IMPLICATIONS FOR TRANSPORTATION OF NEW FEDERAL AIR POLLUTION CONTROLS

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A concise legislative history of federal air pollution control efforts terminating with the Clean Air Amendments of 1970 provides the basis for a discussion of the implications of compliance with federal ambient air quality standards. A major implication is the need in numerous urban areas for transportation controls, control mechanisms not addressed by most of the state implementation plans submitted to the Environmental Protection Agency in January of 1972. A review of the rollback methodology used in predicting future air quality attendant with projected emission reductions is presented. Inherent data base uncertainties and basic technological and socioeconomic assumptions employed are discussed. The use of a comprehensive systems analysis approach for evaluating the externalities of selected implementation plan control strategies is strongly endorsed.

•THE growing recognition of the potentially adverse environmental impact of transportation systems is well documented by 15 years of federal legislation. Legislative history reflects increasingly stringent corrective policies to minimize adverse environmental impacts.

In terms of transportation legislation, there has been a growing concern that the planning process itself be truly "continuing, comprehensive, and coordinated" and that environmental objectives, including air pollution abatement, be given due consideration. Moreover, the necessity to provide a viable alternative to the automobile through acceptable mass transportation is gaining emphasis in policy objectives and financial commitment. As given in Table 1, however, federal subsidies for mass transit remain meager in comparison to highway and aviation subsidies.

Federal air quality legislation was first enacted in 1955 to establish a national commitment to research for air pollution abatement. Research was expanded in the early 1960's to include the study of air pollution from automobiles. Responsibility for air pollution abatement remained totally with the states until 1963 when Congress authorized federal intervention primarily in air pollution problems of an interstate nature. By 1965, Congress determined it necessary to establish national emission standards for new automobiles. The 1967 Air Quality Act, although significant in the evolution of air quality legislation, did not specifically address pollution from transportation sources. In contrast, the most recent federal legislation, the Clean Air Amendments of 1970, impacts directly on the design and operation of transportation systems through several provisions including revised emission standards for motor vehicles; state air quality implementation plans that, if necessary, must include land use and transportation controls to achieve national standards; fuel additive regulations; inspection, maintenance, and retrofit programs for in-use motor vehicles; and emission standards for aircraft.

A major concern is the emission standard provision. The amendments stipulate that motor vehicles manufactured in 1975 must emit 90 percent less carbon monoxide and hydrocarbons than those made in 1970. By 1976, emissions of oxides of nitrogen must

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be reduced 90 percent from the 1971 model level. These reductions must be maintained for the useful life of the vehicle, defined as 5 years or 50,000 miles, whichever occurs first.

The amendments stipulate that, by January 30, 1972, each state is required to submit to EPA an air quality implementation plan showing how the national ambient air quality standards will be achieved. Implementation plans include emissions limitations, compliance timetables, and other measures that may be necessary to attain or maintain primary (related to health) and secondary (related to welfare) ambient air quality standards including, but not limited to, land use and transportation controls.

Primary standards must be achieved by 1975 and secondary standards within a reasonable time period. The degree to which land use and transportation controls actually will be necessary to achieve and maintain air quality standards will be a function of three factors: the degree to which the automobile industry can produce and market a "clean" automobile, the time period for which the automobile will actually remain clean, and the accuracy of vehicle use projections and future operating characteristics in urban areas.

The Clean Air Amendments of 1970 and the Federal-Aid Highway Act of 1970 exhibit a noteworthy mandate for the interface between EPA and DOT on the question of air pollution from transportation. Section 109(j) of the highway act requires the DOT Secretary, after consultation with the EPA Administrator, to develop and promulgate guidelines to ensure that the highways are consistent with the state's air quality implementation plan. Section 210(2) of the 1970 Clean Air Amendments directs that grants for developing and maintaining vehicle inspection systems shall not be made to states unless the DOT Secretary has certified to the EPA Administrator that such an inspection program is consistent with any highway safety program. Furthermore, this transportation and environment interaction at the federal level will necessarily stimulate the cooperation of transportation and air quality agencies on the state and local levels as well as promote research of transportation and air-quality relations.

In addition to specifying transportation and air quality objectives, federal legislation has mandated the coordination of single-objective programs and policies to reduce overlap and conflict (Demonstration Cities and Metropolitan Development Act of 1966 and Intergovernmental Cooperation Act of 1968). The National Environmental Policy Act of 1969 further called for the alignment of all major proposed federal legislation, plans, and programs with a national commitment to environmental quality. For any proposed federal action significantly affecting the environment, a detailed environmental impact statement must be made addressing both the short- and long-run effects in an effort to minimize adverse impacts.

The National Environmental Policy Act of 1969, the Clean Air Amendments of 1970, and portions of the Federal-Aid Highway Act of 1970 represent significant points in the evolution of legislation aimed at protecting the environment from adverse impacts of transportation. Together, these acts establish a framework for the inclusion of environmental objectives in the transportation planning process for the next few years. With such a complex task, no single piece of legislation can be viewed as static.

The necessity for readapting our approach is fully contemplated in the amendments, which require the revision of state implementation plans and air quality standards when appropriate.

Mobile sources are significant contributors to the air pollution problem. More than 92 percent of the carbon monoxide (CO) emissions in 11 urban regions is caused by mobile sources. Mobile sources in these regions also account for at least 67 percent of the hydrocarbon (HC) emissions; in four regions, this value is 90 percent or more. Mobile source contribution to nitrogen oxide (NO_x) emissions ranged up to 88 percent in two regions. Passenger automobiles account for the greatest percentage of all mobile source emissions. Therefore, air pollution abatement strategies in many urban areas must clearly concentrate on reducing automobile emissions either by making the automobiles cleaner or by curtailing automobile use.

The amendments direct that states will formulate an implementation plan that will demonstrate how the air quality standards will be achieved by 1975. The amendments provide for a 2-year extension where "technology or alternatives" will not be available soon enough to permit full implementation; this could extend the compliance date to 1977.

However, the data given in Table 2 show that transportation controls are being considered seriously in many states.

The Appendix gives air quality control regions requiring transportation-land use controls or 2-year extensions or both by EPA to attain carbon monoxide and photochemical oxidant standards.

ANTICIPATED ADEQUACY OF 1972 CONTROL STRATEGIES

The state implementation plans submitted January 30, 1972, should effectively improve air quality and achieve the ambient air quality standards by 1975 or 1977. The ultimate efficacy of the control strategies advanced in the 1972 implementation plan will determine the need and the severity of transportation controls. Therefore, the basis for the 1972 control strategy, that is, the methodology of projecting future air quality and emission reductions, must be evaluated.

GENERAL REVIEW OF ROLLBACK

Rollback technique for calculating future air quality is a first-generation control strategy design tool. The rollback calculation is based on the assumption that regional air quality will improve in proportion to a rollback of regional emissions.

Regional emissions are rolled back on the basis of the air quality reading measured at the highest pollution point, which may vary among pollutants. The adequacy of a regional control strategy is therefore dependent on the representativeness of the sampler location. It is apparent that this technique lacks spatial sensitivity. The rollback technique also lacks temporal sensitivity. Regional emissions are indiscriminately rolled back from a 1- or 8-hour maximum of air quality sample. Therefore, the eventual adequacy of a regional control strategy is dependent on two related factors: the degree to which a 1- or 8-hour air quality measurement at one point consistently fluctuates in proportion to 1- or 8-hour emission rates over the entire region and the degree to which a control strategy brings about a proportional reduction in these 1- or 8-hour emissions. If emission rates increase (during rush hour, for example) or emissions are transported to the sampler from elsewhere in greater quantities, then the maximum concentration measured during one season or year may be exceeded in subsequent years.

The inherent uncertainties concerning spatial and temporal insensitivity in the rollback technique outlined previously advance the case for contingency transportation controls in addition to exhaust controls because they determine regional vehicle-miles traveled (VMT); spatial distribution of VMT, particularly at points of congestion; temporal distribution of VMT, particularly during rush hours; and spatial and temporal distribution of actual route speeds and idling times throughout the region.

All these factors determine emissions. Therefore, the transportation system determinants of emissions must be planned and controlled if ambient air quality standards are to be achieved and maintained.

Basic rollback inputs are averaged urban factors for emissions tested according to the federal emission test procedure, deterioration rate of the exhaust device, projected growth of urban VMT, vehicle age distribution, and annual mileage per model year.

Averaged values for the preceding factors were used in making the curve shown in Figure 1.

Figure 1 shows future decreases in automobile emissions based on the replacement of older cars with new clean cars. Understandably, these assumptions are needed to make a complicated, unwieldy prediction more manageable; however, each of these averaged factors represents a potential error in determining when the air quality standards will be attained. If states had data that were deemed to be better than those on which Figure 1 is based, the states were permitted to use them. Taken singly or in combination, the possible errors can be described as follows: The federal exhaust test procedure has been modified several times to measure automobile emissions more accurately. The driving cycle that is based on an average route speed has been adjusted to simulate the average urban driving pattern more closely. But experts recognize that "conditions to which an emission-control system would be exposed by the driving public are more

Table 1. Federal funding of transportation modes (3).

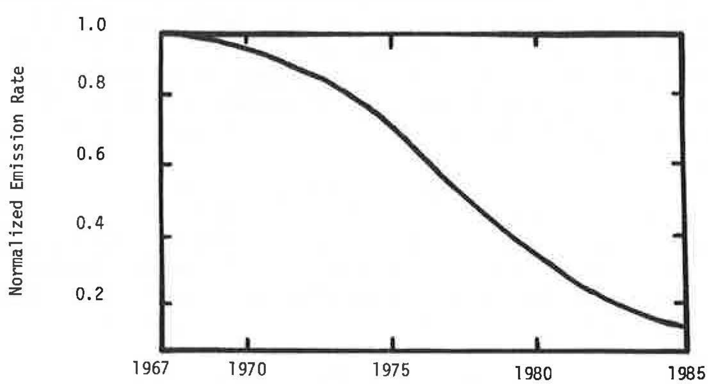
Transportation Mode	Fiscal Year (dollars × 10⁶)				
	1955	1960	1965	1970	1971
Highway	636	2,978	4,069	4,642	4,588
Aviation	122	508	756	1,252	1,636
Urban mass transit	0	0	11	158	280
Railroad	0	3	3	21	23

Table 2. Transportation controls in state implementation plans, February 1972.

Area	Traffic Controls	Parking Restrictions	Retrofit Systems	Testing and Inspection	Gaseous Fuel Systems	Public Transportation Improvements	Work Schedule Changes	Land Use Controls
Illinois (Chicago)				x				x
Wisconsin (Milwaukee)				+				
New Jersey (all)				x				
New York (New York, New Jersey, Connecticut)		0			0	0		
Maryland (Baltimore, Washington, D.C.)	0	0	0	0	0	0	0	0
Pennsylvania (Philadelphia)	0							
Washington, D.C.	+			+	+	+		
Virginia (Washington, D.C.)	+							
Massachusetts (Boston)	0	+		+		+		
Arizona (Phoenix, Tucson)	+	0		+	+		0	
Nevada (Clark, Mohave, Yuma)	x		+	+		x		
California				+		+		
South Coast	+	+	x	+	+	+	+0	+
San Francisco Bay Area	x	+	x	+	+	x	+	+
San Diego	+	+	x	+	+	+	+	+
San Joaquin			+	+				
Sacramento			+	+				
Texas (all)				+				
Alaska (Fairbanks)	0		0		0	0	0	
Oregon (Portland)	0	0		0		0		
Colorado (Denver)	0	+	+		0			
Washington (Puget Sound)							0	
Utah (Wasatch Front)	0			0		0		
Minnesota (St. Paul)	x	0		0		x	0	
Ohio (Dayton)	0	0	0	0		0		

Note: 0 = considered, + = proposed, and x = adopted.

Figure 1. Urban vehicle carbon monoxide emission rates.



variable and extreme than those to which it would be exposed during the emission test" (1). Therefore, exhaust device deterioration and emissions are likely to be greater than those currently calculated. How much greater these emissions will be can only be determined after 1975 and then only if the "spatial and temporal distribution of actual route speeds and idling times" is known.

There are uncertainties about the exhaust control device relating to its deterioration rate and about additional research into catalysts and manufacturing lead times. In addition there are administrative problems concerning mandatory inspection.

Projected urban VMT can vary from city to city. It was assumed that VMT per vehicle would remain constant at an average of 9,800 miles per year per vehicle. The average annual mileages of various model year automobiles according to Bostich and Greenbalgh (2) vary from 13,200 for automobiles less than 1 year old to 5,700 for automobiles 10 to 11 years old.

In areas of increasing urban sprawl and of populaces with increasing leisure time, it has been noted that persons make more frequent and longer trips. Apparently, the improved highway systems required to service urban areas stimulate a latent trip demand. Because traveling is easier and quicker, people travel longer distances more frequently. VMT per year may also increase at a rate greater than currently calculated if total area vehicle populations grow more rapidly than expected.

Vehicle age distribution and hence mileage per model year for specific urban areas can differ significantly from the national average. Therefore, proper determination of urban vehicle age distribution is necessary before establishing the need and severity of transportation controls.

AN IMPLEMENTATION APPROACH: SYSTEMS PLANNING

Possible strategies for altering existing transportation systems in urban areas at this time to achieve air quality standards are indeed limited, both in feasibility of implementation and in potential for emission reduction. It is crucial, however, that strategies selected now for their short-term emission reduction potential not be detrimental in the long run by inducing more or longer trips, for example. Further, longer range planning must begin now on a systematic basis.

Good transportation system design necessitates analyzing transportation as a forceful component in the entire urban development arena. This necessity has long been recognized but has yet to be implemented. Previously, transportation design criteria were limited to factors of technological and economic efficiency. Developing criteria for evaluating the social cost of a transport network is indeed complex. Ambient air quality standards, nevertheless, do offer a quantified criterion for designing future transportation systems with respect to environmental or social objectives.

Air quality standards serve as a useful criterion, however, only if transportation decisions are evaluated in a truly systematic fashion. That is, evaluation must not be limited to the primary impact of a system on air quality. The secondary and tertiary impacts of transportation on land use and activity patterns are crucial to a thorough system analysis. Shifts in land use and activity patterns may intensify the air quality impact of a proposed transportation system beyond that originally predicted. Similarly, land use decisions must consider the potential impacts on activity patterns and subsequently on transport networks.

Environmental management strategies for dealing with pollutants may be classified in three categories: process modifications such as substituting an alternative power source for the internal-combustion engine, source controls such as adding a catalytic muffler, and assimilative capacity of the environment through use of planning land use and transportation systems. Currently, most research is directed toward the first two approaches. The potential of the third approach, however, has been recognized and is being increasingly studied.

In the long run, the assimilative capacity of the environment and the limitations thereof must be the central factor in environmental management. Our society operates in a multiple objective framework including social, economic, and environmental goals; however, the assimilative capacity of the environment poses some definite constraints on any objective societal function. Nevertheless, there are ways in which societal activities can be reorganized to achieve objectives within these environmental constraints. Although we do not now possess perfect technical capabilities for assessing and utilizing this assimilative capacity, our understanding of the relation of land use and transportation to air quality is growing steadily, and this new knowledge must be used in making urban development decisions. Transportation systems can be designed to meet social and economic objectives without adversely affecting the environment, but this will require a radical departure from current concepts of urban land use and travel characteristics. It is rather doubtful that social, economic, and environmental objectives will be achieved if trends continue as projected in the automobile-dominated transportation systems of urban areas.

REFERENCES

1. Semi-Annual Report by the Committee on Motor Vehicle Emissions to EPA. National Academy of Sciences, Jan. 1, 1972.
2. Bostich, T. A., and Greenbalgh, H. J. Relativity of Passenger Car Age and Other Factors to Miles Driven. Bureau of Public Roads, U.S. Department of Commerce, Jan. 1967.
3. Schultze, C. L. Setting National Priorities. In The 1971 Budget, Brookings Institution, 1970.

APPENDIX

State	EPA Region	Air Quality Control Region	Transportation and Land Use Controls Required for	Two-Year Extension (7/75-7/77) Granted for	Justification for Extension[a]
Massachusetts	I	Metropolitan Boston, interstate	CO, O_x	CO, O_x	Stationary source regulations (significant only for O_x) Transportation controls
		Hartford, New Haven, Springfield, interstate		CO	FMVCP alone needs until 1977 to make standards
New Jersey	II	New York, New Jersey, Connecticut, interstate	CO, O_x	CO, O_x	Transportation controls (inspection and maintenance)—already accepted by the Administrator
		Metropolitan Philadelphia, interstate	CO, O_x	CO, O_x	Transportation controls (inspection and maintenance)—already accepted by the Administrator
New York	II	Central New York		CO	FMVCP alone needs until 1977 to make standards
		Genesee, Finger Lakes		O_x	FMVCP alone needs until 1977 to make standards
		New Jersey, New York, Connecticut, interstate	CO, O_x	CO, O_x	Stationary source regulations (significant only for O_x) Transportation controls
District of Columbia	III		CO, O_x		
Maryland	III	Metropolitan Baltimore	CO	CO	Stationary source regulations Transportation controls
		National Capital, interstate	CO, O_x	CO, O_x	Stationary source regulations Transportation controls
Pennsylvania	III	Metropolitan Philadelphia, interstate	CO	CO	Transportation controls
		Southwest Pennsylvania	CO	CO, O_x	Stationary source regulations (significant only for O_x) Transportation controls (required for CO)
Alabama	IV	Metropolitan Birmingham		CO, O_x	Stationary source regulations
		Mobile Pensacola, Panama City, southern Mississippi, interstate		O_x	Stationary source regulations
Indiana	V	Metropolitan Indianapolis		CO, O_x	Stationary source regulations (EPA will promulgate those for O_x)
Illinois	V	Metropolitan Chicago, interstate	CO		
Minnesota	V	Minneapolis-St. Paul	CO	CO	Transportation controls (state needs time to complete auto study and submit results)
Ohio	V	Metropolitan Cincinnati, interstate		O_x	Stationary source regulations
		Metropolitan Dayton	O_x	O_x	Stationary source regulations Transportation controls
		Metropolitan Toledo		O_x	Stationary source regulations
Kansas	VI	Metropolitan Kansas City, interstate		CO	Regulations for catalytic crackers and gray iron cupolas
Texas	VI	Austin-Waco	O_x		
		Corpus Christi Victoria	O_x	O_x	State regulation V—control of air pollution from volatile organic compounds and CO and transportation controls
		Metropolitan Houston-Galveston	O_x	O_x	State regulation V—control of air pollution from volatile organic compounds and CO and transportation controls
		Metropolitan Dallas-Ft. Worth	O_x		
		Metropolitan San Antonio	O_x		
		El Paso-Las Cruces, Alamogordo, interstate	O_x		
Louisiana	VII	Southern Louisiana Southeast Texas, interstate		O_x	Stationary source regulations
Missouri	VII	Metropolitan Kansas City, interstate		CO	FMVCP alone needs until 1977 to make standards
Colorado	VIII	Metropolitan Denver	CO, O_x	CO, O_x	Transportation controls
Utah	VIII	Wasatch Front	CO	CO	Transportation controls
Arizona	IX	Phoenix-Tucson	CO, O_x	CO	Transportation controls
California	IX	San Francisco Bay Area	CO, O_x	O_x	Stationary source regulations Transportation controls
		Metropolitan Los Angeles	CO, O_x	O_x	Transportation controls (EPA will promulgate plan)
		San Diego	CO, O_x		
		Sacramento Valley	CO, O_x	CO, O_x	Stationary source regulations Transportation controls
		San Joaquin Valley	CO, O_x		
		Southeastern Desert		O_x	(This extension was not requested. EPA granting extension because air quality in this region is greatly influenced by air quality in Los Angeles.)
Nevada	IX	Clarke-Mohave, interstate	CO, O_x		
Alaska	X	Northern Alaska	CO		
Oregon	X	Portland, interstate	CO, O_x		
Washington	X	Eastern Wash.-Northern Idaho, interstate	CO	CO (extension until 6/77)	Transportation controls
		Puget Sound	O_x	CO, O_x (extensions until 6/77)	Transportation controls (required for O_x)

[a]Local control measures (in addition to the nationwide Federal Motor Vehicle Control Program) need until 1977 to effect the required reductions in emissions.