LAW AND POLICY (1978);


37. It has been suggested, but by no means proven, that wealthy persons attach a lower value to an additional dollar of income than poor persons. See, e.g., Markovits, Legal Analysis and the Economic Analysis of Allocative Efficiency, 8 Hofstra L. Rev. 811, 815 (1980).

38. Professor Breyer's classic analysis of "regulatory failure," for example, "assumes that an unregulated marketplace is the norm and that those who advocate government intervention must justify it by
Market failure means that someone would be willing to pay more for a thing than the possessor of the thing would be willing to sell it for, but the transaction does not take place. There should be a market for the thing; for some reason or reasons (usually afforded the common label—"transaction costs"), however, the market does not exist. Adopting the Kalder-Hicks formulation of the problem, the policy-oriented economist argues that when markets fail, government should intervene when the beneficiaries would be willing to pay more for the resulting policy than the victims would be willing to sell it for. In simpler terms, a policy should be adopted if its beneficiaries could bribe its victims to accept it. The transaction, however, need not occur; the policy is efficient in any event and should be adopted.

showing that it is needed to achieve an important public objective that an unregulated market cannot provide.” Breyer, Analyzing Regulatory Failure: Mismatches, Less Restrictive Alternatives, and Reform, 92 HARV. L. REV. 549, 552 (1979); see also Posner, Some Uses and Abuses of Economics in Law, 46 U. Chi. L. Rev. 281, 288-89 (1979).

Professor Markovits has articulated an alternative (and in my opinion preferable) test for whether a policy is allocatively efficient. Under the Markovits test:

[a] policy increases allocative efficiency if and to the extent that the number of dollars its beneficiaries would have to receive to leave them as well off as they would be if the policy were adopted exceeds the number of dollars its victims would have to lose to leave them as badly off as they would be if the policy were adopted, assuming no one's real income is affected either directly by the sequence of events which led to his receiving the money in question or indirectly by the payment (by any tendency of the finance payment to charge the prices he must pay for goods, the price or quantity of goods he sells, or the real income of other individuals whose welfare he values).

Markovits, supra note 37, at 817-18. This extremely careful definition more closely comports with the reality that money does not in fact flow from the beneficiaries of a government policy to its victims. In reality, the beneficiaries will be better off with the adoption of a non-Pareto efficient policy and the victims will be worse off. The Markovits test realistically acknowledges this.

The Markovits test as applied will more often support governmental intervention on behalf of the poor than the Kalder-Hicks test:

Since the number of dollars that poor individuals would have to be paid to induce them to reject such a policy will tend to exceed the number of dollars they would be willing and able to pay to obtain the policy, the [Kalder-Hicks] approach will tend to make such policies seem less efficient than they are by measuring the gains they generate for their beneficiaries in an incorrect way—by measuring them according to the lower number of dollars they would be willing to pay for the policy rather than the higher number of dollars they would be willing to accept instead of the policy.

Markovits, supra note 37, at 821-22.

The Markovits test remedies some of the deficiencies of cost-benefit analysis that Professor Kennedy identifies. Kennedy, Cost-Benefit Analysis of Entitlement Problems: A Critique, 33 STAN. L. REV. 387 (1981); R. Markovits, Duncan’s Do Nots (unpublished manuscript) (forthcoming in STAN. L. REV.). See text accompanying notes 57-64 infra. The test, however, is still incoherent or schizophrenic in cases involving large shifts of wealth (defined in utils rather than dollars), such as in the contexts of risks to health and destruction of highly valued natural entities.

The Markovits test is also difficult to apply as a practical matter, because in many cases it poses a difficult psychological question to the potential beneficiaries and victims of a policy. The beneficiary, for example, must tell the policymakers (or the policymaker must somehow otherwise ascertain) the amount of money that would satisfy him as much as a governmental policy without informing him of the direct link between the policy and the dollar gift. When the policy entails a direct transfer of dollars (for example, licensing taxicabs in New York City), this may be an easy operation. When the policy implements other values, it may be more difficult. Implementation of a policy that greatly reduces the risk of death that a person otherwise faces will generate a great feeling of relief. It is difficult, I suspect, to compare this feeling of relief with the feeling of satisfaction or joy that the same person would experience upon receiving a windfall gift of dollars.

It is not clear why the Kalder-Hicks test has historically carried the day. It is clear that the Markovits test has until now attracted few proponents.
A. The Market Paradigm and the Problem of Externalities

In the context of health and environmental risks, the policy-oriented economist would argue that governmental regulation should be strictly limited to the narrow goal of "internalizing externalities" or, phrased differently, "correcting for spillovers." The spillover problem results from the fact that a firm is allowed to engage in conduct that causes harm to others or otherwise consumes a valuable common resource, and from the fact that these costs do not affect the firm's conduct because it does not have to pay them. The market for health and environmental controls has failed.

If the legal system specified a rule that no effluent or emission from any plant could harm any interest of any person and gave any aggrieved party the right to enjoin such conduct, a firm would then be required to purchase the "right" to pollute from its neighbors. The firm would expend resources on pollution controls up to the point at which it would be cheaper to purchase rights from the neighbors. Similarly, if the rule were the opposite—that any firm could pollute with impunity—then those damaged by a firm's conduct would band together and purchase the desired amount of pollution control devices up to the point at which the reduced pollution was no longer worth their resource outlays. Professor Coase has suggested that in a smoothly functioning system the amount expended upon pollution control and the level of pollution would be the same under either rule. A "market" for pollution control would develop under both rules, and government intervention, except insofar as was necessary to enforce the contracts and the "property rights," would be unnecessary. The market would allocate the resources in the optimum manner for society.

A smoothly functioning market would likewise efficiently allocate worker safety. Informed workers could bid up wages to the point at which income from increased wages matched their individual assessments of the disutility of exposure to additional risks. A rational employer would make health and safety related expenditures up to the point at which the cost of such measures equaled the sum of the reduced output due to work-related injury or illness and the increased wages it would have to pay to induce employees to accept more hazardous employment.

41. See F. Anderson, supra note 9, at 3-6; A. Kneese, & C. Schultze, supra note 18, at 4-6; Breyer, supra note 38, at 555.

42. The legal system would also have to acknowledge the right of a person to alienate his "right" to enjoin a polluter, and it would have to be capable of enforcing the contract of alienation. This, of course, is "government intervention" into private conduct, but the economist would probably not consider it intervention into the marketplace because enforceable property "rights" and contracts define the marketplace. Without at least this much government intervention there can be no effective market, and the rule of the jungle would prevail.

43. See Coase, The Problem of Social Cost, 3 J. Law & Econ. 1 (1960). This point is well-illustrated in the pollution control context in R. Stewart & J. Krier, supra note 35, at 133-36.

44. This intervention is not insignificant. The legal system must be prepared to enjoin all emissions that were not bargained for under the first rule, and it must be prepared to protect the firms' facilities from attack by angry neighbors under the second rule.

Again, society would produce the "optimal" amounts of health and other commodities, and government intervention would be necessary only to enforce contracts and "property rights."

Although the policy-oriented economist's goal is to reach that result which the parties themselves would have "freely" reached in a smoothly functioning marketplace, he accepts the fact that the real world does not function ideally. First, the market paradigm requires that both parties to the transaction have perfect knowledge of the risks posed by the release of chemical substances and the incremental costs of reducing those releases. In the case of toxic substances in the workplace or the environment, information on the chronic hazards posed by these substances is very expensive, and "perfect" knowledge is entirely unobtainable. When large uncertainties dominate attempts to assess the risks posed by toxic substances, both sides of the bargaining process are likely to underestimate the true long term costs of industrial illness and death. Furthermore, in the case of two or more sources of pollution, the absence of perfect knowledge about which source contributes how much additional risk to the neighbors further complicates an already impossibly complex bargaining problem.

Second, collective action in the environmental pollution context involves high "transaction" costs. If, for example, the courts were to adopt a rule that polluters may pollute with impunity, then affected neighbors could pay them to reduce pollution. Yet, since each neighbor is damaged only a small amount, no individual


47. F. ANDERSON, supra note 9, at 22; B. MITNICK, supra note 46, at 291.

48. See N. ASHFORD, CRISIS IN THE WORKPLACE 335-38 (1976); J. MENDELOFF, REGULATING SAFETY 7-8 (1979); Zeckhauser & Nichols, supra note 45, at 178-79.


50. Employers facing circumscribed planning horizons feel great pressures to emphasize short term production over long term risk reduction. See generally McGarity & Schroeder, Risk-Oriented Employment Screening, 59 TEX. L. REV. 999, 1016 (1981). Employers will therefore tend to place unrealistically low estimates on risks. Moreover, psychological studies in other low probability-high consequence contexts, where risks can be more objectively assessed indicate that individuals who expose themselves to risks of death or serious bodily injury tend to underestimate the risks to themselves, perhaps in the belief that "those horrible things only happen to the other guy." See, e.g., Arnold & Grabowski, Auto Safety Regulation: An Analysis of Market Failure, 12 BELL. J. OF ECON. 27, 34-35 (1981); Zeckhauser & Nichols, supra note 45, at 178. Hence the short run tendency of both sides of the bargain is toward long run inefficiency and human loss. See McGarity, Contending Approaches to Regulating Laboratory Safety, 26 U. KAN. L. REV. 183, 200 (1980).

51. The problem of multiple sources of chemical pollutants is not as relevant to worker protection where the source of chemical contaminants is nearly always the employer's operations.
would be willing to pay enough to reduce the pollution to a significant extent. All would benefit from a collection from all of the neighbors that would then be paid to the source of the pollution. Unfortunately, the cost of the collection system might be very high, especially if, as the market paradigm would require, the “fee” collected would vary with the amount of harm that each individual felt. Moreover, a “free rider” could reap the benefits of the others’ efforts without contributing to the collection in the absence of an expensive legal mechanism to force contributions. The problem is the same if the opposite liability rule applies. If any damaged party may acquire an injunction against the source, then the firm must seek out and pay off all possible plaintiffs. The seeking-out process alone could be very expensive. Moreover, since any plaintiff could “hold out” for more compensation than the harm actually felt, it would be impossible to tell whether the holdout was expressing his true disutility or merely being too greedy.

Third, the courts have not yet developed an adequate scheme of “rights” in environmental entities. While the pollution source in a jurisdiction in which polluters must pay will have to strike an acceptable deal with all humans that consider themselves affected by its activities, it may damage nonhuman receptors with impunity to the extent that no human is willing to make the nonhuman’s disutility his own. The utilitarian ideal is thus anthropocentric—it considers only human utility.

These practical limitations on the bargaining model have, with the possible exception of the third objection, been well accepted by proponents of the market paradigm. Few of the policy-oriented economists would suggest that the pollution problem should be left to the unregulated marketplace, and only a few more would leave the worker health problem to private negotiations between workers and employers. There is, however, in addition to these practical limitations to the bargaining model, a more serious and ultimately more damaging theoretical flaw in the model. This theoretical flaw stems from the fact that the Coase theorem, as applied to worker safety and pollution control problems where risks are relatively high, is demonstrably wrong.

It is not true that the same amount of resources will be invested in pollution control and worker safety under either liability rule. A neighbor might demand much more in payment per unit of pollution reduction under the first rule (the polluter must pay off neighbors) than he would pay to reduce pollution by the same amount under the second rule (the neighbor must buy off the polluter). The neighbor may not be able to afford the amount of pollution control that he would really like because he is not wealthy. His own financial status, however, will not

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limit to the same extent the amount that he will request from the polluter if he has
a right to stop the pollution. In the second case the neighbor suffers a lost opportu-
nity to add resources to his existing steady-state stream of income and outgo. In
the first case he suffers a disruption of that steady state, and as the “right” involved
becomes increasingly more important, the neighbor suffers greater disruption. If
the neighbor is very wealthy, this disruption may be relatively inconsequential.
But if the neighbor is poor, then the price at which he is willing to buy a very
valuable right will very quickly reach a limit dictated by his impecunious circum-
stances. There is no reason to believe that a poor person values money any less
than a rich person when he has a valuable object to sell.\textsuperscript{57} There is obviously good
reason to believe that a poor person will pay less than a rich person for safety if
they are both required to purchase that commodity. The practical end result is
that more commodities are produced from more polluting plants located near low
income neighborhoods under the first rule whereas fewer commodities are pro-
duced from less polluting plants more evenly distributed among the population
under the second. The current distribution of industrial activity with respect to
rich and poor should suggest which rule has often predominated in this country.

The same dichotomy applies to the workplace. The worker may demand more
for the risk of an industrial disease if he had a “right” to a workplace free of dis-
ease-causing chemicals than he would be willing to pay to be rid of the risk. The
fact that the employment relationship is regarded as consensual by the policy-
oriented economists motivates them to argue that wage premiums for hazardous
jobs would be the same under either rule. A worker has a “right” to as much
safety as he wants because he can shop around for a safer job if he does not care to
accept the wage premium that the employer is willing to offer. The fully informed
worker is willing to sell his health at precisely the price (or wage premium) which
the employer is willing to buy it. Laborers are laborers and not members of the
Board of Directors because they prefer risking their health to risking their
capital.\textsuperscript{58}

To state this proposition is to declare its implausibility. The wage premium
that an employer offers for hazardous work, if such a premium ever exists,\textsuperscript{59} is not
always determined by free parties in an open marketplace. For many low skill jobs
it is set by the unemployment rate and the level of desperation of currently
employed workers. The alternatives to a low skill, low income worker are too few
to support the argument that he freely accepts the employer’s tradeoff between
safety and wages. The low skill worker “chooses” high risk employment in much
the same sense that a robbery victim “chooses” to part with his money—in both

\textsuperscript{57} Indeed, the more plausible assumption is precisely the opposite—a wealthy person probably
values an additional increment of wealth less highly than a poor person. Markovits makes much the same
point when he suggests that the demand for a particular policy may be “wealth elastic.” Markovits, supra
note 37, at 819.

\textsuperscript{58} See F. Knight, Risk, Uncertainty and Profit 301 (1921) (alluding to “the disposition of
laboring people to gamble recklessly with life and limb as well as income”).

\textsuperscript{59} Compare Chelius, The Control of Industrial Accidents: Economic Theory and Empirical Evidence, 38 Law
and Contemp. Probs. 700 (1974) with W. Viscusi, Employment Hazards: An Investigation of
Market Performance ch. 12 (1979) and R. Smith, The Occupational Health and Safety Act
cases, given the alternatives, it is the intelligent thing to do. There would probably be higher wages, more safety, fewer manufactured commodities, and perhaps greater unemployment in a system under which workers have a realistic "right" to trade safety for wages.

In both the environmental and workplace contexts there are likely to be "ideological holdouts" who, under the "willingness to sell" rule, would be unwilling to be bribed by the polluting entity at any price. Even a large copper company, for example, might not have sufficient resources to meet the price that one of the leaders of Earth First, a radical environmental organization, would demand for yielding up his right to stop the construction of a new copper smelter in an Idaho wilderness area. Indeed, for some kinds of transactions we are all probably ideological holdouts; there are some things that most of us are unwilling to sell at any price. Characteristic examples are our general reluctance to become prostitutes or to sell our votes. Risks to health probably belong to this category of "not-for-sale" aspects of personhood. I am unwilling to sell you my arm because I will not be the same person after the transaction is completed. Not only would I be a one-armed person, I would also be a person who has sold my arm. The same analysis applies to the sale of a high risk to my arm or to the sale of a treasured environmental entity. In both cases the price I would demand for the sale would be higher than the amount that would compensate me if the arm or the entity were lost due to an act of God because there is an added cost attributable to the very act of selling something so intimately attached to self-identity.

There is no reason to choose the "willingness to buy" or the "willingness to sell" liability rule on "efficiency" grounds. Professor Kennedy explains that the efficiency criterion as applied to the externality problem is "incoherent." If not incoherent, the market paradigm is at best schizophrenic. It has two very different personalities, and there is no "neutral" way to choose between the two. Yet, the

62. See Markovits, supra note 37, at 824 n.13.
63. Kennedy, supra note 40, at 388.
64. According to Professor Kennedy, "[T]he concept of efficiency is indeterminate—it cannot yield an answer—if we try to apply it to the whole system of private law rules." Id.

Professor Markovits disputes Professor Kennedy's assertion that cost-benefit analysis is incoherent. First, Markovits rejects the Kalder-Hicks "willingness to buy"—"willingness to sell" formulation of cost-benefit analysis. Instead, Markovits asserts that the proper question to ask is whether the amount of money required to make the "winners" as well off as the proposed policy exceeds the amount of money that would have to be taken away from the "losers" to make them suffer as much as the implementation of the proposed policy. See Markovits, supra note 37, at 815-18; R. Markovits, supra note 40. Interestingly none of the policy-oriented economists of which I am aware have used this formulation of cost-benefit analysis, even though it is, as Markovits demonstrates, a more realistic assessment of the real world.

Professor Markovits convincingly demonstrates that when his approach to cost-benefit analysis is employed, it is normally neither incoherent nor biased in favor of the status quo. Nevertheless, Professor Markovits concedes that cost-benefit analysis cannot yield a correct result (and is therefore, in my terms, schizophrenic) when it is applied to cases where dollar costs and benefits are significantly affected by the wealth of the winners and losers. This is precisely the case when the benefits of a regulation (or the costs of a failure to regulate) are life saving in nature. In these cases a proper "Markovitsian" cost-benefit analysis is likely to demonstrate that both the policy and its reversal are cost beneficial. The test is therefore indeterminate. When the policy merely reduces small risks to life, the test may be less indeterminate.
analyst cannot prescribe even a hypothetical "best answer" to the externality problem without first deciding which valuation rule should hold. This determination is quintessentially a political judgment. The "best answer" is therefore not scientific or objective but necessarily ideological and highly dependent on the analyst's view of the status quo allocation of resources.

Health and environmental amenities are valuable societal resources, as are the commodities that industrial processes produce. The market paradigm, if it functions properly, maximizes overall societal wealth or allocative efficiency, but the paradigm will yield different mixes of these two forms of wealth, depending upon how the political system allocates "rights."

This final defect in the "bargaining" model is more than merely a practical problem for which a "second best" solution can be hypothesized. Policy analysts have tools for factoring uncertainty, transaction costs, and incommensurables into a utilitarian equation with varying degrees of analytical validity. Each of these tools, however, ultimately depends upon the analyst's political choice between the "willingness to pay" and "willingness to sell" criteria for valuing health and environmental resources. Its dependency on this political choice is a fundamental theoretical flaw in the market paradigm with profound implications for any attempts to guide health and environmental regulation toward that ideal.

B. The Tort System and the Market Paradigm

Tort law is a form of indirect government intervention into the marketplace that has the potential to reinforce the bargaining model by ensuring that firms and their consumers compensate employees and neighbors for damage that their activities cause. In addition to compensating those actually harmed, the threat of future payouts can provide an immediate inducement to firms to invest in risk reduction technologies. Yet, despite this indirect incentive, the tort system in practice does not produce the results dictated by the market paradigm.

A variety of compensation systems are available to those who have been injured by industrial activities. Neighboring landowners and government entities may sue to abate private or public nuisances. Employees, in addition, may press claims against employers in workers compensation proceedings. All of these compensation systems, however, share one crucial element—they all require the claimant to establish a causal link between the defendant's conduct and the


66. See generally W. Prosser, supra note 65, chs. 5, 13. Employees faced severe obstacles at common law in establishing a cause of action based upon these two theories. At common law employers could raise the "unholy trinity" of defenses—contributory negligence, assumption of the risk, and the fellow servant rule. See Suter v. San Angelo Foundary & Machine Co., 81 N.J. 150, 406 A.2d 140 (1979); 11 A. Larson, LARSON'S WORKMEN'S COMPENSATION LAW §§ 4.30-50 (1978). Workers compensation statutes were enacted to reduce those barriers to employee recovery. However, it has been argued that the "unholy trinity" defenses reappear in different forms in workers compensation proceedings. See, e.g., D. Berman, DEATH ON THE JOB 66-67 (1978).

67. See 1 A. Larson, supra note 66, ch. 5.
claimant’s harm.\textsuperscript{68} This causation requirement poses the same practical problems as the “full knowledge” assumption of the bargaining model.

When the causal link between an individual’s exposure to an acutely toxic substance and resulting harm can be established with an adequate degree of certainty to convince a judge or jury to compensate the injured party,\textsuperscript{69} the threat of potential liability has been a strong inducement to polluters and employers to reduce or eliminate acute health risks.\textsuperscript{70} Claimants have much greater difficulty, however, establishing a sufficient causal link between past exposure to a chemical substance and a present chronic ideopathic disease.\textsuperscript{71} Even if adequate epidemiological or laboratory studies demonstrated a causal relationship between a substance and harm to human beings or environmental species, it would not follow that any individual plaintiff could establish that exposure to the chemical caused identifiable harm to his person or property.\textsuperscript{72} Courts generally require the plaintiff to present expert testimony that the defendant’s conduct “probably” caused the plaintiff’s harm.\textsuperscript{73} Only where the cause-effect relationship is especially well established—as in the case of acute damage, very rare chemically induced diseases,\textsuperscript{74} and

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\textsuperscript{68} See W. PROSSER, supra note 65, § 41; Calabresi, Concerning Cause and the Law of Torts: An Essay for Harry Kalven, Jr., 43 U. CHI. L. REV. 69 (1975); Malone, Ruminations on Cause-in-Fact, 9 STAN. L. REV. 60 (1956).

\textsuperscript{69} See, e.g., Borland v. Sanders Lead Co., 369 So. 2d 523 (Ala. 1979) (nuisance action for damage caused by lead and sulfur oxides); Luthringer v. Moore, 31 Cal. 2d 487, 190 P.2d 1 (1948) (strict liability for personal injuries due to hydrocyanic acid); Cities Serv. Co. v. State, 312 So. 2d 799 (Fla. 1979) (strict liability for fish kill); Roessler & Hasslacher Chem. Co. v. Doyle, 73 N.J.L. 521, 64 A. 156 (1906) (nuisance for personal injuries due to sodium cyanide).

\textsuperscript{70} Systematic worker exposure to acutely toxic chemicals that threaten immediate death or serious bodily injury is virtually nonexistent in the United States today. One important exception is the exposure of farmworkers to acutely toxic pesticides. See S. Epstein, THE POLITICS OF CANCER 291-92 (1979). Although EPA ensures that the labels for acutely toxic pesticides specify appropriate field reentry times, these are not always observed in practice. OSHA has yet to promulgate effective farmworker protection standards. See Comment, Farmworkers in Jeopardy: OSHA, EPA and Pesticides, 5 ECOLOGY L. Q. 69 (1975).

Many kinds of workers are, however, systematically exposed to substances that pose high risks of low consequence harms, such as contact dermatitis. NATIONAL ASSOCIATIONS OF FARMWORKERS ORGANIZATIONS, PESTICIDE DESK REFERENCE (second draft 1980). The tort system apparently fails here not because of problems of establishing causation but because the high costs of entry into the compensation system preclude suits for the relatively small damage recoveries that can be had for such injuries.

Acute environmental risks have likewise been reduced, though not as much as human health risks. While incidences of large fish kills and air pollution-induced deforestation seem to be declining, air and water pollution still generate a large number of common law nuisance suits based upon easily established causal relationships.


\textsuperscript{72} See generally Small, Gaffing at a Thing Called Cause, 31 TEX. L. REV. 630 (1953).

\textsuperscript{73} See, e.g., Kramer Serv., Inc. v. Wilkins, 184 Miss. 483, 186 So. 625 (1939); Comment, supra note 71, at 367, 371.

Although the causation requirement in a workers compensation proceeding is somewhat less stringent, see generally A. Larson, supra note 66, § 1, workers must still show more than a mere possibility that their physical harm resulted from exposure to a particular industrial chemical unless the legislature has already recognized the statistical causal relationship and erected a statutory presumption of causation. See Miller v. National Cabinet Co., 8 N.Y.2d 277, 168 N.E.2d 811, 204 N.Y.S.2d 129 (1960); Miller v. Olin Mathieson Chem. Corp., 398 S.W.2d 472 (Ky. Ct. App. 1966). See generally Comment, supra note 71, at 355-68.

\textsuperscript{74} The courts are beginning to allow plaintiffs to attempt to convince the factfinder that exposure to asbestos causes mesothelioma. See Karjala v. Johns-Manville Prods. Corp., 523 F.2d 155 (8th Cir. 1975); Borel v. Fibreboard Paper Prods. Corp., 493 F.2d 1076 (5th Cir. 1974), cert. denied, 419 U.S. 869 (1974); see also Comment, Asbestos Litigation: The Dust Has Yet to Settle, 7 FORDHAM URB. L.J. 55 (1978-79).
extremely well studied chemicals that emanate from very few sources, seventyeight — will the courts be willing to allow the plaintiff's case to go to the factfinder.

Even when causation can be established, the multiplaintiff lawsuit presents the same transaction costs problem that plagues the bargaining model. In many cases of acute and chronic exposure, no single person has suffered sufficient harm to make it worth his while to sue the defendant. Theoretically, all of the plaintiffs can join together in a single lawsuit, but the costs of bringing and keeping them together are sufficiently high that the lawsuit often never happens. The class action lawsuit is a potential solution to this dilemma, but the courts have not been receptive to innovative uses of the class action tool and have erected sufficient procedural barriers to render the device ineffectual.

Another disadvantage of relying on the tort system to correct for spillovers is its passive character. A plaintiff can only with great difficulty persuade a court to enjoin risky conduct before the plaintiff has suffered actual injury. While the threat of future damage payouts should theoretically induce firms to reduce risks

75. See, e.g., Pritchard v. Liggett & Myers Tobacco Co., 295 F.2d 292 (3d Cir. 1961) (smoking and lung cancer). Even when cause-effect relationships can be established for chronic diseases, statutes of limitations in some states may preclude recovery for diseases that manifest themselves many years after the disease-producing event. See Harwood, Accural Dilemma: Statute of Limitations in Hazardous Waste Cases, 45 ALBANY L. REV. 717 (1981); Comment, Occupational Carcinogenesis and Statutes of Limitations: Resolving Relevant Policy Goals, 10 ENVTL. L. 113 (1979).

76. The causation problem is exacerbated in environmental pollution cases involving multiple defendants. Even when a cause-effect relationship between a particular chemical and a health or environmental effect is well established, the tort system may be unable adequately to sort out which of several firms emitting that substance into an airshed or watershed should be liable for how much damage. While modern courts will generally not allow one of the many polluters to escape liability on the ground that the plaintiff has failed to trace his or her harm directly back to that firm's discharge, see, e.g., Michie v. Great Lakes Steel Div., Nat'l Steel Corp., 495 F.2d 213 (6th Cir. 1974); Landers v. East Texas Salt Water Disposal Co., 151 Tex. 251, 248 S.W.2d 731 (1952), they still have difficulty apportioning the damage among the various defendants. The most commonly applied rule is a simple equal division of the damages among the joint tortfeasors, even if one contributed a great deal more to the pollution than another. See W. PROSSER, J. WADE & V. SCHWARTZ, TORTS: CASES AND MATERIALS ON TORTS 385 (1976); UNIFORM CONTRIBUTION AMONG TORTFEASORS ACT §§ 1(b), 2, 12 U.L.A. 63 (1975). More recent cases in the product liability area divide up liability according to market share. See Sindell v. Abbott Labs., 26 Cal. 3d 588, 607 P.2d 924, 163 Cal. Rptr. 132, cert. denied, 449 U.S. 912 (1980). It is not clear that either of these approaches sends the correct signals to the polluters, although any signal is better than no signal at all.

77. H. NEWBERG, CLASS ACTIONS §§ 1010.1b, 2h (1977); R. POSNER, ECONOMIC ANALYSIS OF LAW 24-25, 349-350 (1972); Dewees, Pritchard & Trebilcock, An Economic Analysis of Cost and Fee Rules for Class Actions, 10 J. LEGAL STUDIES 155 (1981); Note, Notice Cost Problems Under Rule 23(b)(3) and (c)(2) after Oppenheimer Fund Inc. v. Sanders, 1979 DUKE L.J. 882.

up to the point at which current expenditures equal the present value of future payouts, the hit-or-miss nature of tort damage awards and the circumscribed planning horizons of today's corporate management combine to produce management decisions that underinvest in health and environmental controls. It is, in other words, very difficult to induce the tort system to administer that necessary ounce of prevention.\textsuperscript{80}

The tort system thus faces numerous practical obstacles to bringing about the result that the bargaining model would reach in the ideal world.\textsuperscript{81} In addition, tort theory does not necessarily impel the tort system toward that result. Except for the relatively rare case in which a court will enjoin a nuisance,\textsuperscript{82} the tort system begins with the premise that the polluter or employer has a "right" to expose others to risks. Among its other goals, tort law seeks to encourage polluters and employers to optimize those risks.

In some cases of very hazardous conduct the tort rule is that the entrepreneur must pay for all damages caused by the enterprise.\textsuperscript{83} The source will therefore expend money on pollution control or worker safety up to the point that the last dollar spent on controls brings about a dollar's worth of reduced future damage payouts, discounted to present value. The source will elect to pay future damages at this point rather than waste resources cleaning up pollution and the workplace more than it is worth.

The same result will be reached, in theory, under a negligence rationale.\textsuperscript{84} Under the famous negligence formula first articulated by Judge Learned Hand, a defendant should be required to pay for a nonnegligent plaintiff's loss only when the risks posed by its conduct (the probability of harm multiplied by the consequences) exceed the cost of avoiding those risks.\textsuperscript{85} This formula, of course, is simply the balancing test of the bargaining model written in tort law.\textsuperscript{86} The pol-

\textsuperscript{80} The tort system also requires the judiciary as an institution to make difficult balancing decisions concerning the extent to which the costs of development should be borne by the sources and receptors of the unwanted by-products of industrial activities. To leave the entire matter to the tort system is to place a huge responsibility in the hands of persons who are ultimately unaccountable to the democratic process. Society might legitimately determine that these sensitive questions should not be decided on an ad hoc basis by unelected and unresponsible judges. Moreover, since many issues that would be expected to arise in most "toxic torts" suits will involve complicated questions of toxicology and ecology, judges and lay juries may not be in the best position to evaluate the competing scientific claims.

\textsuperscript{81} R. Posner, supra note 77, ch. 23; A. Stone, Regulation and Its Alternatives 102-03 (1982).

\textsuperscript{82} An injunction flatly prohibiting conduct causing a nuisance is an available remedy in a common law nuisance action, but in most cases the court will either award damages or "balance the equities" and order the defendant to implement technologically feasible abatement efforts. See W. Rodgers, supra note 65, at 143-50.

\textsuperscript{83} See W. Prosser, supra note 65, § 78.

\textsuperscript{84} In practice the private nuisance action, which is generally more appropriate to environmental disruption, is similar. See Reserve Mining Co. v. EPA, 514 F.2d 492 (8th Cir. 1975); Spur Indus. Inc. v. Del E. Webb, 108 Ariz. 176, 494 P.2d 700 (1972); Boomer v. Atlantic Cement Co., 26 N.Y.2d 219, 257 N.E.2d 870, 309 N.Y.S.2d 312 (1970); W. Rodgers, supra note 65, at 107-12. The defendant is subject to abatement or damages only if its use of its property is unreasonable in the context of the surrounding activities. W. Prosser, supra note 65, at 596-602; W. Rodgers, supra note 65, at 117-21; see supra note 82.

\textsuperscript{85} United States v. Carroll Towing Co., 159 F.2d 169 (2d Cir. 1947).
luter or employer will, under this rule, invest in cleanup equipment up to the point at which a court holds him to be nonnegligent. But this is precisely what he would have invested under a strict liability rule because the negligence formula cuts off liability at the precise point at which costs exceed risks. The only difference between the two rules is that the defendant must still compensate plaintiffs for the damages that occur despite its control efforts under the strict liability rule, whereas it may force plaintiffs to bear those losses under the negligence rule. The defendant only has to pay damages under the negligence rule when a court or jury later finds that it has made an error in its calculations.

As in the case of the pure bargaining model, the ideal tort model results in the optimum amount of resources spent on pollution control and worker health. Nevertheless, the crucial ambiguity that haunts the bargaining model likewise afflicts the tort model. The polluter's optimization decision (and the court's determination under the negligence formula) depends upon an accurate measurement of the damage caused by pollution discounted by the probability that the damage will occur at various levels of exposure. But what is the measure of the damage? Is it the amount the victims are willing to pay to be rid of the damage or is it the amount they would charge one who would inflict it upon them? The "willingness to buy"/"willingness to sell" ambiguity remains. Like the bargaining model, the ideal tort model is schizophrenic. Neither measure is logically more appropriate.

At first glance, the real world tort system appears to adopt the "willingness to pay" measure of damage. A wrongful death award is usually calculated by reference to the lost wages and services of the decedent. This amount is, of course, all that the decedent could possibly have paid for the right to remain alive had he been able to strike a deal with the defendant that would have prevented his death. The decedent, however, probably would have demanded a great deal more in return for his life had he the power to prevent the defendant from taking it.

Similarly, if the plaintiff is maimed, she may recover for medical expenses, out of pocket expenses such as lost wages, and permanent disability and disfigurement. Most plaintiffs who could afford it would pay at least this much to avoid the damage altogether, assuming (as we must) that the defendant had a "right" to inflict it upon him. Some plaintiffs, however, could not afford to pay the defendant this amount. Thus, to the extent that the tort system requires that it be paid anyway (and to the extent that it is included on the risk side of the negligence formula), then the tort model in practice is departing from the "willingness to pay" version of the bargaining model.

The real world tort system also allows a damaged plaintiff to recover for pain and suffering. This type of recovery goes far beyond the "value" of the plaintiff in any market-determined sense, except to the extent that a suffering person is not as productive as one who is not in pain. While we all are willing to pay dearly to avoid pain and suffering, some of us are able to afford less pain-avoidance than others. Once again, to the extent that this element enters into the risk side of the

calculation, the result reached by the tort system more closely resembles that reached by the “willingness to sell” version of the bargaining model.

In other subtle ways, the tort system in practice orients its outcome toward the “willingness to sell” criteria. The trial court delegates the balancing function in most negligence cases to a lay jury. The court does not tell the jury to apply the knowledgeable buyer or the knowledgeable seller criterion to the hypothetical bargain between the plaintiff and the defendant; nor, in most cases, does it tell the jury to balance the utility of the defendant’s conduct against the risks to the plaintiff or the class of potential plaintiffs. The courts reject the market paradigm altogether. The jury is told only to measure the defendant’s conduct against that of a reasonable person in the same or similar circumstances. This instruction gives the jury a great deal of discretion to apply factors, such as the relative wealth of the parties, that the policy-oriented economist would condemn as irrelevant.

Moreover, the tort system allows the jury, within bounds set by the supervising judiciary, to evaluate the defendant’s conduct under a moral, as well as a utilitarian, standard. Thus, we observe a jury assessing damages for a single plaintiff in the Pinto litigation against Ford Motor Company equal to the amount saved by the company in making its “cold blooded” decision to subject its customers to an increased probability of future deaths rather than expend fifty dollars per auto for additional protection. It will be a rare jury indeed that will accept an automobile manufacturer’s a priori calculation of the costs and benefits of the preservation of human life when presented with a dead or severely maimed plaintiff. Furthermore, in cases of intentional or grossly negligent misconduct, the tort system in most states gives the jury the express option to “punish” the defendant for its moral fault by assessing punitive or exemplary damages against the defendant.

This is an explicit recognition of the decisionmaker’s role as a moral faultfinder as well as a risk and benefit assessor.

While the policy-oriented economist might condemn all of this as irrational, it may very well represent a rough approximation of a “rational” assessment of the net utility and costs of the defendant’s conduct under the market paradigm but applying the “willingness to sell” rather than “willingness to pay” criterion.


88. In some formulations of the standard for strict product liability, juries are told explicitly to evaluate risks and benefits of the product at issue. See, e.g., Mitchell v. Fruehauff Corp., 568 F.2d 1139, 1145 (5th Cir. 1978); Turner v. General Motors Corp., 584 S.W.2d 844, 846-47 (Tex. 1979); Green, Strict Liability Under Sections 402A and 402B: A Decade of Litigation, 54 Tex. L. Rev. 1185 (1976).

89. W. Prosser, supra note 65, at 206; Restatement (Second) of Torts § 464 (1965).


91. A more common alternative explanation for the tort system’s failure in practice to reach results dictated by the bargaining model is that most of us are willing to sacrifice allocative efficiency when it conflicts with justice. See R. Dwarkin, Taking Rights Seriously (1977); Dwarkin, Why-Efficiency?, 8 Hofstra L. Rev. 563 (1980). The tort system should be aimed at achieving just results rather than efficient results. In suggesting that the tort system might be achieving an “efficient” result under the “willingness to sell” test, which recognizes the plaintiff’s “right” not to be harmed, I do not mean to suggest that justice should play no role. Indeed, justice may in many cases not involving large physical loss dictate results different from those arrived at through application of the “willingness to sell” test. My intent here is
Since the economist is no better qualified than the rest of us to make this choice, disapproval of the current tort system may reflect political views about the relative statuses of industrial activity and other human activity. Thus, the current appeals from industry and some economists to reform the tort system\textsuperscript{92} may not be motivated by a desire to implement a more rational system; rather, they may be viewed as calls for a different system in which manufacturers and other defendants do not pay as much to avoid damage to others.

C. Health and Environmental Regulation and the Market Paradigm

Government regulation can to some extent remedy the defects in the tort system and the pure bargaining model. A regulatory regime would not require the causal link between a chemical and a particular disease to be established with nearly the particularity of the tort system because the regulatory system addresses overall societal risks rather than individual damage. The regulatory entity can use broad epidemiological studies and animal experiments to draw conclusions about the nature and extent of the health and environmental harm attributable to the release of a substance into the workplace or the environment. The regulator can often anticipate potential problems in advance and attempt to remedy them before human beings and environmental entities are harmed, perhaps irreversibly. A regulatory regime can offer direct incentives that should considerably broaden societal and individual firm planning horizons. The regulator can also solve the multiplaintiff, multidefendant transaction costs problem by acting as a surrogate for all injured parties and by framing generic controls or incentives that affect all firms discharging harmful substances. A regulatory agency can acquire in-house expertise to aid it in resolving questions of scientific fact and separating resolvable questions of fact from policy or value questions. Finally, the regulatory entity can be placed closer to the political process than the courts, thus ensuring greater political accountability.

Many policy-oriented economists, agreeing that a regulatory system helps resolve many of the practical problems of the bargaining model and the tort system, still argue that the market paradigm should dictate the regulatory results.\textsuperscript{93} Society is best off, according to these economists, when the marginal dollar expended on health and environmental control achieves exactly one dollar's worth of health and environmental benefit.\textsuperscript{94} When more than one of many tech-

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\textsuperscript{93} See, e.g., A. KNEESE & C. SCHULTZE, supra note 18, at 71; Comar, SO\textsubscript{2} Regulation Ignores Costs, Poor Science Base, 57 Chem. & Eng'g News, Apr. 23, 1979, at 42, 46; Lave & Seskin, Neither Cynical nor Idealistic View is Sound Basis for Policy, 57 Chem. & Eng'g News, Apr. 23, 1979, at 49.

\textsuperscript{94} See M. BAILEY, REDUCING RISKS TO LIFE 15 (1980); Breyer, supra note 38, at 570; Chelius, supra note 59, at 701-02; Freeman, Air and Water Pollution Policy, in CURRENT ISSUES IN U.S. ENVIRONMENTAL POLICY 12, 19-20 (P. Portney ed. 1978); Solow, The Economist's Approach to Pollution and Its Control, 173 Science 498 (1971).

Some economists would also add that the costs of imposing a control should include administrative or enforcement costs borne by the government as well as the costs that the regulated entities must pay to
nological solutions can meet this criterion, society should choose that solution which minimizes the sum total of the cost of the damages remaining after implementation of the technology and the cost of implementing the technology. By carefully balancing control costs against health and environmental benefits, society maximizes the total output of goods and services and puts each resource to its best use. Thus, in the context of health and environmental regulation, the policy-oriented economist suggests that immediate regulatory goals be determined by cost-benefit analysis.

This simple utilitarian notion has a firm foundation in plain common sense. It is not sensible to spend more on pollution control than it is worth. Health and environmental quality, in this view, are collective economic commodities that society pays for just as it pays for streets, police protection, and fire prevention. As with these other commodities, there is an optimum amount of industrial and pollution-induced disease, harm to environmental organisms, and damage to material that health and environmental regulators should attempt to achieve. This optimum can be derived through a careful cost-benefit balancing process. To spend more than the optimal amount of resources on pollution control is, in the policy-oriented economist’s engaging metaphor, to reduce the size of the total economic pie.

1. Practical Limitations. In the context of health and environmental regulation, one will discover once again that numerous practical difficulties hobble attempts to accommodate the bargaining paradigm to real world problems. Since these practical limitations are treated in great detail in the policy analysis literature,
they can be briefly summarized here. The following discussion will pay particular attention to the practical problems of health and environmental regulation of the chemical industry. As it happens, the chemical industry poses some of the more intractable real world obstacles to the successful implementation of a balancing approach.

a. Quantifying Costs. Quantifying the costs of regulatory intervention is the simplest of the tasks facing the regulatory entity. It need only sum the forecasted costs of implementing various levels of pollution control. Numerous practical problems, however, plague even this conceptually simple operation. The information necessary to perform these forecasts is very costly, and large predictive uncertainties accompany the calculations. Engineers must estimate the costs of various pollution reduction technologies for all of the firms discharging a particular chemical substance into a relevant body of air or water. The engineers must further predict the effects of the installation of the alternative technologies on receiving media quality so that the regulatory entity can know the total cost of each level of media quality.¹⁰¹ This operation requires both a prediction of the end-of-pipe pollution concentrations resulting from each technology and the development and application of a pollutant dispersion model capable of converting end-of-pipe concentrations to steady-state ambient concentrations. For some pollutants in some media, such models already exist,¹⁰² but they are plagued by large uncertainties.¹⁰³ For other media, such as ground water, dispersion and fate models are still in relatively primitive stages of development,¹⁰⁴ and the huge uncertainties surrounding them make them virtually useless for relating the costs of pollution con-

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¹⁰¹. If more than one firm discharges a pollutant into the relevant media so that the discharges of all firms overlap, the informational costs of assessing the costs of various levels of media quality are further exacerbated. Fortunately, one characteristic of the chemical industry is that this condition is not often met. Hence, the assessment of pollution control costs for a given body of air or water reduces simply to an assessment of a single firm's costs. In cases of multiple polluters, however, the assessment of costs is vastly more difficult. Ruff, The Economic Common Sense of Pollution, 19 PUB. INTEREST 69, 76 (1970).

¹⁰². Requirements for Preparation, Adoption and Submittal of Implementation Plans, 40 C.F.R. § 51 (1980). Texas v. EPA, 499 F.2d 289 (5th Cir. 1974), illustrates some of the disputes that can occur over the accuracy of such models.

¹⁰³. See U.S. Environmental Protection Agency, Cost and Economic Impact Assessment for Alternative Levels of the National Ambient Air Quality Standard for Ozone I-7 (Draft Report June 1978): "Depending on the [modeling] technique used, wide variations can result in allowable emission levels and the concomitant reduction in projected emissions that is required [to meet alternative ambient air quality standards for ozone]." Table I-1 in the Economic Impact Assessment Document for Ozone dramatically demonstrates the sensitivity of cost estimates to the choice of the reduction model. For example, the linear rollback dispersion model yields estimated costs of $6 billion to $8 billion for meeting a 0.08 ppm ozone standard while the empirical kinetic modeling approach yields estimated costs of $9 to $12.5 billion for the same standard. While both of these models are reasonably sophisticated, the choice between them depends upon one's assumptions about air dispersion modeling. Clearly, large uncertainties cloud the application of even those reasonably well accepted models. Even larger uncertainties can be expected with water quality modeling, which is at a more primitive stage of development. However, the fact that only one source need be considered for the discharge of toxic pollutants from chemical industry may simplify modeling assumptions.

¹⁰⁴. Rose-Ackerman, Effluent Charges: A Critique, 6 CAN. J. OF ECON. 512, 518 (1973); A. KNEESE & C. SCHULTZE, supra note 18, at 17.
trol to levels of media quality.\textsuperscript{105}

Another factor on the costs side of the equation that severely confounds any attempt at marginal analysis is the limited supply of pollution control technologies that are available to firms over relevant time periods. A particular source or category of sources may have only two or three realistic pollution control options, each of which yields a particular level of receiving media quality. "Turning down" the pollution control machine may be impossible or may not significantly reduce overall operating and maintenance costs. In other words, control technologies may often come in discrete and nontunable units.\textsuperscript{106} Once a firm has installed a particular technology, any greater reduction in pollution may be achievable only by installing the next most effective equipment, and any lesser reduction may be impossible short of turning off the technology.\textsuperscript{107}

If it is difficult to fine-tune pollution reduction systems to meet specific limitations, it may be impossible to set a limitation at precisely the point at which costs equal benefits. Figure 1 provides a hypothetical example of a costs-versus-pollution-reduction curve and a benefits-versus-pollution-reduction curve. The benefits curve is a simplified linear curve. The costs curve illustrates the technological

\textsuperscript{105} "While reasonably adequate engineering models exist relating discharges to ambient water quality, cost data are generally weak and fragmentary." Rose-Ackerman, supra note 13, at 389.

In addition, the ability of a single technology to reduce concentrations of more than one chemical can be a benefit that is not accounted for in a proceeding involving the costs and benefits of reducing exposure to an individual pollutant. The regulatory entity may simultaneously or within a short period of time regulate several pollutants within a single firm's discharge. It is certainly possible (and for some pollutants likely) that a single technology is capable of reducing discharges or emissions of many pollutants at the same time. See Development Documents for Effluent Limitations Guidelines and Standards for the Inorganic Chemicals Manufacturing Point Source Category (Proposed), Environmental Protection Agency 137 (1980). For example, in the nickel sulfate subcategory, alkaline precipitation with dual media filtration will remove some nickel, copper, chromium, antimony, zinc, and lead. Id. at 771. Similarly, secondary treatment can apparently remove numerous organic toxics from effluent wastes. Implementation of the Federal Water Pollution Control Act: Hearings on Regulation and Monitoring of Toxic and Hazardous Chemicals under the Federal Water Pollution Control Act Before the Subcomm. on Oversight and Review of the House Comm. on Public Works and Transportation, 96th Cong., 2d Sess. XV (1980) (summary of hearings) [hereinafter cited as Implementation Hearings]; Subcomm. on Oversight and Review of the House Comm. on Public Works and Transportation, 96th Cong., 2d Sess., Implementation of the Federal Water Pollution Control Act 49 (Comm. Print 1980) [hereafter cited as PROHLMAN REPORT]. If a single technology can remove more than one pollutant, that additional benefit may not be factored into the cost-benefit balance for a single pollutant. It would therefore be inappropriate to list the entire cost of installing the single technology (or perhaps minor modifications of a single technology) in the cost estimation for each of the individual pollutants.

\textsuperscript{106} "On the basis of what we already know, it is difficult to agree that the shapes of air pollution cost and abatement functions are linear, as implied by Kneese." Wolozin, The Economics of Air Pollution: Central Problems, 33 LAW & CONTEMP. PROBS. 227, 229 (1968). Some technologies, such as scrubbers, can be tuned to some extent to reach a spectrum of emission concentrations. See 1 U.S. Environmental Protection Agency, Proceedings: Symposium on Gas Desulfurization 43-58 (1978).

\textsuperscript{107} For example, it is becoming apparent that the "secondary treatment"—activated sludge, trickling filters, and other minor variations on this theme—which has been required for publicly owned treatment works and for many firms as part of EPA's "best practicable technology" effluent limitations, is capable of removing more than 90% of some toxic organics. Implementation Hearings, supra note 105, at 43 (statement of Walter E. Garrison, Chief Engineer and General Manager, County Sanitation District, Los Angeles County). Lesser technologies remove much lower percentages of these pollutants. Hence, assuming only a single source in a relevant body of water, the cost side of the cost-benefit equation will not vary from some high level of ambient water concentration to that much lower level reached by 90% removal. The choice for the regulatory entity is therefore "all or nothing," even if the benefits side of the equation warranted expenditures less than secondary treatment but greater than less effective treatments.
options available to a source on the assumption that technologies are discrete and nontunable. The broken curve is the curve that would presumably exist if technologies were nondiscrete and tunable. In the real world of discrete technologies, it would appear worthwhile to install technologies A and B but not technology C. The benefits of installing technology B are 6.5 million dollars while the cost is only five million dollars. Technology C is too expensive because thirteen million dollars in expenditures yields only ten million dollars in benefits. It would be ideal to install a technology that cost $8.75 million and produced $8.75 million in benefits, but unfortunately, that technology does not exist. The regulatory entity is therefore likely to settle for technology B. Since the costs of installing technologies capable of reducing pollution by a given amount rise dramatically with the overall amount of pollution reduction, the cost-benefit based approach may result in a systematic bias toward underprotection.\(^{108}\)

Finally, an accurate assessment of the costs of a spectrum of possible regulatory controls would require some measurement of secondary economic effects such as anticompetitive and employment effects.\(^ {109}\) While it would be irresponsible for the regulatory entity to ignore these effects, their very amorphous nature will provide substantial leeway to hinge its cost estimates on untestable assumptions.\(^ {110}\) Moreover, any assessment of costs must depend heavily upon input from the regulated firms. It would be unrealistic to expect that a firm’s cost projections will not be affected by the purpose for which the regulatory entity plans to use the projections.\(^ {111}\) Hence, both primary and secondary costs may be biased against regulatory intervention.

In sum, the estimates of the costs side of the cost-benefit equation will in most cases be highly dependent upon the scientific assumptions that underlie the dispersion model that the agency chooses and the economic assumptions behind cost predictions. The uncertainties inherent in these calculations provide great leeway for the regulatory entity. Since regulated firms can be expected to participate fully in the cost-assessment process, the regulatory entity must either vigilantly police industry-submitted cost estimates or independently produce its own. If it chooses the former alternative, it must acknowledge that its estimates are likely to gravitate toward the high side.

b. Quantifying Risks. The uncertainties that plague the regulatory entity’s attempts to quantify costs pale into insignificance when measured against the uncertainties inherent in assessing the benefits side of the equation. The quantitative study of risks posed by human exposure to environmental contaminants is still

\(^{108}\) If a particular industry contained enough firms, many individual cost curves might aggregate into a single smooth upwardly sloping curve common to the economics literature. Nevertheless, the sources of a particular chemical within the chemical industry are likely to be sufficiently few that a smooth aggregate curve will not result. Indeed, since a given technology for removing particular pollutants has about the same capital costs for any firm, the only variability among firms is likely to be in installation and operation and maintenance costs. The aggregate curve for a small number of sources may therefore look much like the curve for an individual source.

\(^{109}\) See Leone & Jackson, supra note 98, at 232.

\(^{110}\) Id. at 233.

\(^{111}\) See Baram, supra note 100, at 483, 490.
Billions of Dollars

% Reduction

Costs

Benefits

A

B

C
in a state of awkward infancy. Even the comparatively straightforward assessment of the toxicological properties of a particular environmental contaminant is fraught with uncertainty. Epidemiological studies are notoriously inconclusive, as the continuing disputes over the health effects of beryllium and benzene amply demonstrate. Animal studies can provide advance information on the toxicological effects of a chemical, but cost considerations usually preclude testing an adequate number of animals at environmentally relevant dose levels. Hence attempts to extrapolate human risks from animal studies must make untestable assumptions about interspecies extrapolations and about the shape of the dose-response curve for the chemical at low exposure levels. Finally, uncertainties arise in attempts to ascertain actual human exposure to environmental contaminants. The net result is that risk assessments can vary over nine orders of magnitude, depending upon the assumptions that fuel the models.

The science of assessing the risks that pollutants pose to nonhuman species and materials is also imprecise and fraught with uncertainty. Yet these effects, too, must be factored into any reasonable cost-benefit analysis of mandated pollution controls, thus enlarging the overall margin of uncertainty. The National Environmental Policy Act has spurred a large number of commendable efforts to include small effects on ecosystems in the analysis of governmental activities, and this knowledge is now available to regulatory decisionmakers. Still, environmental

112. For the author's analysis of the scientific and policy debates surrounding "science/policy" issues arising out of carcinogen regulation see McGarity, supra note 49.


114. See McGarity, supra note 49, at 733-34; Schneiderman, Mantel & Brown, From Mouse to Man—Or How to Get From the Laboratory to Park Avenue and 59th Street, 246 ANNALS OF THE N.Y. ACAD. OF SCI. 257, 241 (1975).


116. See Leape, Qualitative Risk Assessment in Regulation of Environmental Carcinogens, 4 HARV. ENVT'L. L. REV. 86, 100-01 (1980); McGarity, supra note 49, at 734-35. I have placed the issue of high dose-low dose extrapolation models in a category of science/policy questions that Dr. Alvin Weinberg calls "trans-scientific." These are questions which "hang on the answers to questions which can be asked of science and yet which cannot be answered by science." Weinberg, Science and Trans-Science, 10 MINERVA 209 (1972).

117. McGarity, supra note 49, at 738; see also supra notes 102-05 and accompanying text. The problem of determining human exposure in the workplace is not an especially difficult one. In most cases, the chemical concentrations in the actual workplace can be monitored relatively easily. However, determining human exposure to environmental contaminants is much more difficult. For air pollutants the calculation requires at least an adequate dispersion model and, for chemicals like lead, an assessment of alternative pathways, such as ingestion or dermal exposure, in addition to the more usual inhalation exposure. For persistent water pollutants the calculation is extraordinarily complex, requiring an adequate dispersion model, an assessment that the contaminant will become part of a drinking water supply, an assessment of the exposure to various organisms as the chemical makes its way up the food chain, and a prediction of the amount that will ultimately find its way into the human food supply.


119. Baram, supra note 100, at 483; Gelpe & Tarlock, supra note 71, at 371.

120. For one extensive, though in many ways dissatisfying, effort to quantify the benefits of attaining alternative levels of sulfur dioxide and particulate controls see U.S. Environmental Protection Agency, Benefits Analysis of Alternative Secondary National Ambient Air Quality Standards for Sulfur Dioxide and Total Suspended Particulates (Draft Final Analysis July 1981) [hereinafter cited as EPA Sulfur Dioxide Standards]. See generally A. FREEMAN, THE BENEFITS OF ENVIRONMENTAL IMPROVEMENT (1979).
impact analysis is hardly a precise science, and agency policy analysts tend to belittle these "soft variables."\textsuperscript{121}

The foregoing difficulties with quantitative risk assessment constitute a formidable threat to the rationality of cost-benefit analysis. How much useful knowledge has the regulatory decisionmaker gained when he is told, as the Administrator of the EPA was once told, that the risks posed by a polluting activity range from zero to 660,000 cancers over a seventy-year period?\textsuperscript{122} Arguably, the decisionmaker can use this information in setting priorities;\textsuperscript{123} he might decide to regulate this contaminant after he has regulated one that poses a risk of zero to 990,000 cancers over the same period. This information, however, cannot be of much utility in a marginal balancing analysis.

This branch of reductionist quantitative risk analysis can, however, work a positive harm when the decisionmaker (or, more likely, his or her technical underlings) masks the huge uncertainties inherent in the enterprise and presents to the public a "best estimate" that implies an accuracy that simply does not exist. The public is in a very real sense being deceived when it is told that the lifetime risks posed by a chemical are twenty-six cancers, rather than somewhere in the range between zero and 660,000 cancers. The public is also being deceived when it is told, without further elaboration, that the risks posed by a pesticide are about the same as smoking one cigarette per lifetime.\textsuperscript{124} The regulator can choose from among a wide variety of proposed risk assessment models, some of which resolve uncertainties in favor of protecting the public and the environment and others of which resolve uncertainties in favor of maximizing industrial activity. Only rarely will the proponent of a model acknowledge the covert political considerations that motivate the choice among models.\textsuperscript{125} Yet, until models are developed which can attract a reasonable scientific consensus, the choice between models is entirely policy dominated. Regulators who use such highly refined, but ultimately hollow,

\begin{itemize}
\item \textsuperscript{121} Tribe, \textit{Trial By Mathematics: Precision and Ritual in the Legal Process}, 84 \textit{Harv. L. Rev.} 1329, 1361-65 (1971).
\item \textsuperscript{122} This example comes from the author's personal experience in the Office of General Counsel of the EPA.
\item \textsuperscript{123} Identification, Classification, and Regulation of Potential Occupational Carcinogens, 45 Fed. Reg. 5,002, 5,256 (1980); \textit{see infra} text accompanying note 340.
\item \textsuperscript{124} In August 1981, Dr. John Todhunter, EPA Assistant Administrator for Pesticides and Toxic Substances, determined that the cancer risk from one year's use of ethylene dibromide (EDB) to fumigate citrus crops was 100 times less than the risk of smoking one cigarette in a lifetime. \textit{Pesticide & Toxic Chem. News}, Aug. 26, 1981, at 19-20. One week later, Dr. Todhunter corrected this estimate of cancer risk to equal the risk of smoking between one and two cigarettes over a lifetime. \textit{Pesticide & Toxic Chem. News}, Sept. 2, 1981, at 14.
\item Dr. Adrian Gross, at that time chief scientist of EPA's hazards evaluation division, said that "Todhunter is trying to say that the risk is one in a million that someone will contract cancer whereas I find the data to show that the risk is one in a thousand and possibly 50 to 70 per thousand." Wash. Post, Oct. 8, 1981, at A29, col. 5. He continued that the chemical "is much more dangerous than Todhunter believes because it can find its way into food products as easily as it can be consumed" in fruit. \textit{Id}. One staff member who worked on the Agency position document said he would not eat fruit treated in accordance with Dr. Todhunter's "minimum expectations for residue." \textit{Id}.
\item \textsuperscript{125} \textit{See Mantel & Schneiderman, Estimating "Safe" Levels, A Hazardous Undertaking}, 35 \textit{Cancer Research} 1379, 1382 (1975) (choice of log-probit dose-response model over more conservative linear model justified on grounds that use of former ultimately would result in fewer products taken off the market).  
\end{itemize}
techniques to “fine tune” benefits analyses are deceiving the public and perhaps themselves.

2. **Theoretical Limitations.** In addition to the foregoing practical limitations of cost-benefit analysis, it also has several important theoretical limitations. Some of these have already been suggested in the previous analysis of the “bargaining” and “tort” models.

   a. **Valuing the Benefits.** While the adoption of a regulatory agency approach to the pollution problem remedies many of the practical defects of the “bargaining” and “tort” models, it fails to resolve the debilitating schizophrenia that afflicts the bargaining model. Even if scientists could precisely quantify all of the lives, organisms, and materials lost at all relevant levels of media quality, only some of these could be evaluated in any meaningful way because the “willingness to pay” measure of health and environmental harm will in many cases diverge widely from the “willingness to sell” measure.

   Past attempts by regulatory agencies and policy analysts to measure the benefits of health and environmental controls have invariably invoked the “willingness to pay” criterion. The implicit, and often explicit, assumption of the economists who attempt to place a monetary value on the benefits of health and environmental controls is that the freely polluting market is the norm and any governmental intervention must be justified. This is the equivalent of a rule of law that all polluters may freely pollute unless they have contracted not to. As we have seen, one can have an equally rational society in which the opposite rule holds. Translated to the regulatory sphere, the polluter in the latter society must justify its pollution by showing that the surrounding neighbors would be willing to accept it for the decrease in product price attributable to the amount that the firm saves from failing to control it. Yet, strangely, no economist of which I am aware has taken the “willingness to sell” criteria as the appropriate test for the benefits of pollution reduction. In the case of pollutants that cause only minor discomfort or property damage, the two measures are, as Coase suggests, probably about the

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126. There is a real, working market in most materials. The damage to materials can be evaluated by reference to the market costs of replacement or repair. For some materials, however, such as the Statue of Liberty, this valuation method may not be entirely adequate. Aesthetics as well as economics play a role in the valuation process, and the market paradigm once again becomes schizophrenic. See infra text accompanying notes 127-130.


Even the “willingness to pay” criteria is criticized by some economists as being unrealistic when the beneficiaries of health and environmental controls are not actually forced to pay for them. See Grannell, Environmental Control is Out of Control, CHEM. & ENG’G NEWS, Apr. 23, 1979, at 29, 31.

One instance in which the “willingness to sell” test has been invoked is in current proposals to compensate localities for siting hazardous waste facilities within their borders. See Bacow & Milkey, Overcoming Local Opposition to Hazardous Waste Facilities: The Massachusetts Approach, 6 HARV. ENVTL. L. REV. 265, 275-79 (1982). The authors point out that this is efficient because it allows “projects to proceed only if their social benefits outweigh their social costs.” Id. at 275.

128. See Breyer, supra note 38, at 552.

same. But if willingness to sell were the measure of the benefits of controlling life-threatening industrial activities, the numbers that the various economic models produce, which are indeed quite large under the "willingness to pay" criterion, would probably become significantly larger.

A second theoretical conundrum with benefits analysis is the value of reduced risks to persons not yet in existence. Those persons, of course, are not consulted as to either their willingness to pay for or their willingness to sell additional risks to their health and well-being. The decisionmaker can make a very crude attempt to consider the interests of future generations by adjusting the "discount rate" of the benefits analysis in such a way that a dollar's worth of future benefit is worth more than the value given to it by a current investor. Yet, the fact that future benefits are discounted at all connotes a bias of sorts against future inhabitants of the planet. One report on benefits analysis suggests that "in the future, one may very well value good health and a clean environment even more than one does today so that an individual might choose to use a negative, rather than a positive discount rate for certain future benefits." Indeed, for harms like physical pain and suffering the entire discounting theory may be inappropriate. While a present dollar is clearly worth more than a future dollar, it is not clear that present pain is worth more or less than the promise of future pain.

Another infirmity that afflicts standard economic valuation of pollution control benefits is the disturbing tendency of the policy-oriented economist to "dwarf soft variables." Policy analysts are often inclined to ignore unquantifiable variables, such as the psychic costs of knowing that a species has become extinct, and to undervalue those "soft variables" that they can identify but cannot easily appraise. Moreover, the analyst's assessment of the environmental benefits of

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130. Crude estimates were made of the "willingness to pay" for improved air quality in the south coast air basin of southern California. Assuming approximately 30% improvement in ambient air quality, where a household is willing to pay $42 per month, the annual benefit to this area was predicted to be $950,000,000. 5 U.S. Environmental Protection Agency, Methods of Development for Assessing Air Pollution Control Benefits 16-17 (1979) (executive summary).

131. See Baram, supra note 100, at 486; Rodgers, supra note 100, at 196; Massachusetts Institute of Technology Center for Policy Alternatives, Benefits of Environmental, Health, and Safety Regulation, (1980) (prepared for the Senate Comm. on Govtl. Affairs, 96th Cong., 2d Sess.) [hereinafter cited as MIT Report].

132. The discount rate is a standard economic tool for taking into account the fact that a dollar in hand is worth more than the promise of a dollar in the future. See Baram, supra note 100, at 486-87. Benefits due to a present environmental improvement that accrue in the future must therefore be discounted to their present value.

133. MIT Report, supra note 131, at 18; see also Baram, supra note 100, at 486 n.47 (suggesting that analysts have chosen rates that tend to confirm the outcomes they desire); Rodgers, supra note 100, at 196 ("the decisionmaker who uses today's preferences to discount tomorrow's life is one whose impartiality might reasonably be questioned").


135. See supra text accompanying notes 54-56.

136. The decisionmaking process fixates on the comparison of the monetary terms and fails to suffi-
environmental regulation is invariably anthropocentric. The value placed upon a segment of stream, for example, does not take into account the stream’s value to the fish, deer, insects, and plant life that also use the stream, except insofar as these entities are valuable to humans. Many policy-oriented economists therefore have little patience with statutes like the Endangered Species Act that seem to give nonhuman entities greater intrinsic value than they have in any conceivable marketplace.

b. Distributional Considerations. The policy-oriented economist does not directly concern himself with the distributional effects of the policies that he advocates. He is more interested in maximizing the size of the economic pie than in suggesting how it should be sliced. Yet, virtually any governmental action, including the definition of the property and contract rules that define the “free market,” affects the distribution of wealth among its citizens. A property rule giving a polluter the right to pollute unless he has contracted otherwise makes polluters richer; a rule giving neighbors the right to enjoin polluters makes surrounding property owners wealthier. Even if Professor Coase is correct in maintaining that the unimpeded market will ultimately maximize total wealth under either rule, it is clear that under the first rule polluters will receive a greater proportion of that total wealth than they will under the second.

Regulatory intervention in the workplace and the environment will likewise shift wealth. If the regulatory entity follows the policy-oriented economist’s approach, it must still elect the “willingness to sell” or the “willingness to pay” criterion for valuing the benefits of the intervention. A choice of the “willingness to pay” criteria will shift wealth from the poor to the rich because the poor have fewer resources to draw upon. A choice of the “willingness to sell” criteria will shift wealth from the rich to the poor because the poor can ask for as much in return for risks to their health as the rich. Even if as an empirical matter poor...
people do not generally demand as many dollars for health risks as wealthy people, they will almost certainly demand more than they can pay under the opposite test.

Irrespective of the valuation criteria, governmental intervention will shift wealth from polluters and consumers of their products to the beneficiaries of the regulatory intervention, and any intervention that does not completely eliminate risks will allow the polluters and their consumers to profit from the loss of others. Consumers of the polluter's products would be willing to pay the victims (under the "willingness to sell" rule) or the victims would be willing to pay the polluter (under the "willingness to buy" rule), but the failure of the "bargaining" and "tort" models means that these transactions never occur. The utilitarian regulator would allow the polluting activity to continue if the overall benefits of the activity outweigh its costs, but the regulator will not actually require the beneficiaries to compensate the losers. Any rule short of a complete prohibition of polluting activity or a perfectly enforced strict liability compensation system therefore creates an uncompensated minority of victims who must endure health risks and environmental harm so that the economy as a whole may expand. On the other hand, a rule of complete prohibition forces consumers to pay more for risks than the victims would demand under the "willingness to sell" rule or pay under the "willingness to pay" rule (assuming transaction costs did not impede the transaction), and this would certainly seem inequitable to the beneficiaries of the polluting activity. These distributional concerns can be addressed, perhaps more efficiently, through direct transfers from the public treasury to the "victims" of the governmental policy through mechanisms like a large "superfund." Such transfer devices, however, face the same causation problems as the tort system, and they are often difficult to implement politically.

The distributional concerns raised by regulatory application of the market paradigm are not limited to shifts of wealth between distinctive groups within society. To the extent that the regulatory entity neglects to measure the value of or undervalues future human beings or nonhuman inhabitants of the planet, the result will be a shift of the world's resources away from those neglected groups and toward present human consumers' manufactured products.

Finally, economists have recently postulated that regulatory controls can have

A worker cannot really insist that the employer eliminate toxic substances from the workplace; the worker can always be fired and replaced by a "less picky" worker. Under this sort of economic duress, the worker may be willing to sell his health for an unrealistically low price. Low income persons operating under economic duress may well sell their health for less than the rich. To a limited extent the same is true for environmental controls. Since a dollar means more to someone with very few of them, the poor may sell their right to a clean environment at a lower price than the rich.

145. Occasionally this minority of victims can be identified. For example, many forms of air pollution are more irritable at lower levels of exposure to persons afflicted with emphysema. See, e.g., American Petroleum Inst. v. Costle, 609 F.2d 20 (D.C. Cir. 1979). Many pollutants affect children more dramatically and at lower exposure levels than adults. Lead Indus. Ass'n v. EPA, 647 F.2d 1130, 1141 (D.C. Cir.), cert. denied, 449 U.S. 1042 (1980). For other pollutants a "susceptible" group is less easily identified, although some preliminary attempts have been made. See generally E. CALABRESE, POLLUTANTS AND HIGH RISK GROUPS (1978).

distributional impacts within the regulated industry itself.\textsuperscript{147} Government-required capital investments in pollution controls can put some firms at a disadvantage with respect to their competitors.\textsuperscript{148}

The fact that the economist \textit{qua} economist is uninterested in the distributional impacts of the policies that he advocates does not mean that the rational policymaker is likewise free to ignore the distributional implications of her decisions. The response of some economists that inequities can be resolved through direct transfer payments to the victims of utilitarian policies presumes that a mechanism for this transfer exists and that it will be used. Moreover, this response also ignores the negative symbolic impact of a governmental action which allows some to profit from health risks imposed upon others. Finally, the advocate of transfer payments implicitly espouses the same presumptuous premise that afflicts policy-oriented economists' pursuit of the valuation problem—that all values can be reduced to coin. The policymaker must therefore directly address the distributional concerns that alternative policies raise. A sufficient reason for rejecting a wealth-maximizing policy is that too much wealth would change hands in the process.

D. Politics and the Rejection of the Market Paradigm

The policy-oriented economists often appear frustrated by politicians' persistent failure to heed their teaching with respect to the proper goals of health and environmental regulation,\textsuperscript{149} and to select efficient tools for the pursuit of designated environmental goals. There is some justification for the frustration arising from the failure to select efficient \textit{tools}.\textsuperscript{150} The economist, however, should not feel slighted by the politician's failure to pursue the market paradigm in setting the \textit{goals} for health and environmental regulation because that endeavor requires more than economic expertise. There are important reasons why the politician must reject that paradigm, not the least of which is its basic schizophrenia. The politician does not reject the discipline of economics; she merely seeks to accommodate a broader range of values than most policy-oriented economists are willing to address. The pollution problem is not merely an economic problem, as some policy-oriented economists maintain;\textsuperscript{151} rather, it is primarily a \textit{political} problem to be resolved by the political process.

\textsuperscript{147} See, e.g., A. KNEESE & C. SCHULTZE, supra note 18, at 22-23; Leone & Jackson, supra note 98, ch. 5.

\textsuperscript{148} Relaxation of governmental controls can have similar intrafirm distributional effects, as illustrated by the recent dramatic changes in the airline industry. "Some firms, finding that they simply cannot afford the cleanup may have to go out of business." Leone & Jackson, supra note 98, at 27.

\textsuperscript{149} Over the past decade, the U.S. has made a major commitment to improving the quality of our air and water. During this entire period, economists who think about environmental policy have, virtually without dissent, accused the government of going about the task of environmental cleanup in the wrong way.

\textsuperscript{150} See generally F. ANDERSON, supra note 9; A. KNEESE & C. SCHULTZE, supra note 18; B. MITNICK, supra note 46; Lave, Health and Environmental Regulations, in SETTING NATIONAL PRIORITIES: AGENDA FOR THE 1980's 131 (J. Pechman ed. 1980); Rose-Ackerman, supra note 13.

\textsuperscript{151} Chelius, supra note 59 ("For all the moral anguish associated with accidents, it must be remembered that safety is an economic commodity."); Freeman & Haveman, supra note 149, at 52 (referring to the basic economic nature of the problem); Ruff, supra note 101, at 69 ("We are going to make very
The fact that the market paradigm is only rarely invoked in the actual political debate that impels legislators to enact pollution control statutes is unsurprising to the student of the political process. A politician stands to gain little political capital by announcing to her constituents: "I have identified an instance in which the tort system has failed adequately to internalize externalities, and I am today introducing legislation to minimize the sum of pollution and pollution avoidance costs." The politician is likely to attract much more attention if she announces: "I have discovered that a large chemical company is poisoning its neighbors and the environment, and I am today introducing legislation to protect the environment." The arguments opposed to pollution control legislation can likewise be translated into the language of politics. Rather than arguing that "the statute will require the regulatory agency to induce an inefficient allocation of resources by setting the marginal cleanup costs for most firms higher than the marginal benefits," the anti-interventionist politician assures her constituents that "the statute will create a self-serving bureaucracy that will drive small firms out of business, stifle innovation, contribute to galloping inflation, and send capital overseas."

When the focus of the debate is a subject as sensitive as toxic substances in the air and water and the threat of bankrupting small businesses, symbols play a large role. Proponents of controls are likely to strive for absolutist symbolic legislative statements such as the proposition that "the discharge of toxic pollutants in toxic amounts be prohibited" or that no new sources of pollution should be allowed to degrade media quality in pristine areas of the country. Complex controversies about the extent to which media quality goals may be met through dispersion enhancement, intermittent controls, and flow augmentation reduce to slogans such as "dilution is not a solution to pollution," and "treatment for treatment's sake."

As any smart advertising executive knows, much of our energies are directed toward symbolic and unachievable goals. We do not begin a mountain climb with the goal of scaling to the optimal height; we strive for the summit. The coach does

152. See M. Fiorina, CONGRESS: KEYSTONE OF THE WASHINGTON ESTABLISHMENT (1977); Freeman & Haveman, supra note 149, at 59.
153. See Ingram, The Political Rationality of Innovation, The Clean Air Act Amendments of 1970, in APPROACHES TO CONTROLLING AIR POLLUTION 12, 20-23 (1978); Kelman, supra note 149. Even in those very rare cases in which Congress has considered a tool aimed solely at curing a defect in the market or the tort system, the language of the debate has been largely symbolic. For example, proponents of Senator Proxmire's sulfur dioxide tax stressed that it "makes polluters pay" while detractors contended that it would "force companies to pay twice" or argued that it would give companies a "license to pollute." See Busby, Environment Report/White House Plans Push for Sulfur Tax Despite Strong Industry Opposition, 4 NAT'L J. 1663 (1972); Environment Report/White House Activists Debate Form of Sulfur Tax—Industry Shuns Both, 4 NAT'L J. 1643 (1972); 118 CONG. REC. 833-35 (1972) (statement of Sen. Proxmire).
157. See, e.g., Implementation Hearings, supra note 105, at 40 (statement of Walter E. Garrison, Chief Engineer and General Manager, County Sanitation District, Los Angeles County).
not direct his charges to fight for the alma mater up to the point at which marginal costs exceed marginal benefits; he exhorts them to give their all. We recognize that we will not always reach the summit and that we will not always win. But if we set our sights on the bland optimum, we will always set them too low. The advertising industry invokes this human characteristic in a cynical fashion when it urges us to expend more than the optimal amount of resources on products that are just beyond the material lifestyles that we can safely afford. Congress manifests the same motivation in a more idealistic way when it sets "inefficient" goals for the quality of life.

The political debate is the appropriate locus of that quintessentially political choice between the "willingness to buy" and "willingness to sell" measures of the value of health and environmental improvement in setting national goals. The policy-oriented economist cannot give an apolitical, scientific answer to the question of the appropriate level of pollution control. The economist can inform the political debate by calculating the probable costs of various pollution control measures, yet he can say very little about the benefits absent an a priori political value judgment. The politician must explicitly or implicitly choose between the two approaches—she must decide whether as a starting point companies have a "right" to pollute or citizens have a "right" not to be placed at risk by polluters. The basic political choice that renders the market paradigm impotent as a scientific tool is thus expressed succinctly in the politician's vernacular. The statutory standard that the legislature articulates to guide the implementing agency reflects that body's resolution of this question as well as its assessment of other issues, such as the respect due to future generations and the extent to which environmental controls should redistribute wealth, that are relevant to the political debate. The entire dialogue is, unfortunately, played out against a backdrop of huge uncertainties concerning the relationship between chemical pollutants and human and environmental well-being.

Historically, Congress has behaved as if it were following a "willingness to sell" approach. There has been much talk in the political debate of a "right" to a healthy workplace and a clean environment. Proponents of early occupational

158. The major exception to this proposition is the large construction grants program under the Clean Water Act where the federal government pays up to 80% of the cost of building publicly owned sewage treatment works. Here, it would appear that the federal government is, in a sense, determining its "willingness to pay" for pollution control. The same may be true of pollution control in public utilities, where virtually all citizens pay for the increased costs of controlling pollution that they themselves produce.

159. SUBCOMM. ON LABOR, COMMITTEE ON LABOR AND PUBLIC WELFARE, 92d CONG., 1ST SESS., LEGISLATIVE HISTORY OF OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970 432 (1971) [hereinafter cited as LEGISLATIVE HISTORY OF OSHA]. "The worker is entitled to know that standards in the workplace are geared to overcoming safety and health hazards that are shortening his life." Id. at 865 (statement of Sen. Williams); "The well being of every American working man and woman is an essential human right which we can no longer deny." Id. (statement of Rep. Perkins); "This bill represents a long overdue significant additional recognition that working men and women need Federal assistance to secure their inalienable right to earn their living free from the ravages of job-caused death, disease or injury." Id. at 891 (statement of Rep. Burton); "Mr. Speaker, our Nation has had a sad and frustrating history of weak-kneed inaction by those who have been charged with protecting the divine right of every citizen to breathe clean air." COMM. ON PUBLIC WORKS, 93d CONG., 2D SESS., LEGISLATIVE HISTORY OF THE CLEAN AIR ACT AMENDMENTS OF 1970 116 (1974) (statement of Rep. Hechler) [hereinafter cited as HISTORY OF CAA AMENDMENTS OF 1970]. "Surely in a nation that has scaled the peaks of technological achievement where most people enjoy
and environmental legislation were anxious to enact measures that would successfully “clean up the environment and the workplace” and keep it clean. Since the states were not accomplishing those goals rapidly enough, the federal government had to intervene.\footnote{160} Congress therefore required that media-quality-based standards for exposure to pollutants be set at levels which would “protect public health” with an “adequate margin of safety”\footnote{161} or even an “ample margin of safety.”\footnote{162} If feasible, workers were entitled to a “safe and healthful” place of employment.\footnote{163} The toxics control sections of the statutes are emphatic in their rejection of a narrow cost-benefit approach.\footnote{164} These absolutist legislative statements have great symbolic value. The lofty goals of the environmental statutes give us all a common sense of mission in the same nonutilitarian way that the goal of putting a man on the moon galvanized the American public for a decade in support of the space program. As consumers we may dislike paying more for automobiles, fuel, electricity, and products of the chemical industry, but as citizens we can rationally vote for extremely costly and, by the “willingness to pay” measure, inefficient goals.\footnote{165} The goals that we set as voters constantly remind us


\footnote{160} Prior to 1967, the states had the primary responsibility for air pollution control. The inadequacy of most state programs, however, soon attracted national attention. In the 1967 amendments to the Clean Air Act, Congress removed this sizable and complex burden from the states and substituted a strong national media-quality-based approach. The congressional debate was characterized by strong “cleanup” rhetoric:

This bill . . . recognizes that control efforts considered acceptable just a few years ago are now clearly inadequate . . . . Developed in full awareness of the public's greatly increased support and demand for prompt and effective control action, the Air Quality Act of 1967 broadens control programs at all levels of government in an effort to protect and enhance the quality of the environment.

\footnote{S. REP. NO. 403, 90th Cong., 1st Sess. 17 (1967).}

By 1970 this sense of urgency increased as the compliance deadlines neared. Congress once again amended the statute and once again stressed cleanup and nondegradation goals: “Here we have learned that tests of economical and technological feasibility applied to those standards compromise the health of our people and lead to inadequate standards . . . . It is clear that enforcement must be tightened [sic] if we are to meet the national deadlines.” \textit{HISTORY OF CAA AMENDMENTS OF 1970, supra note 159, at 226 (statement of Sen. Muskie); see also Sierra Club v. Ruckelshaus, 344 F. Supp. 253 (D.D.C. 1972), aff'd sub nom. Fri v. Sierra Club, 412 U.S. 541 (1973); “The problem of assuring safe and healthful workplaces for our working men and women ranks in importance with any that engages the national attention today.” S. REP. NO. 1281, 91st Cong., 2d Sess. (1970), reprinted in \textit{LEGISLATIVE HISTORY OF OSHA, supra note 159, at 141 (statement of Sen. Williams); “We surely owe it to the millions of working men and women whose health and lives are unnecessarily jeopardized by hazards of the workplace to pass the most effective measure we can devise.” Id. at 141 (statement of Sen. Kennedy).}


\footnote{164} Occupational Safety and Health Act § 56(b), 29 U.S.C. § 655(b) (1976); Clean Water Act § 307, 33 U.S.C. § 1317 (Supp. V 1980); Clean Air Act § 112, 42 U.S.C. § 7412 (Supp. V 1981). Indeed even the older health and environmental statutes, such as the Federal Insecticide, Fungicide and Rodenticide Act, 7 U.S.C. § 135 (1982), and the Food, Drug and Cosmetic Act, 21 U.S.C. § 301 (1976), that articulated a risk-benefit approach did so in the context of a product licensing scheme that placed the burden of demonstrating that the benefits of the product outweighed its costs. This surely represented a tacit conclusion that the public had a “right” to reasonably safe pesticides and food and drug products, and that it would exchange for the benefits of the products only upon a showing of reasonable safety.

\footnote{165} \textit{See} Sagoff, \textit{supra} note 97, at 1399.
as we assume our role as consumers that there are things in life more important than the pursuit of material wealth.

In addition, environmental goals reflect society's nonutilitarian moral judgments. We may wish to reaffirm to ourselves that pollution is not merely inefficient—it is wrong.\(^{166}\) We may desire to invoke the ritual of a civil or criminal trial to remind ourselves and the defendant of our determination that pollution is antisocial conduct. The tort system provides an avenue for a plaintiff to seek revenge as well as shift loss, and the tort alternative in theory operates as an inducement to forego self-help.\(^{167}\) The failure of the tort system to shift loss is likewise a failure to assuage this strong human emotion. We may therefore legislatively set goals and prescribe implementation techniques that satisfy our collective desire for retribution.

The Supreme Court has recognized and reaffirmed this political judgment in the worker safety context in the *Cotton Dust* case.\(^{168}\) This case dealt with the Occupational Safety and Health Act, which requires OSHA to establish standards that "require conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary and appropriate to provide safe or healthful employment or places of employment."\(^{169}\) For toxic materials and harmful physical agents, the statute further requires the agency to set the standard "which most adequately assures, to the extent feasible . . . that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life."\(^{170}\) OSHA read these provisions to require it to establish ambient standards for toxic substances at a "safe" level where feasible and at the lowest feasible level if safe levels were infeasible.\(^{171}\) Since OSHA knew of no mechanism for establishing a "safe" level for carcinogens, it set standards for carcinogenic substances at the lowest feasible level without regard to the health effects at that level. In other words, for carcinogens and other nontreshold pollutants, OSHA read the Act as requiring it to adopt a technology-based approach rather than a media-quality-based approach.

The petrochemical industry in the earlier *Benzene* case\(^{172}\) and the textile industry in the *Cotton Dust* case\(^{173}\) challenged OSHA's view. According to these industries, the statute commanded OSHA to adhere to a balancing approach for all chemicals; since section 3(8)'s definition of "standard" modified section 6(b)(5)'s feasibility requirement, OSHA could only promulgate media-quality-based standards that were reasonably necessary or appropriate. The industries further argued that since "reasonableness" connotes cost/benefit balancing,

\(^{166}\) See S. Kelman, supra note 61, at 32-39; Kelman, supra note 149, at 114-15.

\(^{167}\) See W. Prosser, supra note 65, at 23.


OSHA could only promulgate standards at ambient levels at which benefits outweighed costs. The Fifth Circuit agreed with the industry’s contentions in the Benzene case, but the D.C. Circuit disagreed in the Cotton Dust case.

The Supreme Court refused to decide the cost/benefit question in the Benzene case, but a plurality of the Court did find fault with OSHA’s approach to carcinogens. The Court held that OSHA could not promulgate a standard for a toxic substance, whether or not it was a carcinogen, unless it could sustain the affirmative burden of showing that the standard was “reasonably necessary and appropriate to remedy a significant risk of material health impairment.” In the Cotton Dust case, however, the Court squarely addressed industry’s cost/benefit claims and rejected them. At the heart of the majority opinion was its conclusion that “cost-benefit analysis by OSHA is not required by the statute because feasibility analysis is.” The Court was persuaded that Congress had the power to mandate that the agency adopt a nonutilitarian technology-based approach and that it had done so.

While the policy analyst should not be surprised or judgmental when the politician seems to ignore his appeals for more “rational” goals, he should be prepared to elaborate upon many of the disadvantages of adopting nonutilitarian goals. For example, the policy analyst might explain to the participants in the political debate who invoke symbolic and highly moral goals that they should not be surprised if those goals seem long in coming. They may in fact be gaining symbolic benefits at the expense of practical effectiveness.

Congressional articulation of health and environmental goals does not necessarily put the political forces to rest. Very often the locus of the political debate

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174. Id. at 501; Industrial Union Dep’t, AFL-CIO v. American Petroleum Inst., 448 U.S. 607, 634-40 (1980). Although it was not necessary to do so in either of the two cases, industry would presumably have argued further that OSHA could not promulgate infeasible standards even if the benefits of such standards would outweigh the costs because section 6(b)(5) places feasibility limits on section 3(8) standards. Section 6 of the Occupational Safety and Health Act empowers OSHA to promulgate occupational safety and health standards. 29 U.S.C. § 655 (1976). Section 3(8) defines “occupational safety and health standard” to be a standard that “is reasonable, necessary or appropriate to provide safe or healthful employment and places of employment.” Id. § 652(8). Section 6(b)(5) specifies that in setting occupational safety and health standards for toxic materials and harmful physical agents, the agency must set the standard “which most adequately assures, to the extent feasible, . . . that no employee will suffer material impairment of health or functional capacity even if such employee has regular exposure to the hazard dealt with by such standard for the period of his working life.” Id. § 655(b)(5).


178. Id. at 607 (emphasis added). This holding has been criticized. See Rodgers, Judicial Review of Risk Assessments: The Role of Decision Theory in Unscrambling the Benzene Decision, 11 ENVTL. L. 301 (1981); The Supreme Court, 1979 Term, 94 HARV. L. REV. 75, 242-51 (1980).


180. Hence, it would appear that OSHA requires a technology-based approach. Yet, the Court reaffirmed the Benzene plurality’s holding that OSHA may only promulgate standards that are necessary to remedy a significant risk. This approach would appear to be a media-quality-based one. The resulting mixed requirement can probably best be described as a technology-limited, media-quality-based strategy with a zero discharge goal.
merely shifts to the implementing agency. The implementation process often follows a familiar pattern. As the agency pursues the statute’s inspiring goals through its typically hazy implementation instructions, the agency inevitably encounters strong opposition from those who argue that the agency is, in its unrestrained enthusiasm for those goals, ignoring the economic consequences of its activities. The losers of the Congressional debate, in other words, have a second chance to influence policy when the agency attempts to bring the statutory goals to earth.\footnote{181} After the agency has resolved the tensions in a more concrete fashion, the political battle is waged one further time before the reviewing courts.\footnote{182} Statutory deadlines are missed; administrative initiatives are constantly blunted by political and judicial review and the agency begins to lose its enthusiasm for its “mission.” Indeed, it often begins to appear that the political system may have promised more than it could deliver.\footnote{183}

Economic factors must inevitably play an important role in the actual implementation of the goals that society sets for itself.\footnote{184} It is a simple economic reality


\footnote{183. Another disadvantage of relying upon the political system to set health and environmental goals is the potential that such reliance offers for the insertion of other goals, or hidden agendas, that are only tangentially related to society’s efforts to protect human health and the environment. A well-reported example of the insertion of a hidden agenda into an environmental statute is the provision in the 1977 amendments to the Clean Air Act that the EPA establish both an allowable emission limitation and a required “percentage reduction” of emissions for new fossil-fuel-fired stationary sources of pollutants. Clean Air Act § 111(a)(1), 42 U.S.C. § 7411 (Supp. V 1981). This provision was enacted at the behest of a bizarre coalition of environmentalists, who wanted to preserve pristine areas in the West where new sources would burn low sulfur coal, and eastern coal interests, who wanted to ensure that coal-fired power plants in the East were required to install scrubbers so that “dirty” eastern coal would not lose its competitive advantage over “clean” western coal. Whereas the environmentalists’ concerns were clearly related to pollution problems, the provision owes its existence to the hidden agenda of the representatives in Congress of the eastern coal interests. See Ackerman & Hassler, Beyond the New Deal: Coal and the Clean Air Act, 89 Yale L.J. 1466, 1491-95 (1980). This ostensibly protective measure arguably left the eastern United States worse off than it was before enactment of the amendments. See id. at 1496. The lesson here is that when the political process is allowed to define nonutilitarian health and environmental goals, it may be expected to include an occasional red herring. Advocates of the political process are open to legitimate criticism on this score.}

Similarly, the debate over the appropriate regulatory control technique can absorb other hidden agendas that are wholly unrelated to the primary goal of clean air or water. For example, the question whether decisions about individual sources of pollution should be made at a local or national level can be analyzed independently of the implications that the answer to the question has for the power relationships among the affected bureaucracies, but these latter otherwise irrelevant considerations are likely to motivate the bureaucratic participants in the debate more than the merits of the national versus local issue. Similarly, arguments concerning the likelihood that various regulatory techniques may result in “forum shopping” for “pollution havens” may be motivated more out of concern for a loss of a tax base than a concern that the media quality in pristine areas not be allowed to degrade. See id. at 1504-05. Finally, competitive concerns may motivate a company to favor a particular implementation technique that appears anomalous from the perspective of the environment versus economic growth. See, e.g., Leone & Jackson, supra note 98, at 241.

\footnote{184. Another independent reason for taking economic considerations into account in setting health and environmental goals is the possibility that large expenditures on pollution and workplace controls will put the United States at a competitive disadvantage with countries that have lower health and environmental goals. See Senate Comm. on Public Works, 93d Cong., 1st Sess., Legislative History of the Water Pollution Control Act Amendments of 1972 1133 (1973) (testimony of Paul V. McCracken) [hereinafter cited as History of the WPCA Amendments]. There is a great debate over
that the unlimited pursuit of the clean-up and nondegradation goals that emerge from the political system would cost an enormous sum. Indeed, it is probably impossible literally to meet the absolutist goals implicit in the "ample margin of safety" language of the toxics provisions of the Clean Air Act and Clean Water Act short of catastrophic economic disruption.\textsuperscript{185} Cost is therefore an extremely important political consideration, and those with a strong economic interest in continued discharge can be depended upon to raise the question of economic and technological feasibility at every possible opportunity in the political debate before Congress, the agencies, and the courts.\textsuperscript{186}

Congress has reacted to feasibility arguments in two ways. First, it has often simply ignored feasibility concerns and left absolutist media-quality-based goals in place. By adopting a stringent media-quality-based approach, Congress in effect has announced its decision to clean up dirty areas and maintain pristine areas "whatever the cost." The goals are established in the hope that the technology capable of reaching those goals either exists or will soon be developed\textsuperscript{187} and that the implementing agency will have the political courage to resist the pressures generated by regulatees who must pay large sums to meet the goals.

In the alternative, Congress has explicitly acknowledged economic concerns by adopting a technology-based approach. Congress has incorporated feasibility considerations directly into health and environmental statutes through such language as "to the extent feasible,"\textsuperscript{188} and "taking into account the age of equipment and facilities involved, the process employed, the engineering aspects of the application of various types of control techniques, process changes, [and] the cost of achieving

\begin{thebibliography}{188}
\bibitem{185}A. Freeman, R. Haveman \& A. Kneese, \textit{supra} note 141, ch. 2; Kneese, \textit{Pollution and a Better Environment}, 10 \textit{Ariz. L. Rev.} 10, 11-16 (1968).
\bibitem{186}Cost considerations have always been a part of the congressional debates. In arguing that cost considerations should be included in Clean Water Act standards, Senator Bentsen stressed that:

If these programs cause too severe economic dislocations, if the economic and social benefits of pollution control programs bear no reasonable relationship to the costs involved in implementing them, then all of our best efforts to clean up the waterways could be defeated in a backlash against those of us who are working to clean up the environment.

\textit{History of the WPCA Amendments, supra} note 184, at 1281. Senator Dominick succinctly argued that feasibility should be a consideration in promulgating standards under OSHA by suggesting that "[w]hat we are trying to do is put people to work, not put them out of work." \textit{Legislative History of OSHA, supra} note 159, at 526.
\bibitem{187}See J. Bonine, \textit{The Evolution of 'Technology-Forcing' in the Clean Air Act} (BNA Env't Rep. Monograph No. 27, July 25, 1975); La Pierre, \textit{Technology-Forcing and Federal Environmental Statutes}, 62 \textit{Iowa L. Rev.} 771, 776 (1977). Senator Muskie, the author of the 1970 Clean Air Act Amendments, was a strong proponent of this view:

The first responsibility of Congress is not the making of technological or economical judgments—or even to be limited by what appears to be economically or technologically feasible. Our responsibility is to establish what the public interest requires to protect the health of persons. This may mean that people and industries will be asked to do what seems impossible at the present time, but if health is to be protected, these challenges must be met.

\textit{History of the WPCA Amendments, supra} note 184, at 227.
\bibitem{188}Occupational Safety and Health Act § 6(b), 29 U.S.C. § 655(b)(5) (1976).
such [controls]." The statutory language, however, rarely prescribes a finely tuned balancing of environmental considerations against feasibility considerations for setting technology-based standards. The language, rather, is aspirational. The agency is told to require the implementation of the "best available technology economically achievable," or the "best technological system of continuous emission reduction which . . . has been adequately demonstrated," or the technology capable of producing the "lowest achievable emission rate." Economic considerations are relevant to the standard-setting process, but they are not meant to dominate it. The economic impact of achieving technology-based standards is to be considered along with a host of other factors that may legitimately affect the regulatory entity's decision. By contrast, media-quality considerations play only a very small role in technology-based standard-setting. Congress has, in other words, announced to the world: "If we cannot have a perfectly clean workplace and environment, then we shall do the best that we can."

While neither of these goals meets the policy-oriented economist's efficiency criterion, they are both rational political end points. Society may rationally decide to make costs a relevant consideration to a media-quality approach only at the extremes and err on the side of overprotection. Similarly, a rational society might pledge itself to do the best that it can in pursuit of safe workplaces and a healthy environment even though it recognizes that even those efforts will not make those places safe or healthy in any absolute sense and even though they may, in the policy-oriented economist's opinion, cost too much.

If we acknowledge that it was rational for Congress to reject a narrow cost-benefit approach to pollution control and adopt either a media-quality-based approach or a technology-based approach to that problem, it is still necessary to ask which of the two alternative approaches (or, perhaps more appropriately, which combination of the two approaches) is best suited for health and environmental regulation of the chemical industry. This article now turns to a consideration of the factors that can enlighten that choice.

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194. Addressing the rationale for the technology-based effluent limitations of the 1972 amendments to the Clean Water Act, Senator Bayh explained: "The whole thrust of the bill is to force industry to do the best job it can to clean up the nation's water and to keep making progress without incurring such massive costs that economic chaos would result." HISTORY OF WPCA AMENDMENTS, supra note 184, at 216.
195. Recently, Congress has expressed a keen interest in mandating that regulatory agencies balance costs and benefits in promulgating regulations. See S. REP. No. 305, 97th Cong., 1st Sess. (1981) (discussing the Regulatory Reform Act (S. 1080)). None of the serious efforts, however, have sought to overturn the nonutilitarian approaches of the worker safety and environmental statutes.
The Choice Between Media-Quality-Based and Technology-Based Approaches to Pollution Control

Congress has taken a variety of attitudes toward the choice between media-quality-based and technology-based approaches to pollution control. Only very rarely has Congress mandated one to the exclusion of the other. More often, Congress has required agencies to implement both approaches simultaneously. For example, under the Clean Water Act the EPA must prescribe technology-based effluent limitations for new and existing sources while the states with EPA approval must establish and enforce media-quality-based water quality standards. The two approaches come together in the statute’s prescription that every point source of water pollution have a discharge permit. At the permit stage, the implementing agency must require implementation of the more stringent of the two requirements. This strategy of mandating the more stringent of the two requirements typifies the statutes that adopt both approaches. In practice, however, the implementing agency has a great deal of discretion in choosing which of the two approaches to emphasize. Moreover, the statutes that exclusively require a media-quality-based approach often give the implementing agency the practical flexibility to transform the media-quality-based approach into a technology-based approach at the implementation stage.

196. Standards under section 302 of the Clean Water Act are apparently intended to prescribe effluent limitations for point sources of water pollution strictly on the basis of media quality. 33 U.S.C. § 1312 (Supp. V 1981). However, the language, “can reasonably be expected to contribute to the attainment or maintenance of such water quality,” Id. § 1312(a), leaves the door open for a technology-based approach, especially in light of the fact that the hearings on such standards are to “determine the relationship of the economic and social costs of achieving any such limitations . . . .” Id. § 1312(b)(1). This section has never been implemented by EPA.

Section 112 of the pre-1977 Clean Air Act prescribed a strictly media-quality-based approach to emissions limitations for hazardous pollutants. However, when faced with the practical impossibility of prescribing a media-quality-based standard for asbestos emissions from buildings being demolished, the EPA promulgated a technology-based standard. After this standard was overturned by the Supreme Court on the ground that it was not an “emission standard,” Adado Wrecking Co. v. United States, 434 U.S. 275 (1978), Congress amended the statute to allow the EPA to promulgate technology-based standards when “it is not feasible to prescribe or enforce” a media-quality-based emission standard. 42 U.S.C. § 7412(e)(1) (Supp. V 1981).

198. Id. § 303(e), 33 U.S.C. § 1313(e)(1976).
200. Id.
202. The EPA has, for example, concentrated the bulk of its attention on promulgating technology-based effluent limitations under the Clean Water Act, even though it also has authority to implement a media-quality-based water quality standards approach under section 303. 33 U.S.C. § 1313 (1976).
203. See infra text accompanying notes 204-23.
A. The Transformation of the Media-Quality Approach into a Technology Approach

In the case of the primary ambient air quality standards, which are required to protect the public health with an "adequate margin of safety," the EPA has arguably adhered to the statute's absolutist goal without regard to the economic consequences.\textsuperscript{204} The Clean Air Act leaves it up to the states to decide how the ambient air quality standards shall be reached and maintained within their borders. In theory, one would expect the states to determine a pollution load (for areas that currently meet the standard) or a pollution reduction load (for areas that do not currently meet the standard) and then parcel out this load among current and future emitters. The states could distribute the load according to historic use, emissions charges, marketable permits, or political clout as demonstrated in individual permitting proceedings.\textsuperscript{205} In practice, however, the states rarely follow this logical progression. They do calculate pollution reduction loads for nonattainment areas because this is already required by the EPA.\textsuperscript{206} They do not, however, always determine how much additional pollution it will take in attainment areas before the standards will be violated.\textsuperscript{207} Instead, they often force individual sources in individual permitting proceedings to demonstrate no threat to the media-quality-based standards.\textsuperscript{208} In neither case do the states allocate the pollution "pie" among sources according to any fixed formula. Rather, the states typically prescribe technology-based regulations for various categories of new and existing sources of pollutants, not unlike the EPA's technology-based standards for new sources,\textsuperscript{209} and they hope that they can convince the EPA that the technology-based standards will not result in violations of the ambient air quality standards.\textsuperscript{210} Occasionally, the states allow economic considerations to intrude still farther into the implementation process by providing for variances for individual sources upon a showing that the costs of the technology-based controls outweigh the benefits.\textsuperscript{211}

\textsuperscript{204} There are at least two instances in which the EPA has apparently considered the costs of achieving the standard in establishing the "margin of safety." The agency did not require absolute safety for its lead standard; rather, it set the standard at the level that would, according to its statistical analysis, protect 99.5\% of the most sensitive exposed human population. See \textit{Lead Indus. Ass'n v. EPA}, 647 F.2d 1130, 1144 (D.C. Cir.), \textit{cert. denied}, 449 U.S. 1042 (1980). Arguably, the fact that the EPA did not set the standard at the level that would protect 100\% of the population constituted a bow to economic considerations.

In the EPA's decision to raise the national primary ambient air quality standard for photochemical oxidants, economic considerations allegedly played a role through the intervention of White House economic advisors. The Council on Wage and Price Stability "urged EPA to ignore the law—to consider costs, as well as medical information." EXECUTIVE BRANCH REVIEW OF ENVIRONMENTAL REGULATIONS: HEARINGS BEFORE THE SUBCOMM. ON ENVIRONMENTAL POLLUTION OF THE SENATE COMM. ON ENVIRONMENT AND PUBLIC WORKS, 96th Cong., 1st Sess. 28 (1979) (statement of Richard Ayres, Natural Resources Defense Council).

\textsuperscript{205} 40 C.F.R. § 52 (1980) (the EPA state implementation estimate pollution reduction load).


\textsuperscript{207} Interview with Terrel Kott, Permitting Officer, Texas Air Control Board (July 16, 1982).

\textsuperscript{208} \textit{Id.}


\textsuperscript{210} This has been the pattern in Texas. Interview with Terrell Kott, Permitting Officer, Texas Air Control Board (July 8, 1982); see also Currie, \textit{State Pollution Statutes}, 48 U. CHI. L. REV. 27, 65-69 (1981).

\textsuperscript{211} See generally Currie, supra note 210, at 53-62. The heavy reliance on this individual permitting process has two important practical consequences. First, in areas that currently meet the media-quality-
The conversion from a media-quality-based approach to a technology-based approach is even more dramatic in the case of toxic substances regulation under the Clean Air Act\(^{212}\) and the pre-1977 Clean Water Act.\(^{213}\) Both of these statutes mandate a stringently absolutist test regarding standards for the release of toxic substances. Yet, when pressed to set an air-quality-based standard for a carcinogenic substance, for which no "safe" level of exposure or "ample margin of safety" could realistically be established, the EPA ultimately considered economic feasibility and promulgated a technology-based standard.\(^{214}\) Similarly, in light of the immense administrative difficulties that the EPA faced in promulgating water-quality-based effluent standards under the pre-1977 Clean Water Act, the EPA and several environmental groups compromised upon a process whereby the EPA would attempt to promulgate media-quality-based standards for a small number of very toxic pollutants and promulgate technology-based standards for categories of sources of sixty-five other pollutants.\(^{215}\) Congress later amended the statute to incorporate this compromise retroactively.\(^{216}\)

Finally, when many areas of the country failed to meet the media-quality-based national ambient air quality standards by the 1977 statutory deadline, Congress amended the Clean Air Act to address these "nonattainment" areas.\(^{217}\) In addition to requiring the states to meet the standards "as expeditiously as practicable,"\(^{218}\) the amendments require states to require major new stationary sources to install technology capable of achieving the "lowest achievable emission rate"\(^{219}\) and existing sources to use "reasonably available control measures"\(^{220}\) and "reasonably available control technology."\(^{221}\) While not entirely superseding the former media-quality-based approach, the 1977 Amendments do significantly shift the focus from media-quality-based standards to technology-based standards. The based standards the available load is in effect used up on a first-come-first-served basis. There is little opportunity for overall planning and few opportunities for a new source to "purchase" some emissions once the available increment has been allotted. Second, in areas that do not meet the media-quality-based standards, the failure to distribute the pollution reduction load in any explicit fashion means that deadlines will inevitably be missed as optimistic assumptions about the ability of technology-based standards to meet the media-quality-based standards are proven wrong. Federal law currently prevents the construction of major new sources of pollutants in areas that do not meet the national ambient air quality standards for those pollutants unless the new source achieves the "lowest achievable emission rate" (a technology-based standard) and procures an "offset" for its emissions so that total emissions are reduced. Clean Air Act § 173, 42 U.S.C. § 7503 (Supp. V 1981).

218. Id. § 7502(a). The statute sets a new attainment deadline of December 31, 1982, which may be extended for photochemical oxidants and carbon monoxide until December 31, 1987. Id.
219. Id. § 7503(2).
220. Id. § 7502(b)(2).
221. Id. § 7502(b)(3).
Texas Air Control Board, for example, has proposed to achieve the emissions reduction necessary to meet the new attainment deadline by simply incorporating the EPA guidelines for technology-based standards into the state's already existing technology-based regulations.222

The past decade has witnessed a fairly consistent trend toward transforming the pure media-quality-based approach into a technology-based approach. Sometimes this has been mandated explicitly by the legislature in amendments to the relevant statutes; at other times it has been accomplished sub silentio through administrative action. The following section of this article will examine many of the theoretical and practical advantages and disadvantages of both approaches in an attempt to explain this trend and to assess whether it is, by and large, a wholesome development for health and environmental regulation of the chemical industry.

B. A Critical Comparison

An adequate comparison of the media-quality-based and technology-based approaches to health and environmental regulation must begin with a set of criteria against which the two may be measured. This article adopts the following considerations as its list of evaluative criteria, recognizing that every policy analyst's list of evaluative criteria would probably differ in significant respects from that of any other analyst: (1) efficiency; (2) administrative feasibility; (3) survivability (under existing conditions of judicial and political review); (4) enforceability; (5) fairness and equity; and (6) ability to encourage technological advance.

1. Efficiency. While this article has argued that the "efficiency" criterion should not dictate health and environmental goals, efficiency is certainly an extremely important consideration in determining which techniques should be used to implement those goals. It does not profit even the most ardent environmentalist to waste valuable resources to achieve his goals. All other things being equal, if two approaches can reach the desired goal and the implementation of one costs more than the other, it is sensible to adopt the cheaper of the two approaches. The process of choosing the most efficient mechanism for achieving a given political goal is often referred to as "cost-effectiveness" analysis.223

Measured against only the efficiency criterion, the media-quality-based approach can theoretically be much more efficient than the technology-based approach. Media quality standards specify an ascertainable end point in the pursuit of which the implementing agency may choose from among many regulatory tools. Once the pollution reduction load is specified, the regulatory entity can implement positive incentives, such as emissions or effluent charges or marketable permits, that give the regulatees the maximum flexibility to achieve the media-

223. F. Anderson, supra note 9, at 9-12; M. Green & N. Waitzman, supra note 100, at 75; J. Krier & E. Ursin, supra note 53, at 30-32; Baram, supra note 100, at 478.
quality goal at the least cost.\textsuperscript{224} A regulatory scheme that simply divides up the pollution load on a pro rata basis or allocates the load according to historical use is justifiably condemned by economists as wasting societal resources that could be put to better use.\textsuperscript{225}

The efficiency advantage of the media-quality-based approach may, however, be overstated in the context of the chemical industry. Unless two firms discharge the same substance into the same receiving medium, a relatively rare occurrence for the chemical industry, the marketable permits incentive approach is unavailable. When there is no market in which to bargain, the initial sale of the permit is the last, and the technique becomes indistinguishable from a one-time-only “charge.” The “charge” approach still has efficiency advantages, but these too can be overstated. The regulatory entity under the “charge” approach must estimate what charge will induce the necessary cleanup to meet the predetermined media quality goal. Yet the regulatory entity cannot know how various charges will affect the conduct of the regulatees absent knowledge about the technologies available to the regulatee and the costs of implementing those technologies.\textsuperscript{226} The agency may in effect set the charge at the level that will induce the adoption of a particular technology. If technologies come in discrete untunable units, the charge may in practice give the source as little choice as a technology-based command.\textsuperscript{227}

\begin{footnotes}
\item[224] Economists have for two decades urged policymakers to implement incentive-based schemes for achieving pollution control goals. See Economic Analysis and the Efficiency of Government, Part 6—Economic Incentives to Control Pollution: Hearings Before the Subcomm. on Priorities and Economy in Government of the Joint Economic Comm., 92d Cong., 1st Sess. (1971) [hereinafter cited as Economic Analysis Hearings]; F. Anderson, supra note 9; A. Kneese & C. Schultz, supra note 18; Solow, The Economist's Approach to Pollution and its Control, 123 Science 498 (1971). Economists have also been uniformly critical of the technology-based approach for its failure to achieve adequate media quality efficiently. See Henderson & Pearson, Implementing Federal Environmental Policies: The Limits of Aspirational Commands, 78 Colum. L. Rev. 1429 (1978); Ruff, supra note 9, at 314-20; Comment, Forcing Technology: The Clean Air Act Experience, 88 Yale L.J. 1713, 1719 (1979). In theory both the media-quality-based approach and the technology-based approach could be implemented to accord with the market paradigm either through “command-and-control” style standards or through “charges.” Although the “charges” technique is more commonly associated with a media-quality-based performance standard, the technique can be used to implement, presumably at less cost, a technology-based approach. See F. Anderson, supra note 9, at 33. The marketable permits technique, however, is not adaptable to the technology-based approach to pollution control.

\item[225] History of CAA Amendments of 1970, supra note 159, at 752 (letter from Manufacturing Chemists' Ass'n); A. Kneese & C. Schultz, supra note 18, at 26; Freeman & Haveman, supra note 149, at 62 n.16. Another possible advantage of a media-quality-based approach is that for some health and environmental effects it accepts a level of media quality at which there is no harm so that no pollution reduction is necessary. See R. Stewart & J. Krier, supra note 35, at 570. Discharge into pristine waters, however, would violate the nondegradation policy and thus may be inconsistent with a stringent media-quality-based approach.

A similar response can be made to the argument that media-quality-based standards are superior because they can be met through more efficient techniques such as dispersion enhancement and flow augmentation. See, e.g., A. Kneese & C. Schultz, supra note 18, at 86; Solow, supra note 224, at 501. The courts and Congress have frowned upon dispersion enhancement as a media-quality technique under the Clean Air Act. 42 U.S.C. § 7423 (Supp. V 1981); see also Kennecott Copper Corp. v. Train, 526 F.2d 1149 (9th Cir. 1975), cert. denied, 425 U.S. 935 (1976). The situation is more ambiguous under the Clean Water Act. See Ford Motor Co. v. EPA, 567 F.2d 661 (6th Cir. 1977) (flow augmentation not unlawful in absence of EPA regulations to the contrary).

\item[226] See F. Anderson, supra note 9, at 175.

\item[227] There is still a practical difference between the use of a charge in implementing a media-quality-based approach and a technology-based effluent limitation. The charge under the media-quality-based approach will require the implementation of that technology necessary to meet the media-quality-based standard. The effluent limitation under the technology-based approach will be set irrespective of media
The efficiency concept is generally less relevant to the technology-based approach than the media-quality-based approach. The regulatory entity under the technology-based approach searches for technologies that are capable of reducing emissions or effluent from a given category of sources and then prescribes numerical limitations or reductions based on the capabilities of the "best" of these technologies. Cost is certainly a relevant consideration in determining which of a variety of available technologies is "best." The "best efforts" goal itself, however, is ambiguous with respect to economic efficiency because media quality considerations are largely irrelevant. Under the pure technology-based approach, the receiving media is never too dirty nor is it ever clean enough short of zero discharge. The marginal balancing analysis that the efficiency criterion demands is foreign to the technology-based approach.

In practice the regulatory entity examines the costs of the various available technologies, compares their efficacy, and looks for a point at which costs begin to escalate much more rapidly than efficacy. Indeed, the agencies may simply establish a "rule of thumb" of X dollars per pound of removal and look for technologies that meet this rule of thumb in promulgating technology-based standards for several industries. While these approaches may be equitable and in some sense cost-effective, they are not necessarily efficient ways of pursuing an overall societal goal of cleaning up the receiving media. Moreover, the technology-based approach in practice can bias pollution control in favor of capital-intensive "white elephant" technologies which may be ineffective in the long run.

There is a sense, however, in which the technology-based approach is efficient. The promulgation of an ambient media-quality-based standard does not tell an
individual source much about what is expected of it. Unless the media-quality-based standard is implemented through technology-based standards binding on individual sources or through a historically based allocation scheme, the source has little basis for planning for the future. The value of its marketable permit may rise or fall, and its charge may have to be raised or lowered to reflect the addition of new sources to the receiving media. The source may face constant uncertainty about the regulatory entity’s future expectations. This uncertainty can hinder capital investment and precipitate economically wasteful investment decisions. A technology-based new source performance standard tells the regulatee exactly what is expected and can therefore facilitate private planning. This may be particularly valuable in the chemical industry where the regulatory entity cannot be expected to promulgate media-quality-based standards for all of the hundreds of toxic pollutants simultaneously. Technology-based standards can address all of a given plant’s toxic discharges, thereby avoiding the “pollutant of the month syndrome” that often afflicts the media-quality-based approach.

2. Administrative Feasibility. Whatever its theoretical advantages, a regulatory tool that cannot be implemented in the real world is useless. Practical considerations of administrative feasibility must therefore play a large role in the choice between the media-quality-based and technology-based approaches. Indeed, the history of the implementation of the federal pollution control statutes indicates that administrative feasibility has been the dominant consideration. The media-quality-based approach has been abandoned repeatedly because it proved to be, in the minds of the regulatory decisionmakers, administratively infeasible.

The media-quality-based approach demands huge quantities of detailed information about the effects of a discharger’s wastes on the quality of the receiving medium, and uncertainties fill the inevitable informational voids. We have already seen that quantifying the effects of a particular plant’s discharges on humans and environmental entities is a formidable informational challenge that is ultimately policy dominated. The uncertainties that plague this process, when combined with the large unknowns inherent in modeling the fate of toxic substances in receiving media, should dampen the enthusiasm of even the most ardent instrumental rationalist.

236. If a mixed strategy is adopted by the regulatory entity, however, this planning advantage of the technology-based approach may disappear. If, for example, the agency requires sources to meet the more stringent of media-quality and technology standards, compliance with a technology-based new source performance standard will not necessarily protect the source from a later arriving more stringent media-quality-based standard. The Clean Water Act, which takes this mixed approach, however, cushions the harshness of this possibility by protecting the owner of a new source for up to 10 years from more stringent future standards. Clean Water Act § 306(d), 33 U.S.C. § 1317(d) (Supp. V 1981).
237. See supra notes 112-18 and accompanying text.
238. The absence of adequate models for tracing the effects of pollutants back to their sources was one of the primary factors that Congress relied upon in mandating the technology-based approach of section 301 of the Clean Water Act. See S. Rep. No. 92-414, 92d Cong., 1st Sess. 8 (1971) ("Water quality standards... often cannot be translated into effluent limitations—defendable in court tests, because of the
If the regulatory entity operates under a statute that requires a "margin of safety," the regulator's task under the media-quality-based approach may become downright impossible. For some pollutants the agency may be able to rely upon existing epidemiological studies to determine a "no-effect" level and add a margin of safety to that level to arrive at a media-quality standard. It could be argued, however, that even this level would result in harm to some very sensitive persons or environmental entities. Moreover, the nature of the chronic effects of other pollutants is such that there may be no scientifically acceptable way to determine a "no-effect" level, and a fortiori no basis for specifying a margin of safety. For such chemicals the margin of safety requirement simply cannot be implemented in a straightforward media-quality-based fashion. When faced with this dilemma, the EPA has implemented the media-quality requirement through a technology-based approach. In explaining its toxics effluent standards under the Clean Water Act, for example, the agency made this conversion explicit. Referring to the "elastic" nature of the margin of safety concept, the agency suggested that:

In any case where a discharge is allowed, on a spectrum ranging from certain safety (a prohibition) to that uncertain point where harmful effects are caused and safety ends, a logical break point is struck where the very best that control technology can do is required.

The media-quality-based approach also requires economic and technical information about the regulated sources. If the implementing agency chooses any allocation technique other than a marketable permit approach, it must have some idea of the costs faced by the various regulatees for various degrees of pollution control. This in turn requires at least a superficial knowledge of the technologies available to the sources of a given pollutant and the cost of implementing those technologies.

The technology-based approach, by contrast, requires the regulatory entity to struggle with only the latter sort of information, albeit perhaps in greater detail than under the media-quality-based approach. Rather than resolve extremely
complex and value-laden questions about the toxic effects of chemicals, the regulatory entity need only group the relevant industries into categories and subcategories, identify potentially applicable technologies, assess the implementation costs, and choose the technology that best fits the statutory standard. Although this is a formidable task in its own right, it is much simpler than assessing environmental risks in addition to the costs of cleanup technologies. Moreover, implementation of the technology-based approach is at least possible, whereas a strict application of the margin of safety version of the media-quality-based approach cannot be accomplished without a certain degree of administrative dissembling.

The technology-based approach also offers the path of least political resistance. Since this approach does not directly implicate important moral questions about the value of human lives and endangered environmental entities, the standard-setting process is less likely to precipitate the highly emotional controversy that can accompany the promulgation of media-quality-based standards. The important issues under the technology-based approach are unexciting questions of engineering and economics that generally appear better suited for expert resolution than for public debate. Moreover, since the technology-based approach focuses upon industrial categories rather than individual bodies of water or air, a proposed technology-based standard will almost certainly attract greater attention among the regulated industry than it will among the potentially affected public. Public participation will therefore be minimized, and matters can be quietly resolved between the regulator and the regulatees.

Finally, the technology-based approach gives the administrative decisionmaker greater discretion than the media-quality-based approach. Statutes mandating a media-quality-based approach are typically straightforward—"protect the public health with an ample margin of safety." While it may be impossible to implement this directive, it is not difficult to comprehend. Statutes mandating a technology-based approach, however, typically use more vague terms such as "best technology adequately demonstrated" and specify a host of factors that further cloud the meaning of the guiding phrase. This hint at the need for clarification through expertise greatly enhances the administrator's discretion. In practice, the agency has more leeway to bargain with the interested parties and to bend to such political pressures as the process generates.\footnote{See F. Anderson, supra note 9, at 158, 164.}

The technology-based approach is therefore likely to be more attractive to bureaucrats than the media-quality-based approach. Likewise, the regulated firms may feel more comfortable with a process that gives them room to bargain with the agency in low visibility proceedings that depend heavily on industry-supplied information, especially when the agency may be sympathetic toward their plight. Administrative convenience may go a long way toward explaining the historical sources to estimate the effects of various levels of charges on the dischargers. F. Anderson, supra note 9, at 36. The pure technology-based approach requires the agency to survey all appropriate pollution control technologies for efficacy and expense and then choose among them. See id. at 12; A. Kneese & C. Schultz, supra note 18, at 1; R. Stewart & J. Krier, supra note 35, at 557. In the not atypical case where there is only one source of a pollutant and only two or three alternative technologies, however, the amount of information needed for both approaches would seem to be roughly equivalent.\footnote{See F. Anderson, supra note 9, at 158, 164.}
conversion of the media-quality-based approach to a technology-based approach. This historical development, while understandable, is not necessarily sound. Before embarking upon the technology-based approach toward setting effluent limitations for conventional pollutants under the Clean Water Act, Administrator Ruckelshaus warned that:

[In completely obliterating the admittedly complex relationship between municipal and industrial effluent and water quality, the Senate may have sacrificed wisdom for simplicity. It is simpler to address the problem in terms of available technology than in terms of complex treatment and ambient water quality relationships. But it is my conviction that in the environment as elsewhere, the renunciation of known complexity on the altar of simplicity is the essence of bad government policy.]

3. **Enforceability.** No regulatory scheme can function properly if its requirements may be violated with impunity. The regulatory mechanisms that society establishes to influence the conduct of employers and polluters must ultimately be backed by a realistic threat of sanctions for cheaters. Yet, before society can punish someone for cheating, it must specify with sufficient clarity the conduct that will bring forth government sanctions. While this can be done generically, it is often more effective to put each individual regulatee on notice of what is expected of it through a permit system.

At first glance it may appear that the media-quality-based approach is easier to enforce. When the regulatory entity allocates the pollution reduction load, it can simply assign a numerical effluent or emissions limitation to each permitholder or, in the case of the workplace where no allocation is necessary, specify an ambient concentration for all workplaces. The enforcer then requires only an accurate mechanism for monitoring sources. Indeed, enforcement could be further simplified by requiring sources to monitor their own discharges with some acceptable monitoring device that is not subject to undetected tampering.

245. **History of the WPCA Amendments, supra** note 184, at 1183.

246. It has been suggested that some regulatory techniques compatible with the media-quality-based approach, such as marketable permits and charges, do not require as much vigilance by the policy authority because compliance is in the self-interest of the polluter. See B. Mitnick, supra note 46, at 351-52. The regulatory entity, however, must still have an enforcement capacity to ensure that sources are not “cheating on their tax returns” or do not emit more than their marketable permits allow. See Economic Analysis Hearings, supra note 224, at 1284 (testimony of David R. Zwick); F. Anderson, supra note 9, at 93; Rose-Ackerman, supra note 13, at 396-97; Roberts & Stewart, supra note 242, 1652 n.34. This problem can be alleviated somewhat by requiring self-monitoring so that cheating can be easily detected. See F. Anderson, supra note 9, at 93. But even with self-monitoring, enforcement would be necessary to ensure that sources did not cheat by diverting emissions to unmonitored vents and outfalls or (in the case of air pollution) by expanding “fugitive” emissions at the expense of monitored emissions. See Wolozin, supra note 106, at 236.

247. The individual source emission or effluent limitation in the case of a political or historical allocation would be set by the regulatory entity according to its allocation formula. In the case of a marketable permit system, it would be the sum total of the source’s permits. In the case of a charge system, a specific limitation would not be necessary. The enforcing authority would simply take note of the discharge for purposes of calculating the tax at some later time. Under all of the approaches, however, there must be a numerical measure of pollution and a mechanism for monitoring sources in accordance with that measure.

The enforcement agency, however, faces numerous practical limitations that greatly reduce the ease with which it can police the media-quality-based approach.\textsuperscript{249} Accurate monitoring devices do not exist for all toxic chemicals.\textsuperscript{250} Such monitoring equipment as does exist is often very expensive to purchase and use.\textsuperscript{251} Sampling a single stack for sulfur dioxide and particulates can consume two or three man-days and entail over two thousand dollars in equipment costs.\textsuperscript{252} The monitoring costs for a source of many different chemical pollutants can be even higher.\textsuperscript{253} Even when the EPA exercises its authority to require self-monitoring, the cost of installing the equipment can be so high as to be arbitrary and capricious.\textsuperscript{254}

Enforcement costs for a technology-based approach can run considerably less than media-quality monitoring costs. While technology-based standards normally specify numerical limitations for individual facilities, the limitations are based upon the pollution removal capacity of a particular technology or its equivalent. The enforcement officer can normally infer that the numerical limitations are being met from the fact that the technological components are running properly, without monitoring actual discharges. This greatly simplifies the enforcement process because the enforcement officer need only check to see if the pollution control equipment is being properly used and maintained and observe recorded evidence that the equipment was in fact turned on during the relevant enforcement period.\textsuperscript{255}

\textsuperscript{249} For a thorough treatment of the problems of monitoring under a media-quality-based approach, see F. Anderson, supra note 9, ch. 4.

\textsuperscript{250} There is, for example, some question whether an accurate monitoring device exists for monitoring stack emissions of sulfur dioxide. See 40 Fed. Reg. 46,240 (1975); B. Mitnick, supra note 46, at 382; Roberts & Farrell, supra note 232, at 163.

\textsuperscript{251} See Prohlman Report, supra note 105, at 48; F. Anderson, supra note 9, at 91-101; B. Mitnick, supra note 46, at 382; Wolozin, supra note 104, at 235. Relatively inexpensive monitoring devices do exist. For example, environmental protection officials in the decades before the recent federal environmental legislation routinely used bioassays to monitor stream quality near an industrial outfall. Implementation Hearings, supra note 105, at XXV (testimony of Douglas Costle: “EPA soon will form rules to incorporate standardized bioassay tests in its testing regulations, anticipating that bio-testing will play a larger future in toxics control.”); id. at 490 (testimony of John Convery); id. at 33 (testimony of W.E. Garrison). The bioassay directly measures the impact of water on living aquatic species by observing whether a member of a test species dies during the duration of the test. This monitoring device is inexpensive, but it is very crude. It does not reveal the amount of various pollutants in the waters which might cause chronic effects in aquatic organisms and humans who consume aquatic organisms. It is therefore especially inappropriate for monitoring discharges of toxic substances. Nevertheless, it has been suggested that the EPA be allowed to grant media-quality-based waivers from its technology-based standards for toxic water pollutants on the strength of bioassays demonstrating that the receiving water is not immediately toxic to test organisms. Id. at 22 (statement of Dr. John Hernandez).

\textsuperscript{252} See Roberts & Farrell, supra note 232, at 165.

\textsuperscript{253} A monitoring protocol now exists for measuring all 65 of the toxic pollutants listed in the NRDC consent decree. A complete scan for all of these chemicals costs approximately $2,000 per sample. Interview with Dr. Elinor Zimmerman, Office of Water Planning, U.S. Environmental Protection Agency (Mar. 18, 1982).

\textsuperscript{254} See Asarco, Inc. v. EPA, 14 Envtl. Rep. Cas. (BNA) 1340 (9th Cir. 1980) (EPA arbitrary and capricious in requiring smelter to install self-monitoring device at estimated cost of over $300,000); F. Anderson, supra note 9, at 97 (cost of installing continuous monitor for water discharges of total organic carbon and chemical oxygen demand estimated at $5,000-$10,000 plus maintenance).

\textsuperscript{255} See B. Mitnick, supra note 46, at 403. Recording devices for documenting that a machine is operating are very inexpensive. Since they can, of course, be tampered with, the enforcement officer may need to make surprise visits or take other action to discourage tampering. The difficulties with forging
While technology-based standards are probably easier to police, it may be more difficult to convince a judge or a jury to levy an effective penalty for a violation of a technology-based standard than for a media-quality-based standard. It may be more impressive to the fine setter that the defendant has violated a standard that is designed to protect human health than a standard designed only to compel the implementation of the best available technology. On the other hand, the fine setter may be swayed by the fact that a technology-based standard is usually set at a level that someone, perhaps a competitor, has been able to meet. Yet, even this may be unconvincing to a judge or juror when presented with the defendant’s assertion that compliance with the technology-based standard will cause its financial demise, especially if the prosecutor can point to no definite environmental harm that will flow from the violation.256

Moreover, the overall ease of enforcement of technology-based standards may be offset somewhat by the diminished likelihood that any given enforcement action will result in penalties high enough to deter future violations.257 Still, ease of detecting violations is a significant advantage, especially in a regime in which citizens are allowed to prosecute violations of the standards on their own initiative.258

4. Survivability. Any standard or requirement that an agency imposes upon regulatees must ultimately survive review by designated reviewing institutions. Health and environmental standards are no exception to the general presumption in American administrative law that agency actions are subject to judicial review. Under the current environment statutes, the agency must demonstrate that a standard is not “arbitrary and capricious”259; OSHA must establish that its standards are supported by “substantial evidence on the record as a whole.”260 In addition, agency actions must survive less formal, but still very real, review by the political entities that have the power to influence and control the implementing agency’s
conduct. If the agency’s actions do not satisfy the relevant Congressional committees, the agency head faces difficult oversight hearings and possible loss of funds or statutory authority. If those actions do not satisfy the President, the heads of OSHA and the EPA, which are not independent agencies, can lose their jobs. The political supervision described here is not usually the detailed case-by-case review of the judiciary, although it can be detailed and particularized at times; rather, it is the understanding that an agency official rapidly acquires that its actions must be explainable to the satisfaction of politicians whose constituents perceive themselves harmed by those actions.

The inevitability of judicial and political review may have an impact upon the choice of regulatory approaches. If one approach is likely to survive judicial and political review more readily than the other, then proponents of stringent health and environmental goals may prefer the first approach and regulated industries the second.

a. Judicial Review. The EPA’s technology-based standards have taken a terrible beating in the courts of appeals. The agency’s initial effort in the mid-1970’s to promulgate national technology-based effluent limitations for new and existing sources under the Clean Water Act precipitated more than 250 court challenges. After many of these cases were consolidated, the courts of appeals across the country decided sixteen appeals, all but three of which resulted in remands to the agency on one or more substantive issues. While many of the remands involved only minor components of much larger standards, the EPA has had difficulty in establishing virtually all of the engineering techniques that it has adopted for setting technology-based standards. The agency has been most successful when it can point to an existing source which currently meets its proposed effluent limitation. Similarly, when the EPA can point to an existing pilot plant that can

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262. See Note, Effective Regulation of Point Sources Under the 1972 Federal Water Pollution Control Act, 10 Ga. L. Rev. 983, 1019 (1976).
263. There are sixteen written opinions involving appeals from EPA’s BPT effluent limitation regulations under Clean Water Act §§ 301(b)(1)(A), 304(b)(1)(A), 33 U.S.C. §§ 1311, 1314 (1976): Consolidated Coal Co. v. Costle, 604 F.2d 239 (4th Cir. 1979), rev’d, 449 U.S. 64 (1980); National Crushed Stone Ass’n v. Costle, 601 F.2d 111 (4th Cir. 1979), rev’d, 449 U.S. 64 (1980); BASF Wyandotte Corp. v. Costle, 598 F.2d 637 (1st Cir. 1979); Weyerhaeuser Co. v. Costle, 590 F.2d 1011 (D.C. Cir. 1978); American Iron & Steel Inst. v. EPA, 568 F.2d 284 (3rd Cir. 1977); Marathon Oil Co. v. EPA, 564 F.2d 1253 (9th Cir. 1977); Appalachian Power Co. v. Train, 545 F.2d 1351 (4th Cir. 1976); American Paper Inst. v. Train, 543 F.2d 328 (D.C. Cir.), cert. dismissed, 429 U.S. 967 (1976); National Renderers Ass’n v. EPA, 541 F.2d 1281 (8th Cir. 1976); E.I. du Pont de Nemours & Co. v. Train, 541 F.2d 1018 (4th Cir. 1976), aff’d, 430 U.S. 112 (1977); CPC Int’l, Inc. v. Train, 540 F.2d 1329 (8th Cir. 1976); Tanners’ Council of Am. v. Train, 540 F.2d 1188 (4th Cir. 1976); American Petroleum Inst. v. EPA, 540 F.2d 1023 (10th Cir. 1976); FMC Corp. v. Train, 539 F.2d 973 (4th Cir. 1976); American Frozen Food Inst. v. Train, 539 F.2d 107 (D.C. Cir. 1976); Hooker Chemicals & Plastics v. Train, 537 F.2d 620 (2d Cir. 1976); CPC Int’l Inc. v. Train, 515 F.2d 1032 (8th Cir. 1975).

265. See Weyerhaeuser Co. v. Costle, 590 F.2d 1011 (D.C. Cir. 1978); American Frozen Food Inst. v. Train, 539 F.2d 107 (D.C. Cir. 1976); American Meat Inst. v. EPA, 526 F.2d 442 (7th Cir. 1975). But see Tanners’ Council of Am. v. Train, 540 F.2d 1188 (4th Cir. 1976); Hooker Chemicals & Plastics Corp. v. Train, 537 F.2d 620 (2d Cir. 1976).
meet its proposed limitation, the agency can usually survive judicial review. However, when the EPA cannot point to an exemplary or pilot plant in the same industrial category or subcategory and therefore relies upon its prediction that an existing treatment technology will transfer from one industry to another, the courts are more skeptical, and the agency usually loses. In the rare cases in which the EPA has gone beyond existing technology to project that the industry will be able to develop a technology capable of meeting the prescribed effluent limitations at some future date, the EPA has lost two out of three appeals.

A large proportion of the many remands have resulted from the reviewing courts' dissatisfaction with the EPA's numerical calculation of the level of pollution removal that a given technology is capable of producing. Even though the reviewing courts might agree with the EPA's identification of the "best available" or "best practicable" technology, it may be skeptical that the technology, when installed in most plants, can reduce pollution to the extent required by the effluent limitation. This unfortunate impasse results from Congress's general failure to empower the EPA to prescribe the technologies itself; the agency may only promulgate limitations based upon the technologies that it has identified. While this limitation on the EPA's power has the salutary purpose of maximizing an individual source's freedom to develop different technologies capable of meeting the same limitation, the practical effect has been to hamstring the EPA's efforts to set any limitations at all.

The flood of remands ultimately deprived the EPA of the benefit of the Supreme Court's holding in E.I. du Pont de Nemours, Inc. v. Train that the EPA


267. See Tanners' Council of Am. v. Train, 540 F.2d 1188 (4th Cir. 1976); American Petroleum Inst. v. EPA, 540 F.2d 1023 (10th Cir. 1976), cert. denied, 430 U.S. 922 (1977); FMC Corp. v. Train, 539 F.2d 973 (4th Cir. 1976); Hooker Chemicals & Plastics Corp. v. Train, 537 F.2d 620 (2d Cir. 1976); American Iron & Steel Inst. v. Train, 526 F.2d 1027 (3d Cir. 1975); American Meat Inst. v. EPA, 526 F.2d 442 (7th Cir. 1975). But see Weyerhaeuser Co. v. Costle, 590 F.2d 1011 (D.C. Cir. 1978); California & Hawaiian Sugar Co. v. EPA, 553 F.2d 280 (2d Cir. 1977); American Frozen Food Inst. v. Train, 539 F.2d 107 (D.C. Cir. 1976).


269. See National Renderers Ass'n v. EPA, 541 F.2d 1281 (8th Cir. 1976); FMC Corp. v. Train, 539 F.2d 973 (4th Cir. 1976); Hooker Chemicals & Plastics Corp. v. Train, 537 F.2d 620 (2d Cir. 1976); American Iron & Steel Inst. v. Train, 526 F.2d 1027 (3d Cir. 1975); American Meat Inst. v. EPA, 526 F.2d 442 (7th Cir. 1975); CPC Int'l, Inc. v. Train, 515 F.2d 1032 (8th Cir. 1975).

270. Perhaps the most egregious example of judicial second-guessing in all of the appeals is CPC Int'l Inc. v. Train, 540 F.2d 1329 (8th Cir. 1976). The EPA established an effluent limitation for new sources in the Corn Wet Milling Industry of 10 pounds of total suspended solids per thousand standard bushels of corn. The Eighth Circuit held this action to be arbitrary and capricious in CPC Int'l Inc. v. Train, 515 F.2d 1032 (8th Cir. 1975). The EPA responded to the remand by attempting to provide greater record support for its limitation. The court, however, was unpersuaded. CPC Int'l, Inc. v. Train, 540 F.2d 1329 (8th Cir. 1976). The court allowed that a standard of 25 pounds per thousand standard bushels could be supported by the record, but not the original standard of 10 pounds per thousand standard bushels. The court therefore remanded to the EPA "with directions to it to revise the TSS standard to 25 pounds per MSBu or to compile additional evidence to support a lower standard." Id. at 1345. Not surprisingly, the EPA took the none-too-subtle hint. 40 C.F.R. § 406.15 (1982).

had the power to promulgate national effluent limitations. The EPA responded to only a very few of the remands, and even when it did, it could not always persuade the remanding court of the validity of its standards.

The EPA’s batting average in the courts of appeals is not much better for its technology-based new source performance standards (NSPS) under the Clean Air Act. Even with the wisdom gained from its humiliating Clean Water Act experience, the EPA could not in 1977 draft a new source performance standard for lime manufacturing plants that could survive in the generally sympathetic D.C. Circuit.

The EPA’s technology-based standard setting under both the Clean Air and Clean Water Acts has been plagued by the intractable problem of excursions and upsets. The agency readily acknowledges that even the best technologies do not perform flawlessly under strenuous real world conditions. Startups and upsets (such as those caused by unexpected rainfall or equipment breakdowns) can swamp the pollution control technology and cause a facility’s discharge to exceed an effluent limitation that is predicated upon normal operating conditions. The dilemma is initially attributable to the requirement that the EPA write effluent limitations rather than prescribe actual technologies. Yet even if the agency could prescribe technologies, it would face the enforcement problem of limiting the number of upsets to those actually required by bona fide production disruptions. The EPA initially proposed to address this conundrum by wisely exercising its enforcement discretion.

The regulated sources are, not surprisingly, invariably dubious about this “solution” in light of the fact that any citizen may sue to

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277. See Corn Refiners Ass’n v. Costle, 594 F.2d 1223 (8th Cir. 1979); Weyerhaeuser v. Costle, 590 F.2d 1011 (D.C. Cir. 1978); Marathon Oil Co. v. EPA, 564 F.2d 1253 (9th Cir. 1977); United States Steel Corp. v. Train, 556 F.2d 822 (7th Cir. 1977); CPC Int’l, Inc. v. Train, 540 F.2d 1329 (8th Cir. 1976), cert. denied, 430 U.S. 966 (1977); American Petroleum Inst. v. EPA, 540 F.2d 1023 (10th Cir. 1976); FMC Corp. v. Train, 539 F.2d 973 (4th Cir. 1976); Essex Chem. Corp. v. Ruckelshaus, 486 F.2d 427, 432-33 (D.C. Cir. 1973), cert. denied, 416 U.S. 97 (1974); Portland Cement Ass’n v. Ruckelshaus, 486 F.2d 375, 398-99 n.91 (D.C. Cir. 1973), cert. denied, 417 U.S. 921 (1974).

278. See Weyerhaeuser v. Costle, 590 F.2d 1011, 1056-57 (D.C. Cir. 1978); FMC Corp. v. Train, 539 F.2d 973, 986 (4th Cir. 1976).

279. In Marathon Oil Co. v. EPA, 564 F.2d 1253, 1272 (9th Cir. 1977), the EPA refused to include a provision for upsets in the permit, preferring instead to “set a standard by using a 97.5 or 99 percent ‘confidence interval,’ and then to address the expected one percent or more of ‘excursions’ when they actually occur. If there was a violation . . . was not the fault of the permit holder, EPA will informally exercise its discretion not to prosecute.”
enforce an effluent limitation that is reflected in a discharge permit. Yet, if the effluent limitation itself must provide for predictable upsets, a source might abuse its privilege to upset entitlements. And if the EPA must set the limitation so high that it can be reached under upset conditions, as one court has apparently suggested, then the limitation will be far too lenient. While the courts of appeals have split on the issue of whether to require the inclusion of upset conditions as a factor in setting the limitations, most have required the EPA to do more than allude to its enforcement discretion. Most recently, the EPA has decided to write excursion and upset provisions into its general permitting regulations under § 402 of the Clean Water Act. This merely delegates the problem to the permit writers and enforcers.

OSHA's experience with judicial review of technology-based standards has been less bleak. All of OSHA's standards for carcinogens and its standards for lead and cotton dust have been technology-based because the point of economic and technological infeasibility was reached before the level of toxic substance in the workplace was deemed safe. In only one case did a court of appeals reject OSHA's conclusions concerning the feasibility of a standard. In the only case in which the Supreme Court has considered the record's support for a technology-based standard, the Court upheld OSHA's cotton dust standard over vigorous industry objections that OSHA had made wholly unsupported assumptions and had manipulated the existing studies in an unreasonable way to support its conclusions.

In sharp contrast to its mixed experience with technology-based standards, the EPA has been reasonably successful in securing judicial approval of its media-quality-based standards. Industrial firms challenged only one of the EPA's initial national ambient air quality standards. While that challenge was successful, it

280. Marathon Oil Co. v. EPA, 564 F.2d 1253, 1273 (9th Cir. 1977); Bethlehem Steel Corp. v. Train, 544 F.2d 657, 660 (3d Cir. 1976) ("There is no authorization to block a citizen's suit under section 505 even though the agency believes that the suit should not go forward.").


resulted in a relatively limited remand requiring the EPA to provide greater record support for one of its assertions. The EPA apparently learned from this experience, and its revised standard for photochemical oxidants survived challenges from both environmentalists and industry. The reduction models with which the EPA calculates pollution reduction loads have also easily survived judicial review, even when petitioners have pointed to other models that appear to depend upon fewer brash assumptions. There have been no challenges to the EPA's hazardous emission standards under section 112 of the Clean Air Act, and the EPA's media-quality-based toxics effluent standards, promulgated under section 307(a) of the Clean Water Act, easily survived judicial review in the D.C. Circuit.

From a reading of the EPA's history, it would appear that the courts are inclined to review technology-based standards more carefully than media-quality-based standards. Judges may be less hesitant to substitute their judgment for that of the agency on questions of engineering and economics, or it may be that lawyers can characterize an agency action as erroneous and arbitrary more easily when those kinds of issues are involved. When the question before the court concerns the intricacies of toxicology and meteorology, the judges apparently feel uneasy with the conclusion that the agency’s decision lacks support. Yet, this reasoning does not explain why most of OSHA’s technology-based standards have survived so well, even though the standard of review for OSHA’s technology-based standards has traditionally been viewed as more exacting. One explanation for this apparent inconsistency is that OSHA’s standards, like the EPA’s media-quality-based standards (but unlike the EPA’s technology-based standards), are directly tied to human health. OSHA may only impose a technology-based standard when the workplace is already unsafe, and even after the standard is in place the workplace may still pose risks to workers. The direct link between a standard and worker health may make the courts more reluctant to overrule OSHA’s standards. It is also possible that OSHA has simply done a better job than the EPA in justifying its standards.

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288. Kennecott Copper Corp. v. EPA, 462 F.2d 846 (D.C. Cir. 1972). Interestingly, the EPA did not respond to the remand. The agency may have read more into the court’s opinion than was required. See McGarity, Substantive and Procedural Direction in Administrative Resolution of Science Policy Questions: Regulating Carcinogens in EPA and OSHA, 67 GEO. L. REV. 729 (1979).


291. There was a challenge to the section 112 standard for vinyl chloride, but it was not pursued. See Doniger, supra note 214, at 581-85.


293. See McGarity, supra note 288, at 791-92.

294. This explanation is even more true after Industrial Union Dep’t, AFL-CIO v. American Petroleum Inst., 448 U.S. 607 (1980), because OSHA must first determine that current exposure levels pose a “significant risk” to workers before the agency may promulgate a feasibility-based standard.

295. OSHA may be aided in this by the fact that OSHA always allows opposing counsel to cross-examine witnesses and otherwise conducts its hearings in a relaxed trial-like fashion while the EPA’s
One can perhaps draw the tentative conclusion that pure technology-based standards may have greater difficulty in surviving judicial review.296 The evidence on this score, however, which is derived largely from a single agency's experience with two statutes mandating across-the-board technology-based standards, is not especially compelling. Nevertheless, the ability to survive judicial review would appear to be a factor that weighs in favor of media-quality-based standards.

b. Political Review. The evidence concerning political review of the two approaches is extremely sparse, and it supports few conclusions. Since OSHA's health standards usually have both media-quality and technology components, it is impossible to tell whether the considerable political attention that has surrounded many of those standards is directed toward the agency's scientific or engineering judgments. While the first round of the EPA's ambient air quality standards generated little political debate, the more recent revisions are causing intense political interest both in the White House and in Congress.297 On the other hand, the EPA's recent technology-based standard for steam electric power plants has also received a great deal of political attention,298 as did its recent regulation requiring that lead be phased out of gasoline.

While it seems reasonable to surmise that most technology-based standards, which are directed at narrow industrial categories, will not achieve the high political profile of media-quality-based standards for toxic substances that could affect the health of millions, it is impossible to draw that conclusion from the available evidence. In any event, one could equally plausibly argue that the most effective political review is the low-key suggestion by a member of the agency's appropriation committee at the behest of an important constituent who is lagging behind his competitors in installing the technology that the EPA proposes as the basis for a technology-based standard.299

5. Equity. In addition to its great concern for practicality and economic efficiency, this country has always exhibited an often countervailing concern for equity.300 Although pollution control has not raised questions of fairness or equity with nearly the frequency and forcefulness of many other social programs, important equity issues do reside under the surface of the pollution control debate.
These concerns can also have an impact on the choice between the media-quality-based and technology-based approaches.

Any health and environmental standard that does not achieve very close to zero risk will over time shift wealth from those who are harmed by the discharge of hazardous substances to those who benefit thereby. As we have seen, the tort system rarely forces the beneficiaries to compensate the losers. For many polluting activities, the class of beneficiaries—the consumers of manufactured products—overlaps with the class of losers. Much of the chemical industry probably fits within this category of activities for which the winners and losers are largely coterminous. There are, however, exceptions to this more-or-less equitable arrangement. Workers in the chemical industry generally receive higher exposures than other consumers. Moreover, scientists are increasingly able to isolate groups of people who, because of genetic factors, are at a higher risk of contracting disease from low exposure to chemicals than the rest of the population. The EPA has made an effort in promulgating its national ambient air quality standards to identify groups of unusually susceptible persons and to protect a large proportion of them from harm. OSHA, too, has written special provisions into its standards to protect sensitive workers.

The media-quality-based approach can address these inequities directly. As the ambient standard is lowered the disparity weakens. The technology-based approach, however, does not address this equity concern at all because it does not dwell on the quality of the receiving media. In the workplace, the Occupational Safety and Health Act’s combined media-quality-based and limited technology-based approach adequately addresses the worker/consumer inequity by requiring the receiving media to be free of significant risks, but it allows the inequity to creep back in when it is infeasible to protect susceptible populations.

Any health and environmental standard that directly or indirectly requires large capital expenditures can create interfirm inequities. Professors Leone and Jackson have recently undertaken pathbreaking economic studies on the interfirm

301. See supra text accompanying notes 65-92.
302. There is a large literature on this particular inequity. See, e.g., D. BERMAN, DEATH ON THE JOB (1978); C. GERSUNY, WORK HAZARDS AND INDUSTRIAL CONFLICT 143 (1981) (“If there can be no such thing as a riskless society then the distribution of these risks is a matter of grave importance. Are the risks faced by the Rockefellers of this world similar to the risks faced by the manual labor force?”); J. PAGE & M. O’BRIEN, BITTER WAGES (1973); R. SCOTT, MUSCLE AND BLOOD (1974).
305. 29 C.F.R. § 1910.1018 (1981) (arsenic); id. § 1910.1025 (lead); id. § 1910.1045 (acrylonitrile); see Rothstein, Employee Selection Based on Susceptibility to Occupational Illness, 81 MICH. L. REV. 1379 (1983).
306. Media-quality-based standards can also address interspecies inequities directly. The secondary ambient air quality standards are intended to do this, but the fact that harm to other species is encompassed within the term “human welfare” indicates that the standard-setter is to take an anthropocentric approach toward setting these standards.
impacts of capital-intensive health and environmental requirements. From this standpoint the technology-based approach may be less "equitable" than the media-quality-based approach. The technology-based approach groups an industry into various categories and subcategories and prescribes the same effluent limitation for all firms within a given category or subcategory, many of whom compete with one another in product markets. While this approach may at first glance appear equitable because it treats equals equally, it may appear inequitable from the standpoint of the individual sources within a given category. Some may have to undertake greater capital expenditures than others, and (perhaps more importantly) some will have to defer capital investments in production capacity to a greater extent than others.

Technology-based standards for many industries are calculated with reference to the best performers in a given category. The best performers at the time that the standard is promulgated will necessarily face lower cleanup costs than the poorer performers. All of these factors will operate to the competitive advantage of some firms and to the detriment of others. This shift in the relative positions of the competing firms may have very little effect on the product market. However, if the cost increase forces marginal firms out of the product market, the regulation will certainly appear inequitable to them and the net result could be less competition and artificially high prices. Moreover, if a substantial proportion of the "marginal" firms are smaller firms with smaller income streams and less access to capital, the result may appear inequitable from a populist, small business-oriented perspective.

A related interfirm inequity of the technology-based approach is the disparity

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308. See Leone & Jackson, supra note 98.
309. This is not precisely true to the extent that an individual source may secure a variance. See E.I. du Pont de Nemours & Co. v. Train, 430 U.S. 112, 123 n.10 (1977); Clean Water Act § 301(c), 33 U.S.C § 1311(c) (1976).
310. For a detailed explanation of how regulation-induced deferral of capital investments in production capacity can disproportionately harm a firm in comparison to its competitors, see Leone & Jackson, supra note 98, at 234-39.
311. Leone and Jackson demonstrate the effect of the "best practicable technology" standards under section 301 of the Clean Water Act on the competitive positions of firms in the pulp and paper industry. Id. at 254.
312. The shutdown of marginal firms need not appear inequitable to the rest of society. In a sense, to the extent that such firms were surviving because they were able to put the costs of doing business off on others, their demise is well-deserved. They may have been forced out of business by the market in any event. See id. at 257; Letter from Alvin L. Alm to Joe G. Moore (Feb. 6, 1976), reprinted in National Commission on Water Quality, Final Report 44-45 (1976) ("Few industries face the threat of plant closures and many of those plants which are projected to close down rather than invest in pollution control equipment are those which could not remain economically viable over the next decade in the absence of water pollution control."); see also Economic Analysis Hearings, supra note 224, at 1220 (statement of Robert K. Davis).
313. In using the term "marginal" here, I mean marginal with respect to income flow and large and immediate regulation-induced capital expenditures. In this sense it is more likely that small firms fall into this category.
314. This argument has been raised in the political debates. See HISTORY OF THE WPCA AMENDMENTS, supra note 184, at 1355 (statement of Sen. Nelson); National Commission on Water Quality, Final Report 17 (1976). It probably also explains why Vice President Bush ordered the EPA to re-examine its lead phase-down rule immediately prior to the date that it became effective for both large and small refineries. See Small Refiner Lead Phase-Down Task Force v. EPA, 705 F.2d 506, 512 n.9 (D.C. Cir. 1983).
in treatment usually afforded to new firms and existing firms.\textsuperscript{315} Virtually all true technology-based standards set separate requirements for new sources. This practice is justified to the extent that retrofit costs for existing plants are much larger than the costs of designing pollution control into a new plant.\textsuperscript{316} The distinction also has greater political attractiveness because the potential owners of new sources are not always as well represented in the political debates. It is easy for a political body to load the burden of pollution control onto sources that do not exist. The disparity will, however, appear inequitable to the new source owner after the standard has been promulgated. Moreover, the new source/old source distinction has the considerable practical disadvantage of discouraging existing firms from retiring inefficient and heavily polluting old plants and replacing them with newer and more efficient equipment.\textsuperscript{317}

The media-quality-based approach can create similar interfirm inequities. To the extent that media-quality-based standards are implemented through technology-based implementation techniques, the same interfirm inequities exist. If the agency allocates the pollution reduction load in accordance with historical use, the interfirm inequities should be reduced because the pollution reduction required will not depend upon the performance of the best among a category of competitors. The historical allocation approach does, however, put new sources at a disadvantage relative to existing sources when the available increment of pollution has been consumed. A stringently implemented nondeterioration policy will create a similar new source/old source inequity.\textsuperscript{318}

Implementing a media-quality-based approach through incentive-oriented techniques, such as charges and marketable permits, will also create inequities among existing sources in areas where the media-quality-based standards are exceeded, because any regulation-induced cleanup will have some impact on the relative competitive positions of the existing firms.\textsuperscript{319} This should not, however, be equivalent to the impact of a technology-based standard because any particular source will have the flexibility to implement its own optimum pollution control technology. Moreover, a firm can cushion the impact of an incentive-based allocation scheme by paying the charge or purchasing pollution rights out of short term revenues and thereby avoiding the deferral of capital investments in production capacity. Finally, incentive-oriented techniques do not distinguish between new and old sources. Both classes pay the same for an equivalent amount of pollution.

\textsuperscript{315} See B. Mitnick, supra note 46, at 405.
\textsuperscript{316} See generally Huber, \textit{The Old-New Division in Risk Regulation}, 69 VA. L. REV. 1025 (1983).
\textsuperscript{317} See id. at 1073. Ackerman and Hassler suggest that the large differential between the stringent new source performance standards for coal-fired steam electric power plants and the sulfur dioxide removal requirements for old sources under the state implementation plans had the net effect of increasing the amount of acid rain over that which would have resulted from a less stringent NSPS. See Ackerman & Hassler, supra note 183, at 1522-25.
\textsuperscript{318} A stringent PSD policy would preclude any construction of new sources in areas that are already clean. In practice, the PSD policy allows new sources if they can demonstrate that they are beneficial overall and if they implement the best available technology. See Hines, \textit{A Decade of Nondeterioration Policy in Congress and the Courts: The Erratic Pursuit of Clean Air and Clean Water}, 62 IOWA L. REV. 643, 645 (1977). This creates the same new source/old source inequity that exists in a technology-based system.
\textsuperscript{319} See Leone & Jackson, supra note 98, at 239.
6. **Technological Advance.** The policy-oriented economists are right to insist that policymakers recognize that health and environmental protection requires trade-offs. We cannot have as much health and as many environmental amenities as we might like without sacrificing other important material resources. Nevertheless, the economy and technology are not static. Advances in technology can bring about changes that greatly diminish the agony of some tradeoffs. Pollution control problems that today appear intractable may disappear tomorrow with the advent of new technology. Indeed, the possibility of technological advance is itself a strong reason for abandoning the strict economic approach, which in practice often reduces to a static assessment of the costs and benefits of regulatory requirements under existing technological constraints. The government can, of course, encourage technological advance by directly funding engineering and environmental research. Government can also encourage technological progress by molding its regulatory requirements to give private firms, operating under competitive conditions, an incentive to conduct their own research and development efforts.\(^3\)\(^2\)\(^0\) Congress might, for example, decide to “force” technology by prescribing requirements that are capable of being met only through the implementation of newly evolving or nonexistent technologies.\(^3\)\(^2\)\(^1\) Alternatively, Congress might attempt to “nudge” technology by making it very expensive for sources to pollute. The ability of a regulatory approach to encourage technological advance might therefore influence the choice between the media-quality-based and technology-based approaches.

The technology-based approach, when it is functioning properly, can effectively force companies to install technologies that other companies with similar production processes and wastes already use. When the regulatory entity can point to a competitor that is using a technology, it can justifiably insist that the laggard install the same or equivalent technology.\(^3\)\(^2\)\(^2\) Technology-based standards can thus bring all of the firms in an industrial category up to the level of its best performers, and this upgrading activity can in theory be initiated quite rapidly.\(^3\)\(^2\)\(^3\) Technology-based standards are likely to be even more effective in forcing new sources to implement the best of existing technology, because it should be easier to design an existing technology into a new plant than to retrofit it into an existing plant.

When the regulatory entity cannot point to an existing plant that has successfully implemented a technological innovation, it can attempt to rely upon innova-

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\(^3\)\(^2\)\(^0\) For a complete discussion of the choice between technology-based standards and media-quality-based standards and “technology-forcing,” see RADIAN CORP., CASE STUDIES OF AIR POLLUTION CONTROL TECHNOLOGY INNOVATIONS (1980) (Final Task II Report to the National Commission on Air Quality); La Pierre, *supra* note 187; see also Comment, *supra* note 224.

\(^3\)\(^2\)\(^1\) *See supra* note 268 and accompanying text; cf. Renken v. Harvy Aluminum, 226 F. Supp. 169 (D. Or. 1963) (nuisance case in which court was impressed by the fact that competitor had installed existing technology).

\(^3\)\(^2\)\(^2\) Technology-based standards that are based upon technologies already in operation within the relevant category are much more likely to survive judicial review. *See* La Pierre, *supra* note 187, at 823.

\(^3\)\(^2\)\(^3\) *See* American Paper Inst. v. Train, 543 F.2d 328 (D.C.Cir.), cert. dismissed, 429 U.S. 967 (1976); CPC Int'l, Inc. v. Train, 540 F.2d 1329 (8th Cir. 1976); FMC Corp. v. Train, 539 F.2d 973 (4th Cir. 1976); American Iron & Steel Inst. v. Train, 526 F.2d 1027 (3d Cir. 1975).
tive technologies in the "pilot plant" or "demonstration" phase of development for new source standards and for standards that take effect in the future. Technology-based standards can also force the transfer of technologies from one industry to another with similar processes and wastes. We have seen, however, that the EPA has not been especially successful in persuading reviewing courts of the rationality of standards that are based upon innovative techniques and technology transfers.324

The technology-based approach has the further capacity to impel an entire industry forward by requiring firms to install or retrofit nonexistent technologies that are projected to be available in the near future. The courts, however, have been very reluctant to allow the EPA to impose technology-based requirements on the basis of this sort of "crystal ball" inquiry.325

Technology-based standards, in sum, can "press" existing firms toward existing technologies, and they can probably "force" new sources to implement the best of existing technologies and perhaps, if the agency is especially careful in preparing its support documents, force new sources to implement new technologies that are just on the horizon.326 In theory this limited technological advance can be accomplished rapidly and with little risk of unsympathetic judicial review. In practice, however, the EPA's technology-based standards have not been rapidly implemented, and they have not fared well in the courts. This result may be curable with experience, but the EPA's recent mixed record in securing judicial approval of its new source performance standards under the Clean Air Act does not warrant optimism on this score.

It seems clear that the technology-based approach cannot induce real technological change. It can at best bring the laggards into line with the leaders; it cannot effectively force the leaders to innovate.327 Indeed, the leaders have a positive disincentive to invest in research and development toward new pollution control technologies. If a more expensive but less polluting new technology is developed, that firm's own new sources may have to apply it.328

The media-quality-based approach has a greater potential to stimulate technological advance, but only if the right implementation techniques are adopted. If the regulatory entity implements the media-quality-based approach with technology-based standards, then little real innovation can be expected. The agency will make optimistic assumptions about the ability of existing technologies to meet

324. See supra notes 267-68 and accompanying text.
326. Extensive case studies done for the National Commission on Air Quality have concluded that the EPA's new source performance standards have induced technological advance in several industries. See RADIANT CORP., supra note 320. Another study of sulfur dioxide removal from copper smelters and electric power plants has likewise concluded that technology-based standards have induced research and development investment in those industries with the largest investments being directed toward new sources. Comment, supra note 224.
327. See A. KNEESE & C. SCHULTZE, supra note 18, at 82; La Pierre, supra note 187, at 805; Comment, supra note 224, at 1727.
328. See Economic Analysis Hearings, supra note 224, at 1192 (testimony of Michael McClosky, Executive Director, Sierra Club); A. KNEESE & C. SCHULTZE, supra note 18, at 63; La Pierre, supra note 187, at 774; Comment, supra note 224, at 1727.
the ambient media-quality standards and the standards will continue to be exceeded or, at best, incremental progress toward attainment may result. The historical and political allocation techniques are also unlikely to stimulate innovation or even to push existing sources toward the best existing technology. Unfortunately, few, if any, health and environmental agencies go beyond these standard tools for implementing a media-quality-based approach.

Forceful implementation of the media-quality-based approach could stimulate innovation in geographical areas where media-quality-based standards are exceeded as long as there is a firm deadline for attainment of the standards. If the sources in those areas were assured that they in fact faced shutdown if the standards continued to be exceeded after a given period of time, then they would have a very large incentive to develop pollution control technology prior to the deadline. However, the incentive hinges entirely upon the credibility of the shutdown threat. In the past, the threat has not been credible. The threat is largely unavailable to OSHA because it cannot close down too many employers without undermining the purpose of the standard—that is, safe and healthful employment. The threat of shutdown from the EPA is in theory somewhat more credible, but historically it has proved just as empty. The EPA's vinyl chloride experience aptly demonstrates the agency's reluctance to promulgate media-quality-based limitations at near-zero levels if doing so threatens a substantial portion of a vital industry. The states that are charged with implementing the national ambient air quality standards seldom prescribe emissions limitations that cannot be met by existing technology, even when failure to do so means that the ambient air quality standards will be exceeded past the relevant deadlines. Even if the EPA or a state adopted a hard line, it is not clear that a court would not accept an individual company's economic and technological feasibility claims in reviewing the reasonableness of the individual limitation or in framing relief in an enforcement action. Finally, footdragging industries know that failing all else, they can return to Congress and appeal for an extension of the deadline, as many industries successfully did in 1976 and may do again in 1984. With the threat of sanctions or shutdown thus reduced to low comedy, a firm has very little incentive to invest in new pollution control technologies. Indeed, a firm that took seriously its apparent obligations and invested in research and development would probably suffer real economic harm at the hands of its more cynical and less obedient competitors.

A pollution charge or marketable permit allocation technique, by contrast, can stimulate pollution control innovation beyond that necessary to rise to the performance level of the best in the industry. Since every unit of pollution under either of those allocation schemes is a costly item, every source has an incentive to

329. See supra text accompanying note 214; see also Doniger, supra note 214, at 563-64, 572; La Pierre, supra note 187, at 793-94.

330. In many states a source may challenge a state-ordered emissions limitation on economic and technological infeasibility grounds in state court. Courts have held individual requirements invalid on this basis, even though it means in practice that another source must face even more stringent limitations or, more likely, that the media-quality-based standard will not be met sufficiently rapidly. See Menzel v. County Util. Corp., 14 Envtl. Rep. Cas. (BNA) 1126, 1128 (E.D. Va. 1979).

develop pollution reduction technologies, thus creating a market for innovative firms that develop pollution control devices.

The incentive-oriented techniques are, however, no panacea. The charge must be set sufficiently high to provide a realistic incentive to innovate. Research and development is costly and risky; it will not be undertaken unless the firm is persuaded that it will ultimately pay for itself in reduced payments for fees or in sales of permits. Unfortunately, the relationship between financial rewards and research and development decisions in a firm is not well understood. The implementing agency will therefore lack the ability to predict with much accuracy whether a particular charge will provide the threshold incentive to send research and development funds into pollution control rather than into style changes and new product lines. In addition, a fee or permit that is sufficiently costly to send a clear signal to firms may be so expensive that it threatens the financial integrity of a large segment of the regulated industry, in which case the agency will face precisely the same pressure from the regulated firms to lower the fees that it now faces to lower its standards and extend its deadlines. Congress is unlikely to enact a fee or permit allocation scheme without a provision for judicial review. Judicial review of the level of the fee or the number of permits will involve many of the same issues that typify judicial review of technology-based standards, and the courts are likely to be equally sympathetic to claims of economic infeasibility.

If a sufficiently stringent charge or permit scheme can be put into place, it will probably be more efficient and effective in bringing about real technological innovation than the studied brinksmanship of the current technology-based techniques. Still, a media-quality-based incentives scheme would only operate until pollution reductions sufficient to reach the media-quality-based standard were implemented. At that point the incentive to innovate should disappear, at least until a new source entered the area and forced the regulatory entity to inaugurate the charge mechanism once again. One remedy to this uneven incentive structure is to have the charge operate independently of media quality. This could be done on the moral premise that no one has a “license to pollute,” or on the more realistic theory (in the context of the chemical industry) that thresholds for the effects of toxic substances are so difficult to identify, if they exist at all, that it is worth society’s while to keep dischargers of such substances under constant pressure to develop new pollution control technology.

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332. Economic Analysis Hearings, supra note 224, at 1193 (testimony of Michael McClosky); id. at 1188 (testimony of Robert Haveman); F. ANDERSON, supra note 9, at 34; A. KNEESE & C. SCHULTZE, supra note 18, at 24-25, 90-91; B. MITNICK, supra note 46, at 375. 333. See Burby, White House Plans Push for Sulfur Tax Despite Strong Industry Opposition, 4 NAT’L J. 1663, 1667 (1972); Rose-Ackerman, supra note 13, at 400. 334. See B. MITNICK, supra note 46, at 375; Rose-Ackerman, supra note 13, at 399-401. 335. See Rose-Ackerman, supra note 13, at 399-400. 336. The marketable permit scheme would continue to provide incentives to reduce pollution so long as a market existed for the permits. One obvious source for such a market, once the media-quality standard is met, is potential new sources. A firm that cleans up more will have more permits available to sell to new sources. Another source is existing sources that can save in maintenance and operating expenses by turning off their pollution control devices. However, it is entirely possible that this remote incentive will have little impact on a source in an area that meets the media-quality-based standards. In any event, this is an academic question for the chemical industry, where markets are unlikely to develop in the first place.
VI

A SUGGESTED SYNTHESIS

From the foregoing it would appear that neither the media-quality-based approach nor the technology-based approach has a clear advantage as a candidate for health and environmental regulation of the chemical industry. The media-quality-based approach stumbles on its inability to draw clear links between media quality and particular sources in the environmental context, and it is stymied in both the environmental and worker health contexts by the failure of the scientific community to predict with any reasonable degree of accuracy the health effects of low dose exposures to chemical substances. In any event, administrative bodies apparently face irresistible pressures to convert the media-quality-based approach into a technology-based approach in the context of nonthreshold pollutants and to implement media-quality-based standards through technology-based allocation techniques in other contexts.

The technology-based approach is attractive to implementing agencies because it maximizes their discretion in determining the regulatory targets and because it simplifies enforcement. The technology-based approach allows the regulator to motivate laggard companies without threatening the economic viability of whole industrial sectors. Yet, this approach is difficult to implement because reviewing courts seem somewhat less hesitant to search for the implementing agencies' analytical mistakes and to remand standards for corrections. The technology-based approach requires the regulatory entity to rely upon easily challengeable assumptions about the future of industrial and economic growth and the rate of technological development that are perhaps too facilely evaluated by judges. Furthermore, the agency and the public are placed at a great knowledge disadvantage with respect to the regulated industries. The technology-based approach requires the decisionmaker to acquire an extensive familiarity with the processes, products, and by-products of the regulated industry that must come, largely on faith, from the industry itself. Under the media-quality-based approach, which focuses more on toxicology than technology, the sides are more evenly matched. Additionally, the technology-based approach does not address inequities as effectively as the media-quality-based approach. Finally, the technology-based approach is incapable of inducing private investment into innovative technological solutions to pollution problems that can bypass some of the more difficult societal trade-offs and send society farther on its way toward its nonutilitarian health and environmental goals.

Since both approaches have important strengths and weaknesses, it is possible that the best overall regulatory strategy consists of some optimal combination of both approaches. The following section will offer some suggestions for a sensible combined strategy for regulating the chemical industry. These rather modest and somewhat tentative recommendations reflect the perhaps conservative viewpoint of one who is not especially dissatisfied with the current statutory arrangement and who is wary of untried proposals for radical change.

Congress was, in my opinion, wise to reject the narrow balancing approach to setting health and environmental goals. These goals are too important to be left to
the manipulations of a cloistered corps of policy analysts stuck to a schizophrenic paradigm. The absolutist “cleanup” goal will never be achieved in the real world, but with adequate incentives for technological development we can increasingly approach it. As a society we are better for the effort. The balancing goal is set too low. We can become too easily satisfied with a “optimal” steady-state where lives and environmental amenities circulate into and out of the system and are compared to and replaced by electric toothbrushes, push button windows, and other frivolous commodities yet to be imagined. The same intellectual energy that produces needs and creates markets for them can be channeled toward developing technologies capable of enhancing the workplace and of preserving the environment.

I am convinced that the new source/existing source distinction is a good one. Installing pollution control technologies into new facilities is very often less expensive than retrofitting them into old ones. Moreover, entire production processes can be designed for new plants that recycle wastes and thereby reduce overall discharges. The regulatory entity should be allowed to guide the future, even if it cannot correct all of the mistakes of the past.

The major disadvantage of stringent technology-based new source performance standards is the incentive that they provide to firms to extend the life of existing, more polluting sources. Stringent controls on existing sources can reduce this incentive, but the flexibility that agencies have to consider costs in prescribing standards for existing sources normally ensures that the incentive to delay remains alive. Another way to reduce this incentive is to require something less than the very best on-the-horizon technology for new sources. A somewhat lower technology-based standard for new sources would make the shift toward new technology less expensive, and it would provide the regulated firms with a greater degree of certainty that the pollution control technology identified by the regulatory entity would in fact work.

The regulatory entity could further reduce the disincentive to build new facilities by implementing a charge system for new and existing sources. If a firm must pay for every unit of pollution that it discharges and if it can reduce pollution by installing new production and pollution control technologies, then the reduced charge provides an incentive to make capital expenditures on new facilities. Indeed, the regulatory entity could go farther and set the charge at just the level that would induce the changeover to new facilities. In practice, however, such a technology-based charge would be even more difficult to implement than a technology-based effluent limitation, because it would require the regulatory entity to know the details of the investment decisions of the regulated sources as well as the economics of their production and pollution control processes. The regulatory

337. See Dr. Seuss (T. Geisel), The Lorax (1971).
338. Congress recognized the problems created by the technology-based new source performance standard: “It may be that in most instances, the technology for elimination of discharge of pollutants from new sources can be achieved on a considerably more reasonable basis than for existing sources.” 118 Cong. Rec. 33,697 (Oct. 4, 1972) (statement of Sen. Muskie). But see Ackerman & Hassler, supra note 183, at 1529-30 (arguing that a better course would be to design plants with possible modifications in mind instead of modifying existing plants).
entity would be even more at the mercy of the regulated firms for crucial information under a technology-based charge system. If the regulatory entity underestimated the charge necessary to induce the desired technology in a particular category, the new source opportunity would be lost, and the agency would in practice have to wait for the next generation of new sources for another change to induce pollution control technology in that category.

A better solution might lie in a combination of technology-based standards and stringent media-quality-based charges. Since the toxic products and by-products of the chemical industry are likely to lack accepted thresholds of toxicity and since our knowledge of environmentally caused diseases is in any event so weak, the overall media-quality goal should be to reduce exposure as much as possible. This charge would therefore be assessed for every unit of pollution. The charge would eliminate the need for the agency to undertake the almost impossibly difficult scientific and value judgments that are inherent in setting an acceptable level of media quality. The zero-discharge goal would rarely be reached, because at some point it will be cheaper to pay the charge than to reduce the discharge. But the incentive to reduce would always remain.

Since the effect of a charge on capital investment and research and development decisions is so indirect and so poorly understood, the charge standing alone may not be acceptable to proponents of a cleaner environment and workplace. The charge system could therefore be supplemented with a system of technology-based new source standards. The standards would ensure that when firms do shift to new production and pollution control technologies, they will implement the desired first-level technology. The standards need not, however, require untried, on-the-horizon technologies. Rather, the new source technology should be a technology that the implementing agency is confident can be implemented by new sources within the category. This would almost certainly enhance the agency’s ability to survive judicial review, and it would avoid the risk, which must be in the minds of most reviewing courts, that the agency will mandate the implementation of a “white elephant” technology. Finally, the agency should have greater flexibility to prescribe technology and, if necessary, production processes and operating techniques for new sources, rather than relying exclusively upon effluent limitations based on the processes and techniques that its engineers identify. The minor degree of added flexibility that sources receive when the regulatory entity prescribes limitations rather than actual technologies is, in the opinion of the author, far outweighed by the distracting and ultimately senseless disputation that occurs over whether a particular technology is capable of producing a particular level of pollution control in the waste stream and over excursion and upset provisions in standards and permits.339

The new source standards/charge system proposed here would offer a contin-

339. Effluent limitations will still be necessary for enforcement purposes for discontinuous processes and for other technologies for which the knowledge that the installed pollution control technology is operational does not guarantee that it is not being circumvented. Effluent limitations will also be useful when a new source proposes to install an innovative technology capable of even greater pollution reduction than the prescribed new source technology. To verify the greater efficacy of the proposed technology, the
uing incentive to develop pollution control process and technologies even after the firm complies with the technology-based standards. Under the mixed strategy suggested here, the charge must be paid for every unit of pollution, whether it comes from a new or an existing source. Owners of new sources can rest complacently upon compliance with new source standards only if they are willing to pay for such pollution as survives the installation of the new technology. Whereas the pure technology-based approach is inclined to push sources to the limits of today's technology and freeze it there, the mixed strategy suggested here would force new sources to meet a threshold technological burden and provide continuing incentives to do even better.

As a further refinement of the mixed strategy suggested here, the charge could vary from pollutant to pollutant depending upon the relative toxicity of and exposure to the pollutants, thus adding to the incentive to control the pollutants likely to do the most harm. This would require more information and necessitate higher administrative costs, but it would further the cleanup goal, and, to the extent that it could be validated, it would produce a more equitable system in which dischargers of more harmful pollutants must pay more than dischargers of less harmful pollutants. While current risk assessment techniques are thoroughly incapable of accurately quantifying the risks posed by individual chemicals in particular workplace and environmental contexts, they may be appropriate for the cruder task of segregating chemicals into a few distinct categories. Different charges could then be assessed for different categories.

The chief disadvantage of a categorization approach is that it may precipitate sharp debates about the appropriate categorization of a particular chemical that may ultimately result in time consuming administrative and judicial proceedings. It is, in the author's opinion, a close question whether the advantages of a categorization scheme outweigh this significant disadvantage. While the scheme would seem to be a very sensible approach, it may in fact never get off the ground. If the regulatory entity were to delay implementation of the entire mixed approach until categorization disputes were resolved, the categorization attempt would probably not be worthwhile. The EPA's experience with regulating hazardous discharges into water under section 311 of the Clean Water Act offers little comfort here.

The best solution is probably to allow the EPA to promulgate effluent limitations based upon identified technologies but eliminate from the standard-setting hearing the issue of whether the identified technology can achieve the prescribed emission limitation. At the individual permit hearing, the individual source could be allowed to demonstrate that the identified technology, installed in its plant, will not meet the prescribed limitation or that it has an innovative process that will do even better than the prescribed limitation. In either case, a new effluent limitation would be set for the individual plant.

Agencies have attempted to use risk assessment techniques to categorize chemicals according to toxicity in the past. See Identification, Classification, and Regulation of Potential Occupational Carcinogens, 45 Fed. Reg. 5205 (1980) (codified at 29 C.F.R. § 1990.112 (1982)); see also Manufacturing Chemists Ass'n v. Costle, 11 Env't Rep. Cas. (BNA) 2014 (W.D. La. 1978). The EPA attempted an elaborate categorization scheme to characterize substances according to toxicity for purposes of defining "hazardous discharge." The listing and categorizing process itself consumed several years and a huge amount of agency resources. The standard was overturned by a federal
While the charge might be media-quality-based in the limited sense of varying from category to category, it should not be media-quality-limited. The charge setter should not seek to achieve any particular degree of media quality in the receiving waters short of zero exposure. The technology-based new source standards should ensure that reasonable efforts are being made to achieve clean receiving media; this is as much as the current media-quality-based approach seems capable of achieving in any event. The charge should be set at a level which will provide a strong inducement to clean up beyond what might be established as an “acceptable” level of media quality under a balancing approach. This attitude would implement the two strong policies underlying the prevention of significant deterioration approach to new sources. First, it recognizes the absolutist position that no pollution is really acceptable to society. All of it must be paid for. Second, it recognizes that the huge uncertainties involved in assessing the risks of toxic chemicals mean that we can never be sure that a given level of media quality is really safe enough. Sources should be under constant financial pressure to develop technologies for pollution reduction. The predictable response of some environmental purists that this response is merely a “license to pollute” is elevating rhetoric over substance. It is a matter of practical politics that new sources of pollution will be allowed to discharge toxic substances into the workplace, the water, and the air, and that most old sources will not be forced out of business. We can strive toward justifiable absolutist cleanup goals by decrying the construction of new sources and thereby tacitly accepting the discharges of existing sources, or we can pursue those goals more sensibly through a mixed system of technology requirements and charges that insists upon the installation of some reasonably available control technology and that encourages the development of even better technology through a system of stringent charges.

The mixed strategy is also adaptable to existing sources. As previously discussed, the charge system should be implemented with respect to existing sources to encourage pollution reduction and to reduce the disincentive to convert to new production processes that technology-based new source standards provide. The question remains whether technology-based requirements should be imposed upon existing sources in addition to the charge. The case for technology-based requirements is somewhat weaker for existing sources for which any new technology requirements must be retrofitted. Nevertheless, a good case can be made for technology-based requirements in areas in which media quality is poor and for substances for which adequate media-quality-based standards are impossible to promulgate. In both cases the regulatory entity faces strong practical pressures to convert media-quality-based standards into a technology-based implementation

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343. See HISTORY OF WPCA AMENDMENTS, supra note 184, at 1322 (statement of Sen. Muskie: “if the degree of control achieved is adequate to implement effluent standards, the effluent fee is a useful means to implement existing public policy—if less control is achieved, then the fee is a license to pollute”); Burby, supra note 333, at 1665 (“The National Association of Manufacturers believes that taxes on effluents and emissions represent an unmanageable, uneconomic, and negative approach and in principle would allow polluters to continue to adversely sue our environment by payment of a tax.”).
approach. It might be more straightforward to acknowledge this tendency forthrightly and prescribe technology-based requirements in the first place. The chemical industry meets the second of these two preconditions especially well. The large uncertainties that surround attempts to assess health and environmental effects of most chemical substances produced by the chemical industry argues against any media-quality-based standard other than zero. Since the societal cost of zero discharge for most existing sources is ultimately unacceptable, the next best regulatory alternative is to require existing sources to do the best that they can. This will, of course, entail all of the disadvantages of technology-based standards, including the likelihood that not all of them will survive stringent judicial review. However, society will at least assure that "best efforts" are being made toward its absolutist goals. Moreover, the charge will reinforce upon the existing sources society's conviction that any pollution is bad, and it should make the installation of retrofit technologies less painful.

The novel issue in the mixed technology-based standards/charge approach will be the level at which the regulatory entity sets the charge. The charge suggested here is not intended to induce any particular level of media quality; nor is it meant to induce the implementation of any particular degree of technological control. The purpose of the charge is twofold—(1) to reinforce in a very pragmatic way society's absolutist goals for worker health and the environment; and (2) to encourage the development of more sophisticated pollution control technologies. Neither of these purposes can be reduced to a concrete end point. Yet, if we cannot know when we have sufficient reinforcement or when we have provided adequate research and development incentives, how can we prescribe a dollar charge per unit of chemical discharged? Congress could simply articulate a broad goal for the charge, such as "sufficient to encourage significant pollution reduction efforts" and leave the matter to the discretion of the implementing agency and ultimately the reviewing courts. This would make matters extremely difficult for the agency. It would be required to resolve the contending forces generated by polluting sources who would rather pay nothing and environmental groups who would desire very large charges. The agency would then face the prospect of supporting its resolution of the question in a reviewing court, because it is highly unlikely that Congress would delegate such an important and open-ended question to an agency without providing aggrieved parties an avenue for judicial review. This approach toward setting the charge would thus rely heavily upon administrative and judicial discretion. Whether or not one supports this approach would largely depend upon the extent to which one has faith in the current agency and judicial personnel.

The questions of adequate goal reinforcement and research and development incentives are, however, not so much technical as political questions. Once society

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344. Most charge proponents advocate fixing the charge per unit of pollution at the level of environmental harm caused by that unit of pollution. See, e.g., Rosenthal, The Federal Power to Protect the Environment: Available Devices to Compel or Induce Desired Conduct, 45 S. CAL. L. REV. 397, 436-39 (1972). This is merely the utilitarian ideal as implemented through a charge system. We have seen how this goal is impractical and inappropriate.
has invested in up-to-date technologies for all existing sources and has ensured that new sources will likewise implement reasonable technological controls, the question of the additional expense that society will impose on polluting conduct is in a real sense the question of society's willingness to sell workplace disease and environmental harm at the margin. Once we have done all that we reasonably can to stop workplace and environmental harm with today's technologies, how much shall we charge polluters for the right to discharge toxic substances?

Congress may be the more appropriate institution to make this sensitive collective decision. Congress could therefore specify in advance a sum that the charges must produce on a yearly basis and leave it to the implementing agency to ensure that the charges for the discharge of various chemicals are set at the level capable of producing that sum by the end of the year. This sum could be collected in a separate fund, called the "pollution control research and development fund," rather than made a part of general revenues. Under this approach workplace hazards and environmental insults would be allocated on the basis of the willingness of society to sell, rather than willingness of the employers and polluters to pay. Moreover, in setting the amount of this sum, Congress could turn the inevitable industry complaint, that we should not regulate until we know more about the risks of pollution and the capabilities of technology, around on itself. If we need to know more, then we should raise the level of the fund, and hence the level of the charges, so that more research can be performed.

Unfortunately, the system does not compensate those members of society who are especially harmed by the remaining pollution. The fund could be expanded in concept to incorporate a compensation function as well as a research and development function, but this would entail the creation of a complex fact-finding and allocating mechanism that would largely duplicate tort and workers' compensation systems while not eliminating any of the practical difficulties, such as establishing causation, that befuddle those systems.

If the fund served only a research and development function, the strategy proposed here could be even further simplified by giving the regulatory entity the discretion to forego collecting the charge from any entity that could demonstrate that it was expending an equivalent amount on its own pollution control or worker safety research and development. The total annual amount of the fund would reflect this sum, but it would not actually be transferred to the fund. The entity would be required to show that the funds were in fact being spent on ways of reducing pollution. In some cases manufacturing design research would fit this description, especially if the research were directed toward minimizing raw mate-

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345. Obviously, some flexibility will have to be designed into the system to take into account the large uncertainties concerning investment decisions of private firms and the impact of those decisions on the fund. In some years the charges set by the implementing agency may not reach the congressionally mandated target; in others it will exceed that target. The goal should be to reach the target over time.

346. To the extent that the benefits of a particular industrial activity are spread evenly throughout all of society, the willingness of society to sell may roughly equal the willingness of society to pay because the charge will be reflected in price increases. Yet, since very few products have price inelastic demand functions, a charge cannot be passed on entirely to consumers. Shareholders will bear a part of the charge as well. This should have the long term effect of moving both consumers and capital into less polluting technologies.
rial consumption and toward recycling technologies. The agency would have to examine the manufacturer's case with some care, however, to avoid having the fund sponsor product development or marketing research.

One objection that is continually raised to a charge system is that the government will become addicted to the revenue that the charge brings in and will not be willing to accept reductions in the charges as pollution is brought under control. For a charge system grounded in the market paradigm, this is indeed a disadvantage. For the nonmarket system proposed here, it is a less powerful objection. Congress could re-evaluate the fund periodically and thereby reestablish the price at which society is willing to sell worker, public health, and environmental amenities. Unless Congress agreed to lower the level of the fund, the agency would be required to maintain it at the prescribed level despite the shrinking payments attributable to the installation of pollution controls in existing sources.\textsuperscript{347} Unless new sources filled the gap in payments, the charge for each unit of pollution would have to be increased as overall discharges are reduced.\textsuperscript{348} The policy-oriented economist will argue that this will ensure that at some point society is paying too much per unit of pollution, and if the political representatives agree, the fund can be reduced accordingly. But the cleanup advocate can respond that, to the contrary, society is merely engaging in constant efforts to develop technological solutions to the worker health and pollution control problem. The incentive grows as we get nearer to the ultimate cleanup goal.

The charge system advocated here thus resembles a budget for pollution control research, except that it is financed by the polluters on a "worst first" basis. First priority upon the budget resources will go to the polluters themselves, so long as they can demonstrate that the resources will in fact be spent upon research relevant to workplace health or pollution control. The remaining funds will be disbursed by the regulatory entity to other research and development-oriented entities. There is, for example, a burgeoning mini-industry of pollution control vendors that could benefit substantially from grants from the agency or from the regulated companies.

The charge system would entail significant administrative costs, but it would probably not be as expensive as the current system. The agency would have to

\textsuperscript{347} If each assessment were required to be made on the record after a hearing with judicial review, the mixed technology-based-standard/charge strategy proposed here would have no hope of succeeding. However, there is no need to provide for hearings or judicial review of the annual charge reassessments because the risk of error is very small. While the probability of error in any given year is very high, any error in one year can be corrected in the next. The agency's goal is to maintain a fund at a more-or-less constant level over the years. There is no reason to make that level a talisman in any given year. Very little harm can come to regulatees if the agency is off the mark in one year so long as it corrects for its mistakes in the next year.

\textsuperscript{348} One important difficulty with the solution advocated here is the powerful incentive it offers to the polluting industry as a whole to conspire against the agency. If the tax per unit of pollution is merely raised as the total amount of effluent or emissions decreases, the industry as a whole has no incentive to curtail emissions. The gross payout is the same for the whole industry, regardless of the level of pollution abatement installed. Thus, the real incentive for an individual firm to install pollution controls is an incentive to get the jump on its competitors. The industry thus will find itself in a kind of reverse tragedy of the commons. By conspiring against the EPA, the industry could avoid this competition and avoid the installation of controls.
maintain a branch capable of constantly updating new source standards as technology evolves. The same branch could promulgate the initial existing source standards, which should not have to be revised in the future. The agency would also need an economics branch with the necessary expertise to establish the relevant charges. An enforcement branch would be necessary to monitor the technology-based standards and the charge system for cheating. Finally, a research and development branch would be necessary to allocate the fund. The agency would not need a large risk assessment capability, and its technology assessment capability could shrink after it promulgated its standards for existing sources and its first round of standards for new sources. In any event, the costs of administering the suggested system would certainly be no greater than the administrative costs of the present system.

The suggested strategy seems altogether fair and equitable from the standpoint of the regulated firms. Since any discharge of a nonthreshold pollutant may be regarded as harmful, it seems equitable to charge sources that discharge large amounts of a substance more than a source that is discharging smaller amounts. The fairness of the system is enhanced by its willingness to plow the charge directly back into the research that will help reduce discharges. The firm’s resources are not necessarily expropriated; they are merely rechanneled into more beneficial uses for which the firm would not otherwise expend resources. The regulatory entity mandates “inefficient” technology-based standards in the first instance, but further pollution control is brought about by each individual firm in a cost-effective way using the results of fund-sponsored research as well as those of its own research.

VII

CONCLUSION

A society does not always achieve all of the goals that it sets for itself. But reaching El Dorado is not always as important as the attempt. The United States has set very high health and environmental goals for itself and it has launched on a decade-long quest to reach those goals. Not surprisingly, we have failed. We have failed in part because the goals were set too high and in part because some of us do not share those goals and have hampered the quest. In the process, however, we have learned a great deal about worker and environmental health and about ways to reduce risks to health and the environment.

Despite a significant change in the political climate that inaugurated the decade of the 1980’s, there is little indication that Congress intends to retreat from the goals set in the early 1970’s. This is, in the author’s opinion, encouraging. Yet, while we should not abandon our ambitious goals, we can recognize the futility of the media-quality-based approach insofar as it applies to most producers of the chemical industry. The technology-based approach, while no panacea, can, in combination with the charge system described here, keep us on the right path toward the goals that we will probably never reach.