Comments on the January 2008 Draft Report "Multiple Air Toxics Exposure Study in the South Coast Air Basin (MATES-III)"

Prepared for the
Alliance of Automobile Manufacturers

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April 4, 2008

Executive Summary

The MATES III study and draft report follows the template of MATES II consisting of a comprehensive measurement program of air toxics concentrations at fixed monitoring sites, a microscale study of air toxic concentrations, an update to the emission inventory for air toxics, and a modeling effort to fully characterize Basin risk. While the measurements and modeling appear to be of high quality, the analysis and reporting of the results requires additional work. In particular,

- There is a much better 'good news' story in the available air toxic data than the draft indicates. The report needs a more complete discussion of trends, where comparable measurements are available, to show the effectiveness of control programs.

- Uncertainties in cancer risk need to be more fully discussed in the report. Several of the points in the Caveats and Uncertainties section of the Executive Summary need to be expanded to include the uncertainty points made in the MATES II report.

- For the major air toxics associated with highway vehicles, the cancer risk factors used in MATES III are significantly higher than those used by the U. S. EPA in the recent National Air Toxic Assessment.

- The estimated diesel contribution derived from Chemical Mass Balance (CMB) modeling is biased high and should not be used until issues with the analysis are resolved.

- The modeled concentrations are more representative than the average of the fixed monitors, and should be used as the primary estimate of basin-wide average concentrations.

- An adjustment should be added to the modeled concentration results to account for the fact that people move about during the day and spend the bulk of their time indoors.

Introduction

The South Coast Air Quality Management District (SCAQMD) released the draft report[1] "Multiple Air Toxics Exposure Study (MATES III)" for public review in January 2008. The MATES III study and draft report follow the template of MATES II, a similar study that was conducted in the late 1990s and reported in March 2000.[2] Both MATES II and III are comprised of a comprehensive measurement program of air toxics concentrations at fixed monitoring sites, a microscale study of air toxic concentrations, an update to the emission inventory for air toxics, and a modeling effort to fully characterize Basin risk. MATES I was a less comprehensive air toxics assessment carried out a decade before the MATES II study.

Air Improvement Resource, Inc. (AIR) has reviewed the draft report and provides the following comments on behalf of the Alliance of Automobile Manufacturers. While the measurements and modeling appear to be of high quality, the analysis and reporting of the results requires additional work.

There is a much better 'good news' story in the available air toxic data than the draft indicates. The report needs a more complete discussion of trends to show the effectiveness of control programs.

The draft notes that one of the objectives of the study was to provide trend data, and it also notes that five of the fixed monitors were chosen to provide continuity with long term data. In addition, the draft indicates that the risk assessment is a useful yardstick to measure progress. Therefore, the report should include a more extensive discussion of trends to document the progress in reducing atmospheric concentrations and risk.

The draft compares the MATES III results with the MATES II results, but did not refer back to the first MATES study. MATES II, however, included a discussion of trends that included data back to 1990.[3] In MATES II, it was shown that cancer risk (excluding diesel particulate since it was not on the toxic air contaminant list at the time) decreased by about 50 % from 1990 to 1997 (from 44 to 63 % at the six sites with sufficient data). Importantly, for benzene and 1,3-butadiene, MATES II reported a 70 to 80 % reduction in cancer risk between 1990 and 1997. MATES III reports that benzene level were reduced by 50 % from MATES II and 1,3-butadiene levels were reduced by 73 % from MATES II. Thus, the overall reduction from MATES I to MATES III in benzene and 1,3-butadiene atmospheric concentrations and risk is 90 % or more. In addition, there were substantial reductions in atmospheric concentrations of benzene and other motor vehicle air toxics prior to 1990. For example, in the mid-1980's Singh et al.[4] summarized

[1] South Coast Air Quality Management District, "Multiple Air Toxics Exposure Study - MATES III," Draft Report, January 2008.
[2] South Coast Air Quality Management District, "Multiple Air Toxics Exposure Study - MATES II," Final Report, March 2000.
[3] See Appendix II to MATES II study.
[4] H. B. Singh, L. J. Salas, B. K. Cantrell, and R. M. Redmond, "Distribution of Aromatic Hydrocarbons in the Ambient Air," Atmospheric Environment, **19**,1911 (1985).

the long-term trend in benzene and toluene data from Southern California concluding that ambient concentrations of these compounds declined by a factor 5 to 10 over the previous two decades.

Since for key motor vehicles air toxics, such as benzene and 1,3-butadiene, there is data available to show the trend from 1990 to 2005, it should be included in MATES III. The long-term trends for benzene and 1,3-butadiene are particularly impressive and demonstrate the effectiveness of the motor vehicle emission control program.

For diesel particulate, which the draft acknowledges cannot be measured directly, the trend is not as clear. However, the available information from emissions inventories and EC measurements should be summarized to establish the downward trend in diesel ambient concentrations. (See Appendix VII at page 4 – ambient EC decreased between 50 and 57 % from 1995 to 2004, for example.)

Since the MATES II report included an Appendix on trends; the MATES III report should also include a chapter or appendix on trends, with the caveat that only trends in substances that are measured with comparable methods and techniques are reported. The MATES II trends analysis included a section that summarized the various rules and regulations that led to the reductions in risk documented in the report. A similar section should be included in MATES III.

Uncertainties in cancer risk need to be more fully discussed in the report. Several of the points in the Caveats and Uncertainties section of the Executive Summary need to be expanded to include the uncertainty points made in the MATES II report.

The MATES III draft acknowledges that there are uncertainties in the risk potency values used to estimate lifetime risk of cancer. However, this uncertainty should be characterized in a manner similar to that of the MATES II report because it was more detailed and accurate. In MATES II, the comparable section of the Executive Summary indicated that:

- The determination of risk values for each compound carries a level of uncertainty, which for some pollutants, is large.

- When risk factors for specific compounds are determined, levels are usually established conservatively.

- There is considerable debate on appropriate risk values, and often the levels established by the U. S. EPA and CalEPA differ.

- There is further debate as to the appropriate levels of risk ascribed to diesel particulates.

All these points are still true and important, so they should be added to the final report for MATES III.

With reference to the fourth point, the further debate as to the appropriate levels of risk ascribed to diesel particulate, the MATES II report indicated that the U. S. EPA had not yet declared diesel particulate as a toxic air contaminant. The U. S EPA has now completed its analysis[5] and the results should be noted in the report. In addition, there are HEI reports[6] and the Hesterberg et al.[7] review that add to the debate over diesel risk. In particular, the U. S. EPA, the federal Clean Air Scientific Advisory Committee and independent panels of the Health Effects Institute all conclude that issues with the existing studies preclude the development of a unit risk for diesel.

While the report uses California risk values, it is important for the report to acknowledge that there are uncertainties and debates as to the appropriate risk values, especially for diesel particulate. In addition, the fact that the composition of the particulate from modern diesel engines is changing as diesel emissions undergo control should be acknowledged and discussed in the report.

To put the risk estimates in perspective, it would be useful to add information on the total cancer risk so that the reader understands that the overall risk from air toxics is only a very small portion of the cancer risk in the Basin. Furthermore, any conclusions that include comparisons of the risk in MATES III to the risk in MATE II should be limited to substances for which the measurement methodology and risk factors are comparable. For example, the Executive Summary notes that, since the method for estimating diesel particulate changed between MATES II and III, the overall cancer risk estimates are not comparable. In a similar vein, the modeled estimates of risk from MATES III cannot be directly compared to MATES II because of inherent differences in the model and methodologies that would make such a comparison invalid.

The Health Effects Institute recently completed an extensive critical review of the literature on exposure and health effects of motor-vehicle air toxics.[8] It should be referenced in MATES III as an up-to-date review of the literature for those seeking more information on the potential health effects associated with ambient exposure to these compounds.

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[5] USEPA (2002). Health Assessment Document for Diesel Engine Exhaust. EPA/600/8-90/057F. Washington, DC, U.S. Environmental Protection Agency, Office of Research and Development, National Center for Environmental Assessment.

[6] HEI (1995). Diesel exhaust: A critical analysis of emissions, exposure, and health effects. A special report of the Diesel Working Group of the Health Effects Institute. Boston, MA, Health Effects Institute; HEI (1999). Diesel emissions and lung cancer: Epidemiology and quantitative risk assessment. Special report. Boston, MA, Health Effects Institute, Diesel Epidemiology Expert Panel; HEI (2000). Health Effects Institute Review of Draft EPA Document: Reconstruction of Teamsters Union Exposures 1950-1999. Boston, MA, Health Effects Institute; HEI (2003). Improving Estimates of Diesel and Other Emissions for Epidemiologic Studies, Baltimore, MD, Dec. 2002, Health Effects Institute.

[7] T. Hesterberg, et al., "A Critical Assessment of Studies on the Carcinogenic Potential of Diesel Exhaust," Critical Reviews in Toxicology, **36**, 727-776 (2006).

[8] HEI (2007), Mobile-source air toxics: A critical review of the literature on exposure and health effects, A Special Report of the Institute's Air Toxics Review Panel, Special Report 16, Health Effects Institute, Boston, MA, November 2007.

For the major air toxics associated with highway vehicles, the cancer risk factors used in MATES III are significantly higher than those used by the U. S. EPA in the recent National Air Toxic Assessment.

In February 2006, the U. S. EPA released its National Air Toxic Assessment based on 1999 emission levels. The health effects information used to characterize cancer and non-cancer risk for 177 substances in the national scale assessment is summarized in a document on the EPA web site.[9] For MATES III, the risk factors for cancer (unit risk) and non-cancer (inhalation reference exposure levels) are provided in Appendix I of the draft report.

When the EPA risk estimates for key motor-vehicle air toxics are compared to the CalEPA risk estimates used in MATES III, it is clear that MATES III cancer risks are significantly higher than the EPA estimates of cancer risk for the same substances. For example, for benzene, the CalEPA unit risk is 4 times higher than the U. S. EPA unit risk - 29×10^{-6} vs. 7×10^{-6} in units of $(\mu g/m^3)^{-1}$. For 1,3-butadiene, the CalEPA unit risk is 5.7 times higher than the U. S. EPA unit risk – $17 \text{ X } 10^{-5}$ vs. 3×10^{-5}. For formaldehyde, the CalEPA unit risk is 1,091 times higher than the U. S. EPA unit risk – $6 \text{ X } 10^{-6}$ vs. 5.5×10^{-9}. Since these three compounds make up a significant portion of the risk estimated in MATES III, the draft report should acknowledge the differences and include a calculation of the risk using U. S. EPA risk factors to show the sensitivity of the estimate to alternative health effects estimates. In a similar vein, differences between CalEPA and U. S. EPA regarding diesel risk should be acknowledged and discussed.

In the national assessment, EPA considered risk information developed within the Agency, as well as risk information developed by CalEPA, the federal Agency for Toxic Substances and Disease Registry, and the International Agency for Research on Cancer. EPA acknowledged that many of the substances evaluated were classified as probable carcinogens, indicating that data were not sufficient to prove that these substances definitely cause cancer in humans. EPA also cautioned that it is possible that some of the substances are not human carcinogens at environmentally relevant doses and that the true risk associated with them is zero. Thus, there is a possibility that the true cancer risks are even lower than the risks estimated using U. S. EPA risk factors. This should also be acknowledged in the final MATES III report. The Executive Summary already acknowledges that the non-cancer risk from the measured compounds is minimal.

The estimated diesel contribution derived from Chemical Mass Balance (CMB) modeling is biased high and should not be used until issues with the analysis are resolved.

Since the diesel contribution is not directly measured, it must be estimated by indirect methods. The draft reports the results of a CMB analysis and refers to a positive matrix factorization (PMF) analysis that was conducted but not reported in the draft. The draft only indicates that some sources could not be interpreted and some profiles could not be

[9] U. S. Environmental Protection Agency, Health Effects Information Used in Cancer and Non-cancer Risk Characterization for the 1999 National-Scale Assessment, November 7, 2005.

confirmed with confidence. The PMF work should be summarized in the final report even if it is not used as the primary estimate of source contributions.

There are several important questions concerning the CMB analysis. The use of CMB is predicted on the assumption that all sources are identified and that there is an accurate profile for each. While it may appear that all significant sources are identified, there is at least one major source of carbonaceous material in the basin that is not included, natural gas use. A careful evaluation of the inventories should be carried out to possibly identify other missing sources.

Another issue with CMB is that it treats primary source emissions. Since there is also secondary organic matter that is formed from the atmospheric reactions of gaseous anthropogenic and biogenic emissions, one would expect the CMB to not allocate all the PM2.5. Yet the CMB results allocate more than the measured PM2.5 at almost all the sites. For example, the predicted mass is larger than the measured mass by about 2 $\mu g/m^3$ in Tables 1 and 2 of Appendix VII. In addition, the draft indicates that the PM2.5 measurements are biased high due to OC sampling problems. This means that the over-allocation discrepancy is even larger than 2 $\mu g/m^3$.

The combination of these three factors - omitting natural gas use in the basin as a source, not considering secondary organic formation as a source, and the over-allocation of the measured mass – indicates that the CMB results are unreliable for diesel particulate and possibly other sources.

Discriminating between gasoline and diesel particulate emissions in source attribution is notoriously difficult. For this reason a variety of methods and approaches should be evaluated. The CMB results should be evaluated with regard to the inventories, with regard to any C^{14} measurements that might be available, with regard to day of week variations, and with regard to the U. S. Department of Energy Gasoline/Diesel PM Split Study.[10]

A minor but important issue is the way the gasoline and diesel contributions are denoted. In each case, the contribution is not for diesel or gasoline vehicle exhaust as noted in Tables 1 and 2 of Appendix VII, but for all uses of gasoline or diesel fuel in the basin, including on-highway, off-road, in small area sources, and in stationary engines.

The modeled concentrations are, in theory, more representative of basin-wide exposure than the average of the fixed monitors, and should be used as the primary estimate of basin-wide average concentrations.

Although the MATES III fixed sites are neighborhood sites, they represent neighborhoods with higher than average concentrations. This is apparent from the results at the microscale sites which for the most part did not have significantly higher air toxics concentrations than the fixed sites. This was true in both MATES II and MATES III.

[10] E. Fujita, et al., "Variations in Speciated Emissions from Spark-Ignition and Compression-Ignition Motor Vehicles in California's South Coast Air Basin," J. Air Pollut. Control Assoc., **57**, 705-720 (2007).

Since the fixed site measurements represent maximum neighborhood concentrations, the average of those sites will overestimate the basin-wide population-weighted average concentrations. Therefore, the modeled concentrations are more representative than the average of the fixed monitors, and should be used as the primary basin-wide concentration metric highlighted in the Executive Summary. The modeled concentrations have the added benefit of providing results throughout the Basin. In fact, the draft indicates that the modeling was carried out precisely because you can't measure everywhere.

The draft should amplify the discussion of the factors that went into choosing the fixed site monitors by including a discussion of the philosophy behind choosing sites. The federal guidelines for siting of monitors do not discuss the requirements for air toxic monitoring. There is, however, one historic EPA contractor report that discusses network design and site selection for air toxics.[11] The basic philosophy for ambient air quality surveillance in both the current federal guidelines and the 1984 EPA report is the same. The monitoring network is designed to identify the maximum concentrations in the area covered by the network. For the criteria pollutants, this philosophy is stated in the overall monitoring objectives, which are (1) to determine the highest concentrations expected to occur in the area covered by the network, (2) to determine representative concentrations in areas of high population density, and (3) to determine the impact on ambient pollution levels of significant sources or source categories. To clarify the link between these general objectives and the physical siting of specific monitors, the Agency introduced the concept of the "spatial scale of representativeness." Microscale monitors are sited to define the concentrations in air volumes associated with dimensions ranging from several meters up to about 100 meters. Middle scale monitors define concentrations in areas up to several city blocks with dimensions from 100 meters to 0.5 km. Neighborhood monitors define concentrations in areas that have relatively uniform land use with dimensions in the 0.5 to 4 km range. Urban scale defines the overall city-wide conditions with dimensions on the order of 4 to 50 km.

In the 1984 report, network design for air toxics is also focused on maximum concentrations. For example, that report indicates "the most crucial concern from a siting point of view is often that the data represent or be related to the highest ambient concentration." The report goes on to indicate that site selections are often made to satisfy several needs, for example, the maximum concentration and the concentration to which the maximum population or the most susceptible population is exposed. For microscale or middle scale sites, the guidelines stress looking for the point of maximum impact. For neighborhood sites, the guidelines stress siting in neighborhoods with the highest emission density, neighborhoods with relatively high emission density that are downwind of the areas with the highest emission density, and neighborhoods at the downwind end of the longest trajectory over areas with significant emissions.

Given these overall guidelines, it is not surprising that the average concentrations for the fixed site monitors exceed the population-weighted basin-wide average concentrations.

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[11] U. S. EPA, Office of Air Quality Planning and Standards, Network Design and Site Exposure Criteria for Noncriteria Air Pollutants, EPA 450/4-84-022, September 1984.

However, there may be a bias in the modeling that needs further investigation. Information presented at the March 13 Technical Advisory Group Workshop indicated that the modeled concentrations are higher in the coastal areas than the measurements and the opposite is true for the stations east of the coast where the modeled concentrations are lower than the measurements. The possibility of a systematic bias needs to be further evaluated.

An adjustment should be added to the modeled concentration results to account for the fact that people move about during the day and spend the bulk of their time indoors.

Since people move about throughout the day and spend the bulk of their time indoors, adjustments to estimate the true exposures of the South Coast population should be made. For PM, it is well established that the exposure indoors to PM of ambient origin is about half that measured outdoors. Since, under the risk assumptions in the study, the diesel risk is about 85 % of the total risk, a correction for the reduction in PM exposure indoors would suffice. When the ARB designated diesel exhaust as a toxic air contaminant, the exposure analysis accompanying the Staff Report included a detailed analysis of outdoor, indoor, and personal exposures to diesel particles.[12] That analysis indicated that the population time-weighted average total air exposure was about two-thirds of the population-weighted average ambient concentration. Thus, the most realistic estimate of risk, using the CARB risk factors, is not 1200 per million (the average of the fixed monitor sites with the CMB results used to estimate diesel concentrations), and not 812 per million (the population-weighted average from modeling), but about 540 per million.(the population-weighted average concentration from modeling adjusted for time indoors). To the extent that any systematic biases in the modeling are identified, these risk estimates should be modified accordingly.

[12] Report to the Air Resources Board on the Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant, Part A - Exposure Assessment, As Approved by the Scientific Review Panel April 22, 1998, at page A-56