Philadelphia Air Quality Control Region: Need and Recommendations for Revision of Transportation Control Plan

C. Abdul Latif and Rasin K. Mufti, Delaware Valley Regional Planning Commission

The Philadelphia transportation control plan, its status and evaluation process, and the technical background on which it was based are evaluated. A summary of transportation control plan strategies is presented as well as a review of their status and the major implementation problems of the plan. Legal, administrative, and technical problems are found to exist. A review and an analysis of the latest available air quality data for the Philadelphia central business district are presented. Air quality standards were found to be based on limited studies and did not take into account time of day, frequency, or duration of high concentrations of pollutants. The power of the U.S. Environmental Protection Agency to regulate the states or to require them to enforce a regulation has been questioned. A need for revising the Philadelphia plan is established, and it is recommended that the metropolitan planning organization be involved in the revision process. Possible strategies that could be considered in revising the plan and the place of such a plan in the transportation planning process are discussed.

Under the Clean Air Act of 1970, all states were required to submit plans for meeting the national ambient air quality standards set by the U.S. Environmental Protection Agency (EPA) in 1971. Transportation control measures were mandated for the air quality control regions (AQCRs), areas in which controls on stationary sources—such as power plants and other industries—combined with federal emission standards for new automobiles were considered inadequate to ensure attainment or maintenance of the ambient air quality standards.

The Philadelphia AQCR fell into this category. The state of Pennsylvania submitted and later revised a state implementation plan (SIP) that was found to be unsatisfactory by EPA. EPA then supplemented the state-prepared plan, producing the transportation control plan (TCP) currently in effect for the Philadelphia region. The TCP was published in November 1973 (4). At the time of its promulgation it was expected to have a profound effect on travel patterns and, thus, on the quality of the environment and on the economic well-being of the region.

This paper discusses the following major issues concerning the Philadelphia TCP, which has now been in existence for over 3 years:

1. Where does the plan stand today?
2. Which strategies in the plan have been implemented and to what extent have they succeeded in achieving their purpose?
3. What types of problems have been encountered, what are their sources and degree of complexity, and how are potential solutions to be evaluated?
4. Is the TCP a practicable plan? Should it continue or should it be made more realistic through revision?

SUMMARY OF TRANSPORTATION CONTROL STRATEGIES

The primary goal of the SIP and the TCP was to achieve within the Philadelphia region by May 31, 1976, the primary and secondary standards for ambient air quality for several pollutants including carbon monoxide (CO). A reduction of 55.5 percent in CO emissions over the 1971 level was estimated to be necessary. A concurrent result of the successful implementation of the TCP would have been a reduction of about 36.3 percent in the level of hydrocarbons (HC) over the level of the base year, which would go a long way toward achieving a targeted HC reduction of 54.7 percent.

Detailed strategies were promulgated by EPA in the following broad categories:

1. Measures to reduce the emission rates of individual vehicles (automobiles and trucks) and thereby reduce the rate and the quantity of emissions, and
2. Measures to reduce vehicle kilometers of travel, particularly by low-occupancy vehicles (automobiles), to reduce the level of emissions.

Measures to Reduce Emission Rates

Federal Motor Vehicle Control Program

The single most important measure in the emission-reduction category is the federal motor vehicle control program (FMVCP) for vehicles produced in model year 1968 and after. Although the program is not technically a part of the TCP, the resulting reduction of pollution is a necessary input to the TCP.

This program, in its original form, envisaged the introduction of technological changes in the design of automobile engines that would, by the year 1975, reduce the level of CO and unburnt HC emissions from automobile exhaust by more than 90 percent from the pre-1968 level. This measure was expected to contribute to about 44 percent of the CO reduction and 22.7 percent of the HC reduction prescribed by the TCP. For a number of reasons, the major automobile manufacturers have not adhered to this time schedule, and the final compliance date is now likely to be extended to 1981 or later.

The result of this postponement is that the emission reductions called for in this program cannot be accomplished by 1977 or even by 1980. Although interim emission standards are still in effect for vehicles manufactured after 1968, they have not had considerable impact on ambient air quality. In addition, the recent years of economic recession in the United States have resulted in somewhat restricted production and distribution of new automobiles. This factor may also have affected the impact of the lower interim emission rates of newer model automobiles: Many users have retained the older models beyond their customary service life for economic reasons.

Vehicle Inspection and Maintenance Program

A program of strict vehicle inspection was introduced

that was designed to induce compliance with the requirements of corrective maintenance and thus to reduce the rate of CO and HC emissions. The reductions attributable to this program were estimated to be on the order of 4.2 and 1.9 percent for CO and HC respectively.

The Pennsylvania Department of Transportation has recently published proposed voluntary regulations for vehicle inspection and maintenance. These regulations are awaiting fiscal and legislative approval, which is not expected for some time.

Retrofit Devices on Pre-1968 Vehicle Models

Pre-1968 vehicle models that had no antipollution devices were required to be fitted with appropriate devices (called air-bleed to intake manifold) to bring down their emission rates. This step was estimated to account for a 4.8 percent reduction in CO and a nominal 0.7 percent reduction in HC. Again, this strategy has not been put into practice.

Although the installation of such devices was originally considered administratively feasible, many problems were encountered in its implementation. Some of the reasons for nonimplementation are (a) a lack of proven effectiveness for any particular device, (b) problems of manpower training and workshop resources for the installation and upkeep of the devices, (c) the number of devices that would have to be procured for the older fleet of automobiles involved, (d) the purchasing cost involved, and (e) the equity of requiring such devices.

Older model automobiles are owned by those who can least afford a newer model; the retrofit device is therefore a highly regressive requirement. EPA has not insisted on the implementation of this measure anywhere in the country. The effect of nonimplementation is of course significant because an expected 4.8 percent reduction in CO emissions is unrealized.

Measures to Reduce Vehicle Kilometers of Travel

Strategies addressed to reducing vehicle kilometers of travel in the Philadelphia AQCR are the core of the Philadelphia TCP. Although the number of strategies and the range of possibilities in this category are large, the actual reduction attributable to these measures is relatively insignificant (EPA estimated that these strategies would contribute to reductions of 2.9 and 0.2 percent in CO and HC emissions respectively). The following measures designed to reduce vehicle kilometers of travel were included in the TCP:

1. Management of parking by subjecting all new parking facilities for more than 50 automobiles to the requirement of written approval by EPA (the lower limit has been raised to 250 spaces);
2. Limitation of public parking on streets and highways, particularly those where exclusive bus lanes or trolley lanes are established;
3. Introduction and encouragement of computer-matched car-pool systems for all establishments with more than 100 employees;
4. Formation and maintenance of exclusive bus and trolley lanes on certain routes in Philadelphia such as CBD-Ben Franklin Bridge and Roosevelt Boulevard between Grant Avenue and the Huntingdon Park exit as well as on specified CBD streets (with accompanying parking restrictions) and outside the CBD (during morning and evening peaks);
5. Creation of exclusive bus lanes on West Chester Pike, I-95, and the Schuylkill Expressway;
6. Establishment of at least 40 km (25 miles) of bikeways in the CBD; and
7. Introduction of transit-use incentives by employers who provide more than 700 parking spaces, such as restrictions on the number of parking spaces, increased parking fees for automobile users who drive alone, and encouragement of the use of spaces by car poolers and van poolers.

These strategies were expected to shift transportation mode choice in favor of mass transit. The increased mass transit ridership would in turn further improve the quality of service (by reducing headways) and increase the transit share of trips. The reduction of vehicle kilometers of travel, with the associated reduction in highway speeds, would improve air quality as well as reduce energy consumption.

Implementation of strategies in the categories of reduction of vehicle kilometers of travel and traffic-flow improvements has been partly successful. In general, progress was made in implementing those strategies that were the responsibility of the state or the local authorities in the Philadelphia AQCR. These include the establishment of (a) bikeways, (b) a car-pool computer matching system, (c) busways between the Ben Franklin Bridge and the Philadelphia CBD, (d) CBD bus and trolley lanes, and (e) limited public parking on streets where bus or trolley lanes have been established. In addition to these measures, the city of Philadelphia has successfully implemented the Chestnut Street Mall, which provides for an automobile-free zone on Chestnut Street between 6th and 18th streets.

The measures that remain to be implemented are under the jurisdiction of either EPA (management of parking supply) or private employers in the region (mass transit incentives). Measures that require exclusive bus lanes were found to be infeasible (1). Major obstacles in the implementation of these projects include the resistance of citizens to any measure that seeks to limit travel choices without providing equally attractive alternatives.

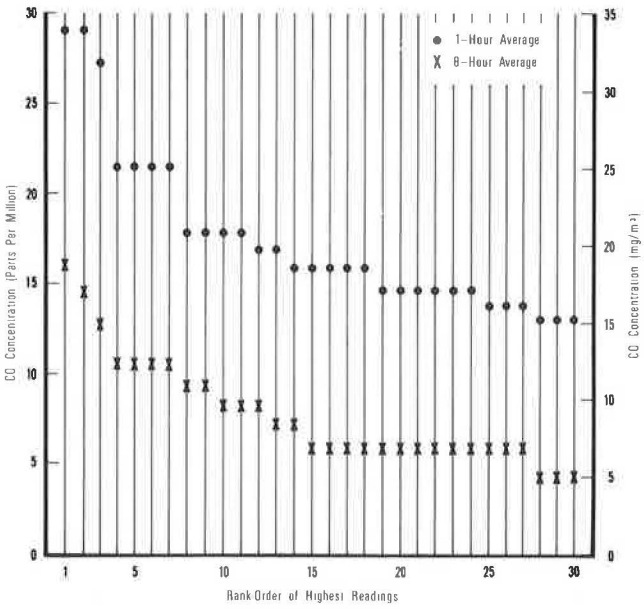
TCP Impact on Air Quality Data

In spite of the partial implementation of the strategies that form the core of the Philadelphia TCP, the real impact of these measures on the level or the density of emissions is very small. Even a complete implementation of all the measures would not have affected ambient air quality to any noticeable extent in the absence of successful measures to reduce emission rates. The total proportion of CO reduction attributable to these measures is only 2.9 percent.

In an assessment of the real impact of partial implementation of the TCP, 1971 to 1976 hourly air quality data from two air-monitoring stations—the Continuous Air Monitoring Project (CAMP) and the Air Management Service (AMS)—were reviewed. Continuous graphs of 8-h average CO concentrations were plotted and violation periods were summarized. The number of violations and their intensities are given below (1 mg/m^3 = 0.87 ppm):

Year	Number of Violations		Highest Concentration		Time of Occurrence of Highs
	CAMP	AMS	Amount (mg/m^3)	Duration (h)	
1971	13	2	23.0	11	12:00 m.n.
1972	12	4	16.8	9	4 a.m.
1973	14	12	20.2	14	2 a.m.
1974	6	3	21.3	14	2 a.m.
1975	2	3	16.8	10	3 a.m.
1976 (to November)	–	1	24.2	13	4 a.m.

Figure 1. Thirty highest average 1-h and 8-h CO readings at CAMP monitoring station in 1974.



Thus, from 1973 to 1976, when some limited elements of the TCP were in effect for over 3 years, the air quality was in violation of the 8-h standards [8-h average CO cencentrations not to exceed 10.3 mg/m^3 (9 ppm) more than once a year]. The situation as observed over these years does not seem to be improving; the level and duration of the highest average concentrations remain high.

PROBLEMS WITH EXISTING TCP

Efficacy of TCP Elements

A review of the status of the various elements of the TCP shows that only a few of the elements of the plan have been implemented and that these elements have a limited chance of having a positive impact on the air quality of the region. As discussed earlier, all of the measures meant to reduce vehicle kilometers of travel taken together were expected to reduce CO emissions by only 2.9 percent.

Other elements of the TCP that did have promise of reducing total emissions were those that would reduce the emission rates of vehicles without reducing the level of travel. These elements of the TCP, which are within the jurisdiction of state and local authorities, encompassed the most unpopular—or unrealizable—elements. Even if the FMVCP is eliminated, the expected emissions reduction attributed to vehicle inspection and maintenance and retrofit devices on older automobile models—a significant 9 percent reduction in CO—remains unrealized because of technological, economic, and administrative factors.

Attitudinal, Institutional, and Legal Problems

The attitudinal problems of the Philadelphia plan were the result of apparent philosophical gaps between EPA staff and the staffs of other transportation agencies that stemmed from an attitude of distrust between environmentalists on one side and transportation planners and engineers on the other. The institutional problems grew out of the absence within EPA of the framework and the expertise to deal with transportation plans and strategies. The situation in these two areas, however, has greatly improved since the inception of the TCP.

Legally, EPA had no authoritative position from which to deal with local governments. Its authority stems from the 1970 Clean Air Amendments, which entitled the agency to deal only with state governments, using the federal interstate commerce power (on the assumption that air pollution fell under interstate commerce). This limited EPA's direct (legal or regulatory) involvement with communities and political jurisdictions affected by the TCP.

A more complex legal problem arises from court decisions in several cases involving EPA and transportation control plans. Common to all these cases is a challenge to the power of EPA to force the states to enact and enforce specific transportation controls. Although the decisions in these cases vary considerably, they have hindered EPA's ability to implement the TCP, particularly in Maryland and California.

Technical Problems

The four major types of technical problems are those pertaining to ambient air quality standards, air pollution monitoring, implementation of the FMVCP, and various elements of the TCP.

Ambient Air Quality Standards

In the 1970 Clean Air Act, Congress called for the establishment of performance standards governing ambient air quality. EPA was assigned this task, which means that the agency was left to quantify the relationship between ambient air quality and the state of the public health and welfare. Based on a study undertaken by the U.S. Department of Health, Education and Welfare (2), EPA fixed the following standards for CO: 1-h concentration not to exceed 40.3 mg/m^3 (35 ppm) more than once a year and 8-h average concentration not to exceed 10.3 mg/m^3 (9 ppm) more than once a year.

The establishment of these standards has given rise to considerable controversy, and the debate still continues. Some believe the standards to be very stringent; others consider them adequate. Nevertheless, the standards appear to be oversimplified, supported by only limited theoretical and experimental data.

Figure 1 shows the 30 highest 1-h and 8-h average CO concentrations at the Philadelphia CAMP station during 1974. The figure suggests that a curve representing CO concentrations in descending order resembles a decaying exponential distribution. The density in such distribution tends to decline very sharply at the beginning and then levels off. Everyone is aware of the serious nature of air pollution, but the safety margin in the concentration standards, the infrequency of and the long periods between high pollutant concentrations, and the human ability to compensate during nonexposure time indicate that a more relaxed stance on the number of permissible violations of standards should be investigated.

Air Pollution Monitoring

Air pollution data collected by monitoring stations are inadequate for several reasons:

1. There are a limited number of monitoring stations, and the number varies depending on the pollutant being monitored. Until 1974 there were only three stations monitoring CO in the Philadelphia area, one of which is in the CBD (CAMP).

2. Although the stations monitor continuously, all of them experience some gaps in data, and significant portions of the data provided are ruled invalid.
3. No clear standards exist in relation to height, distance from the roadway, and general location of the equipment (measurements are extremely sensitive to these factors).
4. Partly as a result of the lack of clear standards, it is not uncommon to find CO concentrations reading higher in the outlying section of the city than in the CBD because, although the traffic may be of decidedly lower density, the monitoring equipment is more sensitive to location factors.
5. A major problem seems to exist with the technique by which 8-h average concentrations are calculated, especially the number and the duration of each violation of the standards and the highest numerical value assignable to each violation. EPA must prescribe the averaging method in clear, specific, and well-documented terms.

Federal Motor Vehicle Control Program

Another problem that has legal as well as technical aspects involves the FMVCP. The unresolved points are intermediate motor vehicle emission standards and the final date established for attainment of the mandated 90 percent reduction of emissions from pre-1968 vehicles. Several versions of an amendment to the Clean Air Act are circulating in Congress, and they all include a deferral of the established date from its latest revised date of 1977 to 1981 or later.

The FMVCP is the most important strategy for reducing emissions. It was expected to contribute over 40 percent of the 55 percent required CO reduction in the Philadelphia SIP. However, there are major problems associated with this program in that the vehicles already in use are emitting more pollution than the respective model-year emissions mandated for them. Lack of adequate maintenance is among the reasons for these excessive emissions.

Inadequacies of Plan

Several problems and inadequacies exist with the transportation control plan in general and with specific strategies in particular, at least partly because of the extremely short statutory deadlines imposed on EPA by the Clean Air Act of 1970. These inadequacies include the following:

1. No evaluation was made of the social and economic costs of implementing the TCP, nor was the plan evaluated for its effect on areas beyond the immediate vicinity of the facilities included in the plan.
2. The strategies seem to have been selected randomly without any regard to their regional applicability. An example is the selection of exclusive bus lanes parallel to commuter rail routes (the Philadelphia-Paoli corridor). Another example is the application of the transit-use incentive to employers who provide more than 700 parking spaces: No employer in the Philadelphia CBD is in this category.
3. The compliance schedule for most of the strategies concentrates on implementation without time for feasibility analysis or study of alternatives.

ALTERNATIVE TCP

From the list of problems summarized above it can be concluded that the Philadelphia TCP requires a major overhaul. The need is serious enough to suggest the development of a totally new plan, built on current experience but based on a more refined process. The refinements, although primarily technical, require more than technical changes. They are very much related to the attitudinal, institutional, legal, organizational, and other types of problems outlined earlier.

In the attitudinal and institutional areas, EPA has taken many forward steps. Its relationship with other agencies, particularly those in the transportation field, has markedly improved. Through better staffing and internal reorganization, EPA has begun to deal with transportation questions more effectively. Its regional staff has recognized many of the local problems inherent in the TCP and has transmitted these problems to policy makers in Washington.

In the legal area, amendment of the Clean Air Act is required to clarify the intent of Congress in granting EPA its regulatory power as well as the extent to which EPA or the federal government as a whole can sanction the action (or inaction) of a state or local government with respect to pollution control.

Involvement of Metropolitan Planning Organizations

Amendments to the Clean Air Act are needed to ensure that transportation control strategies are developed and adopted by local, regional, and state governments rather than promulgated by EPA. This, among other things, would reduce the likelihood that legally controversial strategies would be adopted.

The thinking of lawmakers is already moving along these lines. A 1976 Senate version of the Clean Air Amendments (8) requires the metropolitan planning organizations (MPOs) to carry out the task of defining transportation controls in conjunction with the overall planning process. Both this Senate version and a House version of the measure (H.R. 10498) provide the state with a 2-year period from the date of the amendment to complete and adopt a new TCP.

The thinking of the U.S. Department of Transportation and others is also on these lines. In a 1975 position paper issued by the Intermodal Planning Group for Federal Highway Administration Region 3, it has been rather strongly suggested that the planning of control measures should be done by the MPO because any transportation measures developed outside the 3-C planning process are not likely to have the technical and community support needed to ensure implementation. The position paper recommends that (a) when revising the state implementation plan, the responsible state air pollution control agencies should delegate to the MPO the responsibility and financial support to plan the transportation controls necessary to attain national ambient air quality standards; and (b) no measures should be included in the TCP unless they are also included in the transportation system management elements (TSME). In addition, a stronger emphasis is being placed on short-range planning in transportation, through TSME (7). Under TSME, short-range needs are to be filled by making more efficient use of existing transportation resources without making major changes in the facilities or adding new facilities. The applicable federal regulation requires that the transportation plans of the MPO be consistent with environmental and energy objectives and that these plans be coordinated with air quality planning.

TCP and the Transportation Planning Process

A much more important need for revision in the TCP process is in the area of planning. The region can no longer afford to keep different plan elements separate

from each other. Transportation control strategies must be made an integral part of the regional plans and the planning process and not merely a remedial measure. Environmental considerations should be as much a part of the plan and the planning process as are other selected concerns and goals. The TCP as currently understood may in this context be only an interim measure to be replaced by a transportation plan prepared with all objectives, including environmental objectives, in mind.

The Delaware Valley Regional Planning Commission (DVRPC) has already included environmental concerns in the planning process for the year 2000 plan (9). In fact, environmental objectives are being addressed even at the sketch-planning level. By including environmental concerns in the planning process, the 3-C process is not only being extended but is also being made more responsive.

An implementable and politically and socially workable transportation control plan is necessary for reasons other than air quality concerns. Involving the local constituencies of DVRPC and interested citizens in the preparation of the TCP is therefore very important. A successful TCP process may be instrumental in bringing to the attention of the public the necessity of modifying its automobile travel habits. The TCP will also help to promote energy efficiency as well as to maintain air quality once the standards have been met.

Technical Changes Required

Several technical changes, reevaluations, or refinements in the TCP are necessary, including those discussed below.

Reevaluation of Ambient Air Quality Standards

In view of the difficulty of determining compliance or defining strategies based on a single value, an alternative standard is required that takes into account frequency, duration, and time of day of high pollutant concentrations and that admits the probability of the occurrence of more than one value above the stated concentration. In such a standard, a statistical relation accounting for the relevant parameter (frequency, duration, time) of the measured concentration above the permissible level would replace the single permissible exceedence. The 8-h CO standards could conceivably be lowered below 10.3 mg/m^3 (9 ppm) and the manner in which the standard could be exceeded could be stipulated.

Establishment of Monitoring Criteria and Program

The city of Philadelphia and the state of Pennsylvania have taken steps toward establishing detailed monitoring criteria and a broadly based monitoring program for both air pollution and such transportation characteristics as vehicle kilometers of travel and speed. The number of continuous monitoring stations in the city increased from 3 in 1971 to 11 in 1974; 3 more were added in the suburbs of the region in late 1975. What remains to be achieved is proper maintenance and calibration of the equipment and accurate and consistent data interpretation.

Revisions of Basic TCP Assumptions

An important basis for revisions in the TCP is changes in the state of knowledge about certain basic but key factors and, to some extent, changes in the state of the art. Examples of the first kind include revisions in the basic emissions factors for automobiles and trucks. When the original TCP was prepared, these factors depended only on the model year of the vehicle; a speed adjustment curve was used for different types of vehicles. Later investigations have made it necessary to include the effects of cold starts and ambient temperatures in the calculation of emissions factors (5). The effect of this change is most likely to be evident in the CBD at the p.m. peak because of the relatively high percentage of travel that could qualify as cold starts. Different emissions factors may have to be used for other areas depending on the nature and volume of traffic.

Additional changes are necessary so that the plan will reflect the level of travel in various parts of the region instead of only travel in the CBD. Thus, it may no longer be valid to speak of a given percentage reduction in vehicle kilometers of travel or emissions except in terms of regional totals. It may be much more meaningful to attempt to specify the maximum daily vehicle kilometers of travel and the corresponding level of emissions (yearly or daily) that are consistent with the standards if the worst meterological conditions occur simultaneously. In addition, the actual or forecast amount of travel and emissions (as well as expected ambient concentrations) should also be calculated so that remedial measures can be initiated under emergency conditions (3).

URBAN GOALS AND CANDIDATE STRATEGIES FOR A REVISED TCP

Urban Goals

A large number of strategies responsive to selected planning goals and objectives have recently been compiled under the joint sponsorship of EPA, the Federal Energy Administration, and the Urban Mass Transportation Administration (6). That study presents three major sets of urban goals and systematically presents various strategies that could be used to achieve those goals. Of course, not all of these strategies can be uniformly applicable to all urban areas and not all of them would qualify to be labeled as TCP. Some of the strategies have far-reaching social and economic consequences on the national or even the global level, for example, design of the nonpolluting engine and introduction of non-petroleum-fueled engines. (Action is already being taken in both categories.)

Many of the other strategies discussed here may be unpopular because they would tend to restrict the mobility and the mode choice that people have been accustomed to getting from the automobile. These strategies are directed toward reducing vehicle kilometers of travel and restricting automobile access. A great deal of effort will have to be expended on educating the public before these strategies can be effective. Whatever strategies and measures are selected, successful implementation would need positive commitment from all levels of government in the Philadelphia region, from the federal to the local level.

Various urban goals and broad action categories that should be fully analyzed with respect to their social and economic implications before they are selected for inclusion in a revised TCP are examined below. The three major goals are improvement of urban mobility, reduction in the rate of exhaust emissions, and conservation of energy. The various actions for mobility improvement and energy conservation complement the major goal of improving air quality by helping to reduce the amount of exhaust emissions.

Improvement in Urban Mobility

Historically, improvements in urban mobility have been caused by the introduction of faster means of transportation and an extensive network of highways and other travel modes. Of course, the ever-increasing use of the automobile and low automobile occupancy have ultimately resulted in a waste of energy and increases in pollution, congestion, delays (particularly during peak hours), and accidents.

Major strategies for improving urban mobility should be directed toward providing a reasonable balance between the use of the automobile and public transportation. These strategies must therefore aim at reducing the demand for highway-related automobile use as well as increasing transit supply and demand.

Reduction in Rate of Exhaust Emissions

Besides measures for reducing the use of the automobile and thus vehicle kilometers of travel, measures will be needed to reduce the level of automobile emissions. Such measures do not lie within the scope of the MPO; they must originate in the federal government, which can legislate in this sphere as well as provide the appropriations and the leadership for research and development of new technology.

Although new-automobile strategies and measures belong outside the TCP, they are an essential component of any effort to conform to federal air quality standards. The only jurisdictions outside the federal government that can play a useful role in reducing automobile emissions are the state governments, which can institute more responsible inspection and maintenance policies for vehicles already on the roads so that those vehicles continue to perform as close to the federal standards as possible. MPOs must be kept up to date on the state's progress in implementation of inspection and maintenance programs and control of stationary sources of pollution.

Conservation of Energy Resources

Urban transportation is perhaps the greatest consumer of energy. Not only are huge quantities of gasoline consumed by automobiles, affecting the economy's ability to keep pace with the rising demand for this fuel, but also the fuel after combustion is discharged into the atmosphere in the form of pollutants. Any reduction in gasoline use would favorably affect air quality.

In addition to more efficient engines, the conservation of gasoline can be effected in two ways: (a) by reducing kilometers of travel by automobile and (b) by concomitantly increasing the use of transit, which is usually understood to be a more energy-efficient mode. Rigorous studies of the effect of a more widespread use of transit may, however, be necessary to assess the effect of a change to alternate fuels. For example, more diesel buses on the street may raise other problems, e.g., smoke particles. The use of high-speed transit, such as commuter rail and light rail, will not only change the type of fuel used but will also cause fuel to be burned at fixed points where energy conversion would take place. Effects of increased emissions at those locations will, therefore, also need to be studied.

Measures for realizing the energy objective no doubt belong to various levels of government acting, when appropriate, through the MPO. The federal and state government roles lie in legislating smaller vehicle size, weight, and power, providing research and development assistance for new propulsion technology, and providing leadership in the development of clean energy sources and in inspection and maintenance.

Candidate Strategies for Revised TCP

Possible strategies that should be discussed and analyzed further and incorporated in the revised TCP are presented below. Strategies must be implementable, and their social and economic implications should be analyzed before they are included in a revised TCP. Although this group of strategies includes certain measures that are part of the existing Philadelphia TCP, such as car pools, bus lanes, and parking restrictions, the difference may lie in the specific application of the measures—in how, where, and how much. Locating an exclusive bus lane parallel to a high-speed rail corridor may be an obviously inconsistent or ineffective measure, but it may be quite effective in some situations. Workable elements of the existing TCP should be included in the revised TCP and as part of the region's TSME. The real point in revising the TCP should not be to replace entirely the existing strategies but to make the planning process more responsive and effective.

Automobile Travel

Possible strategies for improving automobile alternatives are as follows:

1. Improve transit service by increasing its frequency, quality, safety, and security;
2. Revamp the transit fare structure and include the possibility of multizone fares and fare-free service on CBD loops;
3. Encourage the use of bicycles and walking by providing safer roads and streets, in terms of traffic engineering for the safety of both people and property; and
4. Extend transit service to the areas not currently served, i.e., areas with latent demand but relatively low patronage.

Vehicle Movement on Highways

Strategies for improving vehicle movement on highways are as follows:

1. Improve the conditions of highway and street networks;
2. Improve traffic control measures, including installation of volume-responsive signaling, provision of appropriate turn restrictions, and use of one-way streets where such use is indicated;
3. Prohibit or at least strictly control on-street parking, particularly in the CBD and on other streets where transit routes are located;
4. Monitor instantaneous conditions of traffic congestion during peak hours and in situations that involve delay caused by traffic accidents and introduce ramp metering and the posting of alternate routes for highway uses;
5. Where possible, and where so indicated, introduce special bus lanes that may also be used by car poolers (bus-activated signals may be installed); and
6. Introduce more and new transit service in heavily traveled corridors and other areas of service (CBD loops, shuttles, airport service).

Reduction of Automobile Use

Strategies designed to reduce the use of automobiles are as follows:

1. Introduce and encourage car, van, and bus pools and other shared-ride programs;
2. Revamp working hours (staggered work hours, staggered workdays, flextime);
3. Rationalize parking policy in congested areas by such actions as providing parking facilities at the fringes of critical areas where they interface with public transportation and manipulating parking fees;
4. Introduce incentives to the use of public transportation (by such measures as reimbursement of transit costs and free or subsidized travel) for use by employers located in critical areas; and
5. Examine and recommend entry and exit points in heavily traveled areas such as the CBD by designating one-way streets and specified points of entry and exit, more turning restrictions, and more automobile-free streets such as the Chestnut Street Mall.

Vehicle Inspection and Maintenance Programs

Periodic checkup and repair of antipollution devices, in accordance with model-year specifications, should be required.

Energy Efficiency of Vehicles

Strategies for improving the energy efficiency of vehicles are as follows:

1. Introduce more efficient passenger pickup and drop-off by public transportation vehicles by introducing appropriately spaced stops and
2. Introduce one-way collection of tolls on toll bridges to expedite the processing of vehicles, improve speed, reduce emissions, and save energy.

CONCLUSIONS

The Clean Air Act, the creation of the U.S. Environmental Protection Agency, and subsequent EPA regulations for clean air are long-overdue responses to the concerns of various segments of society. Like many other responses to public pressure, the act, the agency, and the regulations were all formulated with a certain degree of expediency, which gave rise to many legal, administrative, and technical problems. The legal problems involve a challenge to EPA's regulatory powers, the administrative problems are manifested by the lack of a clear definition of EPA's powers and responsibilities, and the technical problems are inherent in the rather hastily generated regulations. Lack of public acceptance further aggravated the problem.

The need for a revision of the TCP is the most obvious conclusion of this paper. However, that revision perhaps should be extended beyond the TCP to the SIP and possibly to the air quality standards and the Clean Air Act. The Clean Air Act is currently being amended. It is hoped that the amendment will clarify some of the otherwise ambiguous provisions. The national ambient air quality standards are the subject of much debate, and the need still exists for more comprehensive standards that include a multiplicity of pollution factors (level, duration, time of day) and better technical justification. Revision or reformulation of a new TCP must begin with the basic premise that it should evolve through the regional comprehensive planning process with the full participation of local governments and concerned citizen groups.

In formulating the TCP, the MPOs must ensure not only the total cohesiveness of the plan but also its homogeneity with the short- and long-range elements of the regional transportation plan. In particular, the integration of the TCP into TSME is essential to the conduct of the regional planning process.

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