A1F03: Committee on Transportation and Air Quality
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Strategic Plan for Transportation and Air Quality Research, 2000–2010

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The relationship between transportation and air quality has been the subject of research for some time, with interest peaking after passage of the Clean Air Act (CAA) Amendments of 1990 and the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991. Through the support of these two pieces of legislation, much has been learned about the impacts on air quality from transportation investments. The research to date has been critical of the nation's efforts to achieve healthful air quality while retaining current levels of mobility and economic development.

The relationship between transportation and air quality is complex, and needs more evaluation. To understand both areas better, existing tools and data must be refined and new tools and techniques and better data must be developed over the next 10 years if the nation is to accurately assess transportation impacts on air quality.

Furthermore, challenges, including potentially new air quality standards and global warming, that will require even greater depth of knowledge are looming on the horizon. The work of the Transportation and Air Quality Committee will be a vital element in assisting states, metropolitan areas, and the federal government to understand how transportation can best be used to improve air quality and to make rational and cost-effective policies.

MOVING BEYOND STATE OF THE PRACTICE

The current state of the practice in transportation and air quality stems largely from federal legislation passed in the early 1990s. Much has been learned and incorporated already into the current practice, but gaps exist and substantial research must still be done to complete the analytical framework.

Legislative and Regulatory Framework

The country's efforts to reduce mobile source emissions continue to be driven by the legislative and regulatory framework laid out by the CAA, the Transportation Equity Act for the 21st Century (TEA-21), and the transportation and air quality planning provisions included in Titles 23, 40, and 49 of the U.S. Code and Code of Federal Regulations. The 1990 CAA amendments continued the highly successful focus on technological improvements, most notably on progressively tighter vehicle standards, cleaner-burning fuels, and inspection and maintenance (I/M) programs started in the 1970 CAA and subsequent amendments.

Together, the 1990 CAA amendments and ISTEA represented a sea change in the approach taken to address mobile source pollution. They fundamentally shifted the focus of transportation planning from a mitigation approach to more of an improvement orientation by requiring that transportation plans and investments conform through quantitative analysis to the purpose of improved air quality. They also enhanced the emphasis placed on transportation control measures (TCMs) by requiring timely implementation of TCMs and making more funding available for them under federal programs. Failure to implement TCMs that were committed to in a state (air quality) implementation plan (SIP) was sufficient for the Environmental Protection Agency (EPA) to impose highway funding sanctions.

Although much has been accomplished, the research agendas that were engendered by these laws have not been completed, and further work is necessary. The legislative and regulatory approach for transportation air quality programs continues to be dynamic, highlighting the need of, and providing a rich impetus for, effective research.

Current Assessment

In the almost 30 years since passage of the CAA in 1970, one of the lessons research has taught us is that there is no magic bullet that will eradicate emissions from transportation. Rather, the legislation promotes a multipronged approach to reduce emissions through both technological means and travel behavior modification. Both of these approaches, but particularly the latter, require an in-depth understanding of what is a highly complex set of interactions.

Transportation and emissions models were developed on separate tracks for distinct purposes. Transportation models were largely developed to predict the impacts of large infrastructure improvements on traffic flows and congestion levels. Over time, efforts refined the modeling process to include greater and greater detail, with more accuracy to predict impacts further into the future. Yet the state of the practice is such that relatively gross averages have been sufficient for most routine purposes to get a sense of mobility impacts. Like transportation models, emissions models have evolved and improved over time. Work is currently proceeding on the sixth generation of the MOBILE model. As our understanding has grown, more and better features have been incorporated into the model. Even in its current incarnation, MOBILE is still only capable of providing gross estimates of the emissions from transportation sources because it is highly sensitive to the transportation inputs.

The difficulties in accurately estimating and predicting air quality impacts from transportation sources continue beyond the analysis of emissions levels. Emissions disperse into the atmosphere, and the ultimate aim is to analyze not only the emissions levels but also the actual pollutant concentrations. Current research is teaching us that our understanding of the dispersion of carbon monoxide emissions still has many unknowns and that current models and reasonably foreseeable improvements on them will need substantial improvement. The lack of accurate dispersion models is greatly compounded for PM-10 and PM-2.5 emissions, particularly since so little is known about the origins and characteristics of fine particulate matter.

In addition to these issues, another major difficulty in estimating emissions from transportation activity is the lack of real-world data. NCHRP Report 394 cites data limitations in numerous areas that will have an impact on emissions. These include vehicle type and mileage accumulation; speed, summer, winter, and weekend traffic adjustments; and travel on local streets. The lack of these data has caused metropolitan areas to use default values in emissions models, leading to substantial inaccuracies.

Research Needs

Clearly there is a need to continue the refinement of the existing set of models and to collect more and better data. Since engine starts and evaporative emissions occurring at trip ends have a disproportionate impact on emissions, it is critical that more data be collected on the number and length of trips. Better data on vehicle miles of travel (VMT) and the emissions of the vehicles traveling also are needed. Although commuting patterns have been one of the primary focuses of transportation planning, other trip-making behavior is now as or more important, and better data need to be collected for this, particularly for emissions purposes. We need to improve dispersion models to more accurately predict “hotspot” concentrations. Finally, more comprehensive information must be collected on air quality impacts on local roads.

Better integration of the transportation and emissions models will also need to be accomplished in the next 10 years. Much work is going on in this area, and research done under the Transportation and Air Quality Committee’s auspices will be critical to its successful implementation. The model TRANSIMS represents a significant departure from the four-step modeling process, using traditional travel survey data to generate synthetic household activity and subsequently simulating vehicle operations on the transportation network. EPA is also continuing its efforts on the development of MOBILE 6. Much has been learned about deterioration rates of vehicles, and this and other information is being incorporated into the model.

In addition to these modeling and data needs, other research gaps must be addressed. Among these are improved understanding of successful institutional relationships between transportation and air quality agencies, the growing importance of nontraditional transportation control measures, and the sustainability of the nation’s transportation network and services. It is critical for the transportation community to understand and make improvements in institutional control of funds, priority-setting processes for projects, and the inherent trade-offs between sometimes competing social and environmental goals facing transportation and air quality agencies. More information on the most cost-effective traditional transportation control measures and about innovative new measures, such as pay-at-the-pump insurance and car-sharing, that may be effective in reducing transportation-related emissions need to be shared. The transportation community needs to develop and refine data, economic tools, and qualitative methods to allow for the reliable assessment of and best practices for strategies like these.

Finally, national and international interest in the issue of sustainability has been growing. Indicative of this enhanced focus is the Transportation and Community and System Preservation Pilot Program, which is funded by TEA-21. Authorized at $120 million through 2003, this exciting new program makes grants available to communities to demonstrate that sustainable transportation is more than an ideal. Research questions are abundant. What are the trade-offs among economy, environment, and equity? How can we adapt our analytical techniques to encompass these concepts? What data are necessary? How can we better incorporate land use into transportation modeling? Research over the next 10 years will help to provide direction.

RESEARCH NEEDS FOR CRITICAL DEVELOPMENTS, 2000–2010

New Air Quality Standards and Air Toxics

In 1997 EPA promulgated new air quality standards for ozone and fine particulate matter (PM-2.5). These standards pose large challenges for the nation as a whole and the transportation community in particular. (EPA also changed the standard for PM-10, but this represents a less stringent standard and thus is of less concern for research.)

The ozone standard was changed because, according to EPA's scientific advisory committee, evidence indicates that there is no "bright line" below which negative health impacts do not occur. The new PM-2.5 standard was promulgated because the smaller fractions of particulate matter appear to demonstrate a much more significant health impact. Although these standards were challenged in a May 1999 court decision, the potential health effects of these pollutants nonetheless demand attention. New research will be critical if the transportation community is to identify cost-effective means to rise to the challenge inherent in the new standards.

The new standards represent a significant tightening of the effective definition of clean air. The new ozone standard as promulgated in 1997 is 80 parts per billion (ppb) averaged over 8 hours, a substantial change from the current 120 ppb averaged over 1 hour. If ultimately implemented, the new ozone standard may more than double the number of counties in nonattainment. The PM-2.5 standard has no precedent, and areas designated as being in nonattainment for this type of pollution will have to devise new ways to address it. It could result in almost a quadrupling of counties that fail to meet any particulate matter standard. Taken together, these standards could have widespread impacts on the transportation community, especially in meeting the legislative requirements areas of transportation planning and conformity.

Little is known about fine particulate matter pollution. The transportation sources of PM-2.5 have to be identified and defined for the various regions of the country since the indications are that different parts of the country have different problems. The particulate matter species, especially those most harmful to human health, must be specified if we are to most effectively target our efforts. And most critically, effective mitigation strategies, whether technological or behavioral, must be found, implemented, and evaluated. This huge research undertaking will require millions, if not hundreds of millions, of dollars. More is known about transportation's contribution to ozone pollution and possible mitigation strategies. However, the new standard is so much more stringent that identifying additional emissions reduction strategies will be difficult, at least for the largest U.S. metropolitan areas.

In addition to the new air standards, another likely new area in transportation and air quality is air toxics. Although the CAA has existing requirements for addressing air toxics, specific targets and deadlines have not been established. This situation is likely to change. In July 1999, EPA completed its Final Urban Air Toxics Strategy, providing its framework for addressing these emissions in urban areas. More direct federal involvement is anticipated, and additional rules are expected to be promulgated. On the basis of our understanding to date, mobile sources can constitute about 30 to 45 percent of air toxics, making them a major contributor. Yet, the analysis of mobile source-related toxic emissions is in its infancy. Very little is known about these emissions and how best to mitigate them. More needs to be done to understand the process by which the emissions are generated and to quantify them.

The Transportation and Air Quality Committee will play an important role in promoting, performing, reviewing, and disseminating the results from varied research studies needed to address these critical problems. Much more work will be done over the next 10 years to better understand and effectively address these challenges.

New Vehicle and Fuel Standards

Even as the United States is redefining clean air, new approaches are providing the potential to reduce mobile source emissions. Among the significant actions are introduction of the National Low Emission Vehicle (NLEV) program, regulations to reduce emissions from heavy-duty engines, the proposed Tier II standards for automobiles and light trucks, and a concomitant proposal to reduce sulfur levels in fuels. Research will again play a key role in making these approaches effective mitigation strategies.

NLEV rule was promulgated by EPA in December 1997 after extensive debate and negotiation with national experts and state and local officials. The program allows for states to voluntarily adopt new vehicle standards starting with model year 1999 in some northeastern states and 2001 in others. Will the projected, emissions decreases be realized or will changes in the ways that Americans buy and use vehicles, as well as in how long they hold on to their cars, cause shifts in the actual reductions? How far can NLEV program take us toward attainment of the new standards? And finally, are there other factors that could affect the final result? Research is necessary to monitor progress in implementation in areas like expected versus actual fleet turnover, in-use emissions characterization, increasing demand for travel, and other market characteristics that could affect whether predicted emissions declines are realized.

Another recent regulation also shows promise in reducing transportation-related emissions. Although increasingly stringent automobile standards have yielded enormous benefits, relatively little attention has been paid to the heavy-duty engines associated with bus and truck fleets. Research shows that these engines account for only 6 percent of the VMT in the country, but they emit 40 percent of the oxides of nitrogen (NOx). As with the NLEV program, research will play an important role in ensuring that targeted reductions are realized and in finding new ways to make this regulation even more effective.

Looking further in the future, there are plans for even cleaner engines and fuels. EPA, building on regulatory efforts already being tested in California, proposed in May 1999 new Tier II emissions standards, which would affect all new car sales in the nation starting with model year 2004. EPA also plans to call for a first-time-ever reduction in the sulfur content of fuels. Sulfur in fuels accumulates in the engine’s catalytic converter over time and substantially reduces the catalytic converter’s effectiveness in reducing the engine’s emissions. Lower sulfur content, such as in the requirements for fuels in California, could mean lower emissions rates from mobile sources nationally. Finally, onboard diagnostic systems designed to ensure that new vehicles continue to remain clean throughout their in-use lifetime are being required for all new vehicles. Long-term research on effectiveness of these efforts will be ongoing.

But can we implement all of these technological measures to their full level of effectiveness, and what will the true costs be? Will they solve the mobile source pollution problem, or will more work be necessary? To optimize these plans and programs, it is vital that the transportation research community be intimately involved not only to monitor and evaluate these strategies, but also to identify potential roadblocks to their implementation and find solutions. All of this requires a better understanding of the vehicle fleet.

Global Warming

Since at least the early 1980s, concerns have been raised about the possibility that the combustion of fossil fuels and release of anthropogenic hydrocarbons may be causing global temperatures to rise. The United States was a signatory at the Rio Convention in 1992 to voluntarily reduce these greenhouse gases (GHG), and attention to the importance of the phenomenon has grown over the years. The International Panel on Climate Change, a body of 2,500 scientists sponsored by the United Nations, found in its Second Assessment on Global Climate Change that the "weight of evidence suggests a discernible influence" of human activity on global warming.

The Kyoto Agreement of December 1997 proposed to set binding emissions reduction targets for the developed nations of the world. The target set by the Kyoto protocol is 7 percent below 1990 levels for the United States as a whole. Such a large GHG reduction target will be very challenging for the transportation community in light of VMT growth. According to U.S. Department of Energy estimates (which use very modest estimates for VMT growth of 1.5 percent annually), carbon dioxide emissions from transportation sources will increase about 34 percent between 1995 and 2010. This increase means that the U.S. target of 7 percent reduction below 1990 levels translates into about a 40 percent reduction by 2010.

The differences of scale and scope between GHG and criteria pollutants pose vast challenges to the transportation research community. Although previous experience with criteria pollutants can guide our research efforts to better identify the problem and cost-effective mitigation strategies, the solution to reducing GHG is on a much larger scale. Solutions may require a restructuring of the way we view transportation because our entire transportation network is based on the burning of fossil fuels. The secondary impacts of such a radical change, particularly those affecting the nation's economy and the quality of life of its citizens, will also need to be examined closely and in great detail.

As a research question, the potential for global warming cannot be ignored. Even if the Kyoto protocol is not ratified by the U.S. Senate, the scientific concerns, the potentially devastating impacts, and the longevity of the issue to date virtually ensure that it will demand the attention of the research community. Research will be needed to address all aspects of the way that we provide transportation facilities and services, the institutional relationships between the various public agencies and stakeholders within the transportation and environmental communities, and their social, economic, and political ramifications. At the very least, research must focus on how to provide near-term, cost-effective, simultaneous reductions in primary pollutant and GHG emissions.

Potential of New Technologies

Technological advances are always on the horizon, and many of these advancements may have the potential to meet the nation's mobility needs and improve the environment. Technologies such as alternative fuels and fuel cells are nascent and require further research and development to make the technology feasible and further refinement and investment to make them competitive with the existing gasoline and diesel technologies.

Alternative fuels, such as electricity, natural gas, propane, and alcohols (ethanol and methanol, for example), may have characteristics that make them attractive as potential replacements for gasoline and diesel fuels. Electricity and natural gas, for example, demonstrate very favorable emissions characteristics as a means of reducing criteria pollutants. Alcohol fuels, particularly if developed from renewable sources like biomass, may have the potential to reduce transportation-related GHG (provided fuels are processed and transported using biomass fuels). Yet these fuels all face technological and economic barriers to entry in the marketplace and ultimate use.

Two of the most promising new approaches currently on the horizon are hybrid electric vehicles and fuel cell technology. Hybrid electric vehicles use an electric motor, batteries, and a smaller internal combustion engine as the power source and may increase fuel economy greatly and reduce emissions. Hydrogen fuel cell technology derives its electrical power from the chemical combination of hydrogen and oxygen, emitting only water vapor. These highly attractive systems are still in their formative stages and whether car manufacturers and researchers can make them competitive remains to be seen.

Can new technologies help society address environmental problems? Are they likely to overcome the hurdles they face and become cost- and convenience-competitive and will the American people accept them? How can we model their impacts? What are their in-use characteristics; that is, for how long can we expect air quality benefits to accrue? Research by TRB’s Transportation and Air Quality Committee, Energy Committee, Alternative Fuels Committee, and the transportation community at large will help to answer these questions.

CONCLUSIONS

This is an exciting time to work in the transportation and air quality arena. The legislative and regulatory process is in a continual state of flux as new ideas are generated and more is learned about what works and what does not. The research element has been and will continue to be a crucial part of enhancing our basic understanding of the relationship between transportation and air quality and developing good policy that furthers national environmental and mobility goals. Research also needs to be performed on transportation planning issues such as travel demand and driver behavior that touch on virtually every aspect of American life. The research that the Transportation and Air Quality Committee will foster over the next 10 years will provide considerable progress toward understanding these complex relationships.

ACKNOWLEDGMENT

The author thanks the following for contributions to this paper: Chris Saricks, John German, John Suhrbier, John Zamurs, Paul Wentworth, and Randall Guensler.