IV

The Automobile Controversy—Federal Control of Vehicular Emissions

In the Clean Air Act Congress established emissions standards for new cars. The regulations provided for by the Act have been largely ineffective in improving air quality. This Comment examines the reasons for this failure, and suggests alternative solutions to the mobile source pollution problem.

A

THE CLEAN AIR AMENDMENTS OF 1970 AND SUBSEQUENT DEVELOPMENTS

Title I of the Clean Air Act directs the Environmental Protection Agency (EPA) to promulgate national ambient air quality standards. Primary standards must protect the public health with a margin of safety, while the secondary standards must protect the public welfare from any known or anticipated adverse effects. In accordance with the margin of safety requirement, consideration was given to the health of those most sensitive to air pollutants, at least in setting the carbon monoxide standards. EPA has set standards for six pollutants; these are presented in Table I. The standards set limits on average pollutant concentration over certain periods of time. Except for two pollutants, the primary and secondary standards are identical.

The states have primary responsibility for achieving the ambient air quality standards. Title I of the Act requires them to adopt and enforce implementation plans which would allow them to comply with the standards by mid-1975. Under certain circumstances EPA is authorized to grant a state an extension of time for attaining compli-

TABLE 1: NATIONAL AMBIENT AIR QUALITY STANDARDS

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<th>Pollutant</th>
<th>Averaging Time</th>
<th>Primary Standard</th>
<th>Secondary Standard</th>
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<td>Photochemical Oxidants</td>
<td>1 hour</td>
<td>160 μg/m³⁸ᵃ</td>
<td>Same as Primary</td>
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<td>Hydrocarbons</td>
<td>3 hoursᵇ</td>
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<td>Nitrogen Dioxide</td>
<td>annual arithmetic average</td>
<td>100 μg/m³³</td>
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<td>Carbon Monoxide</td>
<td>8 hours</td>
<td>10 μg/m³³</td>
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<td></td>
<td>1 hour</td>
<td>40 μg/m³³</td>
<td>(35 ppm)</td>
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<td>Sulfur Dioxide</td>
<td>annual arithmetic mean</td>
<td>80 μg/m³³</td>
<td>60 μg/m³³</td>
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<td>24 hours</td>
<td>365 μg/m³³</td>
<td>260 μg/m³³</td>
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<tr>
<td></td>
<td>3 hours</td>
<td>1300 μg/m³³</td>
<td>(0.5 ppm)</td>
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<td>Particulate Matter</td>
<td>annual geometric mean</td>
<td>75 μg/m³³</td>
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<td></td>
<td>24 hours</td>
<td>260 μg/m³³</td>
<td>150 μg/m³³</td>
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a. Standards are expressed in micrograms (μg) of pollutant per cubic meter of air (1 μg = one millionth of a gram), and in parts per million (ppm). Concentrations, other than annual averages, are not to be exceeded more than once per year.
b. (6-9 A.M.)

In order to help the states meet national ambient air quality standards, Title II of the Act establishes new car emissions standards. Automobile emissions consist mainly of carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NOₓ.) Photochemical oxidants (smog) are created by the reaction of HC and NOₓ in sunlight. The deleterious effects of these pollutants are well known. The Act

6. Id. §§ 110(e)-(f), 42 U.S.C. §§ 1857c-5(e)-(f).
7. The Federal Government has preempted the regulation of new car emissions; a state is not allowed to establish regulations unless the state standards are stricter than the federal standards and EPA grants a waiver to the state. Clean Air Amendments §§ 209(a)-(b), 42 U.S.C. §§ 1857f-6(a)-(b) (1970). California has established its own standards and has been granted a waiver.
8. Smog causes eye irritation and aggravates respiratory ailments. Attacks of asthma increase when peak oxidant concentrations exceed 200 μg/m³ (0.01 ppm), and athletic performance may be impaired at concentrations above 240 μg/m³. [One microgram (μg) is equal to one millionth of a gram.] A severe example is the Metropolitan Los Angeles Air Quality Region, where the 200 μg/m³ level was equalled or exceeded 206 times within the first ten months of 1970, and the air in nearby Riverside exceeded the standard by a factor of eight. Smog also damages rubber, cellulose, dyes, and other materials. Senate Hearings, supra note 4, at 1548-49. For a summary of the effects of smog on human health, see U.S. DEP'T OF HEW, AIR QUALITY CRITERIA FOR PHOTOCHEMICAL OXIDANTS Ch. 9 (1970).

Hydrocarbons (HC) are a major component of smog and are directly responsible for a number of its properties. HC reduces visibility, injures plants, and causes eye irritation. Senate Hearings, supra note 4, at 1548-49. Fifty-two percent of HC in the air comes from mobile sources, 31 ENV. RPRTR. — FED. LAWS 1981 (1970). For a summary
requires 90 percent reduction of HC and CO in the 1975 model year and 90 percent reduction of NO\textsubscript{x} in the 1976 model year.\textsuperscript{9}

However, the Act also establishes variance procedures which give EPA discretion to grant suspensions of emission standards to automobile manufacturers for up to one year.\textsuperscript{10} The decision to grant or deny

of the toxicological research, see U.S. DEP'T OF HEW, AIR QUALITY CRITERIA FOR HYDROCARBONS, Chs. 6, 7 (1970).

Carbon monoxide (CO) is known for its lethal effects at extraordinarily high concentrations. As an air pollutant, CO increases the burden on the heart, is associated with increased fatalities among heart disease patients, and has been linked with impairment of time interval discrimination and visual acuity. Senate Hearings, supra note 4, at 1550-51. Internal combustion engines produce 58 percent of CO in the air. 31 ENV. RPTL. — FED. LAWS 1951 (1970).

Nitrogen oxides are essential ingredients in the formation of smog and are toxic by themselves. They are associated with bronchitis in children and acute respiratory disease in all age groups. Oxides of nitrogen present a difficult control problem. They are often produced by the very same methods used to control HC and CO. Further, they "scavenge" photochemical ozone by reacting with it, diminishing both the ozone and nitrogen oxide concentrations, but producing other smog constituents. Senate Hearings, supra note 4, at 1549-50. See also Air Pollution Control Office, EPA, Air Quality Criteria for Nitrogen Oxides, Chs. 9, 10 (1971). In cities, automobile exhaust accounts for from 30 to 88% of the NO\textsubscript{x}. PROJECT ON CLEAN AIR NATURAL RESOURCES DEFENSE COUNCIL, TRANSPORTATION CONTROLS FOR CLEAN AIR [hereinafter cited as NRDC MANUAL].


It is difficult to predict how far ambient pollutant concentrations will be reduced when the new car emission standards take effect. This is not an idle exercise since each state must determine what measures to include in its implementation plan in order to meet the national ambient air quality standards. Unless there is also some control of used car emissions, dramatic reductions in ambient pollutant concentrations will not occur in the first few years of enforcement. See text accompanying notes 79-80 infra.

The relationship between given reductions in total emissions and the corresponding reductions in ambient pollutant concentration cannot be defined by a neat set of equations. The chemical reactions that produce smog and the meteorological processes affecting the circulation of pollutants in the atmosphere are quite complex and are not fully understood. Barth, Federal Motor Vehicle Emission Goals for CO, HC and NO\textsubscript{x}: Based on Desired Air Quality Levels, 20 J. AIR POLL. CONTROL ASS'N 519 (1970).

The best that can be hoped for is a reasonably accurate model relating emissions and ambient air quality. The simplest model is the linear rollback model, which assumes that a reduction in emissions will result in a proportionate reduction in ambient pollution concentration after some correction for background concentrations of CO, HC, and NO\textsubscript{x} generated by non-human sources. This model was the best available in 1970 and despite its deficiencies was used to calculate that a 90% reduction in new car emissions was necessary to achieve ambient air quality standards. Since 1970 more sophisticated models have been developed but they are not yet in general use. See, e.g., McCracken et al., Lawrence Livermore Laboratory, Initial Application of a Multi-Box Air Pollution Model to the San Francisco Bay Area (paper prepared for publication in the Proceedings of the Joint Automatic Control Conference, Stanford University, Stanford, Calif., Aug. 16-18, 1972.)

a request for a suspension is to be based on both economic considerations and the public's interest in cleaner air.

1. Suspension of Standards

The automotive industry has attacked the federal emission standards on several grounds. One contention is that the standards are overly harsh. Yet in most urban areas not only individual automobile emission standards but also strict transportation control plans will be necessary to attain the ambient air quality standards. Another attack on the standards is based upon the present state of the national economy. The President has recently suggested that the standards be postponed until 1982 as a means of combating inflation. Industry also challenges the target date for compliance, claiming there is insufficient time for development of equipment able to meet the standards.

In International Harvester v. Ruckelshaus, the automobile industry petitioned EPA for a suspension of the 1975 CO and HC standards, claiming that compliance was technologically infeasible. EPA denied the petitions and the manufacturers brought this action for review of the denial. In reversing the denial, the court relied upon broad economic considerations and the Administrator's failure to establish the reliability of his method of concluding that technology would in fact be available.

The auto manufacturers attacked EPA's decision on two grounds. Their first claim concerned section 202(b)(5)(D)(iii) which requires the Administrator to find that control technology is "not avail-

(1970). In order to grant a suspension, the Administrator must find that:

(i) such suspension is essential to the public interest or the public health and welfare of the United States, (ii) all good faith efforts have been made to meet the standards established by this subsection; (iii) the applicant has established that effective control technology, processes, operating methods, or other alternatives are not available or have not been available for a sufficient period of time to achieve compliance prior to the effective date of such standards, and (iv) the study and investigation of the National Academy of Sciences conducted pursuant to subsection (c) and other information available to him has not indicated that technology, processes, or other alternatives are available to meet such standards.

11. Statement of Ernest S. Starkman, Vice President, Environmental Activities Staff, General Motors Corp., Senate Hearings, supra note 4, at 1273. Mr. Starkman also said that public health and plant life could be adequately protected in even the most polluted areas with less stringent standards.

12. See text accompanying notes 82-105 infra.


15. 478 F.2d 615, 4 ERC 2041 (D.C. Cir. 1973).


This section provides for direct review by the Court of Appeals for the District of Columbia of the Administrator's decision to deny a suspension.
Plaintiffs contended that "available" referred to "off-the-shelf" technology already in existence, not to a program relying on unperfected devices. The court rejected this claim and approved the Administrator's definition of "available technology". The term was held to include a reasonable prediction of how much technological progress industry could attain during the two years before a model reaches full production.18

Industry next contended that it was technologically impossible to meet the standards. It claimed that the Administrator's test results demonstrated that no system had been produced which even showed promise of meeting the proposed 1975 standards.19 A report by the National Academy of Sciences (NAS), based on industry data, partly supported this claim.20 Citing the proposed 1974 emission standards and the mix of new and uncontrolled pre-1968 cars, the report attempted to minimize the effect of a delay on air quality.21 EPA attempted to contradict industry's conclusion using the same data pool as did industry and NAS, but interpreting the data utilizing its own methodology. In a long and cumbersome analysis it sought to predict the utility of proposed and partially tested emission devices. The method was fraught with uncertainties and was, as EPA itself admitted, controversial in its approach.22 During the hearings the Administrator had not allowed industry to challenge the methodology. This had "serious implications for the court," given its role of judicial review.23 In the opinion of the court, the Administrator failed to establish the reliability of his methodology and, since his conclusion that technology was available depended thereon, he had failed to rebut industry's contention that the technology was not available.24

The court's decision rested heavily on what it perceived to be the potentially disastrous consequences of forcing unworkable emission control standards on the auto industry. It used a method of weighing

18. 478 F.2d at 628-29, 4 ERC at 2046.
19. EPA subpoenaed data developed by the four petitioners, eight other carmakers, and manufacturers of catalytic converters and associated equipment in tests of five types of emission control devices on 500 cars. Only one of the 500 cars met the 1975 new car emission standards. 478 F.2d at 625, 4 ERC at 2043.
20. NATIONAL ACADEMY OF SCIENCES, SEMIANNUAL REPORT BY THE COMMITTEE ON MOTOR VEHICLE EMISSIONS, DIVISION OF ENGINEERING, NATIONAL RESEARCH COUNCIL [hereinafter cited as 1972 NAS REPORT], reprinted in Senate Hearings, supra note 4, at 1155.
21. Id. at 45-48, in Senate Hearings, supra note 4, at 1204-07. The graphs in Figs. 7.1 and 7.2 are cleverly drawn to make it appear that a one-year delay would have only a trivial effect on HC and CO emissions.
22. 478 F.2d at 625, 4 ERC at 2044.
23. Id. at 631-32, 4 ERC at 2048-49.
24. Id. at 645, 4 ERC at 2058.
the costs of a wrong decision against the gains of a correct decision.\textsuperscript{25} If a suspension were incorrectly denied, i.e., industry being unable to meet the standards, the court foresaw an “eleventh hour” suspension, which would result in severe economic hardship. Expecting enforcement of the standards, industry would have been producing cars at a limited rate and devoting most of its resources to the development of the unacceptable system. In addition, the technological leaders would suffer because their product would be more expensive and less efficient while the laggards would reap huge benefits from their procrastination or lack of expertise.\textsuperscript{26} In such a situation the improvement in air quality would be minimal. On the other hand, if a suspension were incorrectly granted, i.e., if industry were able to meet the standards, the standards could be reimposed or, if not, there would be only minimal additional pollution. Most important, no economic hardship would result.

The court relied also on what it termed a “safety valve” relief from potential problems caused by the 1975 deadline. It felt that Congress had foreseen the possible difficulty of meeting the standards and accordingly had included a provision for a one year suspension.\textsuperscript{27}

A connected issue, not critical to the decision, involved industry’s assertion that without a suspension it could not meet the public’s basic demand for new motor vehicles.\textsuperscript{28} The Administrator, in his denial of the request for a suspension, had stated that even if enforcement of the standards prevented industry from producing some models (mostly heavy, high performance cars), no suspension of the standards would be proper so long as the public’s basic demand for vehicles was met.\textsuperscript{29} The court approved this rule, commenting that the “driving preferences of a few hot rodders” could not be allowed to interfere with attaining the goal of cleaner air.\textsuperscript{30} However, the court did require the Administrator to determine the feasibility of a production shift from heavier, higher-powered cars which might be necessitated by enforcement of the standards.\textsuperscript{31}

A subsidiary claim made by International Harvester as an individual plaintiff concerned the application of passenger car emission standards to 1975 models of light weight trucks and multipurpose vehicles (MPVs), an application it claimed would prohibit it from competitive marketing. After reviewing the legislative history of the Act,

\textsuperscript{25} Id. at 636, 4 ERC at 2052-53.
\textsuperscript{26} Id. at 642, 4 ERC at 2055-56.
\textsuperscript{27} Id. at 641, 4 ERC at 2055.
\textsuperscript{28} Id. at 640, ERC at 2054-55.
\textsuperscript{29} Id. at 640-41, 4 ERC at 2054-55.
\textsuperscript{30} Id.
\textsuperscript{31} Id.
the court agreed that Congress had not intended to apply the light-duty vehicle emission standards to small trucks or MPVs, but did not reach the issue of competitive marketing.

The court's lack of technical knowledge obviously affected its decision to grant the suspension. It placed too much significance on the economic implications of a last minute suspension, should that have been necessary. In discussing its fear that the technological leader would suffer, it failed to consider that the proposed method of emission control, the catalytic converter, would have minimal effect on engine performance and that the technological leader would therefore not be burdened by a low performance product. The only handicap suffered by the technological leader would be the higher price it would be forced to charge for its automobiles.

The court also placed an unrealistic burden of proof on EPA. The court stated that the automobile manufacturers had the burden of presenting evidence to the Administrator to support their claim of technological impossibility because they were in control of the relevant information, the emissions performance of their cars. The Administrator claimed that the industry had not provided him with sufficient evidence to enable him to determine whether the necessary technology was in fact available. The court stated that this implied demand for more information was equivalent to forcing the industry to prove its claim beyond a reasonable doubt; it held that where the consequences of an incorrect decision were grave, the proper standard of proof was a preponderance of the evidence. But the court then went on to state that because the development and use of the methodology used by the Administrator to disprove industry's claim lay within his particular knowledge, he had the burden of producing evidence and making a "reasoned presentation" of the reliability of the methodology. This appears to have placed the beyond-a-reasonable-doubt standard on the Administrator. It is difficult to understand how the court wished reliability to be shown without first seeing the results of the emission control program. The court asked the Administrator to estimate the degree of error in his prediction. But the new technology is not easily reducible to statistical probabilities. Nor is it easy to see how knowledge

32. Id. at 639-40, 4 ERC at 2053-54. The court struck down EPA's definition of "light duty vehicle," which appears in 40 C.F.R. 85.002(a)(5) (1973).
33. See text accompanying notes 62-77 infra for a discussion of the catalytic converter.
34. 478 F.2d 642, 4 ERC at 2055-56.
35. EPA argued that the testing did not comply with its procedures and had been done in an unscientific manner. Id. at 625-26, 4 ERC at 2044.
36. 478 F.2d 642, 4 ERC 2056.
37. Id. at 643, 4 ERC 2056.
38. Id. at 647, 4 ERC 2059.
of the material lay more within the competence of EPA than of the auto industry or the special NAS panel. Chief Judge Bazelon would have decided the case on the sole issue of EPA’s failure to afford industry an opportunity to comment on the agency's methodology at the suspension hearing. He was deeply disturbed by the willingness of the other court members to participate in a substantive review of an area beyond the court’s competence. The court’s opinion states that EPA failed to respond to what it viewed as flaws in the EPA analysis. But what the court regarded as flaws may have been only defects in the presentation. It is possible that EPA was not adequately prepared to defend its position. It did not present any significant evidence of its own. It relied solely upon its interpretation of data obtained from tests of industry-furnished prototypes and it failed to explain the apparent inconsistency between the NAS study and its own position. Neither explanation, failure to speak the layperson's language nor failure to present a complete case, is defensible.

Two potentially significant themes emerge from an analysis of the court's opinion in International Harvester. The first is the insistence that an agency imposing standards or regulations on an industry show in a clear and convincing manner that compliance is technologically feasible. Proof of feasibility may include reasonable predictions of future developments, but the door is not open to “crystal ball inquiry.” The second theme is that a court confronted with technical issues outside its own expertise tends to avoid a decision on the merits by seizing on other, sometimes speculative, arguments. In International Harvester questionable economic assumptions led to the court’s conclusion that the least harmful wrong decision would be the grant of a suspension. If this theme is to persist, an inquiry should be made into the practicability of empanelling special masters or even establishing separate environmental courts to weigh the technical arguments future litigation will inevitably bring.

After remand by the court in International Harvester, and pursuant to § 202(b)(5)(D) of the Clean Air Act, EPA granted the manufacturers’ request for a one year suspension of the 1975 HC and
CO emission standards\textsuperscript{47} and announced interim standards applicable to 1975 models.\textsuperscript{48} EPA also suspended the 1976 NO\textsubscript{x} emission standards\textsuperscript{49} and announced interim NO\textsubscript{x} emission standards for 1967 models.\textsuperscript{50}

2. The Energy Supply and Environmental Coordination Act of 1974

After the Arab oil embargo and the gasoline and fuel oil distribution problems which followed, Congress was subjected to tremendous pressure to ease the requirements of the Clean Air Act. As a result it passed the Energy Supply and Environmental Coordination Act of 1974 (ESECA).\textsuperscript{51} Among other things, ESECA establishes procedures to encourage the use of coal in electric power generating plants and other major fuel burning installations.\textsuperscript{52} The Act also amends certain provisions of the Clean Air Act relating to motor vehicle pollution control. These are presented in Table 2. The Clean Air Act’s original requirement for a 90 percent reduction in HC and CO emissions is suspended until the 1977 model year and the interim standards already prescribed for 1975 models\textsuperscript{58} are extended to the 1976 models.\textsuperscript{54} The original requirement for a 90 percent reduction in NO\textsubscript{x} emissions is suspended until the 1978 model year, the interim standards already prescribed for 1975 models are extended to include 1976 models, and a NO\textsubscript{x} limit of 2.0 grams per mile applies to 1977 models.\textsuperscript{58} There is provision for a one year suspension of the 1977 CO and HC standards\textsuperscript{58} but no similar provision for suspension of the 1978 NO\textsubscript{x} standards.

ESECA amends the Clean Air Act’s provisions relating to state implementation plans by (1) requiring EPA to research the necessity for regulations covering parking surcharges, management of parking supplies, and preferential bus/carpool lanes,\textsuperscript{57} (2) forbidding EPA

\begin{itemize}
  \item \textsuperscript{48} 38 Fed. Reg. 10318 (1973). See Table 2, infra, for a tabulation of the interim standards.
  \item \textsuperscript{49} See note 10 supra.
  \item \textsuperscript{50} 38 Fed. Reg. 22474 (July 1973). See Table 2, infra, for a tabulation of the interim standards.
  \item \textsuperscript{51} Energy Supply and Environmental Coordination Act of 1974, Pub. L. No. 93-319 (June 22, 1974).
  \item \textsuperscript{52} Id. §§ 2-4(a).
  \item \textsuperscript{53} See text accompanying notes 46-50 supra.
  \item \textsuperscript{56} Id. § 5(c), 42 U.S.C. § 1857f-1(b)(5)(A).
  \item \textsuperscript{57} Id. § 4(b), 42 U.S.C. § 1857c-5(c)(2)(A).
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* in grams of pollutant per vehicle mile.

from requiring parking surcharge regulations as part of state implementation plans,68 and (3) authorizing EPA to suspend state regulations for the management of parking supply or to suspend any requirement that such regulations be part of a state's implementation plan.69

The ESECA amendments easing the requirements of the Clean Air Amendments of 1970 are evidence that the automotive industry still has sufficient clout to force through self-protective legislation. Unwittingly or otherwise, Congress has passed legislation having the overall effect of partially protecting industry from the original strict requirements of the Clean Air Amendments of 1970. Although the ostensible purpose of ESECA is to conserve fuel while insuring against degradation of the environment,60 the actual provisions of the Act, at least with respect to automobile emission standards and transportation controls, are inconsistent with that purpose. For example, ESECA encourages fuel consumption by restricting the use of transportation control strategies.61 Postponing the strict emission standards will not provide significant fuel savings, especially when compared to more direct strategies such as requiring all new automobiles to meet minimum fuel economy standards.

3. The Present Technological Approach

The catalytic converter is expected to be used by the great majority of manufacturers to reduce emissions to the relatively strict 1975 standards.62 It is unclear, however, whether the use of the catalytic converter will be a satisfactory long range solution to the automobile emission problem.

60. Id. § 1(b).
61. See notes 57-59 supra.
62. A catalyst is an element or compound which by its mere presence speeds up a chemical reaction without being used up in that reaction. Catalytic converters, devices inserted in the exhaust flow, are designed so that a large surface area of catalyst is exposed to the exhaust gases. If oxygen is present in the converter, almost complete oxidation of HC and CO to harmless water and carbon dioxide can be achieved. Reduction of NOx to harmless gases can also be achieved by some catalysts under controlled conditions. The catalytic converters installed on 1975 autos use only one catalyst and are only capable of eliminating HC and CO. To eliminate NOx emissions, the more advanced dual-catalyst or three-way catalyst technology must be used. The dual-catalyst system employs two converters, the first set up to reduce NOx, the second to oxidize HC and CO. The dual-catalyst systems which have been developed so far have been plagued with problems, the most serious of which is the lack of durability of the NOx reduction catalyst. The three-way catalyst system uses a single catalyst in a single converter which is capable of promoting both oxidation and reduction reactions simultaneously. Such systems are still in the developmental stage. NATIONAL ACADEMY OF SCIENCES, REPORT BY THE COMMITTEE ON MOTOR VEHICLE EMISSIONS, DIVISION OF ENGINEERING, NATIONAL RESEARCH COUNCIL (1973) [hereinafter cited as 1973 NAS REPORT].
The catalytic converter is superior to the older add-on systems in several respects. Even though emissions standards are stricter for 1975 models, fuel economy of the 1975 models is better than that of 1974 models, evidently because the introduction of the catalytic converter in 1975 models allows the engine to be tuned for better fuel economy. However, when the dual-catalyst systems are introduced in the 1976 models, mileage is expected to decrease. Because only unleaded fuel may be used in autos equipped with catalytic converters, an incidental benefit of the development of the catalytic converter is the development of a widespread distribution system for unleaded fuel and a reduction in lead emissions.

However, the converter is not without shortcomings, some serious enough that a failure to cure them will defeat the practicability of its general use. One problem is that the converter, because of its use of the platinum catalyst, can not be used on an automobile burning leaded fuel. EPA has begun to solve this problem by promulgating fuel regulations pursuant to sections 211(c) and (d) of the Clean Air Act. The regulations require marketing of at least one grade of unleaded gasoline after July 1, 1974 at any retail outlet at which 200,000 or more gallons of gasoline were sold during any year after 1970. In addition, cars equipped with catalytic converters must be clearly labeled and must have a specially sized fuel tank filler inlet which will match nozzles mounted on service station pumps dispensing unleaded fuel. On pain of a $10,000 per day civil fine, retailers are forbidden to introduce leaded gasoline into cars exclusively designed

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63. Wall St. J., Sept. 23, 1974, at 10, col. 1 (Pacific Coast ed.). Cars equipped with catalytic converters accounted for a 13.5% increase in mileage over 1974 models in tests conducted by EPA. This increase was attributed to changes in the engine and emission control systems. Id.


65. See text accompanying notes 153-57 infra.


67. 42 U.S.C. §§ 1857f-6c(c)-(d) (1970). In Amoco Oil v. EPA, — F.2d —, 6 ERC 1481 (D.C. Cir. 1974), many of the nation's oil companies challenged the validity of the regulations promulgated by EPA. The court upheld the regulations against the oil companies' objections that the regulations were not supported by specific findings, that the limit on lead content was not justified by the record, that the requirement for affirmative marketing of unleaded fuel was not supported by the record, and finally that EPA should have been required to file an environmental impact statement for the regulations.

68. 40 C.F.R. § 80.22(b) (1973).


70. 40 C.F.R. § 80.22 (1973).

for use of unleaded fuel.\textsuperscript{72}

Although it is fully realized how destructive leaded fuel is to the converter,\textsuperscript{73} it is not yet known to what extent unleaded fuel will cause similar effects. Some deterioration will undoubtedly occur.\textsuperscript{74} If frequent replacement of the converter is required, a costly program of regular testing and certification will be necessary.

A more serious obstacle to the converter's full acceptance is its production of sulfuric acid, a known health hazard and corrosive. An EPA study confirms that the converter causes sulfur in the gasoline to react with water and oxygen in the exhaust to form a fine mist of sulfuric acid,\textsuperscript{75} but concludes that the emissions will only be a problem in high traffic areas after many cars are equipped with the converter. Despite EPA's minimization of the problem, it must be considered a serious shortcoming of the converter.

Finally, the converter, in spite of its capacity to limit targeted noxious emissions\textsuperscript{76} while permitting good engine performance, has not yet solved the entire automobile emission problem. As seen in \textit{International Harvester} none of the manufacturers managed to test a converter-bearing automobile over a 50,000 mile period.\textsuperscript{77} Although their claim that the converter could not effect a 90 percent emission reduction was contrary to EPA's prediction, congressional legislation easing the standards implicitly accepts the manufacturers' position and indicates that achieving a 90 percent reduction through use of the catalytic converter is not a certainty.

Even if the converter is eventually determined technically capable of reducing HC, CO, and NO\textsubscript{x} emission to required levels, it may be that the problems it creates—administrative burdens, expense, and exposure to sulfuric acid—will prohibit its use.

\textbf{B}

\textbf{DECISIONMAKING DEFICIENCIES AND BYPASSED ALTERNATIVES}

The foregoing sections examine the major developments to date

\textsuperscript{72} 40 C.F.R. §§ 80.22(a), 23 (1973). In \textit{Amoco Oil v. EPA}, — F.2d —, 6 ERC 1481, 1498 (D.C. Cir. 1974) the court construed the vicarious liability provisions of §§ 80.23(a)(1) and (2) to mean that a rebuttable presumption of liability against refiners and distributors arises from violations.

\textsuperscript{73} See note 66 \textit{supra}.

\textsuperscript{74} \textit{International Harvester v. Ruckleshaus}, 478 F.2d 615, 626, 4 ERC 2041, 2048 (D.C. Cir. 1973).

\textsuperscript{75} S.F. Chronicle, Sept. 3, 1974 at 1, col. 3.

\textsuperscript{76} CO, HC, and NO\textsubscript{x}.

\textsuperscript{77} 478 F.2d at 625, 4 ERC at 2043.
in the mobile source pollution control program. The accomplishments are fewer than might be expected. One reason is that the 1975 models now on the market are unequipped with adequate systems to limit emissions to the originally targeted levels. The new models' shortcomings are largely due to EPA's emphasis on the use of add-on devices to the traditional internal combustion engine at the expense of other viable alternatives to the engine itself. These will be discussed in detail below.

The second reason is that EPA has attempted to control only new car emissions; used car emissions are not regulated.

Title I of the Act does not preclude regulation of used cars, but EPA has promulgated no regulations to directly control them. Since new cars are responsible for only a fraction of vehicle miles travelled, it would seem logical to extend regulations to cover more offending vehicles in order to meet the ambient air quality standards. Unless there is also some control of used car emissions, dramatic reductions in ambient pollutant concentrations will not occur in the first few years of enforcement. For example, if 60% of the pollution in an area comes from cars and one sixth of the cars are new, realization of a 90% reduction in new car emissions would only produce a 9% drop in total emissions in the first year. Eventually all cars would be controlled and a reduction of 54% in total emissions would be accomplished.

States which find that the new car emission standards are insufficient to meet the national ambient air quality standards have two general strategies available to them: Control of used car emissions by use of retrofit devices and control of automobile use. The Clean Air Act itself does not require that either of these strategies be adopted. However, each state must meet the ambient air standards and if adoption of one or both of these strategies is the only way to achieve these standards, then the state is virtually forced to act accordingly.

Unfortunately state programs to control used car emissions by requiring installation of retrofit devices have proved to be politically unpopular, even when the devices were relatively inexpensive and reasonably effective. For example, in California a program to require installation of retrofit devices on 1966 through 1970 model cars met with numerous objections and has finally been limited to the severe automo-

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78. See note 113 infra.
79. Cf. § 209(a) which pre-empts state control of new motor vehicle emissions and § 209(c) which allows the states to "control, regulate, or restrict the use, operation, or movement of registered . . . motor vehicles." Clean Air Amendments § 209(a) and (c), 42 U.S.C. § 1857f-6a(a) and (c) (1970).
80. Emissions from used cars may be reduced by installing retrofit devices, pollution control devices designed to be compatible with the engine's performance characteristics.
Control of automotive emissions by limiting automobile usage has proven to be even more controversial than the retrofit device programs.

I. Transportation Control Strategies

The necessity for transportation control plans is not disputed since they may be the only way to limit the number of vehicles in congested areas. Only the degree to which regulating bodies have been forced into their use and the lack of time available for sensible, systematic implementation is questioned.

The grant or denial of the one-year reprieve to automakers under Title II of the Act has little relation to the attainment of ambient air standards by the states under Title I. If the delay had not been granted, the new-car standards would first have been effective with 1975 models, resulting only in minimal effect on air pollution by the deadline for achieving ambient air standards.82

Section 110(a)(2)(B) requires both land use and transportation control plans to be included in state plans when needed to insure attainment and maintenance of national ambient air standards.83 In NRDC v. EPA,84 petitioner challenged extensions of implementation deadlines which EPA had granted to several states. The court directed EPA to rescind the extensions and to approve only those state plans which satisfy every requirement of sections 110(a)(2)(A) through (H).85

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81. Senate Bill 2471 (Holmdahl), 1974 Chapter 670, signed into law on Sept. 5, 1974. Effective Jan. 1, 1975, retrofit devices on 1966 to 1970 models will not be required. However, this did not effect the automobiles required to have the devices installed before Jan. 1, 1975. Owners of these vehicles were exempted from compliance on Sept. 12, 1974 by the state Air Resources Board. More significantly, the bill did not effect automobiles whose owners resided in the South Coast Air Basin, an area composed of Los Angeles, Riverside, Santa Barbara, Ventura, Orange, and San Bernardino counties. See Chernow, Implementing the Clean Air Act in Los Angeles: The Duty to Achieve the Impossible, 4 ECOLOGY L.Q. 537 (1975), text accompanying notes 118-120.

82. Not enough new controlled cars will be in service by May 1975, or even by May 1977, the date when most states with extensions must comply, to significantly influence air quality. In June 1974, Russell Train, EPA Administrator, stated that "even when all cars on the road have controls meeting the statutory 90 percent reduction, many areas will still need transportation controls because of the sheer number of autos involved and the quantity of gasoline consumed." 5 ENV. RPR. - CURR. DEV. 243 (1974).


84. 475 F.2d 968, 4 ERC 1945 (D.C. Cir. 1973).

85. 42 U.S.C. § 1857c-5(a)(2)(A)-(H) (1970). Under these sections, the Administrator may approve a state implementation plan only if he finds that it—

(A) adheres to the deadlines set by the Act;

(B) includes such measures as are necessary to insure attainment and maintenance of ambient air quality standards;

(C) includes provision for monitoring and reporting ambient air quality;
The court also ordered EPA to publish its own plan for any state which failed to submit a proper plan by April 15, 1973.  Although recently promulgated transportation control plans vary from state to state, their common strategy is to restrict individual vehicle usage. Decreasing such usage will in turn reduce total vehicle miles traveled (VMT). The state plans submitted in response to the D.C. Circuit Court's order contained only conventional strategies such as vehicle inspection and maintenance programs and the required use of retrofit devices; these plans were not sufficient. As a result, EPA was forced to promulgate stricter measures to reduce the total number of vehicles travelled (VMT). From an extensive arsenal of strategies, EPA has chosen several for each state and has calculated the emission reductions it expects to attain.

The list of strategies includes: Reserved bus and carpool lanes on major streets and highways, a computerized commuter carpool matching system, a ban on daytime truck deliveries to large businesses, provisions to spur employers to encourage employee use of mass transit, required EPA approval of new parking lot construction, a ceiling on new motorcycle registration and/or a total or seasonal ban on two-stroke motorcycle engines and a peak-hour ban of on-street parking combined with a stiff surcharge for off-street parking. Several plans contain even more drastic measures. EPA feels that VMT will not be substantially reduced by the availability of mass transit unless there are

(D) includes certain procedures for reviewing location of new sources of pollution;

(E) contains adequate provisions for intergovernmental coordination;

(F) provides (i) necessary assurances that the state will provide adequate funding and personnel to carry out the plan, (ii) requirements for installation of monitoring devices by owners or operators of stationary sources, (iii) for periodic reports on emissions from such sources, (iv) that such reports be correlated with relevant standards and be available for public inspection, and (v) authority to bring suits to stop or otherwise limit operation of sources when there is evidence that they are presenting an imminent and substantial endangerment to the public health;

(G) provides, to the extent necessary, for periodic inspection and testing of motor vehicles;

(H) provides for revision of the plan (i) in case national ambient air quality standards are revised or more expeditious methods for achieving compliance become available, or (ii) whenever the Administrator finds that the plan is inadequate.

86. 475 F.2d at 970-71, 4 ERC at 1946-47.

87. NRDC v. EPA, 475 F.2d 968, 4 ERC 1945 (D.C. Cir. 1973).


89. These plans appear in 40 C.F.R. part 52 as a portion of the state implementation plans.


disincentives to auto use. For instance, some plans call for a rotating ban on passenger cars in the central business district (CBD). In the Boston area, stickers in five different colors would be attached to all cars and those bearing stickers of one color would be barred from downtown Boston on one weekday of each week. The Pennsylvania plan involves similar provisions for Pittsburgh and Philadelphia. The California plan includes a ceiling on gasoline sales: For each month, sales would be limited to the amount sold in the same month between July 1972 and June 1973.

Certain measures in the transportation control plans are designed to reduce pollution but not VMT. These include vehicle inspection programs, required catalyst retrofit devices on all 1966-74 cars capable of operating on non-leaded fuel, nozzle-design regulations to limit evaporation losses at fuel transfer points, and encouragement of gaseous-fuel conversion where such fuel is available.

An overall assessment of these plans leads to the suspicion that they are likely to experience the same lack of success realized by their predecessors, the new-car standards. First, if they are to be effective, plans to reduce VMT by specific amount must include some means of measuring the reductions in VMT realized from each strategy. Otherwise, predictive errors cannot be detected or varying strategies improved. The regulations promulgated by EPA require that transportation control plans contain methods of verifying the occurrence of predicted VMT reductions. However, neither the plans proposed by the states nor by EPA comply with this regulation.

96. Certain methods of approximating VMT reduction are available. For example, a calculation may be made of the reduction in incoming traffic or of the decrease in parking revenue. The Department of Transportation presently gathers data on average commuter trip length. Multiplying average trip length by the number of parking spaces no longer used would provide an estimate of VMT reduction.
97. 40 C.F.R. Part 51.
98. The proposed regulations were promulgated on Jan. 12, 1973 (Transportation Control Measures, 38 Fed. Reg. 1464 (1973)); the final ones on June 8, 1973 (Requirements for Preparation, Adoption, and Submittal of Implementation Plans, 38 Fed. Reg. 15194 (1973)), nearly two months after state plans were to have been submitted pursuant to the court order in NRDC v. EPA, 475 F.2d 968, 4 ERC 1945 (D.C. Cir. 1973). One wonders how states were to prepare transportation control plans without any guiding regulations. EPA's own plans could not have been expected to comply either, since most EPA plans were promulgated barely three weeks after the final regulations were first made public. Appendices M and N, 38 Fed. Reg. 15196-97 (1973) are particularly instructive, in that they require plans to include supportive data to buttress claimed VMT and emission reductions. Had these requirements been issued earlier, they would have reduced the flood of litigation that will certainly result from failure to justify selection of control strategies.
Second, the plans are likely to be ineffective and unworkable. The California plan has a particularly pessimistic tone. EPA itself implies that its plan for Los Angeles is impractical, but that it is nevertheless promulgating the plan for the sake of technical compliance with the Act.\textsuperscript{99} There is also a suggestion that the proposed plan is a prelude to a request that one more year be added to the two-year delay already granted.\textsuperscript{100} There are also admissions that in some areas, notably San Francisco and San Diego, even the drastic measures proposed will not reduce VMT by the required amount, and the remainder must be decreased by a gas rationing program.\textsuperscript{101}

Finally EPA's current scheme of transportation controls is unworkable because it ignores economic reality. A restriction on private vehicle use in a society that depends upon mobility will not be accepted without substitute transport. Substitute transport means mass transit— a concept long advocated by city planners. Although mass transit conserves energy, reduces fossil-fuel consumption, and relieves some central business district congestion it is costly and time-consuming to build\textsuperscript{102} and is costly to operate.\textsuperscript{108}

Restrictive programs aimed at reducing urban VMT affect many people who depend on personal mobility for their livelihood. Direct and indirect regulations banning automobile use, such as rationing and taxation, adversely affect many economic interests. Automobile-related industries are obviously harmed, but service industries such as restaurants, grocery stores, mercantile shops, banks, and medical clinics rely on the automobile for customer access. A country whose land use patterns and lifestyles have developed in an era of unlimited personal mobility will not restructure itself in five years to meet a fixed standard, even for the preservation of public health. The automobile can not be banned until some form of mass transit replaces it, and the plans now drawn for such transit systems are not adequate to meet any foreseeable deadline.\textsuperscript{104}

\textsuperscript{100} Id.
\textsuperscript{103} Public transit fare is proving to be more elastic than has been previously thought. In New York the latest five-cent raise in subway fare resulted in a loss of 54 million riders per year and an increase of 21,000 cars per day. NRDC MANUAL, \textit{supra} note 8, at 23.
\textsuperscript{104} Compare, \textit{e.g.}, the detailed requirements of 40 C.F.R. \S 51 Appendix M (1973) demanding adequate assurances of effective mass transit with unsubstantiated pre-
It appears that an impasse has been reached. Because the add-on approach has not matured in time, air quality standards cannot be achieved on schedule in many cities unless vehicle use is restricted to the point of causing economic chaos.\textsuperscript{105} The recent emphasis on transportation control plans and the ensuing confusion is due \textit{inter alia} to the failure in the beginning to consider technological alternatives to the traditional internal combustion engine add-on device program.

2. \textit{EPA Research Limited in Scope}

The Clean Air Act requires EPA to establish a national research and development program for the prevention and control of air pollution\textsuperscript{106} with special emphasis on pollution resulting from the combustion of fuels.\textsuperscript{107} EPA is specifically directed to conduct and accelerate research programs aimed at developing improved, low cost techniques for (1) controlling combustion byproducts, (2) improving the efficiency of fuel combustion, and (3) producing synthetic or new fuels burning cleaner than conventional fuels.\textsuperscript{108}

To conduct this program, EPA is empowered to make grants to or contract with various outside organizations.\textsuperscript{109} The agency may acquire trade secrets and technical information by purchase, license, lease, or donation and is authorized to make inspections of promising foreign and domestic projects and to cooperate and participate in their development when such actions would be consistent with the purposes of the Act.\textsuperscript{110} EPA is also directed to “undertake to enter into appropriate arrangements” with the National Academy of Sciences (NAS) to conduct a study of the technological feasibility of meeting the new car emission standards.\textsuperscript{111}

\begin{itemize}
\item \textsuperscript{105} Of course, what is economic chaos to some will be regarded as an earthly paradise by others. EPA has peculiar ideas on this point:
\begin{itemize}
\item Although some reduction in personal travel could certainly be absorbed without [severe economic and social disruption], to achieve a significant VMT reduction it will be necessary for the bulk of the travel displaced from single-passenger automobiles to be absorbed by such other modes of transportation as car pools, walking, bicycling, or public transit.
\end{itemize}
\item \textsuperscript{106} \textit{Clean Air Amendments} § 103, 42 U.S.C. § 1857b (1970).
\item \textsuperscript{107} \textit{Id.} § 104(a), 42 U.S.C. § 1857(b)-1(a).
\item \textsuperscript{108} \textit{Id.} § 104(a)(1), 42 U.S.C. § 1857b-1(a)(1).
\item \textsuperscript{109} \textit{Id.} § 104(a)(2), 42 U.S.C. § 1857b-1(a)(2).
\item \textsuperscript{110} \textit{Id.} §§ 104(a)(4)-(5), 42 U.S.C. §§ 1857b-1(b)(4)-(5).
\item \textsuperscript{111} \textit{Id.} § 202(c)(1), 42 U.S.C. § 1857f-1(c)(1).
\end{itemize}
Although EPA possessed this authority to conduct a broad program of research and development, numerous pressures discouraged it from making a thorough evaluation of all the possible solutions to the air pollution problem. EPA had barely been formed when the responsibility for research and development was thrust upon it, and it was important that EPA not fail in enforcing the new car emission standards. Moreover, little time was available to develop controls, especially if one included the period necessary for tooling up and producing add-on control devices or alternative propulsion systems. It is therefore not surprising that EPA concentrated its research and development program on the catalytic converter, a relatively uncomplicated device, and failed to devote much effort to more complex technology.  

3. Technological Alternatives

Industry’s persistent claims of technological incapacity might lead to the belief that the vehicular air pollution problem in 1970 was incapable of prompt technological solution and that some prohibition on vehicle use would be necessary. This was the conclusion forced upon EPA after its program for add-on controls had failed. But before EPA’s decision is accepted as inevitable, the decisionmaking mechanism EPA employed in its initial choice of control strategies should be examined. Apparently, the agency did little research on its own to determine the existence of alternative technology. A host of technological strategies were simply ignored because they could not be fully implemented by the 1975 target date. This surrender to deadlines prevailed even though it was understood that a two or even three year extension would be available should it be needed.

Consider first, at a theoretical level, the technological possibilities facing EPA when it decided to adopt an add-on control approach to the automotive pollution problem. In principle, the required emission standards were attainable in three different ways: reducing emissions


113. A clear statement that EPA devoted most of its efforts to the catalytic converter technology appears in 1972 NAS REPORT, supra note 20, reprinted in Senate Hearings, supra note 4, at 1169.

114. Id.

115. Clean Air Amendments § 110(e)-(f), 42 U.S.C. § 1857c-5(e)-(f) (1970). Air quality regions in many states have already been granted extensions. Note the timetables included in each state implementation plan. For example, New York was granted time extensions for CO and smog. Air Programs, 38 Fed. Reg. 16567 (1973).
of the conventional internal combustion engine (ICE) through add-on controls, replacing the conventional ICE, or modifying the fuel used in the combustion process.

a. Add-on Controls

Tests have shown that an add-on combination of combustion controls and catalytic muffler reactors can reduce conventional ICE emissions sufficiently to meet the standards mandated by the Act.\footnote{116} However, the costs of this method in terms of fuel economy and drive-ability are great. At a University of California seminar a combustion engineer, commenting on the performance cost of add-on controls, referred to the fully controlled ICE as "scarcely qualifying as an engine."\footnote{117} Additional drawbacks to the add-on strategy involve deterioration of the control device with age and use. As control systems become more restrictive, system failure may result in proportionately higher emissions.\footnote{118} Also, pollution controls on a car in the possession of a consumer will tend to deteriorate faster than on a manufacturer's test car.\footnote{119} Thus, if add-on controls are to be used, expensive quality control, maintenance, and replacement may be necessary to assure achievement of emission standards.

Even in the area of add-on controls the original industry predictions were unreasonably pessimistic for a number of add-on devices are now capable of meeting 1977-78 standards.\footnote{120} In addition, the dollar

\footnote{116} Cf. 1973 NAS REPORT, supra note 62, which adds the caveat that the catalytic materials may deteriorate within 50,000 miles and therefore not meet the standards. \textit{Id.} at 38. However, the emission standards used in the report are those included in Table 2, supra, which are no longer valid for nitrogen oxides.

\footnote{117} H. Newhall, lecture given at a conference at the University of California, Berkeley, Aug. 27-31, 1973. A collection of lecture notes and papers from this conference has been published as Combustion Sources of Air Pollution and Their Control, by Continuing Education in Engineering, University Extension, and the College of Engineering, U. of Calif., Berkeley [hereinafter cited as Combustion Sources].

\footnote{118} Cf. NATIONAL ACADEMY OF SCIENCES, FEASIBILITY OF MEETING THE 1975-76 EXHAUST STANDARDS IN ACTUAL USE 54-65 (1973).

\footnote{119} 1973 NAS REPORT, supra note 62, at 69-74.

\footnote{120} Footnote 120 on Page 682.
### 120. Effectiveness of Various Add-on Emission Control Devices for Conventional ICE's

<table>
<thead>
<tr>
<th>Pollution Control System</th>
<th>Pollutant Controlled</th>
<th>Effectiveness</th>
<th>Cost</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCV Valve</td>
<td>Bypassed Crank-case Oil</td>
<td>20% of uncontrolled hydrocarbons</td>
<td>minor</td>
<td>Generally required on present cars</td>
</tr>
<tr>
<td>Thermal exhaust Reactors</td>
<td>CO, HC</td>
<td>Can meet 1975-76 standards for CO and HC</td>
<td>$100</td>
<td>Poor gas economy; not affected by leaded gasoline</td>
</tr>
<tr>
<td>Oxidizing Catalytic Exhaust Systems</td>
<td>CO, HC</td>
<td>Can meet 1975-76 standards for CO and HC</td>
<td>$150</td>
<td>Good gas economy; needs unleaded fuel; emits other pollutants</td>
</tr>
<tr>
<td>Exhaust Regeneration, Ignition Cooling, Combustion Control</td>
<td>NOx</td>
<td>80% of required NOx control</td>
<td>variable</td>
<td>Poor gas economy; increases CO &amp; HC</td>
</tr>
<tr>
<td>Reducing Catalytic Exhaust Systems</td>
<td>NOx</td>
<td>Can meet 1976 standards for NOx at low mileage</td>
<td>$150</td>
<td>Poor durability; Poor reliability; emits other pollutants</td>
</tr>
</tbody>
</table>


cost of this approach is high. The add-on devices themselves raise the cost of conventional engines by $350 to $600 for controls sufficient to meet 1976 standards\textsuperscript{121} (cf. Table 3). Furthermore, the combination of detuning from optimum performance and the addition of air pumps, vacuum devices, and exhaust recycling have caused losses in fuel economy and car performance.\textsuperscript{122}

\textbf{b. Unconventional Engines—Why Weren't They Developed?}

The auto industry has known about at least two alternatives to the standard ICE for decades.\textsuperscript{128} Until now, however, production of such engines has not offered sufficient competitive economic advantage to justify the massive retooling costs involved in its development. Recently, two spark-ignition engines, the rotary (Wankel) and the stratified-charge engine, have received considerable attention as partial technological solutions to the auto emissions problem.

The rotary engine does not rely on the standard ICE piston-crankshaft, rather, combustion occurs in an elongated moving recess.\textsuperscript{124} Due to the physical configuration and lower temperature of the rotary engine, it emits more HC, comparable amounts of CO, and less NO\textsubscript{x} than the standard ICE.\textsuperscript{125} High exhaust temperatures allow effective control of HC and CO through thermal reactors.\textsuperscript{126} While in theory the rotary engine can run at extremely lean fuel-air ratios with constant fuel input,\textsuperscript{127} and thereby provide excellent emission characteristics, ultra-lean operation of the rotary engine is still in the developmental stage and is thus not yet available for emission control.\textsuperscript{128}

The stratified charge engine, which has enormous potential for emission reduction, has been known to United States automakers for more than 20 years and has recently been marketed by a Japanese manufacturer.\textsuperscript{129} In a typical stratified-charge engine, combustion occurs in stages rather than in a single explosive burst. The reduced rate of combustion results in overall low emissions and fuel economy is rated as reasonable.\textsuperscript{130} Because the engine does not require catalytic emission control to meet federal standards, the system deteriora-

\textsuperscript{121. }\textit{Id.}
\textsuperscript{122. }1973 NAS REPORT, supra note 62, at 62-65.
\textsuperscript{123. }1972 NAS REPORT, supra note 20, at 32.
\textsuperscript{124. }Newhall, \textit{Control of Spark Ignition Engine Pollutant Emissions} 6, in Combustion Sources, supra note 117.
\textsuperscript{125: }\textit{Id.}
\textsuperscript{126. }\textit{Id.}
\textsuperscript{127. }R. Sawyer, \textit{Combustion Source Inventories}, in Combustion Sources, supra note 117.
\textsuperscript{128. }\textit{Id.}
\textsuperscript{129. }The domestic (Japanese) Honda Civic automobile utilizes the stratified-charge (CVCC) engine. 1973 NAS REPORT, supra note 62, at 57-62.
\textsuperscript{130. }\textit{Id.} at 57, 62.
tion which has plagued the catalytic devices is not a problem. The following table summarizes the characteristics of various alternatives to the ICE.

Table 3: EMISSION CHARACTERISTICS OF ALTERNATIVE ENGINE SYSTEMS

<table>
<thead>
<tr>
<th>Engine System</th>
<th>Emissions</th>
<th>Costa</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wankel (rotary) Engines</td>
<td>Low NOx; With reactor low CO &amp; HC</td>
<td>1</td>
<td>At first limited to small cars; development necessary for large car applications. GM tooled up to produce Wankel engines in 1974 but decided on limited productions because of fuel economy.</td>
</tr>
<tr>
<td>Diesel Engines</td>
<td>CO 2.5 g/mi</td>
<td>2</td>
<td>Available in limited production at present by foreign and domestic manufacturers.</td>
</tr>
<tr>
<td></td>
<td>HC 0.15 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOx 1.65 g/mi (predicted by Daimler Benz)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced Diesel Engines</td>
<td>Low emissions</td>
<td>1</td>
<td>Very developmental, still some technological problems to overcome.</td>
</tr>
<tr>
<td>Gas Turbine</td>
<td>CO 2.0 g/mi</td>
<td>2-3</td>
<td>Modifiable to 1976 standards; Low power, fuel economy poor; Extensive on-road testing complete.</td>
</tr>
<tr>
<td></td>
<td>HC 0.3 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOx 3.0 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced Gas Turbines</td>
<td>Low emissions</td>
<td>1</td>
<td>Developmental.</td>
</tr>
<tr>
<td>Steam (Rankine) Engines</td>
<td>CO 2.0 g/mi</td>
<td>3</td>
<td>Slow starting, very heavy, still developmental.</td>
</tr>
<tr>
<td></td>
<td>HC 0.3 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOx 1.5 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Advanced steam Engines</td>
<td>CO 0.1 g/mi</td>
<td>3</td>
<td>Slow starting, very heavy, still developmental.</td>
</tr>
<tr>
<td></td>
<td>HC 0.02 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOx 0.2 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stratified Charge Engine (CVCC)</td>
<td>CO 2.6 g/mi</td>
<td>1</td>
<td>In foreign production now; Limited production in U.S.</td>
</tr>
<tr>
<td></td>
<td>HC 0.24 g/mi</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>NOx 0.92 g/mi</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data modified from National Academy of Sciences Panel Report and from an EPA report. a. Cost is in multiples of an uncontrolled 1968 engine of comparable size.

(1.) Economic cost

Cost analysis results concerning pollution control are often confusing. Cost is sometimes discussed in terms of cost to industry and sometimes in terms of cost to the consumer; here it will be assumed that all costs to industry are passed on to the public, either through corporate tax deductions or increased prices. The cost of pollution

131. See text accompanying notes 66-74 supra.
132. PANEL ON ALTERNATE POWER SOURCES, AN EVALUATION OF ALTERNATIVE POWER SOURCES FOR LOW-EMISSION AUTOMOBILES, adapted from Table 1-3 at 9-24. [hereinafter cited as NAS ALTERNATIVE POWER SOURCES REPORT].
control to the consumer has been estimated at several different figures. The National Academy of Sciences reported to EPA that the cost of meeting the then scheduled 1975 HC, CO, and NOx emission standards by controlling ICE emissions was approximately $314 per vehicle.\textsuperscript{184} One auto manufacturer estimated this cost at $750 per vehicle.\textsuperscript{185} EPA's estimates for present standards range between $100 and $200,\textsuperscript{186} with more expensive NOx controls yet to be added. Cost data are not available for the stratified-charge or rotary engines, but since these engines are currently sold competitively with the conventional ICE, they are not inordinately more expensive. Whether add-on control systems or alternative engine systems (or a combination of both) are used to control automotive exhaust emissions, it appears from the above estimates that a 10 to 20 percent increase in total auto cost will result.

\textit{(2.) Manufacturing leadtime}

The NAS Alternative Power Sources Report study fixes engineering development leadtime at six to ten years (Fig. 1), although shorter

\textbf{FIGURE 1: NORMALIZED PRODUCTION STATUS—TOTAL INDUSTRY}

\textbf{Source: NAS Alternative Power Sources Report, note 93, at 26.}

\textsuperscript{184} 1972 NAS REPORT, supra note 20, at 43, 71-74, reprinted in Senate Hearings, supra note 4, at 1202, 1230-33.
\textsuperscript{185} Statements of S.L. Terry, Chrysler Motors, and Sen. Tunney in Senate Hearings, supra note 4, at 1312, 1343.
leadtimes have occurred when incentives other than mere economic gain, such as war, were present.

Development of high performance or special contract vehicles may also involve less leadtime, because they are limited production items. Given that stratified-charge engines are currently in limited production, mass production of such engines could begin within five years without disrupting normal development. (Fig. 1). Delaying implementation of clean air controls to wait for the most recalcitrant automaker to “catch up” runs contrary to the Act’s mandate to protect the public health and its policy of rewarding companies who develop the means to achieve emission standards.

(3.) Lack of incentives

Replacement of the standard internal combustion engine as the prime propulsion system for private vehicles would help meet ambient air quality standards. Alternative power systems have surpassed performance required by 1976 emission limitations, and net gains in air quality beyond those previously predicted could be achieved by systematic expansion of low emission power systems. Yet, the same factors retarding development of alternatives to the standard ICE will inhibit attainment of advanced-concept systems such as electric or hybrid engines. Without additional market incentives, research and retooling costs will discourage rapid development of better alternatives to the ICE. In other words, the forces of competition will prevent unneeded expenditures for research.

The Clean Air Act provides one incentive for research by establishing federal purchasing priorities. The Act directs the Administrator to class as “low-emission vehicles” those which meet new car standards and are “significantly below” those standards for any one pollutant. The government must purchase any low-emission vehicle which is certified as a suitable substitute for one in government use if the price is not more than 50 percent higher than a conventional vehicle. If the low-emission vehicle is “powered by an inherently low polluting propulsion system,” the price premium is raised to 100 percent. As yet, however, this incentive has not induced large development expenditures for a limited production run.

137. NAS ALTERNATIVE POWER SOURCES REPORT, supra note 132, at 1.
139. Id. § 212(e)(1), 42 U.S.C. § 1857f-6e(e)(1).
140. Id. § 212(e)(2), 42 U.S.C. § 1857f-6e(e)(2).
141. GENERAL ACCOUNTING OFFICE, CLEANER ENGINES FOR CLEANER AIR (1972), at 59, reprinted in Senate Hearings, supra note 4, beginning at 1445. [hereinafter cited as GAO REPORT].
The Act also provides research funds from the Office of Air Programs for development of low-emission alternatives to the present ICE.\textsuperscript{142} While some research funding has resulted from these provisions, the Government Accounting Office reports that the auto industry spent more money testing one engine, the gas turbine, than the Office of Air Programs spent on testing all engines in its program.\textsuperscript{143} The development of advanced control technologies is impossible without sufficient federal funds to encourage industry research and development. Industry's own efforts will not suffice until it finds that technological improvements are profitable or until it is forced to develop alternatives by government regulations.

c. Fuel Modification and Fuel Additives

Section 211 of the Act authorizes the Administrator to regulate fuel content or fuel additives or, alternatively, to rule that no regulation is necessary.\textsuperscript{144} The Administrator's action in either direction preempts state and local regulation of fuels, except that which is a necessary part of a state implementation plan or that to which a waiver has been granted.\textsuperscript{145} However, in Exxon v. New York City,\textsuperscript{146} the preemption provision was narrowly construed. The Administrator had set limits on the lead content of gasoline,\textsuperscript{147} though these were not to be applicable until January 1, 1975. The district court held that the city is not precluded from applying its own lead content restrictions before that date.

To date the major fuel alteration control technique has been vapor pressure regulation.\textsuperscript{148} Lowering fuel vapor pressure reduces evaporation in gasoline transfer processes. While changes in composition, which are necessary to change vapor pressure, do affect the efficiency of the fuel,\textsuperscript{149} such changes have become a part of the emission control strategy. Conversion of fleet and state vehicles to use of liquified

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The House recently struck $10 million, earmarked for alternative engine development, from appropriations for 1975, leaving $7.2 million for that purpose. 5 ENV. RPTR. — CURR. DEV. 292 (1974).

143. GAO REPORT, supra note 141, at 54, Senate Hearings, supra note 4, at 1501.
145. Id. § 211(c)(4), 42 U.S.C. § 1857f-6c(c)(4).
148. See AIR RESOURCES BOARD, AIR POLLUTION IN CALIFORNIA, ANNUAL REPORT 1972, 29 [hereinafter cited as CALIFORNIA REPORT].
petroleum gas (LPG), liquified natural gas (LNG), or compressed natural gas (CNG) has already been undertaken in California.\textsuperscript{150} Although these fuels are still in short supply\textsuperscript{151} and a changeover would require at least three years, they may ultimately be more available than gasoline since they can be manufactured from nonpetroleum sources. The gasoline shortage should help to further regulations favoring conversion to gaseous fuels if progress is made in promoting coal gasification plants. Although the economic interests of petroleum manufacturers and the service station industry may be adversely affected by the cost of converting their facilities, they are not sufficiently in jeopardy to warrant stopping the expansion of gaseous fuel conversion. The technical problems of economy,\textsuperscript{152} driveability and availability do not make these fuels immediately attractive to the public and the fuel industry. Therefore the impetus for use of gaseous fuels must come from regulatory agencies.

Fuel additives often survive the combustion process to become air pollutants in the exhaust. The major additives in gasoline are members of the lead alkyl family, tetraethyl lead (TEL) and tetramethyl lead (TML). These compounds are added to increase the fuel's effective octane rating to levels necessary in high compression engines. Additionally, lead compounds were reported to reduce valve wear.\textsuperscript{153} They are emitted from internal combustion engines as alkyl vapors\textsuperscript{154} and as particles of inorganic lead compounds formed in the combustion process.\textsuperscript{155} Lead accounts for one-third of the particulate emissions from gasoline engines. It materially diminishes the size of other particles emitted, thereby allowing them to penetrate the respiratory system of animals and humans inhaling the pollutants.\textsuperscript{156} Lead, in the concentrations associated with dispersed automotive exhausts, has not been unequivocally connected with clinically distinguishable diseases. It does, however, add significantly to airborne lead from other sources. Particularly in the urban environment, airborne lead levels are high.

\textsuperscript{150} California Report, supra note 148, at 30.
\textsuperscript{151} Panel on Manufacturing and Productibility, Manufacturability and Costs of Proposed Low-Emission Automotive Engine Systems 29. This volume is another segment of the study commissioned through NAS.
\textsuperscript{152} Id. Economy of operation is restricted by limited availability. Conservation of resources is adversely affected by the poor fuel-to-energy conversion involved in changing crude oil to LPG rather than gasoline.
\textsuperscript{153} Branch, supra note 149, at 15 in Combustion Sources, supra note 117.
\textsuperscript{154} Comm. on Biologic Effects of Atmospheric Pollutants, Div. of Medical Sciences, Nat'l Research Council, Lead: Airborne Lead in Perspective, National Academy of Sciences, 1972, at 192 [hereinafter cited as Airborne Lead].
\textsuperscript{155} Id. at 16.
enough to cause enzymatic changes in the blood. Although this alone has not been found to affect human health, low lead exposure of long duration has been associated with dulled mentation and hyperkinesis. To protect human health, section 211 of the Clean Air Act requires the registration and testing of fuel additives, for effects "including, but not limited to, carcinogenic, teratogenic, and mutagenic effects . . . ." 

Another property of lead which makes its elimination from fuels desirable is that it is a severe poison to the catalysts in converter systems proposed for exhaust control. Use of unleaded fuel requires one of two alterations: (1) lowering the compression ratio to accommodate the lower octane rating, or (2) either increasing the aromatic hydrocarbon content of the fuel or substituting a nonlead additive for TEL to maintain the octane rating. Changes in additives or elimination of additives is made even more difficult by the requirement that cost benefit analysis must justify any restriction on additives. In addition, alternative methods of achieving emission controls must be considered before an additive can be restricted. Despite these difficulties, regulations limiting the lead content in fuels have been established by EPA, reflecting the agency's commitment to catalytic control systems.

4. Fiscal Policy Alternatives

Although a number of technological possibilities are available to directly reduce auto exhaust emissions, non-technological policy decisions are necessary to develop mass transit, the long range solution to the mobile source problem. One device for raising mass transit funds is the federal taxing power. While EPA's power to levy taxes is strictly circumscribed by constitutional constraints, Congress ought to consider taxation strategies in a reevaluation of the Clean Air Act. It should also consider the role that potentially competitive agencies such as EPA and DOT will play in developing private transit alternatives. A great potential for feuding will exist if taxing power is created without careful planning for the distribution of revenue.

157. AIRBORNE LEAD, supra note 154, at 208-11.
163. See text accompanying notes 66-72 supra.
Taxing vehicle emissions is a direct control method. Although several taxation models have been proposed, the ability of each one to limit emissions depends upon its base, rate, and method of assessment. If the purpose is to curtail automotive emissions, rather than primarily to raise revenues, a tax scheme must be devised to achieve this result in the most direct manner.

a. Emissions Tax

The most direct enforcement method would tax vehicle owners on the basis of exhaust emissions and miles travelled. Unfortunately this method would require complicated periodic inspections and is subject to abuses such as detuning or odometer adjustment. It may also benefit the worst offenders, those who take short trips within a city area, thereby producing pollutants out of proportion to the distance travelled. Projecting mileage and emissions for each car model would be an easier project to administer and fairer than the more direct method. The regressivity of this tax would depend upon its application. If the tax is applied retroactively a heavier burden is placed on the owners of older, high polluting cars. On the other hand, taxing only new cars would favor retention of the older polluting vehicles, contrary to the goal of lower emissions. To resolve these inequities, the burden on owners of older cars could be lessened by using revenues to subsidize alternative transportation, thereby lowering its cost.

b. Gasoline Tax

Raising gasoline taxes would reduce VMT and produce revenues for the development of mass transportation programs, and would be an incentive to industry to produce automobiles with improved gasoline economy. Although the gasoline tax is also regressive, allocation of tax revenues to mass transportation programs would ameliorate, though not eliminate, regressivity. Proponents of a gasoline tax scheme for the Los Angeles area claim that a heavy tax could raise sufficient revenue to finance bus-based mass transit while eliminating 70 percent of the gasoline consumption in the area. The plan, which is aimed at the commuter traffic problem, does not deal with potential dislocation of industry, nor does it provide for elimination of the harsh impact of such a tax on the poor.

c. Horsepower Tax

The horsepower tax is an even less direct method of taxing emissions. The least objectionable form of this proposal would seem to

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be a tax scaled to both car model and miles traveled. Such a tax plan would serve as an incentive to the public to purchase smaller, less powerful cars and would thus promote fuel conservation. The effect on pollution control is, however, uncertain: depending upon engine operating conditions, certain small engines will emit as much or more pollution than large engines. As a pollution control device it shares one fault with other tax measures: it becomes a license to pollute for those who can afford to pay the tax. Finally, although it is regressive, the revenues raised could be used to develop other transportation programs, again alleviating regressivity.

CONCLUSION

Congress made it clear in the Clean Air Amendments of 1970 that it was strongly committed to cleaning up the automobile pollution problem, even if the prescription turned out to be strong medicine. The Amendments required a dramatic federally regulated reduction in new car emissions but left to the states unguided control of used car emissions. EPA was required to establish a broad program of research and development of low polluting automobiles. To date automobile industry pressure and the prospect of fuel shortages have led to a relaxation of the requirements of the Act. More important, EPA has failed to implement the Act as well as it might have. All reasonable strategies to reduce automobile emissions should have been explored by EPA on a pilot basis. Several options, including fuel modification and alternative engine systems, were available to EPA or were in varying stages of development in the United States and abroad. Rather than exploring these possibilities, EPA elected to place all its eggs into one technological basket by adding control devices to the standard internal combustion engine.

The selection of the add-on device strategy was based on several naive assumptions. This strategy assumed that devices existed or could be developed within the required time to reduce automobile emissions the requisite amount. It further assumed that this reduction would be sufficient to control ambient air quality levels or, alternatively, that socially disruptive transportation controls necessary to make up the disparity would be acceptable to the public. The strategy assumed that the add-on devices would be less expensive than alternative engine systems and would be effectively developed in a shorter time. Even further, the strategy relied on little change in the efficiency of the ICE when burdened with pollution control devices and public acceptance of changes which did occur. Most of these assumptions were patently

165. See, e.g., 38 Fed. Reg. 18942 (1973) motorcycle engines; Newhall, Control of Spark Ignition Engine Pollutant Emissions 2-3 and Figs. 3-7 in Combustion Sources, supra note 117, for theoretical rationale.
wrong when adopted; all have been shown incorrect within the past few years. Acceptance of them as the basis of its program insured that EPA was pursuing a no-win strategy.

The catalytic converter was not developed in time to meet the original 1975-76 standards. There is still some doubt as to whether it will be a satisfactory long range solution to the automobile pollution problem. If it becomes necessary to abandon the device, many years will be lost in shifting to another control strategy. EPA must not again put itself in the position of having to rely on industry furnished data to establish feasibility. It is vital that EPA accumulate independent data on all reasonable alternatives to the standard internal combustion engine such as the Wankel engine and the stratified charge engine. Unless EPA demonstrates that low polluting cars are feasible, Congress can be expected to postpone deadlines even further than it did in the Energy Supply and Environmental Control Act.

Mass public transit must be made available in all areas where strict transportation control plans are anticipated. The need for strict transportation control schemes will be eased somewhat once emissions from all cars on the road are reduced by the mandated 90%. But because the date when even new cars will meet that standard has been postponed, transportation control plans will have to be more stringent than originally planned to make up for higher than expected emissions. If it becomes necessary to enforce even stricter standards than those already proposed in order to achieve ambient air quality standards, viable transportation alternatives must be made available to those who will be forced to abandon their cars.

Joseph T. O'Connor