October 29, 1999

Mr. Rich Cook
Assessment and Modeling Division / SAG
U.S. Environmental Protection Agency
2000 Traverwood Drive
Ann Arbor, MI 48105

Dear Mr. Cook:

The health impacts of air toxics is a priority concern for the air pollution control programs in the northeast states. Monitoring data and modeling studies, such as the cumulative exposure project, consistently point to mobile source-generated pollutants as the primary threat to public health from exposure to hazardous air pollutants. Consequently, the Section 202(l) assessment of motor vehicle-related air toxics is of significant interest to our member states. NESCAUM provided comments on the USEPA's 1993 Draft *Motor Vehicle Related Air Toxics Study* and has closely tracked the Section 202(l) study since that time. The northeast states appreciate the opportunity to provide further input by participating in the peer review of the Draft study *Estimation of Motor Vehicle Air Toxic Emissions and Exposure in Selected Urban Areas*.

NESCAUM's review and comments include: (1) a general assessment of the accuracy and appropriateness of the methodologies and assumptions used by Sierra Research; (2) a summary of ambient concentrations of mobile source-related toxins; (3) a compilation of toxics inventory data for the Northeast by pollutant and vehicle type; (4) a review of the HAPEM model; (5) a comparison of predictive risk between regional average and urban exposures; (6) a legal assessment of Section 202(l) with regard to the inclusion of nonroad sources; and (7) a feasibility assessment for additional benzene controls.

On behalf of the eight member states, we thank you for this opportunity to review and provide early comment on the study methodology and approach. If you have any questions regarding these comments and suggestions, please feel free to contact Drew Kodjak, Melinda Treadwell or Coralie Cooper on my staff. NESCAUM looks forward to the completion of the Section 202(l) study and rulemaking.

Sincerely,

Jason S. Grumet
Executive Director

Executive Summary
NESCAUM Peer Review
US EPA's DRAFT *Estimation of Motor Vehicle Toxic Emissions and Exposure in Selected Urban Areas*.
October, 1999

Introduction

NESCAUM appreciates the opportunity to peer review the US EPA's DRAFT *Estimation of Motor Vehicle Toxic Emissions and Exposure in Selected Urban Areas*. We understand that this document is intended to update the 1993 Mobile Source Air Toxics Study and will serve as the basis for an April, 2000 notice of proposed rulemaking on motor vehicle air toxics. As part of its peer review process, EPA asked NESCAUM to review the methodologies (e.g., emissions modeling and exposure estimates) and assumptions underlying the documents prepared by Sierra Research for EPA. You also requested that NESCAUM distinguish between two types of recommendations for improvement: those that can be made with existing data, and those that are more theoretical in nature.

NESCAUM's review and comments include: (1) a general assessment of the accuracy and appropriateness of the methodologies and assumptions used by Sierra Research; (2) a summary of ambient concentrations of mobile source-related toxins; (3) a compilation of toxics inventory data for the Northeast by pollutant and vehicle type; (4) a review of the HAPEM model; (5) a comparison of predictive risk between regional average and urban exposures; (6) a legal assessment of Section 202(l) with regard to the inclusion of nonroad sources; and (7) a feasibility assessment for additional benzene controls.

This executive summary is divided into three parts. In the first section, NESCAUM reports the findings of its assessment of the accuracy and appropriateness of EPA's methodologies and assumptions. At the outset, it is important to note that NESCAUM's review of the Congressional intent behind section 202(l) and the air toxics provisions of the 1990 Amendments strongly suggests that EPA should reconsider its source-specific approach to its public health needs assessment. After careful examination of all relevant data and information, we found that the Draft *Estimation of Motor Vehicle Toxic Emissions and Exposure in Selected Urban Areas* is relatively well supported in its estimate of motor vehicle air toxic emission factors. However, the exposure analysis requires additional attention in order to insure that it is both accurate and produces adequately protective results.

Second, NESCAUM recommends an alternative methodology that might enable the Agency to improve upon its exposure analysis. The methodology used by EPA relies on emissions and exposure models to determine average mass emissions, average population exposure and ultimately risk for a certain segment of the population. NESCAUM's alternative methodology is based on a broader reading of section 202(l), relies on ambient monitoring data in addition to emissions modeling, and seeks to pay special attention to

accurately estimating the high and low ranges of risk. The two approaches are likely to generate significantly different results.

Finally, NESCAUM performed a rudimentary feasibility assessment of further controls on benzene content of gasoline. We have long recognized that benzene emissions dominate the mass emissions of motor vehicle air toxics. Substantial overcompliance with the one-percent benzene cap in federal reformulated gasoline demonstrates that reductions in the benzene content of gasoline are highly likely to be cost effective and feasible.

I. EPA's Risk Assessment Methodologies for Motor Vehicle Air Toxics

EPA's current approach includes a five-step process, outlined below.

(1) VOC Emission Rates. This step aimed to estimate current and future VOC emissions from on-road mobile vehicles for nine urban areas. The MobTox emissions model and the Complex model were used in this portion of the analysis for on-road vehicles. The Part 5 model was used to estimate particulate emissions from on-highway diesel trucks. Sierra Research and EPA developed area-specific inputs for the models for fuels, fleet mix, age of the fleet, and a host of other factors. The Mobile and Complex models are based on thousands of data points, and represent the strongest part of the analysis. However, these models are heavily dependent on the accuracy of the input files. Examples of inaccuracies due to generalized or overly optimistic inputs are described later in this summary, and in more detail in the full peer review document. The Part 5 model is not based on sufficient data points and should receive extensive review and revision.

(2) Toxic Emission Rates. This step estimated the toxic fraction of VOC emissions for each of the five mobile source air toxics in this analysis (not including particulates). This process is relatively straightforward and based on available speciation studies.

(3) CO Emission Factors and Exposure Estimates. CO Emission Factors were developed for each of the nine urban areas for 1990. Public exposure to ambient concentrations of carbon monoxide emissions was calculated previously for the nine urban areas for 1990. A relatively unsupported assumption in this analysis is that exposure to ambient concentrations of CO is proportional to air toxic emissions. For example, CO is a combustion by-product, and so evaporative emissions of benzene and MTBE (e.g., during refueling or while parked in an attached garage) are not captured when CO is used as a surrogate for exposure to air toxics.

(4) Exposure Estimates. Exposure is a function of time and the concentration of a particular substance. In the case of air toxics, there are no direct measurements of exposure to a given population. In order to remedy this data gap, carbon monoxide was as a surrogate for air toxics in order to generate exposure estimates. Total exposure to on-road motor vehicle air toxic emissions was determined by estimating total exposure to

CO emissions, and then subtracting that portion of CO emissions that are not emitted by on-road motor vehicles.

The HAPEM-MS3 sub-population exposure model performed this segment of the analysis. Using CO as a proxy for air toxics, the model takes limited time-activity data that represent the movement of sub-populations in and out of various microenvironments. The majority of the datasets are from middle-income, Caucasian Americans. NESCAUM has grave concerns about the ability of this model, in its present form, to generate exposure estimates that truly represent real world exposure to mobile source air toxics. Our comments on the HAPEM-MS3 model appear later in this summary, and in the body of this peer review document.

(5) Characterization of Risk to Public Health. Cancer incidence predictions due to exposure to on-road motor vehicle air toxic emissions are then generated by applying cancer unit risk factors to the mass exposure estimates generated with HAPEM-MS3. This final step in the analysis was not completed in the documents sent to NESCAUM for peer review.

II. Examination of Methodologies and Assumptions

This portion of the NESCAUM peer review identifies areas of where NESCAUM believes the draft study would benefit from additional staff attention. Four areas are identified: Scope of the Needs Assessment, On-Road VOC and Air Toxic Emission Factors, Contribution from the Non-Road Sector, and the HAPEM-MS3 Model.

Scope of Needs Assessment

NESCAUM performed legal research to determine whether a) section 202(l) of the Clean Air Act requires the Agency to limit its needs assessment to the risk posed by on-road motor vehicles or b) this section allows the Agency to perform a broader needs assessment of the total risk from ambient concentrations of benzene, 1,3-butadiene, acetaldehyde, formaldehyde, MTBE and particulate.

The Congressional intent behind the 1990 Amendments is clear on the subject of air toxics. The Agency was directed to aggressively assess the risk to public health from air toxics and then use its substantial authority under the Act to reduce those risks. Instead, in its current draft of the update of the 1993 mobile source air toxic study, the Agency has chosen to interpret the Act to require a source-specific risk assessment from on-highway motor vehicles. This is a significant departure from the Agency's traditional rule making methodology. For example, the Tier-2 rule proposal estimated the total risk from ambient levels of ground-level ozone and fine particulate to determine whether additional motor vehicle controls were necessary. Furthermore, this source-specific approach also runs counter to the ambient air toxics risk comparisons recently completed as part of EPA's cumulative exposure project (CEP). Finally, since the Agency's mandate is to protect public health and the environment with an adequate margin of safety, all regulatory decisions should be based upon the total risk to the public and the environment from ambient levels of the pollutants in question.

An alternative reading of this section would require the Agency to perform a needs assessment based on ambient concentrations of air toxics from all sources, and then determine the contribution from motor vehicles. EPA has the option of choosing to regulate on-road motor vehicles under section 202(l) and to exercise its authority under 202(a) of the Act to also regulate emissions from non-road gasoline and diesel vehicles. This approach is consistent with the Congressional mandate that EPA use all of its authority under the Act to control HAPs from motor vehicles and to reduce the risk posed by ambient levels of HAPs in urban areas.

On-Road VOC and Air Toxic Emission Factors

While NESCAUM compliments the Agency and Sierra Research on this solid portion of the analysis, there are two assumptions that result in significant under estimation of mass VOC and toxic emissions from mobile sources in the Northeast. First, the input files used in MobTox to generate air toxic emission factors apparently underestimate exhaust toxic emissions by about 30%. NESCAUM recommends that the Agency use the mobile model input files provided to the Agency by each state in its SIP submission. These state-based analysis are often the result of hundreds of separate mobile model runs, which the Agency cannot hope to duplicate within its time and resource constraints.

Second, the use of region-specific RFG fuel properties takes credit for the present overcompliance with the RFG toxic performance standards. This margin of overcompliance is likely to diminish or disappear with the expected phase down or ban of MTBE in gasoline. NESCAUM recommends that EPA use the regulatory toxic performance standards for RFG Phase II instead of region-specific fuel properties. This will not only save the Agency significant time and resources, it also offers a more conservative, and unfortunately realistic, version of the future.

Contribution from the Non-Road Mobile Source Sector

Although light duty gasoline vehicles were the dominant source of motor vehicle air toxic emissions in 1990, available modeling suggests that the non-road motor vehicle sector is expected to replace the on-road sector as the largest source of air toxic emissions from the mobile sector by 2005. In 1996, non-road vehicles and equipment accounted for about 50% of the benzene and 1,3-butadiene emissions in rural states, and 20 to 35% in urban states in the Northeast. Non-road gasoline and diesel vehicles and equipment were the dominant source of acetaldehyde and formaldehyde emissions in rural and urban states in the Northeast in 1996. Non-road diesel engines are projected to contribute up to 70% of the total mobile source particulate emissions by 2010. A thorough assessment of the impact of these changes on air toxic emissions from the non-road motor vehicle sector is critical to future air toxic emission risk assessments.

HAPEM-MS3 Model

NESCAUM has significant concerns regarding the ability of the HAPEM-MS3 model to develop accurate exposure estimates. A primary concern is the use of this carbon monoxide exposure model to assess population exposure to potent carcinogenic HAPs such as benzene and 1,3-butadiene. The use of carbon monoxide as a surrogate has

received critical comments when HAPEM-MS was peer reviewed following the 1993 study. The assumption that HAP concentrations are proportional to carbon monoxide concentrations is an uncertain assumption for all HAPs evaluated in this study except benzene. A more direct assessment of HAP concentrations and resulting exposure that would not rely upon the carbon monoxide surrogate would be a significant improvement.

Another concern is the use of single point estimates for exposure to the different population groups. The results of the HAPEM-MS3 modeling would be enhanced with the provision of information regarding the population variability and the user inputs provided to the HAPEM-MS3 model to assess important exposure groups. This analysis and appropriate regulatory decision-making would be strengthened by a qualification and quantification of the data distribution around the point estimates provided for our peer review.

The next concern is the narrow geographic and demographic scope of the data sets. The use of time-activity diaries that represent 3568 person days of activity, addressing activity in the early 1980's from November to February in Washington, DC and Denver, C0 and the months of March and August in Cincinnati, OH have uncertain applicability to the nation as a whole. The seasonal and social pattern variability across the country is not likely to be accurately reflected in this narrow dataset. Furthermore, of the 23 demographic groups represented by these time-activity diaries, the Agency's own statements acknowledge that, "[i]t would be difficult to execute HAPEM-MS3 on any race/income level combination other than Caucasians in the middle income level.[1]" Considering that the most important sub-populations to accurately characterize with respect to exposure to ambient motor vehicle emissions will be partially composed of non-Caucasian, non-middle income individuals residing in densely populated urban areas, this limitation of the time-activity datasets is critical. The Agency should consider supplementing the existing Washington, Denver, and Cincinnati time-activity diary studies with more recent, widespread, and comprehensive analyses.

Finally, the exposure assessment provided by the HAPEM-MS3 model is limited by the selection of relatively unjustified microenvironmental factors. Little supporting documentation was provided for the 34 microenvironmental factors (developed during 1984 in Washington and Denver studies referenced above) used in this assessment. However, in the sensitivity analysis conducted during this project, the Agency identified that the selection of a microenvironmental factor could affect the resulting exposure estimate by as much as 3-fold. Considering the significant impact of these factors, the Agency must provide a more detailed justification for the factors used in the modeling and a quantification of the impact on the ultimate exposure estimation with HAPEM-MS3. It concerns NESCAUM that the additive (non-ambient or microenvironmental-generated concentrations) factor to assess microenvironmental exposure was arbitrarily set to zero for this analysis. A more thorough analysis of microenvironmental concentrations of HAPs, particularly in the commuting vehicle and in the residential-attached garage scenario is necessary. It would also be informative to clarify how, when

[1] Development and Evaluation of Enhancements to the Hazardous Air Pollutant Exposure Model (HAPEM-MS3). T. Palma et al. Contract No. 68-DO-30094, September, 1996.

assessing exposures to ambient HAPs, the multiplicative factor (addressing infiltration of ambient concentrations into less various microenvironments) is less than 1 for all environments, including the roadside microenvironment, whereas the indoor shopping mall multiplicative factor was greater than two (2). The apparent discrepancies raise significant concerns regarding the adequacy and appropriateness of these very important factors in their assessment.

Given the concerns raised above, it is not surprising that EPA's defined sensitive population groups– children and outdoor workers – are either less exposed than the average worker, or only 20% more exposed. It is likely that the paucity of time-activity diary data to represent these sub-populations (368 person-days for outdoor children and 50 for outdoor workers), coupled with microenvironmental factors that aren't appropriate to assess outdoor exposures or the true infiltration of ambient HAP concentrations, has resulted in an underestimation of average population exposures for these groups.

III. Alternative Methodology

NESCAUM's suggested alternative methodology is based on three principles: (1) any public health risk assessment performed by the Agency should include total risk associated with exposure to ambient concentrations of the pollutants in question, (2) outdoor concentrations of air toxics represent the minimum continuous exposure level for all exposure / risk segments of the population, and (3) EPA should generate high and low estimates of population exposure and risk in order to adequately protect the most sensitive, and highly-exposed, portions of the general population. Also included in NESCAUM's comments is a summary of justifications for additional controls on benzene content in gasoline. The following provides a background and justification for the methodology:

<u>Ambient Concentrations of Air Toxics Far Exceed Risk Standards.</u>
Quality assured ambient monitoring results collected by the Northeast states throughout the 1990's show that even the lowest measured outdoor concentrations of benzene, 1,3-butadiene, acetaldehyde and formaldehyde in the Northeast region exceed established health protective guidelines, in most cases by several orders of magnitude.

<u>Outdoor Concentrations Represent a Minimum Exposure Level.</u>
Research has shown a 100 percent infiltration of volatile organic compounds and certain particulate matter species from the ambient environment into various microenvironments. Therefore, ambient concentrations of important air toxics such as benzene will generate a reasonable baseline of continuous exposure when considering individual or population movement through various microenvironments. Levels of air toxics in the vehicle cabin while driving in traffic, when refueling, and when living in a home with an attached garage, are three to five times greater than typical ambient levels. These concentrations result from direct microenvironmental emissions or concentrations within the microenvironment due to decreased clearance of ambient concentration infiltration. Exposure estimates based on the assumption of continuous exposure to ambient

concentrations of air toxics such as benzene, acetaldehyde, formaldehyde, and 1,3-butadiene will be expected to represent the low predicted risk posed to public health.

Cancer Incidences Due to Exposure to Air Toxics are Significant in the Northeast.
NESCAUM calculated lifetime additional cancer incidences from four motor vehicle air toxics (benzene, 1,3-butadiene, formaldehyde and acetaldehyde) for the New York City population in 1996. While NESCAUM believes that the Agency should estimate risk from ambient concentrations of air toxics, our estimates are based risk from motor vehicles (on-road and non-road). We chose to segment the risk by this large category of emissions sources because of their overwhelming contribution, and because EPA seems interested in only looking at emissions from sources that it has the authority to regulate under section 202 of the Clean Air Act. While we do not agree with this self-created limitation, it does not play a large role in our risk estimates. The total additive risk from the four mobile source air toxics in question was estimated at 870 cancer incidences annually in the New York City metropolitan region alone.

NESCAUM's additional cancer incidence estimate for New York City represents the low-end bound of risk estimates. It does not take into account the highest ambient concentrations of air toxics. It does not take into account those portions of the population that may be come into contact with prolonged exposure to microenvironments with elevated levels of air toxic concentrations (e.g., long commutes, residence near heavily-trafficked areas, frequent refueling, homes with attached garages). And it does not account for those portions of the population that are especially sensitive to air toxics, such as women and children.

Proper Risk Quantification Procedures are Critical to Accurate Assessment
In general, we suggest that the Agency focus on the importance of quantifying ranges for each of the three factors that determine risk: (1) concentrations of air toxics in the ambient air and in various microenvironments, (2) duration of exposure to air toxics by the general population and by highly-exposed sub-populations, and (3) reaction by the average person and by especially sensitive individuals. In order to establish an adequate margin of safety for public health, the Agency should assess the high end of risk estimates. A previous NESCAUM analysis found that risk from benzene emissions ranged from a low daily dose of about 25 μg/day to a high of 170 μg/day.[2] The high-end exposure estimates were due to including personal exposure to high ambient concentrations, and significant exposure to microenvironments such as commuting, refueling, and inhabiting a home with an attached garage. Due to resource and data limitations, EPA's current assessment uses averages instead of ranges for each of these three factors. The use of averages for each calculation may result in dramatically lower risk than is actually experienced by large portions of the population. Consider the following examples:

[2] *RFG/ MTBE: Findings and Recommendations (August, 1999),* Attachment I, at 34, Figure 6.

- Ambient concentrations of benzene range from approximately 0.5 $\mu g/m^3$ to 2.8 $\mu g/m^3$ in the Northeast[3]; EPA has chosen a fixed-point estimate of benzene using fixed site monitored carbon monoxide. In microenvironments, EPA's draft assessment sets concentrations in a commuting vehicle at less than concentrations in the ambient air, while a recent California study found in-cabin concentrations of air toxics ranging from three to five times ambient concentrations.[4] Similarly, along a public roadway, EPA estimates ambient concentrations 15% less than ambient while published studies monitor ambient levels at several times ambient levels.

- The duration of exposure to air toxics in the ambient air and in certain microenvironments depends on a person's movements throughout the day. In order to accurately assess this HAPEM uses daily activity logs. However, as noted above, the poor scope of these logs create quantification problems because the population of interest is not likely to be from the same socio-economic background as the Caucasian, middle class respondents used for in HAPEM. Because of this, the Agency should consider supplementing the existing studies with more recent and comprehensive analyses.

- Women, children and individuals with health complications are considered sensitive populations due to the biological variation from women; higher respiratory rate, microenvironment occupancy differences, metabolic differences, and pre-existing health complications.

Future reductions in VOCs generated by on-road motor vehicles are significant, but when the entire motor vehicle inventory is included (on-road and non-road), the future reductions have less of an impact. According to OTAG data using 1990 as a baseline, air toxic emissions are expected to decline by about 50 percent by 2005, in large part due to the phase in of the new vehicle standards and RFG. The Tier 2 motor vehicles standards and low sulfur gasoline is primarily focused (not inappropriately) on NOx reductions, and is only expected to reduce VOC emissions from on-road motor vehicles by about 20%. On-road VOC emissions will be less than half of the total mobile source VOC inventory after 2005. Given the fact that ambient concentrations of mobile source air toxics are exceeding health protective risk levels by several orders of magnitude, the NLEV and Tier 2 programs are not expected to result in a significant change in the public health threat posed by ambient concentrations of air toxics in the Northeast. At this time, it is also important to acknowledge in all of this discussion – no assessment of non-cancer risks has been completed. It is critically important that EPA develop tools to address non-cancer risks associated with air pollution – particularly potent respiratory irritants such as acetaldehyde and formaldehyde.

[3] Id., at 19, Figure 3.
[4] Mea*suring Concentrations of Selected Air Pollutants Inside California Vehicles*, California Environmental Protection Agency, Air Resources Board, December, 1998.

IV. Benzene Control

Benzene emissions dominate the air toxic mass emissions and potency-weighted cancer risk from gasoline combusted in motor vehicles. Even with the substantial overcompliance with the 1% by volume benzene cap in the Northeast RFG pool, relative cancer risk from benzene emissions are about three times greater than the relative cancer risk from 1,3-butadiene, the next largest source of cancer risk from mobile source air toxic emissions. In addition, the Northeast states spend millions of dollars each year to clean up of gasoline spills are largely driven by benzene due to its very stringent remediation standard. Substantial overcompliance with the 1% by volume benzene cap in RFG sold in the Northeast demonstrates that additional reductions are cost effective and feasible.

V. Conclusion and Recommendations

Congress has rarely spoken with a clearer voice than when it instructed the Agency to aggressively assess the risk from ambient levels of air toxics and then to regulate. With such a strong mandate, NESCAUM urges the Agency to broaden its risk assessment to ambient levels of air toxics, or at a minimum, those ambient levels of air toxics directly related to on-road and non-road motor vehicles. This assessment should build upon the Agency's strengths, such as its emissions modeling for motor vehicles, and seek to improve upon the exposure assessment. When the Agency seeks to determine what types of air toxic emission reductions are cost effective and feasible, at a minimum, EPA should seriously consider establishing new controls on benzene content of motor fuels.

Section I: Legal Analysis of Section 202(l)

Issue

Whether section 202(l) of the Clean Air Act requires the Agency to limit its needs assessment to the risk posed by on-road motor vehicles, or whether this section allows the Agency to perform a broader needs assessment of the total risk from ambient levels of air toxics (e.g., benzene, 1,3-butadiene, and formaldehyde) associated with motor vehicles.

Answer in Brief

The statutory language of section 202(l) and its legislative history leaves the Agency free to decide whether to perform a narrow public health needs assessment limited to emissions from on-road motor vehicles, or to perform a broader needs assessment based on ambient air concentrations of benzene, 1,3-butadiene, formaldehyde, acetaldehyde, MTBE and particulates. Since the Agency's purpose is to protect public health and the environment with an adequate margin of safety, EPA should seriously consider broadening the scope of its public health needs assessment to include the total risk from ambient levels of air toxics. In its legislative history, Congress instructed EPA to "broadly characterize the urban air toxic problem by conducting ambient monitoring" in order to determine the "true scope of the problem."[1] At a minimum, the Agency should determine the risk not only from on-road motor vehicles, but from non-road motor vehicles as well, since the non-road sector is projected to account for more than half of the air toxics problem in the next decade (see Section II, *Hazardous Air Pollutants from On-Road and Non-Road Vehicles*).

Discussion

Section 202(l) of the Clean Air Act is relatively silent on the issue of how the Agency should perform its public health needs assessment. There are at least two reasonable interpretations. The Agency has chosen to read section 202(l) as requiring a limited, source-specific needs assessment of on-road motor vehicle air toxic emissions. Another reasonable reading of this section would direct the Agency to perform a more comprehensive public health needs assessment of ambient concentrations of air toxics typically associated with motor vehicles. While both readings are reasonable, the second would better accomplish the Agency's primary purpose to protect public health and the environment. As described in more detail in Section II, a substantial portion of air toxic emissions from mobile sources after 2007 are projected to come from the non-road sector, which is not addressed under the Agency's current reading of the Act.

[1] Senate Report No.l 101-228, 101st Cong. 2d. Sess. , reprinted in 6 U.S.Code Cong. & Admin. News, pp. 3574 (1990).

Statutory Language

The Clean Air Act requires the Agency to produce a study on the "need for, and feasibility of, controlling emissions of air toxic pollutants which are . . . associated with motor vehicles and motor vehicle fuels (sec. 202(l)(1))." The Act instructs the Agency to focus on "those categories of emissions that pose the greatest risk to human health." Section 2020(l)(2) then directs the Agency to "promulgate regulations . . . to control hazardous air pollutants from motor vehicles and motor vehicle fuels." These standards – at a minimum for benzene and formaldehyde – should "reflect the greatest degree of emission reduction achievable through the application of technology which will be available." In short, sections 202(l)(1) and (2) establish a two step process: (1) determine the risk to public health posed by benzene, formaldehyde and other air toxic pollutants associated with motor vehicles, and (2) establish technology-based vehicle and/or fuel standards.

Legislative History

Section 202(l) of the Clean Air Act originated as Section 206 of the House version of the 1990 Amendments. The Senate bill contained no comparable provisions, and the Conference agreement adopted the House provision.

Section 202(l) gives the Administrator no choice but to regulate, at a minimum, mobile source air toxic emissions of benzene and formaldehyde. The Bush Administration sought to relax this provision in order to allow the Administrator discretion in regulating benzene and formaldehyde. Congress rejected the Administration proposal, which demonstrated its strong desire to ensure that EPA regulates benzene and formaldehyde emissions from motor vehicles. Absent a statutory mandate, Congress was clearly skeptical of EPA willingness to follow through with such regulations.

There is little in the House debate to shed light on whether section 202(l) contemplates a source-specific, or an ambient air quality, needs assessment. The only reference to the study states: "EPA is to study the need to regulate air toxics for motor vehicles and fuels."[2] This language does not limit the scope of the needs assessment to only that risk from emissions generated from on-road motor vehicles. Without such an explicit limitation, EPA may reasonably interpret this language to require an ambient air quality needs assessment since the Agency's primary purpose is to protect public health and the environment from all sources of pollution.

In addition, there is evidence from the legislative process to support the notion that Congress deliberately decided that EPA should conduct a public health needs assessment based on air toxic concentrations found in ambient air. The Senate and the House

[2] Senate Debate on Conference Report, Oct. 27, 1990, A Legislative History of the Clean Air Act Amendments of 1990, Congressional Research Service, Library of Congress, Vol. VI, pp. 889 (1993).

versions of the 1990 Amendment each contained mobile source air toxics provisions. The Senate version was found in section 112(k), which sought to quantify the public health threat from ambient levels of air toxics, especially in urban areas, and to reduce those emissions and associated risks through reductions in emissions from area sources. Motor vehicles were included in the definition of area sources in the Senate bill. The particular provision related to mobile source air toxics was drafted narrowly, perhaps because other provisions within section 112(k) required a comprehensive public health risk assessment of air toxics. The provision related to mobile sources stated:

> The Administrator is to report to Congress on the health impacts of mobile source benzene emissions, including consideration of the fuel and vehicle-based strategies, which would reduce significantly public health risks associated with such emissions.[3]

The House provision on mobile source air toxics (section 206, the predecessor of section 202(l)) was considerably broader and more explicit. At a minimum, it required the Agency to establish new standards for benzene and formaldehyde, rather than just report to Congress. The scope was expanded from benzene to all air toxics associated with motor vehicles. It required a study to determine those "categories of emissions" that posed the greatest risk to public health, and did not presuppose that benzene reductions were sufficient to address the public health risk from air toxics.

The Conference committee was faced with a choice between a study of motor vehicle benzene emissions, and a broader provision that required the Agency to study the air toxics problem associated with motor vehicles, and then regulate. If Congress had intended to narrow the scope of EPA's traditional needs assessment methodology, it would have chosen to adopt section 112(k) of the Senate version. Instead, Congress selected the broader House version. EPA should read this history as a demonstration of Congress's desire for the Agency to perform a public health needs assessment based on ambient air concentrations of air toxics associated with motor vehicles, and then to regulate.

When seeking to determine its course of action, EPA may want to consider the tone of Congress's statements surrounding section 112(k), which at the time included mobile sources in the definition of area sources. Congress characterized EPA's previous efforts in the area of regulating air toxics as "this record of false starts and failed opportunities."[4] It stated explicitly:

> The Environmental Protection Agency has not made sufficient use of the existing authorities available under section 112 of the Clean Air Act to protect public health.[5]

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[3] Senate Report No.l 101-228, 101st Cong. 2d. Sess. , reprinted in 6 U.S.Code Cong. & Admin. News, pp. 3576 (1990).
[4] Id., at 3517.
[5] Id., at 3517.

Clearly, Congress was not pleased with the Agency's performance in regulating air toxic emissions. The legislative history notes that in the 18 years of administering section 112, EPA had listed only eight pollutants. Included in the legislative history are quantifications of individual lifetime risks for selected cities from various HAPS (Figure III-5, III-6), that used ambient air quality to determine risk from each pollutant. The vast majority of discussions about air toxics in the Senate and House focused on total risk from ambient concentrations of toxics.

Importantly, Congress stated that the purpose of the area source control program was to assess risk from ambient monitoring of HAPs. EPA was to determine the risk posed by ambient levels of HAPs in urban areas in order to protect public health.

> EPA is to broadly characterize the urban air toxics problem by conducting ambient monitoring for a broad range of pollutants in a representative group of urban areas. Studies reported to date typically analyze emissions or ambient data for a small number of pollutants. The true scope of the problem cannot be determined from these studies. . . . Sampling for the broadest range of pollutants . . . in 25 to 35 cities would be appropriate.[6]

Once the true scope of the problem was characterized by ambient monitoring, the Agency was instructed to "characterize the pollutant loadings measured with special emphasis on determining the contribution of various area source categories to urban ambient concentrations.

The general intent of section 112, and presumably 202(l), was to equip the Agency with sufficient statutory tools to reduce emissions from those air toxic pollutants that pose the greatest risk to public health. Congress found that Agency's past inaction was due, in part, to the statutory requirement that air toxic standards must be set to protect the public with an adequate margin of safety. In most cases, there is no threshold below which exposure to a carcinogen does not pose a health risk. Further, the Agency was barred from considering costs when making its determination of how stringent to set an air toxics standard. Thus, the Agency was placed in an untenable position: establish new air toxic standards that might put certain industries out of business, or do nothing. To rectify matters, Congress decided to make fundamental changes to the basic provisions of section 112 by shifting from health-based standard setting to technology-based standard setting for air toxics. This new approach is evident in section 202(l), which requires a threshold needs assessment, and then standards based on levels that are technologically feasible. Congress wanted no more excuses from the Agency.[7]

[6] Senate Report No.l 101-228, 101st Cong. 2d. Sess. , reprinted in 6 U.S.Code Cong. & Admin. News, pp. 3574 (1990).
[7] Id., at 3518.

Recommendation

The Congressional intent behind the 1990 Amendments is clear on the subject of air toxics. The Agency was directed to aggressively assess the risk to public health from air toxics and then use its substantial authority under the Act to reduce those risks. Instead, in its current draft of the update of the 1993 mobile source air toxic study, the Agency has chosen to interpret the Act to require a source-specific risk assessment from on-highway motor vehicles. This is a significant departure from the Agency's traditional rule making methodology. For example, the Tier-2 rule proposal estimated the total risk from ambient levels of ground-level ozone and fine particulates to determine whether additional motor vehicle controls were necessary. This source-specific approach also runs counter to the ambient air toxics risk assessment recently completed by EPA's cumulative exposure project (CEP). Finally, since the Agency's mandate is to protect public health and the environment with an adequate margin of safety, all regulatory decisions should be based upon the total risk to the public and the environment from ambient levels of the pollutants in question.

An alternative reading of this section would require the Agency to perform a needs assessment based on ambient concentrations of air toxics from all sources, and then determine the contribution from motor vehicles. EPA has the option of choosing to regulate only on-road motor vehicles under section 202(l), or to exercise its authority under 202(a) of the Act to also regulate emissions from non-road gasoline and diesel vehicles. This approach is consistent with the Congressional mandate that EPA use all of its authority under the Act to control HAPs from motor vehicles and to reduce the risk posed by ambient levels of HAPs in urban areas.

Section II: Inventory of Volatile Organic Compounds and Hazardous Air Pollutants in the Northeast

This section contains information on mobile source VOC and air toxic emissions in the northeast. As described in more detail in the following text and charts, available Ozone Transport Assessment Group (OTAG) modeling data predicts that the non-road motor vehicle sector will be the largest contributor of mobile source VOC and air toxic emissions after 2005. The previous section attempted to establish the legal case for EPA to include non-road motor vehicles in the update of its 1993 Mobile Source Air Toxics Study. This section seeks to demonstrate the importance of the non-road motor vehicle sector to current and future motor vehicle and fuel exposure and risk assessments. In addition, this section highlights the availability and reliability of sources of inventory data for the non-road sector.

The emissions inventory data provided in this section demonstrates the following:

- Although light duty gasoline vehicles were the dominant source of motor vehicle air toxic emissions in 1990, the non-road motor vehicle sector is expected to replace the on-road sector as the largest source of air toxic emissions from the mobile sector by 2005 (OTAG)

- In 1996, mobile sources accounted for 89% of the total acetaldehyde emissions, 88 % of the total benzene emissions, 80 % of the total 1,3-butadiene emissions, and 77 % of the total formaldehyde emissions in the Northeast region (USEPA Draft National Toxics Inventory, August 1996).

- In 1996, non-road vehicles and equipment accounted for about 50% of the benzene and 1,3-butadiene emissions in rural states and 20 to 35% in urban states in the Northeast. Non-road gasoline and diesel vehicles and equipment were the dominant source of acetaldehyde and formaldehyde emissions in both rural and urban states in the Northeast in 1996 (USEPA Draft National Toxics Inventory, August 1996).

- Non-road diesel engines are projected to contribute up to 70% of the total mobile source particulate emissions by 2010 (Notice of Proposed Rulemaking, Non-road Engines).

VOC emissions: On-Road and Non-Road

In 1990, light duty gasoline vehicles (LDGVs) dominated the mobile source VOC emissions inventory. However, emissions from this sector are expected to decline by about 74% from 1990 to 2005, in large part due to a combination of new motor vehicle standards (Tier 1, NLEV) and cleaner fuels (RFG, Phase I and II). Toxic emissions are a constant fraction of total organic compounds (TOG), and are expected to decline in similar fashion.

By 2005, VOC emissions from non-road gasoline vehicles replace LDGVs as the largest source of mobile VOC emissions. The non-road gasoline sector will account for about 45% of the total mobile source VOC inventory. In total, VOC emissions from the mobile source sector are expected to decline by about 50% from 1990 to 2005 in the Northeast. The first chart included in this section depicts emissions of volatile organic compounds in tons per year in the Northeast from 1990 and 2005.

Toxic Air Emissions: On-Road and Non-Road

1996 National Toxics Inventory, mobile sources[1]:

The National Toxics Inventory (NTI), compiled by the USEPA is a national repository of inventory data and estimated emissions for hazardous air pollutants and their sources. It was created by the Emission Factor and Inventory Group (EFIG) of the United States Environmental Protection Agency. EFIG consulted with the USEPA's Office of Mobile Sources in developing the emissions inventory for on-road and non-road hazardous air pollutant emissions. NESCAUM received this inventory on August 2nd and generated the figures in this section to represent the variable contribution of mobile source category members to the state-specific emission inventory totals represented here. The charts included in this section of the NESCAUM comments demonstrate the dominant contribution of mobile source emissions to the Northeast State inventories of acetaldehyde, benzene, 1,3-butadiene, and formaldehyde. Ambient concentrations of these compounds were predicted in earlier USEPA analyses to exceed health-protective thresholds in all areas of the region[2]. Please refer to the Ambient Air Toxics Section of these comments for more information regarding ambient air concerns in this region of the country. When developing the NTI Draft inventory, data were collected for the following emission sources:

On-road equipment would include:
Emissions were estimated using one of two approaches: on-road pollutant emissions were calculated using speciated data or vehicle miles traveled emission estimates. The following types of on-road vehicles were included in developing this emissions inventory:

1. Light-duty gasoline powered vehicles
2. Light-duty gasoline powered trucks (up to 6,000 lbs gross vehicle weight)
3. Light-duty gasoline powered trucks (from 6,000 – 8,500 lbs gross vehicle weight)
4. Heavy-duty gasoline powered vehicles
5. Motorcycles
6. Light-duty diesel powered vehicles

[1] Systems Applications International, Inc. Final report Volumes I and II: Modeling cumulative outdoor concentrations of hazardous air pollutants, February, 1998.
[2] Woodruff, T.J., Axelrad, D.A., Caldwell, J., Morello-Frosch, R., Rosenbaum, A. Public Health Implications of 1990 Air Toxics Concentrations across the United States. *Environmental Health Perspectives*, Vol 106, No. 5, 1998.

7. Heavy-duty diesel powered vehicles

Non-road equipment would include:
1. Locomotives
- Includes diesel powered engines only (coal and wood fired not included)
2. Commercial marine vessels
    - Includes: large vessels for commerce or military use (primarily diesel and steam turbines burning residual fuels)
    - Recreational vessels not included in the inventory
    - National estimates based on data from largest 150 ports
3. Aircraft
- Includes: emissions from aircraft only (ground equipment not included)
- Military aircraft not included
4. Non-road equipment
- Includes: lawn & garden, recreational marine vessels, construction equipment, and agricultural equipment

2-stroke, 4-stroke, and diesel engines included in inventory

The NTI compiles air toxics information by state and by source category. In 1996, non-road gasoline vehicles were the largest source of air toxics in rural states such as Maine, Vermont and New Hampshire. Future VOC reductions from on-road gasoline vehicles are expected to further increase the relative VOC contribution from the non-road gasoline sector. Consider the information graphically represented in the charts included in this section:

- Non-road gasoline vehicles emitted more than 60% of mobile source benzene emissions in 1996 in the rural Northeast states of Maine, New Hampshire and Vermont. In urban states, non-road gasoline vehicles accounted for about 35% of total mobile source benzene emissions.

- The non-road sector contributed about half the 1,3-butadiene emissions in rural states, and 20 to 30% of the emissions in urban states in 1996.

- Non-road gasoline and diesel vehicles contributed more than 60% of the acetaldehyde mobile source emissions inventory in 1996.

- Non-road gasoline and diesel vehicles contributed more than 50% of the total formaldehyde emissions from mobile sources in 1996.

These current inventory figures demonstrate that the non-road sector should not be overlooked in a motor vehicle air toxics study conducted by EPA.

Non-Road Particulate Emissions

Non-road diesels contribute a large percentage of the total mobile source particulate emissions. EPA estimated in its recently release low sulfur diesel fuel Notice of

Proposed Rulemaking that 70% of mobile source particulate is projected to come from non-road sources by 2010.

Verification of MobTox Input Files

The MobTox model generates emission factors for each of the mobile source air toxics in question, but it does not generate emission factors for total organic gas (TOG). The Mobile Model generates emission factors for TOG, but not air toxics. The outputs of the two models do not match. Verification of the toxic emission factors generated by MobTox was difficult. NESCAUM solved this challenge by asking the New York State Department of Environmental Conservation insert the MobTox input files used for New York City into the Mobile Model. The Model generated TOG emission factors from MobTox inputs. These TOGs factors were then compared to the VOC emission factors generated from the NYC SIP demonstration. The results of this analysis show that EPA's MobTox inputs tend to underestimate TOG emissions, at least for New York City, by about 30% compared with the SIP methodology.

Recommendation

NESCAUM suggests that the Agency consider including the non-road sector in its assessment of motor vehicle and fuel emissions through the use of ambient air quality monitoring data, which is apportioned to represent the various anthropogenic source category contributions. If, following this analysis, the non-road sector is shown to substantially contribute to the risks to the public health, then EPA may consider regulatory action under its general 202(a) rulemaking authority.

Section IV. Exposure and Risk Assessment of Motor Vehicle Related Toxic Air Pollutants

The section of the USEPA assessment that needs the most additional staff attention is the use of the Hazardous Air Pollutant Exposure Model (HAPEM-MS3) to estimate population exposure to motor vehicle and fuel emissions. Although the HAPEM-MS3 model has great promise to assist in the characterization of sub-population exposure to toxic air pollution, current assumptions and data input limitations likely undermine the ability of the model to accurately assess the magnitude and variability of real world exposures. Critical limitations in the Agency's analyses include: the use of carbon monoxide as a surrogate for exposure to air toxics (especially reactive species); the reliance on severely limited time-activity diary datasets to estimate the widely-varied and complicated microenvironmental movement patterns of the entire U.S. population; and the application of microenvironmental factors that will clearly underestimate the infiltration and concentration of volatile organic and fine particulate matter air pollutants of interest. More detailed comments on the HAPEM-MS3 model are found in Section V of the NESCAUM comments.

It is NESCAUM's opinion that the Agency must conduct a more robust assessment of the cumulative public health risks associated with emissions of motor vehicles and their fuels prior to a regulatory decision-making action. The current evaluation of average annual exposures for the entire US population will inadequately address the clear variability in potential public health risks (please see Section V for NESCAUM's comments regarding the exposure assessment limitations of the Agency's current analysis). A more appropriate assessment of public health risks would include:

- quantification of the public health risks associated with exposure to ambient concentrations of these important pollutants (i.e., consider the ubiquitous "background" concentrations of these compounds, not only the additional category-specific emissions from on-road mobile sources);

- quantification of the total exposure/risk contribution of episodic high-end concentration exposures (known to occur during refueling and commuting and in residential environments adjacent to major roadways and with attached garages);

- quantification of the variability of exposure/risk estimates across sub-populations, particularly when comparing high-end exposure/risk scenarios (i.e.: refueling and commuting and in residential environments adjacent to major roadways and with attached garages);

- more complete consideration of risks for sensitive sub-populations members; and

- consideration of the health risks associated with exposure to mixtures of these pollutants (individual assessment of single pollutant risks will not address the potential magnitude of cumulative exposures within a given sub-population).

Consideration of these points in an exposure and risk assessment will more adequately assess the severity of exposure and magnitude of public health risk in this country than a population-based average exposure assessment will. The remainder of this section will provide a justification for these important considerations.

Point I: quantification of the public health risks associated with exposure to ambient concentrations of these important pollutants.

When assessing the risk associated with motor vehicle-generated toxins, it is necessary to consider more than fuel combustion emissions alone. Recent analyses have shown that ambient air monitoring results in locations removed from anthropogenic emission sources, including motor vehicles, revealed "background" concentrations of benzene and formaldehyde of 0.48 $\mu g/m^3$ and 0.25 $\mu g/m^3$, respectively[1]. Since acetaldehyde, benzene, 1,3-butadiene, and formaldehyde possess atmospheric half-lives ranging from 4 hours to 12 days, motor vehicles clearly contribute to general background concentrations of these pollutants. This information coupled with the secondary atmospheric formation of acetaldehyde and formaldehyde from mobile source emissions obligate an assessment of exposure to ambient air concentrations of these compounds, not merely tailpipe emissions.

It is possible for the Agency to use ambient concentration measurements, which are source apportioned to mobile source categories in this assessment. Furthermore, we recommend that the USEPA use computer dispersion modeling tools being refined within the Agency at this time to provide geographically resolved predictions of motor vehicle HAP concentrations across the country.[2] These dispersion-modeling results provide important information for accurate exposure and risk assessment (i.e., the magnitude of ubiquitous exposures as well as the higher exposure concentrations in more densely populated areas of the country).

Point II: quantification of the total exposure/risk contribution of episodic high-end concentration exposures.

In the following NESCAUM analysis (published in the NESCAUM RFG/MTBE Findings and Recommendations Report, August 1999) of the relative exposure and health risk(s) associated with reformulated fuels, episodic, high-concentration exposures to benzene were shown to substantially increase the total daily dose of this compound in exposed populations. This assessment, intended to serve as a high and low exposure "bounding," demonstrated that exposures during refueling and commuting, coupled with a residential exposure resulting from evaporation of benzene from the fuel tank of a

[1] Rosenbaum A, Ligocki M, Wei Y. Modeling Cumulative outdoor Concentrations of Hazardous Air Pollutants. San Rafael, CA: ICF Kaiser, Systems Applications International Division, 1998.

[2] Assessment of Population Exposure Nationwide model used for the 1990 Cumulative Exposure Project (US EPA's Office of Policy) and for the ongoing 1996 National Air Toxics Assessment (Office of Air Quality Planning and Standards).

vehicle in an attached garage, would dominate the exposure scenario and resulting risk prediction.

Excerpt from: August, 1999 NESCAUM
RFG/MTBE Findings and Recommendations report.

C. NESCAUM's comparative exposure analysis

In order to understand the differences in exposure and the consequences of exposure on health risk(s), different exposure scenarios were compared in this initial comparative exposure assessment. This exposure analysis is intended to compare the highest and lowest potential exposure to MTBE and benzene in different daily activity patterns, using available, peer-reviewed personal exposure monitoring results from the scientific literature. This analysis is intended to provide an estimate of the potential upper and lower potential limit of exposure. More refined exposure analysis would be possible using personal activity diaries and Northeast state-specific personal exposure monitoring. A more comprehensive distributional exposure assessment would provide a more complete understanding of the frequency of exposure under the "high" or "low" exposure scenarios and a more detailed understanding of the percentage of the general population at all risk levels in between. A distributional analysis is beyond the scope of this technical paper at this time however, and would require data not currently available to NESCAUM. [Use of comprehensive activity-pattern data would assist in this type of more refined assessment of distributional exposure analyses.]

Human Contact with MTBE:

Human contact with MTBE and other gasoline constituents has been reported from environmental contamination and/or workplace exposures (Brown, 1997; Wallace, 1996; Huber, 1995). Inhalation exposures to vapors have been shown to span a wide range. The highest ambient concentrations have been observed in workers who handle MTBE and gasoline products, the general public during refueling, and in individuals homes when contaminated groundwater is used for cooking, showering and bathing (Brown, 1997; Keller, 1998). Oral and dermal exposures to MTBE and other gasoline-related compounds can also occur from drinking, cooking, and bathing and showering with water contaminated with these compounds. For this analysis, ingestion and inhalation were considered the key exposure routes as dermal absorption of MTBE has been demonstrated to be very low and without significant impact on potential important systemic exposure. (Johnson, 1993; Huber, 1993).

Analysis of Exposures:

The "high" and "low" exposure scenarios in this analysis are shown to appreciate the various elements of exposure important for health risk. Tables VII and VIII illustrate the personal exposure concentrations of MTBE and benzene measured by others (Huber, 1993; Brown, 1997; Hartle, 1993; and Wallace,1996). Figures 5, 6, and 7 indicate the

relative importance of the inhalation and ingestion exposure to the various concentrations of MTBE and benzene measured during the daily activities shown in the tables. These figures compare exposure estimates for individuals with and without MTBE- and benzene-contaminated drinking water (concentrations above state drinking water standards). High and low estimates are provided to represent the highest and lowest reported average air concentrations of MTBE measured outdoor and within a private residence, as shown in the "exposure bound" column in each table. Therefore, the high/low values within each water contamination level category represent the maximum and minimum inhalation exposures, based on available exposure monitoring results. The use of these values is intended to provide an upper and lower estimate of the inhalation contribution to total daily exposure given the variability reported in the published literature.

In order to qualitatively represent the magnitude of potential daily individual exposures, the air and water concentrations of MTBE and benzene were considered. The daily dose was calculated for a 70 kg adult, with an inhalation rate of 0.0139 m^3/min, who is consuming 2 liters of water per day. Water contamination concentrations were considered to be 35 μg/L or 100 μg/L for MTBE and 5 μg/L for benzene.

As shown in Figures 5,6, and 7 inhalation of MTBE and benzene are the key exposure pathways. Figures 5 and 6 compare the "no Stage II" scenario for MTBE and benzene. This scenario establishes an initial high exposure assumption, given the volatilization of gasoline during refueling. Figure 5, illustrates that, with residential drinking water contamination at 35 μg/L, using the lowest measured airborne concentrations of MTBE during various daily activities, the daily health protective threshold is not exceeded. If however, one incorporates the high exposure assumption (an attached garage increasing the residential air concentrations of MTBE and an "outdoors" ambient air concentration of 36 μg/m^3--approximately 10X the highest measured concentration in the Northeast) the health protective threshold is exceeded. As shown in Figure 6, non-residential ambient air exposure to benzene is substantial enough to exceed the daily threshold exposure concentration. Incorporation of measured residential exposure concentrations of benzene, with no drinking water contamination, would essentially double this exposure estimate.

Stage II vapor recovery was shown to reduce daily exposures to MTBE by approximately 50% through a reduction in high exposure concentrations during refueling (Huber, 1993). Figure 7 illustrates the reduced exposure to MTBE expected with use of Stage II vapor recovery at the refueling pumps. Under this scenario, the daily health protective threshold would not be exceeded with a drinking water concentration of 35 μg/L, even under the high exposure assumptions discussed above. However, a drinking water concentration of 100 μg/L would contribute to a daily health protective threshold exceedance under high or low exposure assumptions. Stage II vapor recovery did not significantly reduce exposure to benzene during refueling in three regions studied by Hartle (Hartle, 1993). Wallace did not evaluate the effectiveness of this emission control technology (Wallace, 1996). Therefore, a Stage II exposure scenario was not completed for benzene. Since 1993 vapor recovery system design and performance has been substantially improved.

Recent Northeast state experience suggests that Stage II vapor recovery systems are greater than 90% effective at capturing MTBE and benzene vapors during refueling. These systems would therefore be expected to reduce exposure beyond that shown in this initial exposure assessment.

Table VII.
Microenvironmental Exposures to Methyl Tertiary Butyl Ether

Type of Exposure	MTBE Concentration	Duration	Exposure Frequency	Inhalation Rate	Exposure	"Exposure Bound"
	mg/m^3	min/event		m^3/min	µg/day	
Refueling *Stage II*	13	2 (2x/week)	Daily	0.0139	102.99	Low Estimate
In gas station ***Stage II***	1.59	3 (2x/week)	Daily	0.0139	19.67	Low Estimate
Refueling ***No Stage II***	36	2 (2x/week)	Daily	0.0139	285.23	High Estimate
In gas station ***No Stage II***	3.6	3 (2x/week)	Daily	0.0139	44.54	High Estimate
Commuting	0.061	90	Daily	0.0139	76.31	-
Residential	0.018	660	Daily	0.0139	165.13	-
Outdoors	0.036	205	Daily	0.0139	102.58	High Estimate
	0.0036	205	Daily	0.0139	10.26	Low Estimate

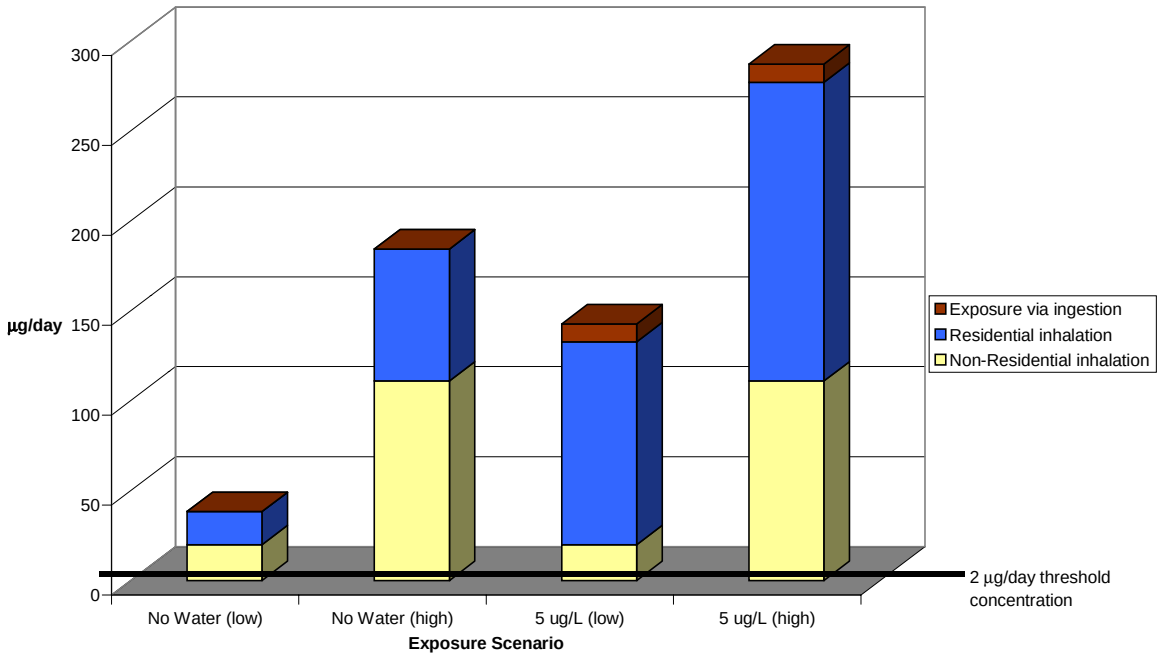
Measured MTBE exposure concentrations reported by Huber, 1993 and Brown, 1997.

Table VIII.
Microenvironmental Exposure to Benzene

Type of Exposure	Benzene Concentration	Duration	Exposure Frequency	Inhalation Rate	Exposure	"Exposure Bound"
	mg/m^3	**min/ event**		**m^3/min**	**µg/day**	
Commute/in vehicle	0.006	90	daily	0.0139	7.50	Low
	0.04	90	daily	0.0139	50.04	High
Residence, non-smoker	0.002	660	daily	0.0139	18.05	Low
	0.008	660	daily	0.0139	73.39	High
Outdoors	0.019	205	daily	0.0139	54.14	High
	0.002	205	daily	0.0139	5.70	Low
					0	
Refueling	0.85	0.57	daily (2 min x 2x/week)	0.0139	6.73	No Stage II

Benzene concentrations reported by Hartle, 1993 and Wallace, 1996.

Figure 6. Estimated Daily Exposure to Benzene, No Stage II
(Estimated for the High Ambient Exposure and the Low Ambient Exposure)



Point III: quantification of the variability of exposure/risk estimates across sub-populations, particularly when comparing high-end exposure/risk scenarios

The prediction of average population-based risk will vary substantially with the estimate of toxic air pollutant concentrations. Consider the following Lifetime Predictive Risk Matrices, which estimate the theoretical increased lifetime cancer incidence for the population of New York City. These estimates are not absolute indicators, but rather theoretical calculations of the risk indices for these pollutants individually and as a group. In order to generate these estimates:

1. average annual monitored concentrations[3] for each of the compounds was adjusted to reflect the expected contribution of mobile sources (on-road only and on and non-road emissions) using the US EPA's draft National Toxics Inventory (compiled by the USEPA Office of Mobile Sources and the Office of Air Quality Planning and Standards, August 2, 1999);
2. unit risk values established by the USEPA were compared against these mobile source adjusted annual average ambient concentrations;
3. the one in one million risk predictions were adjusted to reflect the NY PMSA population derived the lifetime risk total; and
4. the compound-specific risk estimates were summed to reflect the potential additive cancer risk associated with exposure to each of these compounds in the population.[4]

[3] Conservative annual average ambient concentrations of each compound was used (the average of 1996 average annual concentrations in the State of Vermont and East Providence, Rhode Island were compared with the average annual benzene concentration measured in four Statten Island monitoring locations).
[4] In the absence of evidence to the contrary when assessing risks due to exposure to complex mixtures, consistent with past EPA practices, an assessment should assume low dose linearity and additivity of theoretical risks.

This comparison demonstrated that a 0.42 μg/m^3 increase in the benzene concentration considered in the average population risk assessment would result in an additional twenty five predicted cancer incidences for this compound alone.

These risk estimates represent the potential population risk associated with exposure to average annual concentrations of mobile source pollutants in the Northeast and the importance of accurate exposure concentrations for the toxins to these predictions. In addition to the risk estimates provided here, substantial risk(s) are known to be associated with episodic exposures during commuting, refueling, or while inhabiting a residence with an attached garage (as described previously in this section).

An estimation of the population risk associated with exposure to the annual average concentration of each compound will underestimate the higher-end exposures which occur in the densely populated, urban environments. To accurately assess the magnitude of exposure and the resulting health risk for a sub-population given proximity to a higher motor vehicle density, the microenvironmental factors must be adjusted to represent higher concentrations of mobile source pollutants in study areas closest to roadways. Additionally, an accurate assessment of exposure/risk for a given sub-population should reflect the variability within a demographic group that is geographically based (e.g.: for a given sub-population, a subset may reside closer to roadways than others within the same group and will have a substantially higher exposure).

The assertion that motor vehicle generated hazardous air pollutants possess episodic concentration peaks concurrent with mass commuting times and reveal highest concentrations closest to the roadway are supported by numerous analyses. NESCAUM has referenced two cases in comments here: 1) the historical evaluation of lead[5]; and 2) the recent evaluations of high molecular weight polyaromatic hydrocarbons (PAH) associated with particulate matter from motor vehicles.[6]

The Agency for Toxic Substances and Disease Registry, in its 1999 Toxicological Profile for Lead, identified that "…soil beside roadways are typically 30-2000 μg/g higher than natural levels…these levels drop exponentially up to 25 m(eters) from the roadway." The US EPA in the 1983 Air Quality Criteria for Lead text stated, "Near roadsides, this flux [of anthropogenic lead in the upper 2 cm of soil] is largely by dry deposition and the rate depends on particle size and concentration. These factors vary with traffic density and average vehicle speed…deposition flux drops off abruptly with increasing distance from the road." For lead, the importance of proximity to roadway when qualifying and quantifying theoretical health risks for a receptor is clear.

Dubowsky *et al*. recently demonstrated in an analysis of urban, semi-urban, and suburban residential locations in the Boston, Massachusetts area that, "…traffic was the

[5] References included at the end of this section: Toxicological Profile for Lead, July 1999, Agency for Toxic Substances and Disease Registry; Air Quality Criteria for Lead, US EPA, August 1983

[6] Reference included at the end of this section: Dubowsky *et al*., The Contribution of traffic to indoor concentrations of polycyclic aromatic hydrocarbons, 1999.

main outdoor source of PAH concentrations measured indoors for all locations." The urban location was in Kenmore Square, Boston, MA, the semi-urban location was one mile West of the urban site in Brookline, MA, and the suburban location was approximately 15 miles west of downtown Boston. This work demonstrated:

- a statistically significant traffic-related trend in weekday PAH concentrations (a geometric mean of 31 ng/m^3-urban; 19 ng/m^3-semi-urban; and 8 ng/m^3-suburban location was shown);
- hourly average concentration profiles demonstrated a weekday rush hour peak of PAHs in all locations; and
- no peaks and significantly lower concentrations were measured on weekends for all locations.

Without consideration of the impact of these geographically resolved high-end exposures in an assessment of motor vehicle emission risks, entire population groups will be under-represented in the Agency's analysis.

Point IV: a more complete consideration of risks for sensitive sub-populations members must be made.

Toxicological evidence suggesting a variability in adverse health effects in different exposed sub-populations should be considered in exposure and risk assessments and should advise policy decisions governing the emissions from mobile sources. Calculating an average annual exposure for various demographic groups will not adequately address this issue. Consider the comments made by NESCAUM and the California EPA- Office of Environmental Health Hazard Assessment regarding the sensitive sub-population impacts of 1,3-butadiene exposure (included at the end of this section). The Agency should, when faced with this type of evidence, consider the likely excess risks borne by sensitive sub-populations. It is imperative that the variability in population exposure be estimate to ensure that the magnitude of likely sensitive sub-population impact is quantified in these assessments.

Point V. consideration of the health risks associated with exposure to mixtures of these pollutants.

NESCAUM recognizes the limitations of evaluating risks from exposure to complex mixtures, such as motor vehicle emissions; however, the assessment of motor vehicle emission requires special considerations as interaction among individual components may produce a different toxicological profile than would be expected from an analysis of the components independently.

NESCAUM believes that EPA should evaluate motor vehicle emission according to the approach used in previous EPA studies that identify motor vehicle emissions as a complex mixture. Under these circumstances, and, in the absence of evidence to the contrary, theoretical risk assessments should assume low-dose linearity of compound toxicological action. Resulting theoretical risk predictions should therefore use an additive approach for assessing cancer risks associated with exposure to the mixture.

Section V
Peer Review Comments on the use of the Hazardous Air Pollutant Model (HAPEM-MS3), to assess exposure to hazardous air pollutants emitted from motor vehicles and their fuels.

This section of the Northeast States for Coordinated Air Use Management (NESCAUM) comments on the March 1999 DRAFT Environmental Protection Agency (EPA) *Estimation of Motor Vehicle Toxic Emissions and Exposure in Selected Urban Areas* will address the use of HAPEM-MS3 to estimate exposure to motor vehicle-generated hazardous air pollutants (HAPs). A daunting task associated with toxic air pollution is the accurate qualification and quantification of the concentrations present in the ambient air and the identification of the responsible emission sources. For regulatory agencies, an even more challenging task is to accurately characterize the risk to health or the environment in order to justify regulatory requirements for emission reductions. The EPA should be commended for its continued effort to develop and refine tools to assist in these difficult challenges.

Recent tools developed by EPA such as the Assessment of Population Exposure Nationwide (ASPEN) and HAPEM-MS models will enhance the understanding of public health consequences of exposure to toxic air pollution. These models, as with their predecessors, have strengths and limitations that must be fully characterized to appropriately interpret their results and to guide appropriate regulatory policy within the uncertainty of these predictive models. The comments herein will identify elements of the HAPEM-MS3 model that will result in an underestimation of the variability and magnitude of public health impacts associated with exposure to emissions from motor vehicles and their fuels. These comments will also offer insight into an alternative view for assessing the risk posed to public health by these emissions.

HAPEM-MS3 is an incredibly complex and refined tool to assist in characterizing the potential for exposure and health risk in over twenty different demographic groups for every hour of every quarter of a calendar year. Given the complexity of this model and the specific nature of its exposure predictions, it is <u>absolutely critical</u> that adequate input data be provided for the model to accurately characterize the at-risk population being assessed. At this time, substantial questions remain regarding this model's capacity to accurately characterize the population risks due to HAP emissions from motor vehicles.

HAPEM-MS3 is an enhancement of the HAPEM-MS model used in the Agency's 1993 Motor Vehicle-Related Air Toxics Study (MVRAT). Both HAPEM-MS and HAPEM-MS3 use a multi-step methodology to assess exposure to motor vehicle-related HAP emissions (parameters for this 1999 DRAFT assessment are in parentheses and underlined):

1. Define a model study area (<u>fourteen U.S. cities, each study area consisting of a circular region with a 50-kilometer radius</u>).

2. Define a population-at-risk within the study area (23 demographic groups), divide the study area into exposure districts (up to 18 exposure districts/study area), and specify an exposure period.
3. Divide the population-at-risk into cohorts.
4. Using activity pattern data estimate the amount of time spent by each cohort in exposure districts, microenvironment (37 microenvironments), calendar quarter, and clock hour (each clock hour of each day (data for the same hours on all the days in each calendar quarter are averaged together, before being combined with concentration data).
5. Estimate that annual average carbon monoxide exposure of each cohort through the use of fixed-site monitoring data and appropriate microenvironment factors. (In quantifying exposure to HAPs a key assumption is made that the HAP concentration is proportional to the estimated CO concentration).
6. Extrapolate the cohort's HAP exposure to the population-at-risk within the model study area. Associated risks can then be predicted.

The Agency received a number of peer review comments during both the public comment period and a requested peer review of the 1993 MVRAT study regarding the use of this model to assess population exposure(s) to motor vehicle-related air toxics. These comments, although supportive of the Agency's efforts to more completely characterize population-based exposure/risk, articulated a number of recommended improvements for the model.

Excerpts from NESCAUM comments March 5, 1993 (please see Attachment 1 in this section for the complete text of these earlier comments):

"EPA has established a policy, as articulated in the Habicht memo, regarding exposure and risk characterization to present information on the range of exposures derived from exposure scenarios evaluated in the Draft Study [Motor Vehicle-Related Air Toxics Study, 1993] and on the use of multiple risk-descriptor (i.e., central tendency, high end of individual risk, population risk, important subgroups). NESCAUM believed that presenting data in this manner would greatly improve the quality and applicability of the results of the Draft Study. It will also be consistent with the approach EPA has used in the toxicity profiles, which present alternative views and positions to EPA's cancer potency factors.

With regard to the Hazardous Air Pollutant Exposure Model for Mobile Sources (HAPEM-MS) inputs, EPA has not provided a rationale for the methodology used t estimate exposures based on CO monitoring data as a surrogate for motor vehicles toxic emissions. EPA acknowledges that the model is not appropriate for more reactive species, such as 1,3-butadiene and the aldehydes, but nevertheless uses this data without any adjustment to the model. In addition, the Draft Study does not account for that top 10% of the population that experienced greater exposure than was predicted by the NAAQS monitors. Not accounting for upper bound or high-end exposures is inconsistent with EPA's policy discussed above.

In light of the uncertainties of the HAPEM-MS model discussed above, NESCAUM questions the use of detailed activity pattern studies to estimate exposure to motor vehicle emission in various microenvironments. The use of these adjustment factors carried out to three decimal places for various microenvironments is not appropriate considering the assumptions and variability of the other model inputs, particularly when the upper bound exposure estimates are not considered. If activity pattern data are used, a range of exposure estimates should be

evaluated and the uncertainties of applying these data to broad regions of the country should be acknowledged and explained.[1]"

Thomas H. Stock, University of Texas School of Public Health, Peer review comments regarding the Adequacy and Appropriateness of HAPEM-MS Model:

"While the use of a model such as HAPEM-MS, which attempts to move beyond the use of fixed site concentrations as estimates of exposure, is a laudable first effort in assessing the health impact of exposure to air toxics from motor vehicles, this model clearly has many severe limitations which may render it inadequate for its intended use." Professor Stock went on to question the assumption that carbon monoxide was a reasonable surrogate for mobile source air toxic emissions, particularly the more reactive species, such as 1,3-butadiene and the aldehydes. Substantial concerns regarding the use of activity diaries from limited geographic areas to represent the nation's population as a whole and the derivation of the microenvironmental factors for the model were also raised in his comments. With respect to exposure estimates developed with HAPEM-MS2, Professor Stock stated, "The uncertainties associated with the final exposure estimates are unknown, and probably enormous for the highest percentiles of the exposure distribution.[2]"

The Agency's efforts to update/enhance the HAPEM-MS2 model for use in this latest analysis have resulted in the following improvements:

- improved efficiency of data processing;
- the use of 1990 Bureau of Census data rather than 1982 data;
- greater user flexibility for defining demographic data associated with populations at risk; and
- adjustments to the microenvironmental factors for the three garage-related microenvironments.

However, despite these enhancements, HAPEM-MS3, still:

- relies upon limited time-activity diary data based on a total of 3568 person days of data collected in 1982-1987 in Denver, CO[3]; Washington, DC[4]; and Cincinnati, OH[5]. These time-activity diaries, used to establish exposure scenarios for the entire population of this country represent one winter (November-February) in Denver and Washington and the months of March and August in Cincinnati, OH;
- does not account for evaporative loss of benzene (by considering a carbon monoxide exposure indicative of combustion of fuels, not evaporation), which

[1] Comments of Northeast States for Coordinated Air Use Management (NESCAUM) on Motor Vehicle-Related Air Toxics Study Public Review Draft December 1992, submitted to U.S. Environmental Protection Agency Docket No. A-91-19, March 5, 1993.

[2] Thomas H. Stock, Associate Professor University of Texas School of Public Health Houston, Texas, Comments submitted to the USEPA regarding the Motor Vehicle-Related Air Toxics Study, August 24, 1994.

[3] Johnson, T.R., 1984, "Study of Personal exposure to Carbon Monoxide in Denver, CO," EPA-600/54-84-14, U.S., EPA, RTP, NC.

[4] Hartwell, T.D. *et al.*, 1984, "Study of Carbon Monoxide Exposure of Residents of Washinton, D.C. and Denver, Colorado," EPA-600/54-84-031, U.S.EPA, RTP, NC.

[5] Johnson, T.R., 1987, "A Study of Human Activity Patterns in Cincinnati, Ohio," Electric Power Research Institute, Palo Alto.

can have substantial impact on episodic exposures as well as residential concentrations of this HAP (See benzene chart, section XX of these comments);

- assumes the HAP concentration is proportional to the CO concentration, despite the Agency's acknowledgement that this assumption is inaccurate for the more reactive HAP species such as 1,3-butadiene and the aldehydes;
- uses microenvironmental factors with little justification for their derivation;
- generates average exposure estimates in $\mu g/m^3$, with no ranges provided;
- does not adequately represent the variance in the population exposure(s); and
- is so complicated (thirteen programs and preprocessors), it is not possible for interested parties to directly access and evaluate the model more thoroughly.

Time-Activity diary data:

The time activity diary data utilized by HAPEM-MS3 to estimate exposures to the 23 demographic groups in each exposure district within the study area are limited. These data are so crucial to an accurate representation of potential variability in the population exposure the Agency should strongly consider supplementing the existing dataset with more comprehensive and up-to-date time-activity diary studies, such as the Comprehensive Human Activity Database-CHAD. As currently compiled, the population risk predictions developed by HAPEM-MS3 represent a time-activity dataset comprised of only 3568 person-days. This dataset represents four months in two cities (Washington and Denver) and two months in one other (Cincinnati). The greatest number of activity pattern data, 2284, represent Caucasians. It is of concern that some of the most critically important population groups to assess when considering the risks associated with exposure to emissions of motor vehicles and their fuels are those population groups with substantial time-activity diary limitations. For example: a total of 52 activity patterns are available for outdoor workers, 368 for outdoor children, 190 for individuals with heart and respiratory conditions, 133 for African Americans, and 120 for Hispanics. The representative nature of the complicated exposure scenarios compiled by HAPEM-MS3 for these population groups nationwide is in question given this limited activity pattern characterization.

The Agency and the contractor charged to develop the enhancements to HAPEM-MS3 model have acknowledged that, "the activity data available for races other than Caucasian are limited…Caucasian is the only race that has enough person-days to allow users to narrow the demographic groups with other parameter selections. Similarly, activity data representing household income levels is limited for some selections. At both extremes, that is persons with household incomes less that $10,000 [120 activity patterns available] and persons with household incomes greater than or equal to $75,000 [127 activity patterns available], the scarcity of person-days in some pools makes it inadvisable to narrow the selection any further. It would be difficult to execute HAPEM-MS3 on any race/income level combination other than Caucasians in the middle income levels." Little information has been provided to provide the reviewer with an understanding of how the HAPEM-MS3 user adjusted for these clear limitations in this assessment. The Agency report also acknowledges, "The activity data that comprise the

special demographic groups of outdoor workers, outdoor children, and persons with heart and respiratory problems that limit their activities is also limited.[6]" With a limited number of activity pattern entries for a population group, there is increased likelihood that the average point exposure estimate determined by HAPEM-MS3 will be inaccurate for the total sub-population.

It is expected that the highest exposures to emissions from motor vehicles and their fuels will occur in densely populated urban environments. It is of concern that the sub-populations most significantly impacted in these settings will very likely be the most inaccurately characterized in this analysis. In addition to the concern that the HAPEM-MS3 model, by using the limited time-activity diary dataset, will inaccurately determine a point estimate of exposure for many sub-populations, it is also clear that the single point estimate of average annual exposure provides no insight into the variability in exposure magnitude within a sub-population. In the Agency's sensitivity analysis of the HAPEM-MS3 model, it is concluded that, "the HAPEM-MS3 model underestimates variance [in exposure], and this variance estimate can be sensitive to the particular algorithms used internally in the model.[7]" The exposure analysis results would be enhanced with the provision of a distribution in population exposure estimates. By providing a range of anticipated exposures, a more appropriate conclusion regarding public health risks could be made. Additionally, the uncertainties of the model estimates could be accounted for more completely by using a more conservative indicator of potential average annual exposure for sub-populations with limited time-activity diary datasets. As currently presented, the HAPEM-MS3 point estimates provide little information regarding the uncertainty underlying the exposure estimates and all population exposure predictions are treated as equally representative of each sub-population's exposure and risk.

Microenvironmental Factors:

The microenvironmental factors employed by HAPEM-MS3 (see table 2, extracted from the USEPA Final Technical Report[4]) were derived from the data collected in the Washington, D.C. and Denver, CO studies. The applicability of factors derived from November-February, 1984-85, in Washington and Denver to the rest of the country is an area of uncertainty in this assessment. Furthermore, there is little justification for the derivation of the microenvironmental factors. A broader discussion of the foundation for these factors would improve the final report immensely. As it currently stands, one is left to question how the multiplicative factor (which account for ambient carbon monoxide penetration into the various microenvironments) is less than 1 for all outdoor microenvironments considered, including along the roadway. Additionally, given recent evidence of the significantly elevated HAP concentrations measured in the cabin of a commuting vehicle (2X to 4600X greater than ambient concentrations for VOCs and

[6] Development and Evaluation of Enhancements to the Hazardous Air Pollutant Exposure Model (HAPEM-MS3), Contract No. 68-DO-30094. Work Assignment Number 2-8-JTN 763997-8 T. Palma *et al.*, September, 1996.

[7] Final Technical Report on the Analysis of Carbon Monoxide Exposure for Fourteen Cities using HAPEM-MS3, EPA Contract No. #68-D5-0049, March, 1998.

particulate matter depending upon sampling location and traffic pattern studied[8]), one is left to question how the microenvironmental factors for a car or a van during a commute could possibly be less than the ambient concentration. In addition to potentially underestimation of the concentration of carcinogenic HAPs and particulate in the motor vehicle cabin during commute, the current HAPEM-MS3 model is using commuting time-activity data from 1984 which does not consider the variability in weekend/weekday emissions. This is of concern considering the drastic changes that have occurred in our driving habits as a society since the early 1980s and the likelihood that the model will underestimate the peak commuting exposures to motor vehicle emissions.[8, 9]

The utility of using carbon monoxide as a surrogate of HAP exposure in a commuting vehicle was critically analyzed by Chan *et al.* In this analysis the authors found, "…the extrapolation of carbon monoxide commuter exposure models to the study of commuter volatile organic compound exposures would be ill-advised[10]."

Little justification is provided for the decision to set the HAPEM-MS3 additivity (accounting for non-ambient sources of carbon monoxide) to zero for this analysis. It is clear that the Agency does not want to include the emissions from residential combustion activities in this assessment by considering the direct microenvironmental contribution of CO. However, it is of significant concern that no apparent adjustment is available to adequately capture evaporative loss of benzene within the residential microenvironment. Considering the importance of evaporative loss from fuel tanks in the attached garage scenario of exposure (see NESCAUM microenvironmental exposure to benzene comparison-high exposure scenario), the HAPEM-MS3 model has no apparent option to account for this exposure contribution of fuels. The Agency should consider some appropriate methodology to account for evaporative loss and microenvironmental concentration of HAPs in its analyses and should provide a more thorough sensitivity analysis of the variability in exposures given consideration of concentration of HAPs within the vehicle, residence and/or workplace.

The selection of appropriate microenvironmental factors is critical to the accuracy of HAPEM-MS3. The sensitivity analysis report for this assessment demonstrated that variability in exposure of as much as a factor of 3 could result from the selection of a microenvironmental factor[11]. Given the variability shown in exposure predictions with the selection of different user inputs into HAPEM-MS, a more adequate justification for the selection of microenvironmental factors for this analysis must be provided.

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[8] California Environmental Protection Agency, Measuring Concentrations of Selected Air Pollutants Inside California Vehicles. Final Report, December, 1998.

[9] Dubowsky S.D. et al. The contribution of traffic to indoor concentrations of polycyclic aromatic hydrocarbons. Journal of Exposure Analysis and Environmental Health. Pp. 1-10, 1999.

[10] C.C. Chan et al., Driver Exposure to Volatile Organic Compounds, CO, Ozone, and NO2 under Different Driving Conditions." Environmental Science and Technology, 25: 964-972 (1991).

[11] Sensitivity Analysis Report, Analysis of Carbon Monoxide Exposure for Fourteen Cities using HAPEM-MS3. EPA Contract No. #68-D5-0049.

The Agency has acknowledged that HAPEM-MS3 will tend to underestimate the variability in exposure magnitude and will not accurately characterize the highest exposure scenario in numerous sub-populations. Given the uncertainties regarding population exposure variability, the limitations of time-activity data to accurately characterize sub-population activity patterns across the country, and the limitations of HAPEM-MS3 to adequately assess episodic high-end exposures and evaporative loss of important carcinogenic HAPs such as benzene, an alternative exposure assessment approach is warranted. NESCAUM has provided some suggestions for important points to consider during an alternate assessment in Section IV.

The importance of appropriately assessing the risk(s) to public health and determining the need for additional regulatory action warrant a more conservative approach to public health risk assessment. In its current form HAPEM-MS3 has many severe limitations which limit its capacity to accurately predict population-based exposure to emissions from motor vehicles and their fuels. The suggestions in Section IV could be incorporated in the Agency's assessment to more appropriately assess the risks associated with motor vehicles and their fuels. In order for one to have greater confidence in the adequacy of the estimates of the Agency's assessment, the following adjustments must be made at a minimum:

- the current time-activity diaries must be supplemented with more comprehensive and current data if any conclusions are to be drawn for sub-population exposures other than middle income Caucasians;
- exposure predictions should be presented as annual average point estimates with indication of the variability in annual average exposure estimates within a given sub-population;
- quantification of potential magnitude of sensitive sub-population impacts should be made;
- a carbon monoxide: toxics surrogate approach must be replaced with a more accurate ambient toxic concentration estimate when assessing exposure (this should clearly include evaporative loss of benzene and episodic exposures of importance such as refueling, commuting, and the residential impact of proximity to roadways or the presence of an attached garage); and
- rather than narrowly selecting the theoretical impact of a portion of the motor vehicle fleet considering a "clean" ambient environment, the Agency should more realistically assess both existing ambient air concentrations of these HAPs and the additional exposure and risk associated with additional emissions from motor vehicles and their fuels.

In classical risk assessment, one aims to identify a population at risk, to characterize the concentration of hazardous materials available for exposure to occur, the likelihood of exposure, duration of exposure, and important exposure routes available. With respect to HAPs, limitations regarding the quantification of hazardous compounds available for exposure have characteristically limited these assessments. With the advent of increasingly accurate computer dispersion models and more pervasive ambient monitoring efforts in this country, we are beginning to overcome this limitation. The

challenge is now becoming the ability to accurately assess exposure to HAPs and to predict potential public health risks from these assessments. The use of HAPEM-MS3 is the latest Agency effort to provide detailed information regarding the exposure to HAPs emitted from motor vehicles. However, this model, as stated previously, underestimates exposure variability that could be of critical importance with respect to sensitive and high-risk sub-populations.

As described in a number of peer-reviewed published literature reports included at the end of this section, ambient air infiltration of VOCs (benzene) are indistinguishable from unity. In reality, it is the ambient concentration of compounds like benzene that establish an indoor baseline. Personal exposure concentrations have routinely been shown to exceed either indoor or outdoor concentrations. This is due to individual residential activities supplementing the infiltrated ambient concentrations, not a reduction in the infiltration into the residence. The Agency should consider that ambient concentrations, in the absence of clear evidence to the contrary, establish the baseline of indoor microenvironmental exposures. By doing so it is possible to source-apportion the measured ambient air concentrations, assume continuous exposure, and more accurately assess risk. If the risk presented by continuous exposure to source-apportioned ambient concentrations of an individual HAP is unacceptable, then reductions on the important emissions sources are warranted.

Benzene Reductions in Gasoline are Cost Effective and Feasible

This section contains information to support the case for additional regulation of benzene content of gasoline. Most of the information compiled for this section is found in two relatively recent NESCAUM reports: *Relative Cancer Risk of Reformulated Gasoline and Conventional Gasoline Sold in the Northeast (August, 1998), and RFG/ MTBE: Findings and Recommendations (August, 1999).* Relevant tables and charts from these two studies are contained within this binder, and the full studies are included in our overall peer review submission.

1. Benzene emissions dominate the air toxic mass emissions and potency-weighted cancer risk from gasoline combusted in motor vehicles. Even with the substantial overcompliance with the 1% by volume benzene cap in the Northeast RFG pool, relative cancer risk from benzene emissions are about three times greater than the relative cancer risk from 1,3-butadiene, the next largest source of cancer risk in air toxic emissions. (See Figure ES-2, *Relative Cancer Risk of Reformulated Gasoline and Conventional Gasoline Sold in the Northeast*).

2. The substantial overcompliance with the 1% by volume benzene cap in RFG sold in the Northeast demonstrates that additional reductions are cost effective and feasible. In 1997, refiners in each petroleum production region supplying the Northeast overcomplied with the RFG benzene cap by about 40%, achieving benzene content in RFG between 0.6 and 0.7% by volume instead of 1.0% by volume. (See Table ES-3, *Relative Cancer Risk of Reformulated Gasoline and Conventional Gasoline Sold in the Northeast).* This overcompliance with the benzene cap was at last partially responsible for the 100% overcompliance with the Phase I RFG toxics performance standard of 15% (17.5% average). In the summer of 1998, RFG Survey data found even greater overcompliance with the air toxics requirements of RFG. For example, many cities in the Northeast received gasoline that achieved about a 35% reduction in air toxic emissions as compared to the 1990 national conventional gasoline baseline. (See RFG Survey Data, Summer 1998, *RFG/ MTBE: Findings and Recommendations).*

3. The Northeast states spend millions of dollars each year on clean up of gasoline spills. The focus of clean up activities are four compounds in gasoline – benzene, toluene, xylene, and ethyl benzene – commonly referred to as BTEX. Benzene is a known human carcinogen, and its remediation standard for groundwater and soil is far more stringent than those of the other BTEX compounds, which are less toxic. For example, Connecticut's groundwater cleanup standards (ug/L) for BTEX compounds from lowest to highest are as follows: benzene 1 ppb, MTBE 100 ppb, xylene 530 ppb, ethylbenzene 700, toluene 1000. Most states in the Northeast have similar remediation standards. (See page 7 text and footnote 5, *RFG/ MTBE: Findings and Recommendations).*

4. Refiners supplying the Northeast have reduced benzene content in RFG beyond the level required by regulation. There are two likely reasons for this overcompliance: (1)

there is a ready market for benzene as a petrochemical feedstock, and (2) because removal of benzene is a relatively easy to do compared with removal of other aromatics.

Benzene is a chemical feedstock for the production of styrene, which is used to make Styrofoam cups, plates, and other productions, as well as foam insulation. As a result, benzene fetches a higher price on the open market than other aromatics. On March 1999, benzene was selling on the spot market for 68 cents a gallon, down from 76 cents a gallon the year before. Other octane enhancers were only selling for about 52 cents a gallon, down from about 56 cents the year before. This 15-cent spread is a sizeable difference and shows the added value of benzene as a feedstock instead of an octane supplement. (See Table 5, Economic and Public Health Information Related to MTBE and its Alternative Gasoline Constituents, at 17, *RFG/ MTBE: Findings and Recommendations,* and *Octane Week Price Report).*

A recent check of the price per gallon of benzene with other octane enhancers confirms the durability of this price difference. In the September 28 edition of Octane Week, benzene was 71 cents per gallon, toluene was 56 cents per gallon and xylene was 62 cents per gallon. (Source available, but not included here).

One expert believes that refiners have overcomplied with the benzene cap because it is relatively easy to "remove" benzene from gasoline. In practice, refiners "remove" benzene from gasoline by not creating it in the first place. Aromatics such as benzene and toluene are typically found in reformate and produced by the reformer unit. Benzene is created when C-6 compounds (petroleum hydrocarbons with six carbon atoms) are fed into the reformer unit. Refiners are able to prevent the creation of benzene by separating out the C-6 hydrocarbons from the straight run naphtha that typically feeds the reformer unit. Once separated, the C-6 stream can be fed into the isomerization unit to form a high-octane C-6 isomerate.

Recommendation

NESCAUM recommends that EPA aggressively investigate the feasibility of sharp reductions in benzene content of all gasoline sold in the United States. If benzene were removed entirely from gasoline, remediation costs associated with gasoline spills are likely to decline significantly. In addition, benzene evaporative emissions would be eliminated, and benzene tailpipe emissions would decrease substantially.

Below are several possible regulatory options.

1. Zero out benzene in all gasoline in the United States.
2. Establish a 1% by volume benzene cap on all gasoline (i.e., conventional gasoline) sold in the United States.
3. At a bare minimum, lower the amount of benzene in RFG to 0.5% by volume, which is roughly consistent with levels <u>already achieved</u> by the industry.