Chapter 6

ENVIRONMENT ISSUES, POLICIES, AND FINDINGS

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ENVIRONMENT ISSUES, POLICIES, AND FINDINGS

CHAPTER

SUMMARY

The environmental problems created by widespread and intensive automobile use include air pollution, noise, disposal of solid wastes, and water contamination. In addition, the impacts of automobiles and highways on communities, rural areas, parklands, and natural preserves are of concern, not only because of possible harm to the physical environment but also because of adverse social and economic consequences.

Until recently, the amount of atmospheric pollutants emitted by automobiles had been growing each year. Emission controls required by the **1970** Clean Air Act and its amendments are helping to reverse this trend. Projections for the year 2000—assuming compliance with the 1977 Clean Air Act amendments, but no other automobile controls—show that automobile emissions for the country as a whole will be reduced from their current levels, even though automobile travel is expected to grow by 75 percent. Carbon monoxide and hydrocarbon emissions from automobiles are projected to decrease by about **60** percent. The reduction in nitrogen oxide emissions will be smaller—about **30** percent. However, these attainments will still leave the country far short of the air quality goals specified in the Clean Air Act.

Automobiles are not the only source of air pollution. Other transportation modes, industrial plants, power-generating facilities, commercial establishments, and home heating also contribute substantial amounts of pollutants to the atmosphere. While automobile emissions are expected to represent a declining share of pollutants from all sources between now and **2000,** the impacts of automobile use will remain **a** major problem in urban areas.

Projections of regional air quality in **1985** and **2000** show that violations of the carbon monoxide and oxidant standards, though decreasing in frequency, will still be common occurrences. In 2000, about 10 percent of the 247 Air Quality Control Regions (AQCRs) in the United States are expected to experience violations of the carbon monoxide standard. Violations of the standard for photochemical oxidants are expected in almost **25** percent of the regions. Since these violations will generally occur in the most populous areas, the number of persons exposed to hazardous concentrations of air pollutants will remain very high—perhaps as many as 136 million persons, or about half the population in **2000.** Since automobiles are particularly heavy contributors to peak concentrations of carbon monoxide and photochemical oxidants, additional measures to control exhaust emissions will be needed to improve air quality in urban areas,

Three policy alternatives to reduce automobile emissions have been considered: further tightening of new car standards (especially for nitrogen oxides), mandatory inspection and maintenance, and restriction of automobile use. Analysis shows that further tightening of new car standards would be only marginally effective and, in the case of nitrogen oxides, could delay or prevent the use of diesels. A nationwide program of inspection and maintenance of vehicles in use could produce major improvements in air quality. Estimates based on Environmental Protection Agency (EPA) data indicate that, within 8 years after implementation, mandatory inspection and maintenance would reduce automobile emissions of carbon monoxide and hydrocarbons by **60** percent and 35 percent, respectively, from what they would be without such a program. Control of automobile use would be effective as a supplementary measure in specific locations, provided that compensating improvements in mass transit are also made, However, as a general measure or as a long-term strategy, automobile use controls appear to be of limited value since they would place limitations on mobility in return for relatively small improvements in air quality.

Projections of other environmental impacts of automobiles and highways—noise, community disruption, intrusion in agricultural, recreational, and wilderness areas, and disposal of scrap vehicles and parts—do not indicate the need for major new policies by the Federal Government to control automobile system characteristics and use. Existing policies, if judiciously and vigorously applied, appear to be adequate to contain or minimize adverse environmental impacts,

The introduction of new technology for automobile propulsion systems and fuels raises the prospects of new or more serious impacts on the environment. The projected increase in the use of diesel engines may call for new measures to control nitrogen oxide emissions (which are particularly high for diesels) or other substances (such as nitrosamines or particulate matter) found in diesel exhaust. More extensive use of electric vehicles may necessitate placing more stringent controls on power-generating plants supplying the electricity for storage batteries. There are major environmental problems associated with the production of synthetic fuels from coal or oil shale. In addition, the high benzene content of coal-derived liquids could cause serious health and safety problems, both during production and distribution and when burned as a motor fuel.

BACKGROUND

Air Pollution

In 1975, the 95 mil lion automobiles in the United States traveled slightly over 1 trillion miles. During the year, these automobiles emitted more than 81 million tons of atmospheric pollutants. As a result of pollution from automobiles, combined with emissions from other forms of transportation and from stationary sources, the National Ambient Air Quality Standards for either carbon monoxide or photochemical oxidants were exceeded in about a third of the AQCRs throughout the country. [1] (See table 59.)

These figures are national aggregates and do not fully reflect the effects on the population in areas of extensive and concentrated automobile use—chiefly the central parts of cities, but sometimes the surrounding suburbs as well. In those urban areas, where both population and automobile use are the greatest and where air pollution from nonautomotive sources is also the highest, it is estimated that between 125 and 150 million people were potentially exposed at least once during the year to concentrations of carbon monoxide or photochemical oxidants that exceeded established Federal standards. The effects of this exposure on human health cannot be calculated with certainty. Estimates vary both as to the degree of danger and its importance for the more vulnerable segments of the population—infants, the elderly, and those with respiratory or cardiac disorders. However, the evidence clearly indicates that atmospheric pollution (to which the automobile is a major contributor) is cause for serious concern.

Recognition of the automobile as a source of air pollution dates back nearly a quarter of a century to the publication of experimental studies by Haagen-Smit, who described the process by which organic substances (such as hydrocarbons) and nitrogen oxides accumulate in the atmosphere and form photochemical oxidants when exposed to the ultraviolet component of sunlight. Haagen-Smit further demonstrated the role played by automobile exhaust, which contains both hydrocarbons and oxides

[1] Currently there are 247 Air Quality Control Regions (AQCRs) in the United States and its territories. The national standard may not be exceeded more than once per year in each AQCR (i.e., a single reading above standard is not considered a violation).

Table 59.—Automobile Emissions and Air Quality–1975

	Automobiles	All sources
Emissions (million tons/year)		
Carbon monoxide	69.3	119.5
Hydrocarbons	7.9	29.4
Nitrogen Oxides	4.0	22.5

Air quality	Number
Carbon monoxide	
Number of AQCRs[a] exceeding standard[b]	43
Number of AQCRs exceeding 2 x standard	25
Total violations	68
Photochemical oxidants	
Number of AQCRs exceeding standard[c]	49
Number of AQCRs exceeding 2 x standard	20
Number of AQCRs exceeding 3 x standard	8
Number of AQCRs exceeding 4 x standard	7
Total violations	84

[a] AQCR—Air Quality Control Region. There are 247 AQCRs in the United States and its territories
[b] The CO standard used here is 10 mg/m^3 in an 8-hour period.
[c] The oxidant standard is 160 $\mu g/m^3$ in a 1-hour period.
SOURCE: Sydec/EEA, from U.S. Environmental Protection Agency, *Monitoring and Air Quality Trends Report, 1974*, February 1976.

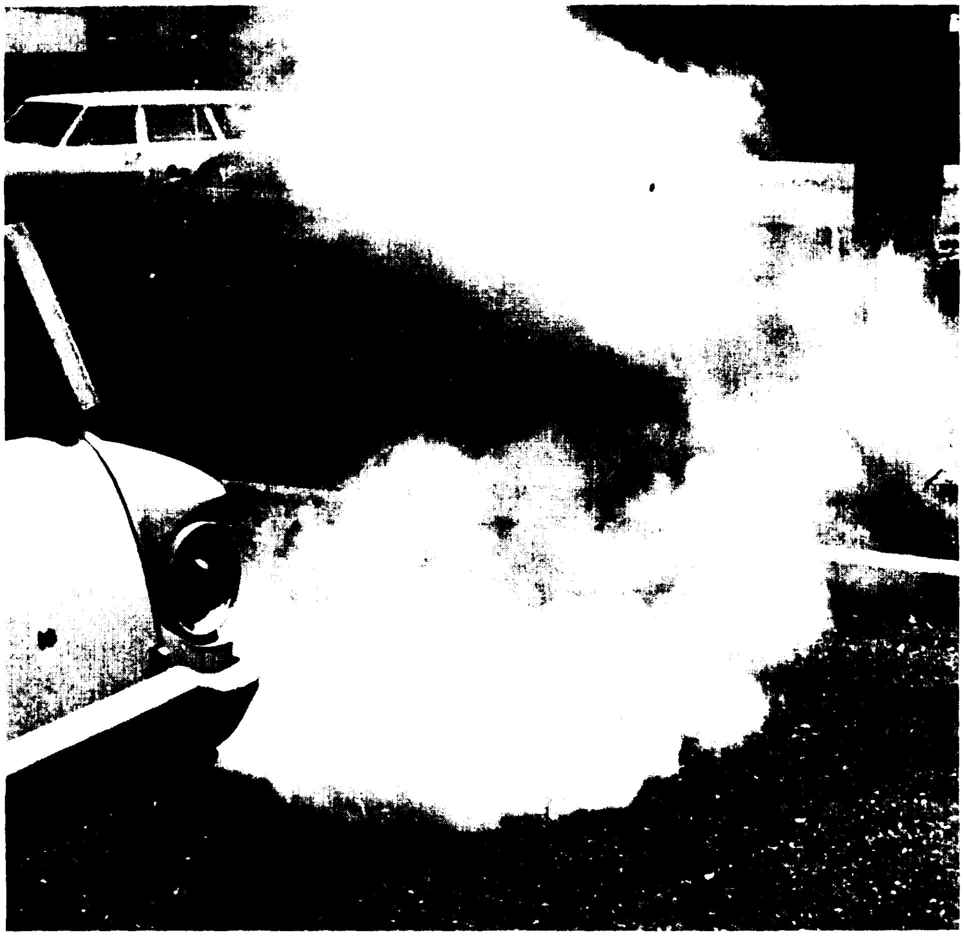

Photo Credit U S Department of Transportation of nitrogen, in the formation of smog.[2] Automobile exhaust also contains carbon monoxide (CO), which results from the incomplete combustion of hydrocarbon fuels. While not involved in the photochemical reaction of hydrocarbons (HC) and nitrogen oxides (NO_x) that produces smog, carbon monoxide is also an atmospheric pollutant because of its toxicity to humans and vegetation. It has been estimated that in 1972, automobiles accounted for about a half of the total CO emissions nationwide and about a quarter of the HC and NO_x emissions.[3]

Carbon monoxide has been linked, either as a causative or contributing factor, to a number of health problems. CO interferes with oxygen transport in the human body by displacing oxygen from hemoglobin and forming carboxyhemoglobin in the bloodstream. Concentrations of carboxyhemoglobin as low as 3 to 5 percent[4] can cause adverse effects both in normal people (decrease of vigilance and shortness of breath) and in those with arteriosclerotic heart disease (inducement of chest pains and reduced heart efficiency).'

Hydrocarbons and nitrogen oxides are the so-called precursor emissions that lead to the production of photochemical oxidants, such as ozone. The health effects of photochemical oxidants range from relatively minor discomforts, such as eye and throat irritation, to aggravation of chronic disorders, such as obstructive pulmonary disease (bronchial asthma, emphysema). It has been estimated that between 3 and 5 percent of the population may be considered to have some degree of obstructive pulmonary disease.[b]

Apart from their role in the formation of oxidants, nitrogen oxides have also been shown to have direct effects on health. Prolonged or repeated exposure to concentrations of NO_x greater than 0.5 parts per million (ppm) appears to be particularly hazardous for persons with asthma, chronic respiratory diseases, and cardiac disease. There are also risks for those suffering from viral and bacterial pulmonary infections (colds, influenza). Some evidence also suggests that the very young have an increased susceptibility to pulmonary damage if exposed to concentrations above 0.5 ppm for prolonged periods. '

The medical evidence on the health effects of CO, HC, and NO_x is far from definitive and complete. Serious questions have been raised about the causal relationships between atmospheric pollutants and health disorders. There is also question about the appropriateness of the present ambient air quality standards.[8,9] The standards and the supporting evidence were reviewed by the Coordinating Committee on Air Quality Standards of the National Academy of Sciences and National Academy of Engineering (NAS/NAE) in 1973. The Committee concluded that:

> Automobile emissions may account for as much as one-quarter of one percent of the total urban health hazard, (representing) as many as 4,000 deaths and 4 million illness-restricted days per year. Four thousand deaths is about an eighth of the deaths from bronchitis, emphysema, and asthma combined, or a twelfth of the deaths from automobile accidents. Four million days of illness is nearly equivalent to a tenth of the total number of days lost from work each year because of respiratory illnesses.[10]

The NAS/NAE report also pointed out the degree of uncertainty surrounding these esti-

'M. M. Fox and A. J. Haagen-Smit, 'Automobile Exhaust and Ozone Formation," *Vehicle Emissions-Part I* (*New* York: Society of Au torn o t ive Engineers, Inc. , 1964), pp. 1-6, 1 b.

'U.S. Department of Transportation, *The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980* volume 2, Sept. 2, 1976, pp. 10-15.

[4]The percentage of carboxyhemoglobin concentration refers to that portion of the hemoglobin in the blood that is bound with carbon monoxide, and thus unable to transport oxygen.

[5]U.S. Congress, Senate, Committee on Public Works, *Air Quality and Automobile Emission Control* Volume I, Summary Report, A Report by the Coordinating Committee on Air Quality Studies, National Academy of Sciences, National Academy of Engineering, Committee Print, 93d Congress, 2d Session, September 1974, pp. 27-29.

'Ibid., p. 49.

"Ibid., p. 43-44

'The present National Ambient Air Quality Standards specify 9 ppm (10 mg m') in an 8-hour period as the maximum permissible concen t ra tion of CO. The standard for photochemical oxidants is 0,08 ppm (160 µg m') in a 1-hour period. There is no standard for short-term exposure to nitrogen dioxide (NO_2) at this time; the existing standard annual arithmetic average of 0,05 ppm (9.4 mg m') is intended to protect against long-term chronic effects. The 1977 amendments t o the Clean Air Act directed EPA to develop a standard for short-term exposure to NO_2.

'See, for example, Petition of American Petroleum Institute and Member Companies Before the Administrator of the U.S. Environmental Protect ion Agency, Dec. 9, 1976, for a review and critique of the laboratory and epidemiological evidence supporting the current standards.

[10]U.S. Congress, Senate, Committee on Public Works, *Air Quality and Automobile Emission Control*, p. 13.

mates, stating that the total urban health hazard from all forms of air pollution might be as low as 0.01 percent or as high as 10 percent. The range of estimates of the part attributable to automobile emissions was also large—between 1 and **25** percent. If these estimates are combined to produce minimum and maximum approximations of the impact of automobile emissions on urban health, the NAS/NAE findings suggest that automobile emissions may account for something between 0.0001 percent and **0.25** percent of the urban health hazard. Clearly, a definitive assessment of the relationship between automobile emissions and public health cannot be made without further laboratory studies and epidemiological research to narrow the range of uncertainty and to establish firmer causal links.

A more recent study, conducted in 1976 by the Air Quality, Noise, and Health Panel of the Interagency Task Force on Motor Vehicle Goals Beyond **1980,** cataloged a variety of health effects linked to automobile emissions. While the panel did not include a review of medical evidence in its report, the analysis was conducted on the assumption that reduction in CO, HC, and NO_x emissions (from automobiles and other sources) would produce substantial health benefits of the types identified by NAS/NAE.[11]

In addition to CO, HC, and NO_x, automobile exhaust contains other substances that, in sufficient concentrations, may be of concern as atmospheric pollutants.

- Lead—emitted as particulate matter from automobiles burning fuel to which tetraethyl lead has been added to increase the octane rating,
- Particulates—contained in diesel exhaust, which have been shown to have strong mutagenic and possibly carcinogenic properties, and
- Nitrosamines —a carcinogenic agent, emitted from the crankcases and fuel systems of diesel engines.

With the exception of lead, which is being phased out as a motor fuel additive under current statutes, the evidence is not conclusive on the health hazards posed by emission of these substances from automobiles at the present levels. Research on both the health effects and the level of permissible concentration is continuing.

Other Environmental Problems

The environmental impacts of the automobile transportation system are not limited to atmospheric pollution. Automobiles and highways have a variety of adverse impacts that should be considered in setting and enforcing policies to protect the general quality of the environment. The noise of vehicles, the disposal of solid wastes (scrap vehicles and major parts, such as tires and batteries), the contamination of water by fuels, lubricants, and road salt, the disruption of communities by highway construction, and the invasion of agricultural lands, natural preserves, and recreation areas by automobiles and highways are problems that also require attention.

The noise of automobiles is of concern both because of its possible health effects and because of its disruption of human activities. Prolonged exposure to high levels of noise can cause hearing damage. Exposure to lower levels has been shown to produce anxiety and distress due to interference with conversation, telephone communication, listening to radio and television, concentration during mental activity, sleep, and relaxation.

The Environmental Protection Agency has defined **70** dB L_{eq}[12] as the noise level below which hearing damage will not occur. Since exposure to urban traffic noise is generally below this level, traffic noise is not regarded as a significant contributor to hearing damage among urban populations as a whole. However, for individuals whose activities place them in a position of regular exposure to high levels of traffic noise (traffic policemen, tollbooth attendants, roadside workers), permanent hearing damage could result. Table 60 shows estimates

[11] U.S. Department of Transportation, Office of the Secretary, *Air Quality, Noise and Health*: Report of a Panel of the Interagency Task Force on Motor Vehicle Goals Beyond 1980, March 1976.

[12] L_{eq} (24) represents the A-weighted sound energy, measured in decibels (dB), averaged over a 24-hour period. Another measure commonly used for noise effects is L_{dn}, which is L_{eq} with a 10 dB incremental weighting applied to the period 10 p.m. to 7 a.m. to account for the increased sensitivity of people to noise at night.

of the number of people exposed to various levels of traffic noise.

Table 60.—Estimated Number of People Subjected to Traffic Noise

At or above outdoor Ldn	Persons subjected (millions)	
	Urban traffic	Freeway traffic
55.	93.4	4.9
60.	59.0	3.1
65.	24.3	2.5
70.	6.9	1.9
75.	1.3	0.9

SOURCE: U.S. Department of Transportation, *Air Quality, Noise and Health*, Report of a Panel of the Interagency Task Force on Motor Vehicle Goals Beyond 1980, March 1976, p. 6-18.

There is no generally accepted standard for evaluating noise as a disruptive or nuisance factor in human activity. The sensitivity to noise varies widely among individuals and for the same individual as a function of age, general health, type of noise, time of day, activity in which engaged, and so forth. Because many of these are subjective factors, there is no reliable way to estimate the extent to which automobile noise has an adverse effect on human activity, personal comfort, and sense of well-being.

The automobile is relatively quiet in comparison with other vehicles that make up the traffic stream. However, because the automobile is the preponderant component of traffic, it must be considered a major contributor to traffic noise, especially in urban areas. (See table 61.) Measures to achieve reduction in traffic noise must therefore give consideration to suppression or elimination of automobile-produced noise.

Table 61 .—Median Noise Levels and Urban Traffic Mix

Source	Median noise level dB(A) at 50 feet[a]	Percent of urban traffic
Heavy-duty trucks . . .	85	1.0
Medium-duty trucks .	77	6.0
Buses	79	0.5
Motorcycles.	82	
Automobiles.	65	91.5:

aThe decibel scale is logarithmic; each Increase of 10 dB represents a doubling of loudness
bAt 27-mph cruising speed, median automobile noise = 60dB(A) During acceleration in urban areas, the median noise level is 72 dB(A)
SOURCE U S Department of Transportation. *Air Quality, Noise and Health*. Report of a Panel of the Interagency Task Force on Motor Vehicle Goals Beyond 1980, March 1976, pp 6-21

The disposal of solid waste produced by the automobile system is also an environmental problem. Each year, about 7 million cars are scrapped—amounting to more than 13 million tons of solid waste, largely steel and iron, but also including aluminum, copper, other metals, rubber, and plastics, About two-thirds of these junk cars are salvaged and processed to recover scrap materials, but the remainder are either disposed of in land fills or left to rust along the roads or in vacant lots. In addition to the vehicles themselves, about 150 million tires and 50 million batteries are discarded each year.[13] Only a fraction of these items is reclaimed through salvage; the rest (amounting to perhaps as much as 5 million tons) is added to municipal refuse. Overall, it is estimated that automobile solid wastes make up about 7 percent of the total commercial, residential, and municipal waste in the United States each year.[14] This figure does not include the additional millions of tons of litter deposited along streets and roads by motorists. While disposal of waste is largely a municipal concern, Federal policy may play a role in determining the composition (and hence recoverability) of automobile scrap or in promoting more productive use of scrap vehicles and parts.

Automobiles and highways also have important impacts on water quality. Highway construction leads to stream pollution by erosion and sedimentation from excavations or by contaminating runoff water with chemicals or other materials used in roadbuilding. Road salt and other chemicals used to clear streets and highways of snow and ice are carried away by runoff water and pollute streams or destroy vegetation in the path of the runoff. Automobiles deposit a variety of materials on the road surface. These are subsequently either dissolved or borne away by runoff water into nearby streams. Automobile deposits include exhaust components, lubricants, coolants, hydraulic fluids, and tire materials. In addition to the materials deposited on the road, the automobile system produces millions of gallons of waste fluids (crankcase oil, hydraulic fluids, battery acid, and spilled fuel) that may make their way into soil and water. Even if measures are taken

[13] Motor Vehicle Manufacturers Association, *Motor Vehicle Facts and Figures 77* (Detroit: Motor Vehicle Manufacturers Association, 1977).
[14] *Sydec/EEA*, p. 111-127.

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to prevent their drainage into the surrounding soil and water, the disposal of these liquid wastes (chiefly used crankcase oil, coolants, and battery acid) poses an important environmental problem. As with solid waste, the treatment and disposal of liquid wastes and effluents are largely local matters. However, Federal policy may have an influence, either through requiring control of water quality impacts (for example, as a precondition for Federal funding of highways) or through promoting environmentally sound methods of treatment, disposal, or reclamation,

The environmental impacts of the automobile and highway system reach far beyond the physical effects on the atmosphere, water, and soil enumerated thus far. There is also a class of impacts that are variously designated as social impacts, community impacts, or quality-of-life impacts. These include a number of undesirable consequences of highway building and automobile use—among which are displacement of homes and businesses, denial of accustomed access to facilities and services, disruption of community cohesion, alteration of land values (and property taxes), removal of land from agricultural production, endangerment of terrestrial ecosystems, invasion of natural preserves and pristine areas, and infringement on sites of historical, archaeological, natural, or aesthetic importance. The need to protect specifically affected individuals (and society in general) from these impacts of automobiles and highways, while assuring all the wider benefits of mobility, is one of the most controversial and keenly debated questions of national environmental policy. Part of the controversy stems from the lack of an objective method to quantify these impacts and to assess costs and benefits, many of which may be intangible. The question is also controversial because it tends to pit the values and desires of the automobile-using public at large against the values of a relatively small group of affected or interested parties (residents of a particular neighborhood, those who want to preserve a certain natural site, or those who want a community of a special character). Environmental considerations of this sort tend to raise profound questions of social and economic equity.

PRESENT POLICY

The present policy of the Federal Government on environmental matters is set forth in a variety of documents—Federal Statutes and the U.S. Code, Presidential Executive Orders, the Code of Federal Regulations, Department of Transportation (DOT) Orders, and administrative rulings by DOT, the Federal Highway Administration (FHWA), the National Highway Traffic Safety Administration (NHTSA), and EPA. However, the essential features of this policy are embodied in the eight major legislative acts described below. Table 62, is a classification of this legislation according to the type of environmental impact dealt with.

It will be noted that much of the legislation is of recent origin. Most of these laws were enacted within the past decade, and half since 1970. Most of the legislation deals with a specific environmental problem (e.g., emissions, noise, social impacts of highways), with air quality being the predominant concern. Also, much of the present policy is regulatory in nature and directed toward particular automobile performance characteristics.

The Clean Air Act of 1963 (Public Law 88-206) provided for interstate conferences on abatement of air pollution and authorized the Federal Government, in some cases, to initiate suits to force reduction of emissions. The Act also designated three major areas of air pollution research: control of motor vehicle emissions, removal of sulfur from fuels, and development of air quality criteria. An amendment to the Act (Title 11), passed in 1965, authorized the Department of Health, Education, and Welfare (HEW) to set emission standards for automobiles beginning in the 1968 model year.

The Department of Transportation Act of **1966** (Public Law 89-670) stated that it was the national policy to make a special effort to preserve "the naturaI beauty of the countryside and public parks and recreational lands, wildlife and water-fowl refuges, and historic sites. " The Act provided that transportation programs and projects involving the use of public land be approved only if it was demonstrated that there was "no feasible and prudent alternative to the use of such land" and that such programs include "all possible planning to minimize harm" to natural, recreational, and historic sites.

The Air Quality Act of **1967** (Public Law 90-148) attempted to remedy some of the deficiencies of the 1963 Clean Air Act by preempting States from setting emissions standards for new motor vehicles unless they had done so before March 30, 1966. California was the only State to have imposed emissions standards by this deadline. The Act, in effect, indicated the intent of the Federal Government to assume the lead in setting automobile emissions standards.

The National Environmental Policy Act of **1969** (Public Law 91-190) established a broad policy for environmental protection. NEPA set policies and goals concerning all aspects of the environment and required that specific Federal policies, regulations, and programs be administered in accordance with these policies and goals. NEPA also provided for the creation of the Council on Environmental Quality (CEQ) and the adoption of an interdisciplinary approach in planning federally assisted highway projects. To do this, NEPA established provisions for environmental impact statements, public hearings on environmental impacts, and preparation of environmental action plans.

The Highway Act of **1970 (23 U.S.C. 109)** directed the Secretary of Transportation, in consultation with EPA, to develop and put into effect guidelines to assure consistency of highways with approved plans for implementation of ambient air quality standards. The Act also provided for DOT to develop and promulgate standards for highway noise levels compatible with different land uses and to withhold approval of highway projects that do not include adequate measures to comply with noise standards.

The Clean Air Act of 1970 (Public Law 91-614), technically amendments to the 1963 Clean Air Act, set standards for emissions of CO, HC, and NO_x from new light-duty vehicles at a level 90 percent below that of 1970 vehicles. The CO and HC standards (later determined administratively to be 3.4 grams per mile for CO and 0.41 gram per mile for HC) were to be met

Table 62.—Selected Laws Relating to Environmental Impacts of Automobiles and Highways

Statute	System component affected		Type of impact controlled						
			Physical						
	Vehicles	Highways	Air quality	Noise	Historic & aesthetic	Land ecosystems	Water ecosystems	Economic[a]	Social[b]
Clean Air Act of 1963	●		●						
Department of Transportation Act of 1966		●			●			●	●
Air Quality Act of 1967	●		●						
National Environmental Policy Act of 1969	●	●	●	●	●	●	●	●	●
Highway Act of 1970		●	●	●					
Clean Air Act of 1970	●	●	●					o	
Noise Control Act of 1972	●	●		●					
Clean Air Act of 1977	●		●						

[a]Economic impacts include those on employment business activity residences, prOperty taxe S. regional & community growth and resources
[b]Social impacts include those on community *cohesion* accessibility to facilities and Services and displacement of peo Ple

by 1975. The NO_x standard, to be met by 1976, was 0.4 gram per mile. The Act required that these standards be met over the useful life of the motor vehicle, defined as the first **50,000** miles or 5 years, whichever comes first. The Act authorized EPA to establish National Ambient Air Quality Standards (NAAQS)[15] and AQCRs. The Act required States to submit plans for attaining NAAQS and authorized the imposition of transportation control plans, if necessary, to attain air quality standards for particular AQCRs by the specified deadline. Title 11 of the Act provided for a fine of $10,000 per vehicle to be levied against manufacturers marketing vehicles not certified as meeting standards.

The Noise Control Act of **1972** (Public Law 92-754) provided EPA with authority to set comprehensive standards and regulations for abatement and control of noise, including that from automotive sources. While recognizing the primary responsibility of State and local governments in noise control, the Act affirmed that Federal Government action is essential to assure national uniformity in dealing with major noise sources. States and localities retain rights and authorities to determine the levels of noise permitted in their environments and to establish and enforce controls on noise through licensing, regulation, or restriction of noise sources. The Act, however, authorizes EPA to establish noise emission standards for products distributed in interstate commerce and to set deadlines based on the application of best available technology. The Act also foresees the need for Federal assistance to State and local governments in enforcement and research.

The Clean Air Act of 1977 (Public Law 95-95), the most recent of a series of amendments to the 1970 Clean Air Act, established automobile emission standards to be met in successive steps through 1981:

	1977-79	*1980*	*1981*
HC	1.5 gm / mi	0.41 gm/mi	0.41 gm/mi
co	15.0 gm/mi	7.0 gm / mi	3.4 gm/ mi
NO_x	2.0 gm / mi	2.0 gm / mi	1.0 gm / mi

The 1977 amendments also allowed a 2-year waiver of the 1981 CO and NO_x standards under certain conditions and postponed imposition of the 0.4-gram-per-mile standard for NO_x until further research is conducted. The 1977 Act contained some provisions that indicate a shift from the policy of the **1970** Clean Air Act, such as permitting States to adopt the more stringent California standards if they desire, granting States explicit authority to adopt indirect source control programs, requiring promulgation of an air quality standard for short-term exposure to nitrogen dioxide, requesting EPA to report to Congress on the advantages and disadvantages of a system of penalties for NO_x emissions, and requiring EPA to set emissions standards for trucks, buses, and other vehicles over 6,000-pound gross weight manufactured for use on public roads and streets.

From the foregoing summaries, it can be seen that present environmental policy with respect to the automobile transportation system is of two basic types—statements of goals, principles, and guidelines (such as in NEPA), and specific regulatory standards (as in the case of automobile emissions and noise). The regulatory policies have four basic features:

- They are predicated on objective and quantified measures that are directly related to public health.
- They call for progressive attainment of goals by a series of deadlines.
- They embody the concept of "technology forcing."
- The sanctions for noncompliance are set so as to remove any economic incentive for not meeting the standards (i.e., the fine for not complying is at least as great as the cost of complying).

The present environmental protection policies, especially automobile emissions standards, have met with several criticisms. The adequacy of the research on health effects and the benefits ascribed to specific reductions in pollution levels have been challenged.[16] The goals and deadlines for achieving air quality standards have been

[15] NAAQS have been established for five pollutants: particulate matter, sulfur dioxide, nitrogen dioxide, carbon monoxide, and photochemical oxidants.

[16] See, for example, American Petroleum Institute (footnote 9); and F. P. Grad, et al., *The Automobile and the Regulation of Its Impact on the Environment* (Norman, Okla.: University of Oklahoma Press, 1975), pp. 31-66.

called unrealistic and economically unsound. 1[7] It has been argued that the strategy of technology forcing removes the Federal Government too much from the field of research and places the burden of innovation almost exclusively on manufacturers without any assurance that they will be able to meet the challenge. [18] It has been asserted that the deadlines accompanying the standards have the effect of pushing manufacturers toward short-term, remedial techniques (such as catalytic converters) at the expense of encouraging efforts to find more fundamental, long-term solutions. '9 Questions as to the appropriateness of a single standard for all automobiles in all parts of the country under all conditions of use have led to suggested alternative approaches, such as regional standards or the so-called two-car strategy .20 There is doubt about the ability to enforce standards, the strict application of which might do grave harm to one or more manufacturers or to the economy as a whole. " There has been strong resistance to transportation use controls as a means to reduce air pollution on the grounds that they represent intrusion by the Federal Government into traditionally local decisions on transportation and land use policy .22 It has been suggested that the present approach is too rigidly concerned with automobile emissions and should be replaced with a more flexible policy that treats mobile and stationary source emissions as a whole and permits tradeoffs.[23] Finally, the basic strategy of regulation has been attacked on economic grounds as more costly and less efficient than an approach based on taxation or market incentives.[2q]

No attempt will be made at this point to deal in detail with the arguments for and against the present environmental protection policy of the Federal Government. However, the questions raised above should be kept in mind during the discussion of policy alternatives, where ways of changing the Federal role in environmental protection are considered. Also, some of these criticisms will be examined specifically in the analysis of effects and impacts that may ensue from these policy options.

ISSUES

Several issues of public policy surround the general problem of how to prevent harm to the environment by the automobile transportation system. These issues involve the need to protect the health and well-being of the populace from the adverse effects of automotive technology, while assuring the continued benefits of a personal transportation mode that is vital to the economic and social structure of the country. Some of the issues arise from the way in which present environmental protection policies are formulated and applied. Others stem from the characteristics of automotive technology, both now and as it may evolve in the future. Some confront us now; others are expected to emerge or intensify later as the number and concentration of automobiles in use increase over the rest of this century.

The environmental issues addressed in the automobile assessment are:

- How should the Federal Government set environmental standards relating to the characteristics and use of the automobile system, and how should they be enforced?
- Should Federal environmental standards be extended to control of passenger vehicles in use?

I-A, V. Kneese and C. L. Schultze, *Pollution, Prices and Public Policy* (Washington, D. C.: The Brookings Institution, **1975).**

[1*]H. S. Jacoby and J. D. Steinbruner, *Clearing the Air* (Cambridge, Mass.: Ballinger Publishing Co., **1973).**

[1] *U.S. Congress, Senate, Committee on Public Works, *Air Quality and Automobile* Emission *Control*, Volume 3.

[20]Kneese and Schultze, op. cit.

[21]D. Harrison, Jr., *Who Pays for Clean Air—The Cost and Benefit Distribution of Federal Automobile Emission Controls* (Cambridge, Mass.:Ballinger Publishing Co., 1975),

[22]J. E. Blodgett, *Environmental Protection*, Issues in Public Policy Series, IPP *76-19 (Washington*, D. C.: The Library of Congress, Congressional Research Service, Nov. *5*, 1976).

[23]U.S. Department of Transportation, *The Report by the Federal Task Fore-c on Motor Vehicle Goals Beyond 1980* pp. 10-1 to 10-19.

[24] Harrison, Jr., *Who Pays for Clean Air.*, Kneese and Schultze, *Pollution, Prices and Public Policy*, E. S. Mills and L. J. White, "Auto Emissions: Why Regulation Hasn't Worked, " *Technology Review* March April *1978*, pp. *55-63.*

- To what extent should transportation use controls be applied to reduce the environmental impacts of the automobile?
- What criteria should be used to judge the value of environmental policies and programs related to the automobile?
- To what extent should factors other than public health (e.g., community impacts, quality of life, and aesthetics) be considered in setting environmental standards?
- What environmental problems should be considered in the evolution of new automotive technologies and at what point in the development process should research on environmental effects be started?

These issues have been examined in the automobile assessment and used both to identify potential impacts and to guide the formulation of policy alternatives relating to environmental protection.[25] The issues also provide a framework for evaluation of the policy alternatives that are discussed later in this chapter.

POLICY ALTERNATIVES

The range of policy alternatives for dealing with the environmental effects of automobiles is shown on the relevance trees in chapter 4. These policies include new or more stringent standards for new vehicles, control of automobile use, alternatives to regulation, and encouragement of other more environmentally benign modes of personal transportation. Because the range of policy options is broad, not all could be examined during the automobile assessment. Some selectivity was therefore required.

The two contractors supporting OTA were directed to take different approaches to policy selection. SRI performed separate analyses of three individual policies. Sydec/EEA examined a group of policies, which had the collective intent of achieving major improvement in environmental quality beyond that projected for the Base Case. Thus, neither contractor attempted a comprehensive treatment of all possible environmental policies. SRI concentrated on air quality as the most important concern, and examined three different approaches to supplement present policy on automobile emissions. Sydec/EEA formulated a coordinated set of policies aimed at general environmental improvement, but consistent with other concerns such as safety, mobility, energy, and cost.

The policies studied by SRI were:

- Mobile-Stationary Source Tradeoffs.—Consideration of tradeoffs between automobile emission standards and stationary source controls as a more cost-effective appreach to meeting air quality objectives;
- Regionally Specific Standards.—Differentiation between the air pollution problems of cities and rural areas by setting standards for automobiles based on the air quality in the region where the vehicle is owned and operated (i.e., the two-car strategy);
- Mandatory Inspection and Maintenance.—Adoption, at the State level, of a program for periodic inspection and required maintenance of vehicles in use to ensure that they continue to meet emission standards for new cars.

It should be noted that these policies are not mutually exclusive, nor are they inconsistent with the present policy governing the emissions characteristics of new cars. Any or all could be combined with the current provisions of the Clean Air Act or with either tighter or more relaxed versions of these standards.

The Sydec/EEA policy set (called the Improved Environment Case) is made up of several measures, which are of two types: major policy actions to reduce the negative environmental effects of automobiles, and supporting measures

[25] Fuller discussion of the issues is contained in a series of working papers prepared by the OTA staff, issues *Involved in the Study of Potential Changes in the Characteristics and Use of the Automobile Transportation System,* OTA, Oct. 21, 1977.

to increase the effectiveness of the major policy actions. (See table 63.)

Table 63.—Policies for Improved Environment Case

Major Policies

- Mandatory inspection and maintenance of vehicles in use.
- More stringent NO_x *standard for new cars,*
- *Motor fuel tax to keep the cost of driving constant.*
- *Parking management (including zoning and restraints on use of land for parking lots).*
- *Restraints on automobile use in urban areas (except e/ectric vehicles).*
- *Improved transit.*

Supporting Policies

- Carpool and van pool incentives.
- Transit incentives.
- Incentives for use of electric vehicles in commercial applications.
- Bicycle incentives.
- Other transportation system management projects.

The major policies assumed for the Improved Environment Case are:

- Mandatory Inspection and Maintenance. — A program of annual or semiannual inspection of all cars on the road would be instituted with the cooperation of State and local governments. Vehicles failing to meet standards would be required to have adjustment, repair, or replacement of emission control devices. It is assumed that a program, with sufficient facilities and trained mechanics to inspect all vehicles semiannually and to deal with an expected 30-percent failure rate, would be implemented.

- More Stringent NO_x Standard.—A NO_x emission standard of **0.4** gram per mile would be imposed on all new vehicles (including light trucks, vans, and diesels) in **1990.** If diesels were unable to meet this standard, they could not be sold as passenger or light-duty vehicles,

- Motor Fuel Tax. —To offset the decline in real fuel cost per mile as the result of fuel economy improvements, Federal motor fuel taxes would be increased periodically to hold the cost per mile constant at the 1975 level. This would tend to discourage increased auto use and the attendant growth in emissions.

- Parking Management.—Local and regional authorities would be encouraged (or in extreme cases, required) to restrict or eliminate parking in congested areas by means of such measures as parking surcharges, elimination of on-street parking, bans on parking for nonresidents, and limits on construction of new parking lots.

- Restraints on Automobile Use.—Local and regional authorities would be encouraged to limit the use of automobiles in congested areas. Possible restrictions that might be imposed are auto-free zones, restricted access by time of day or type of vehicle, and limitation of commuter traffic (either by tax or outright prohibition) except for carpools and vanpools. Electric vehicles would be exempt from these conditions.

- Improved Transit.—To provide a useful alternative means of personal transportation and to compensate for the restrictions on automobile use, public transit facilities would have to be expanded or improved. It is assumed that Federal Government funding of capital improvements would increase 15 percent per year from 1975 to 1985 (in constant 1975 dollars) and that the 1985 level of funding (also in constant dollars) would be maintained through 2000. Federal subsidy of mass transit operations would also be increased. In the first year, funding would double. Thereafter, it would increase at 15 percent annually through 1985 and then remain at the 1985 level until 2000 (all in constant 1975 dollars).

- Noise Standards.—It is assumed that noise standards for all new motor vehicles (medium and heavy trucks, buses, and motorcycles as well as passenger cars, vans, and light-duty trucks) will be in force by 1985. In areas of particularly high or objectionable noise, additional measures would be imposed either to control motor vehicle use or to provide sound insulation for unusually sensitive buildings (e. g., hospitals or schools) or for severely affected areas.

- Supporting Policies.—In addition to the major policies above, certain supporting measures would be required. It is assumed that the Federal Government would adopt policies to provide incentives for carpools, vanpools, mass transit, and bicycle use as alternatives to the single-occupancy automobile. Incentives would also be offered for commercial and personal use of electric vehicles, principally in congested areas.

The rationale of this policy set is to foster a substantial improvement in environmental quality, but without major adverse impacts in the areas of energy, safety, mobility, and cost. Accordingly, certain additional assumptions and conditions were made in constructing the Improved Environment Case. These assumptions and conditions are summarized in table **64 and** described briefly below.

- Total expenditures for highways are assumed to remain constant in real dollars at the 1975 level. The distribution of Federal highway funding is assumed to change so that capital expenditures decrease at the rate of 1 percent per year, while maintenance expenditures increase at a corresponding rate. (This is the same assumption as in the Base Case.)
- It is assumed that a separate transportation system management program is established and funded at the level of $200 million per year (in constant 1975 dollars). The emphasis of this program would be on projects designed to serve high-occupancy vehicles, thereby reducing emissions per passenger mile.
- Level I crashworthiness standards and mandatory installation of air bags (or their equivalent) are assumed to be in effect by 1980. The mandatory inspection and maintenance program for emissions control would include inspection of critical safety-related equipment as -well.
- It is assumed that the technology to meet automobile emissions and noise standards is available, or will be at the time the standards go into force. Specifically:
  - —NO_x emission levels of 0.4 gram per mile will be attainable for spark-ignition engines by 1990.
  - —Diesels will be able to meet the standard of 1.0 gram per mile for NO_x by 1981. They may not be able to meet the 1990 standard of 0.4 gram per mile. (The influence of NO_x standards on diesel penetration is discussed later in the analysis of effects and impacts.)
  - —Automobile noise levels can be reduced to 65 dB(A) during acceleration and 60 dB(A) for cruise.

EFFECTS

The primary objective of the policies studied in the Improved Environment Case is to bring about an improvement in air quality through reduction of automobile emissions. Other environmental concerns—such as noise and community disruption by highways—are also addressed, but only as secondary objectives. The heavy emphasis on policies to control auto emissions stemmed from analysis of Base Case projections. These showed that the dominant adverse impact of automobile characteristics and use in 1985 and 2000 would be on air quality, particularly in urban areas where automobile use is concentrated.

Air Quality

The Improved Environment Case contains three kinds of policies to reduce automobile emissions:

1. Policies to reduce auto travel,
2. A stricter NO_x emission standard for new cars, and
3. Mandatory inspection and maintenance of automobiles in use.

Figure 30 shows the combined effect of these policies on automobile emissions of CO, HC,

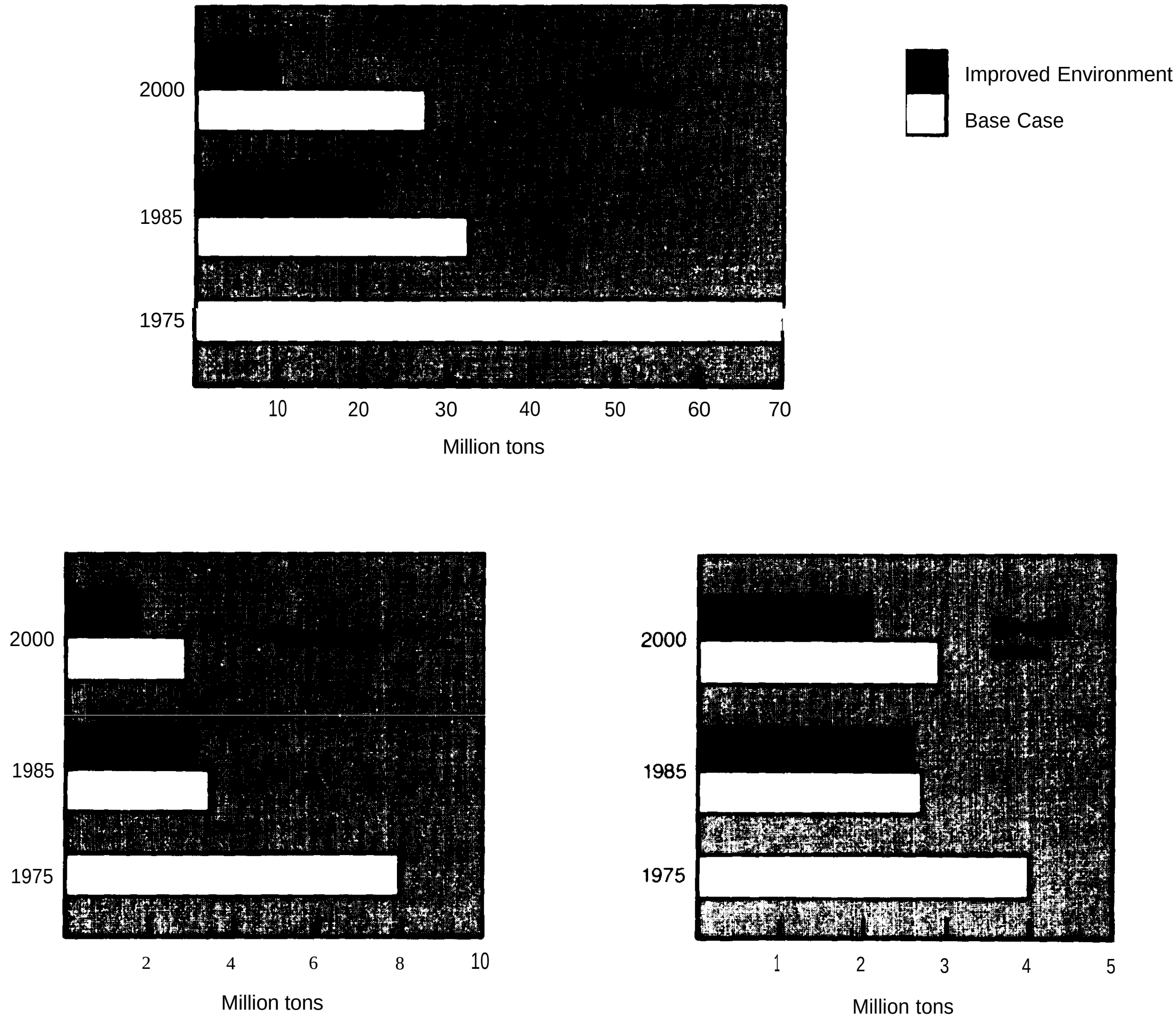
Table 64.—Assumptions and Conditions for Improved Environment Case

Assumptions	Base Case	Improved Environment
Transportation system		
Highway		
Total expenditures	Stable at 1975 level (in constant dollars).	Same as Base Case
Construction	Decreases from 50°/0 of total highway expenditures in 1975 to 25°A in **2000.**	Same as Base Case.
Maintenance	**Increases from 50°/0 of total highway expenditures in 1975 to 75°/0 in 2000.**	Same as Base Case.
Transportation system management	**Existing policies, no special funding.**	Separate program, funded at $200 million per year.
Mass transportation		
Capital improvements	Funding increased 10% per year (constant dollars) through 1985 and maintained at 1985 level through 2000.	Funding increased 15% per year (constant dollars, through 1985 and maintained at 1985 level through 2000.
Operations	Funding increased 10%A per year (constant dollars) through 1985 and maintained at 1985 level through 2000.	Funding doubled initially and then increased at 15% per year (constant dollars) through 1985 and maintained at 1985 level through 2000.
Environment		
Air quality		
Vehicle emissions	1977 Clean Air Act standards met, waiver for diesel NO, at 1.5 gpm for 1981-83.	CO and HC same as Base Case, Nonstandard tightened to 0.4 gpm, no diesel waiver, two-car strategy (electric cars).
Inspection and maintenance	No mandatory program.	Mandatory program by 1985.
Transportation controls	Negligible.	Parking and auto use restraints.
Noise		
Vehicles	Noise standards for trucks, buses, and motorcycles.	Noise standards for all vehicles.
Noise abatement	Continuation of existing policies.	Continuation of existing policies. plus funding for soundproof ing buildings.
Energy		
Fuel economy	**Case A: 27.5 mpg.** **Case B: 30 mpg by 1990,35 mpg by 2000.**	**Same as Base Case.**
Highway speed	Moderate Enforcement (present averaqe of 62 mph).	Same as Base Case.
Safety		
Occupant restraint	Airbags or equivalent on new vehicles as now scheduled.	Same as Base Case.
Crashworthiness	Existing standards.	Level I.
Taxes		
Fuel taxes	Fuel taxes increased to maintain revenue at 1975 level.	Fuel taxes adjusted to hold cost per mile constant.
Vehicle taxes	No new taxes.	Gas-guzzler tax on new cars.
Technology		
Propulsion	**Case A: 100/~ diesels by 1985, 250/o by 2000.** **Case B: 15°/0 diesels by 1985,** 40% by 2000.	**Same as Base Case A, except diesels phased out after 1990** unless 0.4 gpm NO_x standard can be met.
Diesel fuel consumption (percent of all motor fuel)	Case A: 4% by 1985, 18% by 2000. Case B: 6% by 1985, 29% by 2000.	Same as Base Case A, except accelerated penetration of electric vehicles.

and NO_x in 1985 and 2000. The greatest benefit is reduction of CO emissions which, by 2000, are expected to decline to about one-third of what they would be under Base Case conditions. The reductions of HC and NO_x emissions, while not as great as CO, are also significant.

A more detailed picture of the effects is presented in table 65, which shows quantitative estimates of automobile emissions in comparison with 1975 levels and projected Base Case levels in 1985 and 2000. Compared to 1975, all automobile emissions in 2000 would be greatly reduced. The national aggregate of CO emissions from automobiles is expected to fall to 9.7 million tons in 2000 (14 percent of the 1975 level). Hydrocarbons are projected to decline to 1.8 million tons (23 percent of 1975). The corresponding reductions for other pollutants are: NO_x, 52 percent of 1975; and particulate, 12 percent. The projected effects of present policies (the Base Case) are also given in table 65. By comparison, the package of improved environment policies would be considerably more effective in reducing air pollution from automobiles.

Figure 30.—Comparison of Automobile Emissions, Base Case vs. Improved Environment Case



SOURCE: *Sydec/EEA,* p V-33 and Supplementary Report

Table 65.—Projected Automobile Emissions for the Improved Environment Case (million tons per year)

Pollutant	1975	1985 Base Case	1985 Improved Environment	1985 Percent change	2000 Base Case	2000 Improved Environment	2000 Percent change
Carbon monoxide	69.3	32.6	21.4	–34	27.3	9.7	–64
Hydrocarbons	7.9	3.5	3.1	– 11	2.9	1.8	– 40
Nitrogen oxides	4.0	2.7	2.6	– 4	2.9	2.1	–28
Total suspended particulates[b]	0.377	0.077	0.094	+ 22	0.250	0.044	–82

[a]Includes crankcase emissions and evaporative losses. [b]Incl les lead. SOURCE: *Sydec/EEA*, p. V-33

Effects of Individual Policies

Table 66 shows the contributions of individual policies to the overall decrease in CO, HC, and NO_x emissions. Policies to reduce automobile travel—increased gasoline taxes, automobile disincentives, and transit improvements—are expected to have small, but beneficial, effects for all types of pollutants. The assumed tax on gasoline, designed to keep the fuel cost per mile constant through **2000,** is expected to reduce auto VMT by 0.8 percent from 1985 Base Case VMT and 0.4 percent from 2000 Base Case VMT, Auto disincentives and transit improvements would create further VMT reductions of 1 percent in 1985 and 3 percent in 2000. Unlike the gasoline tax, which would affect rural and urban travel equally, the effects of auto disincentives and transit improvements would be concentrated in urban areas, primarily for journey-to-work trips. As a result, urban VMT under these policies would be down 2 percent from the Base Case in 1985 and 6 percent in 2000. As a whole, the effects of policies to reduce VMT will account for between 5 and 20 percent of the total decrease in CO, HC, and NO_x expected from Improved Environment policies.

The second major feature of the Improved Environment Case is lowering the NO_x standard for new automobiles from 1.0 to **0.4** gram per mile beginning in the 1990 model year. The need for tightening the automobile NO_x standard stems from two considerations. First, projections of atmospheric pollution under Base Case conditions show that NO_x emissions will be the major air quality problem in coming years. Unless more stringent measures are adopted to control NO_x emissions from all sources, air quality in many urban areas in 1985 and 2000 may be worse than today. Second, the most serious aspect of the NO_x problem is likely to be how to control peak concentrations, which often coincide with rush-hour automobile traffic. Thus, a more stringent standard for NO_x in automobile exhaust becomes a particularly important control strategy.

From table 66 it can be seen that lowering the new car emission standard for NO_x to 0.4 gram per mile has the potential of reducing the national aggregate of NO_x emissions by 690,000 tons per year by 2000. This represents nearly 80 percent of the total reduction of NO_x from automobiles projected under Improved Environment policies.

Table 66.—Analysis of Effects of Improved Environment Policies

Contributing factor	Change from Base Case year 2000 (million tons): Carbon monoxide	Hydro-carbons	Nitrogen oxides	Particulate
Decreased auto travel	- 0.840	-0.164	-0.190	– 0.007
Stricter NO, standard	—	+ 0.098	– 0.690	– 0.199
Inspection and maintenance	– 16.730	– 1.040	—	—
Net	– 17.570	– 1.106	– 0.880	– 0.206

SOURCE *Sydec/EEA,* supplementary report

However, this potential benefit would entail certain penalties. First, the lower 0.4-gram-per-mile standard probably could not be met by diesel engines, which currently emit 2 grams per mile or more of NO_x. By 1990, the level of NO_x emissions from diesels might be reduced to 1 gram per mile, but probably not much lower unless there is a major technological breakthrough. For the Improved Environment Case, no such breakthrough in diesel technology has been assumed. As a result, the immediate consequence of a 0.4-gram-per-mile NO_x standard would be preclusion of diesels from the new car market after 1990.

This, in turn, would lead to a greater proportion of cars powered by conventional Otto-cycle engines in the new car fleet from 1990 to 2000. Such automobiles emit more hydrocarbons and lead per mile than diesels. The projections shown in table 66 indicate that the tightening of the NO_x standard for new cars could result in a nationwide increase of about 98,000 tons per year of hydrocarbons, in comparison with the level of this pollutant expected under Base Case conditions. The consequences are not so important since the increase stemming from the lower NO_x standard is far outweighed by reductions in HC emissions brought about by other Improved Environment policies.

The new policy which has the greatest net air quality benefits in the Improved Environment Case is the nationwide program of mandatory inspection and maintenance for all automobiles in use. The analysis of this policy assumes that, starting in 1985, all States implement programs requiring annual or semiannual inspection of all registered automobiles. Owners whose vehicles failed inspection would be obliged to have the necessary repairs or adjustments made before being allowed to continue operating the vehicle, which is similar to a provision now employed in motor vehicle safety inspection programs in many States.

The program could be administered and implemented either by State-run inspection centers or by licensing private service stations and garages as inspection facilities. Inspection standards could be set either nationwide through administrative action by EPA or by the States individually in accordance with Federal guidelines. It has been assumed that standards would be set for each model year and that they would vary with the age of the vehicle. Generally, the standards would be set at levels such that approximately 30 percent of the vehicles in each model year would fail and be required to have maintenance performed. For further discussion of the administration of a mandatory inspection and maintenance program, see the final section of this chapter.

The inspection procedure itself would be limited to tests of CO and HC exhaust emissions. At present, there are no test procedures for NO_x emissions and evaporative HC losses in general use. While some benefits in terms of reduced NO_x and evaporative HC emissions might reasonably be expected from the adjustments and tuneups required under this program, none have been assumed in the analysis of this policy. Therefore, the projected effects of the inspection and maintenance program include only the potential reductions in CO and HC from automobile exhaust.

It is projected that mandatory inspection and maintenance would reduce CO emissions by almost 17 million tons per year for the country as a whole in 2000. This amounts to 95 percent of the total reduction of CO from automobiles expected under Improved Environment policies. The reduction of HC is equally substantial—slightly over 1 million tons per year in 2000, or almost 95 percent of the total reduction projected for all Improved Environment policies combined. (See table 66.)

Mandatory inspection and maintenance thus appears to have great potential as a means to reduce automobile emissions. However, a word of caution is needed about the magnitude of the projected effects. The benefits of inspection and maintenance depend heavily on estimates of, the deterioration rates of emission control devices—oxidation catalysts and three-way catalytic converters. These devices have been in use for only a short time, and the data on their continued effectiveness over 50,000 or 100,000 miles of actual driving are limited. Estimates made by EPA during the period 1975-77 indicated that the performance of emission control devices was relatively stable over time and that they would retain about half their initial effectiveness throughout 10 years of use on the road.[26]

Data from more recent tests by EPA indicate that emission control devices have much more rapid rates of deterioration than originally expected. For example, CO emissions from a vehicle certified as meeting a standard of 3.4 grams per mile when new are now estimated to increase to **10** grams per mile after **5** years **(50,000** miles) and **22** grams per mile after 10 years (100,000 miles). Similar sixfold to eightfold increases are estimated for HC and NO_x emissions from automobiles after **10** years on the road without maintenance or repair of the emission control system .[27]

Thus, the benefits of inspection and maintenance are proportional to the assumed deterioration rates of emission control devices. The more rapid the deterioration rate, the greater the benefits of periodic adjustment and repair. The analysis presented here is based upon the most recent EPA data. If the EPA estimates are accurate, the benefits of mandatory inspection and maintenance would be very great. If, however, the EPA estimates are overly pessimistic and emission control devices do not lose their effectiveness as rapidly as now believed, the benefits of inspection and maintenance would be lessened accordingly, although they still might be large enough to warrant imposition of a mandatory inspection and maintenance program. A full assessment of this policy must await more definitive information about the continued effectiveness of emission control devices under actual driving conditions.

Overall Air Quality

To appreciate the effects of policies to reduce automobile emissions, it is necessary to consider the future magnitude of air pollution from all sources. Figure 31 shows estimates of the national aggregates of emissions from all sources in 1985 and **2000,** divided into three classes: automobiles, other mobile sources, and stationary sources.

On the whole, atmospheric pollution is expected to remain high. The levels of CO and HC will be down somewhat from 1975, but NO_x emissions are expected to continue rising. In all cases, however, the levels of emissions are projected to be lower than in the Base Case because of measures to control automobile emissions. The most substantial improvement is in CO emissions, which by 2000 will be down **27** percent because of a 64-percent reduction in automobile emissions. The effects of policies to control HC and NO_x in automotive exhaust will have a relatively smaller payoff since the automobile is expected to be only a minor source of HC and NO, in comparison with stationary sources.

While automobile exhaust will make up a declining share of total emissions, the importance of continuing efforts to control automotive sources of pollution can be seen by examining the projections of urban air quality for 1985 and 2000. Table 67 shows that a significant decline in violations of the carbon monoxide standard can be expected in both 1985 and 2000 as a result of auto emission controls. In 2000, for instance, the total number of CO standard violations would fall from **24** under Base Case policies to 7 under Improved Environment policies. On the other hand, violations of the oxidant standard would remain high, largely because of stationary source emissions. Measures to control automobile HC and NO_x emissions would have a relatively minor effect on the production of photochemical oxidants.

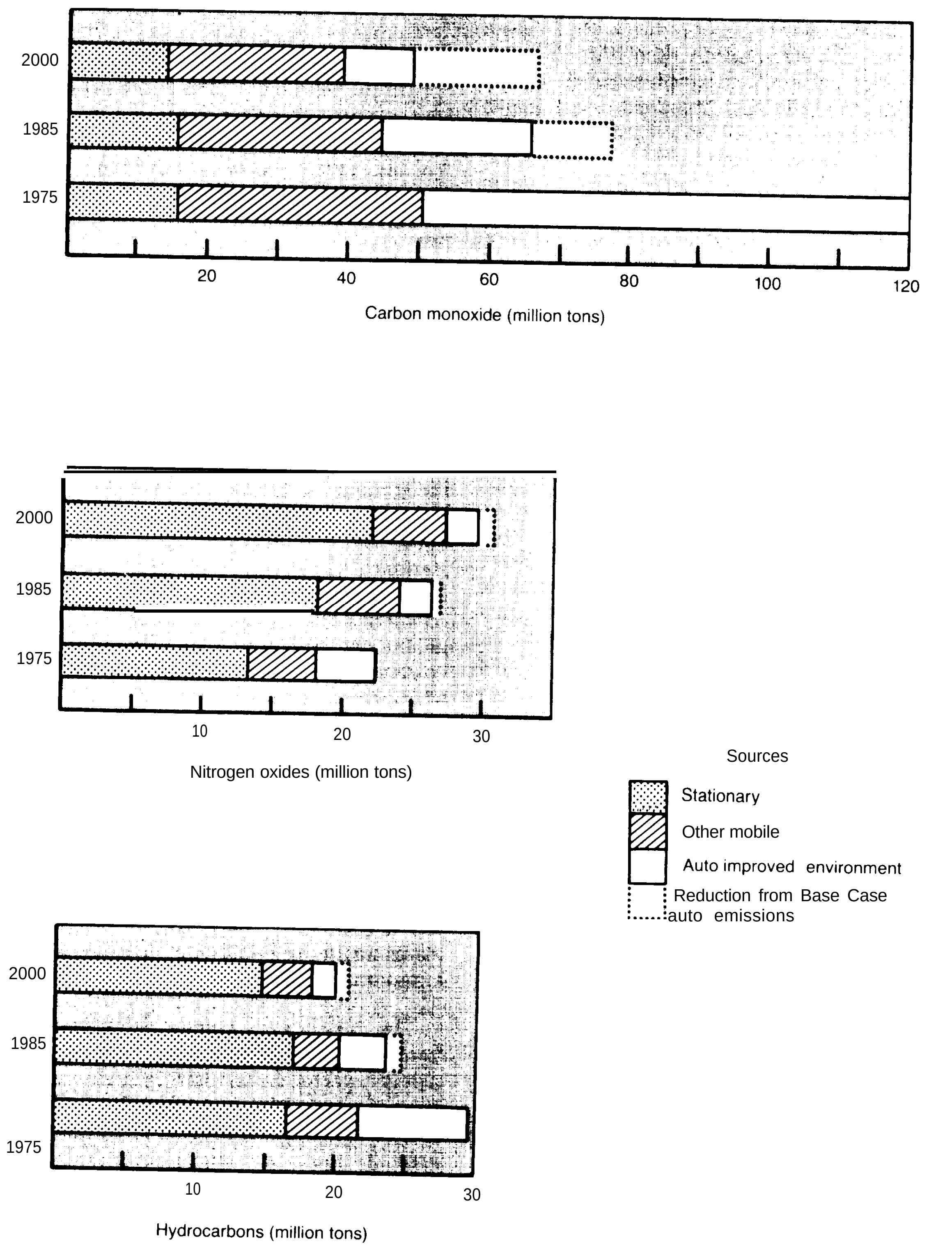
Figure 32 translates the 1985 and 2000 air quality projections into estimates of the population exposed to hazardous concentrations of criteria pollutants, The difference between the Base Case-and Improved Environment policies for CO is quite large, especially by 2000, and illustrates again the-value of controlling automobile emissions of CO.

The number of people exposed to oxidant concentrations higher than the national standard is expected to be essentially the same for the Base Case and Improved Environment policies in 1985. By 2000, however, small improvements are expected as a result of automobile *emissions* controls. The total number of people exposed to oxidant standard violations will remain about the same, but the number exposed to extreme violations (greater than 320 micrograms in a 1-hour period, i.e., twice the national standard)

[26] U S. Environmental Protection Agency, *Compilation of Air Pollutant Emission Factors*, Part A,

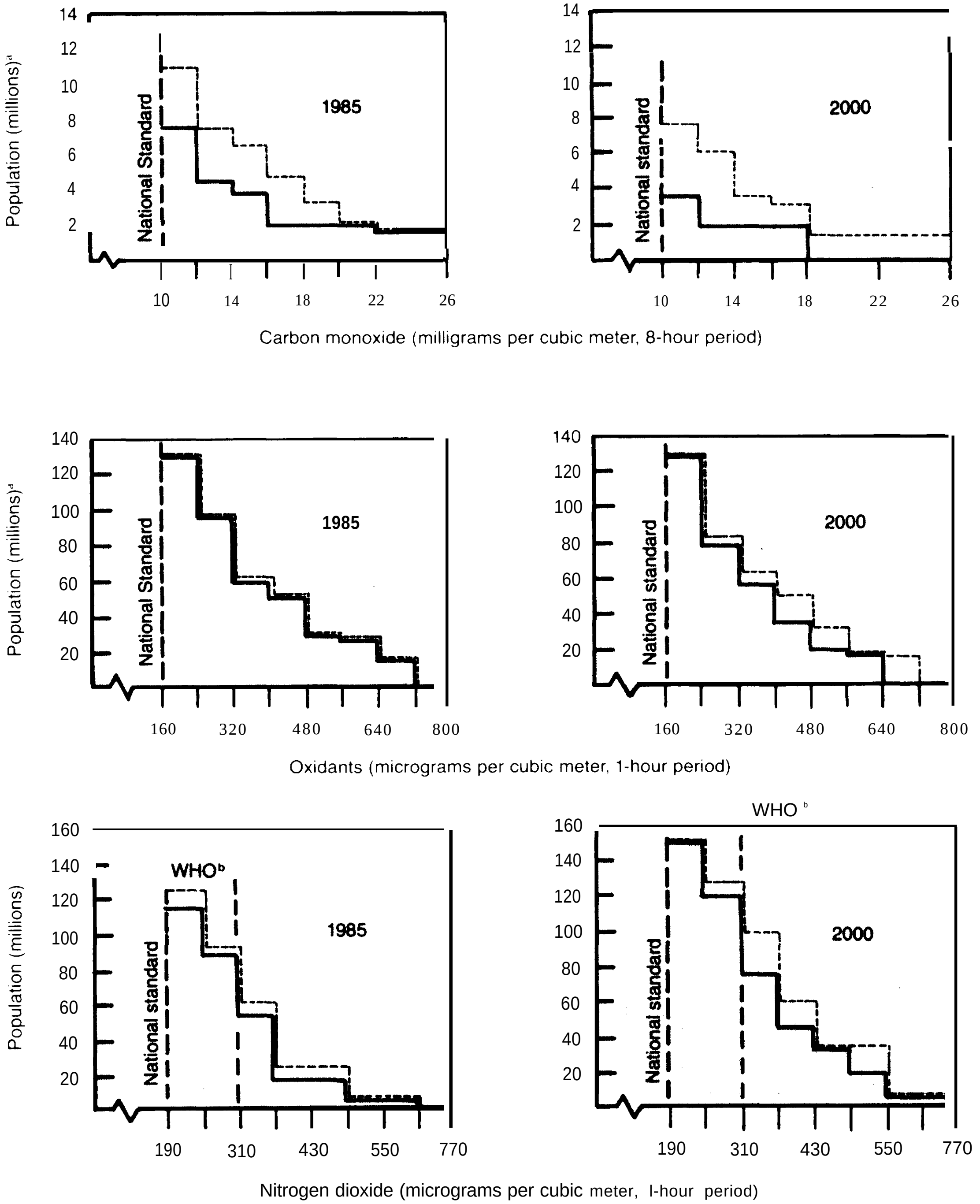
[27] EPA memorandum on revised mobile source emission factors, dated January *1978*, incorporated in the revised edition of *Compilation of Air Pollutant Emission Factors*, AP-42.

Figure 31 .—Projected Emissions from All Sources, 197 S-2000 Improved Environment Policies



SOURCE: .*Sydec/EEA,* p, V-33 and Supplementary Report

Figure 32.—Population Exposed to Air Pollution, Improved Environment Case



[a]Population in Air Quality Control Regions exposed to above-standard levels of air pollutants. For CO, populations of AQCRs were divided by 10 to account for localized effects

—— Improved Env.
Base Case

[b]One-hour standard advised by World Health Organization, *Environmental Health Criteria for Nitrogen*, February 1977

SOURCE *Sydec EEA*, pp V-36-38

Table 67.—Projected Violations of Air Quality Standards, Improved Environment Case

Pollutant	1975	1985 Base Case	1985 Improved Environment	2000 Base Case	2000 Improved Environment
Carbon monoxide					
Number of AQCRs[a] exceeding standard[b]	43	34	22	22	7
Number of AQCRs exceeding 2X standard	25	3	2	2	0
Total violations	68	37	24	24	7
Oxidants					
Number of AQCRs exceeding standard[c]	49	46	45	41	40
Number of AQCRs exceeding 2X standard	20	11	10	8	8
Number of AQCRs exceeding 3X standard	8	2	2	3	2
Number of AQCRs exceeding 4X standard	7	3	3	2	1
Total violations	84	62	60	54	51

[a]AQCR—Air Quality Control Region. [b]The CO standard is 10 mg/m³ in an 8-hour period [c]The oxidant standard is 160 μg/m³ in a 1-hour period
SOURCE Sydec/EEA, p V.40.

will be lower under Improved Environment policies. Thus, policies to control automobile emissions, while having only a slight effect on the national aggregate of HC and NO_x, can be expected to have an important benefit in populous areas, where automobile use is concentrated.

Figure 32 also shows estimates of exposure to nitrogen dioxide in relation to two standards that have been suggested for maximum l-hour concentrations by the World Health Organization. The picture for nitrogen dioxide is similar to that for photochemical oxidants. The small overall reductions in NO_x emissions due to automobile emission controls would have disproportionately large benefits in urban areas. The general effect of measures to reduce automobile emissions is to help lessen both the magnitude and frequency of peak concentrations.

A major finding from these projections is that attainment of air quality standards nationwide will require more than automobile controls. Emissions from other mobile sources and stationary sources also must be reduced. Even so, the concentration of automobiles, trucks, and industry may remain so high that, even with the maximum possible controls, violations will persist, Realistically, some cities may never be able to meet the National Ambient Air Quality Standards.

Other Environmental Effects

The set of policies examined in the Improved Environment Case included measures aimed at lessening the adverse effects of the automobile on other aspects of the environment—noise, solid waste disposal, water quality, and community disruption. Quantitative projections of these effects were not made. What follows, therefore, are general estimates of the nature and direction of environmental effects expected under these policies.

Noise

Automobile noise is expected to be somewhat less in the Improved Environment Case than in the Base Case because of reduced auto VMT and, in 2000, because of fewer diesels on the road. Greater reduction would be possible if noise standards were imposed for new cars or if there were vehicle-in-use noise standards requiring every automobile to have a properly main-

Photo Credit: U.S. Department of Transportation

tained muffler. It is not foreseen that automobile noise will become so great as to warrant such measures, except perhaps on a selective, local basis.

Reduction of highway noise could be achieved by improved roadway and tire design, although there would be some safety penalty in the form of reduced skid resistance. Highway noise could also be reduced by erection of sound barriers to screen residences, businesses, and institutions from highways. However, since trucks and buses will continue to be the noisier elements of the traffic stream, exclusion of trucks and buses from noise-sensitive areas may be the more effective noise reduction measure.

Solid Waste

The amount of solid waste from automobiles is a function of the vehicle retirement rate, scrappage and materials recycling practices, and the amount of component replacement during the lifetime of the vehicle. Greater durability of new cars and a requirement that some percentage of every new vehicle be easily recoverable could greatly decrease present levels of waste from automobiles.

Methods to increase vehicle durability include design for longer overall vehicle life, use of less corrosive and more durable materials, and emphasis on repair rather than replacement of components. A vehicle with an engine life expectancy of 200,000 miles would be of little use if the body were designed to last only 50,000 miles. Conversely, a very durable body would have very little benefit if the expected engine life were only 50,000 miles. A long-life body and engine would also be useless in a vehicle that would require intricate and costly repairs or replacements to keep the durable components operating properly. Thus, the essential for increasing average fleet life is a combination of a body built of durable, corrosion-resistant material, a long-lasting engine, and vehicle systems and components that can be repaired easily.

A second way to reduce automobile waste would be to encourage recycling of components and materials. Batteries and tires are both commonly recovered from scrapped vehicles. Many auto hulls are processed for their scrap metal value. However, much of the plastic and interior materials is discarded. Present techniques for recovery of metals use large shredders and separators, which can operate economically only in urban areas where there is a large volume of junk cars from which to recover metals and components. Vehicles retired in less populous areas are often not processed for scrap since the cost of delivering them to a metal recovery plant exceeds their salvage value.

At present, there are no Federal policies directed at promoting recycling of automobile materials. Among the policies that could be adopted are a requirement that new cars be designed such that some percentage of the component materials can be recovered at a reasonable cost or a policy adding a deposit to the cost of a new car that can be returned only if the vehicle is recycled.

Water Quality

Water quality impacts of highway construction and use will be approximately the same under Improved Environment policies as in the Base Case since both have identical assumptions about the level of Federal funding for highways and the allocation of funds between construction and maintenance.

Community Disruption

Because capital expenditures for highways assumed for the Improved Environment Case are the same as for the Base Case, the projected number of highway-related displacements is identical. It is expected that the average annual number of displacements will be about half those experienced in the 1971-75 period, totaling about **7,700** in **1985 and 6,200** in 2000.

As in the Base Case, it is projected that highway construction will be concentrated in the outlying suburban and rural communities where the potential for disruption of community cohesion is somewhat less than in the central cities. Therefore, these social effects are expected to decline over the remainder of the century.

IMPACTS

Energy

The chief energy impact of Improved Environment policies would be a reduction in automobile fuel consumption, amounting to 4 percent less than the Base Case level in 1985 and 10 percent less in 2000. These reductions would be brought about primarily by the expected reductions in auto VMT and, in 2000, by the growing use of electric vehicles. Table 68 summarizes automobile fuel consumption impacts projected under Improved Environment policies.

The projected decline in automobile VMT is partially the result of the motor fuel tax designed to make fuel cost per mile constant through 2000 and partially the result of urban traffic restrictions imposed for environmental reasons. The combined impact of these policies would be to lower the annual consumption of motor fuels by slightly more than 6 billion gallons (0.4 MMBD) by 2000—a reduction of about 10 percent from Base Case levels.

Because of the 0.4-gram-per-mile NO_x standard, diesel sales will be restricted after 1990, and the diesel fuel consumption by the auto fleet as a whole would begin to decline sharply. By 2000, diesel fuel consumption is expected to be only 2 percent of that forecast under Base Case conditions. Sales of gasoline-powered automobiles are assumed to expand after 1990 to satisfy the additional demand created by the phase: out of diesels. Accordingly, gasoline consumption is expected to be 27 percent higher than Base Case levels in 2000. Another impact of this shift back to gasoline-powered automobiles is expected to be increased pressure on the automobile industry to improve the fuel-economy of conventionally powered vehicles as a compensation for the phase-out of the more energy-efficient diesels.

The growing use of electric vehicles by 2000

Table 68.—Automobile Energy Demand, Improved Environment Case

	Actual	Base Case[a]		Improved Environment	
	1975	1985	2000	1985	2000
Automobile VMT (trillions)	1.03	1.43	1.80	1.40	**1.74**[b]
Diesel penetration (percent of new car sales)	(c)	10	25	10	(c)
New car fuel economy (mpg)					
Regulation— EPA certification value	None	27.5	27.5	27.5	**40.0**
Attained— EPA certification value	15.6	28.5	29.4	30.4	**40.0**
Attained—actual driving	14.0	23.2	25.0	24.6	**34.0**
Fleet fuel economy (mpg)					
Attained— EPA certification value	15.1	24.0	28.5	24.3	**33.4**
Attained—actual driving	13.6	19.4	24.6	19.8	**28.3**
Annual fleet fuel consumption					
Billions of gallons	76.0	73.9	73.3	70.7	**58.3**
MMBD	5.0	4.8	4.8	4.6	**3.8**
Percent of domestic consumption	30.6	23.9	21.4	23.1	**17.8**

[a]Base Case "A," as defined in chapter 3. [b]Includes 85 billion electric vehicle VMT. [c] significant
SOURCE Svdecl EEA

would improve fleet fuel economy and help offset some of the adverse impacts of phasing out diesels. By the end of the century, it is estimated that electric vehicles will travel about **85** billion miles annually, resulting in net fuel savings of about 0.2 MMBD. Since electric vehicle use is expected to be concentrated in urban areas, there could also be secondary benefits in the form of small decreases in CO, HC, and NO_x emissions,

Safety

There is little safety benefit expected from Improved Environment policies per se, except for the minor decrease in automobile crashes brought about by the reduction in VMT. The decreases in death, injury, and property damage that are forecast for the Improved Environment Case ensue from other, safety-specific policies that have been incorporated into this policy set. Chief among these are Level I crashworthiness, passive restraints, and mandatory periodic safety inspections carried out in conjunction with the nationwide program of inspection and maintenance of emission control equipment.

The introduction of passive restraints and Level I crashworthiness is expected to reduce fatalities and injuries by about 11 percent from Base Case levels in 1985, when about one-quarter of the fleet will be so equipped. In **2000,** vehicle occupant fatalities and injuries would be about **20** percent below projected Base Case levels.

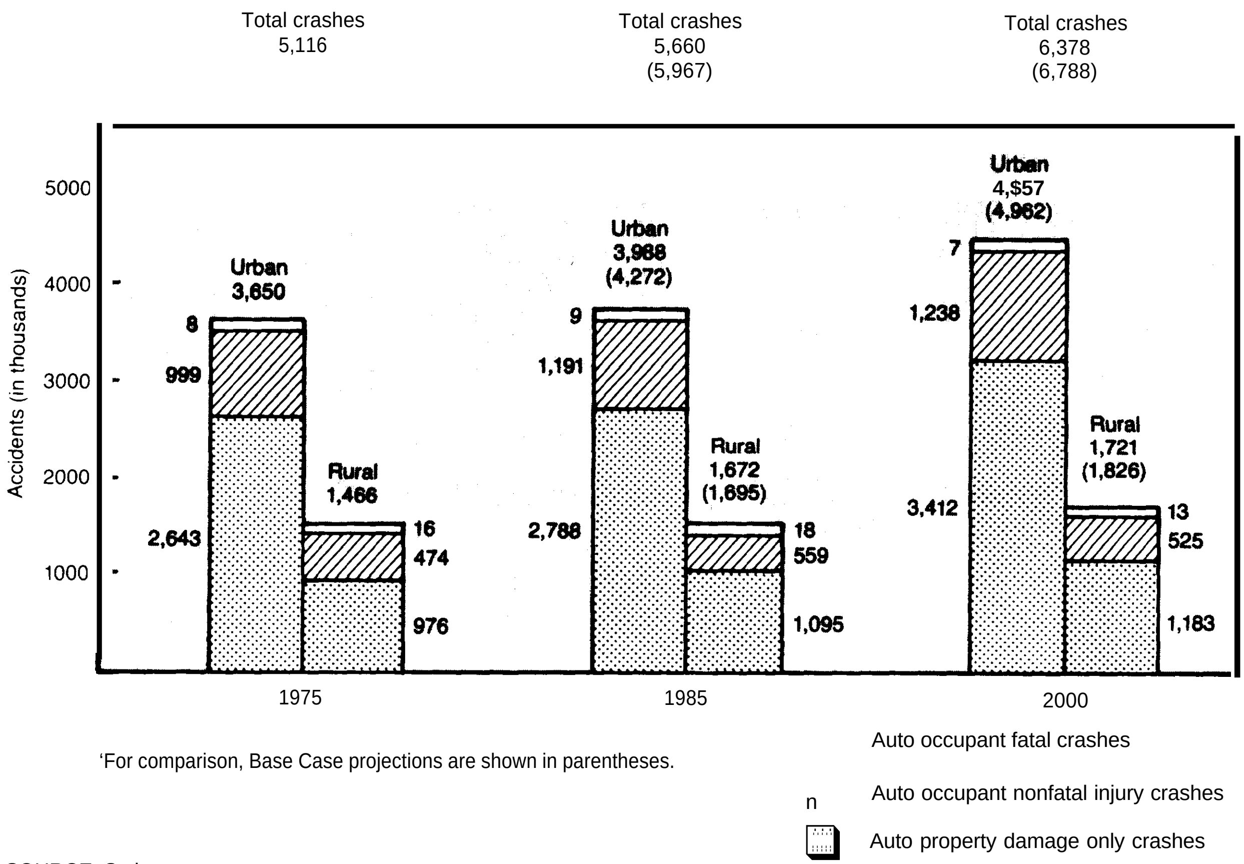
The inspection of safety features that is assumed to accompany the periodic check of emission control devices is projected to bring about a reduction of 4 to 5 percent in traffic crashes by 2000. The reduction of death and injury may be somewhat greater because the crashes that occur because of failure of safety equipment tend to be more severe than crashes produced by other causes.

Figure 33 shows the expected safety benefits that result from the combination of Level I crashworthiness and periodic safety inspections.

Mobility

A major emphasis of the Improved Environment policies is reduction in automobile use for

Figure 33.—Auto Occupant Fatal and Injury Crashes and Auto Property Damage Crashes, Improved Environment Case[a] (thousands)



‘For comparison, Base Case projections are shown in parentheses.

SOURCE: Sydec *EEA,* p V-57

work travel in major urban areas as a means to improve air quality. Specifically, the following target levels were established for SMSAs with populations over 1 million:

- For those large SMSAs with relatively good transit service, automobile VMT by commuters would be reduced by 10 percent by 1985 and 25 percent by 2000.
- For those large SMSAs with relatively poor transit service, automobile VMT by commuters would be reduced 10 percent by 2000.

If these targets were attained, the nationwide reduction in VMT would be 57 billion miles per year by 2000, or 6 percent of the total urban VMT in the Base Case.

A pure transit incentive strategy, a strategy of improving transit services and decreasing transit fares without pricing or regulatory actions directed against auto use, would not achieve the target reductions of automobile VMT. The problem in using transit incentives by themselves to attempt to bring about large reductions in automobile VMT is that, even in large SMSAs with relatively good transit service, the proportion of home-to-work trips that can be made conveniently by conventional transit is less than 50 percent. Even in large SMSAs, more than half the jobs are located in areas where conventional transit service is relatively poor, such that less than 1 employee in 10 currently uses mass transit to get to work. Thus, carpooling, vanpooling, paratransit, and transportation system management strategies would have to play a major role in achieving large decreases in automobile VMT.

Given that transit incentives alone will not produce the desired decreases in auto commuting, it will be necessary to apply other actions to increase the cost of "drive alone" commuting relative to other modes.

A study of travel changes that could be brought about by various policies applied in the Washington, D. C., metropolitan area concluded that the areawide application of a $3-per-day parking surcharge would produce an 11-percent decrease in auto trips to work. " This price increase would bring about roughly half the decrease in VMT in large urban areas sought by the Improved Environment policies.

Approximately half of the desired decrease in "drive alone" commuting could also be achieved by imposing a $6-per-day charge for all long-term parking in downtown areas of large SMSAs. However, a potentially serious long-run impact of such severe parking fees is that many businesses would relocate to areas not affected. This could have longrun counter-productive effects on transit and on the environmental goal of VMT reduction.

Alternatively, reductions in automobile VMT could be achieved by actions that decrease the travel time by carpooling or transit relative to that required for "drive alone" commuting. Such decreases could be provided through the institution of exclusive or priority lanes, traffic signalization, and transportation system management procedures that give special priorities to buses and carpools. If transit or carpool travel times were reduced by an average of 4 minutes per one-way trip compared to "drive alone" commuting, it is estimated that "drive alone" auto commuting would be reduced by about 5 percent.

[28] US Department of Transportation, Federal Highway Administration, *Applications for New Travel Demand Forecasting Techniques to Transportation Planning* March 1977

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Opportunities exist in most large metropolitan areas for providing priority lanes without causing large decreases in speed on parallel lanes. However, to achieve the carpool or transit time reduction of 4 minutes per one-way trip for the metropolitan area as a whole, it would be necessary to reduce the nonpriority capacity on many already congested streets and highways. In such circumstances, most of the relative travel time gain for carpools and transit would come about through increased congestion for auto commuters. Aside from causing strong resentment among auto commuters, this effect would also be counterproductive from an environmental point of view. Idling automobiles emit more pollutants per hour of operation—and in more densely concentrated pockets—than automobiles in smoothly flowing traffic.

Additional disincentives for "drive alone" commuting could be achieved by providing premium parking locations for carpools. Time spent walking to or from an automobile is considerably more onerous than in-vehicle travel time, such that drivers would spend an additional 3 to 5 minutes of in-vehicle travel time to reduce their walk time by 1 minute. If premium parking locations were provided for carpools, such that an average metropolitan areawide reduction of 1 minute in walking time would result, an additional 5-percent reduction in "drive alone" commuting might be expected.

The three actions discussed above—increasing the cost of "drive alone" commuting, reducing carpool and vanpool travel time by an average of 4 minutes, and providing preferential parking for carpools—could produce the target reductions in VMT sought in the Improved Environment Case.

One possible consequence of such transit and ridesharing promotion programs that has not been adequately evaluated is that additional trips might be made by other household members in the car left at home. To some extent, these trips might defeat the purpose of measures to discourage "drive alone" commuting by merely substituting one automobile trip for another. However, such trips would probably not be to congested downtown areas during rush hours. It is the use of automobiles in heavily traveled corridors at peak periods that creates much of the air pollution problem; transit and ridesharing incentives seek to reduce these types of trips. Presumably, much of the travel induced by the availability of automobiles that would otherwise be used for commuting would occur at times and places that would not contribute significantly to air pollution.

The Washington, D. C., mode split model was used to estimate the impacts of decreased commuting by auto on transit ridership. About 30 percent of the decrease in auto commuting would occur through diversion to transit while the remaining 70 percent would occur through transportation system management actions to increase carpooling and paratransit usage. The effect of this diversion to transit, together with the effect of increasing transit vehicle miles, would be to increase total transit ridership from 5.6 billion revenue passengers in 1975 to 7.1 billion in 1985 and 8.7 billion in 2000. Transit ridership under Improved Environment policies would thus be 35 percent higher in 2000 than under the Base Case.

Cost and Capital

Under Improved Environment policies, gasoline prices (including tax) would be 89.9 cents per gallon in 1985 and 123.5 cents per gallon in 2000. This represents increases of 12.2 cents and 1.7 cents per gallon, respectively, over Base Case prices. On a per-mile basis, this amounts to increased fuel costs of 0.3 to 0.5 cent compared to the Base Case in 1985. For 2000, the difference between fuel cost per mile for the two cases is negligible.

In addition to increasing fuel costs, Improved Environment policies would also cause automobile maintenance costs to rise. It is estimated that mandatory inspection and maintenance of emission control equipment would add between 0.4 and 0.5 cent per mile to the cost of owning and operating an automobile in 2000, compared to the Base Case.

The total increase in operating costs per mile for the Improved Environment policies ranges from 0.7 to 1.0 cents per mile in 1985 compared with the Base Case, an increment of about 5 percent. In 2000, the cost increases would be 0.4 to 0.5 cent per mile, or about 3 percent higher than the Base Case.

One measure to reduce air pollution in the Improved Environment Case is the application of strong cost disincentives for commuting to work by automobile. Adding $3 per round trip to the cost of "drive alone" commuting would amount to $34 billion per year. Assuming 20 miles as the length of the average round trip to work, this would constitute an increase of 15 cents per vehicle mile, or a doubling of the average operating cost for work trips. If there were no other penalty charges applied to automobile travel, the increase would average 2 cents per vehicle mile for all travel.

Auto sales and size class distribution under Improved Environment policies are projected to be about the same as those under the petroleum conservation policies discussed in chapter 5. Improved Environment policies are expected to have little or no impact on auto prices through 1985. However, after 1990, when the 0.4-gram-per-mile NO_x standard goes into effect, the cost of the improved emission control equipment would add between $5o and $2OO to the price of a new car.

ANALYSIS OF INDIVIDUAL POLICIES

These policies are frequently suggested to deal with the problem of automobile emissions:

1. Regional standards (the so-called two-car strategy),
2. Tradeoff between control of mobile and stationary sources, and
3. Mandatory inspection and maintenance of vehicles in use.

None of these policies is proposed as a replacement for the present new car emission standards. Rather, they would serve as supplementary measures to enhance the effect of new car standards or as a way to deal with aspects of the automobile emissions problem not adequately addressed by new car standards.

The following’ analysis is intended to shed light on the applicability and effectiveness of these measures in reducing air pollution from automotive sources in the period 1985-2000.

Regional Standards

Present Federal policy on automobile emissions is, in effect, a regional or two-car strategy. The 1977 Clean Air Act amendments allow the States to adopt either the Federal emission standards for new cars or the somewhat stricter standards now in force in California. It has been suggested that the present strategy be modified to allow two different standards to be set within each State—a strict standard in areas of high air pollution (primarily large metropolitan areas), and a somewhat relaxed standard for less populous parts of the State where air pollution is not a problem. Such a policy would allow automobile manufacturers to produce two rather different types of vehicles —''city cars” very much like those designed to meet the present 1981 Federal standards, and “country cars” whose emissions would be somewhat higher (perhaps on the order of 15 grams per mile CO, 1.5 grams per mile HC, and 2 grams per mile NO_x).

The logic behind this modified two-car strategy is that air pollution is basically a localized urban problem that does not correspond to State boundaries. Many States have severe air pollution problems in one or more metropolitan areas, but virtually no problem in the remainder of the State, covering perhaps as much as 80 or 90 percent of the land area and including up to half of the State’s population. By applying automobile emission standards selectively, States could avoid the inequity of penalizing some owners by making them have emission control equipment they do not need in order to reduce air pollution in other areas where automobile use is concentrated.

A quantitative analysis of regional standards was not made in this assessment. The comments that follow are offered to suggest the major policy questions raised by establishing such a two-car standard and to indicate the avenue of inquiry that should be taken.

The major advantage of the regional two-car strategy is its purported efficiency. Measures to control automobile emissions would be applied only where they are needed, Residents of unaffected areas would be spared the unnecessary expense of pollution control equipment. Thus, the efficiency of this policy is both technical (reduced auto emission in cities) and economic (the costs are borne chiefly by those whose use of automobiles creates the problem). Regional standards may also be more cost-effective than other nationally applied emission control policies, although this point has not been firmly established.

The disadvantages of a regional two-car strategy lie primarily in implementation. For the standards to be effective, it would be necessary to obtain the cooperation and support of **50** State governments and hundreds of local jurisdictions. Since many metropolitan areas span State boundaries, it wouId also be necessary for some states to reach bilateral or trilateral agreements to coordinate standards and enforce compliance. Registration of vehicles and determination of which standard each vehicle in the State should meet could be a cumbersome process, both at the time of initial sale and subsequent resale. Since standards would probably be applied on a county-by-county basis, the burden on the administrative apparatus of county governments could be enormous.

Automobile manufacturers are likely to oppose regional standards. The higher cost of cars equipped to meet urban standards might reduce sales, without any prospect of recouping these losses through increased sales of less expensive cars in rural areas. Because of economies of scale in manufacturing, the present single standard might yield 1ower new car prices than a regional two-car standard, which would call for two somewhat different product lines. A detailed analysis of the comparative costs needs to be made both to determine the impacts on consumers and to assess the consequences for industry profitability and production.

Mobile-Stationary Source Tradeoff

The projections of air quality for 1985 and 2000 under Base Case and Improved Environment policies indicate that, for HC and NO_x, automobile emissions will constitute a small and diminishing fraction of the total of these pollutants from all sources. By 2000, automobile-emitted hydrocarbons will make up about 10 percent of the national aggregate, and automobiles and other mobile sources combined are expected to account for only one-quarter of all hydrocarbon emissions. The picture for NO_x is similar. Automobiles are projected to emit less than 10 percent of all NO_x in **2000, and other** mobile sources will emit an additional 18 percent. Thus, the major share of these pollutants **(70** to **75** percent) will come from stationary sources.

These figures are national aggregates and do not necessarily reflect the situation that is expected to exist in many urban areas where, because of concentrated vehicular traffic, automobiles and trucks may continue to be large (if not major) sources of pollution. Still, it appears that consideration should be given to tradeoffs between mobile and stationary source standards. These tradeoffs might be applied either as an alternative to setting new and stricter standards for automobiles after 1985 or as a way of relaxing existing standards for one *or* n-tore automobile-emitted pollutants in the interest of reducing cost or improving fuel economy.

An illustration of how this tradeoff policy might be applied can be seen in the question of whether to tighten the NO_x standard for new cars from 1.0 gram per mile to 0.4 gram per mile after 1985. The cost-effectiveness of various control measures for mobile and stationary sources was analyzed by the Federal Task Force on Motor Vehicle Goals Beyond 1980.[29] The results of this analysis, shown in table 69 and figure 34, indicate that—in terms of cost-effectiveness—several strategies aimed at stationary sources are superior to a stricter NO_x standard for automobiles.

In all, nine measures to control mobile or stationary source NO_x emissions were considered in the analysis. The cumulative effect of the six that ranked highest on the criterion of cost-effectiveness (four measures to control stationary sources, one for trucks, and a I. O-gram-per-mile standard for automobiles) was an annual reduction of 14 million tons of NO_x at a cost of $4 billion per year. 30 By adopting the remaining three measures on the list, an additional 8 million tons of NO_x could be removed from the atmosphere per year, but at a further cost of $9 billion per year.

The cost-effectiveness of automobile NO_x standards of 1.0 gram per mile and 0.4 gram per mile can be compared to that of various stationary source controls by examining figure 34. The I .()-gram-per-mile standard has a cost-effectiveness rate of **$450** per ton of NO_x removed and ranks sixth among all measures. The 0.4-gram-per-mile standard has a cost-effectiveness rate of **$2,300** per ton—the 1east cost-effective of the nine measures considered.

Analysis such as this indicates that control of stationary sources would be the more effective expenditure of funds to achieve an overall reduction in NO_x emissions. Further, lowering the automobile NO_x standard from 1.0 gram per mile to 0.4 gram per mile appears to yield rather small benefits in terms of the cost incurred. Changing the standard from **2.0** to 1.0 gram per mile would remove 1.91 million tons of NO_x from the atmosphere per year, at a cost of $45o per ton. Reducing the standard from 1.0 to 0.4 gram per mile would remove an additional 1.15 million tons of NO_x per year and cost $2,300 per ton. In other words, 60 percent more benefit but at a cost 5 times greater.

Cost, however, is but one criterion for making tradeoffs. Consideration must also be given to other criteria, such as the relative importance of each type of emission source in the overall pattern of air pollution. For example, there is some evidence from a recent study of smog formation in the Los Angeles Air Basin[31] that emissions from automobiles figure more prominently than stationary source emissions in severe smog episodes. If this interpretation of the data is confirmed and similar results are found in

‘W, S. Department of Transportation, *The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980,* pp. 10-1 to 10-5.

³⁰The projected emission reductions cited here should not be confused with those given elsewhere in this report. The figures here are from the Federal Task Force report and are based on a different forecasting methodology from that used by OTA. The projections by the Federal Task Force and OTA, while in general agreement, cannot be compared point by point.

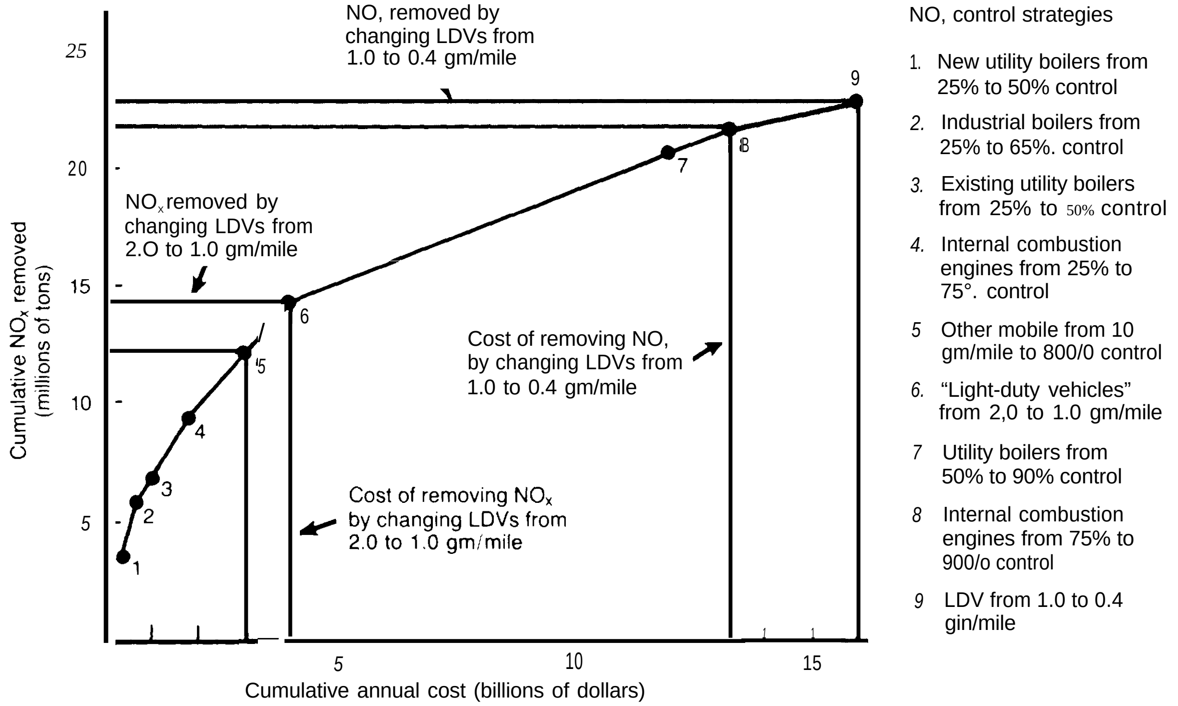
“A. Eschenroeder, *Applications of the Los Angeles Reactive Pollutant Program (LARPP) to the Assessment of Proposed California Emission Controls,* presented to the California Air Resources Board Workshop, Jan. 5-6, 1977.

Table 69.—Cost Effectiveness of Control Strategies for NO_x Emission in 2000

Control strategy	NO_x removed (10^6 tons)	0/0 of baseline emissions removed[a]	Cumulative 0/0 of baseline removed	cost effective-ness ($/ton)	Annual cost of strategy (billions $)	Cumulative annual cost (billions $)	Cumulative NO, removed (10^6 tons)
1 New utility boilers from 25% to 50% control	3.52	11	11	100	0.35	0.35	3.5
2 Industrial boilers from 25°/0 to 65°/0 control	2.46	7	18	150	0.37	0.72	6.0
3 Existing utility boilers from 25% to 50% control	0.62	2	20	225	0.14	0.86	6.6
4 Stationary internal combustion engines from 25% to 50% control[b].	2.87	**9**	29	340	**0.98**	1.84	**9.5**
5 Other mobile from 10 gm/mile to 80°/0 control	2.9	**9**	38	450	**1.3**	3.14	**12.4**
6 Lightweight vehicles from 2.0 to 1.0 gin/mile	1.91	**6**	44	450	**0.86**	4.0	**14.31**
7 Utility boilers from 50% to 90°/0 control	6.62	**20**	64	1,200	**7.94**	11.94	**20.93**
8 Stationary internal combustion engines from 75% to 90°/0 control.	0.86	**3**	67	1,700	1.46	13.43	21.79
9. Light utility vehicles from 1.0 to 0.4 gin/mile	1.15	3	70	2,300	2.65	16.08	22.94

[a]Internal combustion engine control does not include small engines.
[b]Baseline emissions = 34.1 × 10^6 tons in 2000 and is based upon light-utility vehicle standard, 2.0 gm/mile. Other mobile, 10 gm/mile, 25% control of all stationary source emissions.
SOURCE: *SRI*, p. G-24

Figure 34.—Cost-Effectiveness of NO_x Control Strategies



NOTE: Baseline emissions = 34,1 x 10^6 tons in 2000 and is based upon-LDV standard 2.0 gin/mile, other mobile 10 gin/mile, 25%. control of all stationary source emissions

SOURCE U S Department of Transportation, *The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980,* p 10-3

Photo Credit: U.S. Department of Energy

other cities, a much stronger argument can be made for a stricter automobile NO_x standard despite its relatively high cost.

A second, somewhat different example of the need for a policy that permits tradeoffs can be found in the comparison between emissions from gasoline-powered vehicles and those from powerplants producing electricity for battery-powered vehicles. In this case, the tradeoff to be made is not between alternative measures to control a single pollutant but between different types of pollutants. The results of one such analysis are shown in table **70.**

This analysis indicates that the use of electric vehicles would result in the virtual elimination of carbon monoxide and hydrocarbon emissions, even if the powerplants were fired by coal. Nitrogen oxides and sulfur dioxide, however, would be emitted in much greater quantities. The emission of NO_x, in terms of the equivalent per vehicle mile, would be 3 to 4 times higher for electric vehicles. Sulfur dioxide emissions would be 20 to **30** times higher. Thus, the potential use of electric vehicles forces a tradeoff that must take into consideration not only the quantities of each type of pollutant, but also the comparative cost and technical feasibility of mobile and stationary source controls.

Regardless of the importance attached to these two examples of mobile-stationary source tradeoffs, one point emerges clearly. No single pollution control measure—whether it is directed at automobiles or other sources—is uniformly superior in all situations and for all pollutants. A mixture of controls (some for mobile sources, others for stationary sources) will be required. Further, this mixture will almost certainly have to be varied from site to site. What is optimum for one city may be inadequate for another.

Substantiation of this point can be found in the analysis of present and future air quality problems performed for three U.S. cities during this assessment. The cities studied were Washington, D. C., Houston, Tex., and Chicago, Ill.,—each representative of a certain urban situation. Washington is a city with very little industry and a high dependence on automobile transportation. Houston is also a city with a heavy degree of automobile use, but it has a much greater amount of industry, notably petroleum refining. Automobile use in Chicago is also high, but Chicago has an extensive and well-developed transit system. The industrialization of the Chicago area is intense.

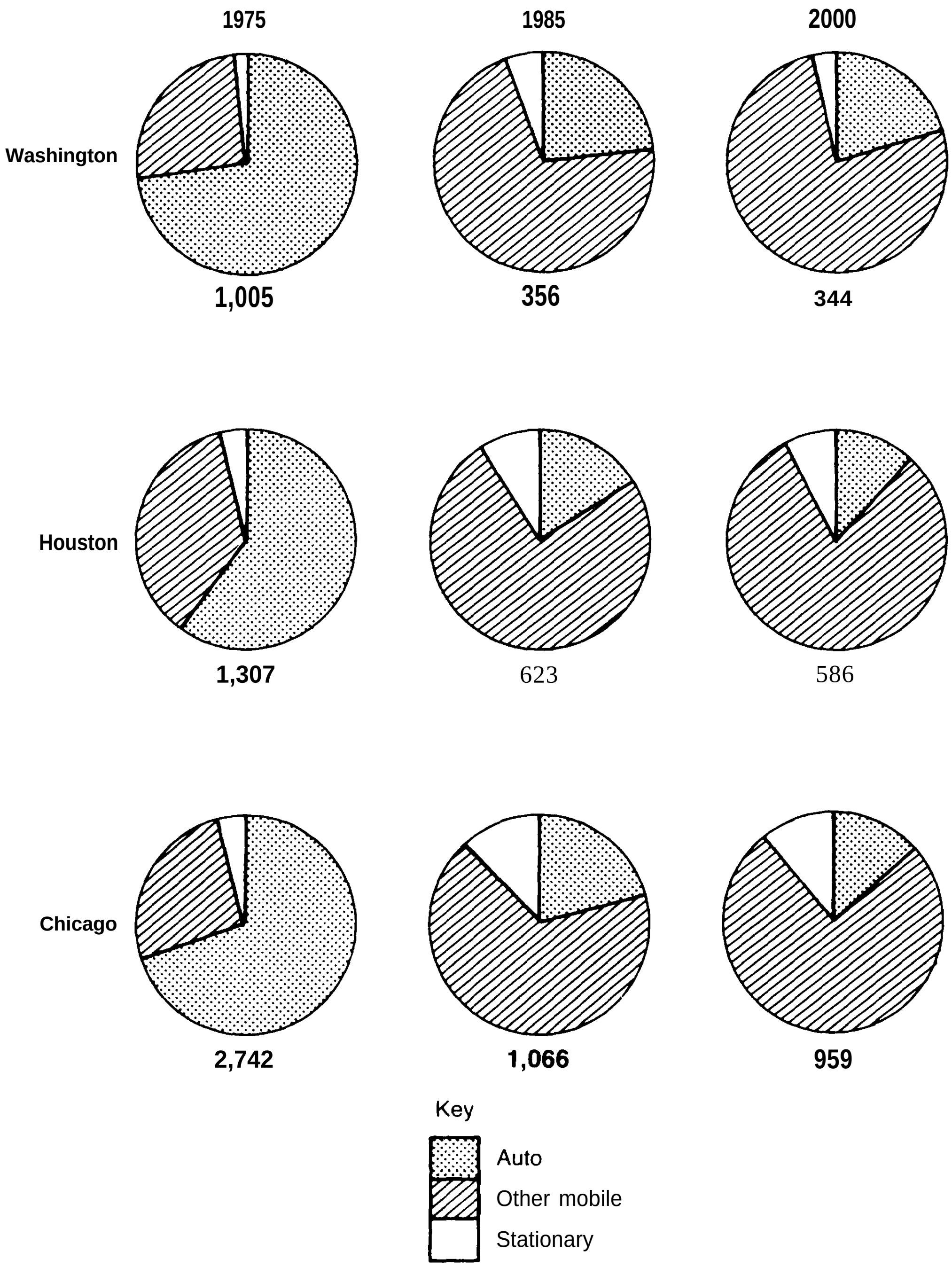
Figures 35, **36,** and **37** show the actual and projected levels of CO, HC, and NO_x emissions in these three cities for **1975, 1985,** and **2000.** More significant than the absolute quantities of pollutants is the **way** in which the distribution by source changes over time and from city to city. No attempt is made here to draw detailed conclusions about the relative effectiveness of different control measures. The figures speak for themselves and illustrate the basic point that future air pollution control strategies must be both flexible and selectively applied.

Table 70.— Electric-Vehicle Emisisons Compared to Gasoline-Vehicle Emissions, 2000

Type of emission	Gasoline vehicle (composite) (gm/mi)	Electric-vehicle powerplant emissions[a]	
		Coal fired (gm/mi)	Oil fired (gm/mi)
Carbon monoxide . . .	3.78	0.012-0.021	0.0001
Hydrocarbons	0.461	0.004-0.007	0.0001
Nitrogen oxides[b]. . . .	0.588	1.51-2.66	0.649-1.14
Sulfur dioxide[c].	0.13	2.597-4.57	1.731-3.02

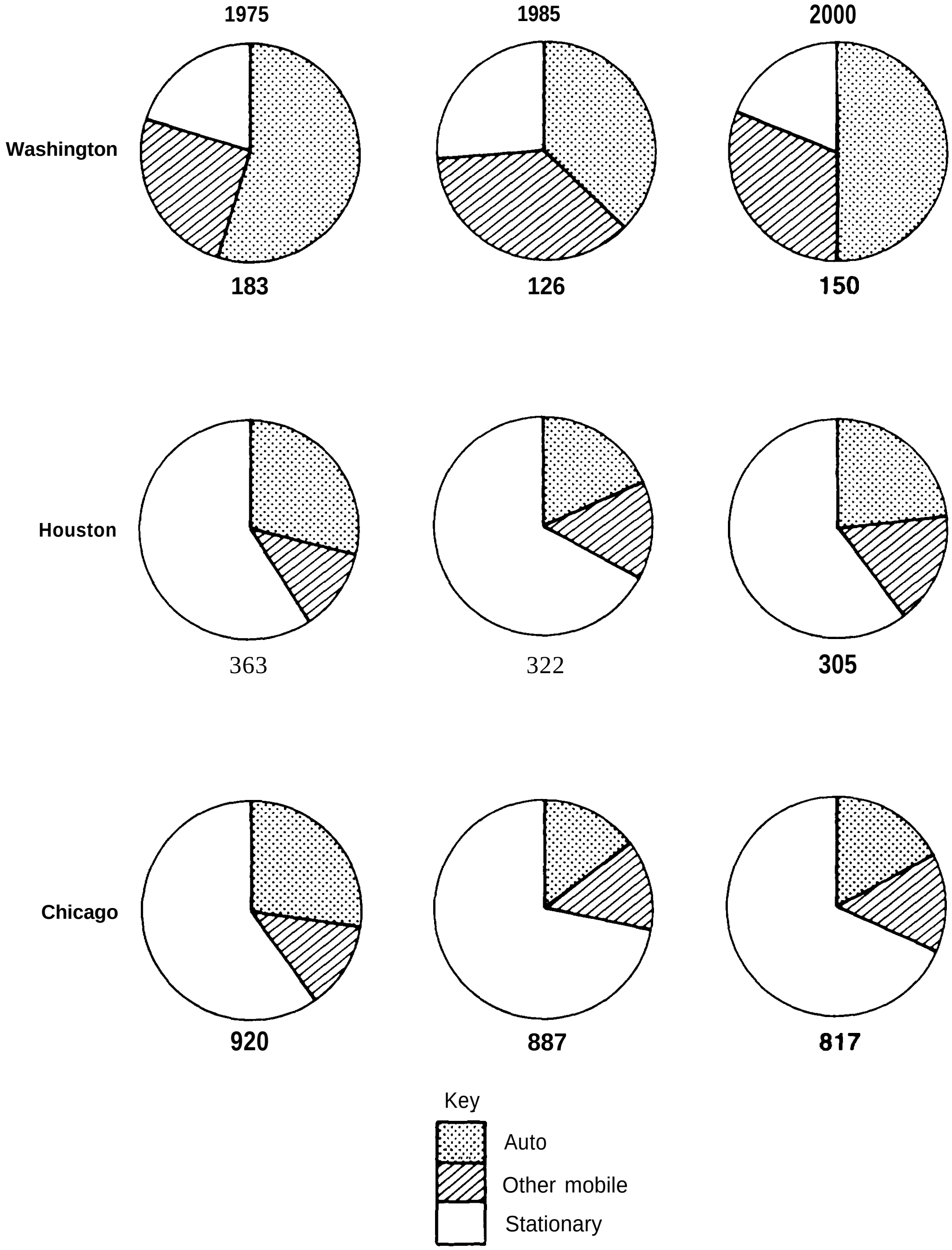
[a]Powerplant emissions are controlled to New Source Performance Standards levels, when applicable, assumed 35 percent efficiency. These standards are being revised at present to lower the allowable emissions, and further reductions by 2000 could occur.
[b]Assumes automobile standard of 1.0 gm/mile from 1981 to 1990.
[c]Based on EPA data from *Compilation of Air Pollutant Emission Factors*, AP-42, Supplement 5, December 1975.
SOURCE: *Sydec/EEA*, p. V-44.

Figure 35.— Projected Carbon Monoxide Emissions for Washington, Houston, and Chicago (thousands of tons)



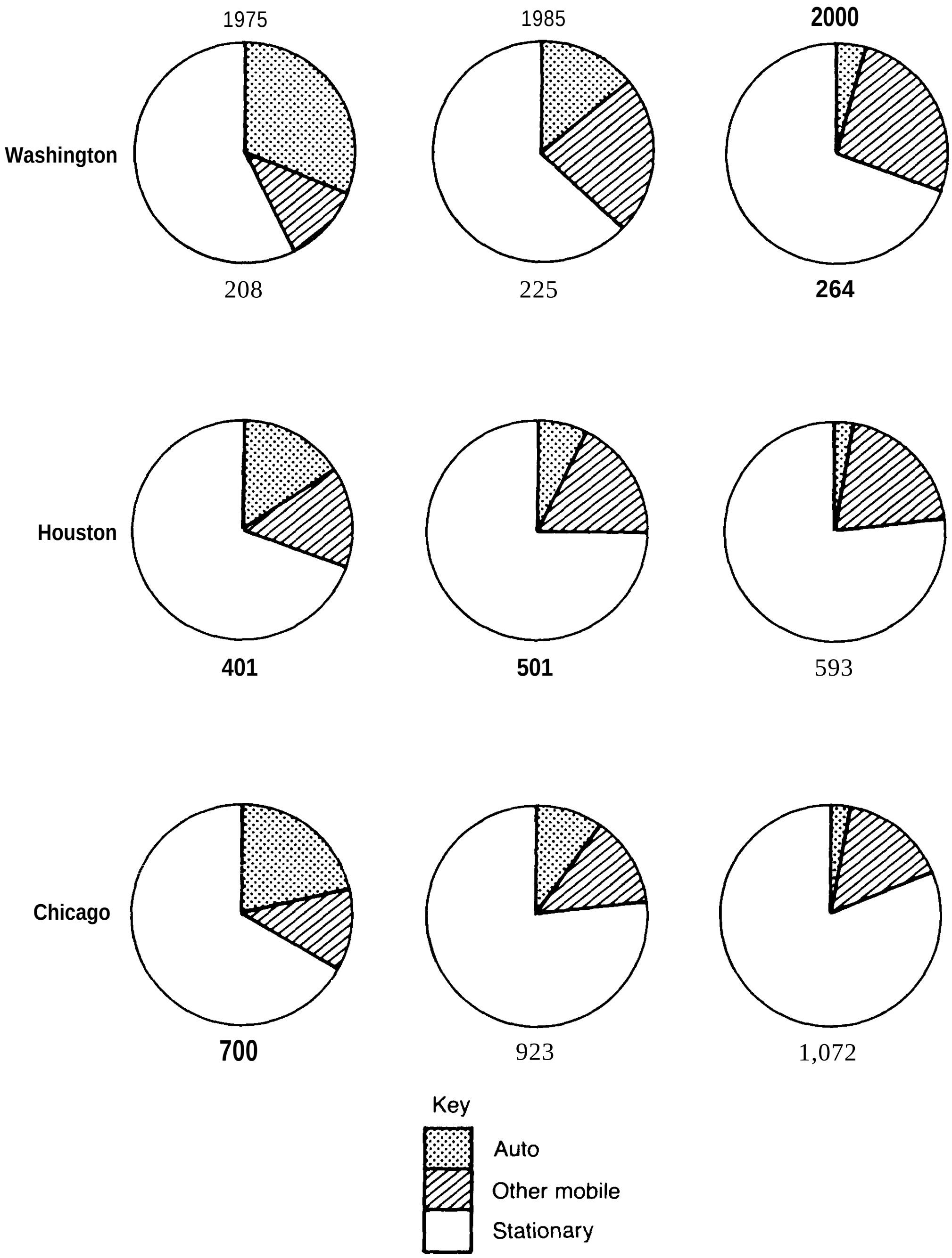
SOURCE: *Sydec/EEA*, pp. V-48, V-50 and V-53.

Figure 36.— Projected Hydrocarbon Emissions for Washington, Houston, and Chicago (thousands of tons)



SOURCE Sydec *EEA,* pp V-48, V-50 and V-53

Figure 37.— Projected Nitrogen Oxide Emissions for Washington, Houston, and Chicago (thousands of tons)



SOURCE: *SydeclEEA,* pp. V-48, V-50 and V-53

Mandatory Inspection and Maintenance

The projected effects of a program of inspection and maintenance of vehicles in use were presented earlier in this chapter. It was found that inspection and maintenance could yield substantial benefits—the largest of any environmental measure considered—if adopted nationwide and consistently enforced. The purpose of the discussion offered here is to examine some of the factors that would influence the implementation of the program and its potential cost to the public.

To implement the program would require that inspection stations be set up in all localities, either in private service stations and garages or in State-operated facilities, to measure the amounts of CO and HC in automobile exhaust. At present, there is no rapid and practical test for NO_x or evaporative HC, and no inspection procedure for these emissions is assumed for this discussion. Based on empirical data on emissions from vehicles of various ages, the controlling Government agency would establish emission standards. Some percentage of the vehicles in each age group would fail the inspection, and owners would be required to effect the necessary adjustments, repairs, or replacements and submit to reinspection.

An inspection and maintenance program could be administered and implemented in several ways. Two of the most likely methods would be State-run inspection centers or certification of private service stations as inspection stations. The former would give the State or local government a direct role in the inspection process, whereas the latter would delegate a large portion of the responsibility for the program to private service station operators. Both programs would require special equipment to analyze emissions. Costs can range from $2,000 per analyzer for an idle mode test to $12,000 per analyzer for a test that simulates the various driving modes.

Both programs would require employment and training of personnel. The State-run inspection would need personnel to run the facility and to perform the inspections. Maintenance would be carried out at a private station or garage of the owner's choice. The privately run program would require State personnel to train the service station employees in the use of the equipment and to certify and to check on their proficiency. In either case, it would be necessary for the agency responsible for the program to have legislative authority to inspect private vehicles and require maintenance if emissions exceeded a specified level.

An appreciation of the complexities of establishing a nationwide system of inspection can be gained by looking at the efforts of DOT to establish the Periodic Motor Vehicle Inspection (PMVI) program for safety features. In 1966, DOT encouraged States to establish inspection programs to assure the safety of vehicles on the road. Twenty-three States voluntarily established PMVI programs. In 1967, 10 more States passed laws in response to the Highway Safety Act that provided for withholding Federal highway funds from States without PMVI programs. Table 71 shows the results of DOT's effort to encourage State inspection programs over the 6- year period between 1969 and **1974.** Aside from the original **32, no State** adopted a true periodic inspection program during this period, but three States adopted programs of inspection of vehicles at the time of title transfer or on the spot or on a random basis. The inability of DOT to expand the concept after the initial flurry has been attributed to several factors:

- The cost of establishing a thorough national program,
- Disagreement on appropriate levels of standards and testing,
- Inability to demonstrate the benefits of the program, and
- Adverse public reaction to inefficient or unethical testing practices and subsequent repair costs.

This experience suggests that an inspection program is likely to be successful only if the following conditions are met:

- There is a simple uniform testing procedure that is easily implemented and audited.
- The costs of the program are kept within acceptable limits.
- The benefits of the program are projected before the program starts and updated with

Table 71.—State Motor Vehicle Inspection Programs

Type of inspection	1969 No. of States[a]	1969 Registered vehicles (millions) Total	1969 Registered vehicles (millions) Inspected	1974 No. of States[a]	1974 Registered vehicles (millions) Total	1974 Registered vehicles (millions) Inspected
No inspection	**10**	**23**	0	7	25	0
Spot/title transfer	9	25	3	12	35	8
Annual inspection	25	45	45	25	57	57
Semiannual inspection	7	12	12	7	14	14
Total	51	105	60	51	131	79
Percent of registered vehicles inspected	—	57%	—	—	61‘A	—

[a]Including the District of Columbia
SOURCE: *SRI*, p. G-29.

actual results after the program is in operation.

These three areas of concern—testing procedures, cost, and benefits—are closely tied.

Currently, there are a variety of testing procedures that could be used. They can be grouped in two categories:

1. Direct examination of specific maladjustments and malfunctions using conventional or more sophisticated garage-type equipment, and
2. Indirect diagnosis of engine maladjustments and malfunctions using measurements of exhaust emission levels under different engine loadings.[32]

No single procedure is ideally suited to all situations. However, in the interests of uniformity and ease of administration on a nationwide basis, it may be desirable to adopt a common procedure. If so, the procedure should meet the following minimum criteria:

- All cars should be inspected on a periodic basis, either annually or semiannually, on a schedule that coincides with vehicle registration.
- The inspection costs should be low so as not to impose economic hardship.[33]
- The inspection program must provide for mandatory maintenance and repair.[34]

The question of payment for maintenance and repair or replacement is particularly troublesome. One method is to include the cost of repair or maintenance in the inspection fee. The cost of repair could be averaged for all vehicles inspected. Another method would be to increase the initial cost of the emissions control devices to include warranty coverage for necessary maintenance and repairs. If automobile or equipment manufacturers were obligated to provide this insurance, as they presently do in warranties on other parts of the automobile, an additional benefit gained from the program would be an incentive for the manufacturer to produce reliable and durable emission control systems that are easy and inexpensive to repair or maintain.

It would probably be necessary for the Federal Government to assume financial responsibility for the development of a uniform testing program and for disseminating information to State personnel. Once the program is in opera-

[32]O. P. Hall, Jr., and N. A. Richardson, The *Economic Effectiveness of Vehicle Inspection Maintenance as a Means for Reducing Exhaust Emissions A Quantitative Appraisal* Society of Automotive Engineers, Automotive Engineering Congress (Detroit: Feb. 15-Mar. 1, 1974).

[33]The State of Arizona provides an inspection program that costs $5 per vehicle, which is entirely covered by increased registration fees. The State of New York has estimated that emissions testing would cost *$3.72* per vehicle inspected if the program were State-administered. Both of these States were costing programs to test vehicles under both idle and loaded conditions.

[34]O.P. Hall, Jr., and N.A. Richardson.

tion, the Federal Government would have to fund the monitoring of the program on a national level. The States would have to fund initial expenses of establishing the programs, unless the Federal Government were to provide grants to cover these costs, Federal funds might also be necessary either to operate the program or to monitor privately operated test facilities. However, these expenses might be recovered through inspection fees, as in the State of Arizona. The consumer would probably have to pay the inspection fee and the cost of maintenance either by means of the inspection fee or by increased cost of emissions control devices if a warranty system for emission control equipment could be devised. Automobile manufacturers would incur higher expenses in covering the emission control equipment under warranty, but this cost would almost certainly be passed along to the owner.

The political impacts of the program would also be important. From DOT's experience in trying to implement the PMVI program, it is obvious that Federal standards for testing and the threat of withholding Federal funds from States are not sufficient to guarantee adoption of an inspection and maintenance program. In order to achieve uniform testing in all States, it would probably require some form of Federal legislation—either a mandate or a strong system of incentives. States, in turn, would have to pass enabling legislation to modify portions of their legal codes–a process that would be lengthy and fraught with political difficulties.

Table **72** is a summary of the impacts that a mandatory inspection and maintenance program could have on Federal and State governments, consumers, and the automobile industry.

Table 72.—impacts of Mandatory Testing and Maintenance of Emissions Control Devices

	Cost impacts	Political impacts	Other impacts
Federal	Funding for development of uniform test procedure. Funding for initial program development. Funding for national monitoring.	Legislation requiring State participation.	Additional personnel for program development and monitoring.
State	Funding for establishing program. Funding for either operating or monitoring testing and repair procedures. Funding for data collection and processing.	Changes of vehicle registration procedures or new procedures to require testing of vehicles. Decreased State independence in solving emissions problems.	Additional personnel for system operation and monitoring.
Consumer	Increased cost of either vehicle registration or emissions control devices.		Inconvenience and time required for inspection and maintenance Independent automobile repair. Shift of some personnel to testing and repair programs.
Automobile maintenance	Increased cost and inconvenience of insuring emissions control devices.		Increased incentive for reliable, maintenance-free emissions control devices.

SOURCE Sff/ p G 35