REGULATING AIR QUALITY THROUGH LITIGATION

The Diesel Engine Episode

By

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and Lea-Rachel Kosnik

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Bozeman, Montana

PERC—the Center for Free Market Environmentalism—is a nationally recognized institute located in Bozeman, Montana. The organization's primary goal is to provide market solutions to environmental problems. PERC pioneered the approach known as free market environmentalism and conducts research in the areas of water, forestry, public lands, and endangered species, among others.

Free market environmentalism is based on several tenets: Private property rights encourage stewardship of resources; government subsidies often degrade the environment; market incentives encourage individuals to protect environmental quality; and polluters should be liable for the harm they cause others.

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INTRODUCTION

Writing in the *American Prospect* in February 1999, Robert Reich, Secretary of Labor in the Clinton administration, announced that "Regulation is out, litigation is in. The era of big government may be over, but the era of regulation through litigation has just begun" (Reich 1999).

Robert Reich's comment seems to have been on point. At the time his opinion piece was published, the state attorneys general of 46 states had signed a $246 billion settlement with the tobacco industry that specified, among other things, how the firms would market their products. The terms of the settlement now form part of the industry's regulatory environment. This was not all. The major producers of heavy-duty diesel engines had signed a $1 billion settlement with the U.S. Environmental Protection Agency (EPA), which specifies when and how the industry will regulate nitrogen oxide (NO_x) emissions. Added to the regulation-by-litigation (reg-lit) list were major refinery operators, electric utilities, and wood product firms. In each case, the firms involved have paid or expect to pay huge fines and have accepted new regulations as part of a litigation settlement. They have been regulated by litigation.

Reg-lit has become the subject of conferences, symposia, and books. Yet like most complex social phenomena, it is far from clear what triggered this new form of regulation and what the implications may be as it displaces other regulatory and legislative processes. But before proceeding any further, we must address the term of art we are using. Just what is regulation-by-litigation?

What Regulation-by-Litigation Is and Is Not

The broad dimensions of what is meant by regulation-by-litigation are contained in a short discussion of the topic by the Center for Regulatory Effectiveness (2002b). The discussion, repeated here, describes a process that fits the tobacco industry suits and settlement, but not other regulation-by-litigation episodes. The Center for Regulatory Effectiveness describes the process as follows:

- A government official, often a state attorney general, establishes a policy objective involving the practices of a given industry that has not been validated by Congress through the legislative process.
- The office determines that if it can circumvent the lack of legislative authorization, it will work with private trial attorneys to prosecute lawsuits that would coerce the industry into complying with the agency's goals.
- The plaintiffs and their government sponsors openly acknowledge that a key goal in filing the lawsuit is to achieve a stated policy or regulatory goal (e.g., forcing gun manufacturers to install "trigger locks" in all guns).
- Often the official selects the law firms that have contributed to him or his party.
- Once the lawsuit settles, or once damages are awarded by the jury, the law firm pockets a significant portion of the proceeds, which were intended to benefit the allegedly injured public. In effect, the proceeds fund the contributions to the government official.

While the tobacco and other similar cases are clearly examples of reg-lit, there are other reg-lit episodes that do not involve state attorney generals who are achieving by suit what a legislature would not do by way of statute. Indeed, in some instances, U.S. Justice Department litigators are suing on behalf of federal regulatory agencies that have normal regulatory channels available to them. The EPA's suits against firms operating coal-fired plants in the electric utility industry and producers of heavy-duty diesel engines are two examples where the terms of settlements replace or augment regulations issued through public processes.

As we use the term, we intend for regulation-by-litigation to be limited to those situations where suits are brought by government organizations against private parties for the purpose of regulating the private parties' behavior in ways that could be accomplished by traditional regulation. We use the term traditional regulation to mean the kind of regulation that is associated with official notice of rulemaking, public comments, and final notice of rules. At the federal level, this procedure is constrained by the Administrative Procedures Act and other statutes and regulations. At the state government level, administrative rulemaking procedures vary from state-to-state but generally include elements of notice and public comment that allow for the rules of due process to be met.

To constrain our approach to and discussion of regulation-by-litigation, we emphasize what it is not. Reg-lit is not the use of common law suits by private parties, or by public defenders in behalf of private parties or communities, to enforce and protect property rights. These civil suits are an alternative to legislation and regulation through rulemaking. And while we admit that defining the boundary becomes riskier as the fence comes into view, we also view traditional antitrust litigation as not being reg-lit. Antitrust is itself an alternative to regulation. In other words, there is no regulatory alternative available to antitrust agencies for accomplishing their goals.

How This Report Is Organized

In this report, we seek first to position regulation-by-litigation in the context of other regulatory instruments used by the federal government in regulating firms and industries. Our purpose here is about more than taxonomy. We seek to develop elements of a theory of reg-lit, a system of logic that can explain the circumstances that encourage the use of this form of regulation as opposed to some other regulatory instrument. We will develop these concepts in the next section and return to them in the report's last section.

Since, to our knowledge, ours is a first attempt to explain, as opposed to discuss, this phenomenon, we seek to identify key elements of a general explanation for the rather sudden and high visibility attained by reg-lit. We do this by addressing a few reg-lit episodes, giving more extensive discussion to a series of suits brought by the EPA against coal-burning electricity generators, and then by focusing on one episode, the suit brought by the EPA against domestic producers of large diesel engines. Our reason for connecting the EPA action against electricity generators and diesel engine producers is straightforward; both are large producers of NO_x emissions, a pollutant whose successful control has plagued the EPA regulators. As we shall point out, the two suits shared common logic. Background to the diesel litigation and settlement story is contained in the next section of the article. As we tell the story, we identify key "stylized facts" about the diesel episode. We then present a detailed history of the regulation of diesel engine emissions that illuminates the facts identified in the previous section. Finally, we merge our discussions of theory, facts, and history in the last section and explain why reg-lit emerged in this particular case and how reg-lit might be predicted in future cases. Our conclusion then speaks to the major lessons we have learned from this research project.

LITIGATION AS REGULATION

We begin our exploration of regulation-by-litigation by first considering the general and specialized theories of regulation that have been developed by political scientists, historians, and economists. Explaining how the world works is the purpose of theory. The theories we outline should be measured against a positive standard: How well do they predict regulatory outcomes? We now discuss three general and two specialized theories of regulation.

Theories of Regulation

The public interest theory is the oldest theory of regulation. A generic part of a civics book interpretation of politics, this theory argues that legislative bodies purposefully seek to improve the nation's overall well-being rather than advance the interests of particular groups of individuals at the expense of the public generally. Each legislator is motivated to serve a broadly defined public interest. If pollution is the problem to be addressed, then the legislature seeks to minimize global costs in reducing the cost that pollution imposes on an unwilling society. If the cost of regulating is larger than the cost that pollution imposes, then no action is taken. The legislature seeks to serve the public interest, not special interests, the interests of one state or community, or the interests of a particular industry or firm. The public interest theory recognizes that politicians are human, and that, as a result, errors and even deliberate acts of chicanery will occur. Still, examining regulation as though the politician seeks to serve all interests taken together provides the best explanation of regulatory outcomes, at least in terms of the public interest theory.

Dissatisfaction with the predictive ability of the public interest theory led to the development of the capture theory, a notion associated with the work of political scientist Marver Bernstein (1955) and economic historian Gabriel Kolko (1963). This theory goes something like this: Starting with the notion of serving the public interest, and perhaps dedicated to it, the politician faces a fundamental problem. There is no clear-cut definition of what might be the public interest for each and every bill being considered in a legislative session. Indeed, providing service to the public may be an outcome of the legislative process, not an input to it. In any case, the dedicated legislator finds an ample supply of private and public sector advisors who happily recommend how best to vote on particular issues.

Suppose the issue at hand has to do with setting tighter limits for NO_x emissions from diesel engines. What is the standard that serves the public interest? Lobbyists, whether from engine or fuel manufacturers, environmental groups, organized religious groups, or government agencies, come with concrete suggestions for political action. In many cases, the special interest groups claim to be serving the public interest, even though there is disagreement about what the standard should be. Persuaded by some of the interest groups, the legislator takes a position that turns out to be advantageous to certain groups.

The capture theory puts politics in a different light. It says that special interest groups will organize and use the political process to their private advantage. With the capture theory in mind, one can imagine how producers of eastern high-sulfur coal may have captured key members of Congress when the 1977 Clean Air Amendments were being written, amendments that required scrubbers for newly constructed coal-fired electricity plants, this even if the plants planned to burn western low-sulfur coal that did not need scrubbers. One can also picture railroad interests capturing the Interstate Commerce Commission (ICC) and limiting the entry of unregulated motor carriers into the business of hauling freight. The capture theory seems to explain a lot of regulatory history. But there are key elements of the political struggle that the theory does not explain. It does not predict which of several competing interest groups caught in a political struggle will capture and which will lose out. Why, for example, did the eastern coal producers win and western producers lose in the battle over the 1977 Clean Air Amendments? Why did truckers lose in competition with the rail interests before the ICC?

The special interest or economic theory of regulation, most notably associated with the late Nobel laureate George Stigler, addresses more precisely what happens when competing interest groups seek to influence political outcomes to their advantage (Stigler 1974). As a thought-facilitating device, the theory suggests that one should view the legislative process as an auction where the content of specific bills is auctioned to the highest bidder. Those who might bid the most are generally those who have the most to gain, or lose, net of their cost of organizing and communicating their bids.

Consider this: Eastern coal workers were organized in trade unions; western coal workers generally were not. Key legislators on EPA's oversight committee came from eastern coal producing states, and the eastern coal mine owners had been organized for years. The gain from excluding western coal from eastern markets less the relatively low costs of organizing to do so was greater than the gain to the western interests in expanding their market eastward, less their greater costs of organizing to do so. What about truckers versus railroads? There were far fewer railroad companies than trucking companies. The organizing costs were lower for the rail interests. The railroads owned huge amounts of land and real estate, thus giving them important and permanent political presence. And the ICC had long served the railroad interests. Transaction costs of organizing and securing beneficial regulation were lower for railroad than trucking interests.

A more specialized theory of regulation is put forward by Fred McChesney (1991). McChesney describes some regulatory attempts as efforts by politicians to extract payments from the threatened firms and industries. For example, this extraction theory suggests that congressional leaders offer bills that call for some industries to be regulated for the first time, only later to let the bills go down in defeat. The action inspires an unorganized industry to become organized and generates campaign contributions and other meaningful political support. In yet another form, a politician may encourage a regulatory body to open a threatening industry investigation, only later to chastise the regulatory agency for overreaching its authority, this of course, after the threatened industry has gained the ear of the legislator.

Finally, Yandle's bootleggers and Baptists regulation theory explains how successful lobbying efforts often result when one supporting group, the Baptists, takes the moral high ground while the other group, the bootleggers, simply seek to gain competitive advantage (Yandle 1983). The Sunday closing of liquor stores is favored by Baptists and bootleggers. To illustrate an application of the theory, some environmental groups and corn producers support legislation that requires the use of ethanol as a fuel supplement in gasoline. The environmentalists claim that ethanol is a relatively clean renewable energy source. The corn producers simply want to expand the market where they have specialized advantage. When combined with the special interest theory, or with McChesney's extraction theory, bootleggers and Baptists explains how shared lobbying efforts reduce the cost of gaining political advantage.

Each of the theories addresses the behavior of a legislator/regulator as a purposeful decision maker whose behavior is explained by one of the theories. Of course, in the real world, there is slippage or agency cost in the linkage between legislator and regulator. The legislator may intend that the regulator act in a particular way, but the regulator may either misunderstand or have another agenda to satisfy. Theories of regulation can carry us only so far in building detailed forecasts of regulator behavior.

None of these theories should be viewed as a silver bullet that can be used to explain all regulatory actions. Each of the theories contains concepts that may be useful, though not definitive, in explaining certain aspects of regulation and in particular, when regulation-by-litigation will occur. Consider what can be learned from the theories. First, there is the notion of concentrated gains and diffuse costs. All else equal, regulators will act when it is possible to spread the cost of their action across a large number of relatively powerless consumers while achieving an extraordinary and concentrated political gain. For example, the gains from the tobacco settlement are concentrated in a relatively few hands. The cost of the settlement is imposed on smokers worldwide. Outside the Western world it is unlikely that the typical smoker is even aware of the settlement and its costs and, in the United States, smokers will not pay itemized surcharges to fund the settlement, simply a higher price.

EPA's suit against diesel engine producers involved a small number of engine producers and a massive number of users who purchase diesel engine-equipped trucks and other machinery. The cost of EPA's action could conceivably be spread across this huge number of buyers. Of course, if the cost per consumer is still large enough, consumer groups can overcome the cost of organizing, band together and deflect political efforts to impose costly regulation on the firms that supply them, even when the number of producer firms is small. This identifies a second useful concept for predicting reg-lit. Since litigation is costly, it will only be used when there is a relatively small number of targets. On the other hand, traditional rulemaking, which also is costly, can be used like a vast dragnet that captures and affects hundreds of firms in the regulatory process.

Reg-lit may also be used as a way to divide and conquer. If an industry has organized around past regulation, which may require all firms to adopt similar technologies or meet similar standards, then successful suits attacking one or two major firms in the industry will disrupt the regulation-based cartel, raise costs for the firms that are sued, and remove them from opposing regulatory actions that might be taken against other firms in the industry. Indeed, the bruised firms may become quiet supporters of action against their competitors as they argue for a level playing field.

Finally, reg-lit will be used when there are true gains that can be captured. There is little point in winning settlements from bankrupt firms. The announcement of large civil penalties telegraphs to important constituents the fact that enforcement actions are being taken; the amount of the settlements can be seen as trophies by those who favor regulation. Traditional regulation, on the other hand, hardly makes headlines once the rules are in place and are operating.

The image of bankrupt firms and an industry severely weakened by reg-lit raises the whole matter of strategic behavior by firms and industry. After all, as suggested by the capture and other theories of regulation, firms are not passive players in the regulatory process. What can regulation do for firms, other than impose costs? Our previous discussion implies that regulation can cartelize an industry. By setting standards to be met by each firm in an industry, and establishing controls on new entrants, regulation reduces competitive pressures and can thereby improve profitability. In the process of cartelizing an industry, regulation can generate differential effects across firms. If a particular control technology favored by regulation happens to be the technology used by one of the firms, but not others, then the chosen technology raises the competitors' cost. The differential effects of regulation may also be enjoyed by firms that produce substitutes for those made by the regulated industry. For example, firms that produce diesel fuels may favor regulations that affect diesel engine design and oppose rules that call for cleaner diesel fuel. Firms that produce natural gas may favor regulations that raise the cost of burning coal. Competition within the field of regulation can be as intense, theoretically, as competition in product markets.

Once regulation becomes a part of an industry's legal environment, adjustments are made to accommodate the regulatory constraints. The more frequent the change in regulation, all else equal, the more costly the accommodation process. In short, even if regulation is costly, producers adjust as the cost of regulation becomes part of their competitive environment. Any unexpected action taken by regulators disturbs this equilibrium and introduces uncertainty into what was before a somewhat predictable relationship. Regulatory certainty is preferred to uncertainty. The cost imposed by regulatory uncertainty rises with the length of the product design cycle that typifies an industry. For example, if the auto industry works on a five-year design cycle for the interiors of new cars, rule changes that might affect the kind and location of passive restraints can be very disruptive and costly if imposed in mid-cycle. Lead time on regulation ideally matches lead time on product design. When regulatory authorities shift from one form of regulation to another, for example when a regulator decided to litigate in lieu of or in addition to using traditional rulemaking, uncertainty rises within an industry. Cartelization that may have been formed by older regulations is threatened, and the normal planning and design cycled is disrupted. Firms previously regulated by some other means will logically seek to avoid or minimize regulation-by-litigation. The cost of uncertainty can far exceed the amount of penalties imposed by courts or through settlements.

Traditional Rulemaking

Almost since the founding, the U.S. government has relied on regulatory agencies to carry out the wishes of Congress. Going back to the nineteenth century, the Comptroller of Currency was the first agency created by Congress and then charged with responsibilities for managing certain aspects of banking (U.S. Department of Treasury 2002). The Comptroller of Currency, in turn, established regulations to be followed by all national banks. Along with its day-to-day responsibilities for overseeing the business of banking, the agency was a regulator. Regulation had a veritable heyday in the nineteenth century with the 1887 Act to Regulate Commerce (Anderson 1966, 111–20.) This established the Interstate Commerce Commission (ICC), which was charged initially with regulating railroads. In a relatively brief time, Congress empowered the ICC to regulate freight rates, levels of service, and the entry and exit of railroads offering service to particular cities. While cutting its teeth on railroad regulation, the agency was later called on to regulate long distance telephone service, barges, trucking, and pipeline operators. The ICC later accomplished its regulatory mission by holding hearings, writing proposed rules, and after receiving comments and testimony, giving notice of final regulations. ICC rulemaking procedures set the standard for regulatory commissions that were formed later. These commission-type regulators today form what are called independent agencies. The ICC, Federal Trade Commission, and Nuclear Regulatory Commission, to name three, are independent of the executive branch and answer to Congress. Other agencies, such as the Occupational Safety and Health Administration and the U.S. Environmental Protection Agency, are either part of an executive branch agency or are themselves executive branch agencies that answer to the president.

In a real sense, the regulatory process begins when Congress writes legislation that instructs a regulatory agency to develop and promulgate rules for accomplishing some policy goal embraced by Congress. While sometimes providing detailed instructions to the agency, Congress generally leaves more than enough room for regulatory agencies to discover the limits of their regulatory powers. Congressional oversight committees then play the role of monitoring the agencies in an effort to reduce slippage between Congress and agency personnel. In an attempt to maintain fairness and assure due process when regulatory agencies act, Congress developed and passed the Administrative Procedures Act, which defines the bright lines of federal administrative law.

Congress delegates regulatory authority to the regulatory agencies, which are operated by real people with diverse goals and objectives. Even with monitoring and control of agency budgets, Congress faces the common problem of all principals who hire agents to do their work. There is agency cost, slippage between the kind of actions Congress might prefer and the actions preferred by agency personnel. Regulatory agencies can be quite creative in exploring the limits of the law. In the process, the regulatory agencies develop support groups of their own as well as interest groups that they support. It might be said that all regulatory agencies become somewhat independent.

The EPA's Three Process Options

The U.S. Environmental Protection Agency, like most regulatory agencies, has three options available when initiating a new regulation. The agency can engage in what we call traditional regulation or "regulation-by-regulation."

Regulation-by-Regulation

This involves a notice of a proposed rule, a comment period for any and all parties to express their reactions to the agency, and a final notice of rulemaking that addresses the comments received from interested parties. In the process, the agency may hold hearings, and may offer more than one proposed rule before a final regulation is announced. Once regulations are final, those affected by them may bring suit against the agency, if there is a basis for doing so. For example the agency might be charged with exceeding its legislative authority or for adopting a rule for addressing a technical problem when the scientific rationale for the rule is faulty. At some point in this adversarial process, regulations become final and are made part of the U.S. Code of Federal Regulations.

Regulation-by-Negotiation

Instead of engaging in traditional regulation, the EPA may choose a modified and somewhat less contentious approach, "regulation-by-negotiation." Also called negotiated rulemaking, regulation-by-negotiation, or reg-neg, was initially promoted by Philip J. Harter (1982) as a way out of regulatory gridlock. Having grown by leaps and bounds in the 1970s, new regulation had spawned more than its share of complaints about cost, confusion, and uncertainty. Harter was working under the auspices of the Administrative Conference of the United States, which oversees the operation of the Administrative Procedures Act that describes and constrains all federal regulatory procedures (Harter 1982; Wendel 1990). As a result of his proposals, reg-neg entered the regulatory arena as a way to reduce litigation and as a way to increase respect for regulation after the rulemaking process has ended. Seen as an appendage to the regulatory process, not as a replacement for it, reg-neg could theoretically reduce the cost of achieving less burdensome rules while also reducing costly litigation (Susskind and McMahon 1985, 136).

As part and parcel to the regulation-by-regulation process, reg-neg works in the following way: A regulatory agency decides that it will use reg-neg as a formal consensus-building process before coming forward in the *Federal Register* with a proposed rule. The agency determines the composition of a working group that will consider the rule to be developed, names a time, place, and moderator for the negotiation, and announces the details in the *Federal Register* along with a request for additions to the list of parties to be represented and other suggestions for improving the reg-neg process. After receiving comments, the agency goes forward with reg-neg and ideally seeks to negotiate around objections and concerns that are expressed about a proposed rule. Gaining consensus among the negotiating parties is the goal of the process. Once gained, or once the session ends, the rule developed in the reg-neg process is published as the proposed rule, and traditional regulation follows. A successful reg-neg means that few objections or major concerns are communicated from interest groups in the evolving regulatory procedures. Then, after the rule is made final, there will be fewer, if any, suits brought to overturn or affect the final rule. At least this is the theory of reg-neg.

Reg-neg has been used extensively by the EPA, which suggests that the agency and some of the parties most interested in EPA regulations find reg-neg to be beneficial. From the standpoint of our discussion of regulation theory, reg-neg seems well suited for reducing regulatory burdens when the number of key players is small. If, on the other hand, reg-neg takes place with trade association representatives and leaders of national environmental organizations, and others, it is likely that a consensus gained with these participants may not be a true consensus for members of the represented organizations. In any case, reg-neg can be seen as an adaptation to regulation-by-regulation, not as a replacement of it. In the sense, reg-neg does not add uncertainty, per se, when used to form new rules.

Regulation-by-Litigation

Regulation-by-litigation, reg-lit, on the other hand, is all that reg-neg is not. Following this tack, the regulator abandons the traditional regulation-by-regulation process and heads to the courts. The large hammer of suit, penalties, and or settlement is used to achieve what might be accomplished by other means. Reg-lit comes in different forms. In some cases, state attorneys general or Justice Department attorneys bring suit against firms or an industry. The tobacco industry and diesel engine suits are examples.[1] In other cases, the state may contract out its litigation to private attorneys who work on a contingency fee basis (Center for Legal Policy 1999, 5). In still other cases, government agencies arrange for grant recipients to bring suit. Efforts by the U.S. Department of Housing and Urban Development (HUD) to generate gun control regulation fall into this last category of cases (Center for Regulatory Effectiveness 2002a). Noting that HUD would not be a party to the taxpayer-funded suit, the Center for Regulatory Effectiveness described the action this way:

> In the wake of the Clinton Administration's failures to get gun control legislation enacted, Executive Branch officials began using a different mechanism: litigation. The government, specifically the Department of Housing and Urban Development (HUD), is organizing a class action lawsuit against gun makers by requesting federally-funded housing authorities to take legal action. The goal is to achieve changes in the firearm industry that were not obtained through legislation. (Center for Regulatory Effectiveness 2002a)

The gun control suit is interesting for a number of reasons. First, like other reg-lit examples, the effort seeks to use the judiciary as a means to regulate an industry. The suit is not about law violation or recovery of damages. It is about regulation. If successful, the resulting remedy will alter the economic landscape for the industry without altering any fundamental legislation or regulation. A second aspect of the suit relates to who is paying for it. Taxpayer money allocated to housing authorities nationwide will be used to fund the suit. But the suit will not be brought in the name of the United States. Instead, a regulatory agency, HUD, may be using purchased litigation to accomplish a policy goal that could not be achieved through the legislative process.

In purely theoretical terms, one might argue that the use of litigation to achieve regulatory goals is no less efficient or effective than using the legislative process. In either case, the same people bear the cost of bringing either action—the taxpayers, and the same people bear the burden of any change that results—the consumers who are affected by higher prices and the owners of specialized assets that depreciate because of the action. Meanwhile, the benefits contemplated by the court, on the one hand, may be compared to benefits contemplated by politician/voters on the other hand. Viewed as stated here, there seems to be little difference between the two processes. The gross revenue is the same, so consider the transaction costs of one approach versus the other and pick the lower cost option. Of course, there is misplaced concreteness in the example. This is not a matter of individual choice where a decision maker puts the facts or estimates on the table and makes an informed choice.

The process of choosing is far more complex, and perhaps interesting, for those who seek to redistribute income from poorer to richer citizens. When tobacco companies, electric utilities, and diesel engine producers are sued and settle, the cost of their settlement becomes captured in the price of the affected firms' product. Taxpayers don't pay the tab directly, consumers do. If the product is consumed more heavily by lower than higher income people, then the settlement can transfer income from poor to rich. Legislators are constrained by public opinion, if nothing else, when deciding how much to tax tobacco products or handguns. There is no public opinion or voter-reaction constraint that is imposed when attorneys bring suit against the major firms in an industry, or the entire industry.

Litigation in some cases is being driven by contingency fee attorneys who have an incentive to impose as much defendant cost as possible. In their paper on reg-lit, John Fund and Martin M. Wooster (2000, 9) report a Hudson Institute estimate of the tobacco settlement that predicts payment of $500 million per year to 200 to 300 lawyers, perhaps in perpetuity. There are clearly situations where a legislative body could not gain the majority needed to pass a tobacco tax but could readily lay the groundwork for contract attorneys, selected by the governor, to bring suit and obtain far more net state revenue than would be generated by the spurned tobacco tax.

The movement from the legislative body to the courts raises a basic constitutional question as to where and how public policy will be made. By constitutional design, collective decisions that affect one and all are to be made by elected representatives. Decisions to regulate guns, diesel engines, emissions from electric utilities, and drugs are political decisions made by legislative bodies. Once written, statutes generally delegate the details of regulating to administrative agencies, not to courts. The courts are there to adjudicate matters of legislative intent and interpretation. They also play an important role in the enforcement of rules that have evolved through the regulatory process envisioned by the legislature when the basic statutes were passed.

Legal scholar Richard A. Epstein addressed these fundamental matters in a 1999 forum devoted to regulation-by-litigation and where it might be headed (Center for Legal Policy 1999, 60–62). Speaking in terms of the tobacco litigation, Epstein noted that whether to pursue a policy end through the courts or legislation was not the fundamental question. The fundamental question has to do with whether or not costs net of benefits were being imposed by the producers of cigarettes or any other product we might consider. If we somehow conclude that harm is being imposed on individuals against their will, then, we must decide how to deal with the problem. As Epstein puts it: "Are we going to allow state attorneys general, or private plaintiffs, or the legislature decide when and how to act?" (61).

In addressing the question posed, Epstein lays out a simple analytical framework. If one or a small number of people are harmed by an industry's product, then the individuals harmed have standing to sue. The state does not enter. In contrast, "if the claims are broad and diffuse, and nobody has a large enough stake to sue, then the state can bring action under *parens patriae*" (61).

The tobacco suits were not based on damages imposed on unwitting smokers. Instead, the states themselves argued that they were damaged by having to provide disproportionate health care benefits to smokers (47). The case was made without recognizing research that showed that smokers, due to their shorter life expectancies, imposed less health cost on the state than nonsmokers (70). Similar arguments are being raised in suits brought by cities against handgun manufacturers and producers of paint containing lead (47).

Of course, Professor Epstein noted that he was describing a traditional view here (61). By contrast, he notes, the modern view of collective decision making seems to hold that legislative bodies are just the first forum for resolving policy questions. Then, as the story goes, if the legislature fails to act, that failure is a sign that democracy does not work effectively. This is so because special interest groups with unfair power have distorted the process. When the legislature fails to work properly, it is time for the losing special interest group to turn to the courts, or so the theory goes.

Industry is then placed in the position of being hounded by litigators whose success turns on winning in only one of many jurisdictions. When the political stakes are high enough, legislative bodies have been known to alter state rules governing civil procedure in order to facilitate regulation-by-litigation.[2]

REGULATION-BY-LITIGATION: THE NEW SOURCE REVIEW EPISODE

We now focus more narrowly on reg-lit that involves suits brought by a federal regulatory agency against firms or industries that are subject to the agency's traditional regulatory powers. To do that we turn to a recent episode involving the EPA and new source review requirements contained in the Clean Air Act. We note two similarities in the new source review and diesel emission suits. First, this litigation and the diesel engine litigation that forms the central part of this report are both motivated by efforts to reduce NO_x emissions, the one criteria pollutant regulated by EPA whose emissions continue to grow in spite of extraordinary efforts made since 1970 to control it (Parker and Blodgett 2001; *Environment Reporter* 2001, 34). As the nation's protector of environmental quality, EPA has faced a serious challenge. The level of NO_x emissions, a precursor to ozone, was so large that a major region of the northeastern United States was about to be declared "nonattainment" with respect to the ozone standard. Being nonattainment can trigger the imposition of severe transportation controls and costly limitations on future growth.

Because of this, a group of northeastern states petitioned EPA to limit the NO_x emissions from upwind states, emissions that, following wind patterns, made their way to the northeast. EPA ordered the downwind states to revise their air quality control plans in order to reduce the level of uncontrolled and controlled NO_x emissions. The agency then searched for other ways to gain significant NO_x emission reductions. One of these ways had to do with coal-fired electricity generators. Another focused on large diesel engines that power large cross-country transport trucks. Second, both represent situations where traditional regulations have limited short-term impact because existing sources and vehicles remain in service and are only gradually replaced by sources subject to more stringent standards.

The 1990 Clean Air Act contains a New Source Review (NSR) requirement that addresses old plants that were operating in 1970 when the Clean Air of 1970 was passed (Hsu 2001, 427). These NSR requirements were introduced in the 1977 Clean Air Act Amendments. At the time when the 1970 amendments were passed, less strict, and much less costly, emission control standards were imposed on older or "grandfathered" plants (Office of Legal Policy 2002, 5–6). EPA's first regulations, which broadly involved all new sources, whether related to grandfathered plants or not, were issued in 1971. More specific NSR regulations came in December 1975. These rules require operators of older plants to obtain regulatory clearance when plans are made to modify or reconstruct old plants in ways that lead to increased emissions. The permit process takes place prior to the construction or maintenance undertaking (Adams 2000, 9).

While inordinately complex on its face, NSR is made more complex by the different standards to be met depending on a plant's location. If the location is a nonattainment region for one or more pollutants, which is to say, the region has not met the federal standards for a particular pollutant, then one set of technology-based standards will apply. If the plant is located in one of the nation's cleanest regions, the so-called prevention of significant deterioration areas, another standard must be met requiring other control technologies.

The statutes and regulatory behavior that have evolved recognize implicitly that old pollution sources would eventually become new and therefore subject to stricter standards. Senator Jim Inhofe, speaking at a February 2000 hearing on the topic, offered this explanation of congressional intent:

> Congress required existing large facilities to undergo a New Source Review before they make major expansions or modifications in order to prevent significant new air emissions. There facilities have been referred to as grandfathered facilities, meaning that they are originally exempted from the new provision controls. Although, of course, they have had to install other control devices over the years. (*Environment Reporter* 2001, 1–2)

The definition of maintenance or reconstruction activities that might be exempt from NSR was of crucial importance to the NSR controversy that emerged in the mid-1990s. The agency made it clear that Congress did not intend for all plant construction activities to be subject to NSR when the relevant code was written: "[m]aintenance, repair, and replacement which the Administrator determines to be routine for a source category are not considered to be review-triggering modifications."[3]

Because of the inordinate difficulty in dealing with thousands of repair and reconstruction possibilities, the definition of major modification and what might count as routine maintenance versus a capacity- and emission-expanding rebuilding of a facility has never been rigorously defined. Failing to receive a rigorous EPA definition of what might lead to review for old sources led firms and state regulators to develop a common sense working relationship that enabled industrial plants to be maintained without triggering NSR (Domike and Zacaroli 2000, B-1). All along, however, the troublesome definition of what might cause an old plant to become new plagued both industry and the regulators. Indeed, several unsuccessful attempts, involving more than 4,000 pages of guidance documents, were made to remove this uncertainty through the regulatory process (*Environment Reporter* 2001, 2). As recent as February 2000, EPA's Office of Air Quality Planning was deeply involved in meetings and discussions with industry and other officials that focused on the development of clarified NSR regulations. In discussing the work leading up to regulation, John S. Seitz, EPA Director, Office of Air Quality Planning and Standards, referred to plans to allow for plant-level flexibility in meeting NSR requirements and indicated other features that might be found when the NSR rulemaking occurred (*Environment Reporter* 2001, 11). After more than twenty years with NSR on the books, firms and regulators might logically assume that what had worked all along would continue to work, at least until the process was clarified by either the standard rule making process or by legislation.

The whole matter of NSR is made meaningful for two reasons that relate to costs. First, the NSR process itself is costly. Firms must identify their plans, engage in emission record keeping and modeling, and submit applications to state regulators. On average, EPA takes 12 months to approve an NSR permit (*Environment Reporter* 2001, 47) and on occasions, the time required reaches two years. There are obviously times when a firm discovers unexpected failures in major components of a plant's machinery. There is no time for a two-year notice; the repair or rebuild decision needs to be made quickly. The second cost consideration relates to the cost of meeting new plant standards. At the time of passage, the 1970 legislation required stricter and more costly standards to be met by new plants than older ones (Adams 2000, 9). As long as the older plants remained "old," there would be no requirement for installing the more costly air pollution control equipment. However, when major additions, improvements, or modifications are made in these older plants, NSR requires the plant operator to undergo a regulatory review that may lead to the imposition of costly new source pollution control equipment (Sullivan 2001, 6).

It is obviously logical for operators of older plants to keep them "old," and empirical work by Maloney and Brady (1988, 203–26) indicates this is the case. But keeping them "old" does not mean that emissions have gone uncontrolled. In the case of the electric utility industry, sulfur dioxide emissions peaked in 1975 at 18.3 million tons. According to the Edison Electric Institute, the industry trade association, annual sulfur dioxide emissions are targeted to decline to 9 million tons by 2010, their lowest level in 100 years. Annual emissions of oxides of nitrogen, which stood at 7.0 million tons in 1980 are predicted to decline to 4.3 million tons by 2010 (Edison Electric Institute 2001, 2). These reductions are partly due to restrictions imposed on coal-fired plants by the 1990 Clean Air Act and by the expanded use of gas-fired turbines. However, even with this reduction record, coal-fired electricity producers continued to be the major source of sulfur dioxide, NO_x, and mercury, accounting for approximately 50 percent of all sulfur dioxide emissions and 25 percent of all NO_x emissions; the coal-fired plants also accounted for 32 percent of carbon dioxide and 21 percent of airborne mercury emitted nationwide (Hsu 2001, 428).

Recognition that NSR had become a major source of uncertainty for industry and a sticking point in achieving further emission reductions brought a number of unsuccessful attempts to introduce NSR-modifying legislation in Congress (Hsu 2001, 436). All along, agency litigation was beginning to supplement traditional regulation and statutes that might inspire the regulatory process.

While still wrestling with the definition of routine maintenance and major modification, the EPA began to litigate new source review requirements of the 1990 Clean Air Act in the early 1990s. Wood products was the first industry to feel the agency's wrath. Within the industry, Louisiana-Pacific Corporation was the first firm challenged in court. The agency settled with the firm for a record $11 million in civil penalties and required installation of $70 million in new pollution control equipment (Martel 1999, B-1). Along with wood products, the agency targeted pulp and paper, chemicals, and most recently electric utilities.

Perhaps, the EPA enforcement division learned a positive lesson from the wood products industry suits. Regulation through litigation was not only feasible, but politically profitable. The displacement of traditional rulemaking by litigation brought along other desirable features. As pointed out by Jonathan Martel, the new enforcement strategy

> can provide emission reductions faster than an extended and uncertain cycle of rulemaking and regulatory litigation. EPA's apparent strategy is to utilize enforcement to increase the agency's leverage in negotiating rulemaking outcomes with industry to avoid a more protracted process. By reaching an agreement with targeted defendants to commit to installing state-of-the-art emission control equip-

> ment on existing facilities, EPA might hope to remove the defendant companies as opponents in rulemaking to require such controls on a broader basis, and might even gain their support in a rulemaking effort to "level the playing field" with respect to other sources. (Martel 1999, B-1)

On November 3, 1999, EPA's enforcement division issued notices of violation to seven electric utilities, and issued administrative compliance orders to TVA, indicating that since 1977, the firms had modified plants in ways that should have triggered NSR and the possible installation of new source emission controls. One of the notices indicated that the agency was moving "in a way quite different from earlier, more traditional inspections" and that it would "identify and recognize less-than-obvious changes/modifications that may have been made" (Domike and Zacaroli 2000, B-1). At a press conference announcing the investigation, EPA Administrator Carol Browner indicated the enforcement action was "one of the largest investigations in the history of EPA." Attorney General Janet Reno described the effort as "one of the most significant enforcement actions in our nation's history" (Stagg 2001). The investigation and notice of violations quickly expanded to include 32 power plants operating in ten states.

At about the same time, EPA investigated the 20-year history of NSR permits issued to firms in the petroleum refining industry. Suits were filed against 31 refineries. By July 2001, EPA had settled with BP Amoco, Koch Petroleum Group, Motiva Enterprises, Equilon Industries, Deer Park Refining, Marathon Ashland, and Premcor Refining. The record settlements covered one-third of domestic refining capacity. Testifying before a Senate subcommittee in February 2000, Bob Slaughter, a spokesman for the refining industry, pointed out that the permits were not questioned during the 20 years of state and EPA inspections (Office of Legal Policy 2002, 17). The uncertainty raised by retroactive examination of NSR decisions was a major concern of the refinery operators. Even greater concern about regulatory uncertainty was expressed at the same hearing by W. Henson Moore, industry spokesman for the American Forest and Paper Association (U.S. Senate 2000, 46–48). Moore was quite specific:

> In 1980 EPA provided an exclusion from NSR review for routine maintenance. We operated fine under that for 8 years. Then EPA came out and said, well, we're going to change that. We're going to weigh a variety of factors to arrive at a common sense finding of what was routine maintenance. We operated with that. Then, last year, the enforcement office now, the people who actually fine you and hold you in violation of the rules, substantially narrowed this exclusion and without any public input stated it was meant to cover . . . "frequent, traditional, and comparatively inexpensive repairs to maintain existing equipment." That's a 180-degree change. Now you are liable retroactively for fines and penalties back to 1980 when you were told it was OK. (U.S. Senate 2000, 48)

Even with litigation challenging some firms, as late as November 2001 the agency's Office of Air Quality Standards and Planning was working with state regulators to create a list of "appropriate activities" qualifying as routine maintenance and therefore avoiding NSR. At the time, the electric utility industry was lobbying for use of a dollar cost cutoff for defining routine maintenance. State regulators argued that they could not provide enough engineers to monitor activities using this approach (*Environment Reporter* 2001).

EPA's "lawmaking through litigation" brought interpretations to the NSR statutory language not seen before in past administrative and enforcement actions. According to attorney Peter E. Seley (2001, 260–61), "the agency has advanced regulatory interpretations during litigation that are found nowhere in the statute or implementing regulation or even in guidance documents." Although this litigation strategy is certainly not novel, the strategy does not come without longer-run costs, at least according to Seley, who suggests the agency's relationship with Congress, the judiciary, and the regulated industries will suffer.

Regulation-by-litigation, at least in theory, can be seen as an end-run around congressional safeguards that have been put in place by Congress to give the Congress final say on regulation. These safeguards now include the Unfunded Mandates Reform Act of 1995, the Regulatory Flexibility Act of 1980, and the Congressional Review Act. These statutes taken together provide a political mechanism that can be used to reign in overly zealous regulators. Congress has no explicit mechanism for reigning in overly zealous litigators.

The implied shift of power within EPA from program offices to enforcement carries a redefinition of what is important within the agency. EPA program offices develop relationships, even compromises, that make it possible for diverse regulated firms to operate within the framework of uniform rules and regulation. There is a two-edged sword that cuts here. Cooperation can reduce costs and enable all parties to find more cost-effective solutions to the regulatory puzzle. At the same time, comfortable relationships make capture a bit easier, which may lead to lower cost but less effective outcomes. Litigators, on the other hand, tend to tighten the focus and to emphasize strict interpretations that may be totally at odds with the regulatory processes developed in the program offices.

The NSR controversy is one of the most recent examples of litigation supplanting regulation-by-rulemaking. The shifting regulatory techniques generate uncertainty and require massive legal expenditures that might better be spent in more productive pursuits. The division of attitudes regarding the move to litigation, which is generally supported by environmental groups and disliked by industry, beclouds the fact that practically all knowledgeable parties felt that NSR was a process that had to be fixed. And this is precisely what the Bush administration has done (*Environment Reporter* 2002, 1309–10).

While the Justice Department continues to litigate against the targeted firms and industries, and to obtain settlements, the Bush administration has proposed to eliminate NSR by doing away with its rationale (U.S. EPA 2002). In addition, the administration's Clear Skies proposal calls for significant cuts in sulfur dioxide, NO_x, and mercury emissions for all plants—new and old—and for the use of marketable permits to cushion the cost of achieving the reductions. The new legislative model also makes another important fundamental change in how air pollution control has been designed in the past. There are no technology-based standards. Reducing air pollution is the goal, not government engineering industrial plants. Regulation-by-litigation may have contributed to the development of a superior blueprint for improving air quality. If that turns out to be case, the cost of getting there will not have been trivial. Not only have huge amounts been spent in litigating, but a large amount of uncertainty has been raised about the extent to which regulated firms can trust the rulemaking process. When rules are made final, are they really final?

We turn now to a detailed account of the heavy-duty diesel engine reg-lit episode. Once again, we will observe common themes that play through the story. The U.S. EPA is again the litigator. Reductions in NO_x emissions is the putative goal. The number of firms to be engaged in suit is small, and the number of consumers who will bear the cost of litigation is large. Much like the coal-fired electricity generating industry, diesel engine manufacturers cannot quickly and easily modify the sophisticated technology affected by regulations. A long lead time is necessary for altering the design, testing, and gaining market acceptance of modified engines. Certainty is prized. Regulatory uncertainty is corrosive.

REGULATING DIESEL EMISSIONS BY LITIGATION

EPA's decision to abandon the traditional regulation track and bring suit against all U.S. producers of large diesel engines was a part of a dramatic change in the way EPA had previously carried out its regulatory mandates. The shift to litigation was more than just a decision of EPA program officials to use another enforcement tool; it was a shift of responsibility within the agency from program officials to the enforcement division. Within the program offices, the credibility of program directors rested on maintaining some modicum of a working relationship with the industry regulated. This is not the case in the enforcement division. Enforcement was about going after people and firms that violate EPA rules. Their work is not about building working relationships. Program offices specialize in building cooperation. Enforcement specializes in confrontation. The shift to reg-lit was dramatic, and so, one would think, had to be justified.

To find some understanding of this shift and its implications for all parties concerned, we must place the diesel episode in the context of the Clean Air Act, the larger statute that frames the regulatory environment within which the diesel suits emerge. As we have mentioned, EPA was caught between an environmental rock and a regulatory hard place. The states in the northeastern region of the United States were on the verge of being classified as nonattainment areas with respect to major air pollutants. Nonattainment status was serious and costly business for any state, especially when the most attractive means of avoiding nonattainment were to be found outside the region. Because of prevailing wind currents, cities and states in the Northeast were receiving NO_x emissions from stationary sources located in the South and Midwest, and from mobile sources passing through the region. The northeastern states had placed pressure on EPA to do something. We must now describe the statutory context within which EPA responds.

The Clean Air Act Context

Understanding regulation of diesel emissions and EPA's choice of reg-lit requires understanding the context of those regulations. Six things are critical. First, starting in 1970 the Clean Air Act required EPA to establish "national ambient air quality standards" (NAAQS) for pollutants that endanger public health or welfare.[4] EPA has established NAAQS for CO, SO_2, particulates, hydrocarbons, NO_x, ozone, and lead.[5] Each state then developed a state implementation plan (SIP) describing how it would ensure air quality met the NAAQS within its borders.[6] This plan had to be regularly updated. For our purposes, what is important is that the total emissions from all sources within a state must not cause air quality to fall below the relevant EPA-set NAAQS—if air quality deteriorates below NAAQS for any pollutant, a region becomes a nonattainment area for that pollutant. Although EPA has been reluctant to invoke the full range of penalties against states with nonattainment regions, which include increased regulation and preclusion of new sources and so of economic growth and loss of federal highway funds, there are negative consequences to nonattainment status (Reitze 1996, 1477–81). In short, states must keep the total emissions from all sources, including natural sources and population growth, to a level that ensures the NAAQS are met. If air quality falls below a NAAQS, states must have a plan to reduce emissions so that air quality will meet the NAAQS.

Second, the Clean Air Act has different regulatory regimes for emissions from stationary and mobile sources. Stationary sources, such as coal-fired electricity generators, are regulated through state-issued permits for emissions, and states are responsible for determining how much each stationary source is allowed to emit of each pollutant, subject to technology controls required of particular source categories by EPA. Mobile sources, on the other hand, are regulated through EPA-mandated regulations requiring vehicles or engines, depending on type, to meet emissions controls. Sample light-duty vehicles and heavy-duty engines are tested by the producer using EPA-approved test procedures. Product lines then are certified as meeting EPA requirements.

This division of authority and approach is logical—mobile sources are, by definition, mobile and their contribution to pollution affects multiple states, as cars and trucks drive the nation's highways. National regulation comes at a cost, however, since reducing mobile source emissions anywhere requires reducing them everywhere, even if reductions are only necessary in some areas, such as those out of attainment with air quality standards.

The division is important because it creates a distinction between mobile and stationary sources in terms of regulators and regulatory approaches. It also creates competition between the categories for the ability to emit pollutants, since states' "state implementation plans" had to account for emissions from both categories but states lacked control over manufacturers of mobile sources.

EPA and the states are thus regularly put in a position of searching for ways to obtain more emissions reductions from mobile and stationary sources, and in some cases, it may be "cheaper" for states to push for mobile source reductions. For example, EPA's "mobile source tech review subcommittee" is examining ways to cut heavy-duty diesel emissions to help states earn "state implementation plan (SIP) credits" (*Diesel Fuel News* 2001b, 6) which can be used to allow new stationary sources or maintain current stationary source emission levels. As indicated earlier, heavy-duty engine manufacturers are not alone when they contend that EPA's suit against them alleging use of "defeat devices" was motivated by northeastern states' attempts to avoid noncompliance penalties (Parker 1998, 25). Disputes within categories of sources also occur, as different interest groups attempt to allocate the cost of emissions reductions to others (Reitze 2000, 309, 369). The states' only means of controlling mobile sources are to impose controls on vehicle use—a politically unpopular route. When either states or EPA have incorporated such controls in SIPs, they have generally been criticized as unrealistic. For example, EPA's 1975 mandate to Los Angeles to reduce auto traffic by 70 to 80 percent was widely seen as impossible to implement.

Third, EPA and the states depend primarily on environmental modeling rather than direct measurement for the regulatory structure (Reitze 2000, 357). The use of models is logical—collecting sufficient accurate data on air quality to regulate the entire country's air through command-and-control regulation would be so costly as to preclude the entire effort if models could not be used. Models, however, create the possibility that their predictions—used to establish the command-and-control permits and regulations—might not accurately predict actual emissions with the controls in place. For example, if laboratory measurements of the efficacy of a type of control did not accurately predict real-world use results (exactly what happened in the case of heavy-duty diesel engine emissions controls), the model's predictions do not match output. If the model overpredicts control, the result will be dirtier air than predicted (U.S. General Accounting Office 1987, 31); if it underpredicts control, the result will be cleaner air. Unfortunately, although huge amounts per year in transportation funding are linked to air quality attainment plans, EPA's models were labeled "geriatric" in 2001 by the head of EPA's Office of Air Quality and Monitoring (Tierney 2002). As a result, model characteristics, rather than reality, can drive regulatory measures unrelated to improvements in environmental quality (*Diesel Fuel News* 2001a, 1). Control of the models' assumptions gives EPA "significant influence" over abatement strategies "because the agency's modeling techniques determine the number of tons of emission reduction that will be credited for each measure selected" (Reitze 1996, 1482).

Modeling thus has important consequences for air pollution control.

> MOBILE is used in the development of national, regional, and urban emissions inventories; the simulation of regional air chemistry and microscale dispersion of pollutants; the assessment of the effectiveness of control strategies; the documentation of emissions reductions in State Implementation Plans (SIPs); the assessment of air-quality impacts of transportation projects, including the demonstration of conformity of transportation and air-quality plans; and the assessment of air-quality impacts of transportation-control measures and projects. (National Research Council 2000, 33)

States must construct SIPs that satisfy EPA's model of air quality, which may diverge from actual environmental conditions. Indeed, EPA's current model has been explicitly criticized for its inaccurate modeling of heavy-duty vehicle emissions because those emissions "are expected to be a major target" of current SIP revisions (National Research Council 2000, 9). Changes in models, because of improvements in modeling technology or new measurements of actual conditions, can lead to states being required to reallocate emissions in their SIPs. Failure to update models to incorporate new information or new knowledge of model inaccuracies can prevent states from receiving appropriate credit in their SIPs, and so discourage effective measures. Economic or population growth may also require changes in SIPs. States must therefore continually rebalance emissions allocations among sources in their states.

Fourth, as explained in the previous section, EPA has choices about how to regulate (as well as, in some instances, whether to regulate at all). EPA can proceed through regulation-by-regulation, regulation-by-negotiation, or regulation-by-litigation. The agency faces different costs and benefits from the three modes of regulation available to it. In its regulation-by-regulation activities EPA is constrained by a variety of restrictions. As with all agencies, the Administrative Procedures Act[7] restricts EPA's ability to issue regulations by prescribing procedures that agencies must follow in writing regulations. The Administrative Procedures Act, for example, requires that EPA seek public comment on proposed regulations before issuing them, and the courts require that the agency consider the comments submitted. EPA also has restrictions on its regulation-by-regulation ability imposed on it by various substantive federal laws. In some cases, the restrictions are there to reduce regulatory uncertainty. For example, EPA cannot issue regulations tightening mobile source emissions standards without providing a four-year lead time for manufacturers.[8] Under the lead time and stability provisions, regulations cannot change for three years after each change and must be issued four model years ahead of their effective date.[9] If EPA issues one change to those regulations, therefore, EPA's ability to issue additional changes is limited for a time. Indeed, EPA was constrained by this statute when the agency sought to change diesel emission regulations in 1999. EPA issued MY2004 standards in 1997. They later sought to add the "not to exceed" provisions to the MY2004 standards, but failed to issue the regulation in 1999. As a result, EPA could not make the "not to exceed" rules applicable until MY2007, since the MY2004 standards had to remain stable for three years.

EPA also faces political constraints on its regulatory abilities—Michigan Congressman John Dingell, for example, for years has exerted great influence over EPA's regulatory efforts regarding mobile sources (Joskow and Schmalensee 1998, 37). Finally, EPA is regularly sued by interest groups over its regulation-by-regulation activities, alleging EPA's regulations are too lenient, too strict, or otherwise violate federal law (Schneider 1986, 7). These suits are costly for EPA and delay its ability to implement regulation-by-regulation edicts. Thus these restrictions on regulation-by-regulation can make regulation-by-negotiation or regulation-by-litigation more attractive than regulation-by-regulation for EPA in some circumstances. It is for this reason, the EPA, more than any other agency, has used regulation-by-negotiation as an appendage to regulation-by-regulation. By building a consensus in advance of announcing a proposed rule, EPA can avoid some of the suits that might come when a contentious final regulation is announced.

In addition to legislative and agency constraints that figure into an agency decision as to how to proceed when regulating, the different approaches carry different expected transaction costs. If the members of an affected industry are large and unorganized, say in the case of operators of country grain elevators, then bringing suits or engaging in reg-neg is out of the question. The agency will logically employ regulation-by-regulation. In contrast, if the major players in a regulated industry are solvent, few in number, and not unaccustomed to being engaged in high profile, costly suits, then the agency may choose regulation-by-litigation. Another important part of the calculus relates to the number of consumers who will bear the cost of any form of regulation. If the number is large, then the cost can be spread thinly over all future buyers. On the basis of avoiding constraints that effect traditional regulation and these considerations, EPA may choose the regulation-by-litigation option.

To engage in reg-lit requires cooperation and agreement with government actors outside the agency. EPA must persuade the Justice Department to support EPA's strategy. EPA's solution must also ultimately be approved by a court if EPA prevails. The role of interest groups in settlement approval proceedings is, however, significantly more restricted than their role in regulation-by-regulation. EPA also incurs political risk as it may not prevail in the litigation. EPA reaps political benefits, however, if it succeeds and is able to announce "tough on polluters" verdicts or settlements. EPA must balance these costs and benefits in determining which regulatory strategy to pursue.

Fifth, the Clean Air Act relies heavily on "technology-forcing" regulations for mobile sources, that is, regulations that require implementation of technology that does not exist at the time of the adoption of the regulations. Thus, for example, in reaction to the MY1980 and 1981 automobile standards, car manufacturers equipped cars

> with newly designed engines whose cylinders, pistons, and other essential components were engineered to produce fewer emissions. Engine operating parameters were controlled more precisely through vacuum and electronic controls and the use of fuel injection systems became widespread. Computer systems also were used to control engine operation, and became an important technology for controlling emissions. (Reitze 2000, 327)

As Lee Iacocca, then president of Ford, put it in 1976: "If we cannot save ourselves from unrealistic government requirements in fuel economy and emissions, our greatest hope in meeting these requirements is through electronics" (*Business Week* 1976, 90). Technology-forcing also, however, created the potential that the regulators would underestimate the time necessary to produce the needed innovations. A regular series of battles between sources (especially automobile manufacturers), regulators, and environmental pressure groups resulted, with EPA and Congress attempting to determine whether or not sources' claims that the technology was not yet ready were legitimate or the result of underinvestment in developing new technology.

Among mobile sources generally, technology-forcing created an incentive to design vehicles to meet standards, rather than design of pollution control technology simply to reduce emissions. Differences in the testing standards, not just different emissions standards, in Europe and the United States, for example, require different pollution control strategies (Bielaczyc and Merkisz 1999, 127). As pollution control requirements grew more stringent and emissions control technology grew more complex, manufacturers had an increasing incentive to view federal emissions tests as the blueprint for their products. In other words, technology-forcing regulations require manufacturers to invest in developing features not demanded (or even rejected by) customers. Their profit-maximizing strategy, therefore, is to minimize those investments and to minimize the negative features introduced into the vehicle by the new technology. Investments in political means of delaying requirements is one strategy for doing so, and was used effectively by automobile manufacturers in the 1970s. Investment in new emissions control technology that both minimizes the aspects of pollution control that customers dislike (e.g., reduced fuel economy) and which does not waste resources by overcomplying with regulations (e.g., reducing emissions outside of testing parameters) is another.

Finally, mobile source regulations require turnover in fleets before controls will be effective. For example, if a vehicle's average life is ten years, vehicles sold in 2000 under regulations in effect at that time will still be emitting pollutants in 2005, even if new vehicles in 2005 must meet stricter emissions control levels. Because diesel engines have such long lives, fleet turnover takes a long time. Turnover can be delayed by requiring new emissions controls that increase user costs (Ball 2002, A12) or speeded up through incentives to retire older vehicles (Dolan and Chedekel 2001, A1).

To illustrate the dynamics of large truck replacement, consider these very simplistic calculations. In 1997, according to reports, there were 4,302,915 trucks on the road in the size 6 to 8 categories, which cover 19,5001 to 33,001 pound vehicles (U.S. Census Bureau 2000). Over the years 1995 through 2000, there was, on average, 291,000 new vehicles purchased in the size 6 to 8 categories. A back-of-envelope calculation suggests that at this average replacement rate, without accounting for some expansion, it would take slightly less than 15 years to replace the existing stock. If only the larger size 8 vehicles are considered, there were 2,211,283 on the road in 1997 (U.S. Census Bureau 2000). Then, on average, there were 205,000 trucks added each year in that category across 1995–2000. Again, a rough calculation indicates it would take slightly more than ten years to renew the existing stock. If we assume that the diesel share of the total market remains about constant over the interval of the calculation, we can use the crude turnover estimate as the number of years necessary to bring cleaner technologies to the diesel fleet.

In 1998, when EPA brought suit against the diesel engine manufacturer, the lead time limitations associated with regulation-by-regulation would have delayed obtaining changes in the test procedure and emission standards until MY2007. Then, there was a 1999 regulatory event that would have allowed modifications. The settlement of the 1998 suit requires that changes be in place by fall of 2002, which corresponds to MY2003.

Reg-lit appears to have gained four years over regulation-by-regulation. Using our crude estimate of conversion time suggests that fleet conversion will be accelerated by 26 percent to 40 percent. There is more to the story, however.

We recognize that the conversion process is not this simple and that anything that increases the cost of new engines will favor keeping the older ones on the road for a longer period. Vehicle owners have choices about maintenance investments and purchase of new vehicles. Put another way, vehicle life is endogenous with respect to regulations. Most importantly for our purposes, vehicle consumers' choices can be affected by regulatory behavior. If the purchase of a new vehicle is made more expensive or otherwise less desirable by regulators (e.g., by requiring emissions controls that reduce mileage), current vehicle owners will invest in maintaining their existing vehicles' lives (Ball 2002; *Diesel Fuel News* 2002, 18). Using older engines tends to increase emissions, both because older engines tend to be dirtier than newer engines (International Program on Chemical Safety 1996, 124) and because of the trend toward requiring cleaner engines. Increasing the cost of new engines by requiring stricter emissions controls thus has an offsetting impact by increasing fleet age.

Stylized Facts

To summarize, we have five "stylized facts" about regulation to consider as we attempt to understand EPA's choices in regulating heavy-duty diesel engines:

1. States must meet federally mandated ambient air quality standards; failure to do so is costly for states. Because of wind currents that carry emissions from one region to another, the ability of any given state to meet these standards is partly controlled by activities in other states.

2. States can achieve air quality improvements from either mobile or stationary sources. Mobile and stationary sources are regulated differently under the Clean Air Act, with states having more limited control over mobile source emissions than they do over stationary sources, creating the potential for "regulatory arbitrage" across categories. Emissions of particular pollutants by one source implicitly require fewer emissions of that pollutant by other sources.

3. The extent to which air quality improvements may emerge is estimated in the planning stages by the use of models. Models drive much of the regulatory agenda because models are how EPA evaluates compliance with the Clean Air Act requirements. Overprediction of control allows approval of a SIP but eventually forces changes as the control measures do not lead to compliance with the NAAQS.

4. When models no longer match reality, EPA must take action. EPA faces different costs and benefits for the agency in choosing among regulation-by-regu-

lation, regulation-by-negotiation, and regulation-by-litigation. Different situations will lead EPA to choose different regulatory instruments.

5. Even if stricter emission standards are to be set for mobile sources, the final effect will depend on fleet turnover. Turnover is partly endogenous to regulatory costs and so can be slowed by new controls that increase costs directly or indirectly (e.g., by reducing fuel efficiency).

All of these constraints are important to understanding the regulatory context because they contribute to our understanding of why EPA chose to regulate heavy-duty diesel engines through regulation-by-regulation in some cases and regulation-by-negotiation and regulation-by-litigation in others. In our final section we will explore each of these constraints in more detail. Before doing so, however, we must explore how diesel engines pollute and how that pollution is controlled.

Diesel Engines and Air Pollution

Diesel engines operate differently from gasoline engines. In a diesel engine, fuel is injected directly into high pressure air in the combustion chamber. The fuel self-ignites from the heat caused by the compression of the air within the cylinder. In a gasoline engine, by contrast, carburetion or injection outside the cylinder is performed and the fuel-air mixture is then ignited within the cylinder by a spark. As a result of this difference in combustion, diesel engines require a significantly different fuel. Diesel and spark-ignition engines thus have quite different combustion processes and so also have different emissions, with important consequences for pollution control. An important disadvantage of diesels is that they emit more particulates and NO_x than gasoline engines; (International Program on Chemical Safety 1996, 91); an advantage is that diesels emit less CO than gasoline engines. Besides the difference in which pollutants they emit, diesel emissions also have different characteristics that affect pollution control measures. For example, diesel emissions are much cooler than emissions from the spark-ignition engines in most passenger automobiles, raising problems for using postcombustion catalysts that require higher temperatures for their operation (National Research Council 1981, 23). Control measures for diesel engines thus differ from those used for spark-ignition engines. This also reduces the usefulness of emission reductions from gasoline engines as a benchmark for progress.

One important result of the differences in combustion technology is that diesels have a higher compression ratio than gasoline engines, making them more technically efficient—so much so that the *Diesel Engine Reference Book* terms them "the most efficient liquid fuel burning prime mover yet derived" (Challen and Baranescu 1999, 25). This substantial fuel savings advantage is a major reason for the transportation industry's preference for diesels over other possible engine types (most notably gasoline engines), with diesels accounting for 80 percent of the trucks that haul freight every day across the United States. Diesels are also relatively easy to maintain without the need specialized personnel for routine maintenance. Relative to gasoline engines, diesel use saves truckers and therefore consumers, as much as $6,600,000 in fuel costs every year.[10] Fuel efficiency, however, is not the only advantage diesels have over spark-ignition engines. Diesel engines also have greater packaging efficiency,[11] durability, and safety.[12] As a result of these advantages, diesel's market share has increased significantly since the 1970s, with its share of total highway fuel use increasing from 8.9 percent in 1973 to 20.6 percent in 2000.[13] As diesel's market share grew, there was a significant shift in combustion technology, with turbocharged, after-cooled engines becoming dominant in the United States after the 1970s.

Regulatory Consequences

EPA, like most other industrialized countries' regulatory agencies, regulates four components of diesel exhaust: CO, hydrocarbons, particulates, and NO_x. The first three are the result of incomplete combustion; NO_x, however, is a side-effect of combustion. CO emissions are not a significant problem for diesel engines. Hydrocarbon emissions can be solved by measures to reduce particulate emissions or improve fuel efficiency (Challen and Baranescu, 1999, 479). Particulate and NO_x emissions are thus the major problems.

Diesel emissions are the result of complex processes and, as a result, are difficult to model (Clark et al. 2001). Even today, modeling of diesel emissions lags behind gasoline engine emissions modeling, complicating regulation and control.

Because of the differences in technology and combustion between diesel and gasoline engines, regulators in the United States, EU, and Japan have regulated diesel emissions separately from gasoline engine emissions.[14] Although today diesels are recognized as a significant source of air pollution,[15] diesels were initially regulated much less heavily than gasoline engines. Indeed, at least one early report on air pollution depicted diesels as preferable to contemporaneous gasoline engines (Larkin 1962, 968). As a result, diesel emissions control standards and technology have lagged gasoline engine control standards and technology (Sawyer and Johnson 1995, 69). As emissions from gasoline engines declined due to control measures, the relative share of diesel engine emissions has increased, prompting the *Los Angeles Times* (1999, B8) to call it "one of the last great problems in complying with federal clean air mandates."

Emissions Controls

Emissions controls for diesel engines were initially relatively primitive. For example, odor has been a long-running problem with diesel engines and EPA initially regulated only "soot" emissions.[16] Engine conditions, including whether the engine is accelerating or decelerating, have a significant impact on diesel emissions, something that has been known since the 1970s. As a result, and because of customer demand for fuel efficiency, control of diesel emissions was initially largely done through changes in the combustion process rather than through postcombustion-stage technology (Sawyer and Johnson 1995, 73). By comparison, emissions control in gasoline engines was largely done through postcombustion techniques (catalytic converters) and fuel modifications (removing lead from gasoline). The more stringent diesel standards coming in the future will likely require postcombustion techniques and new technologies.

Because of the importance of combustion techniques to controlling diesel emissions (Sturgess 1994, 27), the development of mechanical and then electronic engine controls have been, and continue to be, critical to the ability to improve emissions control (Moser, Sams, and Cartellieri 2001, 53). Electronic engine controls created an entirely new level of ability to control combustion in both diesel and gasoline engines, and eventually did so relatively cheaply (*Business Week* 1976, 90). "Since the first introduction of fully controlled electronic engines in 1983, the changes in engine control . . . have been revolutionary" (Challen and Baranescu 1999, 556). EPA endorsed this view of electronic controls as critical to emissions control in a technical review document in 1981: "In short, the field of electronic controls—which have already revolutionized the light-duty fleet and which will certainly be carried over into the heavy-duty gasoline engine fleet—is a control strategy which EPA believes will permit significant NO_x reductions to be realized at minimum [fuel economy] penalty" (Office of Mobile Source Air Pollution Control 1981, 76). As microprocessor costs fell, use of electronic controls became viable in larger numbers of vehicles (*Business Week* 1976, 1977).

These controls, whose development was a response to emissions controls (Mele 1997, 64), for the first time allowed variation in a number of engine parameters to meet performance criteria, such as emissions standards or maximizing fuel economy (Nejlepszy 1998, 3). Engine manufacturers tout these controls as allowing manufacturers to "tailor the performance of [their] engines to the individual needs of their customers" (Cummins Engine Company 1997, 5) and to prevent the sacrifice of fuel economy to meeting more stringent emissions standards (Moncelle and Fortune 1985, 10). By allowing upgrades to in-use engines, existing engines can easily be made to run cleaner if new engine settings were found that improved emissions control (*Fleet Owner* 2001, 53). Electronic controls also complicate emissions predictions (Clark et al. 2002, 94) and make far greater demands on emissions testing because they enable the engine to operate quite differently depending on conditions, leading to differences in emissions under different operating conditions.

Given that the federal test procedures specified conditions under which engines would be tested, EPA sometimes had to revise procedures to account for emissions from conditions not tested. For example, in its 1995 support document for the revised test standard for light-duty vehicles, EPA noted that particular types of driving not previously tested had been discovered to be the source of higher emissions. "One possible explanation of these emission increases is that the engines were not calibrated for emission control during the higher engine loads associated with aggressive driving, as these loads are not encountered during current FTP [federal test procedure] testing" (Office of Air and Radiation 1995b, n.p.). With the evolution of sophisticated electronic engine controls came concern that the controls might have become too sophisticated for existing test cycle, a concern that was noted in a 1993 report by the Organization for Economic Cooperation and Development (1993, 45).

Tradeoffs in Controls

Because there are tradeoffs between control of pollutants, increasing controls on one may increase emissions of another. For example, one early study found that earlier injection of fuel in the combustion cycle reduced smoke exhaust, but increased NO_X emissions, while retarding injection timing, reduced NO_X but increased unburned hydrocarbons (Reitze 2000, 324). Similarly, exhaust gas recirculation (EGR) systems can reduce NO_X emissions, but may also increase soot and CO emissions. The *Diesel Engine Reference Book* even refers to a "natural tradeoff between particulate emissions and NO_X" as "one of the critical challenges in the design of diesel combustion systems" (Challen and Baranescu 1999, 93). Another example is that the engine timings and fuel characteristics necessary to minimize NO_X and particulates are different (Virk and Lachowicz 1995, 170, 177; International Program on Chemical Safety, 1996, 19). Regulators and manufacturers thus face important tradeoffs among pollutants and regulatory standards. Indeed, the 1977 Clean Air Act Amendments recognized these tradeoffs among pollutants, altering the requirements for California's waiver of federal standards to allow California to tradeoff NO_X control for CO control. Importantly, "[m]ost trade-off curves are approximately hyperbolic in shape, so that the first increment of control produces only small degradation of performance while later increments cause accelerating degradation of performance" (National Research Council 1981, 23). Progressive tightening of diesel emissions standards, as EPA has done over the last thirty years, will eventually move tradeoffs onto the less favorable portion of the curve. Put another way, the cost of gaining additional air quality improvement from diesel engine controls now tends to rise rapidly. Particular control measures may also have impacts on other parts of the industry some control technologies, for example, depend on significantly reducing sulfur in diesel fuel and many measures for reducing emissions require redesign of engine oils.

The resulting changes can themselves have far-reaching impacts. Significantly lowering sulfur content in diesel fuel, for example, has implications for the pipeline system used to transport various fuels, since low-sulfur fuel could be contaminated through contact with other, higher-sulfur fuels or residues left in the pipeline (Mercatus Center 2000, 17–18). Moreover, requiring equipment that demands extremely low-sulfur fuel has national implications, even if only some regions are not in attainment for the pollutant to be controlled by the equipment, since the low-sulfur fuel will have to be sold exclusively nationally to avoid fouling equipment needed inside the nonattainment areas when it is refueled outside the nonattainment areas.

There are also tradeoffs between engine types, with diesel engines offering some environmental advantages over gasoline engines because of their greater fuel efficiency. Improving fuel efficiency can also adversely affect pollution control measures. For existing heavy-duty trucking diesels, there is a general tradeoff between fuel economy and emissions, with greater emissions control reducing fuel economy. Of course, some improvements may not require tradeoffs, the point is merely that heavy-duty diesel trucks are complex systems in which any change may have significant consequences for other parts of the system.

The existence of these tradeoffs is important for several reasons. First, it suggests that making the tradeoffs through a regulatory agency may cause the choices to diverge from the consumer-choice tradeoff. Thus, for example, EPA may opt for less fuel economy and more emissions control, more NO_x control and less CO control,[17] or a more maintenance-intensive form of emissions control than engine consumers would in the absence of regulatory controls. (Indeed, if EPA does not expect its choice to be different from market outcomes, there is no reason for EPA rather than consumers to make the choice at all.) Justifying shifting the choice from consumers to EPA therefore requires identification of a market failure (Mercatus Center, 2001, 7).

Second, the market failure cannot be identified solely by noting the difference between EPA's and customers' choices since each tradeoff presents its own advantages in terms of emissions control. Consumer preferences for fuel economy, and hence lower CO emissions, control CO at the expense of NO_x.

Third, to the extent possible, engine manufacturers "move last" in the design of engines, i.e., they make choices about engine design after EPA has announced regulatory requirements, and customers demand choices EPA attempts to prohibit. As a result, market pressures will lead engine manufacturers to emphasize the features customers desire at the expense of those that EPA desires. For example, "[o]ne of the most commonly used approaches for setting injection timing for a diesel engine is to optimize it for a given speed to obtain optimum fuel consumption, power output and emissions." Since, however, engines typically "exhibit minimum specific fuel consumption and particulate and NO_x emissions at different injection timings," (Virk and Lachowicz 1995, 169) engine designers must tradeoff the three criteria against each other. Given the limits of EPA's ability to specify all the parameters involved in engine design, it is likely that engines will diverge from the regulators' preferred design if consumer preferences differ from regulators' preferences. Market pressures will push engine design toward consumer preferences and the increasing complexity of engine design and enhanced control over engine operation offered by the sophisticated controllers necessary for emissions reduction will produce numerous opportunities for satisfying consumer preferences.

Fourth, these tradeoffs will influence how manufacturers implement regulations. A European engine manufacturers' association paper noted this effect:

> The final choice always results from a compromise between environmental targets (low exhaust emissions) and users' requirements (power availability, fuel consumption). The tool available to development engineers for the definition of this compromise is the test cycle. The test cycle identifies the engine operating conditions under which emission aspects must take the predominant role in selecting the technological solutions. Different test cycles often result in different technological solutions and as a consequence different engine performance. (Association des Constructeurs Européens d'Automobiles 1994, 2)

As a result of the differences in tradeoffs made by regulators and consumers, manufacturers will be driven by market pressures to match their choices to regulators' preferences only at the points specified in test procedures (or at points necessary to reach such performance). Elsewhere they will match the choices among tradeoffs to consumer choices. As a 1972 EPA memorandum concluded, "The standard Federal test cycle and procedure are exactly that—the standard. They are the yardstick by which all vehicles are measured. They serve as design criteria for vehicle manufacturers. If the test cycle and procedure do not evaluate what EPA desires them to, the manufacturers can hardly be blamed." (Office of Air Programs 1972, 7). Thus the test cycles selected by the regulator will have consequences for off-cycle emissions as well as on-cycle emissions, making the former higher than if they had been included in the test cycle (Association des Constructeurs Européens d'Automobiles 1994, 4).

Finally, the widespread existence of tradeoffs among pollutants requires that a rational regulatory policy consider the relative costs of reducing particular pollutants from different classes of sources (National Research Council 1981, 18).

More Stylized Facts

Our overview of diesel engines and air pollution allows us to add two additional "stylized facts" to our earlier list:

6. The Clean Air Act sometimes requires technology-forcing for mobile sources. Manufacturers must invest in developing technology to which their customers are indifferent or hostile. Some investments will be made to minimize the customer-perceived negative impacts on the product. Regulatory choices for diesel engines involve important tradeoffs across pollutants controlled. Increasing control of one may "cost" regulators increased emissions of another. Such tradeoffs are not generally linear. Regulations specified in terms of satisfying specific test standards provide an incentive to design engines to the standards.

7. Among the technologies "forced" by earlier regulatory efforts is sophisticated electronic control of combustion, making possible different modes of operation under different conditions sensed by the controller. Such controllers make it possible for engine manufacturers to offer customers enhanced performance in customer-demanded dimensions outside areas of performance examined directly by regulators' tests. At times, the customer may assign higher value to fuel efficiency than emission reductions. Tradeoffs exist between regulator-desired engine characteristics (e.g., low emissions) and customer-desired engine characteristics (e.g., low cost, high fuel economy).

The Heavy-Duty Diesel Engine Industry

The final piece necessary to understand the diesel regulation story is the structure of the industry being regulated. Five characteristics of the heavy-duty diesel engine industry are especially important.

First, heavy-duty diesel engines are a significant and growing part of the transportation industry. "The heavy-duty diesel engine has an excellent reputation for fuel efficiency, reliability, and durability. These three characteristics, together with its ever improving emissions performance, mean that the heavy-duty (HD) diesel engine mean that it remains the 'engine of choice' for commercial transport worldwide" (Lee, Pedley, and Hobbs 1998, 13). Diesel engines are more likely to be chosen the larger the truck, the more miles the truck is operated each year, and the longer the typical trip for the truck. For example, 40 percent of "medium" trucks are diesel-powered, while 50 percent of "light-heavy" trucks have diesel engines, and 91 percent of "heavy-heavy" trucks are diesel-powered. Trucks that operate 75,000 miles or more annually are 85 percent diesel (as compared to only 4.3 percent for trucks operating less than 20,000 miles annually), and trucks having typical trip lengths in excess of 500 miles are 66 percent diesel (as opposed to 6.2 percent for typical trip lengths less than 50 miles, 16 percent for typical travel 51–100 miles, 30 percent for trips of 101–200 miles, and 55 percent for typical trips of 201–500 miles) (Charles River Associates 2000, 10).

Second, the market is relatively thin. There are only a few heavy-duty diesel engine manufacturers in the United States market. World markets are fragmented, with "every major industrialized country" having "its own range of diesel engines" (Challen and Baranescu 1999, 5). The major manufacturers of diesel engines for use in trucks in the United States today include: Caterpillar, Cummins, Navistar, Detroit Diesel, and Volvo. Together these five companies produce 98 percent of the heavy-duty market and 90 percent of the medium-duty market. Although the trucking industry has always been competitive, in the 1990s competition increased resulting in a trend toward larger, more cost-effective companies (Intelligent Transportation Systems 2000). Partly this was a result of the increasing demands on engine manufacturers to develop products with improved efficiency and environmental standards. It became necessary for companies attempting to take advantage of economies of scale to spread investments over larger volumes of production. Third, diesel truck manufacturing is not a fully vertically integrated industry. Some firms manufacture only heavy-duty diesel engines (e.g., Caterpillar, Cummins, and Detroit Diesel), some manufacture only truck bodies (e.g., Ford, GM, PACCAR, and Western Star Trucks), and some manufacture both (e.g., Volvo). Some firms offer truck lines with a choice of engines from different manufacturers (e.g., Navistar). This lack of vertical integration has consequences for emissions control. The first consequence is to complicate testing. Since engines and trucks are not designed together, testing actual vehicles would require significantly more testing than simply testing engines alone (Challen and Baranescu 1999, 473). To minimize EPA cost, the agency chose to certify engines rather than trucks (Reitze 2000, 401). This raises the cost of truck manufacturers, since truck and engine designers often do not work for the same firm. Putting an engine into a truck is not simply a matter of tightening a few bolts—new engines often require extensive redesign of the existing truck body, something that can take years (Kachadourian 2001, 17; *PR Newswire* 2002). Redesign is necessary to accommodate the shape of the truck body to the engine and other components, especially the cooling system, and to accommodate the location of the other engine compartment components to the engine (moving wires away from particularly hot areas, for example). Truck customers often insist on extensive testing opportunities for new models before committing to purchases (Ball 2002, A12; *PR Newswire* 2002). Design changes thus require lengthy lead times before they can appear in production models (Mele 1997, 64). Indeed, emissions regulations are driving a trend toward vertical integration because of the increased difficulty in integrating new engines into trucks (Sparkman 2001). The third consequence is that it complicates modeling: Engine emissions must be measured in lab tests, then vehicle emissions estimated from test results (National Research Council 2000, 25).

Fourth, the use of heavy-duty engines has become increasingly important to the U.S. economy over the past thirty years. Truck registrations have grown by 70 percent in the past three decades, while miles traveled and fuel used has more than doubled (U.S. Department of Transportation 2000). Freight activity through the single-mode transportation of trucks has grown 20.6 percent between just 1993 and 1997. In 1997 there were 104,000 establishments involved primarily in truck transportation, employing 1.3 million people and garnering revenues totaling $141 billion (U.S. Census Bureau 2000). Trucking and warehousing accounted for 1.2 percent of the nation's GDP in 1997 (Charles River Associates 2000, 9).

Finally, heavy-duty diesel engines are used in the market in a different way from other types of engines. Trucks using diesel engines are expensive, often costing substantially more than $50,000. Their durability gives them exceptionally long useful lives (Challen and Baranescu 1999, 555), much longer than the Clean Air Act assumes (Reitze 2000, 407). Many smaller trucking companies primarily purchase used trucks, extending truck lives even further.

The market thus follows the life cycle of trucks. New trucks are typically purchased by long distance shipping companies, including the large national fleets. Trucks are then sold to regional trucking companies and other shorter-haul users. Eventually used trucks sometimes find their way to small companies that need occasional transport. Some trucks are also sold into foreign markets (e.g., Mexico) where they continue to operate. Heavy-duty trucks have long lives, although they tend to be driven progressively fewer total miles each year as they age and are sold into shorter-haul markets.

Additional Stylized Facts

Our review of the industry enables us to complete our list of "stylized facts" necessary to understand and analyze the regulatory story:

8. Heavy-duty diesel use has been growing since the 1970s, increasing the importance of controlling diesel emissions and magnifying any discrepancies between the air quality model predictions and ambient pollutant levels due to differences between predicted and actual emissions.

9. Changes in heavy-duty diesel engines are slower to work their way into and through fleets because of the non-integrated nature of the industry. This slows the introduc-

tion of changed engines into production models. Because of the long life of heavy-duty diesel engines, compared to other mobile sources, older engines continue to emit pollutants long after comparable car engines are scrapped.

REGULATION OF HEAVY-DUTY DIESEL ENGINES

Regulation of heavy-duty diesel engines has had five phases, involving all three forms of federal regulation: regulation-by-regulation, regulation-by-negotiation, and regulation-by-litigation. The first phase was during the pre-Air Quality Act of 1967 period when diesel emissions were left unregulated. The second was the period of regulation-by-regulation from the Air Quality Act of 1967 through the 1990 Clean Air Act Amendments. The third phase was a brief flurry of formal and informal regulation-by-negotiation after the 1990 amendments. The fourth, involving regulation-by-litigation, began with EPA's suit against the heavy-duty engine manufacturers in 1998. The fifth is the post-1998 consent decree period when reg-lit continued to affect the industry. In this section we describe the substance and history of the regulations produced by each of these forms, subdividing several of the broader periods according to the various major amendments to the Clean Air Act.

Over the course of the last four decades, regulation of heavy-duty diesel emissions has gone from being virtually nonexistent, to an opacity test for "smoke," through a series of increasingly stringent standards for NO_x, hydrocarbons, and particulates. The amount of NO_x emissions allowed has fallen, for example, from a combined 16 g/bhp-hr for NO_x and hydrocarbons in 1988[18] to separate limits of 0.20 g/bhp-hr for NO_x and 0.14g/bhp-hr for nonmethane hydrocarbons.[19] Particulate standards have fallen from 0.6 g/bhp-hr in 1988[20] to 0.01 g/bhp-hr for MY2007.[21] Regulations have also tightened in other ways: new test procedures required greater emissions controls and the "useful life" of heavy-duty diesel engines—during which emissions must meet standards—grew from five years, 100,000 miles, or 3,000 hours to ten years, 435,000 miles, or 22,000 hours.[22]

Since results matter, the method of determining that level is just as important as the level of emissions that is allowed. Test standards are extremely important for understanding emissions generally, since they specify the means of measurement. They are particularly important for heavy-duty diesel engines, since it is the engine rather than the vehicle that is tested. The specification of the test standard can have a significant influence on the outcome. For example, when EPA switched from the steady state to transient testing in MY1984, engines that had been in compliance with hydrocarbon regulations could not pass the new test (U.S. Environmental Protection Agency 1979, 14).

Regulation-by-Regulation: 1967 to the 1990s

The first federal regulatory efforts were a series of regulation-by-regulation restrictions on heavy-duty diesel engine emissions under the Air Quality Act of 1967 and the Clean Air Act Amendments of 1970, 1977, and 1990.

The Air Quality Act of 1967

The next major air pollution national regulatory effort was the Air Quality Act [AQA] of 1967, which established a complex approach based on national ambient air quality criteria and state ambient standards (Morriss 2000, 280–82). Of most importance for our purposes, the AQA addressed a major concern of mobile source manufacturers: the threat of inconsistent state standards that could lead to having to outfit vehicles differently for sale in different states. California had adopted auto tailpipe emissions standards for hydrocarbons and carbon monoxide in 1966 and begun regulating mobile source emissions in 1961, spurred by Los Angeles' smog problems (California Air Resources Board 2002). With the growing interest in air quality, the auto industry feared other states would begin to do so as well. The AQA preempted all state regulatory efforts to regulate motor vehicle emissions, except for California's, which presented a special case by virtue of its existing regulatory structure and particular environmental conditions. (The 1990 amendments allowed other states to adopt the California standards, but not their own unique standards.) The price of preemption for the mobile source manufacturers was agreement to national regulatory efforts. Mobile source emissions standards would in the future be created only at the national level and this time regulation included diesel emissions.

The initial concern with diesels was "smoke"—the heavy, black exhaust visible from many diesel exhausts. Smoke standards for diesel engines began with standards applicable to model year 1970. To measure "smoke" required the Department of Health, Education, and Welfare (HEW) to specify the conditions under which measurements of exhaust would be made. The measurements could then be compared to the standard and the engine evaluated. HEW's proposal, issued January 4, 1968, required that heavy-duty diesel engines: "shall not reduce the transmission of a beam of light by more than 20% except that reduction of light transmission of not more than 40% for a total of not more than 5 seconds shall be permitted during the running of the two dynamometer tests described in section 85.122(a) (2) and (3)" (U.S. EPA 1968a, 112). The final regulations took the same approach, but specified separate measurements for "engine acceleration mode" and "engine lugging mode."[23] An initial standard was set for MY1970 to MY1973, and a stricter level for MY1974 and forwards. These standards for diesel exhaust smoke would remain the same through model year 1973, even after the passage of the 1970 Clean Air Act Amendments (U.S. EPA 1971, 22452; 1972, 24295).

The 1967 Air Quality Act thus created the format that diesel engine regulation follows to this day: specific standards for specific pollutants, standard lab tests to measure the emissions, and standard sets of conditions under which the tests were to be conducted. Given what regulators were attempting to do, this format represented a reasonable set of choices: Standardization of procedures and consistency in test conditions was necessary to prevent manipulation of engine operations and provide fairness to engine manufacturers. The focus on "smoke," which today seems remarkably vague, addressed what was then seen as the most important pollutant—the highly visible emissions from tailpipes.

The 1970 Clean Air Act

The year 1970 brought major changes to air pollution regulation. The Nixon administration created the EPA, and air pollution control was transferred to it from HEW. The Clean Air Act Amendments of 1970 established the basic approach to mobile sources that continues today. The statute mandated reductions of 90 percent of hydrocarbon, carbon monoxide, and nitrogen oxides, with an initial target of 1975; and mobile source air pollution was to be primarily controlled through federally mandated technology standards on new vehicles. States were left the regulation of in-use vehicles, a politically difficult issue, and authority they were not eager to exercise.

Heavy-duty diesel engines continued to receive less stringent treatment through the early 1970s, with only smoke regulated until the 1974 model year engines, when hydrocarbon, NO_x, and CO emissions would begin to be regulated. The lack of attention to diesel emissions is not surprising, given their small contribution to U.S. air pollution at the time: only 1.75 percent of total particulates, 0.02 percent of CO, 1.9 percent of hydrocarbons, 4.8 percent of NO_x, and 0.4 percent of SO_x in the early 1970s (Henein 1973, 211).

After the 1970 amendments the smoke exhaust emission standard was tightened for MY1974 and later engines. The new regulations continued the format of specifying emissions levels for specific "modes" of operation both for smoke and for the newly regulated substances. This first set of emission standards issued by EPA would be in effect through MY1978. By this time the academic community had recognized that more realistic test standards were needed and federal emissions standards for automobiles were being specified in terms of a driving cycle, something California had done since 1960 and which was adopted by the federal government in 1968. The test standards thus evolved from the original opacity test. The first improvement was the creation of a steady-state test, which simulated highway driving conditions.

Already, however, EPA was concerned with the potential inconsistencies between test-cycle performance and off-cycle performance for other engines—concerned enough to issue an advisory circular warning light-duty vehicle and light-duty truck manufacturers that "the rapid advance in the introduction of more sophisticated emission control systems, especially those that offer new flexibility in control capability," a development that EPA thought would, by the early 1980s, be incorporated into "most, if not all, motor vehicles and engines," could be considered illegal "defeat devices" (Office of Air and Waste Management 1978, 1; U.S. EPA 1979, 6–7). Controllers were not illegal, EPA concluded, if NO_x emissions under the Highway Fuel Economy Test were within a specified range of test protocol emissions or could otherwise prove to EPA's satisfaction that the equipment was not a defeat device (Office of Air and Waste Management 1978, 3). EPA was thus concerned, as early as December 1978, about the potential for controllers to create excess emissions in off-test-cycle conditions.

The Clean Air Act, as recreated by the 1970 amendments, was largely the result of a game of political one-upsmanship between Republican President Richard Nixon and Democratic Maine Senator Edmund Muskie, who anticipated being rivals in the upcoming 1972 presidential election. Although the amendments imposed emissions standards on mobile sources, they were not a serious blow to the auto industry. The automobile makers prevailed on a number of key conference committee issues, including deleting the requirement of testing each new vehicle in favor of prototype testing and preventing public disclosure of emissions control testing results and equipment costs. Most important, the 1970 amendments left open the possibility of delays in the new standards—delays the auto industry lost little time in seeking (Morriss 2000, 282–87). Particularly given the anti-car attitudes in 1970,[24] the degree of regulation of mobile sources that resulted was comparatively mild. Moreover, the constant battles over automobile emissions that resulted as the industry sought repeated extensions of deadlines likely helped distract EPA from the comparatively small heavy-duty diesel engine sector.

The 1977 Clean Air Act Amendments

Dissatisfaction with the 1970 version of the Clean Air Act prompted a major effort at reform in 1976. Although the proposed 1976 amendments were blocked from final passage by western senators unhappy about the impact on western development during a midnight marathon session at the close of the 1976 session of Congress, the measures were reintroduced and a revised version was enacted in 1977. Relaxing mobile source regulations on automobiles was an important purpose behind the 1977 amendments.

For our purposes, the important parts of the 1977 amendments were those that delayed the unmet mobile source reductions mandated in 1970 until the 1980s, required inspection and maintenance programs, and added an explicit requirement for regulations requiring "the greatest degree of emission reduction achievable" consistent with cost, technical feasibility, noise, energy, and safety factors for heavy-duty diesel engines.[25] The lack of EPA's regulatory activity in the heavy-duty diesel sector in particular prompted Congress's action in directly specifying reductions (Currie 1979, 848).[26] The amendments called for significant reductions from heavy-duty diesel engines of hydrocarbons and carbon monoxide (during and after model year 1983 of at least 90 percent), oxides of nitrogen (during and after model year 1985 of at least 75 percent), and particulate matter (during and after model year 1981 [or earlier, if practicable]).[27] Despite the tightening of the standards, EPA's proposals in 1980 did not require new technology to meet them.[28]

The new standards could be revised starting in 1979 and again every three years thereafter. Although the statute imposed more stringent standards, "escape valves" were also included in the statute, allowing EPA to temporarily or permanently revise the statutory standards for several reasons, including for reasons of cost. Congress also imposed extensive reporting and other requirements relating to fuel efficiency costs. Importantly, Congress also created the requirement of a four-year lead time requirement for changed standards.

When EPA set out to implement its new mandate to further reduce diesel emissions, part of its approach was to propose extensive changes in test procedures and instrumentation requirements to make the tests more closely resemble engine use conditions. Test procedures are important not only because of the role they play in establishing whether a particular engine receives certification, but because EPA continued to rely on its test procedures not only to check compliance but in formulating the standards themselves. Using its models, EPA translated the new standards into changes in air quality, predicting substantial reductions in emissions. Industry comments on EPA's proposal were highly critical. One of the most important comments had to do with insufficient lead to comply with the rules proposed for the 1979 model year. After consideration, EPA concluded that the industry was correct and allowed the continued use of existing test procedures and instrumentation to demonstrate compliance for 1979. All subsequent demonstrations of compliance (1980 and later) will be only by the new test procedures (with the exception of small volume manufacturers). EPA also made extensive changes to the testing procedures in response to industry comments. Nonetheless, the industry remained critical of the new test procedures.

The most important development was EPA's creation of the transient engine test standard in 1979, designed to simulate urban driving conditions (U.S. House 2000, 5). Under steady-state operation, temperatures of engine components and the fuel "have reached an equilibrium value that varies only slightly and randomly from one cycle to the next." However, under transient conditions, fuel pressures and temperatures and engine component temperatures vary "progressively rather than randomly from cycle to cycle" (Myers, Uyehara, and Newall 1973, 23). Since diesel emissions are sensitive to temperature, pressure, and the like, transient and steady-state testing will have different results for the same engine.

The new test was introduced because of EPA's concern that "[t]he mandated 75% reduction will be difficult for the manufacturers of diesels, and the incentive to design around the test will be great. Transient testing will be needed to assure that the reductions mandated by Congress will actually be achieved . . . " (U.S. EPA 1980, 4138). "EPA's theory at the time was that urban emissions likely would be greater and, by controlling those emissions, one would also control emissions under highway, or steady-state conditions"—a theory that even the highly critical House Commerce Committee Report *Asleep at the Wheel* later termed "plausible given that, in the 1970s, heavy-duty diesel engines were controlled by unsophisticated mechanical carburetors such that emission levels when the engine was *not* performing on the designated test cycle were not likely to vary much from emission levels experienced when the engine was operating on the test cycle" (U.S. House 2000, 5–6).

> The culmination of five years' development by EPA (and, in part, by the heavy duty manufacturing industry), the transient test exercises the engine through a continually changing series of speed/torque conditions as emissions are sampled. The new testing and sampling requirements differ so greatly from those currently in place that the development of an entirely new set of regulations has been necessary. (U.S. EPA 1980, 4137)

The transient system was designed to make the tests more representative of in-use conditions. EPA selected the specific test conditions after a survey of forty-four trucks and seven buses driven in New York City and Los Angeles. These two cities were selected as representing "the extremes of urban traffic flow" (Wysor and France 1978, 1).

The transient test also required new test equipment and the delays in obtaining the equipment prompted EPA to delay introduction of the new test. Despite EPA's argument that the transient test was needed to make testing reflect real world conditions, EPA not only did not attempt to validate its new test but denied that validation was desirable:

> Heavy-duty truck operation, and therefore heavy-duty emissions, are application-specific. The objective of CAPE-21 was to arrive at an 'average' duty cycle for an 'average' urban truck. Any given application wouldn't necessarily correlate with emissions measured on the average cycle. To choose an on-road application identical in duty cycle to the test procedure itself would prove nothing. (U.S. EPA 1979, 31)

Engine manufacturers were critical EPA's proposal for transient testing.[29] Their comments during rulemaking "centered around the justification for the tests, their representation of real life operation, their validation, their repeatability, and the lack of current knowledge upon which to base comments" (U.S. EPA 1980, 4147). They also regularly expressed concerns about the lead time necessary to implement new standards and procedures.

The transient test introduction made a major change in engine emissions testing. Testing engines under both the old and new standards found "[t]here is no general correlation between emissions measured on the two cycles; correlations are different for different emission species, for different engine types, and even for different manufacturers" (National Research Council 1981, 8). There were also initially large differences in emissions test results under the new procedure between laboratories. The transient test procedure did appear to produce approximately 10 percent lower NO_x levels than did the steady-state test (National Research Council 1981, 29). This difference suggests the critical importance of designing engines to the test procedures for engine manufacturers, since sales of their engines depend on receiving EPA certification that their engines met the standards. Later analysis in Europe determined that the transient test cycle, while more realistic of U.S. driving conditions, was also more vulnerable to engine controller strategies aimed at test passage rather than emission reductions.

Over the next decade, EPA continued to tighten heavy-duty diesel emission standards under the transient test. From HEW's regulations of only "smoke" in 1970, the diesel emission regulations evolved into a complex and stringent list of regulations covering hydrocarbons, CO, NO_x, and particulates. MY1988 brought the first particulate standards for heavy-duty diesels, five years after EPA imposed the first diesel particulate standards in the world on cars and light-duty trucks.

Lead time to meet new standards continued to be an important issue. After EPA promulgated the 6.0 g/bhp-hr NO_x heavy-duty diesel engine standard on March 15, 1985, the Engine Manufacturers Association sued EPA for not providing four years lead time as required by the Clean Air Act. The EMA prevailed in the DC Circuit, which ruled that the NO_x standard for all heavy-duty engines could not go into effect until the 1990 model year.

MY1991 standards tightened the NO_x standard to 5.0 g/bhp-hr, and introduced an innovation: allowing the averaging and trading of emission credits, with "not to exceed" levels for engine families (FELs) (U.S. EPA 1990, 30622). These "innovative, voluntary programs" allowed engine manufacturers "who reduce emissions below regulatory requirements for a particular MY for a particular engine to offset these reductions against emissions in a later MY or to trade credits for these reductions to other manufacturers of similar engines. . . " (U.S. EPA 1990, 30584). Limited banking was allowed starting in 1990. The value of the programs was reduced by the requirement of a 20 percent discount required by EPA "as an added assurance that the incentives created by the program will not only have no adverse environmental effect but also provide an environmental benefit" (U.S. EPA 1990, 30584).

One reason EPA continued to tighten the standards was the increasing importance of diesel engines in the heavy-duty truck market. As the EPA noted in 1981,

> As diesel engines continue over time to power an even greater portion of the nation's heavy-duty vehicles (on-the-road trucks and buses whose gross vehicle weight rating exceeds 8,500 pounds), their contribution to ambient levels of total suspended particulate (TSP) will increase over levels that are already significant. Current heavy-duty diesels emit more than twice the particulate per mile emitted by heavy-duty gasoline engines operated on leaded gasoline. (U.S. EPA 1981, 1910)

Gasoline burning engines were being heavily regulated by EPA and their emissions were being reduced. The increasing use of diesel engines, however, threatened to wipe out these gains. As gasoline engines' emissions declined, diesel engines' relative share also increased. In 1981, EPA suggested that:

> If current trends continue, EPA expects the use of diesel engines in heavy-duty vehicles to increase dramatically over the next 15 years. While diesel engines currently power about one-third of all new heavy-duty vehicles sold in the U.S., EPA expects this percentage to increase to 57–69 percent by 1995. This move toward more diesels will increase nationwide particulate emissions from heavy-duty diesels to an estimated 218,000-266,000 metric tons per year by 1995. Urban areas would be the most heavily affected by these emissions. (U.S. EPA 1981, 1910)

Truck manufacturers managed to meet the increasing standards through the 1980s without adding postcombustion treatment of exhaust, through improvements in combustion. Indeed, the first particulate standards, effective in 1988, required relatively minor actions to reduce the level of uncontrolled engines. One important result of the tougher clean air standards was the increasing reliance on electronic controls in mobile source engines to meet standards and improve performance. While the first electronic controls were simply add-ons to existing engines, by the late mid-1980s engine manufacturers began to introduce fully electronic control systems. Electronic engine controls also allowed manufacturers to price discriminate among customers, since engines were programmed differently for conditions that would result in higher warranty claims.

The 1990 Clean Air Act Amendments

The next set of major amendments to the Clean Air Act came in 1990, after more than a decade of political stalemate due in part to Michigan Congressman John Dingell's attempts to weaken mobile source regulation and divisions over acid rain (Bryner 1995, 111; Morriss 2000, 305–6). When the stalemate finally broke, the result was a large, complex bill that addressed multiple major programs, "an eight-inch pile of approximately 1,500 pages of typescript" (U.S. GAO 2000, 5). As part of that rewrite, the 1990 Clean Air Act Amendments added a number of new programs to mobile source regulation. Most of these were not relevant to the heavy-duty diesel engine industry, but new fuel mandates did come into being and standards were tightened again. Many of the mobile source provisions affected consumers rather than manufacturers and helped stationary sources shift burdens onto mobile sources. The 1990 amendments shifted heavy-duty diesel regulation to section 202 generally, except for NO_x, removing the requirement for specific reductions in emissions. The effect of the 1990 amendments "is to freeze the newly established provisions for 14 years" (Grad 2001, §2.06[d]).

Section 201 of the Clean Air Act Amendments of 1990 revised the standards applicable to emissions of HC, CO, NO_x, and particulate matter from heavy-duty vehicles or engines manufactured during or after model year 1983 to ones "which reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to cost, energy, and safety factors. . . ."[30] The Administrator was also given the authority to revise heavy-duty vehicle or engine standards "promulgated under, or before the date of, the enactment of the Clean Air Act Amendments of 1990 (or previously revised under this subparagraph)." The amendments also set stability of at least three model years and a lead time of no earlier than the model year commencing four years after promulgation of revised standards. After the 1990 amendments, EPA added regulations forbidding the use of "defeat devices" that would interfere with emissions controls in automobiles and light trucks.[31]

By 1997 EPA was reporting that heavy-duty diesels were the largest sources of particulates and NO_x among mobile sources. This assessment was made on a per-engine basis, not on the basis of the two fleets, of which the gasoline fleet was far larger than the diesel fleet. While emissions per se were at first an issue, concerns shifted in the early 1990s to matters of public health.

Regulation-by-Negotiation

As it tightened standards during the 1980s, EPA modified its approach in several ways to accommodate the need for greater flexibility in engine and truck manufacture. First, EPA introduced delays in implementation to accommodate economic conditions in the industry. Second, EPA delayed tighter standards to accommodate manufacturers' need for lead time. Third, EPA introduced "noncompliance penalties" that allowed engines that exceeded the standards (but did not pollute beyond an "upper limit" of acceptable pollution) (U.S. EPA 1985 35374) to be sold despite their failure to meet the standards.[32] The NCPs were intended to ameliorate problems with developing technology to meet the "technology-forcing" regulations (U.S. EPA 1985, 35375). This innovation was the result of EPA's first "negotiated rulemaking" exercise.[33] Agreement on the rule was reached in four months (Bryner 1995, 213).

Although not formally regulation-by-negotiation under the statute, EPA did engage in further cooperative efforts with the engine manufacturers and California regulators. In 1995, the engine manufacturers, EPA, and the California Air Resources Board negotiated a "Statement of Principles" for future regulation of heavy-duty diesel emissions, intended to provide the manufacturers with greater stability in the regulatory environment (U.S. EPA 1975, 45602–04). At the time, EPA termed the SOP "an historic agreement" and "an example of the type of private/public and federal/state partnership approach to environmental regulation that EPA is pursuing" (Office of Air and Radiation 1995a). When EPA later proposed additional regulations, however, the engine makers had "a sense of betrayal" and called on EPA to honor its "gentleman's agreement" (Kiesel 1997, 34).

Regulation-by-Litigation and the Consent Decree

In 1998 EPA sued the makers of more than 95 percent of U.S. heavy-duty diesel engines. EPA's suit came after remarks by EPA's engine programs director told a California air pollution meeting that diesel emissions were not declining, as EPA had predicted, but increasing (Bowman 1997).

Although some EPA staff's initial approach to the issue had been conciliatory, identifying "to more actively engage industry" as necessary (France n.d., 19), EPA soon argued that the use of electronic controllers to increase fuel economy during nonurban driving conditions amounted to illegal "defeat devices" under the Clean Air Act (Kennedy 1998). Since EPA's test simulates only urban driving conditions, EPA contended, the controllers were able to allow the engines to pass EPA's test without impairing long-haul fuel economy by reducing emissions only under test conditions. EPA Administrator Carol Browner claimed that the engine manufacturers "programmed the engine so that it knew when it was being tested and when it was on the road" (Johnson 1998, 1). EPA estimated that the practice improved fuel economy by 4-8 percent. Although the engine manufacturers denied EPA's claim that the controller use was illegal, on October 22, 1998, the seven U.S. heavy-duty engine manufacturers settled the enforcement actions by agreeing to pay substantial fines and to devote resources to approved environmental activities[34] and to retrofit the vehicles when they were rebuilt (Johnson 1998, 120). They also agreed to a parallel settlement with California (*Environment Reporter* 1998, 1286).

The engine manufacturers alleged that EPA knew about their use of electronic controllers from the beginning and had at least tacitly approved it (Galligan 1998, 30). For example, Volvo officials pointed to the existence of test results from Europe, using the quite different European test protocol, showing different results from the U.S. tests to demonstrate that EPA was aware of the off-cycle program by at least 1994 because the results were presented at a meeting attended by EPA officials (Parker and Johnson 1998, 47; U.S. House 2000, 14). A presentation by an EPA staff member had identified control strategies "based on the transient test cycle" as "the regulatory environment," (France n.d., 12) again suggesting EPA was aware of (and approved) building emissions control strategies around the test protocols. Environmental organizations concurred, claiming they had identified the problem in 1995 to EPA (Parker and Johnson 1998, 47). The California Air Resources Board also initially identified the problem as EPA's test procedures and northeastern states raised the issue with EPA in 1996.

The highly critical House Commerce Committee staff report *Asleep at the Wheel* also concluded that EPA was aware of the engine manufacturers' use of electronic controllers, as early as 1991 (U.S. House 2000, 6–7). Among the additional instances recounted in *Asleep at the Wheel*:

- In June 1991, representatives from Mercedes-Benz met with EPA officials and presented test data that showed that "engine timing on a competitor's engine increased after a certain amount of time had elapsed beyond the length of the FTP cycle." (6–7)

- In the course of reviewing the Mercedes' data, an EPA employee wrote a report concluding that "electronic controls are being used to tailor an engine's performance to the transient test." (7)

- In July 1991, an independent computer programmer approached EPA, alleging he had been hired to write defeat device code for Detroit Diesel. (9–12)

- John Deere & Co. submitted comments to an EPA rulemaking on off-road diesel engines noting it had discovered software in on-road engines that distinguished steady-state and transient operation, and producing higher NO_x emissions under the transient conditions. (12–14)

- A 1993 OECD publication on emissions control noted that "a recent set of tests in the US EPA Motor Vehicle Emission Laboratory found evidence of a "defeat strategy." (Appendix J)

EPA officials, however, denied knowledge before 1997, claiming they discovered the problem only when retesting an engine that had failed its initial test (Johnson 1998, 1; Galligan 1998, 30) Given the extensive evidence of multiple EPA employees' knowledge of the controller use and the agency's work on exactly the same issue during the 1970s in the automobile area, it is implausible that the agency was unaware of the problem well before the decision to litigate.

Regardless of the merits of this particular dispute over whether EPA had known of the use of electronic controllers or not, there is clearly a gray zone involving controller use. Indeed, in a 1972 memo, EPA's Office of Air Programs identified precisely this problem:

> Where does the basic engine stop and the control system begin? In a strict sense, even basic components such as a carburetor and a distributor could be considered defeat devices. The carburetor varies the air-fuel ratio, depending on air flow, throttle position, throttle movement, manifold vacuum, and other parameters. The distributor advances the spark as engine speed increases or load decreases. (Office of Air Programs 1972, 6)

Using such devices to protect engines or vehicles from damage "under extreme operating conditions" is clearly not illegal (1). Using them to "reduce control system effectiveness under ambient or operational conditions which are characteristically low emission modes in order to improve engine economy and/or performance" would not harm emissions goals and would improve engine performance. Rather, as EPA concluded in 1972, the devices are illegal when they are "intended to 'beat the test'" (7, 8).

Thus in 1972 EPA wrestled with exactly the same issue with respect to automobiles as it faced in 1997–1998 with the heavy-duty diesel engines. EPA's investigation then, for example, determined that prohibiting "*all* temperature actuated devices" the result would affect "substantially all of the production of 14 [automobile] manufacturers" (Mobile Source Pollution Control Program 1972, 3, 5). When considering how to treat these controls, EPA's staff position paper determined that rejecting a vehicle because of its emissions outside of the federal test procedure ("FTP") was inappropriate and that revision of the FTP was the more appropriate means to address such concerns. The staff recommended putting the focus on whether or not a particular control was aimed at discovering the test cycle or at modifying operations to adapt to engine conditions (16–18).

Early work identified that "[t]he major advantage of electronic controllers, in terms of emission control is that they permit control system components to be programmed based on instantaneous sensing of engine variables. This allows control devices to operate fully when they have the most beneficial effect on emissions and the least deleterious effect on other aspects of engine performance" (Motor Vehicle Nitrogen Oxides Standard Committee 1981, 24). A controller that varies engine operation during certain conditions to protect the engine may be hard to distinguish from one that does so merely to avoid performance penalties, particularly when emissions controls are not postcombustion "black boxes" like catalytic converters but combinations of injection timing and other engine parameters. Moreover, even before the advent of electronic controllers, the optimization of emissions control during testing was a well recognized strategy of mobile source manufacturers (U.S. EPA 1979, 7). Indeed, as Caterpillar told EPA in 1978, "manufacturers have no choice but to design engines to meet whatever test is prescribed" (11). EPA itself concluded in 1979 that "the attainment of emission standards entails designing to a given test procedure" (219). Such optimization need not be the result of bad motives: Engines optimized to the U.S. test cycle performed poorly on European tests and vice versa (Association des Constructeurs Européens d'Automobiles g.i.e. 1994, 4, table 2). Indeed, the most plausible explanation for the difference between test results and actual emissions was offered by *Fleet Owner* magazine: EPA "told engine makers to develop new technology to meet the law, but wrote enforcement procedures based on old technology" (Mele 1998, TC3). The technology that developed was "far more sophisticated than EPA anticipated."

One result of the combination of the form of EPA's regulations and advances in engine controls was that it became possible for engine controllers to detect the EPA test cycle and manage engine performance to minimize emissions of regulated pollutants during the test cycle. Testing of pre-MY1999 engines showed that controllers were programmed to do so (Clark et al. 92). As a result, diesel emissions were significantly more than predicted for NO_x and particulates.[35] Similar problems occurred with automobiles (Reitze 2000, 359–60).

Because of the lead time provisions, EPA was unable to act through regulation-by-regulation to tighten diesel emissions standards before MY2007. Moreover, the Statement of Principles agreed to by EPA in 1995 would have constrained any regulation-by-negotiation outcome—the engine manufacturers would have surely resisted changing the terms of the SOP to permit faster tightening of regulations and environmental groups had not accepted the SOP from the start.

EPA also had strong incentives to proceed by regulation-by-litigation in addition to the disadvantages of regulation-by-regulation and regulation-by-negotiation in these particular circumstances. First, the gap between predicted and actual diesel emissions was contributing to EPA and the states' problems in bringing nonattainment regions into compliance with the NAAQS. Inspection and maintenance programs were causing popular unrest with clean air regulations in several states, for example. Second, EPA and the Clinton Administration could reap immediate political rewards by appearing "tough on polluters" during the runup to the 2000 presidential election (Wilson 1999, 3268–69). Third, EPA faced relatively low risks of losing the litigation because the enormous leverage it had over the engine manufacturers made a settlement all but assured.

Regardless of the merits of EPA's case, vigorously contested by the engine manufacturers,[36] EPA and the Clinton Administration reaped a publicity windfall from the settlement. Attorney General Janet Reno, for example, was quoted as saying "Every polluter in America had better take note of these record penalties—if you pollute America's air, you are going to pay a very high price" (Johnson 1998, 120).

EPA had enormous leverage over the engine companies because of the requirement for annual certification of engines (U.S. House 2000, 5). Mack's vice president of engineering and product planning, for example, told a reporter that EPA "held a gun to our head by threatening to withhold certification for 1999" (Galligan 1998, 2). Other companies echoed the concern, citing the need to litigate with EPA annually over certification until the issue was resolved. The negotiations took place after EPA had issued "conditional" certificates of conformity for MY1998 engines that exempted engines that employed defeat devices,[37] while the engine manufacturers were seeking certificates for MY1999 engines, and while a related "show cause" order from EPA to the engine manufacturers was pending (U.S. House 2000, 16). This leverage minimized the political risk that EPA might lose the litigation since it increased the probability of settlement.

Engine customers immediately expressed concern that the settlement provided inadequate lead time for designing new trucks to accommodate the redesign of the engines that would be necessary (Johnson 1998, 120; Berg 2000, 10). Because EPA implemented its response through regulation-by-litigation, the truck manufacturers had no ability to participate in the regulatory process. The Truck Manufacturers Association sought to intervene in the litigation to make its views opposing the terms known, but its request to do so was denied. Environmental groups were also shut out of the process, and they objected to the terms of the settlement as insufficiently stringent (Meinert 1998). In particular, they argued that EPA should require immediate recall and retrofitting of the trucks with the objectionable controllers, rather than allowing them to be changed only during a regular rebuild.

The varying degrees of vertical integration found in the diesel engine/truck building industry imply differing competitive effects resulting from the 1998 consent decree, but the overall effects are by no means clear. For example, pure engine manufacturers, of which there are now only two—Caterpillar and Cummins—must work extensively with different truck builders to design engines that will integrate into the various truck models. Working on multiple models with multiple truck builders is costly under the best of circumstances. Vertically integrated engine/truck producers, such as Daimler-Chrysler that now owns Detroit Diesel and truckbuilder, Freightliner, may avoid some elements of transaction cost faced by the pure engine builders. In either case, engine and truck producers must be concerned about lead times for integration of engines and trucks. All the while trucking companies fear formidable production bottlenecks as just-in-time engines are certified but then cannot be sold without first being properly tested and approved for particular truck chassis.

There has been confusion, therefore, among independent truck manufacturers as to why the engine manufacturers have been supporting the 1998 consent decree even as the technology for satisfying the stringent requirements by October 2002 has yet to be proven, but likely these are strategic decisions based on competitive advantages perceived, or at least hoped for, by the individual firms. If one engine manufacturer can satisfy the October 2002 requirements before any of the others, regardless of any practical lead time for the truck manufacturers, they would have a substantial competitive advantage in engine production for model year 2003 and beyond.

In this sense, the EPA initially was a cartelizing influence on the engine manufacturing industry. Indeed, industry analysts have praised tightening emissions controls as good news for market leaders, citing a number of manufacturers' exits from engine markets (Amberg-Vajdic 1993, 10A). Lately, however, the cooperation has broken apart. The five remaining main North American diesel engine manufacturers banded together in 1998 against EPA accusations of illegal defeat devices and signed a consent decree to move the industry forward, but as the deadline for satisfying the decree approaches, there are gains to be had by any firm that can break free from the cartel through technological advantage. The five adopted different technological approaches to meeting the consent decree requirements: Detroit Diesel is using an EGR system; Volvo is using an EGR system that uses high pressure pulses created by the exhaust system; Mack is using a "cooled EGR" system; Cummins has a cooled EGR system with a proprietary "variable geometry turbocharger;" Caterpillar has a non-EGR system that "involves optimizing in-cylinder combustion and using exhaust after treatment along with an oxidizing catalyst chamber" (Deierlein 2001, 32). This race-to-the-top is a driving motivation behind the major engine manufacturers' current stance of ignoring truck manufacturers' pleas for lead time and agreeing to satisfy the terms of the decree even as time runs out with the deadline approaching, and no tested technology for satisfying the requirements assuredly proven.

EPA certified a Cummins' engine as meeting the consent decree terms in April 2002. Cummins, which opted not to develop a new engine technology as a means of saving costs, thus met the deadline, while Caterpillar, which invested in new technology (Hartley 2001, 16), was not (*Overdrive* 2001, 16). EPA has also proposed noncompliance penalties of up to $15,000 per engine for those manufacturers who do not meet the consent decree standards. Truck engine consumers appear to be expressing skepticism about the new engines, with "pre-buying" taking place while MY2001 engines are still available (Schneider 2002, 9; Ball 2002, A12; Whitten 2002, 33). And for good reason. The market requires more than EPA certification. Whether vertically integrated or not, engine producers must work intently with truck builders to make the necessary modifications so that engines will fit and function effectively in newly designed trucks. An editorial in *Transport Topics* (2002, 8) predicted that large fleets would buy a "few" new engines when they became available to test them for up to a year before integrating them into fleets. Demand for three- to five-year-old used trucks is also up (Heine 2002, 14).

EPA continues to view heavy-duty diesel engines standards as in need of additional tightening, proposing in 2001 a significant reduction for MY2007. These standards incorporate elements based on the settlements from the litigation with the engine manufacturers. Japanese and European regulators are also significantly tightening heavy-duty diesel emissions standards. However, the standards proposed for MY2007 in the United States are significantly tougher than those proposed for Europe and Japan.

The MY2007 standards reflect a significant cost increase relative to earlier standards. One study concluded that, compared to the EU2 regulations in effect after 1998, the MY2007 U.S. regulations were 32 to 37 percent tougher for heavy-duty trucks, depending on the technology used, and were more costly on at least ten of fourteen design criteria and better on only one (Moser, Sams, and Cartellieri 2001, 61–62, tables 2 and 3). The ever-increasing stringency of the U.S. standards will require major engine redesign (59).

The regulations are forcing increased vertical integration, with truck makers offering fewer choices of engines with their trucks (Longton 2002, 14). They are the major driving force in engine development today—an *Overdrive* cover story summed up their impact: "The near future of heavy-truck engines can be summed up in two numbers, 2002 and 2007—the years the Environmental Protection Agency has chosen to further tighten the regulatory clamps on exhaust emissions" (Hartley 2001, 64). Both the 2004 and 2007 standards will require substantial increases in control systems complexity, both in controlling combustion and adding after-treatment devices.

Anticipation and Results

At this point, we can address what may have been anticipated by EPA litigators when the 1998 consent was obtained and what has resulted. Taking a public interest theory approach to this matter leads to the conclusion that EPA anticipated obtaining large reductions of NO_X and other emissions sooner than reg-reg would have provided, and that the consent decree would force technical solutions to the engine control problem that would eliminate the whole matter of defeat devices. These expectations logically assume that engine producers would somehow meet the stricter emission standards on time and that truck builders and fleet operators would stand in line to purchase the new engines when they emerged from the factories, which is to say that engine buyers would not dramatically change their normal buying patterns. Indeed, the consent agreement required that engine producers not engage in marketing activities designed to subvert the intentions of the consent. The expectations would also assume that engine producers would leapfrog the electronic engine controller technology and adopt a new technology that could not be operated as a defeat device.

As it turns out, there has been a huge industry prepurchase response to the consent mandates. For example, to consider only one manufacturer, Detroit Diesel Corp. has received sufficient preorders that its manufacturing plant is running at capacity, 24 hours per day using three shifts. By contrast, its post-October 1 demand forecast will require a 79 percent drop in engine production (Allran 2002, 2). Detroit Diesel's sales of MY2002 engines have been more than double normal sales volume and it has had to reject more than 1,000 orders due to lack of capacity (Detroit Diesel Corp. 2002, 11). By some estimates, more than 70 percent of the clean air benefits are lost due to these types of effects (Harrison and Darlington 2002, vii). Not only are the new engines more costly, but they are untested as compared with preconsent engines. In short, the expectations of purchases of the mandated and cleaner engines will not occur smoothly. Instead, there will be a larger stock of preconsent engines operating that might have been the case had the consent not been negotiated.

As to defeat device controllers, only Caterpillar has thus far indicated that its engines will use a new emission control technology that avoids entirely the use of electronic controllers for that purpose. The other engine producers have not as yet adopted new technologies but still appear to be using electronic controllers to manage engine emissions. With electronic controllers still being used, it is conceivable that some diesel engine producers could again be accused of using a defeat device in the form of electronic controllers.

In short, what might have been reasonably anticipated by EPA litigators has not been achieved. At the same time, massive costs are being borne by trucking companies, truck producers, and diesel engine producers as they grapple with EPA's efforts to short circuit the route to cleaner engines. Of course, these costs will eventually be borne by consumers.

We have obviously made no attempt to quantify the benefits and costs of the reg-lit episode, but it seems clear that what might be termed the ideal outcome has been frustrated for all parties. EPA's own estimates of the costs per engine are now from $1,100 to $2,899 in additional hardware and $1,260 per year of additional maintenance and operating costs in addition to any fuel economy losses (Detroit Diesel Corp. 2002, 16). Even ignoring fleet effects, the cost-per-ton of reducing NO_x+NMHC is now more than $1,800 by EPA's own estimates; considering fleet effects, it rises to as much as $13,000 (Harrison and Darlington 2002, vi).

We have now completed our discussion of the history of the regulation of diesel engine emissions. We will now merge our discussion of regulation theory, the stylized facts regarding the regulatory controversy, and the history of EPA regulation of diesel engine emissions. Our final integration of these three components of the article will then lead to some final conclusions on the regulation of litigation.

SUMMARY AND CONCLUSION

We began this report with a general discussion of regulation that included a summary of major theories of regulation and a review of regulatory process options that are available when a regulator chooses to act. We then provided a detailed review of regulation-by-litigation, giving examples of its application along with comments from various scholars and practitioners who have assessed reg-lit and its implications. Our discussion next focused on EPA's move to apply regulation-by-litigation and the agency's actions that were taken against coal-fired electricity generators and other industries. We saw EPA's effort to generate reductions in nitrogen oxide emissions was a part of the agency's motivation for bringing these suits. It was not immediately clear why the agency brought suit instead of using traditional regulation to accomplish the same end. Theoretical notions that might help answer this question were raised in our discussion of the episodes.

We next turned to the central purpose of this paper, recounting and analyzing the diesel engine manufacturers' controversy. We emphasized EPA's challenge: How to generate significant progress in reducing nitrogen oxide emissions amidst a host of regulatory and political constraints that we identified. As the story unfolded, we developed a list of stylized facts that captured the essence of the constraints affecting EPA's and the regulated industry's behavior. We next provided a detailed history of the regulation of diesel engine emission. We will now use key elements of the theory of regulation to explain how, given the constraints, EPA chose to use regulation-by-litigation. We will then provide some final thoughts on the future implications of reg-lit.

The Theory and the Facts

There are nine stylized facts that we have identified in the EPA/diesel engine controversy. We will now address the facts with notions drawn from our earlier discussion of regulatory theory.

1. States must meet federally mandated ambient air quality standards; failure to do so is costly for states. Because of wind currents that carry emissions from one region to another, the ability of any given state to meet these standards is partly controlled by activities in other states.

    We see this fact as the basic stimulus for EPA's decision to take regulatory action. Suits and petitions from northeastern states that risk being placed in nonattainment status add urgency to the stimulus. Agency leaders trumpeted their support for stricter emission regulations. A tough presidential campaign lies ahead. The politics and the "get tough" policy of EPA's enforcement division call for action. The targets for EPA's actions, and the choice of regulatory process, are to be determined by legal and other constraints that place firms and industries out of the reach of traditional regulation, the number and size of firms to be regulated, the diffuse nature of consumers who will bear the cost of EPA's final action against producers, and the extent to which firms that may be sued will be capable of paying sizable fines that signal action, which is to say, the political action will extract payments.

2. Mobile and stationary sources are regulated differently under the Clean Air Act, with states having more limited control over mobile source emissions than they do over stationary sources, creating the potential for "regulatory arbitrage" across categories. Emissions of particular pollutants by one source implicitly require fewer emissions of that pollutant by other sources.

    This fact predicts the form of action taken by the states in seeking EPA action. The state SIPs include planned reductions in pollution from stationary sources and predicted levels of pollution from mobile sources. States are caught in a competitive struggle for employment-generating stationary sources; stricter and less certain stationary standards can translate into higher relative costs for firms that might locate or remain located in a particular state. If the state can induce reductions from mobile sources at low cost, doing so is a substitute for imposing even stricter standards on stationary sources. Of course, if the state fails satisfactorily to obtain sufficient reductions from all sources taken together, the state can be classified as nonattainment, which triggers costly actions to be taken for stationary and mobile sources. The downwind states seek to minimize their internal costs. By petitioning for reductions to be made by upwind states in the new source review controversy, the downwind states hoped to shift the regulatory burden to other shoulders. If EPA imposes stricter controls on diesel engine manufacturers, the same upwind states, as well as others, can avoid taking action against local stationary sources, which is more costly in political terms.

3. Models drive much of the regulatory agenda because models are how EPA evaluates compliance with the Clean Air Act requirements. Overprediction of control allows approval of a SIP but eventually forces changes as the control measures do not lead to compliance with the NAAQS.

   The lack of an extensive, nationwide, air quality monitoring system means that EPA must rely on engineering models to forecast air quality outcomes. All model results have error terms; none give perfect forecasts. In building a regulatory strategy, EPA designs a regulatory approach on the basis of model-based expectations, then a reality check determines the extent to which the regulatory approach is working. When EPA realized that nitrogen oxide emission levels in urban areas exceeded the expected amount, action was called for. This galvanized and reinforced the political urgency of obtaining quick results.

4. EPA faces different costs and benefits for the agency in choosing among regulation-by-regulation, regulation-by-negotiation, and regulation-by-litigation. Different situations will lead EPA to choose different regulatory instruments.

   The public interest theory predicts that regulators will seek to minimize all costs taken together when developing and implementing a regulatory strategy. The special interest theory says that regulators will seek to minimize their cost when developing and implementing a strategy. The extraction theory says regulators will seek remedies that generate tangible political rewards. Bootlegger-Baptist theory predicts regulators will be aided by groups that bring moral authority to their cause. In the diesel engine controversy, with all its constraints, EPA still had a choice when considering regulatory strategies. Environmental groups, accustomed to using the courts in pursuit of their interests, would predictably call for quick and meaningful action. They would support bringing suits against violators and penalize them. The agency would evaluate the targeted firms. Could they pay penalties and were they and their constituencies powerful enough politically to deflect the agency's actions? A decision to use regulation-by-regulation could be criticized by environmentalists because of the delay in getting results. On the other hand, reg-lit offered the attraction of bringing a timely outcome in a politically visible way. The diesel engine producers and their constituencies apparently lacked the political clout to deflect the action. There is one other timing consideration. Actions under litigation are not likely to be interrupted by a new administration. Regulations in the pipeline can easily be stopped. Selection of reg-lit placed the action out of the reach of an opposing political party, should there be a change in administration.

5. The form of mobile source controls in the Clean Air Act depends on fleet turnover for introduction of improvements and so has only a gradual impact on emissions. Turnover is partly endogenous to regulatory costs and so can be slowed by new controls that increase costs directly or indirectly (e.g., by reducing fuel efficiency).

   EPA is constrained by the dynamics of the marketplace when seeking to achieve quick results for lower nitrogen oxide emission reductions from mobile sources. The population of vehicles to be affected was huge, and only a small part of the stock was replaced annually. In addition, decisions to replace old model engines were conditioned by economic costs. If newer engines are more costly and less fuel efficient than older ones, then older engines will be conserved. Some engines will be replaced earlier, in advance of the more costly engines. Others will be operated longer. When confronting a process choice—reg-lit versus reg-reg, EPA sees an advantage in reg-lit. With a favorable settlement, the agency can trumpet the prospects of earlier improvements, no matter what the final accounting might render. This, too, supports reg-lit.

6. The Clean Air Act sometimes requires technology-forcing for mobile sources. Manufacturers must then invest in developing technology to which their customers are indifferent or hostile. Investments will therefore be made to minimize the customer-perceived negative impacts on the product. Regulatory choices for diesel engines involve important tradeoffs across pollutants controlled. Increasing control of one may "cost" regulators increased emissions of another. Such tradeoffs are not generally linear. Regulations specified in terms of satisfying specific test standards provide an incentive to design engines to the standards.

7. Among the technologies "forced" by earlier regulatory efforts is sophisticated electronic control of combustion, making possible different modes of operation under different conditions sensed by the controller. Such controllers make it possible for engine manufacturers to offer customers enhanced performance in customer-demanded dimensions outside areas of performance examined directly by regulators' tests. At times, the customer may assign higher value to fuel efficiency than emission reductions. Tradeoffs exist between regulator-desired engine characteristics (e.g., low emissions) and customer-desired engine characteristics (e.g., low cost, high fuel economy).

> As diesel engine emission regulation evolved, EPA took a performance standard approach in setting emission standards. That is, the agency did not specify generic technologies to be applied to engines, with the expectation that the technologies, when operated, would achieve the implicit clean air goal. Performance standards allowed producers to compete in the development of engines that would meet the standard. Then, EPA used a technology standard in developing test procedures. While producers competed in the design of engines, they ultimately competed with the details of the test procedure itself in developing controls for operating the clean engine technologies. A characteristic of diesel engine technology causes a tradeoff between nitrogen oxide and other emissions and fuel economy. At the margin, cleaner air comes at the expense of fuel efficiency. As emissions are reduced sequentially, the cost in fuel economy foregone rises. Because of this, diesel engine producers, seeking to minimize the cost induced by regulation, have an incentive to design engine controllers that enable engines to satisfy EPA-dictated tests developed out of concern for urban air quality but also improve fuel efficiency when the engine operated out of urban environments. In terms of the relevant private interests, one part of the technology mattered little to trucking companies and their customers. The other part, fuel efficiency, mattered a lot. Apparent decisions to trade private benefits (fuel cost savings) for public benefits (cleaner air) played into a successful litigation strategy for EPA. The engine controller, which could be described as a performance maximizer, subject to an urban emission control constraint, could now be demonized for being simply a defeat device.

8. Heavy-duty diesel use has been growing since the 1970s, increasing the importance of controlling diesel emissions and magnifying any discrepancies between the model predictions and ambient pollutant levels due to differences between predicted and actual emissions.

> EPA's modeling difficulties were confounded further by the growth in the population of heavy diesel-equipped trucks relative to those powered by gasoline engines. Significant improvement in diesel technology, coupled with the engine's inherent fuel efficiency advantage over gasoline engines, made the diesel engine more attractive to the highly competitive trucking industry. Models for forecasting urban air quality underpredicted the diesel engine nitrogen oxide contribution to the problem, making diesel engines an apparent target for regulatory action. The success of the engine contributed to its attraction as a target. Here was an economically strong product. The increase in cost associated with litigation, which could be spread across hundreds of thousands of units, should not be large enough to capsize the product in the market.

9. Changes in heavy-duty diesel engines are slower to work their way into and through fleets because of the nonintegrated nature of the industry. This slows the introduction of changed engines into production models. Because of the long life of heavy-duty diesel engines, compared to other mobile sources, older engines continue to emit pollutants long after comparable car engines are scrapped.

> In spite of the diesel engine producers' inherent attractiveness as a regulatory target, their being few in number and financially capable of handling a heavy fine, the industry structure made it difficult to bring a well-articulated change on the road. At the same time, it was less costly to impose regulation on engines destined to be installed in trucks and equipment than to sue all those who might install or operate diesel engines in their equipment. EPA had previously identified diesel engine producers as the component of the industry that was more readily targeted, and the part of the diesel emission control problem that when regulated would eventually bring the emission reductions the agency desired. The logic that supported initial regulation became the logic that supported litigation.

Regulation-by-litigation prevailed over regulation-by-regulation.

Serving the Public Interest

In his discussion of reg-lit, Richard Epstein described two responses that might be taken by a constitutional government to address harms imposed by some members of the community on others against their will (Center for Legal Policy 1999, 61–62). The first response he described called for a determination of the number being harmed and, implicitly, the cost of their organizing common law suits against the parties that had invaded their property rights, assuming, of course, a common law framework exists. If private action was feasible, then there would be no further role for the state. Epstein implies that government has a responsibility to assist in defining and enforcing property rights. The provision of a system of justice for settling property rights disputes provides adequate protection of the public interest. Epstein goes on in his comment to consider briefly those situations where many unwilling individuals are harmed; the collective harm is large but the individual harm is too small to justify taking private action. In these cases, he suggests, government can act for the citizens, following a tradition that relates to a "distinction between general and special damages as early as 1535" (61).

Epstein moves from antiquity to the present in his next comment where he explains that our modern interpretation of government calls for government to act; if, after proper deliberations among appropriately elected officials, government fails to act, then government has failed. Under this theory, any failure to intervene in the name of public health, no matter the cost, is a failure to serve the public interest. Given that government has failed, special interest groups that claim to be serving the public interest move to the courts. As Epstein puts it, "So-called public health positions are always going to get at least two bites at the apple. They, in effect, have to win only one war; industries in defensive positions are going to have to fight their battles over and over again" (Center for Legal Policy 1999, 62).

The Epstein discussion was focused on suits undertaken by attorneys general in moves against handgun and cigarette producers; the discussion was not about the use of reg-lit by federal agencies in their pursuit of firms or industries already regulated. But while this was not the focus on Epstein's comments, it is still possible to glean something from them for the case at hand. In doing so, we return to Epstein's point about constitutional government and the democratic process and apply to the diesel engine case.

It seems clear enough that the harm imposed on individuals by diesel engine emissions coming from trucks and other equipment is so small that no one person or small group could justify organizing a suit against the emission producers. Indeed, we will not attempt to reach a judgment as to whether or not the collective harms would justify action, but we will assume that to be the case. Assuming that a case for general harm can be made, then, as Epstein suggests, government can act for the harmed individuals. The passage of the Clean Air Act and its amendments is the first result. The regulations affecting diesel engine emissions that evolved from the statute is the continuing result. When Congress debated the statute, the affected industry and all other interested parties had access to the debate. When EPA engaged in regulation-by-regulation and regulation negotiation, the industry and all other interested parties had access to the regulatory process and to the courts if the regulatory process was seen as improper. Everyone had the same number of bites at the apple. In the process, some modicum of regulatory certainty was assured for the industry and for all who favored stricter standards. The process was transparent to the participants and to the monitors of the regulatory process in the legislative and executive branch.

EPA's decision to litigate did not necessarily represent a second bite at the apple for those who support cleaner air, although that was a result of the settlement. It was rather a fresh bite by the regulator for the regulator. As we see it, EPA, as a regulator, faced a political challenge. The agency was caught between northeastern states who faced the cost of nonattainment status, recognition that past estimates of improvements in air quality were faulty, an administration that wished to be recognized as being tough on polluters, and a regulatory process that constrained fast action.

By employing reg-lit, EPA took its own bite from the apple.

The cost of this episode cannot be reckoned in terms of the magnitude of the settlement, which was a transfer from the owners of the diesel engine producers to federal taxpayers. Nor can it be reckoned just in terms of its effects on the cost of diesel engines and related effects on transportation and other activities powered by large diesel engines. These are clearly costs to consider, and to be minimized if possible. The more serious cost of the diesel reg-lit relates to the integrity of the regulatory process itself and the effect of reg-lit on the behavior of participants in future regulatory episodes.

EPA's recent and extensive employment of regulation-by-litigation has set a new precedent in the already controversial annals of federal regulation. It remains to be seen if reg-lit will become a dominant form of regulation or if EPA's expansive and recent use of the process will mark the end of reg-lit.

We have no reason to predict that reg-lit will end any time soon. Indeed, the various theories we have employed to explain this episode suggest that when the conditions that triggered this episode arise again, then reg-lit will just as surely emerge again.

NOTES

1. For a brief account of the diesel litigation, see Diesel Progress (1998).
2. For an example involving the state of Maryland, see Fund and Wooster (2000, 13). For the reverse of this, see comments by litigator Michael Wallace (Center for Legal Policy 1999, 8–9), where he explains how the Mississippi legislature adopted a tort reform act in 1994 that would have precluded the successful tobacco unit.
3. 40 CFR S 60.14(e).
4. 42 U.S.C.A. §7408(a)(1).
5. 40 CFR § 50 (2001).
6. 42 U.S.C.A. §7410(2).
7. 5 U.S.C.A. §551 et seq.
8. 42 U.S.C.A. § 7521(a)(3)(C). The federal restriction does not, of course, prevent states in nonattainment areas from adopting California's standards that effectively duplicate EPA's intent. However, this requires obtaining a "waiver of preemption," which cannot be obtained if the state's intended strategy is inconsistent with federal programs.
9. 42 U.S.C.A. § 7521(a)(3)(C).
10. The trucking industry uses over $11,000,000 worth of diesel fuel per year (Charles River Associates 2000, 58). Without the 35 percent fuel efficiency savings, that would be $16,500,000. The difference (5.5 bn) calculated at an average U.S. diesel price of $1.34 per gallon equates to $7,370,000 in savings (U.S. Department of Energy 2002).
11. Packaging efficiency refers to the higher power output levels, at low speeds, that diesels are able to achieve. Diesels require less cooling than spark-ignition engines and for this reason they can generate more power at lower speeds. In the exhaust system of a typical compression-ignition engine the temperature will average between 200 and 500 degrees Celsius, whereas in the exhaust system of a typical spark-ignition engine the temperature will average 400-600 degrees Celsius, and will rise to about 900 degrees Celsius at maximum power (Charles River Associates 2000, 2).
12. The fuel used in diesel engines is less volatile and safer to store than other fuels. This safety aspect to diesel engine use is attractive for certain applications including trucks that ferry hazardous material, in fire fighting equipment, ambulances, military vehicles, and school buses (Charles River Associates 2000, 2).
13. U.S. Department of Transportation (2000, tables MF-21 and MF-33E). This increase is virtually entirely due to engines in trucking.
14. Diesel emissions are different from gasoline engines: "Diesel-powered engines emit significantly less CO than comparable gasoline engines. HC emissions from diesels are comparable to those of gasoline vehicles, but diesel engines generally produce more of the kinds of HC emissions associated with cancer. NO_x emissions from diesels, however, are considerably higher than from comparable gaso-

line vehicles due to the higher temperature combustion, the oxygen concentration, and residence time of the fuel" (Reitze 2000, 395).

15. Ambient data is "sparse" but measurements in Los Angeles in the 1980s found "diesel emissions accounted for approximately 3 percent of the mass of total particulate matter and 7 percent of the mass of fine particles emitted into the atmosphere," results that accord with EPA model (Health Effects Institute 1995, 6).
16. U.S. EPA (1968b, 8306) established hydrocarbon and CO standards for heavy-duty gasoline powered engines (Subpart D) differentiated from heavy-duty diesel exhaust emissions standards contained in Subpart E.
17. EPA's choices differ significantly from those of regulators in other countries. For example, in the 1990s Japan required 50 percent more stringent CO controls but allowed more than 100 percent more hydrocarbon emissions and seven times as much particulate emissions (International Program on Chemical Safety 1996, p. 134, table 30).
18. 40 C.F.R. §85.974-1 (1974).
19. 40 C.F.R. §86.007-11(a)(1)(A)(I), (ii) (2001).
20. 40 C.F.R. §86.088-11 (1988).
21. 40 C.F.R. §86.007-11(a)(1)(A)(iv) (2001).
22. 40 C.F.R. § 86.004-2 (2001).
23. "The opacity of smoke emissions from new diesel engines subject to this subpart shall not exceed: (1) 40% during the engine acceleration mode; (2) 20 % during the engine lugging mode" (U.S. EPA 1968b, 8306).
24. One congressman called the internal combustion engine the "most serious and dangerous source of air pollution in the Nation today" (Morriss 2000, 286).
25. Section 224 of the Clean Air Act Amendments of 1977 (P.L. 95-95) amended Section 202(a) of the Clean Air Act by adding the following: "(3)(A)(I) The Administrator shall prescribe regulations under paragraph (1) of this subsection applicable to emissions of carbon monoxide, hydrocarbons, and oxides of nitrogen from classes or categories of heavy-duty vehicles or engines manufactured during and after model year 1979. Such regulations . . . shall contain standards which reflect the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the model year to which such standards apply, giving appropriate consideration to the cost of applying such technology within the period of time available to manufacturers and to noise, energy, and safety factors associated with the application of the technology" 91 Stat. 685, 765 (1977).
26. The 1977 amendments' congressional findings included that: "heavy-duty truck and bus emissions have not been adequately reduced. Although standards applicable to new heavy-duty engines have been promulgated, their requirements are much more lenient (even in terms of per cent reduction from uncontrolled levels) than the statutory requirements for light-duty vehicles. . . . The 1977 federal standards require no reduction of HC, NO_X, or CO from uncontrolled diesel-powered engines" (U.S. House 1977, 271–72).
27. Section 224, Clean Air Act Amendments of 1977, P.L. 95-95, 91 Stat. 685, 765.
28. "EPA projects that 36% of the diesel engine families will emit at or below target emission levels. . . . The approaches that EPA anticipates for achieving the targets are not new: such things as injector spray pattern and sac volume, after-cooling of turbocharged intake flows, and turbocharging of naturally-aspirated engines are available paths to compliance" (U.S. EPA 1980, 4144). The same was true for automobile standards through the 1990s.

29. "Transient testing requirements were roundly criticized by both gasoline and diesel engine manufacturers [and others]" (U.S. EPA 1980, 4147).
30. Section 20, Clean Air Act Amendments of 1990, P.L. 101-549, 104 Stat. 2399, 2472 as codified at 42 U.S.C.A. §7521(a)(3)(A)(I) (West 1995).
31. 40 C.F.R. § 86.094-16(a) (2001) (light-duty vehicles and trucks).
32. On Aug. 30, 1985, the EPA promulgated the generic aspects of a nonconformance penalty (NCP) rule to: "allow a manufacturer of heavy-duty engines (HDEs) or heavy-duty vehicles (HDVs) whose engines or vehicles fail to conform with certain applicable emissions standards, but which do not exceed a designated upper limit, to be issued a certificate of conformity upon payment of a monetary penalty" (U.S. EPA 1985, 35374).
33. "This rule is the result of an innovative rulemaking process called Regulatory Negotiation, the concept of which is to allow the parties interested in or affected by the outcome of the rule an opportunity to participate in its development through face-to-face negotiations. This rule, which was proposed in 50 FR 9204 (March 6, 1985), is based upon the consensus reached during the Regulatory Negotiation process. This is EPA's first completed rulemaking under this new regulatory process" (U.S. EPA 1985, 35374).
34. The fines and commitment of resources to approved environmental activities were based on sales of engines alleged to violate the rule and totaled:

Caterpillar	$60,000,000	
Cummins	$60,000,000	
Mack Trucks	$31,000,000	
Detroit Diesel	$24,500,000	
Volvo	$14,000,000	
Navistar International	$ 2,900,000	(Johnson 1998, 120).

35. A comparison of EPA test cycle data with actual operating data on two engines found, for example, that test and operating conditions differed by large amounts. (Clark et al. 2002, 92).
36. There was (and remains) an important legal issue of whether the Clean Air Act grants EPA authority to regulate emissions off the test cycle. In a letter commenting on EPA's proposed post-1990 amendments changes to the test procedure, the Specialty Equipment Market Association argued that "The proposal would essentially mandate emission control under all possible driving conditions. This requirement, in whatever form it would take, could have the potential to essentially extend emission control compliance liability to all operating conditions. There is no statutory mandate or authority for such action. Moreover, under Section 206(h), Congress required that test procedures focus on representative driving behavior. This limitation indicates the desire of Congress to avoid regulation that would cover infrequent or unusual behavior.

    By extending emission control compliance liability to all operating conditions, EPA is effectively changing the numerical standards under Clean Air Act Section 202(a)(3)(B)(ii), (g), (h) and (I), by requiring numerical standards in vehicle operational modes where previously the emission standard was unlimited" (John Russell Deane III, written correspondence to EPA, 1995, 10–11, copy on file with the authors).
37. See, e.g., "1998 Model Year Certificate of Conformity with the Clean Air Act," issued to: Caterpillar, Inc., Certificate Number CPX-MHDD-98-03, dated November 20, 1997 (copy on file with authors).

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