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# Memorandum

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To: Dr. Holly Stallworth,
Designated Federal Officer (DFO)
EPA Science Advisory Board
Clean Air Scientific Advisory Committee (CASAC)

From: David Heinold, CCM and Robert Paine, CCM, QEP on behalf of the American Petroleum Institute (API)

Subject: **Comments on Particulate Matter NAAQS: Scope and Methods Plans for Health Risk and Exposure Assessment**

AECOM Environment has reviewed EPA's *Particulate Matter NAAQS: Scope and Methods Plans for Health Risk and Exposure Assessment*, which in part will be the subject of the April 1 and 2, 2009 meeting of CASAC. AECOM's focus for this review has been the aspects related to characterization of existing and future air quality, the level of uncertainty and bias in the approach and factors that should be addressed in characterizing exposure and health risk. Our comments are provided below.

## 1. Definition of Policy Relevant Background (PRB) Results in Unrealistically Low Concentrations

The development of a PRB based on "natural conditions" is illogical for the purposes of establishing a NAAQS for PM. The concept of natural conditions is based on the objective of regional haze in federal Class I areas as clarified in the 1990 Clean Air Act Amendments. The concept does not apply to setting NAAQS, because "natural conditions" as interpreted for Class I area protection are inconsistent with human habitation and associated societal activities that by nature, alter airborne PM. There is no policy regarding regulation of human activity that could be established by EPA that could totally eliminate these emissions, especially in urban areas or in areas where there is considerable human activity. Furthermore, in defining PRB, EPA plans to assume, through "zero-out" modeling, that there are no anthropogenic emissions that contribute to primary or secondary PM not only in the U.S., but throughout Canada and Mexico as well. Even the Regional Haze Rule, promulgated on July 1, 1999, does not consider that the U.S. has sovereignty over foreign countries and can dictate their emissions. Therefore, EPA cannot assume any reduction in present-day Canadian and Mexican emissions, which could actually increase due to increased population and NAFTA trading activity. EPA's approach also does not recognize that in remote areas, especially in the western U.S., it is likely that the artificial suppression of naturally occurring wildfires, if halted, could result in having "natural" ambient concentrations due to untamed wildfires greatly exceed present day PM emissions from that important source category. Rather than relying on "zero-out" modeling to estimate natural background EPA should investigate alternative, viable approaches at developing realistic PRB concentrations.

It is important for EPA to consider that monitoring data has been considered in PRBs for other pollutants, and that it should be considered, in conjunction with modeling, for the $PM_{2.5}$ PRB. One way to do this is to run an advanced regional model with baseline emissions and future emissions consistent

with an appropriate PRB approach to develop factor adjustments to be applied to appropriately selected present day monitored PM species-dependent concentrations in order to determine what the future monitored PRB concentrations would be. In the event that the modeled concentrations indicate that the modeling tool is unreliable for one or more PM species, then reliance upon appropriate monitoring data should be seriously considered to determine the PRB.

**2. Use of GeosChem and CMAQ to Estimate PRB is Subject to Bias and Uncertainty Due to Data and Model Limitations**

Rather than relying on measurement data and receptor modeling to estimate the fraction of "background" $PM_{2.5}$, EPA plans on using GeosChem to set the boundary conditions for CMAQ, which will be applied only with non-anthropogenic sources for the U.S., Mexico and Canada (we comment on treatment of Mexican and Canadian sources above). This "perfect model" approach relies on models that have not received extensive validation, and for which there are known biases for predictions in Class I areas that have been learned through modeling applications involving the Regional Haze Rule. Such modeling would need to be done on a "relative reduction factor" basis, for which the change in model predictions from a "baseline" condition <u>for each PM species</u> would need to be applied as a ratio to the observed baseline PM species concentration. Specifically, EPA's plan discusses how CMAQ is incapable of accurately simulating PM concentrations in the Western U.S. and there are issues related to the simulation of secondary species, especially nitrates and organics that are as yet unresolved. In addition, the understanding of "natural background" emissions is limited and somewhat speculative. Therefore, while the application of these models may possibly contribute to the understanding of PRB levels, given their biases and limitations, they should not be used in an absolute fashion. It would also be useful for EPA to compare model estimates to those derived from measurement-based, e.g., receptor modeling, methods to arrive at the most scientifically sound estimate of PRB.

**3. "Alternate" Roll-back Procedure Needs to be Tested and Validated**

EPA's recognizes that roll-up and roll-back are only appropriate when the source configuration and relative contribution are invariant and when there are no non-linear effects. Because these conditions are not met for $PM_{2.5}$, especially with the complications of both direct and secondary emissions, it is essential that EPA seek an alternative approach roll-up when projecting changes in $PM_{2.5}$ air quality to just meeting present and possible future standards. EPA proposes to attempt to use CMAQ to relate changes in emissions control to future air quality by using the model to indicate how hourly, 24-hour and annual PM-25 concentrations respond to various control strategies, and to keep track of the various contributions from primary and secondary species. While CMAQ probably represents the best modeling tool presently available, its results need to carefully examined in terms of inherent model limitations and potential biases. Evidence of these limitations is alluded to in EPA's study plan, indicating that CMAQ does not accurately characterize $PM_{2.5}$ in the Western U.S. Test case measurement and/or evaluation databases should be reviewed to judge the extent to which the CMAQ can accurately track changes in $PM_{2.5}$ levels and contribution of primary and secondary PM species. If there are noted limitations, these should be incorporated into the interpretation of CMAQ results rather than using a "perfect model" assumption.

**4. National Scale Health Impact Assessment will not Materially Contribute to Risk Knowledge due to Large Uncertainty**

An attempt to conduct a nationwide $PM_{2.5}$ assessment of premature mortality, in light of the many serious and inherent limitations, some of which are delineated in the study plan, does not represent a sound scientific approach. In addition to the many sources of uncertainty in the urban-scale risk assessments, the additional uncertainties noted by EPA are the estimation of $PM_{2.5}$ concentrations far

from monitoring locations and the extrapolation of the concentration-response functions derived from specific epidemiological studies in urban areas to other areas.

EPA plans to use a data fusion approach to data interpolation, whereby the concentration patterns modeled by CMAQ will be used in conjunction with monitoring data to estimate concentrations in monitoring data sparse areas. Before applying this method, EPA should "blind test" the methodology in various settings, for instance by withholding some of the monitoring data and comparing measured and fusion-interpolated values. In these tests, the method should also be compared with other data interpolation methods, such as Krieging.

Extrapolation of C-R functions, derived in urban areas to other urban, suburban and rural areas is entirely inappropriate because the method inherently assumes commonalities of the demographics of the at-risk population, human activity patterns, life-affecting stressors, weather-related health stressors (e.g., temperature, humidity), co-pollutant exposure, PM speciation and PM size distribution. Because there are likely to be large disparities in these factors from place to place, the national scale assessment would serve only as an academic exercise and would add little scientific value to the REA. Given the potential implications, it is inappropriate as proposed by EPA to relegate consideration of these important factors to an uncertainty assessment. EPA should either incorporate these types of factors into the assessment or demonstrate that these factors either do not vary from place to place or they do not affect the C-R function.

**5. Exposure Analysis Does not Appropriately Address Indoor Air, the Most Important Microenvironment**

EPA's reason for conducting a $PM_{2.5}$ exposure analysis is *"providing insight on population exposures with respect to informing the interpolation of available epidemiological studies."* It is unclear however, if and how this information will be used in the REA to assess the adequacy of the present and potential future $PM_{2.5}$ standards.

A major weakness of the methods to be applied using ASPEN is that indoor sources of PM will not be addressed. This is noted in EPA documents, such as http://www.epa.gov/iaq/pubs/hpguide.html. The omission of indoor air pollution sources is an inherently fatal flaw for this study because of the large proportion of time that people spend indoors at home, work, shopping, social events, sporting events, etc., and the multitude of potential indoor sources of PM. It is therefore likely the ambient PM exposure both on a 24-hour and annual basis will be dwarfed by indoor exposure.

The exposure assessment will also require extrapolation and interpolation of monitoring data in both space and time for various micro environments. For instance, a modeling-based algorithm will be applied in an attempt to model $PM_{2.5}$ in the vicinity of roadways and hourly outdoor concentrations may be estimated using diurnal profiles.

**6. C-R Functions to be Applied Ignore the Important Effects of $PM_{2.5}$ Speciation on Health Effects**

EPA has chosen not to address mounting epidemiological and toxicological evidence that airborne mass concentrations of $PM_{2.5}$ alone do account for the noted premature mortality effects, indicating that there is insufficient evidence to consider. This viewpoint differs from those of recent research such as published in "*The Role of Particle Composition on the Association Between $PM_{2.5}$ and Mortality" (*Meredith Franklin, Petros Koutrakis, and Joel Schwartz, Epidemiology • Volume 19, Number 5, September 2008), which indicates that "certain chemical species modify the association between $PM_{2.5}$ and mortality and…mass alone is not a sufficient metric when evaluating health effects of PM exposure." Airborne particulate matter is a complicated mixture of solid and liquid particles that vary

widely in characteristics such as size, surface area, chemical composition and toxicity. Treating all $PM_{2.5}$ as being equally problematic for human health is an unsupportable simplification that is inconsistent with many research findings on both individual and combined $PM_{2.5}$ components. Not fully considering this evidence could lead to ineffective PM reduction strategies that could lead to decreases of emissions for PM species that have little threat to human health, but do not address the PM species that are more important. No changes in the $PM_{2.5}$ NAAQS should be attempted until further evaluation of the effects of individual species to human health are considered and better understood. Speciated PM data from several urban-area supersites as well as rural sites such as IMPROVE sites could be used in this analysis.

## 7. Limited Sensitivity Study Proposed in Place of an Uncertainty Assessment will Not Provide Sufficient Information to Establish Risk-based Standards

Given the myriad sources of uncertainty in evaluating $PM_{2.5}$ exposure and risk, the uncertainty assessment should be viewed as an intrinsic component rather than an afterthought. Rather than a multivariate assessment of uncertainty, EPA is planning to conduct a much more limited sensitivity analysis of some of the important parameters. While such univariate assessments can provide some insight, it should only be used to help identify the key sources of uncertainty, not as a quantitative assessment. To more fully understand the magnitude of uncertainty, multivariate methods, e.g., Monte Carlo techniques, should be applied (e.g., see Hanna, S., R. Paine, D. Heinold, E. Kintigh, and D. Baker, 2007. *Uncertainties in Air Toxics Calculated by the Dispersion Models AERMOD and ISCST3 in the Houston Ship Channel Area*. Journal of Applied Meteorology and Climatology, Vol. 46, Iss. 9)

## 8. Conclusions

EPA's Scope and Methods Plans for Health Risk and Exposure Assessment is insufficient to fully and accurately characterize risk associated with ambient concentrations of particulate matter. Improvements in the following areas are especially needed in order for the REA to provide useful information in terms of considerations of the NAAQS for $PM_{2.5}$.

- Policy Relevant Background should be realistic rather than based on natural conditions that are inconsistent with human habitation, especially in urban areas.
- Alternative roll-back procedures using CMAQ should be reexamined to account for known model biases and limitations.
- Given the extremely high uncertainty, a National scale health impact assessment should not be undertaken.
- The exposure analysis should not be conducted unless indoor sources can be accurately addressed, since this component can be the most important contributor to health effects due to exposure to particulate matter.
- The application of C-R functions that do not account for speciation will mischaracterize $PM_{2.5}$ risk, possibly leading to the development of ineffective health standards.
- A more comprehensive uncertainty assessment is needed to inform the development of risk-based standards.